# UNIVERSITY OF ZULULAND

**Exploring the Role of Fiscal Policy and Sovereign Debt Shocks on Economic Growth among Southern African Developing Communities**


By

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# DECLARATION

I, **Bongumusa Prince Makhoba**, hereby declare that this thesis is my own original work, save for citation and referencing signify otherwise in the text. The thesis has not, and will not be in part or entirely, submitted for the award of any degree at any other university.

**Signature:** ........................______ **Date:** 15/02/2021_______

**Bongumusa Prince Makhoba**

## CERTIFICATE OF APPROVAL

I declare that this thesis is from the student's own original work and acknowledgements have been made through proper citations where other sources of information have been consulted. Therefore, this doctoral thesis is submitted with my approval.

**Signature: ___________________________** **Date: _____________________________**

**Professor I. Kaseeram**

**Signature: ___________________________** **Date: _____________________________**

**Professor L. Greyling**

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## PUBLICATION OF ARTICLES

The researcher(s) published five research articles in accredited peer-reviewed journals emanating from this doctoral thesis.

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# DEDICATION

To my parents, Ntombiyenkosi and Bhekizwe Mthembu,

and my daughter, Asanda Makhoba.

## ABSTRACT

Fiscal policy remains a key macroeconomic stabilisation mechanism at the disposal of governments and fiscal policymakers to influence economic activities consistent with balanced and sustainable economic growth. A thorough understanding of the role fiscal policy remains extremely paramount for fiscal authorities to consistently formulate prudent fiscal stimulus packages that enhances sustainable economic expansion. This thesis critically examines the role of fiscal policy and sovereign debt shocks on economic growth in the Southern African Developing Communities (SADC). Over the years, fiscal policy and austerity measures have triggered a deterioration in the fiscal position of these member countries primarily due to the relatively high budget deficits, inducing even further sovereign debt risk in long-term economic prosperity. The phenomenon of fiscal policy has gained immense scholarly popularity among both researchers and policymakers, stimulating intensive debate in the body of literature as to whether fiscal policy has been able stabilise macroeconomic fluctuations across different economies characterised by different phases of economic growth and development.

The study starts by giving a thorough background and introduction in Chapter 1. Chapter 2 discusses a detailed review of existing theoretical frameworks on the role of fiscal policy and sovereign debt on economic growth. Chapter 3 analyses the role of fiscal policy and sovereign debt shocks on economic growth in the SADC region. In this chapter, a Panel Vector Autoregressive (PVAR) model was estimated using annual data for 13 SADC countries ranging from 2000-2018. The empirical results revealed that government expenditure, employment and public debt has a significant positive influence on economic growth while gross fixed capital formation exerts a negative effect on growth. The findings of the study are consistent with the Keynesian school of thought, which strongly argues that governments use countercyclical expansionary fiscal policy as a credible tool to spur economic activities and stabilise macroeconomic fluctuations during different phases of the business cycle.

Chapter 4 estimates a Panel Smooth Transition Regression (PSTR) model to examine a nonlinear effect of public debt on economic growth among SADC members for the period

2000-2018. The findings show a significant asymmetric relationship between public debt and economic growth in the SADC region. The results further indicate a debt threshold of 60% at which public debt deters economic growth in SADC region. The empirical results of a linear and nonlinear effect of public debt on growth are consistent with several prior empirical studies conducted across different economies using different methodologies. In line with the Keynesian approach, the results further suggest that fiscal policy plays a central role in augmenting economic activities both in the low-debt regime and high-debt regime, indicating that, indeed, a positive shock in government spending positively influence economic growth in SADC economies, reinforcing the findings of the previous chapter. Furthermore, the results reveal a significant positive impact of public debt on economic growth during the low regime when the debt level is below the threshold of 60%. Moreover, there was a significant negative effect of debt on economic growth during the high-debt regime as debt level reach the threshold of 60%. This result indicates that there is an inverted U-Shape relationship between public debt and economic growth among SADC economies.

Chapter 5 empirically interrogates the asymmetric relationships between public debt and economic growth among selected emerging and frontier SADC economies over the period 2000-2018. In this chapter, a Smooth Transition Regression (STAR) and Nonlinear Autoregressive Redistributed Lag (NARDL) is estimated to analyse the asymmetric effect of public debt on economic growth among selected SADC economies. The results revealed mixed findings on nonlinearity among emerging and frontier SADC members. The findings indicate a concave relationship between debt and economic growth in South Africa, while Botswana, Namibia, Zambia and Zimbabwe showed a U-shape relationship between debt and economic growth. This implies that public debt exerts a significant positive influence on economic growth during low-debt regime while there is a negative effect of debt on economic growth during a high-debt regime in South Africa. Conversely, Botswana, Namibia, Zambia and Zimbabwe show a negative effect of debt during the low-debt regime and a positive influence during a high-debt regime. Malawi, however, showed a positive impact of debt on growth during both low-debt and high-debt regimes.

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## DEFINITION OF KEY TERMS

***Debt sustainability*:** Is the ability of the country to meet all its current and future payment obligations without exceptional financial assistance or default overtime.

***Fiscal fatigue*:** Occurs when a country that faces an increase in sovereign debt stops adjusting its primary balance when debt reaches a high level (Ghosh *et al*., 2013).

***Fiscal limits*:** Occurs when government is unable to react to a rise sovereign debt with further adjustment (Leeper, 2013).

***Fiscal policy*:** A government policy which focuses on the use of government spending and taxes to influence macroeconomic conditions, including aggregate demand for goods and services, employment, inflation, and economic growth.

***Fiscal sustainability*:** Is the ability of a government to sustain its current spending, taxes and other related policies in the long-run without threatening government solvency or defaulting its liabilities overtime.

***Gross fixed capital formation*:** Refers to the acquisition of assets, including production of such assets by producers for their own use, minus disposals.

***High debt regime*:** Is the period when public debt is high, essentially above sustainable threshold with high the possibility of sovereign insolvency.

***Low debt regime*:** Refers to the period when public debt is still low in the economy with no sovereign debt risk.

***Sovereign debt risk*:** Refers to the possibility that government would default on its sovereign debt by failing to repay its principal obligations or interest on loans.

## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ADF: | Augmented Dickey Fuller |
| ARDL: | Autoregressive Distributed Lag |
| BRICS: | Brazil, Russia, India, China and South Africa |
| CCR: | Canonical Cointegrating Regression |
| DOLS: | Dynamic Ordinary Least Squares |
| FE: | Fixed Effects |
| FMOLS: | Fully Modified Ordinary Least Squares |
| GDP: | Gross Domestic Product |
| IMF: | International Monetary Fund |
| NARDL: | Nonlinear Autoregressive Distributed Lag |
| OECD: | Organisation for Economic Cooperation and Development |
| OLS: | Ordinary Least Squares |
| PP: | Phillips-Perron Test |
| PSTR: | Panel Smooth Transition Regression |
| PVAR: | Panel Vector Autoregressive Model |
| RE: | Random Effects |
| SA: | South Africa |
| SSA: | Sub-Saharan Africa |
| SADC: | Southern African Developing Communities |
| SARB: | South African Reserve Bank |
| STAR: | Smooth Transition Regression |
| WDI: | World Development Indicators |

# CHAPTER ONE

# INTRODUCTION

## 1.1 BACKGROUND AND INTRODUCTION

Several classical economic theories argue that the primary objective of any national government is to advance a balanced national budget through fiscal sustainability. Fiscal policy refers to governments' prerogative to regulate the nature and size of government expenditure, revenues and borrowings aimed at pursuing specific economic objectives of the country. Generally, fiscal policy is used in conjunction with monetary policy in different combinations to address specific macroeconomic goals of the economy. This policy is a major macroeconomic stabilisation tool at the disposal of government to influence economic activities through its control over the size and structure of public finances (Rena and Kefela, 2011). Fiscal policy remains the most important component of a government's socio-economic policy to influence economic activities in an attempt to boost economic growth and development, employment, and alleviate poverty and inequality.

Public finances in the majority of SADC economies are inherently fragile primarily due to structural instabilities recorded during the period between 1960s to 1980s. These include sanctions, colonialism, the apartheid regime, and global economic developments which all destabilised vulnerable fiscal systems and prompted fiscal imbalances across African economies. Fiscal challenges in SADC economies are mainly driven by macroeconomic illness which include, but are not limited to, stagnant economic growth, high level of unemployment and poverty, income inequality and a weak domestic currency in many African economies. Hence, fiscal fragility remains formidable, exacerbated by narrow tax revenue base, bloated government expenditure and under-developed financial markets as major contributors for several African economies to rely on foreign borrowings to finance government expenditure (Black *et al.,* 2005). As a result, fiscal policymaking decisions would lead to fiscal deficits and subsequently, unprecedented level of sovereign indebtedness. This kind of fiscal position subsequently leads to economic downgrades by international rating agencies, reluctance on the part of investors and a loss in business confidence in the economy. Therefore, SADC economies ought to intensify the fight in dealing with macroeconomic challenges and public finance stability in order to fulfil the objective of sustainable fiscal policy in the region.

The South African National Development Plan (NDP) Vision 2030 (2012) stipulates that fiscal policy would be expected to play a central role in influencing the speed of growth in South Africa's economy and to further deal with other economic challenges that may arise over the next decades (NPC, 2011). The fiscal policy is further expected to address not only the issue of macroeconomic stability but also to steer economic expansion, create job opportunities, address income inequality and alleviate poverty (Chitiga *et al.,* 2015). According to Fourie and Burger (2010), fiscal policy refers to the use of government's budget instruments which include expenditure, taxes and borrowings by fiscal authorities to pursue particular fiscal objectives. The government uses fiscal policy to address macroeconomic objectives which include, but are not limited to, sustainable economic growth, poverty alleviation, job creation, price stability and redistribution of income (Maidi, 2013).

Keynes described fiscal policy as the steering wheel that drives aggregate demand in the economy. Keynes further posited that fiscal policy is not only about the allocation of scarce resources, but it is also more about bringing macroeconomic stability and certainty during different phases of the business cycle within the economy. In line with the Keynesian view, Budnevich (2002) asserted that the objective of fiscal policy is to promote the sustainability of public finances and consistently regulate aggregate demand in the economy. Gupta *et al.,* (2005) point out that the fiscal sustainability is in line with the Keynesian theory that requires fiscal policy to operate with fiscal surplus during economic upswings and full employment and allows for fiscal deficits during the economic downturn. A study carried out by Ocran (2011) on fiscal sustainability in South Africa contends that the role of fiscal policy is essential for spurring socio-economic development and growth by pursuing macroeconomic policies that foster a balance between sustainable expenditure, taxation and borrowings that are consistent with sustainable long-term economic growth.

The main objective of fiscal policy is to stabilise fluctuations in aggregate demand in the economy consistent with sustainable long-term economic growth, which is known as a countercyclical fiscal policy. Keynes suggested that fluctuations in the business cycles can be smoothed through discretionary fiscal policy activities (Black *et al.*, 2005). Maidi (2013) posited that the decision to pursue a particular fiscal policy stance largely depends on the business cycle at the time, and fiscal policy ought to have real effects on the economy either through the Keynesian or neoclassical effects. Carmignani (2010) argued that fiscal policy is at the centre of governments' responses to cyclical economic downturns or crises, and thus fiscal stimulus packages that are adopted by different countries ought to conform to the Keynesian prescriptions. The significance of fiscal policy became highly paramount after the emergence of the global financial crisis in 2008 as an expansionary and stabilisation mechanism for many governments with the aim of smoothing cyclical economic fluctuations across several economies. Rena and Kefela (2011) further contend that the global financial crisis in 2008 left several economies in severe recession that saw a number of fiscal authorities around the world employing expansionary fiscal policy mechanisms in attempt to rescue their respective economies.

The core function of public finance is to ensure a balanced allocation and redistribution of financial resources consistent with a balanced and sustainable economic growth. Blanchard (2010) stresses that the stabilisation function of public finance embodies the systematic use of government revenues and expenditures to influence economic policy that seeks to address macroeconomic objectives which includes, but is not limited to, achieving full employment, sustainable economic growth and a positive current account. This function is consistent with the Keynesian view, which advocates for an active stabilisation role of government expenditure to advance growth and development.

The accumulation of public debt may lead to a reduction in the fiscal space available for other important expenditures within the economy. A continuing rise of public indebtedness may further create an adverse cycle of higher borrowing costs and worsening fiscal balances. Vasishtha *et al.,* (2006) claimed that levels of public debt can impede economic growth because governments may formulate policies that crowd-out private sector borrowing in light of its own financial needs. The IMF (2018) pointed that developing countries may develop their fiscal space through different approaches: First, a proper collection and management of public revenues provides a good opportunity for countries to increase their fiscal reserves and reduce dependency on foreign loans. Second, the availability of debt financing and the willingness of investors to provide funding at reasonable borrowing costs may help determine the ability of countries to focus on fiscal priorities and infrastructural development. Lastly, ensuring a good management of public finances plays a central role in the development of fiscal space.

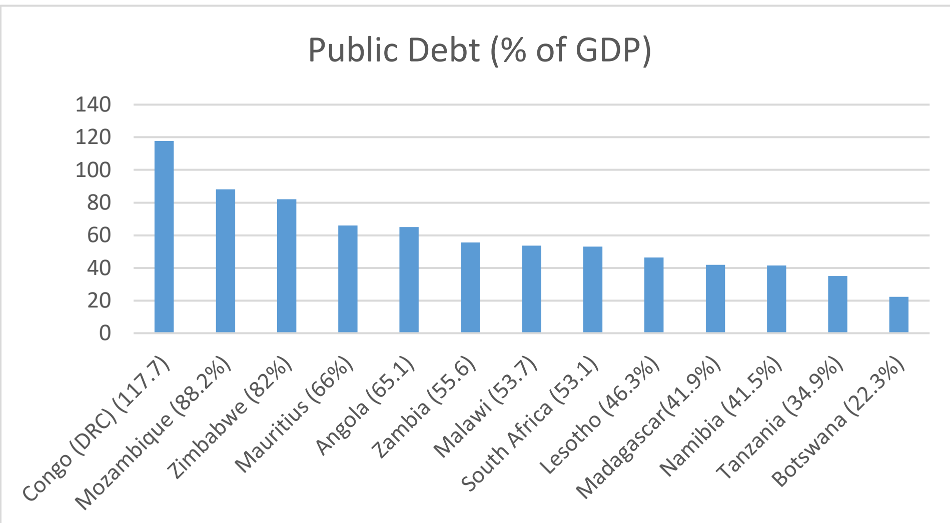
The SADC Treaty (1992) clearly states that the primary goal of the SADC is to promote equitable economic growth and socio-economic development through efficient and productive systems, deeper cooperation and integration, good governance and durable peace and security among its member states. The majority of SADC members are very fragile in terms of coordinating prudent fiscal policy and sustainable public finances. These developing economies need to work on addressing fiscal fragilities and promote fiscal sustainability in order to achieve sustainable economic growth. A continued failure to accurately manage public finances and accumulating public debt levels would ultimately deter expansionary objectives of the economy and weaken its ability to respond to future fiscal challenges and economic crises (IMF, 2018).

According to the IMF (2018), SADC economies can be categorised into four categories, viz., oil-exporting countries, middle-income countries, fragile countries, and non-fragile, low-income countries. Among SADC members, Angola remains the only oil-exporting country where oil, as an important export commodity, plays a vital role in driving economic development in the country. The middle-income countries (with reference to the World Bank's classification of economies by GDP per-capita and the level of institutional quality) include South Africa, Botswana, Lesotho, Mauritius, Namibia, Seychelles, Eswatini (formerly known as Swaziland) and Zambia. Meanwhile, fragile countries consist of those whose economies are largely influenced by non-economic events such as civil war, high levels of corruption and inequality, etc. These SADC countries comprise the likes of Zimbabwe and Democratic Republic of Congo (DRC). The non-fragile, low-income countries are those whose economic developments are attributed to more conventional economic factors. These countries are Madagascar, Malawi, Mozambique and Tanzania.

The SADC economies differ distinctly in terms of economic structure, production capacity and national income. The majority of SADC economies have a narrow production capacity that is more reliant on agricultural products (such as Madagascar, Malawi, and Tanzania).

Some members depend heavily on specific mineral resources (such as diamonds in Botswana and Namibia, copper in Zambia, and oil in Angola) while others rely on specific manufacturing industries (such as the textile industry in Mauritius, and the soft-drink industry in Eswatini). Among SADC members, South Africa, Mauritius and Botswana are further classified to have more developed economies compared to their counterparts in the region. Furthermore, Figure 1.1 below, with figures extracted from the World Bank (2018), clearly demonstrates that SADC economies differ distinctly in terms of public indebtedness, and ultimately GDP growth rate in the region.

**Figure 1.1: Public debt as a percentage of GDP in SADC**




*Source: Own computation, World Bank Data (2018)*

The expenditure pattern of these countries has been growing significantly over the past decades, leading to a significant rise in the public debt-to-GDP ratio of these countries as shown in Figure 1.1. The above diagram demonstrates that the DRC recorded the highest percentage of public debt to GDP (117.7%) while Botswana recorded the lowest public debt to GDP of 22.3%. The endogenous growth model pioneered by Romer (1986) and Barro (1990) advocates that a positive shock in public debt may have a positive influence on real economy if expenditure of such debt are channeled towards productive sectors such as infrastructure, education and technological advancement. In line with the endogenous growth model, Perlo-Freeman and Webber (2009) found that public debt would have a positive effect on long-term growth if public expenditure is directed towards productive sectors such as education and healthcare. Several advanced economies such as United States of America (USA), United Kingdom (UK) and Germany have a public debt-to-GDP ratio of more than 60%, but they remain economic giants in the world due to sound fiscal policy measures aimed at supporting and boosting sustainable long-term economic growth.

Among SADC members, South Africa remains the economic hub and a powerhouse of the African economy, and its fiscal policy has demonstrated successes over the years since the transition period in 1994. Du Plessis *et al.,* (2007) cautioned that South Africa's fiscal policy has been exceptional since 1994 in its effort to stabilise and promote growth in the economy after the period of transition. The major achievement of fiscal policy in the South African economy since the period of transition, among others, include the reduction of budget deficits, improved revenue collection system, improved infrastructure, and continuous efforts to ensure quality standard of living by providing basic social services.

The aftermath of the transition period required a well-coordinated effort between fiscal and monetary policies in the South African economy. The South African Reserve Bank (SARB) supported the economy by reducing interest rates, thereby boosting domestic aggregate demand, and subsequently, output growth. Spilimbergo *et al.,* (2008) contend that the role of monetary policy is to support fiscal stimulus policy by avoiding any possible increase in interest rates during economic downturn. According to Fofack (2010), the effectiveness of fiscal policy should be guided by the productivity of investments and efficiency. Furthermore, the South African fiscal policy trajectory was mainly driven by an increase in investment expenditure. Kandil (2006) asserts that for a country to maximise the effectiveness of fiscal policy, it needs to have a large marginal propensity to spend on domestic products and a small marginal propensity to spend on imported products.

Similar to other SADC members, over the last decade, South Africa's economy has been running a considerable fiscal deficit and government debt-to-GDP ratio of 53.10%, as of 2017. The public debt to GDP in South Africa has averaged to 39.45% from 2000 to 2017, with a record high of 53.10% in 2017 and a lowest record of 27.80 % in 2008 (National Treasury, 2018). The majority of developing economies have been characterised by a lack of fiscal discipline, leading to fiscal fragility and exposure to enormous financial risks imposed by negative fiscal shocks and global economic and financial crisis. The global financial crisis in 2008-2009 brought sufficient evidence of the harmful effects of excessive fiscal deficits and further left considerable strain on public finances across different economies. During economic crisis, fiscal expansionary policy remains the only credible macroeconomic stabilisation tool at the disposal of government to influence economic activities through an increase in public expenditure or reduction in taxes to revive and foster economic growth. Furthermore, it is only through the fiscal transmission mechanism, with the adoption of expansionary policy instruments, that it is possible for policymakers to attain full employment and optimal output during economic downturn (Blanchard, 2010).

Empirical studies on the role of fiscal policy on economic growth has gained prominence over the years. However, the majority of prior literature has been predominantly confined to advanced economies, thus leaving an empirical gap in literature from the perspective of developing economies, particularly SADC economies. Some previous studies conducted on the impact of fiscal policy on economic growth among others, include Lusinyan and Thornton (2009), who assessed the impact of fiscal policy on economic growth in South Africa; Oshikoya and Tarawalie (2010) examined fiscal sustainability among countries that forms part of West African Monetary Zone (WAMZ); Ocran (2011) studied fiscal sustainability in the South African economy; Ogbole, Amadi, and Essi (2011) investigated fiscal policy and economic growth in Nigeria; Oyeleke and Adebisi (2014) scrutinise fiscal policy sustainability in Ghana, and Jawadi *et al.,* (2016) analysed macroeconomic impact of fiscal and monetary policy shocks among BRICS economies.

Notwithstanding, intensive debate literature, the role of fiscal policy and sovereign debt shocks on economic growth, has not received adequate scholarly attention in the context of developing economies such as SADC, using advanced cutting-edge estimation techniques. Therefore, the current study empirically examines the role of fiscal policy and sovereign debt shocks on economic growth using various sophisticated estimation techniques which include a Panel Vector Autoregression (PVAR), Panel Smooth Transition Regression (PSTR) and Smooth Transition Regression (STAR) approach. The study employed a combination of panel and time series data for 13 SADC countries over the period 2000-2018. In line with the work of Ocran (2011) and Taylor *et al.,* (2011), the macroeconomic variables used to conduct empirical investigation are: Gross Domestic Product (GDP), government expenditure, public debt, employment and gross fixed capital formation. The estimation process of these models were carried out using STATA 15, RStudio and EViews 10 for empirical analysis.

## 1.2 PROBLEM STATEMENT

A study carried out by Ocran (2011) estimated a Vector Autoregression (VAR) model to scrutinise the role of fiscal policy measures, which include government expenditure, tax revenues, government gross fixed capital formation and budget deficit on economic growth in South Africa over the period 1990-2004. This study used a small sample size to assess possible long-run effects among the variables. Taylor *et al.,* (2011) employed a VAR model to examine the nexus between fiscal deficits, economic growth and government debt in the USA for the period 1961-2011. Ghosh *et al.,* (2013) investigated fiscal fatigue, fiscal space and debt sustainability using a panel data fixed effect for 23 advanced economies. Moreover, there are many arguments, contradictions and gaps in both theoretical and empirical literature on the relationship under investigation.

Henceforth, the study intends to provide robust empirical analysis on the interactions between fiscal policy, sovereign debt and growth in the context of the Southern African Developing Communities (SADC). While a considerable amount of literature has been confined in on advanced economies, only limited empirical studies have been conducted on the role of fiscal policy and sovereign debt on economic growth in developing economies. Among others, these studies include Oshikoya and Tarawalie (2010) who investigated fiscal sustainability in the West African Monetary Zone (WAMZ); Ocran (2011) in South Africa; Ogbole, Amadi, and Essi (2011) for Nigeria; Oyeleke and Adebisi (2014) examined fiscal policy sustainability in Ghana; and Jawadi *et al*., (2016) scrutinised macroeconomic impact of fiscal and monetary policy shocks among BRICS members.

Notwithstanding the importance of addressing unfavourable economic conditions and achieving economic integration among SADC members through the adoption of prudent macroeconomic policies in line with the common objective of achieving sustainable economic growth and development, the SADC region has received little scholarly attention on this contemporary issue. Furthermore, the aforementioned studies do not fully provide in-depth empirical analysis on the role of fiscal policy and sovereign debt on economic growth as well as the specific debt threshold at which excessive public debt compromise long-term economic growth. The current study seeks to contribute to the body of knowledge through providing robust empirical evidence that is SADC-specific for accurate policy analysis and relevance.

The primary aim and objectives of the study are achieved through the estimation various sophisticated estimation techniques which include a PVAR, PSTR, STAR and NARDL model using the panel data ranging from 2000-2018. The above-mentioned econometric methods are used to conduct policy analysis to understand how fiscal policy instruments interact, and what implications the degree of inertia in the structural model and in the policy design have for fiscal policy design. The previous empirical studies (see, for example, Ocran, (2011) and Jawadi *et al*., (2016) remain silent on whether fiscal policy provides a useful stabilisation effect as well as asymmetric effects of debt on growth, and debt threshold which could deteriorate economic growth. From what can be gathered in the body of literature, there is still a lack of consensus on the usefulness of fiscal policy to stabilise the economy and the extent to which fiscal policy affects economic activities.

The current study is distinct from prior empirical studies such as Ocran (2011) and Baaziz *et al*., (2015) due to the application of a more recent dataset and advanced econometric methodologies. There has been quite a number of empirical enquiries carried out on the role of fiscal policy on economic growth such as Lusinyan and Thornton (2009); Ocran (2011); Ghosh *et al.,* (2013); and Jawadi *et al.,* (2016), among others. However, there is still argument on the net change effects of government expenditure, taxes and debt on long-term economic growth, and thereby assist developing economies to formulate evidence-based fiscal policies aimed at pursuing sustainable economic growth. To the best of the researcher’s knowledge, there has been no study of this nature that has been conducted in the same region (SADC-specific) employing the methodological techniques that the current study proposes to apply. Therefore, the current study intends to fill the gap in literature by providing a rigorous empirical analysis on interrelationships between fiscal policy, sovereign debt and economic growth within the context of SADC economies.

## 1.3 RESEARCH AIMS

The primary aim of the study is to investigate the impact of fiscal policy and sovereign indebtedness on economic growth in the Southern African Developing Communities (SADC) using a combination of panel and time series data covering the period 2000-2018. Furthermore, the study explicitly analyses asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies. The study undertakes this empirical analysis using fiscal policy instruments which include government expenditure, gross fixed capital formation, employment, public debt and gross domestic product (GDP). The study employed a Panel Vector Autoregressive (PVAR) to investigate the role of fiscal policy and sovereign debt on economic growth in SADC over the period 2000-2018. To examine asymmetric effects of public debt on economic growth, the study estimates a Panel Smooth Transition Regression (PSTR) model. Moreover, the study further estimates a Smooth Transition Regression (STAR) and Nonlinear Autoregressive Distributed Lag (NARDL) technique to analyse asymmetric relationships between public debt and economic growth among selected emerging and frontier SADC economies.

## 1.4 RESEARCH OBJECTIVES

The primary aim of the study was accomplished through the following specific objectives:

- To empirically investigate the role of fiscal policy and sovereign indebtedness on economic growth among SADC economies.
- To critically analyse the nonlinear effects of public debt on economic growth and the debt threshold at which public debt stifles economic growth in SADC region.

- To examine asymmetric relationships between public debt and economic growth among selected emerging and frontier SADC members.
- To analyse asymmetric effects of public debt on economic growth in South Africa.

## 1.5 RESEARCH HYPOTHESES

The following research hypotheses are centered around the main objectives of the study to fulfil the primary aim of the study:

- Hypothesis 1: There is a significant positive influence of fiscal policy and sovereign debt on economic growth among SADC economies.
- Hypothesis 2: There is a significant nonlinear effect of public debt on economic growth in SADC region.
- Hypothesis 3: There are significant asymmetric relationships between public debt and economic growth among selected emerging and frontier SADC members.
- Hypothesis 4: There are significant asymmetric effects of public debt on economic growth in South Africa.

## 1.6 SIGNIFICANCE OF THE STUDY

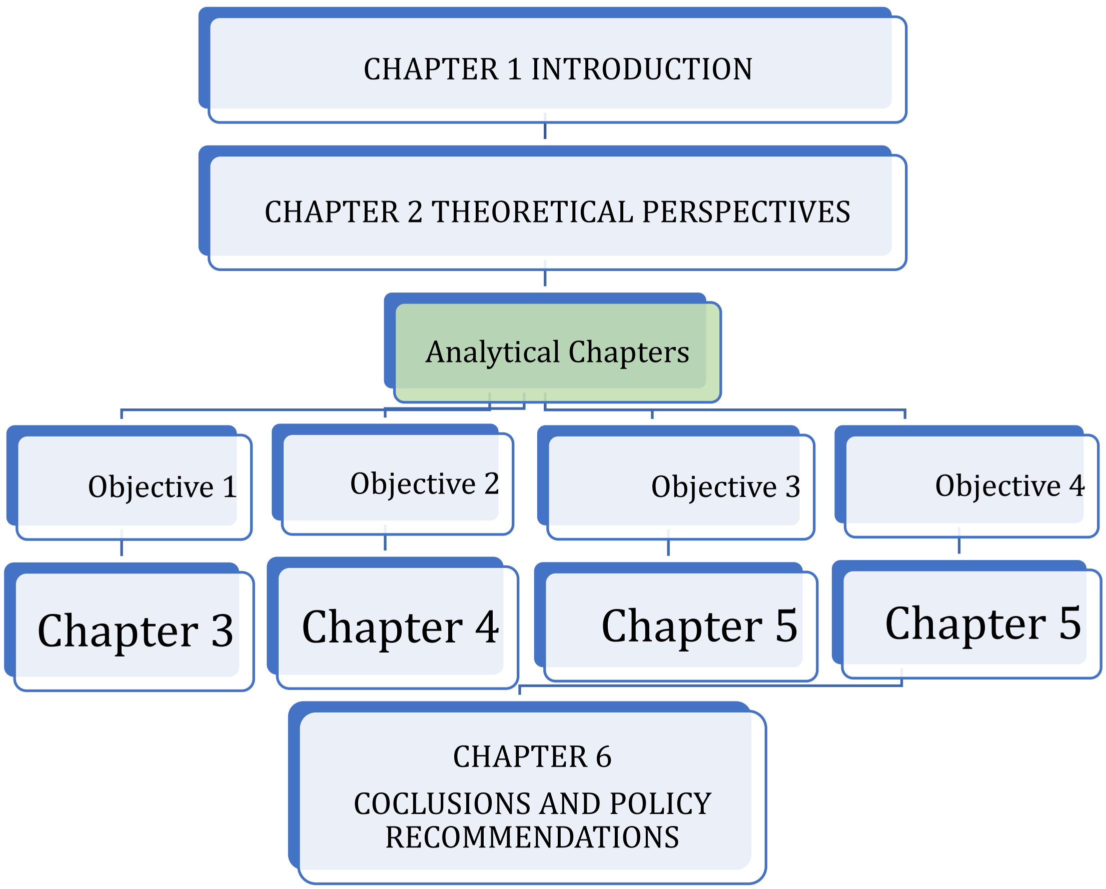
The current study aims to extend the body knowledge through the provision of empirical evidence on the impact of fiscal policy and sovereign indebtedness on real economic performance in the SADC region. The findings of the study ought to be valuable to the fiscal authorities in exploring the usefulness of fiscal expansionary policies to augment economic activities, and to curb public debt within a sustainable threshold that would promote long-term economic growth in SADC economies. The correct application of robust econometric analysis on the impact of fiscal policy and public indebtedness on economic growth dynamics would ensure a better understanding of fiscal policy interaction with other crucial macroeconomic variables among SADC members. The empirical findings of the study ought to be useful to SADC members in advancing their common macroeconomic economic objectives and economic prosperity, especially regarding the furtherance of the goal of one day having a Southern African Economic Union not dissimilar from the European Union.

As mentioned earlier, the study contributes to the body of knowledge through assessing this relationship using various sophisticated estimation techniques which include the PVAR, PSTR, STAR and NARDL methodology. The study undertakes this empirical investigation on this relationship from SADC perspective of which a majority of previous studies examining this relationship has been confined out within the context of advanced economies. From what can be gathered in literature, there is no scientific study of this nature that has been conducted in the SADC region using advanced estimation tools employed in the current study, i.e. a PVAR, PSTR, STAR or NARDL technique. The accurate estimation of advanced econometric techniques ought to assist SADC members to better understand their economic stance within a panel framework. The empirical findings ought to be legitimate and statistically reliable due to the application of recent datasets and rigorous cutting-edge methodological techniques. Furthermore, the findings of the study ought to be valuable to other researcher and policymakers whose research interest is vested and confined in the same subject matter.

## 1.7 STRUCTURE OF THE STUDY

Further to the introductory chapter, the rest of the study proceed with the following chapters: Chapter 2 provide an extensive review of theoretical and conceptual literature on the relationship between fiscal policy, sovereign debt and economic growth. Chapter 3 investigates the impact of fiscal policy and sovereign debt on economic growth in SADC economies. Whereas Chapter 4 examines the nonlinear relationships between public debt and economic growth in SADC region. Chapter 5 analyse asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies. Chapter 6 provides a summary of the study, conclusions, and policy recommendations from the overall empirical findings of the study.

**Figure 1.2: Schematic Structure of the Thesis**




*Source: Researcher's own computation*

# CHAPTER TWO

# THEORETICAL AND CONCEPTUAL PERSPECTIVES

## 2.1 INTRODUCTION

This chapter discusses the theoretical foundations which underpins existing relationships between fiscal policy, public debt and economic growth. Several theoretical frameworks assessing the impact of fiscal policy and government debt on growth argue for the existence of a positive effect of fiscal policy and sovereign debt on the real economy. Reem (2009) contends that fiscal policy is based on the Keynesian perspective, which assumes that the government uses spending to influence macroeconomic fluctuations through continuous adjustment of government expenditure and taxes consistent with increased economic activities. This process translates to the creation of jobs, low inflation, a reduction of income inequality and ultimately promotes sustainable economic growth. The Keynesian approach believes in active countercyclical fiscal policy, while new classical economists argue that fiscal austerity measures exacerbate soaring fiscal deficits. The classical economic theory asserts that the primary objective of the government is to ensure a balanced budget for healthy public finances. This assertion is known as the 'Treasury view' which claims that fluctuations in expenditure have no effect on real economic growth (De Long, 1998).

The intuition behind the 'Treasury view' is that a rise in government spending is entirely offset by a reduction in private consumption by the same amount. This assumption is consistent with the classical economic theory which contends that there is an invisible hand that continuously adjusts the economy to the state of full employment. Henceforth, the 'Treasury view' insinuates that government intervention to influence economic activities through increasing government expenditure is entirely unnecessary and can even be detrimental to the economy. Cruz-Rodriguez (2014) suggests that fiscal sustainability is all about the implementation of government policies that do not threaten the current and future solvency of a country. Adams *et al.* (2010) posit that solvency requires that both current and future expenditures and revenues are balanced and reduced to a common denominator to ensure that government has the financial capacity to service its long-term debt without default over-time. This chapter reviews conventional theoretical frameworks on the existing relationship between fiscal policy, sovereign debt and economic growth. Moreover, the chapter provides robust theoretical understanding and arguments in literature underpinning the interrelationships thereof, with relevance to SADC economies.

Section 2.2 unpacks the chronological development of fiscal policy and economic growth among SADC economies. Section 2.3 discusses the relevance of the Keynesian approach on fiscal policy and economic growth in the SADC region. Section 2.4 presents the relevance of the neoclassical theory on fiscal policy in SADC, and thereafter section 2.5 provides an analysis of the IS-LM Model on fiscal policy and output growth. In section 2.6, the study discusses Wagner's law on fiscal policy and economic growth, followed by the analysis of the Endogenous growth model in Section 2.7. Section 2.8 reviews sovereign debt sustainability in the SADC region, while Section 2.9 provides an analysis of the Solow growth model from the SADC context. Section 2.10 discusses the Ricardian equivalence theorem perspective in SADC region. Finally, Section 2.11 provides concluding remarks on the underlying theoretical perspectives.

## 2.2 CHRONOLOGICAL DEVELOPMENT OF FISCAL POLICY IN SADC ECONOMIES

### 2.2.1 An Overview of SADC Economies

The Southern African Development Community (SADC) was initially established in 1980 as a development coordinating conference of Southern African countries (SADCC) and later transformed into a development community in 1992 by its fifteen Southern African Member States. The SADCC was established to advance the agenda of national political liberation in Southern Africa and to reduce dependence particularly on the then non-democratic South Africa. This was to be achieved through effective coordination of the specific characteristics and strengths of each country and its resources with the main focus on regional integration and economic development. The SADC member States are: Angola, Botswana, Comoros, Democratic Republic of the Congo (DRC), Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe.

The SADCC was transformed into the SADC in 1992, which was established as an inter-governmental organisation with the primary objective of promoting sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper co-operation and integration, good governance and durable peace and security among its member State. Fiscal policy plays a crucial role in ensuring that regional integration and economic development is achieved among SADC member countries. The majority of SADC members are characterised by fiscal fragility to initiate prudent fiscal policies. The SADC need to actively address these fiscal fragilities in line with their central objective of promoting sustainable economic growth in the region. The IMF (2018) pointed out that a continuous failure to accurately manage public finances would continuously hamper economic expansion and weakens the ability of fiscal policy to respond to future fiscal challenges and economic crises.

As previously mentioned, IMF (2018) contends that SADC economies can be classified into four different categories, namely, oil-exporting countries, middle-income countries, fragile countries, and non-fragile low-income countries. Angola is the only oil-exporting nations in SADC where oil is the most crucial export commodity playing an important role on economic development. The World Bank classifies middle-income countries using *per-capita* GDP and the level of institutional quality, and these SADC countries are: South Africa, Botswana, Eswatini, Lesotho, Mauritius, Namibia, Seychelles and Zambia. The IMF (2018) further classify fragile economies as countries whose economies are largely influenced by non-economic events such as civil war, political instability and riots, high corruption level, inequality etc. Among SADC members, these countries comprise of Zimbabwe and Democratic Republic of Congo. The non-fragile low-income countries are classified as countries whose economic developments are attributable to conventional economic factors, and such SADC countries currently comprise of Madagascar, Malawi, Mozambique, and Tanzania.

Over the years, the overall fiscal balance in the SADC has improved owing to increased regional integration and co-operation with the aim of advancing their common macroeconomic objectives. Table 2.1 below shows records of significant improvement of fiscal balance among SADC members over the years owing to stronger co-operation and regional integration.

**Table 2.1: SADC Fiscal Surpluses/Deficits**

| Country | 2005 | 2010 | 2015 | 2019 |
|---|---|---|---|---|
| Angola | 9.4 | 3.4 | -3.3 | -2.2 |
| Botswana | 10.2 | -7.9 | -4.6 | 1.1 |
| DR Congo | 0.8 | -0.9 | -0.2 | 0.1 |
| Lesotho | 3.5 | -3.8 | -1.0 | -4.9 |
| Malawi | -1.9 | 1.8 | -6.2 | -3.7 |
| Mauritius | -4.4 | -3.3 | -3.5 | -3.3 |
| Mozambique | -2.4 | -3.8 | -7.2 | -10.9 |
| Namibia | -0.5 | -4.6 | -8.2 | -9.5 |
| Seychelles | 0.4 | 0.5 | 1.9 | 1.1 |
| South Africa | -0.1 | -5.0 | -4.8 | -4.1 |
| Eswatini | -1.6 | -8.9 | -4.5 | -5.9 |
| Tanzania | -3.3 | -4.8 | -3.3 | -4.6 |
| Zambia | -2.4 | -2.4 | -9.3 | -7.4 |
| Zimbabwe | -6.3 | 0.7 | -0.9 | -1.9 |
| **SADC Average** | **0.1** | **-2.8** | **-3.9** | **-4.0** |

*Source: International Monetary Fund (2019)*

The above Table 2.1 demonstrates the fiscal balance figures recorded by SADC member countries over the years computed as the percentage of government revenue to GDP minus government expenditure as a percentage of GDP. After the global financial crisis in 2008, a number of countries experienced budgetary issues which saw a reduction in their budget surpluses. Others went as far as to record soaring budget deficits, an effect that still persists to date. Interestingly, countries such as Angola, the DRC and Malawi recorded budget surpluses in 2010. In 2010, only two member countries recorded budget deficits greater than 5% of GDP. The number of SADC countries with budget deficits above the 5% macroeconomic convergence target rose to four in 2015 and 2019. This implies that the SADC region has done well in its effort to reduce budget deficits to remain within its macroeconomic convergence target band of 5% of GDP.

Despite the overall decline of fiscal health in SADC economies, the SADC region has been able to attain its target band with a budget deficit of 2.8% in 2010, 3.9% in 2015 and 4% in 2019. This fiscal position remains plausible compared to other developing regional economic communities in the African continent, such as the East African Community (EAC) and the Common Market for Eastern and Southern Africa (COMESA), which have recorded unsatisfactory fiscal balances since the emergence of the global financial crisis in 2008.

Interestingly, Angola recorded the highest budget surplus between the period 2005 and 2010 in the SADC. In 2019, only Botswana, the DRC and Seychelles were able to run a budget surplus. On the other hand, Mozambique, Namibia, Eswatini and Zambia recorded the highest soaring fiscal deficit between 2015 and 2019. These member countries recorded a significantly higher than expected fiscal balance outside the SADC macroeconomic targets. Fiscal woes in Eswatini were largely influenced by a significant decline in Southern African Custom Union (SACU) revenue. On the other hand, the Tanzanian government aggressively pursued expansionary fiscal policy to finance infrastructural development in the country. Namibia's fiscal position was largely affected by the Targeted Intervention Program for Employment and Economic Growth (TIPEEG). The Namibian government adopted this policy to improve employment and economic growth in the country (Pillay and Dlamini, 2012).

The protocol on finance and investment on macroeconomic convergence in the region maintains that the SADC aims to promote a prudent fiscal position by keeping budget deficits within macroeconomic convergence targets and avoiding high public debt-to-GDP ratios among SADC economies. According to this protocol, SADC member countries use their annual fiscal balances computed as a ratio of budget deficit to GDP as a key economic indicator to measure macroeconomic health status in the region.

Over the years, the SADC has been able to maintain a sustainable fiscal balance through effective policies implemented to promote macroeconomic stability in line with their microeconomic convergence targets in the region. The protocol on finance and investment set out deficit targets for SADC members. This was to achieve the budget deficit to GDP ratio of less than 5% in 2008, and with the expectations for this ratio to fall to less than 3% by 2012. This was to be maintained through 2018 (SADC Treaty of 1992). However, the global economic crisis of 2008 came as an unanticipated shock and heavily affected SADC economies, and the global economy in general which saw instability in public finances translating to a shrink in budget deficits and economic downturn in several economies.

**Table 2.2: Government Gross Debt (Percent of GDP) in SADC Region**

| Country | 2005 | 2010 | 2015 | 2019 |
|---|---|---|---|---|
| Angola | 35.7 | 44.3 | 64.6 | 71.6 |
| Botswana | 7.4 | 20.4 | 16.3 | 12.8 |
| DR Congo | 101.5 | 30.9 | 16.1 | 13.3 |
| Lesotho | 48.7 | 31.4 | 41.2 | 41.7 |
| Malawi | 106.6 | 29.6 | 61.1 | 57.6 |
| Mauritius | 50.6 | 52 | 60.2 | 59.1 |
| Mozambique | 70.2 | 43.3 | 88.1 | 116.6 |
| Namibia | 27.1 | 16.3 | 40.3 | 58.5 |
| Seychelles | 144 | 82.2 | 68 | 53.7 |
| South Africa | 33.2 | 34.7 | 49.3 | 55.7 |
| Eswatini | 12.9 | 13.7 | 18.4 | 40.9 |
| Tanzania | 46.8 | 27.3 | 37.4 | 40.7 |
| Zambia | 75.7 | 18.9 | 62.3 | 68 |
| Zimbabwe | 32.2 | 59.3 | 51.9 | 72.6 |
| **SADC Average** | **57.0** | **36.0** | **48.2** | **54.5** |

*Source: International Monetary Fund (2019)*

The SADC member countries were able to achieve their macroeconomic convergence target of less than 60% of GDP except for Angola, Mozambique, Zambia and Zimbabwe. The higher public debt-to-GDP ratio in some of these member countries may be attributed to poor economic performance over recent years. The Seychelles recorded the highest public debt-to-GDP ratio prior to 2010 due to high government deficits before the IMF reform programme in 2008 (Pillay and Dlamini, 2012). Interestingly, the majority of SADC members have been able to limit their government debt ratio to GDP within the 60% macroeconomic convergence target.

In 2010, the SADC recorded the all-time low average debt-to-GDP ratio of 36%, down from 57% in 2005. The SADC economies saw a sharp increase in government debt to an average of 48.2% in 2015 probably due to fiscal adjustments through borrowings following the global financial crisis in 2009. The government debt-to-GDP ratio continued to rise in 2019, reaching an average of 54.5%. This drastic increase in government debt is anticipated to be sustained in the coming years due to the emergence of Covid-19, which brought the global economy to a standstill. This has caused severe economic damage in the global economy as one of the greatest economic crises in the 21st century.

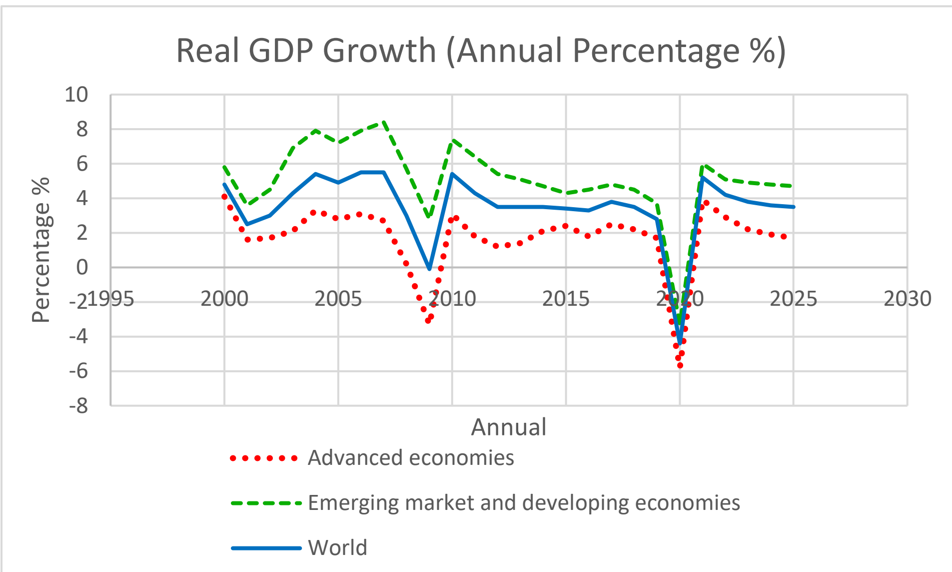
**Table 2.3: GDP Growth Rate (Annual %) in SADC Region**

| Country | 2005 | 2010 | 2015 | 2019 |
|---|---|---|---|---|
| Angola | 15.0 | 4.9 | 0.9 | -0.9 |
| Botswana | 4.6 | 8.6 | -1.7 | 2.9 |
| DR Congo | 6.1 | 7.1 | 6.9 | 4.4 |
| Lesotho | 3.5 | 0.8 | 2.7 | 1.5 |
| Madagascar | 4.8 | 0.6 | 3.1 | 4.8 |
| Malawi | 3.3 | 6.9 | 2.8 | 4.4 |
| Mauritius | 1.8 | 4.4 | 3.6 | 3.6 |
| Mozambique | 6.6 | 6.5 | 6.7 | 2.2 |
| Namibia | 2.5 | 6.0 | 4.5 | -1.1 |
| Seychelles | 9.0 | 5.9 | 4.9 | 4.7 |
| South Africa | 5.3 | 3.0 | 1.2 | 0.2 |
| Eswatini | 5.9 | 3.8 | 2.3 | 2.0 |
| Tanzania | 7.5 | 6.3 | 6.2 | 5.8 |
| Zambia | 7.2 | 10.3 | 2.9 | 1.7 |
| Zimbabwe | -5.7 | 19.7 | 1.8 | -8.1 |
| **SADC Average** | **5.2** | **6.3** | **3.3** | **1.9** |

*Source: World Development Indicators (2019)*

The SADC region was able to attain their macroeconomic convergence target with the average GDP growth rate of 6.3% in 2010, up from 5.2% in 2005. In 2015, the region failed to maintain their target with the average of 3.3% growth rate. The economic woes in the region continue to persist with the average GDP growth rate oscillating between 1% and 3% in the previous decade. The SADC region recorded the all-time low average GDP growth rate in 2019 with the regional economy expanding by only 1.9%. A significant economic slowdown was recorded in Angola, Botswana, South Africa and Zimbabwe as the real GDP growth kept on declining in last decade. Angola, Namibia and Zimbabwe are the only member countries that recorded a negative GDP growth in 2019. Member countries which include Seychelles, Tanzania and the DRC remain consistent in maintaining exceptional economic performance as compared to other member States in the region and is likely to be sustained in the coming years. Figure 2.1 below demonstrates global real GDP growth rate as well as figures anticipated by the IMF in the next five years for the global economy.

**Figure 2.1: The Overview of Global Real GDP Growth**




*Source: IMF, World Economic Outlook (2020)*

Figure 2.1 with real GDP growth rates from IMF (2020) demonstrates that over the years, several countries classified as part of emerging markets and developing economies have been enjoying a considerable real GDP growth rate as compared to advanced economies. The scourge of Covid-19 as an economic crisis is expected to be extremely harmful to the global economy far more than the global financial crisis of 2009. This is mainly due to stringent lockdown regulations imposed by several countries during the Covid-19 pandemic which brought the global economy to a standstill. These measures prevent international trade from taking place, leading to job losses in key sectors of the economy across different countries. However, IMF forecasts reveal a significant global economic recovery in the coming years with the global real GDP expected to grow by more than 5%. This economic prosperity is more likely to be sustained going forward.

After emergence global financial crisis in 2009, the global economic growth rebounded considerably from -0.5% in 2009 to above 5% in 2010, although economic conditions varied significantly across different countries of the world. This global economic recovery was informed by several special interventions mainly through special drawing right (SDR) by the IMF, tight legislative and regulatory interventions, relaxation of interest rates and quantitative easing across different countries. These stimulative measures contributed immensely to the improvement of global economic and financial conditions, and further translated to a fast-paced economic growth in the majority of emerging markets and developing economies (RBZ, 2011).

Following the emergence of Covid-19, growth of over 5% is projected for the global economy in 2021. Furthermore, the economic growth momentum is expected to be sustained from 2021-2025, driven by strong potential growth in emerging and developing economies and relatively accommodative macroeconomic conditions. The growth of emerging markets and developing economies is projected to accelerate above the global economy with an average of 5% during the period 2021-2025 following economic slowdown in 2020 due to the Covid-19 pandemic. However, it is important to note that some countries might be constrained by large fiscal or current account imbalances.

SADC members are classified as emerging markets and developing economies, and the above information displayed in Figure 2.1 shows that the economic performance of these countries have been at a peak in the past decades. This economic prosperity is expected to be sustained in future. However, economic activities in the SADC are still weighed down by risks emanating from energy constraints, infrastructural bottlenecks, the slow pace of industrialisation, high dependence on primary commodities, relatively underdeveloped financial markets, subdued foreign direct investment flows and the relatively high costs of doing business (RBZ, 2011). Furthermore, SADC economies remain susceptible to external shocks such as sharp increases in food and fuel prices. These price shocks are likely to lead to higher inflation in most countries and further deteriorate current account deficits in the number of fuel-importing countries.

## 2.3 THE KEYNESIAN APPROACH ON FISCAL POLICY

This section provides an overview of the theoretical relevance of the Keynesian (1936) model on the role of fiscal policy in economic expansion in SADC region. Several previous studies such as Perlo-Freeman and Webber (2009) and Teles and Mussolini (2014) have argued that government expenditure plays a crucial role in economic expansion if such expenditures are channelled towards growth-stimulating sectors. This is where the divergence lies between advanced and developing countries including SADC economies as it relates to the accurate allocation of government expenditure towards productive sectors. This assertion is in line with the Keynesian school of thought. Keynes (1936) formulated a ground-breaking theoretical framework which postulates that fiscal policy plays a stimulative role on the economy when aggregate demand is inadequate (Cammarosano, 2016). The Keynesian approach to fiscal policy points out that economic slumps are not self-correcting since there could be deficiencies in aggregate demand that may lead to excess capacity. This may render monetary policy inefficient to deal with cyclical fluctuations in the business cycle.

The Keynesian approach maintains that fiscal policy ought to play a critical active role in stabilising the economy through expansionary and contractionary effects on aggregate demand to influence economic activities. According to Keynes, expansionary policy occurs when governments increase public spending or reduce taxes and thereby stimulate aggregate demand in the economy. This expansionary process eventually leads to an increase in the level of production, creating jobs and ultimately improving output growth. Conversely, contractionary effects occur when the government cuts expenditure or increases taxes to absorb pressure and slow down the over-heating economy. Contractionary intervention usually occurs when policymakers intend to control high inflation by reducing the amount of money available in circulation in the system, and thereby by reduce aggregate demand and spending, and subsequently release pressure on current prices. Both expansionary and contractionary interventions by government holds for SADC member states as part of their effort to drive aggregate demand and stabilise economic fluctuations. However, the major public outcry in the majority of SADC member countries over the years have been the high levels of corruption by government authorities which directly deters the any significant effort to bring economic prosperity consistent with high levels of employment, poverty alleviation and equitable distribution of income.

In a nutshell, the Keynesian theory posits that the reason for fiscal change is to alter the aggregate demand consistent with sustainable growth. Blanchard (2010) asserts that a tax reduction leads to an increase in consumer’s disposable income, *ceteris paribus*. An increase in consumers’ income lead to a rise in consumption expenditure which translate to an increase in aggregate demand, and subsequently result in full employment and output growth. Consistent with the Keynesian view, Morabe (2008) pointed out that expansionary fiscal policy occurs when the government increases expenditure or reduces taxes with the belief that the economy is not growing as expected or the unemployment rate is too high. Conversely, contractionary fiscal policy is a tight fiscal policy that is most likely to occur during periods of high inflation. Such policies intend to restrict the amount of money in circulation, thereby reducing consumption spending and aggregate demand, and subsequently reducing pressure on general prices. Basic (2007) asserted that an increase in government spending leads to expansion in the economy.

Arguing along the Keynesian theory, Bank (2011) and Mathewos (2015) asserted that a rise in government expenditure accompanied by tax cuts lead to an increase in the real wage and private sector consumption, and ultimately an increase in aggregate demand. The Keynesian approach to fiscal policy insinuates that the business cycle requires fiscal policymakers to employ countercyclical expansionary policy during economic downturns, and contractionary policy during economic upswings (Woo, 2009). The National Treasury (2010) points out that countercyclical fiscal policies enable governments to respond flexibly to various economic shocks, which involve adjusting fiscal deficits during different phases of the business cycles, thereby allowing for more fiscal space for other instrumental economic activities. However, countercyclical fiscal policy remains a major concern for the majority of SADC member countries. Most of these countries are characterised by high level of fiscal deficits and public debt and low levels of employment and growth. They remain fragile to global economic crises, which make it more difficult for countercyclical fiscal policy to function effectively without increasing government debt.

Carmignani (2010) contends that if fiscal policy conforms to the Keynesian prescriptions, fiscal policy instruments should be used as countercyclical mechanisms to stabilise fluctuations in the business cycle. On the other hand, consistent with the neoclassical view, Carmignani (2010) stresses that if expansionary fiscal policy leads to contraction, the intended countercyclical response would exacerbate economic fluctuations and destabilise the whole economy. However, both Keynesian and Neoclassical theories maintain that fiscal policy ought to respond countercyclically to economic fluctuations. According to the Keynesian theory, fiscal policy operates through various components of domestic aggregate demand, which include government and private sector consumption, and fixed capital formation (Siebrits and Calitz, 2001). The fiscal transmission mechanism within the Keynesian framework aims to fosters private investment by sustaining domestic expenditure through aggregate demand. The majority of middle-income SADC member countries have been able to promote investments. However, these investments have proved over time that they are not associated with long-term employment and economic growth.

According to Swanepoel and Schoeman (2003), unemployment insurance pay-outs by government serves as automatic stabilisers since unemployment trends tends to follow fluctuations of the business cycle. The total unemployment insurance payments increase during the economic downturn and decreases during economic boom, and contributions towards unemployment insurance premiums are adjusted accordingly. These automatic stabilisers through spending and taxes to influence aggregate demand are also valid for SADC countries and other countries in general. This process is known as the Keynesian fiscal transmission mechanism. Several developed countries tend to direct a substantial portion of government expenditure towards growth-stimulating sectors while developing economies on the other hand (including SADC countries) usually tend to direct the majority of government expenditure towards social consumption such as social security, aids, education, healthcare, protection and safety. The assumptions of the Keynesian school of thought seems to hold for several countries including advanced and developing countries. However, the following chapter intends to provide empirical evidence to determine the validity of the Keynesian view within the SADC context, and thereby contributing to the body of literature with robust findings for policy implications.

### 2.3.1 The Keynesian Expenditure Model

As previously stated, Keynesian economists argue that fiscal policy is a powerful mechanism used to stabilise economic fluctuations since the effect of increased expenditure or tax reduction would be multiplied by stimulating additional demand for consumption of goods by households. Keynes argue that economic growth is mainly determined by changes in aggregate demand in the economy. The components of aggregate demand are consumption (C), investments (I), government purchases (G) and net exports (X). The aggregate demand (AD) equation can be expressed follows:

$$AD = C + I + G + X \tag{2.1}$$

The Keynesian model assumes that aggregate supply (AS) is equal to the actual value of GDP, $AS = GDP$. At the equilibrium, aggregate demand equal to aggregate supply, therefore, this yields:

$$GDP = C + I + G + X \tag{2.2}$$

This equation (2.2) is well-known as it gives an idea of how GDP is determined within the Keynesian context through aggregate demand from four different sectors of the economy. The consumption component of aggregate demand can be expressed as a function of disposable income (Y), as demonstrated in the following equation:

$$Y = GDP - T \tag{2.3}$$

The above equation represents the simple Keynesian model, which treats taxes (T) as a lump sum value rather than as a function of GDP. However, a sophisticated model would allow taxes to be used as a function of GDP to analyse the effect of changes in taxes. Therefore, this would give us the following consumption function:

$$C = a + b \cdot Y = a + b \cdot (GDP - T) \tag{2.4}$$

From the above consumption function (2.4), we substitute consumption (C) with GDP and obtain the following equation:

$$GDP = a + b \cdot (GDP - T) + I + G + X \tag{2.5}$$

Furthermore, we solve for GDP from equation (2.5) and obtain the following equation:

$$GDP = \frac{1}{(1+b)} \cdot [a + I + G + X] - \frac{b}{(1-b)} \cdot T \qquad (2.6)$$

According to the Keynesian assumptions, equation (2.6) shows how GDP respond to a change in autonomous components of spending that does not depend on GDP. The above equation shows that a one percentage change in either a, I, G, or X lead to a 1/(1-b) change in GDP. However, this is the spending multiplier that applies to any increase in spending by any sector of the economy. Moreover, the tax cut multiplier is b/(1-b), where a tax cut is a negative increase in taxes, demonstrating the effect of tax reduction. Keynes posits that a government must be able to manage employment and growth by constantly adjusting the level of aggregate demand using countercyclical fiscal policy. The fiscal transmission mechanism is also valid for the majority of SADC members. However, these economies enjoy little multiplier effects due to lower level of employment and economic growth, which may render stimulus fiscus inefficient for the majority of its people.

## 2.4 THE NEOCLASSICAL THEORY ON FISCAL POLICY

The neoclassical approach argues that fiscal policy remains sustainable over time if public debt-to-GDP ratio is stable over the medium to long-term period. The neoclassical prescription claims that if a country has a real interest rate that exceeds the real economic growth rate, all coupled with a fiscal deficit, the fiscal position of such economy is unsustainable to achieve long-term economic growth (Fourie and Burger, 2003). Most of SADC member countries have real interest rates that are much higher than real GDP growth, with substantial budget deficit on fiscus. According to neoclassical principles, such SADC countries have unsustainable fiscal policy, and as a result they are most likely to encounter economic challenges to respond to possible future economic shocks.

International investors and credit-rating agencies normally use the neoclassical prescriptions to assess sovereign risks and creditworthiness. As previously mentioned, neoclassical prescriptions suggest that fiscal policy is sustainable if the public debt-to-GDP ratio remain stable overtime. The neoclassical theory proposes that the government should run a sufficient primary surplus in the medium to long-term if the real interest rate exceeds the real GDP growth rate to achieve sustainable fiscal policy (Fourie and Burger, 2003; Maidi, 2013). According to Basic (2007), the neoclassical theory posits that an expansionary fiscal policy lead to a decrease in economic activities, and thus results in a decline in overall output and inflation. The logic is that a 1% rise in in government expenditure is offset by a 1% reduction in private investment consumption. Ocran (2011) notes that a decline in private investment as a result of expansionary fiscal policy is referred to as a 'crowding-out effect'. Black *et al.* (2007) describes the 'crowding-out effect' as the dampening of private consumption and investment on account of increases in interest rates associated with an increase in debt-financed public expenditure. Black *et al.* (2007) further explains that crowding out may occur as a result of expansionary fiscal policy that lead to interest rate hikes by monetary policy, thus implying a future rise in taxes to finance public expenditure.

Ocran (2011) stresses that, according to the neoclassical theory, the effects of an increase in government expenditure are just temporary and ineffective in the long-run because, when prices adjust, employment and output levels would remain unchanged in the long-run. The work of Perotti (2008) points out that the neoclassical theory advocates that a positive shock in government expenditure will lead to a decrease in private consumption and real wages due to a negative wealth effect and future expectations of higher taxes. Contrary to this, the neo-Keynesian approach suggested that an increase in government spending would cause a shift in the labour supply that would result in an increase in real wages, thus boosting private consumption expenditure through the substitution effect (Maidi, 2013). A study carried out by Baldacci *et al.* (2004) supported the neoclassical approach with the findings that private investment is a key transmission channel through which fiscal policy affects aggregate output level. The results of the study reveal that an increase in private investment would lead to fiscal contractions if government reduces expenditure or runs budget deficits. This implies that there is a long-run trade-off between government expenditure and private sector investment. Bank (2011) points out that the neoclassical school of thought, which assumes flexible prices, does not regard discretionary fiscal policy to have any significant influence on the business cycle. Hence, an increase in government spending leads to a contraction in the economy through the crowding-out of private consumption and investment. The view of Mathewos (2015) supports the claims made by Bank (2011), stipulating that according to neoclassical theory, a rise in government consumption financed by higher taxes may lead to a negative wealth effect that discourages household consumption and increases labour supply, and, since labour supply increases along with a given labour demand, the level of real wage declines which further discourages households savings. Moreover, both Keynesian and neoclassical theory claims that governments should act countercyclically, i.e. raise government expenditure or cut taxes when private sector demand is too low, deflating the economy by reducing expenditure or raising taxes when private sector demand is too high. To test the validity of the neoclassical theory in the SADC region, the study further incorporates the gross fixed capital formation as an exogenous variable to scrutinise its impact on growth and determine its relevance within the SADC perspective.

## 2.5 WAGNER'S LAW ON FISCAL POLICY AND GROWTH

As previously stated, the Keynesian theory advocates for active intervention of government through countercyclical fiscal policy to influence aggregate demand in the economy and bring economic stability and sustainable growth. On the other hand, Wagner's (1890) theory contradicts the Keynesian theory by strongly assuming that economic growth determines government expenditure, not vice versa. Wagner's theory hypotheses that aggregate economic performance is the main driving force of fiscal policy reaction (Ismal, 2011). Wagner's theory contends that fiscal authorities tend to increase government expenditure as the economy expands through increased economic activity. Concurring with Wagner's (1890) framework, Ismal (2011) suggests that economic expansion should be at the center of economic policy if aggregate national income proves to be a main deterministic factor of government expenditure. Furthermore, analysing both Keynes and Wagner's theoretical foundations is crucial to understand important determinants of economic growth consistent with sustainable expansionary fiscal policy.

The analyses of Keynes' and Wagner's theories are paramount to trace causality between fiscal policy and economic growth as suggested by conventional theoretical literature. Furthermore, understanding the relationship advocated by the two dominant economic theories is important to describe economic agents of development to provide accurate SADC-specific findings for policy design consistent with sustainable fiscal policy and economic expansion. The growth-led expansionary fiscal policy has not been very effective in the SADC region mainly due to low levels of economic growth and large budget deficits for the majority of SADC countries. Therefore, this renders Wagner's theory as irrelevant for most SADC members. However, the following analytical chapter aims to provide robust empirical evidence to address this theoretical disparity on the relationship between fiscal policy and economic growth.

## 2.6 THE ENDOGENOUS GROWTH MODEL

The endogenous growth model pioneered by Romer (1986), Lucas (1988), and Barro (1989) advocates that there would be a positive impact of public debt on economic growth in the transition stage to the steady state. This would depend on whether the borrowed funds are channeled toward productive and growth-stimulating sectors, or up to a certain threshold level when public debt is used to finance productive and sustainable public services (Aizenman *et al*., 2007; Checherita-Westphal and Rother, 2012). Theoretically, both endogenous growth and neoclassical models argue that public debt has a negative long-run effect on economic growth through the crowding-out effect (Barro, 1989). The negative effects of government debt increase sovereign risk and lowers the productivity of government expenditure. This leads to expectations of future confiscation through the risk of high inflation and unanticipated economic crisis (Teles and Mussolini, 2014). However, Antonakakis (2014) points out that 'hysteresis effects' (persistent effects of the previous shocks in the system even after the initial causes of the shocks have disappeared) can lead to conditions where expansionary fiscal policy plays a central role in influencing economic activities consistent with long-term growth of the economy.

The endogenous growth model addresses major shortcomings of the neoclassical growth models to incorporate critical aspects that economic growth rate ought to be guided by the behaviour of economic agents in the economy. The endogenous growth model claims that economic growth is generated because of direct investment in human capital, innovation, research and development. Moreover, the endogenous growth model further postulates that there are no diminishing returns to capital, but investments made by firms and individuals translate to an increase in the level of productivity. A simple production function consistent with the endogenous growth model employed by Lucas (1988), Romer (1986) and Romer (2012) can be expressed as $Y = AK$.

Here, $Y$ represents output level. $A$ is an expression that represents factors that affect technological progress and $K$ is capital (both physical and human capital). This production function assumes that there is a linear relationship between total output ($Y$) and capital ($K$) comprising of same commodity.

Therefore, the rate of returns on capital ($\boldsymbol{r}$) is given as:

$$r + \delta = \frac{Y}{K} = A \tag{2.7}$$

Where, $\delta$ represents the exogenous rate of depreciation**.** Furthermore, this theoretical framework assumes that the relationship between the output growth rate ($Y$) and the rate of profit ($\boldsymbol{r}$) is endogenously determined by the saving-investment mechanism with the assumption of steady-state equilibrium as demonstrated by the following equation:

$$g = \frac{A - \delta - \rho}{\sigma} = \frac{r - \rho}{\sigma} \tag{2.8}$$

Where, $\rho$ represents the discount rate, and $\frac{1}{\rho}$ is the elasticity of substitution between present and future consumption, $1 \neq \sigma > 0$ and $Y = c(t) + K$. In this model, the rate of growth is endogenously determined by the saving-investment mechanism, and profit is mainly determined by the level of technological progress. The major assumption is that the greater the propensity to acquire physical and human capital, the higher the growth rate. The main tenet of the endogenous growth model is the role of human capital in augmenting real economic growth. A number of developing countries including SADC countries have been moving towards investing in human capital to equip people with knowledge and skills to contribute meaningfully to the economy. This is especially important in the 21st century, where the fourth industrial revolution has taken a toll and requires people to advance their skills and keep up with advancing technological level to improve productivity. A thorough understanding of the relevance of the endogenous growth model in the SADC region gives an important direction to economic factors that continuously affect growth as we attempt to explore macroeconomic factors that influence productivity levels and output growth among SADC economies.

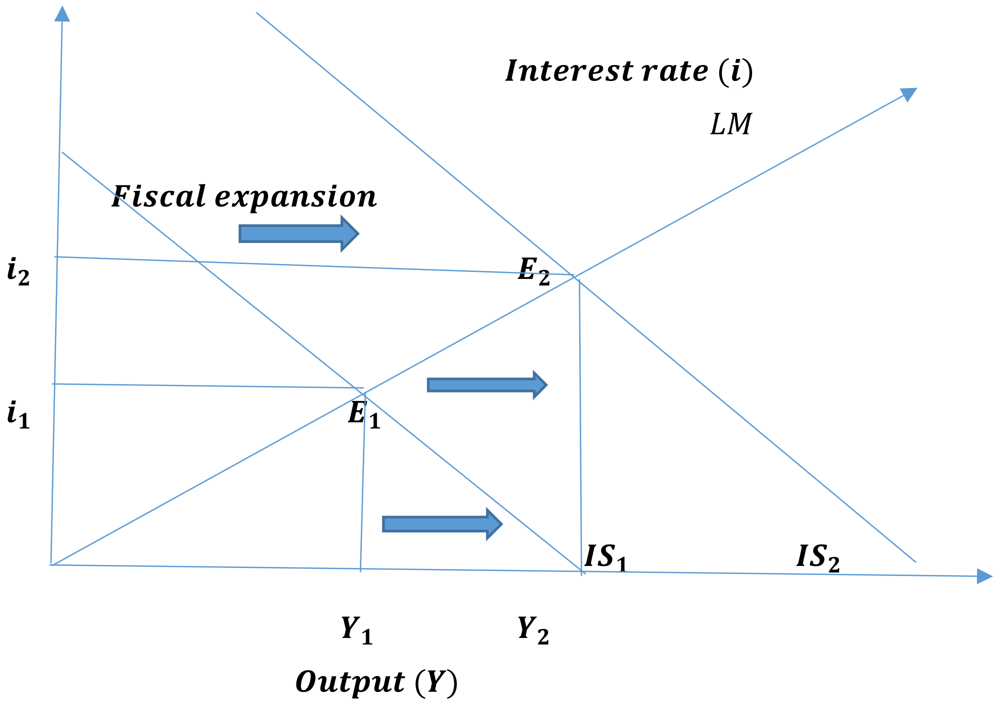
## 2.7 THE IS-LM MODEL ON FISCAL POLICY AND OUTPUT

According to Colander (2008), fiscal policy transmission mechanisms can be best analysed through the use of Aggregate Supply/Aggregate Demand (AS/AD) model. This model is very useful when analysing factors that affect output, inflation and the fiscal multiplier in the economy. Fiscal policy can be viewed as a demand management tool that strongly affects aggregate demand and supply and other crucial macroeconomic variables, including output, prices and employment. Therefore, fiscal authorities employ various combinations of fiscal instruments in an attempt to influence aggregate demand and the level of output during different phases of business cycle consistent with sustainable economic growth.

Moreover, the government may use borrowings to finance an expansionary policy when the economy runs into an unprecedented fiscal deficit, resulting in economic expansion. Jha *et al.* (2010) asserts that an increase in government borrowings boosts government expenditure and positively affects output through a direct effect on aggregate demand. Furthermore, government borrowings may have a positive influence in the long-run if the borrowed funds are used to finance growth-stimulating capital projects, promoting growth through improving the supply-side capacity of the economy (Baldacci *et al.,* 2004). The majority of SADC countries borrow funds from financial institutions such as the International Monetary Fund (IMF) and the World Bank to fund social consumption such as social security, aid, health etc., since these countries are characterised by stagnant growth and high unemployment. This eventually translates to a high budget deficit and public debt since government is unable to collect sufficient tax revenues on par with expenditure.

Some SADC members that are considered as developed countries within SADC such as South Africa, Seychelles, Mauritius and Botswana have been able to channel a significant portion of government funds towards capital investment projects such as infrastructure, technology, SMME development. This effort consistently enforces a conducive and friendly environment for both domestic and foreign direct investments to flourish and thereby ultimately promote economic growth. The injection of government expenditure towards the development of these growth-stimulating sectors has earned these countries a classification of well-performing economies over the years, within the SADC region and Sub-Saharan Africa at large. Figure 2.2 shows the impact of expansionary fiscal policy on output growth within IS-LM framework.

**Figure 2.2: Fiscal Policy in the IS-LM Model**




*Source: Mankiw (2012)*

The Keynesian Theory of Employment, Interest rate, and Money advocates that a change in government spending has a significant influence on real interest rates. Figure 2.2 shows how an expansionary policy, through an increase in government expenditure and a reduction in taxes, affects output growth in the economy. In the work of Evans (1969), as cited by Ramey (2011), the magnitude of the fiscal multiplier due to a change in government expenditure is approximately 2. Hence, an increase in real GDP is much bigger than the initial increase in government expenditure due to the multiplying transmission mechanism fiscal process. This implies that fiscal policy is theoretically the most effective tool to stabilise and spur output growth in the economy (Mencinger, 2016). A decision to adopt a particular discretionary fiscal policy during fluctuations in the business cycle would certainly result in a particular multiplier effect. According to Jha *et al.* (2010), a multiplier is a measure of how effectively an increase in government expenditure or tax reduction can stimulate aggregate output level.

Contrary to the Keynesian theory, the neoclassical approach to fiscal policy posits that a fiscal multiplier would be zero, either as a result of an increase in public debt or a reduction in taxes to finance government spending (Jha *et al.*, 2010). Consistent with the Ricardian equivalence theorem, the neoclassical theory insinuates that consumers are forward-looking and are knowledgeable about the intertemporal budget constraints of the government. The forward-looking consumers are aware that any increase in government spending or a cut in taxes due to borrowing would lead to higher tax burden in future. Therefore, rational consumers will not deviate from their normal consumption patterns.

The IMF (2018) indicated that fiscal multipliers may vary from positive consistent with the Keynesian approach to negative effects in line with the non-Keynesian views, depending on adopted fiscal instruments and the nature of the economy. A negative fiscal multiplier implies that fiscal policy expansion is contractionary. The money market is in equilibrium in the IS-LM model when the real money supply ($M/P$) is equal to the demand for money in real terms ($Y*L(i)$) as shown in the following equation:

$$\frac{M}{P} = Y * L(i) \tag{2.9}$$

The above equation (2.9) postulates that a rise in disposable income ($Y$) brings about an increase in money demand. The IS-LM equilibrium in Figure 2.2 shows how the economy responds when the government adopts an expansionary fiscal policy. As shown in Figure 2.2, the adoption of a fiscal policy transmission mechanism results in an increase in output level and an increased interest rate. This theoretical framework seeks to determine the magnitude of the impact of the fiscal transmission mechanism conditional on an increase in output and interest rate initiated by the expansionary fiscal policy. An increase in interest rate has a negative impact on private investment and overall output. This suggests that the fiscal transmission mechanism is more effective when the response of fiscal measures on the interest rate are smaller since the size of the fiscal multiplier is higher (Mencinger, 2016).

The monetary transmission mechanism is more effective for maintaining and stabilising economic fluctuations through the adoption of expansionary monetary policy instruments. However, in economic conditions where the economy faces severe financial crises or a liquidity trap, the transmission mechanism of monetary policy loses much of its effectiveness as a countercyclical policy instrument and cannot be used to stimulate aggregate output levels since the interest rate are already too low (Blanchard *et al.*, 2010; Jansen *et al.*, 2015). The term liquidity trap relates to economic conditions where the economy is hard-hit by a sudden, unexpected economic shock or large-scale negative demand shock. This has a negative effect on the expectations of key economic agents and subsequently triggers a huge increase in savings and low spending and investment.

During economic crises where the heterodox monetary policy instruments have a limited impact on economic growth, fiscal policy transmission mechanisms remain the only macroeconomic stabilisation tools available at the disposal of fiscal policymakers through which a rise in government spending or reduction of tax burdens may influence economic activities and foster economic growth. This theoretical framework suggests that the optimal magnitude of fiscal multipliers is possible during an economic crisis mainly through the fiscal transmission mechanism with the adoption of expansionary policy instruments to attain full employment and maximum output (Ismal, 2011 and Mencinger, 2016).

## 2.8 SOVEREIGN DEBT SUSTAINABILITY

The global debt crisis across both advanced and developing economies has cast a negative perception of the interaction between the financial sector and public sector. The fiscal risks tend to spread from the financial sector to the sovereign sector through the following two channels: first, the provision of government support to the financial sector which translates to an increase in the sovereign debt and, second, financial sector deleveraging which amplifies hampering overall economic activities, further translating to a continuous rise in government expenditure and decline in revenues. Janacek *et al.* (2012) assert that the main channels through which growth in sovereign risk is spread to the financial sector are as follows: first, a change in the level of risk of assets that is denominated in the same currency as sovereign exposure and, second, through government bond revaluation losses. For each economy to achieve financial stability, both the financial and sovereign sectors must be stable and avoid any form of financial risks that may prevail over-time (Caruana and Avdjiev, 2012). While it is important to encourage traditional capital and liquidity buffers within the financial sector, it also remains important to achieve sustainable public finances within the economy (Komarkova *et al.,* 2013).

### 2.8.1 Public Finance Sustainability

Over the years, the public finances of several developing economies have been characterised by accumulating public debt and high fiscal deficits. Several fiscal policymakers in many countries have adopted some form of fiscal rule that seeks to achieve prudent fiscal policy and sustainable public finances. Hence, investigating the implications of fiscal shocks and accumulating debt has gained significant scholarly attention among researchers and policymakers. The legacy of the 2008 global financial crisis left several governments and policymakers uncertain about future unexpected economic shocks. This has imposed an additional premium on their capacity to provide clear directions for prudent future fiscal policies and sustainable public finances (Morabe, 2008).

A good debt management policy is a very important component of a fiscal strategy as the need for financing government programmes continues to grow. Good public debt management plays a fundamental role in public finances and any attempt to determine the country's financing scheme ought to involve an adequate public debt management strategy. Morabe (2008) contends that any debt policy design ought to simultaneously address different objectives, e.g., serving future financing needs, promoting fiscal sustainability, and minimising debt servicing costs and vulnerabilities to achieve sustainable public finances. Sovereign debt sustainability is traditionally assessed by analysing the sustainability of public finances from an accounting perspective. This is done by comparing government tax revenues (T) and expenditures (E), and also taking into account the size of public debt (D) and debt servicing costs, i.e., the effective interest rate (r) as shown in equation (2.10):

$$D_t = (1 + r_t)D_{t-1} - (T_t - E_t) \qquad (2.10)$$

The above equation shows that sustainable public debt (D) depends on the government's ability to successfully manage public finances to remain stable and sustainable over the long-term. The relationship between public debt and macroeconomic performance can be best analysed in relation to GDP growth in relative terms using the following equation:

$$\underbrace{\frac{D_t}{Y_t} - \frac{D_{t-1}}{Y_{t-1}}}_{Change\ in\ Debt} = \underbrace{\underbrace{(r_t - g_t)}_{RG\ Differential}\left(\frac{D_{t-1}}{Y_{t-1}}\right)}_{Debt\ Servicing\ Costs} - \underbrace{\frac{(T_t - E_t)}{Y_t}}_{Primary\ Balance} \tag{2.11}$$

The above equation (2.11) shows that a change in real public debt dynamics depends on the differential between the initial public debt level, weighted by the real interest rate (r) minus real output growth (g) and fiscal policy stance as reflected in the primary balance. The primary balance indicates whether government has a surplus ($Primary\ Balance > 0$) or a deficit ($Primary\ Balance < 0$). The main driver for the public debt dynamics is the RG differential ($RG = r_t - g_t$). In line with the neoclassical theory prescriptions, assuming that there is a balanced government budget ($Primary\ Balance = 0$), if the real interest rate (r) is lower than real output growth (g) in the long-term, then public debt converges to a sustainable level. Conversely, if the real interest rate (r) exceeds real GDP growth (g), then the public debt level diverges from the sustainable level (Komarkova *et al.,* 2013).

The assessments of sovereign risk ought to consider public debt dynamics from the RG differential context. A change in real interest rate (r) and real output growth (g) may cause a sudden change in the debt dynamics from sustainable to unsustainable level triggering sovereign risk to materialise (Komarkova *et al.,* 2013). The RG differential may change due to macroeconomic dynamics, including unanticipated economic shocks or due to a sudden shock in fiscal policy. In extreme cases, if the RG differential remains positive for a long period or is suddenly overshot, the debt dynamics may even explode, and the primary balance becomes the only fiscal policy adjustment mechanism available. This implication is most likely to prevail in the majority of developing countries, like those in the SADC, especially during periods of unanticipated economic crises where the fiscus may be inadequate to absorb unexpected economic shocks.

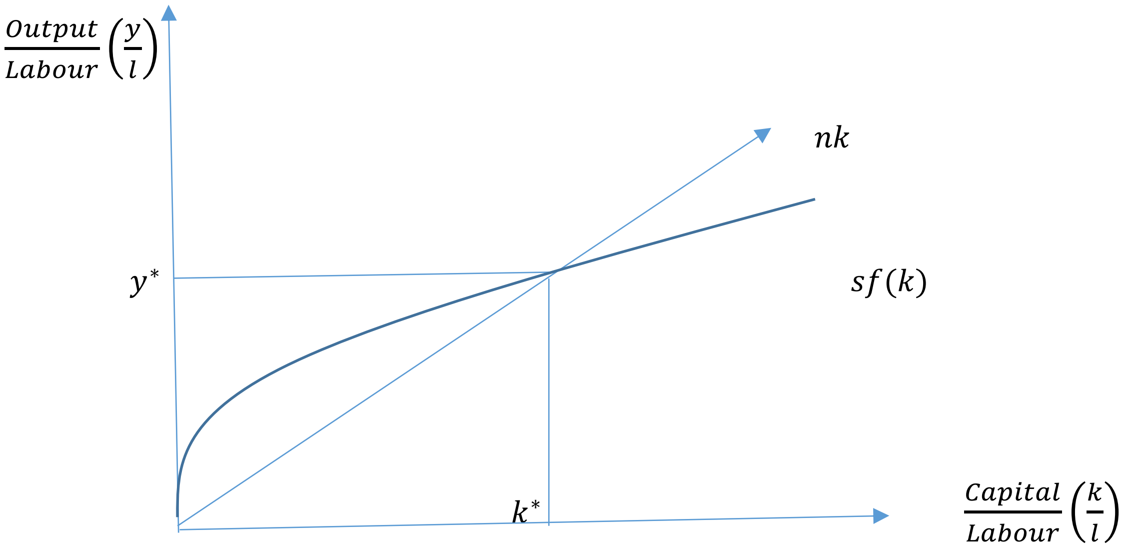
Therefore, fiscal authorities ought to ensure that a specific fiscal policy stance, imposed by government, is continuously adjusted and flexible to changes in the economic environment to prevent possible debt explosion. However, several developing countries usually struggle to keep up with unexpected changes in their economic environment mainly due to lower levels of development and growth, unemployment and unstable public finances. The SADC is no exception. Theoretically, public debt is considered sustainable if the primary surplus is equal to debt service interest costs. Furthermore, in circumstances where a primary deficit is recorded, the debt only remains sustainable if the difference between the real interest rate (r) and real output growth rate (g) exceeds the primary balance (Komarkova *et al.,* 2013). Over the past decades, interest rate-growth differentials in the SADC region varies across countries. However, a significant number of member countries have adopted tight monetary policies that aim to narrow the gap in RG differentials, consistent with their economic objectives and development within their economies. In the SADC context, the real interest rates of the majority of member countries have far exceeded the real GDP growth rate over the years (Ncube and Brixiová, 2015). However, continuous improvement has been recorded in recent years with tight monetary policies implemented in several SADC member countries to address high RD differentials among member countries in SADC region.

## 2.9 THE SOLOW GROWTH MODEL

The Solow growth model focuses on the economic analysis of long-run output growth through savings and investments as the key components of output growth within the economy. This theory assumes that a rise in savings and investments brings about an increase in capital stock, leading to full employment and ultimately to an increase in gross national income. The Solow model posits that labour productivity grows continually and exogenously while capital stock remains homogeneous over time, thus translating to a continuous expansion in output level. Moreover, the higher the saving and investment, the higher the rate of growth of gross national income. The Solow model analyses dynamics of long-run growth with the assumption that there is full employment of capital and labour in production processes. It also makes assumptions about continuous changes in population growth, savings and technological progress. This study tests the validity of the Solow growth model in developing countries specifically in SADC region. The findings of the Solow model tends to vary based on the level of development of each region. Numerous developing countries, including SADC members, tend to hold a limited amount of savings and investment on their offshores due to lower levels of development and growth. This is coupled with little effort to establish investment friendly policies which hinders the development capacity for economic convergence with advanced countries.

The Solow model suggests that while the effect of higher savings and investment boosts the growth rate of national income in the short-run, it has no effect on the long-run growth rate because the economy would have reached the steady state. According to the Solow growth model, the production function exhibits constant returns to scale, implying that doubling both capital and labour would result in a doubling of the output level. Furthermore, Solow contends that capital accumulation can be taxonomized into two separate categories, i.e., capital deepening and capital widening. Capital deepening refers to increasing the amount of capital per worker. On the other hand, capital widening means equipping new workers with sufficient capital as population increases in the economy. Figure 2.2 below demonstrates the analysis of a long-run steady state within the economy as advocated by the Solow growth model where capital, labour and output are constant at a steady-state.

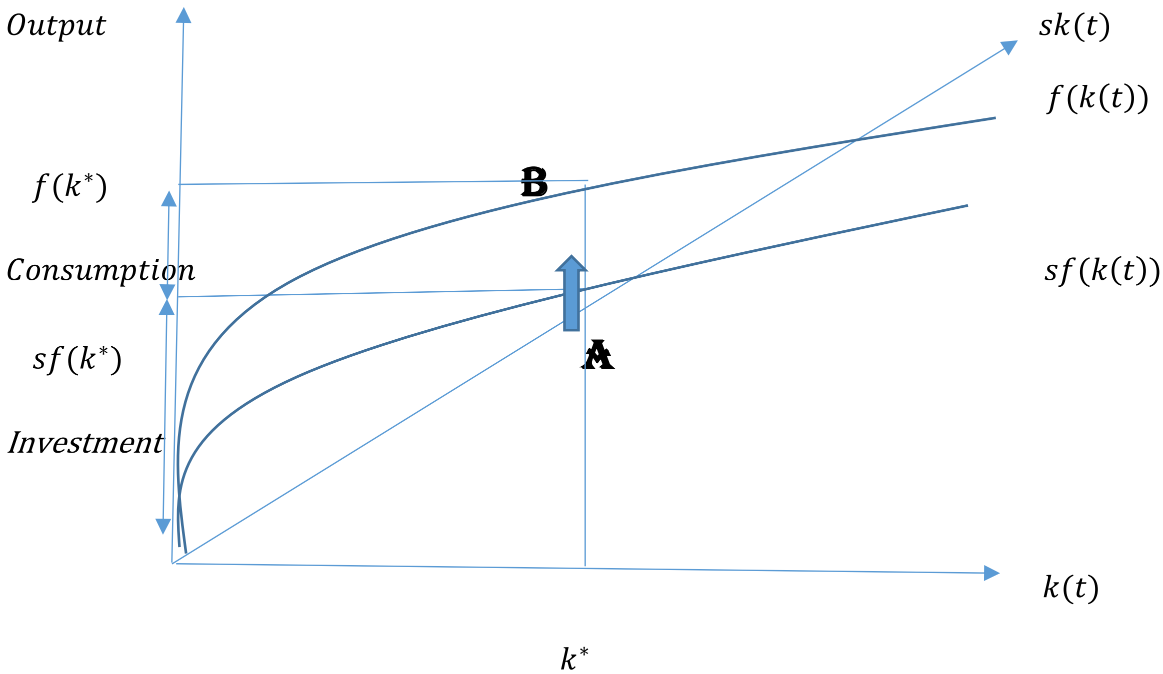
**Figure 2.3: Long-Run Steady State**




*Source: Researcher's own computation*

Figure 2.3 above shows that capital (*k)* is increasing since there are enough savings earmarked to equip new workers with capital. The capital/labour ratio converges to $k^*$ in the long-run, and available savings are only meant for capital widening. Therefore, there is no investment left for capital deepening. Hence, the Solow growth model claims that there is steady-state economic growth rate in the long-run since the capital to labour ratio is constant at $k^*$. Furthermore, as labour grows at $n$ rate, the amount of capital also grows at $n$ rate. The assumption of constant returns to scale implies that the national income, saving and investment as well as consumption all grows at $n$ rate. Hence, income *per capita* and *per capita* consumption also remains constant in the long-run. Figure 2.4 shows the effects of a change in investment and consumption in the long-run steady state.

**Figure 2.4: Consumption and Investment in Steady State**




*Source: Researcher's own computation*

The above diagram shows the role of changes in investment and consumption in the long-run steady-state equilibrium with the assumption of changes in the population growth. In a competitive market economy, the real interest rate is the marginal product of capital and the real wage is the marginal product of labour. The Solow growth model assumes that, since the capital to labour ratio is constant in the steady-state, the marginal products of capital and labour are constant in the long-run. This implies that the real interest rate and real wages are also constant. As the population grows at $n$ rate, capital-widening $(nk)$ also increases. Subsequently, the capital to labour ratio *k* decreases, and this further translates to a decline in *per capita* output. As a result, this decline in capital, labour and output would translate to a higher real interest rate and lower real wages during the steady-state.

As mentioned earlier, the Solow model suggests that higher savings would lead to an expansion in the economy in the short-run, but this has no effect on the long-run growth. An increase in savings would lead to a higher steady-state capital to labour ratio as well as *per capita* output. Hence, this would result in a lower real interest rate and a higher real wage in a steady state. The Solow model posits that the economy cannot continuously generate economic growth during the steady-state. The logic behind this is that the marginal product of capital is diminishing capital itself and *per capita* output can only grow if there is an increase in capital per worker. Furthermore, as the capital stock grows, it takes more investment to produce additional unit of output, and at times the economy would only invest to keep up with higher depreciation rate. Therefore, the only key to continuous growth is to devise an effective mechanism that would address the non-diminishing marginal product of capital.

The Solow model has been instrumental to analyses of the role of savings and investment on output growth in the long-run among both advanced and developing countries. The SADC region is no exception to the prescriptions of the Solow growth model. The SADC, as a developing region, has been long characterised by low levels of savings and investment over the years. However, the majority of SADC members have seen significant improvements in both private savings and investments probably due to the level of financial development and governments' efforts to formulate investment-friendly policies among. The significance of this theoretical framework is that it enables us to accurately incorporate controlling exogenous variables for empirical modelling, supported by conventional economic theory. The Solow growth model allows us to incorporate gross fixed capital formation as a proxy for investment in our empirical modelling on the relationship between fiscal policy and economic growth in SADC region.

## 2.10 RICARDIAN EQUIVALENCE THEOREM

The Ricardian equivalence theorem is an economic hypothesis formulated by the classical economist Ricardo (1951), and later extended by Barro (1989) It suggests that consumers are forward-looking and tend to internalise the government's budget constraints when they make consumption decisions. The Ricardian equivalence argument is built on the fact that the government can finance expenditure through printing money, increasing taxes, and borrowing or selling government securities. The Ricardian view claims is that when the government resorts to borrowings instead of levying more taxes to finance expenditure, this implies that the current generation is under-taxed. The theory postulates that forward-looking consumers realise that high public debts would lead to a high tax burden in future. Therefore, in theory, consumers would choose to increase their savings by an equal amount of an increase in future taxes as they do not want to be in a poorer position in future for the current under-funded benefit as a result of lower taxes.

During an economic downturn, when the economy runs a budget deficit, a government normally approaches the IMF for financial relief to finance expenditure with the aim of stabilising macroeconomic fluctuations and promoting economic activities consistent with sustainable economic growth (Lee and Ng, 2015). However, the continuous accumulation of debt becomes a burden to the government and eventually translates to a higher tax levy in future. The Ricardian equivalence theory hypothesises that taxpayers will anticipate that they will pay higher taxes in the future and would therefore choose to save more rather than spending. With the extra disposable income from the initial tax reduction, the aggregate demand and output remains constant. Therefore, there would be a voluntary reduction in private spending by forward-looking tax payers. Subsequently, the impact of debt-financed expenditure on domestic aggregate demand would be insignificant.

Jha *et al.* (2010) pointed out that consumers know that a rise in government expenditure due to current borrowings would be offset by a future reduction in expenditure or a rise in taxes, thus leaving output level unaffected. Maidi (2013) contends that this behaviour from consumers to offset current spending while considering sustainability in future debt payment would render countercyclical fiscal policy ineffective. The Ricardian equivalence model has a critical theoretical contribution to economic literature of new classical macroeconomics formulated based on the assumptions of rational consumer’s expectations. Barro (1989) noted that the Ricardian equivalence theorem suggests that a shift between financing public expenditure with either public debt or taxes would have no first-order effects on the real interest rate and the amount of private investment. The Ricardian equivalence was criticised by Martin Feldstein in 1976, who argued that Barro ignored the impact of population and economic growth, which plays a crucial role on consumer’s consumption decision. Feldstein further argued that accumulating public debt tend to supress savings and investment, which translates to a contraction in the economy.

Romer (2012) proposed that the Ricardian equivalence model can be represented by the household budget constraint as demonstrated in the following equation:

$$\int_{t=0}^{\infty} e^{-R(t)}\, C(t)dt \leq K(0) + D(0) + \int_{t=0}^{\infty} e^{-R(t)}\, W(t)dt - \int_{t=0}^{\infty} e^{-R(t)}\, T(t)dt \qquad (2.12)$$

Where, $\int_{t=0}^{\infty} e^{-R(t)}\, C(t)dt$ represents the present value of household consumption, $\int_{t=0}^{\infty} e^{-R(t)}\, W(t)dt$ represents the present value of household income, and $\int_{t=0}^{\infty} e^{-R(t)}\, T(t)dt$ represents the present value of taxes. $C(t)$ is consumption at time ($t$), $K$(0) is the quantity of capital at time ($t$), and D(0) is the quantity of government bonds at time ($t$). According to Romer (2012), the above equation (2.12) of the representative household budget constraint demonstrates that the present value of representative household consumption cannot exceed the sum of consumers' initial wealth and present value of income after tax.

Suppose the government satisfies its budget constraint with stable finances. This implies that the present value of taxes, $\int_{t=0}^{\infty} e^{-R(t)}\, T(t)dt$ equals initial debt, $D$(0) plus the present value of government budget purchases, $\int_{t=0}^{\infty} e^{-R(t)}\, G(t)dt$. If we substitute this into the above equation (2.12) for household budget constraint, we obtain the following equation:

$$\int_{t=0}^{\infty} e^{-R(t)}\, C(t)dt \leq K(0) + \int_{t=0}^{\infty} e^{-R(t)}\, W(t)dt - \int_{t=0}^{\infty} e^{-R(t)}\, W(t)dt \qquad (2.13)$$

The above equation (2.13) shows that the representative household budget constraint is expressed in terms of government purchases without incorporating the role of financing those government purchases through taxes and bonds. Therefore, it is only the quantity of government purchases that is more important in the economy and not the division of the funding model of those purchases through taxes and bonds. In a nutshell, the Ricardian equivalence argues that public debt and taxes are equivalent in their effect on household consumption. The Ricardian equivalence theorem proposed by Barro (1986) pointed out that public debt would be offset by an increase in private savings as taxpayers realise that tax is merely deferred and not entirely cancelled. The Ricardian equivalence theory posits that public debt does not affect national savings, interest rates or the balance of payments. Therefore, the investment and trade balance remains unaffected.

In line with the Ricardian equivalence model, Thornton (2011) pointed out that fluctuations in public debt have no effect on economic growth and therefore does not lead to any macroeconomic instability. The larger portion of public debt acquired by SADC member countries over the years has been predominantly directed towards social development and infrastructural development in line with fiscal policy strategies. This effort has seen a significant economic improvement among these developing countries. Perlo-Freeman and Webber (2009), and Teles and Mussolini (2014) posit that using public debt to fund public consumption should have a positive influence on growth if the expenditures are channelled towards productive sectors such as education, healthcare, technology and other sectors related to the development capacity of the economy. Several advanced countries have been able to effectively use government debt towards the development of growth-stimulating sectors in their economies. Therefore, it is imperative for SADC members to adopt effective debt management mechanisms consistent with sustainable economic growth in the region.

The major drawback of the Ricardian equivalence theorem is that it may be difficult to draw statistical inferences on his hypothesis. However, for the purpose of this study, the effect of public debt on economic growth ought to be statistically insignificant for the Ricardian equivalence theorem to hold. The main implication of the Ricardian equivalence model is that public debt does not contain enough meaningful information to explain variations in long-term economic growth. Furthermore, if public debt is found to be statistically significant but with a small coefficient magnitude to influence the macroeconomy, this effect may further insinuate that the Ricardian equivalence theorem holds in the relationship between public debt and economic growth in the SADC region. In Chapter 4, this study aims to contribute to the body of literature by providing robust empirical evidence that is SADC-specific on the relationship between public debt and economic growth.

## 2.11 CONCLUDING REMARKS

This chapter thoroughly outlined several existing macroeconomic theories underpinning the relationship between fiscal policy, sovereign debt and economic growth. As evident in the afore-discussed theoretical foundations on the relationship under investigation, there are still contradicting views in the literature with respect to the impact of fiscal policy and sovereign indebtedness on economic growth, especially when taking into account the level of economic development across different economies. Hence, this chapter provides strong evidence of the theoretical divergence on the role of fiscal policy on economic growth. Therefore, the SADC-specific effect of fiscal policy cannot be generalised based on the contradictory theoretical paradigms.

In light of the above, this theoretical disparity calls for a robust empirical investigation to understand the true SADC-specific empirical relationship that exists between fiscal policy, sovereign indebtedness, and economic growth in the region. As mentioned earlier, this study aims to fill the gap and contribute scientific empirical evidence to the body of literature on the relationship between fiscal policy, sovereign debt and economic growth in SADC region. This will be done using recent panel data techniques and advanced econometric methodologies in the following chapters. Therefore, the following chapter discriminates against competing theoretical literature and provides a robust empirical investigation into the relationship between fiscal policy, sovereign debt and economic growth in SADC region.

# CHAPTER THREE

# THE ROLE OF FISCAL POLICY AND SOVEREIGN DEBT SHOCKS ON ECONOMIC GROWTH IN SADC ECONOMIES: A PANEL VECTOR AUTOREGRESSIVE APPROACH

## 3.1 INTRODUCTION

This part of the study examines role of fiscal policy and public indebtedness on economic growth in the Southern African Developing Communities (SADC), over the period 2000-2018. This chapter addresses the first objective of the study, which is to evaluate the impact of fiscal policy and sovereign debt shocks on economic growth in SADC region. The study estimated a Panel Vector Autoregressive approach to carry out empirical investigations that would provide rigorous empirical analysis on interrelationships among variables in the system. The study further estimates a Fixed effects (FE), Random effects (RE), Fully modified least squares (FMOLS) and Dynamic least squares (DOLS) as verification methods to confirm the robustness of the empirical findings of the study. This chapter is separated into five sections: Section 3.1 gives a brief introduction and justification of the research. Section 3.2 provides a detailed review of the empirical literature on fiscal policy and economic growth across different economies. Section 3.3 discusses the applied research methodology and estimation techniques adopted for the empirical investigation. Section 3.4 discusses empirical results while Section 3.5 will provide concluding remarks for the chapter.

## 3.2 MOTIVATION FOR THE STUDY

Over the years, several empirical studies have predominantly been confined in advanced economies on the effectiveness of fiscal policy and sovereign debt on economic growth. However, little scholarly attention has been given to developing economies, particularly SADC-specific studies with policy implications relevant for SADC economies. The primary objective of this chapter is to investigate the impact of fiscal policy and sovereign debt on economic growth in SADC region. Therefore, this chapter intends to conduct extensive empirical analysis on the impact of fiscal policy and sovereign indebtedness on economic growth and provides robust empirical findings for SADC-specific policy implications. To fulfil the primary aim and objective, this study estimates a Panel Vector Autoregression (PVAR) estimation technique supported by various panel data techniques which include the Fixed Effects (FE), Random Effects (FE), Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) methods. The above-mentioned cutting-edge panel data estimation techniques allows for an estimation of the dynamic relationships between identified variables within a panel framework and provides robust SADC-specific empirical evidence for suitable policy analysis in the region.

Several classical economic theories postulate that the primary objective of any national government is to ensure a balanced national budget through sustainable fiscal policy. This chapter intends to uncover whether accumulating public expenditure and public debt promotes or deteriorates long-term growth prospects in SADC. The analysis of this kind of relationships is crucial to inform policymaking decisions that are SADC-specific and assist SADC members to understand the macroeconomic influence of fiscal policy. This study contributes to the scientific literature by assessing the role of fiscal policy and sovereign debt sustainability on economic performance using a panel data analysis.

The study employed secondary annual panel data for 13 Southern African Developing Communities (SADC), viz., Angola, Botswana, DRC, Eswatini, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Seychelles, Tanzania, Zambia and Zimbabwe, covering the period 2000-2018. In line with Ocran (2011) and Taylor *et al.,* (2011), the macroeconomic variables used throughout the empirical investigation include gross domestic product (GDP), government expenditure, gross fixed capital formation, employment and public debt. The annual panel data for all variables was extracted from the World Development Indicators (WDI), Federal Reserve Economic Data (FRED), and Quantec EasyData through their online downloading facilities. The entire empirical estimation process in this chapter was carried out using Stata 14 and Eviews 10 statistical computing software.

## 3.3 THEORETICAL FRAMEWORK

### 3.3.1 The Keynesian View on Fiscal Policy

The Keynesian approach contends that government expenditure is a triggering factor of economic growth through expansionary or contractionary fiscal effects on aggregate demand in the economy. As mentioned earlier, expansionary fiscal policy occurs when government increases public expenditure or cuts taxes. On the other hand, contractionary effects take place when the government reduces expenditure or increases taxes to influence economic activities through changes in aggregate demand. In this chapter, the Keynesian theory allows us to relate the empirical results of the study with the conventional theory and thereby provides conclusive empirical evidence, supported by economic theory for SADC-specific policy implications. The study extends the theoretical framework pioneered from the Keynesian school of thought as a theoretical justification for empirical modeling. As previously mentioned, the Keynesian theory assumes that fiscal expenditure is the key driving force for economic growth while Wagner's theory argues that economic growth is the driving factor of fiscal expenditure. In line with the work of Samudram *et al.,* (2009), the model specification of the study is constructed based on the Keynesian function expressed as follows:

$$Y_t = f(X_t) + \varepsilon_t \qquad (3.1)$$

Where, from the Keynesian perspective, $Y_t = lnGDP$ (logarithm of GDP) and $X_t = lnGOE$ (logarithm of government expenditure). Contrary to this, Wagner's law posits that $Y_t = lnGOE$ (logarithm of government expenditure), and $X_t = lnGDP$ (logarithm of GDP), and $\varepsilon_t$ represents the idiosyncratic errors at $t$. This theory enables us to construct a strong argument regarding the relationship between government expenditure as a proxy for fiscal policy and economic growth from empirical analysis supported by economic theory. Carmignani (2010) postulates that if fiscal policy conforms to the Keynesian view, then fiscal policy instruments should be used as countercyclical mechanisms to stabilise fluctuations in the business cycle.

The Keynesian approach further claims that fiscal policy operates through various components of domestic aggregate demand which includes government consumption and private sector consumption, and fixed capital formation (Siebrits and Calitz, 2001).

The fiscal policy transmission mechanism augments private investment by sustaining domestic expenditure. Gross fixed capital formation is used as one of the exogenous variables in this study, and therefore this theory further enables us to support the empirical results on the relationship between fixed capital formation and economic growth.

### 3.3.2 The Endogenous Growth Model

As previously discussed in Chapter 2 of the study, a production function in line with the endogenous growth model proposed in the work of Lucas (1988), Romer (1986) and Romer (2012) can be expressed as follows:

$$Y = AK \tag{3.2}$$

In equation (3.2), $Y$ represent output, $A$ is an expression that represents total factors that affect technology and $K$ is capital (physical and human capital). This production function assumes that there is a linear relationship between total output ($Y$) and capital ($K$) both comprising the same commodity. The rate of return on capital ($\boldsymbol{r}$) is given as follows:

$$r + \delta = \frac{Y}{K} = A \tag{3.3}$$

The term, $\delta$ in equation (3.3) represents the exogenous rate of depreciation**.** Furthermore, this theoretical framework assumes that the relationship between the growth rate ($Y$) and the rate of profit ($\boldsymbol{r}$) is determined by the saving-investment mechanism with the assumption of steady-state equilibrium. The analysis of the endogenous growth model would assist in support of empirical results on the relationship between gross fixed capital formation and economic growth, thereby propose sound policy prescriptions.

### 3.3.3 The Solow Growth Model

As discussed in Chapter 2, the Solow growth model primarily focuses on the analysis of long-run output growth through savings and investment as the key components of economic growth. The main assumption of the Solow model is that a rise in savings and investment leads to an increase in capital stock, and subsequently lead to full employment and output growth. This theory postulates that labour productivity grows continually and exogenously while capital stock remains homogeneous over-time, translating to a continuous expansion in the level of output. Moreover, the higher the savings and investment, the higher the rate of GDP growth. The Solow growth model analyses the long-run dynamics of output growth with the assumption that there is full employment of capital and labour in production, and with further assumptions about changes in population growth, savings, and technological progress. Furthermore, the Solow model suggests that while the effect of higher savings and investment boosts output growth rate and national income in the short-run, this has no effect on the long-run output growth rate because the economy would have reached the steady state. This theory gives strong analysis on the influence of investment and labour on output growth that allows for robust assertions to be made to support the empirical findings on the relationship between gross fixed capital formation and output growth.

### 3.4 REVIEW OF EMPIRICAL LITERATURE

This section focuses on the review of scientific literature related to the influence of fiscal policy and public debt on economic growth across different economies. The IMF (2018) suggests that developing economies may develop their fiscal space through various approaches. Firstly, through ensuring proper collection of revenues and management which provide a good opportunity for countries to improve their fiscal reserves and reduce dependence on foreign financing. Hence, governments would be able to sustainably manage public finances and debt over the long-term. Secondly, the availability of debt financing and the willingness of investors to provide finance at reasonable interest costs would allow developing countries to finance fiscal priorities and develop infrastructure. Lastly, good management of public expenditure has a prominent role in the development of the fiscal space. As mentioned earlier, the majority of SADC members are fragile in terms of sound fiscal policy and sovereign indebtedness. Hence, these countries need to work on addressing these fragilities in their fiscus. The continuous failure to manage dependence on foreign finances and accumulating debt stock would ultimately lower economic growth potential among these countries, and further stifle their ability to address future fiscal challenges and unanticipated macroeconomic crises (IMF, 2018).

Van Zyl and Bonga-Bonga (2008) estimated a Structural Vector Auto Regressive (SVAR) to examine whether fiscal policy improves the rate of economic growth in South Africa.

Surprisingly, their study discovered that government expenditure, particularly towards education, does not boost economic growth in the South African economy. Lusinyan and Thornton (2009) investigates the sustainability of fiscal policy in the South African economy over the period 1995-2005. Their study used a cointegration approach to assess the long-run relationship between fiscal variables. The findings showed that fiscal variables are cointegrated, and the long-run equilibrium relationship showed a weak deficit sustainability condition. Oshikoya and Tarawalie (2010) examined the sustainability of fiscal policy among West African Monetary Zone (WAMZ) countries for the period 1980-2008. Their study used annual time series data employing the Granger causality methodology to assess fiscal sustainability in a cointegrating framework. The findings showed that fiscal policy is weakly sustainable for all the countries except Sierra Leone, which had seemingly unsustainable fiscal policy.

Adams *et al*., (2010) conducted three different empirical analyses to assess Asia's fiscal sustainability in the post-crisis period. The first analysis focused on the actual state of public finances, dealing with key fiscal indicators across the region. The second analysis dealt with the estimation of fiscal policy reaction functions that measured the response of primary fiscal balances to changes in debt ratio among Asian countries. The third analysis used fiscal simulations to assess the effect of the anti-crisis fiscal stimulus on debt sustainability in the region. Their study found that public finances of the region were in good shape, and thus had a sustainable fiscal policy. Moreover, there was considerable heterogeneity across the region. Some of the earlier studies that examined fiscal policy sustainability across different countries include Bascand and Razin (1997) in Indonesia, Budina and van Wijnbergen (2009) in Turkey, and Koch *et al.* (2005) in South Africa.

Ocran (2011) scrutinises the role of fiscal policy measures which include government consumption expenditure, tax revenues, government gross fixed capital formation and budget deficits on economic growth in South Africa. The study estimates the VAR technique using quarterly time series data covering the period 1990-2004. The study discovered that government consumption expenditure and gross fixed capital formation have a significant positive impact on economic growth. Moreover, positive shocks to tax receipts were found to have a positive effect on economic growth. The size of the budget deficit had an insignificant effect on growth outcomes. Ogbole, Amadi, and Essi (2011) studied the effect of fiscal policy on economic growth in Nigeria for the period 1970-2006. The empirical findings reveal that there is a difference in the effectiveness of fiscal policy in promoting economic growth during and after a regulation period. The study recommend that the country should prioritise an appropriate policy mix, prudent public spending, and setting realistic fiscal targets.

A study by Afonso and Sousa (2011a) investigated the macroeconomic effects of fiscal policy in Portugal using the Bayesian Structural Vector Autoregression model. Their findings revealed that a positive shock in government expenditure has a negative impact on real economic growth and thus translates to a ‘crowding-out’ effect on private consumption and investment. Moreover, there is a persistent positive impact of government spending on price level and a mixed effect on the average financing cost of government debt.

Another study carried out by Taylor *et al.* (2011) estimated a VAR model to assess fiscal deficits, government debt and economic growth in the United States of America (USA) using quarterly data from 1961-2011. Their findings suggest that there is a strong positive impact of a higher primary deficit on growth, even when possible increases in the interest rate are taken into account. The study suggests that to achieve a situation with a low fiscal deficit and high economic growth, the federal government should focus on further stimulating economic activity through effective stimulus fiscal policy. This could be possible by increasing government spending, which would in turn accelerate economic growth and subsequently increase government revenues.

Fry'McKibbin and Zheng (2012) estimates a Factor Augmented Vector Autoregression (FAVAR) framework to examine the impact monetary and fiscal policy shocks on macroeconomic fluctuations in the USA. The study dealt with the identification of issues through the sign restriction methodology in line with Dungey and Fry (2009) and Fry and Pagan (2007). The study found that the impact of the government expenditure shock on output is significant and explains more variability in macroeconomic variables compared monetary policy shock. Moreover, their results further revealed that an increase in government spending tended to ‘crowd-out’ private sector activities, leading to an overall decline in output level.

Ghosh *et al.* (2013) examined fiscal fatigue, fiscal space and public debt sustainability in 23 advanced economies over the period 1970-2007. Fiscal fatigue refers to the inability of the primary balance to meet interest payments at a high debt level. The study found strong empirical support for fiscal fatigue and that the marginal response of the primary balance to lagged debt is non-linear, remaining positive at moderate debt levels but starting to decline when debt reaches around 90-100% of GDP, becoming negative as the debt ratio approaches about 150% of GDP. Oyeleke and Adebisi (2014) assesses fiscal policy sustainability in Ghana for the period 1980-2010. The study used the error correction method to conduct empirical analysis. The results showed a long-run relationship between variables which indicate fiscal sustainability, albeit weak. This suggests that the country may not qualify for membership in West African Monetary Zone (WAMZ). Moreover, the findings further revealed that only 29% long-run disequilibrium is corrected yearly between government revenue and expenditure following exogenous shocks to the economy. The study further proposed that policymakers ought to focus on improving tax revenue collection to ensure a sustainable national budget.

Bi *et al.* (2014) estimate a DSGE model to study the role of fiscal policy in developing countries with external debt and sovereign risk default. Their findings showed that expected future revenue plays an important role in the low fiscal limits of developing countries relative developed countries. External debt was found to have additional risks since large devaluations of the real exchange rate can suddenly raise the probability of default. Moreover, when the economy approaches its fiscal limits, government expenditure becomes less expansionary than a low-debt country. The study further suggests that as more revenue is required to service high debt, higher tax rates raise the economic cost of consumption and subsequently reduce the fiscal multiplier.

A recent study by Jawadi *et al.* (2016) estimates a Panel Vector Auto-Regressive (PVAR) model to examine the macroeconomic impact of fiscal policy and monetary policy shocks for five emerging market economies which include Brazil, Russia, India, China and South Africa (BRICS) using quarterly data from 1990-2013. The empirical result of this study indicated that monetary contractions stifle real economic activities and tighten liquidity market conditions, while a positive shock in government spending had strong Keynesian effects among BRICS members. Unexpected fiscal policy expansion has a persistent and positive impact on real economic growth and price level, and does not lead to an increase in interest rates. This study supports the accommodative stance between fiscal and monetary policy. The empirical results became robust even after controlling economic instability during financial crises.

A recent study conducted by Jawadi *et al.* (2016) employed a Panel Vector Auto-Regressive (PVAR) approach to analyse the macroeconomic effects of fiscal policy and monetary policy shocks among five emerging market economies, i.e., Brazil, Russia, India, China and South Africa (BRICS). The study found that a contractionary monetary policy lead to a decline in economic activities and tighter liquidity market conditions, while a positive shock in government expenditure demonstrated strong Keynesian effects, i.e., that fiscal policy has an expansionary and persistent impact on real output growth. The results of the study further supported the existence of an accommodative stance between fiscal and monetary policy which is crucial for prudent economic policy formulation. As stated earlier, this section presented empirical findings that demonstrated divergence from one study to the other. Therefore, the following section outlines the estimation procedure that will be undertaken for empirical investigation to provide robust empirical evidence on the relationship between fiscal policy and economic growth in SADC economies.

## 3.5 RESEARCH METHODOLOGY

This section discusses the relevant statistical estimation techniques to be employed during the estimation process. As mentioned earlier, the study estimates a Panel Vector Autoregressive (PVAR), Fixed effects (FE), Random effects (RE), Fully Modified Least Squares (FMOLS) and Dynamic Least Squares (DOLS) model to achieve the main aim and objectives and addresses respective hypotheses of the study. All macroeconomic variables used for empirical investigation were carefully chosen based on theoretical grounds underpinning the relationship between economic variables under investigation. In line with the work of Ocran (2011), Taylor *et al.* (2011) and Ghosh *et al.* (2013), macroeconomic variables under examination include economic growth (growth in GDP), government expenditure, government revenue, gross fixed capital formation, employment and public debt.

As mentioned earlier, the study employed a panel data of 13 Southern African Developing Communities (SADC), viz. Angola, Botswana, Democratic Republic of Congo, Eswatini, Lesotho, Mauritius, Malawi, Mozambique, Namibia, South Africa, Seychelles, Tanzania, Zambia, and Zimbabwe, and covers the period 2000-2018. The time series data of all variables were extracted from the World Development Indicators (WDI), Federal Reserve Economic Data (FRED) and Quantec EasyData database. Stata 14 and EViews 10 software are used to conduct estimation process. The macroeconomic variables under consideration for empirical investigation, their sources and *a priori* expectations are shown in Table 3.1 below:

**Table 3.1: Data issues**

| **Variables** | **Description** | **Units of Measurement** | ***A prior* expectation** | **Source** |
|---|---|---|---|---|
| Economic Growth | Gross domestic product (GDP) at constant prices | $ Millions | | WDI/ Quantec |
| Government Expenditure (GOE) | National government expenditure as percentage of GDP | Percentage | + | WDI/ Quantec |
| Gross Fixed Capital Formation (GFCF) | Gross fixed capital formation (Investment) as a percentage of GDP | Percentage | + | WDI/ Quantec |
| Employment (EMP) | Total employment to population ratio | Percentage | + | FRED |
| Public Debt (PD) | Total loan debt of national government as a percentage of GDP | Percentage | - | WDI/ Quantec |

*Source: Generated by the researcher*

The few variables that were expressed as monetary values were transformed into natural logarithmic form to interpret the coefficient values as elasticities and to further mitigate the issue of heteroscedasticity in the model. The data for GDP was extracted in monetary values and therefore converted into natural logarithms to deal with the problem of heteroscedasticity among residuals in the regression. The rest of the variables were not transformed into natural logarithms since they were expressed as percentages.

If it is supposed that there exists a linear relationship between the variables in the model, then the linear equation representing the model specification can be written in the following expression:

$$lnGDP = \alpha_0 + \beta_1 GOE + \beta_2 GFCF + \beta_4 EMP + \beta_5 PD + \varepsilon_t \qquad (3.2)$$

In the above equation (3.2), GDP is transformed into a natural logarithmic form since the series is expressed in monetary values rather than a percentage form. As previously stated, this process enables us to interpret coefficients $\beta_{1,2,3\ldots}$ as elasticities and to mitigate heteroscedasticity in the regression model. The model specification in equation (3.2) is fundamentally supported by theoretical foundations in the Keynesian model, Endogenous growth and Solow growth model discussed in chapter 2. As mentioned earlier in chapter 2, the Keynesian approach is based on the active role of government countercyclical intervention through spending and taxes to influence output and employment. Whereas the Endogenous growth and Solow model put more emphasis on the impact of investment in human capital, innovation, technology and knowledge as fundamental contributors to an increase in productivity. Estimating a PVAR model requires all variables to be integrated of the same order, i.e. I(1). Hence, it is important to test for stationarity among variables before the specification and estimation of the actual model. Testing for stationarity among variables allows us to understand the underlying data generating process in the data series and helps to avoid the estimation of spurious regression if the regressions are estimated using non-stationary data series.

The graphical analysis of variables in both levels and first difference were used as the first preliminary assessment of data to analyse stationarity among variables. The study conducted the unit root test using the Im-Pesaran-Shin (IPS), Levin and Lin and Fisher-type Choi tests which are all applicable within a panel framework. The purpose of this process was to determine the order of integration and stationarity status in the data series. Moreover, as part of a preliminary examination of the data, the study further computed descriptive statistics to reveal important statistical measures such as measures of central tendency, skewness and kurtosis to determine deviations of the data series from the normal distribution.

Stationarity helps to understand some of the useful descriptions of future behaviour of variables in the time series. A stationary time series is the one that has a constant mean, variance and covariance over-time. If variables are non-stationary in their level form, the most common technique to transform a non-stationary series ($Y_t$) to stationary is through first differences to render the series stationary, i.e. $\Delta Y_t = Y_t - Y_{t-1}$. The variable $Y_t$ can now be deemed as stationary since it equates to the idiosyncratic error term. The correlation-covariance matrix was computed to understand *a priori* expectations, co-movements, and possible multicollinearity among variables over-time.

### 3.5.1 Panel Vector Autoregressive (PVAR) Approach

As previously mentioned, this study adopted a PVAR approach proposed in the pioneering work of Holtz-Eakin *et al.* (1988), which is further cited by Love and Zicchino (2006) and Abrigo and Love (2016), to examine the role of fiscal policy and sovereign debt on economic growth in the SADC region. The PVAR technique is one of the most sophisticated and cutting-edge estimation techniques which collaborates the characteristics of both panel data and VAR methodology. The PVAR has the ability to deal with the issues of heterogeneity and endogeneity within a panel setup. A PVAR model combines the traits of a VAR with a panel data approach, which treats all variables as endogenous, allowing for unobserved heterogeneity and endogeneity within a panel data framework.

A PVAR estimation technique is widely used in panel data applications to determine the average effects across heterogeneous groups of units, and to further generalise unit specific differences relative to the group average. Canova and Pappa (2006) contend that a PVAR approach has the ability to analyse whether government expenditure is more countercyclical on average among different groups of countries which have fiscal restrictions, or to assess whether the fiscal rule depends on the type of fiscal restrictions imposed by each country. A simple PVAR equation for 13 selected SADC countries can be written in the following linear matrix expression form:

$$Y_{it} = \alpha_0 + \Gamma_1 Y_{i,t-1} + \Gamma_2 Y_{i,t-2} + \cdots + \Gamma_p Y_{i,t-p} + \varepsilon_{it} \quad (3.3)$$

$i \in \{1,2, \dots, N\}, t \in \{1,2, \dots, T_i\}$

Where $Y_{it}$ represents a (5×1) vector of stationary endogenous variables which include economic growth (GDP), government expenditure (GOE), gross fixed capital formation (GFCF), employment (EMP) and public debt (PD). $\alpha_0$ is a (5×1) vector of a constant coefficients, $\Gamma_{1,2,3\ ,\dots,p}$ is a (5×5) matrix of coefficient estimates, $\varepsilon_{it}$ represents a (5×1) vector of innovations in the system, $\boldsymbol{i}$ is a cross-sectional identifier, and $p$ is the optimal lag length of each variable selected using the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) due to substantial number of observations that comes with the estimation of a PVAR technique. In line with the Wagner's hypothesis, Ravnik and Žilić (2011) suggests that when ordering fiscal variables with other macroeconomic variables, government expenditure is not contemporaneously affected by changes of other variables. Rather, its movements are solely dependent on government decisions, and all other macroeconomic variables can only affect the government expenditure with a lag. Other variables in the model specification are likely to respond to contemporaneous changes in the government expenditure.

Furthermore, the impulse response functions (IRF) and variance decompositions are computed to examine the response of GDP due to the innovative shocks of endogenous variables in the system once the identification of structural shocks have been successfully attained. Additionally, the study further computes a Granger causality test to analyse the causal relationship between endogenous variables in the system. As supporting models, the study further employed the Hausman test to choose the most appropriate model between the country's specific fixed-effects (FE) and the random-effects by accepting or rejecting the null hypothesis of no correlation between the regressors and individual effects within a panel framework.

### 3.5.2 The Fixed Effects (FE) Model

As stated earlier, this study estimates various estimation techniques to support and verify the results of the PVAR model. The Fixed effects (FE) and Random effects (RE) modelling has been frequently used in econometric modelling to determine conventional relationships among economic variables in a panel data analysis. The FE explore the relationship between predictor variables and outcome variables within a panel setup. The individuals within a panel have individual characteristics that may or may not influence the predictor variables, for example, a political system of a particular country could have certain effects on economic growth of the country (Torres-Reyna, 2007). The FE model assumes that there are some factors within individuals that may affect or cause bias in the endogenous or explanatory variables and therefore must be accounted for and corrected.

The FE model seeks to remove the effect of time-invariant characteristics to solely examine the net effect of each explanatory variable on the endogenous variable. The FE further assumes that the time-invariant characteristics are different across countries and ought to be uncorrelated with other individual characteristics. This suggest that that the error term and intercept of each country that captures individual characteristics should be uncorrelated with each other. If they are correlated, then the FE is not an appropriate model to be used due to its bias. Thus one should consider using the RE model through the computation of the Hausman test. The FE equation can be expressed as follows:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + \varepsilon_{it} \tag{3.4}$$

Where, $Y_{it}$ is the dependent variable, $i =$ country and $t =$ time, $\beta_1$ is the slope coefficient of the independent variable, $X_{it}$ represents a vector of explanatory variables, $\alpha_i$ represents the unknown intercept for each country, and $\varepsilon_{it}$ represents an idiosyncratic error term. Stock and Watson (2003) suggested that the key assumption of the FE model is that the unobserved variables do not change over-time, and thus any changes in the endogenous variable must be due to other influences except those of the fixed characteristics.

### 3.5.3 The Random Effects (RE) Model

The RE model assumes that the variation across countries is random and uncorrelated with the predictor variable and explanatory variables in the model. The key distinction between the FE and RE effects lie on whether the unobserved individual effect embodies an element of correlation with regressors rather than stochastic relationships in the model. Moreover, if one believes that different countries may have various influences on the endogenous variable, then RE should be chosen as an appropriate model based on such reasons. The major advantage of the RE is that it can account for time invariant variables such as gender, race, age etc., while the FE absorbs the effect of these variables through the constant term (Torres-Reyna, 2007). The RE equation may be written as follows:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + \varepsilon_{it} + \mu_{it} \tag{3.5}$$

Where $Y_{it}$ is the dependent variable, $i =$ country and $t =$ time, $\beta_1$ is the slope coefficient of the explanatory variables, $X_{it}$ is the independent variable, $\alpha_i$ represents the unknown intercept for each country, $\varepsilon_{it}$ represents the within-country error term, and $\mu_{it}$ represents the between-country error term. The RE model allows for time-invariant variables to be included as explanatory variables in the model. The RE requires the identification and specification of individual characteristics across countries that may influence the predictor variable. However, a key challenge with this estimation process is that there may be data unavailability issues for time-invariant variables which may lead to omitted variable bias in the model (Torres-Reyna, 2007).

As stated earlier, the Hausman test is carried out to choose the most appropriate model between the FE and RE models. The Hausman test examines the null hypothesis that the RE is the preferred model against the alternative of the FE model. The diagnostic inspection tests include testing for the time-fixed effect to determine whether the time-fixed effects are necessary when estimating the FE model, testing for the random effects using the Breusch-Pagan Lagrange multiplier (LM) test in order to decide between the random effects and OLS regression and lastly, testing the cross-sectional dependence using the Breusch-Pagan LM test of independence. According to Baltagi (2001), the cross-sectional dependence remains a major problem in macro panel data with large time series but not much of an issue in small panel data samples.

### 3.5.4 Fully Modified Ordinary Least Squares (FMOLS)

As previously mentioned, the study further employs various single-equation estimators for robustness to verify the PVAR estimates. The FMOLS is one of the most recent and robust dynamic panel estimators that was estimated as part of robustness checks to deal with endogeneity in the model. The FMOLS estimation technique was developed by Pedroni (2001). Consider the following regression equation:

$$Y_{it} = \alpha_{it} + X_{it}\beta + \varepsilon_{it} \tag{3.6}$$

Where $Y_{it}$ is a matrix of a dependent variable, $X_{it}$ is a vector of first differenced exogenous variables, $\beta$ is the vector of slope coefficients, $\alpha_i$represent the individual fixed effect, and $\varepsilon_{it}$ is an $I(0)$ idiosyncratic errors. The FMOLS estimator can be presented as follows:

$$\hat{\beta}_{FMOLS} = \left(\hat{\beta}^*_{NT} - \beta\right) = \left(\sum_{i=1}^{N} \hat{L}^{-2}_{22i} \sum_{i=1}^{T} (X_{it} - \bar{X}_t)^2\right)^{-1} \sum_{i=1}^{N} \hat{L}^{-1}_{11i}\, \hat{L}^{-1}_{22i} \,(\sum_{t=1}^{T}\, (X_{it} - \bar{X}_{it})\, \varepsilon^*_{it} - T\gamma_i)$$

Where, $\gamma_i$ represents the term used to correct for autocorrelation in the system, and $\varepsilon^*_{it}$ is the error term used to account for endogeneity issues in the model.

### 3.5.5 Dynamic Ordinary Least Squares (DOLS)

The DOLS is an extension of a single DOLS estimator developed by Stock and Watson (1993). The DOLS has the ability of addressing endogeneity issues through the use of leads and lags of first difference regressors while correcting for possible serial correlation using generalised least squares procedures. The DOLS equation can be written as follows:

$$Y_{it} \;=\; \alpha_i \;+\; X_{it}\beta \;+ \sum_{j=-q}^{j} c_{ij}\; \Delta\, X_{i,t+j} + \varepsilon_{it} \tag{3.7}$$

Where $X_{it}$ is a vector of explanatory variables that affect the endogenous variable $Y_{it}$, which represents economic growth. $c_{ij}$ represent the coefficients of leads and lags of the first differenced regressors. The DOLS estimates are given as follows:

$$\hat{\beta}_{DOLS} = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \mathrm{X_{it}}\; X'_{\mathrm{it}}\right)^{-1} \left(\sum_{t=1}^{T} X_{\mathrm{it}}\; \hat{\mathrm{Y}}^{+}_{\mathrm{it}}\right) \tag{3.8}$$

Where $\mathrm{X_{it}}$ represents a $2(q+1)\;\times 1$ vector of all exogenous variables in the equation as given by [$X_{it} - \bar{X}_i$, $\Delta X_{i,t-q}$, $\ldots$ , $\Delta X_{i,t+q}$].

## 3.6 ANALYSIS OF EMPIRICAL RESULTS

This section reports on the empirical estimation procedure that was undertaken, and further presents the discussion of the empirical results of the PVAR model as well as supporting single equation methods that were estimated. These include fixed effects, random effects, Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimation techniques. The PVAR model was employed, which was estimated using Stata commands and instruments offered by Abrigo and Love (2015). As previously mentioned, the main focus of the study is to investigate the role of fiscal policy and sovereign debt on economic growth using a panel data of 13 SADC members-states, running from the period 2000-2018. The macroeconomic variables used in the model specification are economic growth (GDP), government expenditure (GOE), gross fixed capital formation (GFCF), employment (EMP) and public debt (PD).

The study took advantage of a PVAR's superiority to trace the responsiveness of each endogenous variable to the innovative shocks of other endogenous variables through the use of the impulse response Functions (IRF) and Cholesky variance decomposition. The Granger causality test offered within the PVAR model was also estimated in order to check the causality link among variables in the system. This procedure enables us to intensively study the dynamic interactions between fiscal policy, public indebtedness and economic growth in the SADC region as the primary objective of this chapter. This then addresses the first research hypothesis on the empirical relationship among the variables in the system. Moreover, the estimation of panel single equation methods, which include fixed effects (FE), random effects (FE), FMOLS, and DOLS estimation methods, allows for support and verification of the empirical results produced by the PVAR model framework.

### 3.6.1 Descriptive Statistics

This section provides for the analysis of descriptive statistics which include measures of central tendency, skewness, kurtosis and Jarque-Bera statistics for testing normality in the data series. The analysis of descriptive statistics in a time series analysis is a very important practice that helps understand and ascertain deviations, dispersions and normality of the data series before the estimation of the actual model.

**Table 3.2: Descriptive Statistics**

| | LGDP | GOE | GFCF | EMP | PD |
|---|---|---|---|---|---|
| Mean | 3.160249 | 28.13423 | 23.23933 | 61.09469 | 47.58418 |
| Median | 3.118839 | 27.55900 | 22.83800 | 61.23600 | 38.24300 |
| Maximum | 4.018579 | 60.36900 | 55.36300 | 85.58700 | 260.9640 |
| Minimum | 2.179968 | 2.483000 | 2.000441 | 35.23600 | 6.228000 |
| Std. Dev. | 0.508977 | 10.41797 | 9.675532 | 15.16098 | 35.81790 |
| Skewness | -0.017165 | 0.274193 | 0.478289 | -0.089174 | 2.281652 |
| Kurtosis | 1.648224 | 3.207442 | 3.393952 | 1.698220 | 10.45165 |
| Jarque-Bera | 18.81808 | 3.537865 | 11.01453 | 17.76794 | 785.7780 |
| Probability | 0.000082 | 0.170515 | 0.004057 | 0.000139 | 0.000000 |
| Sum | 780.5816 | 6949.155 | 5740.115 | 15090.39 | 11753.29 |
| Sum Sq. Dev. | 63.72824 | 26699.38 | 23029.51 | 56544.44 | 315598.8 |
| Observations | 247 | 247 | 247 | 247 | 247 |

*Source: Researcher's own results*

Theoretically, the series is considered to be normally distributed if the kurtosis value is around three (3) and with zero (0) skewness. Table 3.2 shows that the mean and median values of all the variables are not significantly different from each other. The skewness values of almost all variables are equals to zero, except for public debt which is equal to 2.3. The kurtosis values of all variables lie between 1 and 3, which is fairly plausible except for public debt with the kurtosis value of 10.45. This implies that the public debt series is not normally distributed. Furthermore, the researcher tested heteroscedasticity among the residuals which could be presented by the problem of skewness of the data in order to arrive at robust empirical findings. The positive values of skewness suggest that there is a long right tail in the dataset distribution, while a negative skewness value indicates a long-left tail. The summary descriptive statistics indicate that the majority of the data series is not normally distributed since the respective p-values are less than 0.05. However, these kinds of results are common and expected in the case of panel data setup and are less of an issue in the estimation of panel data models. The descriptive statistics shows that on average, GDP growth in the SADC region is around 3.16%, GOE is 28.13%, GFCF is around 23.23%, EMP is around 61.09% and PD is around 47.58% from the period

2000 to 2018. The descriptive statistics results are considered plausible since the majority of these figures are realistic to reflect the economic outlook of developing regions.

**Table 3.3: Covariance Analysis**

Covariance Analysis: Ordinary
Date: 11/19/19 Time: 13:42
Sample: 2000 2018
Included observations: 247

| Correlation<br>Probability | LGDP | GOE | GFCF | EMP | PD |
|---|---|---|---|---|---|
| LGDP | 1.000000 | | | | |
| | ----- | | | | |
| GOE | 0.383278 | 1.000000 | | | |
| | 0.0000 | ----- | | | |
| GFCF | 0.184547 | 0.436430 | 1.000000 | | |
| | 0.0036 | 0.0000 | ----- | | |
| EMP | -0.646559 | -0.417853 | 0.052565 | 1.000000 | |
| | 0.0000 | 0.0000 | 0.4108 | ----- | |
| PD | -0.488323 | -0.228364 | 0.029548 | 0.319318 | 1.000000 |
| | 0.0000 | 0.0003 | 0.6440 | 0.0000 | ----- |

*Source: Researcher's own estimation results*

Table 3.3 shows the results of the correlation matrix for all variables in the model. The results of pair-wise correlations show that there is a significant positive correlation between economic growth (GDP), government expenditure (GOE) and gross fixed capital formation (GFCF). On the other hand, there is a significant negative correlation between economic growth (GDP), employment (EMP), public debt (PD). The expected positive sign of GOE is plausible since the governments use fiscal stimulus through an increase in government expenditure to promote economic growth. The expected significant positive correlation between GDP and GFCF is theoretically plausible as suggested by the Solow and Endogenous growth models. On the other hand, the negative correlation between GDP and EMP is not plausible and may suggest the existence of a Jobless growth theory among SADC member-states. Public debt shows a correct and expected significant negative correlation with GDP. Moreover, the correlation coefficients are moderate. This implies that there are no signs multicollinearity among variables in the model.

According to Asteriou and Hall (2016), a correlation coefficient of 0.9 indicates a strong probability of multicollinearity between variables under consideration. Furthermore, the depiction of correct correlation coefficient matrix signs between GDP, GOE, GFCF, EMP and PD confirm the economic relationships as supported by conventional economic literature, except for the correlation coefficient for employment, which contradicts the conventional theoretical literature. The majority of correlation matrix are consistent with empirical studies and conventional economic theory discussed in Chapter 2 of the study.

### 3.6.2 Formal Panel Unit Root Inspection of Variables

This section presents the results of formal unit root testing to determine stationarity and order of integration among variables. The study utilised the Im, Pesaran, and Shin (2003) (IPS), Levin, Lin and Chu (2002) (LLC) and Fisher-type Choi (2001) (FSR) test to check for a unit root among variables in a panel framework. These tests are carried out based on the null hypothesis that the data series has a unit root. The null hypothesis is rejected if the value of the t-statistic is greater than the critical value, hence there is no unit root. Table 3.4 below presents the unit root tests results for each variable using IPS, LLC and FSR.

**Table 3.4: Unit Root Test Results**

| TESTS | LGDP | GOE | GFCF | EMP | PD |
|---|---|---|---|---|---|
| **IPS W-stat** | | | | | |
| Levels | -0.1213 | -1.7216** | -2.2932** | -1.3967* | 0.5709 |
| [*P-value*] | [0.4517] | [0.0426] | [0.0109] | [0.0812] | [0.7160] |
| Differences | -6.7957*** | -6.9142*** | -7.3154*** | -3.2266*** | -6.8567*** |
| [*P-value*] | [0.0000] | [0.0000] | [0.0000] | [0.0006] | [0.0000] |
| **LLC t*-stat** | | | | | |
| Levels | -1.3803* | -5.1182*** | -3.4834*** | -5.0823*** | -5.1083*** |
| [*P-value*] | [0.0837] | [0.0000] | [0.0002] | [0.0000] | 0.0000] |
| Differences | -6.7750*** | -7.1254*** | -5.9607*** | -4.0213*** | -5.1892*** |
| [*P-value*] | [0.0000] | [0.0000] | [0.0000] | [0.0000] | [0.0000] |
| **Fisher-type** | | | | | |
| Levels | 6.8882*** | -1.7442 | -0.1736 | -0.6503 | -2.1810 |
| [*P-value*] | [0.0000] | [0.9594] | [0.5689] | [0.7423] | [0.9854] |
| Differences | 18.9540*** | 15.3760*** | 17.5574*** | 1.4532* | 19.1373*** |
| [*P-value*] | [0.0000] | [0.0000] | [0.0000] | [0.0731] | [0.0000] |

*Notes: Asterisks ***, ** and * denotes the statistical level of significance at 1%, 5%, and 10%, respectively. The [p-values] are shown in parenthesis.*

*Source: Researcher's own results*

The IPS test assumes that there are individual unit root processes across the cross-section which allows for heterogeneous parameters in a balanced panel data. On the other hand, the LLC test assumes that there is a common unit root process for all cross-sections, allowing for homogeneity parameters. The IPS is the main test for testing the unit root since LLC does not account for heterogeneity bias in a panel data. Hence, the LLC and FSR unit root tests are computed to complement and verify IPS test results. The IPS test shows that GOE, GFCF and EMP are stationary in level form while LGDP and PD are stationary at first difference and significant at 1% level of significance. The LLC test shows that all variables are I(0) at 1% significance level, except for LGDP which is significant at 10% level of significance.

Conversely, the FSR shows that all variables are nonstationary in levels, except for LGDP, which is stationary in level form but significant at 10%. Therefore, in the presence of controversy among these unit root tests, the series was first converted into differences, and thus all three tests suggested that all variables are stationary at first difference, i.e. I(1). However, the inferences were drawn upon the IPS test due to the afore-mentioned advantages of the IPS test and rigor involved in computation.

### 3.6.3 Panel Vector Autoregression Results

This section deals with the interpretation of the estimated PVAR coefficients, and further computes the impulse response functions (IRF), variance decomposition and Granger causality test. The detailed results of the estimated model are reported to show how the entire execution process of a PVAR was generated. A five-variable PVAR model was estimated, viz, GDP, GOE, GFCF, EMP and PD. The study estimated the PVAR model using Stata commands offered by Abrigo and Love (2015).

**Table 3.5: PVAR Lag Length Order Selection**

```
pvarsoc LGDP GOE GFCF EMP PD, maxlag(3) pvaropts(instl(1/6))
Running panel VAR lag order selection on estimation sample
 Sample: 2006 - 2017              No. of obs   =    156
                          No. of panels  =    13
                          Ave. no. of T  =  12.000
```

| lag | CD | J | J pvalue | MBIC | MAIC | MQIC |
|---|---|---|---|---|---|---|
| 1 | .9999998 | 126.4534 | .4468167 | -504.7786 | -123.5466 | -278.3865 |
| 2 | .9999998 | 94.32337 | .6412739 | -410.6622 | -105.6766 | -229.5486 |
| 3 | .9999995 | 62.13668 | .8558537 | -316.6025 | -87.86332 | -180.7673 |

*Source: Researcher's own estimation*

The process of determining the lag length order is the most important practice that allows for the selection of the most appropriate lag order within a PVAR framework before the actual estimation of the model. Andrews and Lu (2001) and Abrigo and Love (2015) contend that the appropriate lag order that should be chosen within a PVAR model is the one at which the MBIC, MAIC, and MQIC have the smallest statistic values. The above Table 3.5 shows that MBIC, MAIC, and MQIC are all smaller at lag 1. Therefore, we proceed with the estimation of the first order PVAR model since the three-model selection criterion have the smallest statistical values at lag 1 as proposed by Abrigo and Love (2016).

**Table 3.6: PVAR Model Estimates**

```
pvar LGDP GOE GFCF EMP PD, instl(1/6)
Panel vector autoregresssion
GMM Estimation
Final GMM Criterion Q(b) =   .811
Initial weight matrix: Identity
GMM weight matrix:   Robust
                          No. of obs    =    156
                          No. of panels  =    13
                          Ave. no. of T  =  12.000
------------------------------------------------------------------------------
       |   Coef.  Std. Err.    z  P>|z|    [95% Conf. Interval]
-------------+----------------------------------------------------------------
LGDP     |
    LGDP |
     L1. |  .6645398  .0217474  30.56  0.000   .6219157  .7071639
       |
     GOE |
     L1. |  .010939  .0006493  16.85  0.000   .0096665  .0122115
       |
    GFCF |
     L1. | -.0034472  .0003584  -9.62  0.000  -.0041497  -.0027448
       |
     EMP |
     L1. |  .0038031  .0012699   2.99  0.003   .0013141  .0062921
       |
     PD |
     L1. |  .0003212  .0001474   2.18  0.029   .0000323  .0006101
```

*Source: Researcher's own estimation*

This section provides the discussion of a PVAR estimate on the relationship between fiscal policy instruments and economic growth in SADC region. As mentioned earlier, the study employed a PVAR model to capture dynamic relationships between economic growth (GDP), government expenditure (GOE), gross fixed capital formation (GFCF), employment (EMP), and public debt (PD). The PVAR results are reported in the following equation with the slope coefficients of variables and t-statistics shown in parenthesis:

$$LGDP_t = \mathbf{0.66}\boldsymbol{LGDP}_{t-1} + \mathbf{0.011}\boldsymbol{GOE}_{t-1} - \mathbf{0.003}\boldsymbol{GFCF}_{t-1} + \mathbf{0.0038}\boldsymbol{EMP}_{t-1} + \mathbf{0.00032}\boldsymbol{PD}_{t-1} \tag{3.9}$$

$$[30.56] \quad [16.85] \quad [-9.62] \quad [2.99] \quad [2.18]$$

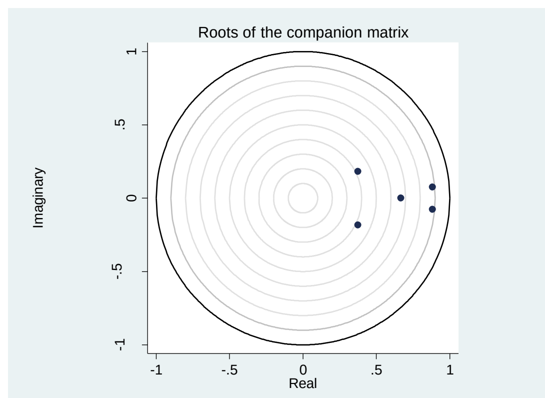
Since explanatory variables in the above equation are expressed as log-linear models, one has to multiply the respective coefficients by 100. A positive elasticity coefficient of GOE suggests that a $1\%$ rise in lagged GOE causes a $1.1\%$ rise in GDP this period, which is significant at conventional level. This result implies that economic growth responds positively as a result of a positive shock in fiscal policy. Thus, government expenditure is indeed an important determinant of growth as proposed by the Keynesian approach. On the other hand, GFCF holds a significant negative effect on economic growth. This result implies that a $1\%$ rise in GFCF would lead to economic growth contracting by $0.3\%$ since this is a log-linear representation. Although the coefficient magnitude is too small to exert a severe effect, this relationship is not plausible since it contradicts the conventional theory in the Solow and Endogenous growth models which suggest that investment ought to bring about a positive impact on economic growth. Moreover, the results shows that employment has a significant positive impact on economic growth albeit with a small coefficient magnitude. This suggests that if employment increases by $1\%$, the economy will grow by $0.3\%$, at $1\%$ level of significance. Even though the magnitude of the coefficient is modest, this finding is plausible and in line with conventional literature.

The elasticity coefficient of public debt (PD) has a significant positive impact of $0.03\%$ on economic growth (LGDP), implying that if PD increases by $1\%$, GDP will rise by $0.03\%$, which is significant at a $5\%$ significance level since this is a log-linear model. This result reveals a modest effect. However, this finding is theoretically plausible since it is consistent with the Endogenous growth model proposed by Romer (1986) and Barro (1989), which states that the effect of public debt on economic growth would be positive if that debt is channelled towards productive sectors such as infrastructural development, technology, education, and innovation rather than directing more finances towards social consumption such as social security, AIDS and healthcare in developing countries.

Furthermore, the economic divergence is traceable between advanced and developing economies. Among developed countries such as the USA, Japan and Germany, a high level of government debt is channelled towards productive sectors such as manufacturing, infrastructural development, technological advancement, and innovation to promote sustainable economic growth. On the other hand, developing economies, including SADC member-states, are characterised by high government debt that are often directed to financing social consumption such as social security, health, and AIDS. The empirical results shows that the Keynesian hypothesis holds in the SADC region, and thus the first hypothesis of the study cannot be rejected as suggested by the PVAR estimates.

**Table 3.7: PVAR Stability Test**

```
.
pvarstable, graph
  Eigenvalue stability condition
 +----------------------------------+
 |    Eigenvalue    |       |
 |  Real   Imaginary | Modulus |
 |----------------------+-----------|
 | .8837326 -.0761423 | .8870067 |
 | .8837326  .0761423 | .8870067 |
 |  .667121      0 |  .667121 |
 | .3752628  .1824351 | .4172586 |
 | .3752628 -.1824351 | .4172586 |
 +----------------------------------+
  All the eigenvalues lie inside the unit
circle.
  PVAR satisfies stability condition.
```



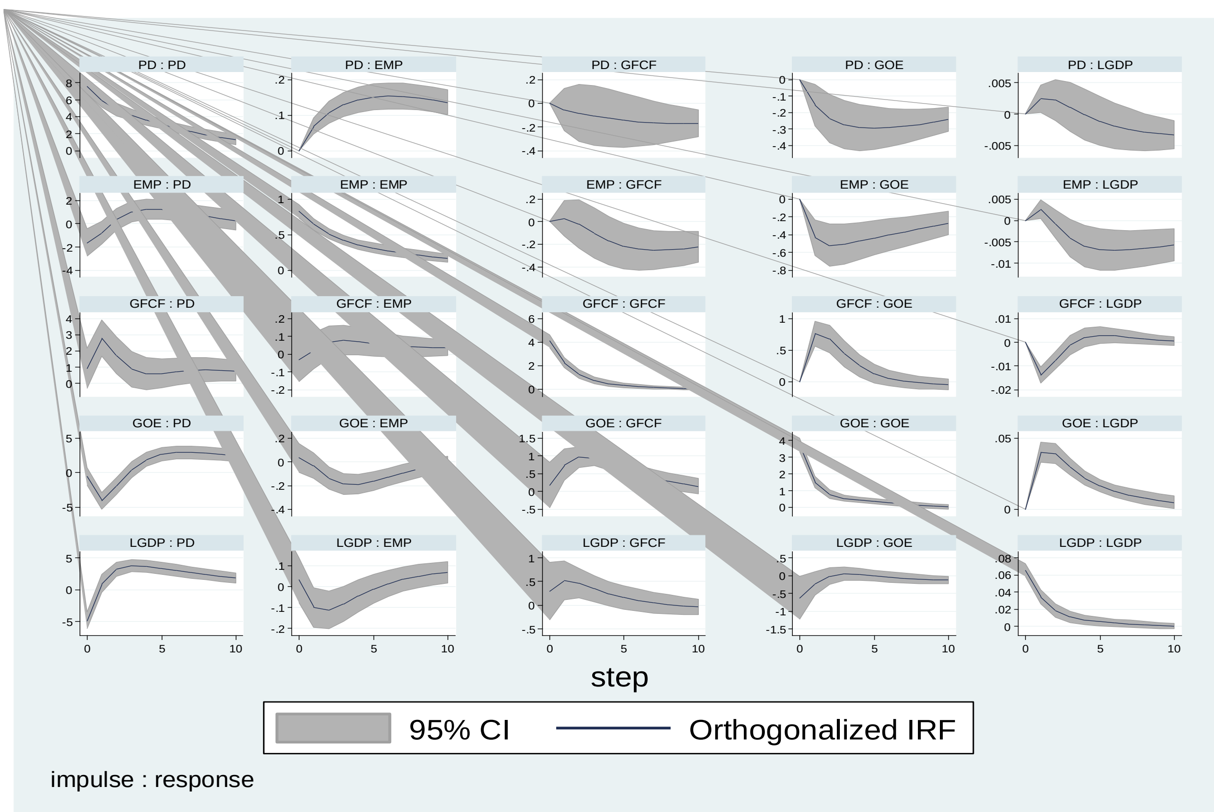

*Source: Researcher's own results*

The stability condition of the estimated PVAR model was inspected prior to estimating the IRF, variance decomposition, and Granger causality test. The above PVAR eigenvalues stability condition results shows that the estimated PVAR model is stable (Abrigo and Love, 2015). The findings from the Autoregressive (AR) roots tests indicate that all eigenvalues lie inside the unit circle, and therefore the PVAR satisfies the stability condition. Hence, the reported AR roots test results show that the PVAR is an appropriate technique. Therefore, the study further estimates the IRFs and variance decomposition to ascertain the degree of different shocks between GDP, GOE, GCFC, EMP and PD within a PVAR to achieve the first objective of the study and address the respective hypothesis.

#### 3.6.3.1 PVAR Impulse Response Functions (IRF)

As mentioned earlier, the impulse response functions (IRF) are computed to trace the responsiveness of each endogenous variable due to the innovative shocks in the system. The IRF results are presented over a ten-year horizon. These results are reported to give analysis of selected variables in addressing the study's objectives and hypotheses. The main purpose of estimating the IRF and variance decomposition is to ascertain the degree of different innovative shocks between GDP, GOE, GFCF, EMP and PD. The IRFs are carried out for a system of all stationary endogenous variables within a PVAR system.

**Figure 3.1: Impulse Response Functions (IRF)**




*Source: Researcher's own estimation*

Following the work of Holtz-Eakin *et al.* (1988), it is assumed that the innovative shocks in LGDP have a direct impact on contemporaneous GOE, GFCF, EMP and PD, while these variables only affect LGDP in the future. The IRF confidence intervals are computed using 200 Monte Carlo drawn from the estimated PVAR model. The IRF result of interest remains the response of economic growth (LGDP) in SADC region to the positive shocks of fiscal policy as measured by government expenditure (GOE), investment (GFCF), employment (EMP) and sovereign indebtedness (PD). The IRF plot on the fifth row shows that a positive unexpected shock from the GOE leads to a significant positive response of LGDP, which implies a positive impact of fiscal policy stimulus on growth in SADC region. Interestingly, the GOE responds positively to the innovative shock of LGDP. Notably, the current unexpected shock in GOE have a positive yet short-lived impact on both GOE and LGDP because these unanticipated shocks fade away after the period of approximately 2 years. As expected, the impact of unexpected current shocks of LGDP has a positive effect on future LGDP, but the shock disappears after a 5 year period lags.

The IRF results exhibit a slightly positive yet short-lived response of LGDP to the shocks of GFCF, and a negative short-lived response of GFCF from the shocks of LGDP. Consistent with the estimated PVAR coefficients, a negative response of LGDP is observed from the unanticipated innovative shock in EMP. However, this shock fades away after approximately 2 years. Lastly, there is a positive yet short-lived shock from PD to LGDP. This unexpected shock in PD is immediately felt in the economy. The impact of the shocks of all variables are significantly felt in the economy. However, these innovative shocks fade away within a 10-year horizon. Moreover, the results of the IRF are consistent with the Granger causality test results and are in line with the PVAR coefficient dynamics presented in section 3.4.3. These findings suggest that the Keynesian hypothesis holds true for SADC region. Thus, the first hypothesis of the study holds in the SADC region.

**Table 3.8: PVAR Variance Decomposition**

```
. pvarfevd, mc(200)

Forecast-error variance decomposition

---------------------------------------------------------------

Response  |

variable  |

and       |

Forecast  |                Impulse variable

horizon   |     LGDP       GOE       GFCF       EMP        PD

----------+----------------------------------------------------

LGDP      |

        0 |        0         0          0         0         0

        1 |        1         0          0         0         0

        2 | .7493333  .2224059    .026513  .0009388  .0008091

        3 | .6283415  .3423859   .0272646  .0008329  .0011752

        4 | .5764833  .3952606   .0246357  .0024419  .0011786

        5 | .5508633  .4186224     .02373   .005668  .0011164

        6 |  .535971   .429411   .0237794  .0096464  .0011921

        7 | .5262025   .434629   .0239555   .013726   .001487

        8 |  .519299  .4371127    .024015  .0175718  .0020015

        9 | .5142139  .4380798   .0239674  .0210427  .0026962

       10 | .5103869  .4381374   .0238676   .024091  .0035171
```

*Source: Researcher's own estimation*

This section undertakes the estimation of a variance decomposition in order to ascertain the ability of fiscal policy and sovereign debt shocks to explain fluctuations in economic growth in the SADC region. As mentioned earlier, we compute a variance decomposition to measure the contribution of each type of shock from each variable to the forecast error variance. Hence, this process allows us to determine the importance of each variable in explaining economic growth variations in SADC region. The estimates of the variance decomposition represent the percentage of variation of GOE, GFCF, EMP and PD as explained by the LGDP. The results of the variance decomposition show the fraction of a ten-year period ahead forecast error that can be explained by the variables utilised.

As expected, the overwhelming variation in the variance decomposition of LGDP is explained by its own variations. The Cholesky variance decomposition result shows that LGDP starts by explaining itself by $100\%$, and then begins to shrink at a decreasing trend down to $51\%$ throughout the ten-year period, implying that it takes a very long time for the effects of the shock to dissipate. Interestingly, the variation of GOE explains about $22\%$ and keeps on increasing up to $43\%$ after a 10-year horizon. The GFCF has a marginal effect in the forecast error variance of GDP, accounting for about $0.02\%$ on average of its short-run and long-run variance. The EMP has a very small percentage of variations on GDP, accounting for only $0.01\%$ on average of the variation in EMP explained by changes in LGDP. Finally, PD only accounted for as small as $0.01\%$ of the variation on average on LGDP over-time. Furthermore, the results of variance decomposition on the coefficients of variables are consistent with theoretical basis of Cholesky variance decomposition.

**Table 3.9: PVAR Granger Causality Wald Test**

```
pvargranger
panel VAR-Granger causality Wald test
  Ho: Excluded variable does not Granger-cause Equation variable
  Ha: Excluded variable Granger-causes Equation variable
```

| Equation \ Excluded | chi2 | df | Prob > chi2 |
|---|---|---|---|
| LGDP | | | |
| GOE | 283.866 | 1 | 0.000 |
| GFCF | 92.523 | 1 | 0.000 |
| EMP | 8.968 | 1 | 0.003 |
| PD | 4.748 | 1 | 0.029 |
| ALL | 308.403 | 4 | 0.000 |

*Source: Researcher's own estimation*

The Granger causality Wald tests for all variables were computed to check for the direction of causal effects among variables. The Granger causality test inspects the significance of the null hypothesis, which states that there is no causality between variables under examination. The study uses a $5\%$ level of significance to decide on whether to accept or reject the null hypothesis. The Granger causality test results show that there is uni-directional causality from GOE to LGDP, i.e. GOE Granger-causes GDP at 1% significance level. Therefore, the null hypothesis stating that GDP does not cause GOE is rejected. This result is in line with the PVAR estimates and the IRF on the relationship between government expenditure (GOE) and economic growth (LGDP), and further confirms the Keynesian effects on economic growth in SADC region.

Moreover, the null hypothesis of no causality between GDP and GFCF is rejected at the conventional level since there is a significant bi-directional causality between GFCF and LGDP, implying that GFCF causes LGDP, and LGDP causes GFCF. Furthermore, there is a significant bi-directional causality between EMP and LGDP, and PD and LGDP. The results of the Granger causality test are statically significant at a conventional level, and theoretically plausible on the causality direction between LGDP and its regressors. The study is inclined to trust these findings from the PVAR technique due to the rigour involved in examining the residuals of this model and the accompanying stability tests.

## 3.7 VERIFICATION REGRESSIONS – ROBUSTNESS CHECKS

As previously mentioned, this study estimated the fixed and random effects, DOLS and FMOLS as supporting methods for PVAR estimates. Therefore, this section reports the estimated results of these verification estimation techniques for the purpose of empirical comparison and robustness checks. The Hausman test results presented in Appendix A, Table A9, showed that the fixed effects is the most appropriate model. However, this section reports the results of both fixed and random effects for robustness. The Hausman test examines the null hypothesis that the random effects is the appropriate model against the alternative of the fixed effects. The results of the Hausman test reveal that we reject the null hypothesis of the random effects, and thus the fixed effects is the appropriate model.

### 3.7.1 Fixed Effects (FE) Model

The fixed effects estimated slope coefficients is reported in the following equation:

$$LGDP = \mathbf{0.007}\boldsymbol{GOE} + \mathbf{0.006}\boldsymbol{GFCF} + \mathbf{0.034}\boldsymbol{EMP} - \mathbf{0.003}\boldsymbol{PD} \qquad (3.10)$$

$$[4.04] \quad [3.96] \quad [10.07] \quad [-11.28]$$

The results of the fixed effects are presented in Appendix A, Table A9, and these results complement the PVAR estimates and IRF. The explanatory variables in the above model are log-linear models, therefore one has to multiply the respective coefficients of all explanatory variables by 100. The above equation (3.8) suggests that a $1\%$ rise in GOE causes LGDP to expand by $0.7\%$, which is statistically significant at conventional level, *ceteris paribus*. A significant positive coefficient of GFCF indicates that a $1\%$ increase in GFCF would lead to a $0.6\%$ growth in GDP, which is statistically significant at $1\%$ significance level. The slope coefficient of EMP suggest that if employment increases by $1\%$, the economy would grow by $3.0\%$, *ceteris paribus.* On the other hand, the elasticity coefficient of PD indicates that if PD increases by $1\%$, GDP will contract by $0.3\%$, which is significant at conventional level. The FE rho statistic which is known as the intraclass correlation shows that $97.8\%$ of the variance is due to differences across panels. Furthermore, the F-test is less than $0.05$, which indicates that the estimated FE is a good model. This implies that all the coefficients in the regression are significantly different from zero. The fixed effects estimates are consistent with the PVAR results except for the EMP and PD coefficients which have different signs. However, this empirical finding is theoretically justifiable and supported by existing theoretical literature discussed in Chapter 2 of the study.

### 3.7.2 Random Effects (RE) Model

The estimated random effects equation is presented in the following equation:

$$LGDP = \mathbf{0.007}\boldsymbol{GOE} + \mathbf{0.005}\boldsymbol{GFCF} + \mathbf{0.021}\boldsymbol{EMP} - \mathbf{0.003}\boldsymbol{PD} \qquad (3.11)$$

$$[3.61] \quad [3.02] \quad [6.56] \quad [-10.05]$$

The random effects results are not significantly different from those of the fixed effects. These results are plausible and supports the PVAR estimates. The above equation (3.11) suggests that if GOE increases by $1\%$, LGDP would rise by $0.7\%$, which is statistically significant at $1\%$ level of significance, *ceteris paribus*. A positive and significant coefficient of GFCF is plausible since it is consistent with the Solow growth model. This implies that a $1\%$ increase in GFCF would cause LGDP to contract by $0.5\%$, which is statistically significant at $1\%$ significance level. The coefficient of EMP has a significant positive impact on LGDP, implying that a $1\%$ rise in EMP would lead to a $2.1\%$ growth in LGDP. Lastly, PD has a significant negative effect on LGD. This suggests that a $1\%$ rise in PD would cause LGDP to contract by $0.3\%$. The RE rho statistic shows that $86\%$ of the variance is due to differences across panels. Furthermore, the Wald F-test is less than $0.05$, which indicates that the estimated RE is a good model. This implies that all coefficients in the regression are significantly different from zero. The random effects estimates are theoretically plausible and confirm the PVAR outputs. These results are presented in Appendix A, Table A10.

### 3.7.3 Fully Modified Ordinary Least Squares (FMOLS)

The FMOLS model was carried out with the non-prewhitened Barlett kernel, Newey-West fixed bandwidth $= 40.000$. The FMOLS outputs are presented in Appendix A, Table A12. The FMOLS coefficients and their respective t-statistics are reported as follows:

$$LGDP = \mathbf{0.008}\boldsymbol{GOE} + \mathbf{0.006}\boldsymbol{GFCF} + \mathbf{0.033}\boldsymbol{EMP} - \mathbf{0.003}\boldsymbol{PD} \qquad (3.12)$$

$$[3.48] \qquad [3.22] \qquad [7.05] \qquad [-7.32]$$

The FMOLS results show that there is a significant positive relationship between GOE and LGDP. The results indicate that a $1\%$ rise in GOE causes LGDP to increase by $0.8\%$, which is significant at $1\%$ significance level. Therefore, we cannot reject the first hypothesis of the study, which states that there is a significant positive relationship between government expenditure and economic growth. Thus, the Keynesian hypothesis holds in the SADC region. A positive coefficient of GFCF implies that a unitary increase in investment would lead to a $0.6\%$ rise in economic growth, *ceteris paribus*. This result is consistent with the Solow and Endogenous growth model. As expected, the slope coefficient EMP is positive and statistically significant at $1\%$, implying that if employment increases by 1%, LGDP would expand by 3.3%. A significant negative coefficient for PD suggests that a 1% rise in public debt would cause economic growth to contract by 0.3%. Interestingly, these findings are theoretically plausible and supports the PVAR, FE and RE estimates.

Furthermore, the coefficient elasticity of government expenditure is theoretically plausible in a conventional sense as supported by the Keynesian approach on fiscal policy, which states that government expenditure should be used to influence economic activities through an increase in aggregate demand consistent with sustainable economic growth. The coefficient of GFCF is also theoretically plausible since it is expected that an increase in investment correlates with a rise in economic growth as proposed by the Solow growth model. The positive impact of employment on growth makes economic sense since, as the number of employed people increases, output level also increases. The negative effect of public debt on economic growth is in line with conventional economic literature which states that high public debt is detrimental for economic growth. However, this effect of PD on growth contradicts the PVAR coefficient, which is our main model of interest.

#### 3.7.3.1 FMOLS Diagnostic Test

The FMOLS has an adequate $R^2$ of 0.94%, which indicates that the regression model has a robust goodness-of-fit, and variations in economic growth are fully explained by variations in GOE, GFCF, EMP and PD. The normality test presented in Appendix A, Figure A2, shows that the residuals of the FMOLS model are normally distributed. Moreover, this notion is further supported by the skewness value of zero (0) and kurtosis value of 2.89 as proposed by the theory. Therefore, the FMOLS model passes all the post-diagnostic inspection tests for normality, thus confirming statistical adequacy.

### 3.7.4 Dynamic Ordinary Least Squares (DOLS)

The DOLS estimates are shown in Appendix A, Table A13. The estimated DOLS equilibrium equation with t-statistics in parenthesis is reported by the following equation:

$$LGDP = 0.008GOE + 0.007GFCF + \mathbf{0.037EMP - 0.004PD} \qquad (3.13)$$

$$[1.48] \quad [1.43] \quad [5.47] \quad [-5.56]$$

The above DOLS estimated equation (3.13) suggests that a $1\%$ increase in GOE causes LGDP to rise by $0.8\%$, but this effect is statistically insignificant. A positive impact of GFCF on growth is also statistically insignificant. On the other hand, EMP has a significant positive impact on growth, indicating that a $1\%$ rise in employment level would cause LGDP to grow by $3.7\%$, *ceteris paribus*. The elasticity coefficient of PD is negative and significant, implying that if PD increases by $1\%$, LGDP would decline by $0.4\%$ significant at $1\%$ significance level. The DOLS coefficients are consistent with the PVAR, FE, RE and FMOLS estimates, except for the insignificant effect of GOE and GFCF in the DOLS.

#### 3.7.4.1 The DOLS Diagnostic Tests

The DOLS regression has a very high $R^2$ of $0.99\%$, which indicates that the DOLS model is perfectly fitted with an excellent goodness-of-fit as explained by explanatory variables in the model. The results of normality test displayed in Appendix A, Figure A3 indicate that the residuals of the DOLS model are not normally distributed as indicated by a left-tail skewness and high kurtosis value. Hence, the analysis of the results produced by the DOLS model ought to be treated with caution and may not be used for policy prescription.

**Table 3.10: Summary of Empirical Results**

| Sample Size 1980 - 2018 (39 Periods, 14 Panel) | | | | | |
|---|---|---|---|---|---|
| **Variables** | **PVAR** | **FE** | **RE** | **FMOLS** | **DOLS** |
| **GDP** | 0.66***<br>[30.56] | - | - | - | - |
| **GOE** | 0.011***<br>[16.85 ] | 0.007***<br>[4.04] | 0.007***<br>[3.61] | 0.008***<br>[3.48] | 0.008<br>[1.48] |
| **GFCF** | -0.003***<br>[-9.62] | 0.006***<br>[3.96] | 0.005***<br>[3.02] | 0.006***<br>[3.22] | 0.007<br>[1.43] |
| **EMP** | 0.003***<br>[2.99] | 0.033***<br>[10.07] | 0.021***<br>[6.56] | 0.033***<br>[7.05] | 0.037***<br>[5.47] |
| **PD** | 0.0003***<br>[2.18] | -0.003***<br>[-11.28] | -0.003***<br>[-10.05] | -0.003***<br>[-7.32] | -0.004***<br>[-5.56] |

*Notes: 1. The table demonstrates PVAR, FE, RE, FMOLS and DOLS estimates, respectively. 2. t-statistics are shown in parentheses [ ]. 3. Asterisks ***, **and * indicate significance level at 1%, 5% and 10% respectively.*

The use of benchmark models has become the most appealing practice in modern econometric modeling to verify the robustness of empirical findings. The above results of the PVAR, FE, RE, FMOLS and DOLS models provide robust evidence of a significant positive role of fiscal policy on economic growth in the SADC region. The empirical results of the study are very robust and highly significant as estimated through various estimation techniques. The results show a strong fiscal policy credibility to promote economic growth in the SADC region. The majority of our empirical findings are consistent with conventional economic literature reviewed in section 3.2, such as Ismal (2011), Ocran (2011) and Taylor *et al.* (2011) among others.

The summary of the results reported in Table 3.5 shows that the PVAR estimates are supported by the FE, RE, FMOLS and DOLS, except for the contradiction in the coefficient sign for GFCF and PD. Moreover, the FE, RE, FMOLS and DOLS results are consistent and statistically significant at a conventional level for coefficients, except for the insignificant effect of GOE and GFCF under DOLS estimates. However, this consistency across various estimation techniques is plausible. Thus, this process accomplish the primary aim and objectives and address the hypotheses of the study.

As previously mentioned, since all explanatory variables are expressed as log-linear models, one has to multiply the respective coefficients by 100 when interpreting elasticity coefficients. The PVAR model generated a significant positive coefficient, capturing the role of government expenditure on growth in the SADC region. The results showed that if government expenditure rises by $1\%$, the economy would grow by $1.0\%$. The FE, RE, FMOLS and DOLS also showed that a positive shock in government expenditure promotes economic growth in SADC. The FE, RE, FMOLS and DOLS coefficients shows that GOE positively affect growth on the following spectrum $0.7\%$, $0.7\%$, $0.8\%$ and $0.8\%$, respectively. This implies that a $1\%$ rise in GOE would cause the economy to grow by $0.7\%$ estimated by the FE and RE, and $0.8\%$ for FMOLS and DOLS. These are statistically significant and theoretically plausible as supported by the Keynesian hypothesis.

The coefficient slope for GFCF under PVAR has a significant negative effect on growth and contradicts the FE, RE, FMOLS and DOLS coefficients. The results show that a $1\%$ increase in investment would cause the economy to contract by $0.3\%$. On the other hand, the FE, RE, FMOLS and DOLS shows that if investment increases by 1%, the economy would grow by 0.6%, 0.5%, 0.6% and 0.7%, respectively. This finding is in line with conventional economic literature and supported by the Solow growth model.

The slope coefficient for EMP is consistent and statistically significant at conventional level for all estimated models. The PVAR results suggest that a 1% increase in employment level would lead to 0.3% growth in GDP. Interestingly, the FE, RE, FMOLS and DOLS shows that if employment improves by 1%, the economy will grow by 3.3%, 2.1%, 3.2% and 3.7%, respectively. This finding makes economic sense because as the number of people employed increases, outputs levels are also expected to increase, and this is theoretically plausible as supported by the Keynesian theoretical framework.

A significant positive elasticity coefficient for PD under the PVAR estimates contradics the coefficient signs offered by the FE, RE, FMOLS and DOLS. The PVAR results indicate the if public debt increases by 1%, the economy would be expected to grow by 0.03%. Conversely, the FE, RE, FMOLS and DOLS results suggest that there is a significant negative effect of public debt on economic growth, implying that a further 1% rise in public debt would lead to a contraction in the economy by 0.3%, 0.3%, 0.3% and 0.4%, respectively. These disagreements in empirical results explain the contradiction of several empirical studies that have been reported cross different countries. However, in the midst of controversy in the results, the PVAR estimates are trusted due to the rigor involved in the estimation process and accompanying IRF, variance decomposition and Granger causality test supporting this relationship.

The overall empirical findings are theoretically plausible since all estimated models offered estimates that point in the same direction with respect to the role of fiscal policy on economic growth in SADC region. The empirical findings suggest that that fiscal policy and public debt plays a pivotal role in promoting economic growth in SADC. These findings are consistent with the empirical literature conducted in the same subject area as shown in the work of Ocran (2011), Taylor *et al.* (2011) and Ghosh *et al.* (2013), among others. As mentioned earlier, the Granger causality was carried out to ascertain the direction of causality between variables, and thus addressing the fourth hypothesis of the study. The Granger causality test showed a significant causal relationship between economic growth, government expenditure, gross fixed capital formation and public debt. Therefore, this finding suggest that we cannot reject the fourth hypothesis which states that there is causality among variables. Furthermore, after a thorough evaluation of the empirical results, the the following conclusions can be drawn regarding the research hypotheses:

- The first hypothesis cannot be rejected since the results shows evidence of a positive significant impact of fiscal policy on growth in SADC region.
- Moreover, the empirical results strongly suggest that there is a significant causal relationship that exist between economic growth, government expenditure, gross fixed capital formation, employment and public debt.

### 3.8 CONCLUDING REMARKS

The central focus of this chapter was to provide robust empirical findings on the role of fiscal policy and public indebtedness on economic growth in SADC region. The empirical investigation was carried out using cutting-edge panel regressions, which include PVAR, FE, RE, FMOLS and DOLS methods. The empirical results were found to be theoretically plausible and consistent across various estimation techniques. The point of departure for empirical estimation was to first test for stationarity of the panel data series on each variable separately. The study employed the Im, Pesaran and Shin (2003) (IPS), Levin, Lin and Chu (2002) (LLC) and Fisher-type Choi (2001) (FSR) tests to check for the order of integration among variables in a panel data setup. These unit root test found that some variable are I(0) but all variables became stationary after first differences.

The study first estimated a PVAR and went further to compute the IRF, forecast error variance decomposition and Granger causality test within a PVAR model. The results from these econometric techniques revealed a significant positive impact of fiscal policy through government expenditure and sovereign debt shocks on economic growth in SADC region. The FE, RE, FMOLS and DOLS supported the majority of PVAR estimates. Moreover, the elasticity coefficients of variables are in line with the *a priori* expectations of the study as estimated by the PVAR, FE, RE, FMOLS and DOLS model. The empirical results of the study suggest that a positive shock of fiscal policy and sovereign debt promotes economic growth in SADC region. The results showed that the Keynesian view holds in the SADC region. Therefore, this study recommends that fiscal policymakers ought to use government expenditure wisely on productive sectors as a crucial fiscal stimulus instrument to stimulate economic growth through fiscal expansionary policy.

Furthermore, policymakers in developing regions such as SADC tend to channel the majority of public finances toward social consumption such as social security, AIDS and healthcare. There is little expenditure on productive and growth-stimulating sectors such as infrastructure, education and skills development, technology and innovation which are more important for growth and development. Consistent with Ismal (2011) on the Keynesian approach, the empirical results of the study revealed that government expenditure is an important determinant of aggregate output in the SADC region. This suggests that fiscal policy ought to be at the center of formulation of prudent economic policies of sustainable public finance management strategies that aims boost and stabilize public finances to positively influence long-term economic growth in SADC region. This process would eventually translate to enhanced sustainable economic growth, subsequently improving government revenues and reducing fiscal deficits in the region.

# CHAPTER FOUR

# ASYMMETRIC RELATIONSHIPS BETWEEN PUBLIC DEBT AND ECONOMIC GROWTH IN SADC REGION: A PANEL SMOOTH TRANSITION REGRESSION ANALYSIS

## 4.1 INTRODUCTION

In this chapter, the nonlinearity effect of public debt on economic growth in the Southern African Developing Communities (SADC) is analysed over the period 2000-2018. The study estimates a Panel Smooth Transition Regression (PSTR) technique to determine asymmetric and threshold effects at which public debt affects economic growth in SADC economies. This chapter provides a thorough breakdown of the empirical investigation into the nonlinear effects of public debt on economic growth in SADC. The purpose of this chapter is to fulfil the second objective of the study, which is to interrogate the nonlinear relationships between public debt and economic growth in SADC. The chapter comprises of the following sections: Section 4.1 gives a detailed background and introduction. Section 4.2 reviews empirical studies conducted on the relationship between public debt and economic growth. Section 4.3 provides an overview of research methodology, and Section 4.4 presents the empirical results. Lastly, Section 4.5 summarises the chapter.

A number of countries over the years have proven that higher levels of public debt may be detrimental to economic growth prospects, despite the level of development. Perlo-Freeman and Webber (2009) and Teles and Mussolini (2014) postulates that public debt would have a negative effect on growth if debt expenditures are channelled towards unproductive sectors. However, this has proved to be opposite in several developing countries, where governments solely rely on borrowings to respond to unanticipated macroeconomic shocks given the low level of government revenue triggered by stagnant economic growth and unemployment. The majority of SADC members are characterised by a discouraging investment climate and low economic growth and development. Thus, it becomes compelling for these developing countries to borrow even more funds from international financial institutions to finance their economic activities towards growth and development. Generally, the government raises its revenues through the printing of money, collecting taxes, or taking debt to maintain sustainable economic activities. The difference between government expenditure and tax revenues (budget deficit) usually compels the government to borrow funds from different international institutions in order to fulfil its obligation which is the provision of public goods and services and development objectives.

Numerous studies, which include Reinhart and Rogoff (2010), Teles and Mussolini (2014), Antonakakis, 2014, Checherita-Westphal *et al.,* (2014) and Baaziz *et al*., (2015), found a nonlinear relationship between public debt and economic growth with a debt threshold level at which high public debt contracts economic growth in their respective economies. These empirical enquiries indicate that the analysis of nonlinear effects of public debt on economic growth has gained scholarly popularity among researchers. In light of this view, the significance of this study is to add to the collective scientific literature and provide empirical evidence on the nonlinear relationship between public debt and growth from the context of the SADC economies. From a development planning perspective, a proper analysis of empirical insight into the nature of sustainable debt threshold may assist policymakers to formulate appropriate policy mix that aims to curb debt within a sustainable level, which is presently unknown in several SADC economies.

This study analyse asymmetric effects of public debt on economic growth among SADC economies using a combination of panel and time series data ranging from 2000-2018. The study contributes to literature through examination of nonlinear effects of public debt on economic growth using fixed and time-varying threshold models. This study estimates a Panel Smooth Transition Regression (PSTR) to investigate the nonlinear relationship and debt threshold at which public debt stifle economic growth, with annual data extracted from the World Development Indicators (WDI) and Quantec EasyData. The estimation process is carried out using R Studio statistical computing software.

## 4.2 MOTIVATION OF THE STUDY

Several studies on asymmetric relationships between public debt and economic growth has been predominantly confined in advanced economies over the recent years. This has left a vacuum in the body of literature from the perspective of developing economies, particularly SADC-specific empirical studies with policy implications for SADC economies. Therefore, the primary objective of this chapter is to examine the nonlinear effect of public debt on economic growth among SADC economies. In this chapter, we estimate a Panel Smooth Transition Regression (PSTR) to analyse the nonlinear relationships and debt threshold at which public debt deters economic growth. A PSTR model is the most appealing and sophisticated nonlinear estimation technique within a panel data setup which allows for the estimation of the nonlinear dynamic relationships among variables under examination while allowing for regression coefficients to vary smoothly over time and across cross-sectional individuals. Therefore, this study intends to produce robust SADC-specific empirical evidence on the nonlinear relationship between public debt and economic growth and further proposes a suitable public debt to GDP threshold that SADC members ought to target for policy implications in line with sustainable economic prosperity in the region.

This study intends to contribute to the debate in literature through the provision of robust empirical evidence on asymmetric and threshold effect of public debt on economic growth for SADC-specific policy prescriptions. As previously mentioned, this study employed secondary panel data for 13 Southern African Developing Communities (SADC) namely, Angola, Botswana, Democratic Republic of Congo, Eswatini, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Seychelles, Zambia, and Zimbabwe over the period 2000-2018. The economic variables employed for empirical investigation include gross domestic product (GDP), government expenditure, gross fixed capital formation, employment and public debt. The data sources include World Development Indicators (WDI), Federal Reserve Economic Data (FRED), and Quantec EasyData. The empirical estimation process in this chapter is conducted entirely using RStudio software. The study appreciates the work of Gonzalez *et al.,* (2015) for providing a useful guide of PSTR package and modelling procedure on RStudio CRAN repository.

## 4.3 THEORETICAL FRAMEWORK

In this section, the theoretical background underpinning the relationship between public debt and economic growth is discussed. The section also details the underlying economic position with chronological development of fiscal policy and economic growth in SADC region.

### 4.3.1 Ricardian Equivalence Theorem

The Ricardian equivalence theorem proposed by Ricardo (1951) claims that consumers are forward-looking and are considerate of government's budget constraints when they take consumption decisions. The Ricardian theory asserts that accumulating public debt indicates that the current generation is under-taxed. Governments usually borrow more during economic slowdowns. The accumulation of debt eventually becomes a burden to governments and leads to higher tax in future. The Ricardian theorem hypothesises that forward-looking taxpayers would anticipate a future rise in taxes and would therefore choose to save more rather than spending. And, with the extra disposable income from the initial tax reduction, the aggregate demand and output remains unchanged. Therefore, there would be a voluntary reduction in private spending by forward-looking taxpayers. In the end, the effect of debt-financed expenditure on domestic aggregate demand would be insignificant.

Studies by Perlo-Freeman and Webber (2009) and Teles and Mussolini (2014) suggest that using public debt to fund public consumption should have a positive impact on growth if such expenditures are channelled towards growth-stimulating sectors such as education, healthcare, technology, and infrastructural development. Several advanced economies have been able to effectively use government debt towards nurturing productive sectors in their economies. Therefore, SADC members ought to adopt stimulative debt management mechanisms consistent with sustainable growth. Moreover, although it can be difficult to draw statistical inferences on the Ricardian equivalence, the effect of public debt on growth ought to be statistically insignificant for the Ricardian equivalence theorem to be valid. The key implication of the Ricardian equivalence model is that public debt does not contain meaningful information to explain variations in long-term economic growth.

### 4.3.2 The Neoclassical Theory on Fiscal Policy

The principal argument of the neoclassical framework is that fiscal policy is considered sustainable overtime if the public debt-to-GDP ratio remains stable over the medium to long-term. Fourie and Burger (2003) asserts that the key neoclassical prescription contends that fiscal policy would be an unsustainable supplement to real economic growth if the real interest rate exceeds the real GDP growth rate given a fiscal deficit in the economy. Several SADC members have real interest rates that are higher than their real GDP growth rates, coupled with considerable fiscal deficit. From the neoclassical perspective, such countries are thus considered to have unsustainable fiscal policy. Neoclassical theory prescribes that governments ought to run a sufficient primary surplus during the medium and long-term if real interest rates are higher than the real GDP growth rate to realise sustainable fiscal policy (Fourie and Burger, 2003; Maidi, 2013). According to Ocran (2011), the effects of government expenditure are temporary and ineffective because, as prices readjust to the equilibrium, the level of employment and output remains unaffected in the long-run. As mentioned earlier, this study intends to examine the nonlinear effect of public debt on economic growth in the SADC region, and thereby provide robust empirical findings on the sustainability of public debt and fiscal policy in the region.

### 4.3.3 Sovereign Debt Sustainability

Several developing economies have been characterised by a growing level of public indebtedness due to fiscal deficits in their public finances. As a result, policymakers across different countries have adopted some form of fiscal rule that aims to achieve prudent fiscal policy and sustainable public finances. Sovereign debt sustainability is traditionally examined through analysing the sustainability of public finances from an accounting perspective, comparing government tax revenues (T) and expenditures (E), and also taking into account the size of public debt (D) and debt servicing costs (r) as shown in equation (4.3):

$$D_t = (1 + r_t)D_{t-1} - (T_t - E_t) \tag{4.3}$$

Equation (4.3) suggest that sustainable public debt (D) depends on the ability of governments to successfully manage public finances to remain sustainable over the long-term. The relationship between debt and macroeconomic performance can be analysed in relative terms with the real GDP growth rate as follows:

$$\underbrace{\frac{D_t}{Y_t} - \frac{D_{t-1}}{Y_{t-1}}}_{Change\ in\ Debt} = \underbrace{\underbrace{(r_t - g_t)}_{RG\ Differential}\left(\frac{D_{t-1}}{Y_{t-1}}\right)}_{Debt\ Servicing\ Costs} - \underbrace{\frac{(T_t - E_t)}{Y_t}}_{Primary\ Balance} \quad (4.4)$$

The above equation (4.4.) indicates that a change in real public debt dynamics depends on the differential between the initial public debt, weighted by real interest rate (r) minus real output growth (g), and the fiscal policy stance reflected in the primary balance. The primary balance shows whether government runs a surplus ($Primary\ Balance > 0$) or a deficit ($Primary\ Balance < 0$). The key driver for the public debt dynamics is the RG differential ($RG = r_t - g_t$). Consistent with the neoclassical prescriptions, if real output growth (g) exceeds the real interest rate (r) in the long-term, public debt converges to a sustainable level. On the other hand, if the real interest rate (r) exceeds real GDP growth (g), the debt level diverges from the sustainable level, assuming that there is a balanced government budget ($Primary\ Balance = 0$) (Komarkova *et al.,* 2013). Even though several SADC members have recorded positive real interest rate-growth differentials over the years, this group has adopted tight monetary policy rules with the intention of narrowing the RG differentials gap consistent with their common economic objectives within the region.

### 4.4 REVIEW OF EMPIRICAL STUDIES

Groundbreaking work pioneered by Romer (1986), Lucas (1988), and Barro (1990) on the endogenous growth theory postulates that public debt can have a positive influence on economic growth depending on the kinds of public investments financed by public debt. A significant level of public debt directed towards productive sectors, growth-orientated sectors, and sustainable public investment can assist countries in achieving their economic objectives (Checherita-Westphal and Rother, 2012). Conversely, Barro (1990) asserts that public debt may have negative long-run effects on economic growth through the crowding-out effect. High public debt can expose a country to macroeconomic illness, sovereign risk and affect the effectiveness of public expenditure (Teles and Cesar Mussolini, 2014).

As previously discussed in chapter 2 of the study, with respect to theoretical foundations underpinning fiscal policy, the neoclassical theory regards fiscal policy as sustainable if the public debt-to-GDP ratio of the country is stable over the long-term. The neoclassical prescriptions suggest that if a country has a real economic growth rate that is below the real interest rate, coupled with a budget deficit, fiscal policy is unsustainable and cannot stimulate long-term growth (Fourie and Burger, 2003). A majority of SADC member states operate under economic conditions where the real interest rate exceeds the real GDP growth rate, with substantial budget deficits, according to the neoclassical principles, this fiscal policy stance is thus unsustainable to promote long-term growth.

A study carried out by Reinhart and Rogoff (2010) examines the role of public debt on economic growth among 20 advanced economies for the period 1946-2009. The study found a negative correlation between government debt and economic growth. They suggest that the negative effects fade away when public debt falls below the debt threshold of 90% of GDP. This study became the first to discover the nonlinear relationship with the threshold effect of public debt to growth. However, the work of Reinhart and Rogoff (2010) was later criticised by Herndon *et al.* (2013) with respect to the accuracy of a 90% debt threshold level. Herndon *et al*. (2013) identified the selective exclusion of data, coding errors and inappropriate methods for weighting summary statistics. They corrected these methodological errors and applied different weighting data methods. Their study revealed that public debt level of 90% to GDP ratio cannot be defended and would consistently reduce a country’s economic growth. Herndon *et al*. (2013) concluded that non-linearity only occurs when debt level ranges between 0% and 30% of GDP. However, it is important to note that debt threshold levels are dependent on the characteristics of the group of countries selected in the sample. Below, the core issues are discussed.

The issue of data availability is a serious concern in some SADC member countries. SADC member countries are classified by the World Bank in terms of each country’s level of development through the assessment of GDP *per capita* and the level of institutional quality, i.e., middle-income, fragile countries, and non-fragile low-income countries. SADC middle-income countries as classified by the World Bank include South Africa, Angola, Botswana, Eswatini, Lesotho, Mauritius, Namibia, Seychelles and Zambia. The fragile SADC member countries, as classified by the World Bank), consist of Zimbabwe and the Democratic Republic of the Congo. The non-fragile, low-income countries in SADC currently comprise of Madagascar, Malawi, Mozambique and Tanzania. The quality of data among this group of countries may be poor due to the historical background of their geographical region. Hence, our study focuses primarily on the most recent available data running from 2000‑2018. Similarly, to other regions, this period offers a relatively smooth data set with some significant changes in the economic trends owing to the global financial crisis in 2009, however the analytical part in the following section ought to verify this general observation through structural breaks analysis. This period provides the most recent and relevant data to construct rigorous empirical analysis to the ongoing SADC policy debates on the impact of fiscal policy on economic growth.

Taylor *et al.* (2011) studied the effect of fiscal deficits and government debt on economic growth in the USA using a VAR model for a period 1961-2011. The study found a strong positive effect of the primary deficit on economic growth. The study suggests that in order to achieve a low fiscal deficit and high growth, the government ought to focus more on improving economic activities through fiscal policy. A study conducted by Ghosh *et al*. (2013) assesses fiscal fatigue, fiscal space and debt sustainability in 23 advanced economies with panel data fixed effect over the period 1970-2007. The results show strong evidence of fiscal fatigue and that the marginal response of primary balance to debt is non-linear. This relationship becomes positive at moderate debt levels but starts to decrease when debt levels approach about 90-100% of GDP and start to become negative as the debt ratio reach 150% of GDP.

Another study conducted by Checherita-Westphal and Rother (2012) tested the non-linear effects of public debt on economic growth among 12 European countries for the period 1990-2008, employing a non-dynamic panel method on growth expressed as a quadratic functional form of debt. The study found a non-linear effect of debt on economic growth with a threshold level of 90% to 100% of debt-GDP ratio. Baum *et al.* (2013)

studied a similar relationship using same set of countries, applying a dynamic panel threshold method for the period 1990-2010. The results reveal a significant positive impact of public debt on growth for debt-to-GDP ratio below the threshold of 67%. Furthermore, a significant negative effect of debt-to-GDP ratio was found above the 95% threshold.

The work of Checherita-Westphal *et al*. (2014) used panel data for OECD and European countries to investigate fiscal sustainability of utilising a growth-maximizing debt target, which comprises of a public debt target that government ought to maintain to maximise the economic output level. The findings of the study propose that the Euro area ought to target a debt level of 50% of GDP if member states are to have a common public debt target. A study carried out by Teles and Mussolini (2014) examines how the size of the debt-to-GDP ratio affects long-term economic growth. The study estimated the GMM and OLS model using unbalanced panel data of 74 countries for the period 1972-2004. They proposed a theoretical endogenous growth model in which the government uses public debt to improve productive expenditure. The study found a negative effect of the public debt on long-term economic growth. The results reveal that although an increase in government expenditure leads to a rise in output, a negative effect was also observed through a rise in the tax burden on consumers and government indebtedness as necessary measures to finance the public spending.

Another study carried out by Baaziz *et al*. (2015) assessed the relationship between accumulating public debt and real GDP in South Africa for the period 1980-2014. Their study discovered that public debt becomes negative to economic growth when public debt-to-GDP ratio reaches a threshold of 31.37%. Jacobo and Jalile (2017) investigated the effect of government debt on economic growth in 16 Latin American economies. The study used a panel fixed-effect estimation technique for the period 1960-2015. They found a positive effect of debt on GDP growth in the short-run. However, the findings also shows that this effect decreases to almost zero between 64% and 71% of debt-to-GDP ratio. This disparity in the results of previous empirical work calls for a thorough empirical investigation into the nonlinear relationship between public debt and economic growth using the most appropriate and advanced estimation technique in the PSTR methodology as a contribution to the body of literature.

## 4.5 RESEARCH METHODOLOGY

A PSTR model developed by González *et al.* (2005) is one of the most attractive and appealing panel data modelling techniques for estimating non-linear relationships among economic variables. It also comes with the ability to overcome the issues of endogeneity and heterogeneity. The PSTR is an extension of a univariate smooth transition regression (STAR) model to panel framework analysis with heterogeneity across different panel groups and over time (Chang & Chiang, 2011). Hence, the study will adopt this model to examine the non-linear effect of public debt on economic growth in SADC region. The research contributes to the body of knowledge by examining the threshold level of public debt in SADC region endogenously. Moreover, the study also assesses the speed of the transition from one regime of public debt to another using a PSTR model.

As previously mentioned, the study investigates the nonlinear effect of public debt on economic growth in SADC region. The study employs a combination of panel and time series data of 13 SADC countries, namely, Angola, Botswana, Democratic Republic of Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Zambia and Zimbabwe, covering the period 2000-2018. This study acknowledges the work of Gonzalez *et al.,* (2017) for providing a PSTR codes package and modelling procedure on the RStudio CRAN repository. The study employed GDP as an endogenous variable. The explanatory variables are public debt (PD), employment (EMP), gross fixed capital formation (GFCF) and government expenditure (GOE). A proposed model specification can be expressed as follows:

$$lnGDP = \alpha_0 + \beta_1 PD + \beta_2 PD_t^2 + \beta_3 GFCF + \beta_3 EMP + \beta_4 GOE + \varepsilon_t \quad (4.5)$$

In the above equation, we transform GDP and GOE into natural logarithmic form since these two variables were extracted in monetary values. This process allows us to interpret $\beta_{1,2,3\dots}$ as elasticities and to further mitigate heteroscedasticity in our model. The study employs the Im-Pesaran-Shin (IPS), Levin and Lin and Fisher-type Choi unit root test to test for stationarity and ascertain the order of integration among variables in the model. Even though stationarity is not much of a concern in panel data analysis (since the combination of time series and panel data tends to revert around zero mean and constant variance in their nature) this process enables an understanding of the underlying data generating properties of our data series.

### 4.5.1 Panel Smooth Transition Regression (PSTR) Model

The study adopts a PSTR model proposed by González *et al*. (2005) to ascertain the potential non-linear effect of public debt on economic growth among SADC countries. A PSTR model is an extended version of the panel threshold regression (PTR) model developed by Hansen (1999). A PSTR is a non-linear homogeneous panel data model that allows regression coefficients to vary over time and across cross-sectional units or individuals. The study makes a contribution using this model to determine the threshold level of public debt that stimulate long-term economic growth, and also to investigate the speed of the transition from one public debt regime to another. Like any time-series analysis, each variable is subjected to the unit root test to ascertain stationarity of variables in the system. Hence, the study employs units root tests developed by Maddala and Wu (1999), Levin, Lin and Chu (2002), and Im, Lee and Tieslau (2005). The entire empirical investigation is conducted using R Studio statistical software.

The PSTR model is built with two different assumptions. First, one may assume it has a nonlinear homogeneous panel model which is in line with the work of Teräsvirta (1998) for assumptions of a smooth transition autoregressive model (STAR). The second one is that the PSTR can be purely a heterogeneity model with coefficients that differs across individuals over-time. The transition variable $q_{it}$ is an observable variable that drives the assumption of bounding the regression coefficients under the assumption of heterogeneity. This assumption allows coefficients to vary between a limited number of extreme regimes – usually two or three different regimes within a PSTR model. Hence, the transition variable is a time-varying and individual-specific variable that allows regression coefficients to change smoothly over time and be different from each individual in a panel framework (Gonzalez *et al.,* 2005). The PSTR generalises the PTR by allowing the regression coefficients to change smoothly when moving from one extreme regime to another (Gonzalez *et al.*, 2017). Therefore, we express the PSTR with a threshold of two extreme regimes and a single transition function to illustrate a nonlinear relationship between public debt and economic growth. According to González *et al.* (2005), the basic PSTR with two extreme regimes and a single transition function can be written as follows:

$$Y_{it} = \alpha_i + \lambda_t + \beta'_0 X_{it} + \beta'_1 X_{it} g(q_{it}; \gamma, c) + \varepsilon_{it} \quad (4.6)$$

Where $Y_{it}$ is a scalar representing the endogenous variable (GDP), $q_{it}$ represents public debt (PD), which is the transition variable. $X_{it}$ is a vector of time-varying exogenous variables (PD, EMP, GFCF and GOE). $i = 1 \ldots, N, t = 1 \ldots, T$, and $N$ and $T$ represent the cross-section and time dimension of the panel, respectively. $\alpha_i$ and $\lambda_t$ denote fixed individual effects and time effects, respectively, and $\boldsymbol{\varepsilon_{it}}$ are error terms in the system. The transition function $g(q_{it}; \gamma, c)$ in (4.6) is a continuous function of the observable threshold variable $q_{it}$ (public debt) and is normalised to be bounded between zero and one. $\gamma$ represent the slope parameter that denotes the smoothness of the transition from one regime to another, and $\boldsymbol{c}$ is the threshold parameter (debt-GDP threshold). The value of the transition variable $q_{it}$ determines the value of $g(q_{it}; \gamma, c)$ and thus the effective regression coefficients $\beta_0 + \beta_1 g(q_{it}; \gamma, c)$ for individual in a period (Gonzalez *et al.*, 2017). The PSTR is subjected to robustness checks such as testing for linearity, parameter output constancy and the amount of transition function offered by the PSTR as proposed by Gonzalez *et al.* (2017).

A PSTR model is an extended version of the panel threshold regression (PTR) model developed by Hansen (1999). This panel data technique allows regression coefficients to vary over-time and across cross-sectional units or individuals. The PSTR generalises the PTR by allowing the regression coefficients to change smoothly when moving from one extreme regime to another (Gonzalez *et al.*, 2017). According to González *et al.* (2005), following the work of Granger and Teräsvirta (1993), Teräsvirta (1994), Jansen and Teräsvirta (1996) and Teräsvirta *et al.* (2010), the logistic transition function for the time-series STAR models can be represented in the following expression:

$$g(q_{it}; \gamma, c) = \left(1 + exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right)^{-1} \; with\, \gamma > 0 \; and \; c_1 < c_2 < \cdots < c_m \quad (4.7)$$

In the above equation (4.7), $c = (c_1 \dots .., c_m)$ is an *m*-dimensional vector of location parameters, and the slope parameter $\gamma$ determines the smoothness of the transition. A PSTR model can be generalised to allow for more than two different regimes. Furthermore, the model imposes restrictions $\gamma > 0 \; and \; c_1 < \cdots < c_m$ for identification purpose. Generally, $m = 1 \; or \; m = 2$ are values that allow for commonly encountered types of variation in the parameters. The model suggests that both extreme regimes are related with the high and low values of $q_{it}$ for $m = 1$, $\beta_0 + \beta_1$ are monotonic transition of the coefficients as $q_{it}$ increases, and the alteration is fixed around $c_1$. The STAR model developed by Hansen (1999) is reduced to the PSTR model by the two-regime panel threshold as shown in equation (4.6). Moreover, for any positive integer value $m$ the transition function in equation (4.7) becomes constant when $\gamma \to 0$, and the model then falls into a homogenous panel regression model with fixed effects (González *et al.,* 2005). Consider an additive model which is a generalization of a PSTR model that allows for more than two extreme regimes:

$$y_{it} = \mu_i + \lambda_i + \beta'_0 x_{it} + \sum_{j=1}^{r} \beta'_j x_{it} g_j \left( q_{it}^{(j)}; \gamma_j, c_j \right) + \varepsilon_{it} \qquad (4.8)$$

In this equation, the transition function $g_j \left( q_{it}^{(j)}; \gamma_j, c_j \right)$, $j = 1 \dots, r$ explained in equation (4.6) depends on the slope parameters $\gamma_j$ and on location parameters $c_j$. If $r = 1, q_{it}^{(j)} = q_{it}$, and $\gamma_j \to \infty$ for all $j = 1 \dots, r,$ the transition function becomes an indicator function. The above model (4.8) then becomes a PTR model with $r + 1$ regimes. Hence, the additive PSTR model can be regarded as a generalization of the multiple regime panel-threshold model as explained by Hansen (1999). According to González *et al*. (2005), the estimation procedure for a PSTR ought to include testing for the linearity against the PSTR model, followed by parameter output estimation, and testing for number of transition functions.

#### 4.5.1.1 The PSTR Estimation Procedure

The estimation procedure of a PSTR model requires a well-thought systemic modelling strategy. The PSTR modelling procedure consists of model specification, estimation and evaluation of parameters of the estimated model. The PSTR model estimation procedure includes testing homogeneity, selecting the appropriate transition variable $q_{it}$, and choosing the appropriate value of $m$ in equation (4.6). Parameter estimation in a PSTR model is carried out using the nonlinear least squares (González *et al.,* 2005). Furthermore, the evaluation of the estimated PSTR model is based on the misspecification tests as part of model evaluation to check for the adequacy of PSTR estimates. The null hypotheses of these tests include parameter constancy, no remaining nonlinearity and serial correlation testing of residuals in the model. The final stage in the estimation process is to choose the most appropriate number of extreme regimes or transition functions, and to further determine no remaining nonlinearity within the PSTR model.

#### 4.5.1.2 Testing for homogeneity

The first step when estimating the PSTR model is to test for linearity against the PSTR model. González *et al*. (2005) assert that testing for linearity in a PSTR model tests the null hypothesis of $H_0\colon \beta_1 = 0$. Testing for linearity may be useful for testing propositions of existing economic theories. Moreover, the PSTR model is unable to identify if the data-generating process is homogeneous. Thus, to avoid the estimation of unidentified models, homogeneity ought to be tested for (González *et al.,* 2005). However, Hansen (1999) suggests that this test is non-standard because, under this null hypothesis, the PSTR model contains unidentified nuisance parameters. When one imposes either $H_0\colon \gamma = 0$ or $H_0' : \beta_1 = 0$, the PSTR model in equation (4.6) and (4.7) can be reduced to a homogeneous model. The study tests the null hypothesis of $H_0\colon \gamma = 0$ to avoid the identification problems that may arise in equation (4.6) by its first-order Taylor development around $\gamma = 0$. González *et al*. (2005) adopted a possible solution by replacing $(q_{it}; \gamma, c)$ in equation (4.6) with its first-order Taylor expansion around $\gamma = 0$ and test the linearity hypothesis of $H_0\colon \gamma = 0$. This produces the following auxiliary regression:

$$y_{it} = \mu_i + \beta_1'^{*} x_{it} + \beta_2'^{*} x_{it} q_{it} + \cdots \beta_m'^{*} x_{it} q_{it}^m + \varepsilon_{it}'^{*} \tag{4.9}$$

In this equation, $(\beta_1^*, \ldots, \beta_m^*)$ are the parameter vectors that are the multiples of $\gamma$, and $u_{it}^* = u_{it}^* + R_m \beta_1' x_{it}$, $R_m$ represent the remainder of the Taylor-expansion. Hence, testing for $H_0\colon \gamma = 0$ in equation (4.6) is equivalent to testing the $H_0^*\colon \beta_1'^{*} + \cdots + \beta_m'^{*} = 0$ in equation (4.9), and $q_{it}^{m}$ represents the possibility of having up to three or more extreme regimes. Importantly, in a PSTR model, the Taylor series estimate does not involve asymptotic distribution theory when the null hypothesis is verified by the Wald LM test. Thus, this null hypothesis can be tested using a Wald and Likelihood ratio test. The Wald LM test can be written as follows:

$$LM_W = \frac{NT(SSR_0 - SSR_1)}{SSR_0} \tag{4.10}$$

Meanwhile, the Fischer LM test equation can be written as follows:

$$LM_F = \frac{NT(SSR_0 - SSR_1)/mk}{SSR_0/(TN - N - mk)} \tag{4.11}$$

Moreover, the Likelihood ratio test can be presented in the following equation:

$$LR = -1[\log(SSR_1) - log(SSR_0)] \tag{4.12}$$

where $SSR_0$ represents a panel sum of squared residuals under $H_0$ (linear panel model with individual effects), and $SSR_1$ represents a panel of sum of squared residuals under $H_1$ (PSTR model with $m$ regimes). Moreover, the LM-type test can be written in a matrix form as follows:

$$y = D_\mu \mu + X\beta + W\beta^* + u^* \tag{4.13}$$

Where $y = (y_1', .., y_N')$ with $y_i = (y_{i1}', .., y_{iT}')$, $i = 1, \dots, N, D_\mu = (I_N \otimes i_T)$, and $I_N$ is the $(N \times N)$ identity-matrix, $i_T$ a $(T \times 1)$ vector of one, and $\mu = (\mu_1, \dots, \mu_N)$. $X = (X_1', \dots, X_N')$ where $X_i = (x_{i1}, \dots, x_{iT})$, and $W = (W_1', \dots, W_N')$ with $W_i = (w_{i1}, \dots, w_{iT})$, and $w_{it} = (x_{it}' q_{i1}, \dots, x_{it}' q_{it}^{m}), \beta = \beta_0^* \; and \; \beta^* = (\beta_1^{*\prime}, \dots, \beta_m^{*\prime})$. Lastly $u^* = (u_1^{\prime *}, \dots, u_N^{\prime *})$. The LM test statistic then becomes:

$$LM_\chi = \hat{u}^{0\prime} \widetilde{W} \Sigma^{-1} \breve{W} \hat{u}^0 \tag{4.14}$$

The model with the null hypothesis $\hat{u}^0 = (\widehat{u_1}^{0\prime}, \dots, \widehat{u_N}^{0\prime})$ yields the vector of residuals and the standard transformation matrix becomes $M_\mu = I_{NT} - D_\mu (D_\mu D_\mu)^{-1} D_\mu$, where $\overline{W} = M_\mu W$. The denotation of $\hat{\Sigma}$ represents a reliable estimator of the covariance-matrix $\Sigma =$

$(\hat{\beta}^* - \beta^*)(\hat{\beta}^* - \beta^*)$, when the errors are identically distributed across time-individuals and homoscedastic. The standard covariance-matrix estimator becomes:

$$\hat{\Sigma}^{HAC} = \left[-\widetilde{W'}'\breve{X}\left(\widetilde{X'}'\widetilde{X'}\right)^{-1}: I_{km}\right]\hat{\Delta}\left[-\widetilde{W'}'\breve{X}\left(\widetilde{X'}'\widetilde{X'}\right)^{-1}: I_{km}\right]' \qquad (4.15)$$

Where $I_{km}$ is $(km \times km)$ identity-matrix, and $\hat{\Delta} = \sum_{i=1}^{N} \widetilde{Z_\iota}'\widehat{u_1}^{0'}\widehat{u_N}^{0'}\widetilde{Z_\iota}$. With $\widetilde{Z_\iota} = I_T - i_T(i_T' i_T)^{-1} i_T')Z_i$, where $Z_i = [W_i, W_i], i = 1, \dots, N$ the estimator in equation (11) is consistent for a fixed $T$ as $N \to \infty$, as suggested by Arellano (1987) and Hansen (2007). For tests where $N, T \to \infty$, with a fixed $N$, the $LM_\chi$ would be asymptotically distributed as $\chi^2(mk)$ with the null-hypothesis where the F-version $LM_F = LM_\chi(TN - N - l - mk)/(TNmk)$ has an estimated $F(mk, TN - N - k - mk)$ distribution. The homogeneity test does two important things within the PSTR framework: First, the homogeneity test is used to determine the suitable order $m$ of the logistic transition function expressed in equation (4.6). Second, the homogeneity test can be used to select a suitable transition variable $q_{it}$ within a PSTR model. When selecting the appropriate transition variable, the test through the Taylor expansion is conducted for a set of candidate transition variables. The variable that gives rise to the strongest rejection of linearity is chosen as the most appropriate transition variable (González *et al.,* 2005).

The work of Granger and Teräsvirta (1993) and Teräsvirta *et al.* (2010) proposes a sequence of tests for selecting whether $m = 1, m = 2 \; or \; m = 3$ using the auxiliary regression expressed in equation (4.8) for testing the null hypothesis: $H_0^*: \beta_3^* = \beta_2^* = \beta_1^* = 0$. If this null hypothesis is rejected through the test $H_3^*: \beta_3^* = 0 \; or \; H_2^*: \beta_2^* = 0/\beta_3^* = 0$ and $H_1^*: \beta_1^* = 0/\beta_3^* = \beta_2^* = 0$, then the selection $m = 2$ is also rejected at $H_2^*$. Hence, the selection of $m = 1$ ought to be proceeded with (Teräsvirta, 1994; Teräsvirta *et al.* (2010).

#### 4.5.1.3 Parameter estimation

The PSTR model estimation parameters $\theta = (\beta_0', \beta_1'; \gamma, c')'$ expressed in equation (4.6) is a relatively straightforward application of the fixed effects and nonlinear least squares (NLS). The study first eliminates the individual-effects $\mu_i$ by removing individual-specific means and then applies the NLS for data transformation. To remove fixed effects, the within-transformation is commonly used in linear panel data models, hence, applying the within-transformation in a PSTR set-up requires one to be more cautious with its estimation. Suppose we rewrite equation (4.6) in the following form:

$$y_{it} = \mu_i + \beta' x_{it} g(\gamma, C) + u_{it} \tag{4.16}$$

Where $x_{it}(\gamma, C) = (x'_{it}, x'_{it} g(q_{it}; \gamma, c))'$ and $\beta = (\beta'_0, \beta'_1)'$. The NLS is applied to determine the values of these parameters that minimise the concentrated sum of squared errors (Thanh, 2015; González *et al.*, 2017). Subtracting the individual means from equation (4.9) produces the following equation:

$$\tilde{y}_{it} = \beta' \tilde{x}_{it} g(\gamma, c) + \tilde{u}_{it} \tag{4.17}$$

Here, $\tilde{y}_{it} = y_{it} - \tilde{y}_{it}, \tilde{x}_{it}(\gamma, c) = \left(x'_{it} - \bar{x}'_{it}, x'_{it} g(q_{it}; \gamma, c) - \bar{w}'_i(\gamma, c)\right)', \tilde{u}_{it} = u_{it} - \tilde{u}_i,$ and $\tilde{y}_i, \bar{x}_i, \bar{w}_i \; and \; \bar{u}_i$ are individual means, with $\bar{w}'_i(\gamma, c) = T^{-1} \sum_{t-1}^{T} x_{it} g(q_{it}; \gamma, c)$. Therefore, the transformed vector $\bar{x}'_{it}, (\gamma, c)$ in the above equation (4.17) depends on $\gamma$ and $c$ through both the levels and individual means. Hence, $\bar{x}'_{it}, (\gamma, c)$ needs to be recomputed at each iteration in the NLS optimization (González *et al.*, 2017). Equation (4.17) shows a PSTR model that is linear where $\beta$ is restricted on $\gamma$ and $c$. Therefore, to estimate the values of these parameters that minimises the concentrated sum of squared errors, the NLS, as mentioned earlier, is applied as follows:

$$Q^c(\gamma, c) = \sum_{i=1}^{N} \sum_{t=1}^{T} \left(\tilde{y}_{it} - \hat{\beta}(\gamma, c)' \tilde{x}_{it}(\gamma, c)\right)^2 \tag{4.18}$$

Here, $\hat{\beta}(\gamma, c)$ is obtained from equation (4.13) by the OLS at each iteration in the nonlinear optimization. Therefore, the disturbance term $\tilde{u}_{it}$ in equation (4.16) becomes normally distributed. This estimation procedure is similar to the maximum likelihood (ML) [function?], where the likelihood function is concentrated with respect to the fixed effects $\mu_i$. The estimation of the PSTR model requires greater attention when selecting the starting values for the NLS optimization. The PSTR estimation procedure follows the same approach as STR models to obtain starting values by means of a grid search across the parameters in the transition function $g(q_{it}; \gamma, c)$ as proposed by Hansen (1999). This approach is based on the assumption that if $\beta$ in equation (4.17) is linear then $\gamma$ and $c$ are fixed. Therefore, the concentrated sum of squared residuals in equation (4.18) can be computed easily for an array of values for $\gamma$ and $c$ in such a way that $\gamma > 0$, and $c_{j,min} >$

$min_{it}\{q_{it}\}\ and\ c_{j,min} < min_{it}\{q_{it}\}, j = 1, \ldots, m$ and the values minimizing $Q^c(\gamma, c)$ can be used as starting values of the nonlinear optimization algorithm.

Furthermore, it must be noted that numerical complications may arise if the slope parameter $\gamma$ is too large since, if $\gamma$ has a completely different large magnitude from other parameters, this slows down the convergence of any standard derivative-based optimization algorithm. Moreover, the log-likelihood typically goes to the direction of $\gamma$ when its parameter coefficient is large, which may lead to biased estimates. However, one may overcome this problem by applying the transformation $\gamma = \exp\{\eta\}\ or\ (\eta = ln\gamma)$ in equation (4.2) and estimate $\eta$ instead of $\gamma$. This transformation may cause the identification $\gamma > 0$ to be redundant (Goodwin *et al.,* 2011; Hurn *et al.,* 2016).

#### 4.5.1.4 Model evaluation

The evaluation of the estimated PSTR model by testing for misspecifications is important to confirm the robustness and adequacy of parameter estimates. Therefore, the study adopts the testing of parameter constancy over time and no remaining nonlinearity as proposed by Eitrheim and Teräsvirta (1996) for STAR models to fit the panel data framework for PSTR model evaluation. Testing for no remaining nonlinearity as part of the misspecification test is also very useful for further determining the number of transition functions within the PSTR model (González *et al.*, 2005).

**i. Testing parameter constancy**

The testing of parameter constancy has received more attention from time series analysis as compared to a panel data setup. This is because, more often than not, the dimension $T$ in a panel data application is usually relatively small, which makes the assumption of parameter constancy a less interesting hypothesis to examine. However, as the number of panel dataset $T$ becomes relatively large, testing for parameter constancy also becomes more crucial within a panel data framework. The main assumption regarding parameter constancy is that the parameter coefficients in equation (4.6) change smoothly over time. The model under this assumption is known as Time Varying Panel Smooth Transition Regression (TV-PSTR) model. The TV-PSTR model can be expressed as follows:

$$y_{it} = \mu_i + (\beta_{10}' x_{it} + \beta_{11}' x_{it} g(q_{it}; \gamma_1, c_1)) + f(t/T\,; \gamma_2, c_2)(\beta_{20}' x_{it} + \beta_{21}' x_{it} g(q_{it}; \gamma_1, c_1))$$
$$+ u_{it} \qquad (4.19)$$

Where $g(q_{it}; \gamma_1, c_1)$ is explained in equation (4.6), and $f(t/T\,; \gamma_2, c_2)$ is another transition function. The above equation (4.19) has the same structure as the time-varying smooth transition autoregressive (TV-STAR) model studied by Teräsvirta *et al.* (2010). Therefore, equation (4.19) may be rewritten as follows:

$$y_{it} = \mu_i + (\beta_{10} + \beta_{20} f(t/T\,; \gamma_2, c_2)' x_{it} + (\beta_{11} + \beta_{21} f(t/T\,; \gamma_2, c_2)' x_{it} g(q_{it}; \gamma_1, c_1)$$
$$+ u_{it} \qquad (4.20)$$

The TV-STAR model in equation (4.20) explicitly shows the deterministic character of time-variation in the parameters of the model. The TV-PSTR model in equation 4.19 assumes that $\beta_{10} = \beta_{11} = 0$ (Geng, 2011). Moreover, the TV-PSTR model in equation (4.19) accommodates different assumptions to parameter constancy depending on the definition of $f(t/T\,; \gamma_2, c_2)$. The equation that accommodates these assumptions for this function can be written as follows:

$$f(t/T\,; \gamma_2, c_2) = \left(1 + exp\left(-\gamma_2 \prod_{j=1}^{h} (t/T - c_{2j})\right)\right)^{-1} \qquad (4.21)$$

Here, $c_2 = (c_{21}, \dots, c_{2h})'$ is an $h - dimensional$ vector of location parameters with $c_{21} < c_{22} < \cdots < c_{2h}$, and where $\gamma_2 > 0$ represents the slope parameter. This is the same as $g(q_{it}; \gamma, c)$ explained in equation (4.6), with $q_{it} = t/T$. Hence, inserting $h = 1$ in the TV-PSTR model allows for a single monotonic change while the change is symmetric around $(c_{21} + c_{22})/2$ when $h = 2$. Therefore, the smoothness of the change is controlled by $\gamma_2$. When $\gamma_2 \longrightarrow \infty, f(t/T\,; \gamma_2, c_2)$ becomes an indicator function $I[t/T > c_{21}]$ when $h = 1$ and $1 - I[\,c_{21}\, t/T > c_{22}]$ when $h = 1$. This implies that equation (4.21) also accounts for instantaneous structural breaks in the model.

When $\gamma_2 = 0$ in equation (4.17), $f(t/T\,; 0, c_2) = {}^{1}/_{2}$. Thus, the model shown in equation (4.19) will have constant parameters and therefore $H_0\colon \gamma_2 = 0$ can be chosen as the null hypothesis of parameter constancy. If the null hypothesis holds, the parameter coefficients $\beta_{20}, \beta_{21}$ and $c_2$ in equation (4.19) cannot be identified. Therefore, the solution to this identification problem is to replace $f(t/T\,; \gamma_2, c_2)$ by its first-order Taylor expansion around $\gamma_2 = 0$. Thus, we obtain the following auxiliary regression:

$$y_{it} = \mu_i + \beta_{10}^{*'} x_{it} + \beta_1^{*'} x_{it}(t/T)' + \beta_2^{*'} x_{it}(t/T)^2 + \cdots + \beta_h^{*'} x_{it}(t/T)^h + (\beta_{11}^{*'} x_{it}$$

$$+ \beta_{h+1}^{*'} x_{it}(t/T)^2 + \cdots + \beta_{2h}^{*'} x_{it}(t/T)^h) g(q_{it}; \gamma_1, c_1) + u_{it} \qquad (4.22)$$

where $u_{it}^* = u_{it} + R_h(t/T\,; \gamma_2, c_2)$ and $R_h(t/T\,; \gamma_2, c_2)$ represents the remainder term. The parameter vectors $\beta_j^*$ for $j = 1.2, \dots, h, h+1, \dots 2h$ in equation (4.22) are multiples of $\gamma_2$ such that the null hypothesis in equation (4.19) can be reformulated as $H_0^*: \beta_j^* = 0$ for $j = 1.2, \dots, h, h+1, \dots 2h$ in the auxiliary regression. The Taylor expansion approximation does not affect the asymptotic distribution theory under $H_0^*$ $\{u_{it}^*\} = \{u_{it}\}$. The null hypothesis states that $LM_\chi$ is asymptotically distributed as $\chi^2(2hk,)$ and $LM_F = LM_\chi/2hk$ is approximately distributed as $F(2hk, TN - N - 2K(h+1) - (m+1))$. When the null hypothesis of the model is a homogeneous fixed effects model ($\beta_{11} = \beta_{20} = \beta_{21} = 0$) in equation (4.19), equation (4.22) renders a parameter constancy test for this model (Eitrheim and Teräsvirta, 1996).

**ii. Testing for the number of extreme regimes (transition functions)**

The PSTR model evaluation refers to testing for parameter constancy, and no remaining nonlinearity can be generalized to serve as misspecification tests in an additive PSTR model with $r > 0$. Therefore, testing for no remaining heterogeneity becomes useful for testing misspecification and for determining the number of transition functions in the PSTR model. Testing for a number of transition functions within a PSTR framework tests the null hypotheses of no remaining nonlinearity in the transition function. When testing for the number of transition functions, we assume that the linearity hypothesis is rejected (González *et al.*, 2005). Furthermore, it is tested whether there is one transition function $H_0: r = 1$ or two transition functions $H_0: r = 2$. Consider an auxiliary regression model with $r = 2$ regimes:

$$y_{it} = \mu_i + \beta_0'^* x_{it} + \beta_1'^* x_{it} g_1(q_{it}^1; \gamma_1, c_1) + \beta_2'^* x_{it} g_2(q_{it}^2; \gamma_2, c_2) + \varepsilon_{it}^* \qquad (4.23)$$

The null hypothesis stating that there is no remaining heterogeneity in an estimated three-regime PSTR model can be expressed as $H_0: \gamma_2 = 0$. The transition function, $g_2(q_{it}^2; \gamma_2, c_2)$ is replaced by the Taylor expansion around $\gamma_2 = 2$ and then in testing linear constraints on the parameters. Therefore, the equation (4.23) can be expressed as follows:

$$y_{it} = \mu_i + \beta_0'^{*} x_{it} + \beta_1'^{*} x_{it} g_1(q_{it}^1; \gamma_1, c_1) + \theta x_{it} q_{it} + \varepsilon_{it}^{*} \qquad (4.24)$$

Testing for no remaining nonlinearity is expressed as $H_0: \theta = 0$. $SSR_0$ denotes the panel sum of squared residuals under $H_0$, while $SSR_1$ represents the sum of squared residuals of the transformed model in a PSTR model with one transition function. Given a PSTR model with $r = r^*$, the null hypothesis $H_0: r = r^*$ is tested against the alternative $H_1: r = r^* + 1$. If $H_0$ is not rejected, we cannot proceed with this estimation procedure. Otherwise, the null hypothesis $H_0: r = r^* + 1$ is further examined against the alternative hypothesis $H_1: r = r^* + 2$. This testing procedure continues until the null hypothesis of no remaining heterogeneity in a PSTR is accepted. González *et al*. (2005) proposed a sequential testing procedure for no remaining heterogeneity with the following steps:

i. First, estimate a linear model and test for homogeneity at a conventional significance level $\alpha$.
ii. If homogeneity is rejected, proceed with the estimation of a two-regime PSTR model.
iii. Test the null hypothesis of no remaining heterogeneity for this model. If the null hypothesis is rejected at significance level $T\alpha$ with $0 < T < 1$, proceed with the estimation of an additive PSTR model with $r = 2$.
iv. This process is to be repeated until the null hypothesis of no remaining heterogeneity can no longer be rejected at the level of significance $T^{r-1}\alpha$ when the additive PSTR model under the null hypothesis include the number of transition functions.

**iii. Testing for no remaining nonlinearity**

The assumption of a PSTR model with two extreme regimes, as shown in equations (4.6) and (4.7), adequately captures the heterogeneity within a panel data framework. This assumption can be tested in different ways. However, the common practice is to consider an additive PSTR model shown in equation (4.7) with two transitions ($r = 2$) as an alternative. This yields the following equation:

$$y_{it} = \mu_i + \beta_0'^{*} x_{it} + \beta_1'^{*} x_{it} g_1(q_{it}^{(1)}; \gamma_1, c_1) + \beta_2'^{*} x_{it} g_2(q_{it}^{(2)}; \gamma_2, c_2) + u_{it}^{*} \tag{4.25}$$

Where the transition variables $q_{it}^{(1)}$ and $q_{it}^{(2)}$ can sometimes be the same; even though this is not necessarily always the case. The null hypothesis of no remaining nonlinearity in the estimated PSTR model with two regimes can be formulated as $H_0: \gamma_2 = 0$ in equation (4.21). Testing for no remaining nonlinearity can be complicated by the presence of unidentified nuisance parameters under the null hypothesis. Therefore, the identification problem can be circumvented by replacing $g_2(q_{it}^{(2)}; \gamma_2, c_2)$ by a Taylor expansion around $\gamma_2 = 2$. Therefore, this yields the following auxiliary regression:

$$y_{it} = \mu_i + \beta_0^{*\prime} x_{it} + \beta_1^{*\prime} x_{it} g_1\left(q_{it}^{(1)}; \hat{\gamma}_1, \hat{c}_1\right) + \beta_2'^{*} x_{it} q_{it}^{(2)} + \cdots + \beta_{2m}^{*\prime} x_{it} q_{it}^{(2)m} + u_{it}^{*} \tag{4.26}$$

where $\hat{y}_1 \, and \, \hat{c}$ are estimates under the null hypothesis of no remaining heterogeneity. Since $\beta_{21}^{*}, \ldots., \beta_{2m}^{*}$ are multiples of $\gamma_2$, the null hypothesis of no remaining heterogeneity can be tested as $H_0^{*}: \beta_{21}^{*}, \ldots., \beta_{2m}^{*} = 0$. If $\beta_1 = 0$ in equation (4.26), the test collapses into the homogeneity test as discussed in sub-section 4.5.1.2. To compute the Wald LM test statistic discussed in equation (4.10) and its F-version, we make an expression of $w_{it} = x_{it}' q_{it}^{(2)} + \cdots + x_{it}' q_{it}^{(2)m\prime}$ and replace $\bar{X}$ in equation (4.11) and (4.12) by $\bar{V}$, where $u_{it} = (\, x_{it}' \; x_{it}' \; g, (q_{it}^{(1)}; \hat{y}_1, \hat{c}_1)(\partial\, \hat{g}/\partial\gamma)\; x_{it}'\hat{\beta}_1, (\partial\, \hat{g} c_1/\partial)\; x_{it}'\hat{\beta}_1)'$. If the $H_0^{*}$ holds, the $LM_{\chi}$ statistic has an asymptotic $\chi^2(mk,)$ distribution, whereas $LM_F$ has an approximate $F(2hk, TN - N - 2K(h+1) - (m+1))$ distribution (González *et al.,* 2005).

## 4.6 ANALYSIS OF EMPIRICAL RESULTS

This section focuses on the execution of empirical estimation procedure undertaken in the previous section, as well as the interpretation and discussion of the empirical results on the nonlinear effect of public debt on economic growth in SADC region. As mentioned earlier, the PSTR model was estimated to study the nonlinear relationship between public debt and economic growth in SADC region for the period 2000-2018. This section is divided into eight sub-sections. Section 4.6.1 reports the results of stationarity testing.

Section 4.6.2 discusses the results of linearity test. Section 4.6.3 gives the results of the sequence of homogeneity tests for selecting order m for transition function. Section 4.6.4 discusses the PSTR results. Section 4.6.5 reports the results of parameter constancy. Section 4.4.6 discusses the results for no remaining nonlinearity test. Section 4.6.7 deals with robustness of the PSTR parameter estimates. Furthermore, the empirical results from the estimation procedure of the PSTR model are clearly presented, interpreted and discussed in the sequence in which they were discussed in the previous section. Section 4.4.8 addresses the issue of anomalies to support our empirical results. Lastly, Section 4.4.9 provides concluding remarks for the chapter.

### 4.6.1 Formal Panel Unit Root Tests

This sub-section reports the results of the formal unit root tests to ascertain stationarity and order of integration among variables in the model. As mentioned earlier, the study employed the Im, Pesaran, and Shin (2003) (IPS), Levin, Lin and Chu (2002) (LLC) and Fisher-type Choi (2001) (FSR) to test for unit root among the variables within a panel framework. These tests are conducted based on the null hypothesis that the series has a unit root. Therefore, the null hypothesis is rejected if the t-statistic is greater than the critical value, implying that there is no unit root. Conversely, the null hypothesis cannot be rejected if the t-statistic is smaller than the observed critical value.

**Table 4.1: Unit Root Test Results**

| TESTS | LGDP | PD | EMP | GFCF | GOE |
|---|---|---|---|---|---|
| **IPS W-stat** | | | | | |
| Levels | -0.1213 | 0.5709 | -1.3967* | -2.2932** | -1.7216** |
| [*P-value*] | [0.4517] | [0.7160] | [0.0812] | [0.0109] | [0.0426] |
| Differences | -6.7957*** | -6.8567*** | -3.2266*** | -7.3154*** | -6.9142*** |
| [*P-value*] | [0.0000] | [0.0000] | [0.0006] | [0.0000] | [0.0000] |
| **LLC t*-stat** | | | | | |
| Levels | -1.3803*** | -5.1083* | -5.0823*** | -3.4834*** | -5.1182*** |
| [*P-value*] | 0.0837] | [0.000] | [0.0000] | [0.0002] | [0.0000] |
| Differences | -6.7750*** | -5.1892*** | -4.0213*** | -5.9607*** | -7.1254*** |
| [*P-value*] | [0.0000] | [0.0000] | [0.0000] | [0.0000] | [0.0000] |
| **Fisher-type** | | | | | |
| Levels | 6.8882 | -2.1810*** | -0.6503 | -0.1736 | -1.7442 |
| [*P-value*] | [0.0000] | [0.9854] | [0.7423] | [0.5689] | [0.9594] |
| Differences | 18.9540*** | 19.1373*** | 1.4532* | 17.5574*** | 15.3760*** |
| [*P-value*] | [0.0000] | [0.0000] | [0.0731] | [0.0000] | [0.0000] |

*Notes: Asterisks ***, ** and * denotes the statistical level of significance at 1%, 5%, and 10%, respectively. The p-values are shown in parenthesis.*

*Source: Researcher's own results*

The above unit root test results clearly indicate that all variables are stationary in their level form as suggested by the LLC. On other hand, the IPS test shows that GOE, GFCF and EMP are I(0), and LGDP and PD are I(1). The FSR test shows that only LGDP is stationary in level form, and the rest of the variables are stationary after first differences. However, the IPS test is chosen as the main test over the LLC test since the latter does not account for heterogeneity bias in a panel framework.

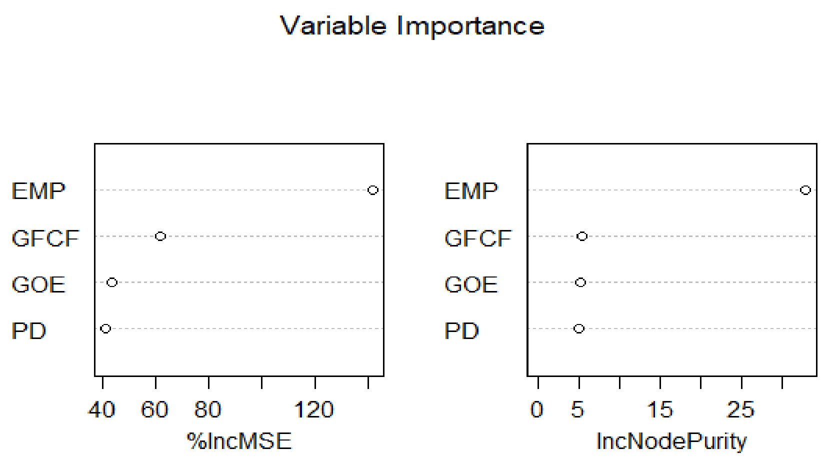
The IPS test assumes that there are individual unit root processes across the cross-section which allows for heterogeneous parameters in a balanced panel data. Contrary to this, the LLC test assumes that there is a common unit root process for all cross-sections, allowing for homogeneity parameters. IPS is the main test for testing the unit root since the LLC test does not account for heterogeneity bias in a panel data. Hence, the LLC and FSR unit root tests are computed to complement and verify the IPS test results. The IPS test shows that GOE, GFCF and EMP are stationary in level form while

LGDP and PD are stationary at first difference and significant at $1\%$ level of significance. The LLC test shows that all variables are I(0) at $1\%$ significance level, except for LGDP which is significant at $10\%$ level of significance.

Conversely, FSR shows that all variables are nonstationary in levels, except for LGDP, which is stationary in level form significant at $10\%$ significance level. Therefore, in the presence of contradiction among these tests, all these variables were converted into first differences. Thus, all three tests suggest that all variables are at first difference, i.e. I(1). However, inferences are drawn upon the IPS test due to the aforementioned advantages of IPS test and rigor involved in computation.

Figure 4.1 below allows for the determination of the importance of each variable on the endogenous variables when ordering the variables for model specification of a panel data regression.

**Figure 4.1: Determining the Variable of Importance**




*Source: Author's own estimation using R Studio*

Figure 4.1 demonstrates the importance of each of the variables on LGDP as an endogenous variable in the model. The exogenous variables include EMP, GFCF, GOE and PD on GDP. The results shows that employment (EMP) is the most important variable with $141.8\%$ importance to GDP. Gross fixed capital formation (GFCF) is the second most influential exogenous variable with $61.2\%$ importance on LGDP. Government expenditure (GOE) is the third exogenous variable with $43.4\%$, and public debt (PD) is the last exogenous variable, contributing the least important percentage of $41\%$ on LGDP. These findings are in line with conventional economic literature such as the Cobb-Douglas production function and endogenous growth models which specify output growth as a function of capital (GFCF) and labour (EMP) as key variables. Other explanatory variables, i.e., GOE and PD, follow as controlling explanatory variables in the model.

### 4.6.2 Results of the Homogeneity Test

Table 4.1 reports the results of linearity test which indicate that the null hypothesis of linearity/homogeneity is rejected by both the Lagrange Multiplier Wald ($LM_W$) and the Fischer ($LM_F$) test. This implies that the relationship between public debt and economic growth in the SADC region is indeed nonlinear.

**Table 4.2: Linearity Tests**

| **Test** | $\mathrm{m} = 1$ | | $\mathrm{m} = 2$ | |
|---|---|---|---|---|
| | Statistic | p-value | Statistic | p-value |
| Lagrange Multiplier – Wald ($LM_W$) | 34.01 | 7.423e-07 *** | 53.06 | 1.051e-08 *** |
| Lagrange Multiplier – Fischer ($LM_F$) | 7.57 | 9.847e-06*** | 5.80 | 1.044e-06 *** |

*Notes: Asterisks ***, ** and * denotes significance level at 1%, 5% and 10%, respectively.*

$H_0$*: Linear model, and* $H_1$*: PSTR model with m = 1 or m = 2.*

*Source: Author's own estimation using R Studio*

Testing homogeneity of the coefficients of these country-specific variables implies the assumption that macroeconomic effects on growth do not differ across countries. The linearity test helps us to determine whether the order m (number of transitions) is one or two. The result of linearity shows the p-value of the Lagrange multiplier test for the null hypothesis of homogeneity/linearity against the alternative of logistic ($\mathrm{m}=1$) or exponent ($\mathrm{m} = 2$) PSTR specification. The results indicate that the null hypothesis of linearity under both $LM_W$ and $LM_F$ test is strongly rejected at $1\%$ level of significance. Furthermore, the rejection of linearity is stronger when $\mathrm{m} = 1$. Hence, the logistic specification ($\mathrm{m} = 1$) is preferred to exponential specification ($\mathrm{m} = 2$). Moreover, it is assumed that $\mathrm{m} = 1$ is the preferred over $\mathrm{m} = 2$ if both $\mathrm{m} = 1$ and $\mathrm{m} = 2$ are rejected at conventional levels by both $LM_W$ and $LM_F$ tests. The wild bootstrap (WB) test further identifies that a specified transition variable has p-values that are practically equal to zero. This finding implies that there is a non-linear relationship between public debt and growth in the SADC region. Hence, the study proceeds with the estimation of the PSTR with a single transition to examine the non-linear effect of public debt on economic growth in SADC region.

### 4.6.3 Sequence of homogeneity tests for selecting order m of transition function

**Table 4.3: Homogeneity tests for selecting order m of transition function**

```
Sequence of homogeneity tests for selecting number of switches 'm':
```

```
LM tests based on transition variable 'PD'
 mLM_X        PV   LM_F        PV HAC_X     PV HAC_F     PV WB_PV WCB_PV
  1 34.01 7.423e-07 7.573 9.847e-06 3.561 0.4686 0.793 0.5308     0   0.75
  2 22.09 1.923e-04 4.830 9.470e-04 4.712 0.3181 1.030 0.3926     0   0.00
```

*Source: Author's own estimation using R Studio*

Table 4.3 above presents the sequence of homogeneity tests for selecting the order m of the logistic transition function in a PSTR model for a nonlinear relationship between public debt (PD) and economic growth (LGDP), and with explanatory variables, which include gross fixed capital formation (GFCF), employment (EMP) and government expenditure (GOE) for a balanced panel of 13 SADC countries over the period 2000-2018. This section shows the results for the PD sequence test as a transition variable due to brevity. However, other variables were tested, and the result identified PD as a transition variable. Table 4.3 reports the results of the specification sequence test for PD variables to determine the order m of the logistic transition function. The HAC and WCB tests indicate that $m = 1$ is the best number of transitions, while LM and WB statistics are not informative since their p-values are significantly different from zero.

Therefore, the study proceeds with the estimation of the PSTR model with two extreme regimes and single transition function specified as follows:

$$\begin{aligned} LGDP_{it} &= \mu_i + \lambda_i + \beta_{11}PD_{i,t-1} + \beta_{12}EMP_{i,t-1} + \beta_{13}LGFCF_{i,t-1} + \beta_{14}GOE_{i,t-1} \\ &\quad + \left(\beta_{21}PD_{i,t-1} + \beta_{22}EMP_{i,t-1} + \beta_{23}LGFCF_{i,t-1} + \beta_{24}GOE_{i,t-1}\right)g\left(PD_{i,t-1};\gamma,c\right) \\ &\quad + \varepsilon_{it} \end{aligned} \tag{4.27}$$

where $\lambda_i$ represents the fixed time effects, and

$$g\left(PD_{i,t-1};\gamma,c\right) = \left(1 + \exp\left(-\gamma\left(PD_{i,t-1} - c\right)\right)\right)^{-1}, with\, \gamma > 0. \tag{4.28}$$

### 4.6.4 PSTR Model Estimates

**Table 4.4: PSTR estimates**

| Panel smooth transition regression (PSTR) model | | |
|---|---|---|
| Endogenous variable : GDP | | |
| Explanatory variables | Low regime $\beta_{0j} \times 100$ | High regime $(\beta_{0j} + \beta_{0j}) \times 100$ |
| Public debt($PD$) | **0.35** (0.43) | **-0.33***** (0.11) |
| Employment (EMP) | **-2.1***** (0.6) | **-1.53***** (0.7) |
| Gross capital formation (GFCF) | **0.98*** (0.54) | **-0.05** (0.45) |
| Government expenditure ($GOE$) | **0.06** (0.7) | **0.01** (0.7) |
| Transition Parameters | | |
| **Threshold** (**c**) | | **60.36***** (0.03) |
| **Slope** ($\gamma$) | | **20.27***** (3.62) |
| No. of obs. | | **247** |
| No. of countries | | **13** |

*Notes: Asterisks ***, ** and * denotes significance level at 1%, 5% and 10%, respectively.*

*Source: Author's own estimation using R Studio*

Table 4.4 reports the estimated parameter estimates for a PSTR model with a single transition function and two extreme regimes. As mentioned earlier, one of the procedural requirements for estimating a PSTR model is to test for no remaining nonlinearity to further determine the number of transition functions within the estimated PSTR model. The nonlinear relationship between public debt and economic growth in the SADC region has a single transition function and two regimes as shown in Table 4.5 for no remaining nonlinearity results. Hence, the study estimates the PSTR by applying a nonlinear least square to a panel data eliminated for the individual effects.

The empirical findings reveal that public debt indeed has a nonlinear relationship with economic growth in the SADC region. As expected, the public debt threshold level is found to be $60\%$ for the SADC region, statistically significant at $1\%$ level of significance. Importantly, the estimated threshold of $60\%$ public debt-to-GDP ratio is equivalent to the SADC macroeconomic convergence targets stipulated in the SADC treaty. The findings on the threshold of $60\%$ public debt-to-GDP ratio in SADC are not significantly different from the results reported by Baum *et al*. (2013), who studied the nonlinear effect of public debt on growth in 12 European countries and found the debt threshold target to be $67\%$. Another study by Checherita-Westphal *et al*. (2014) also investigated the nonlinear effect of public debt on economic growth and found a debt threshold level of $50\%$ among OECD and European countries.

The estimated debt threshold level for the SADC region is found to be significantly higher than the $31.37\%$ threshold level found by Baaziz *et al*. (2015) for South Africa. The study carried out by Baaziz *et al*. (2015) employed time series data over the period 1980-2016, which comprises a significant part of the apartheid era where the growth risks arising from high budget deficits to prop up a failed system were high – hence, such low threshold level was expected. Moreover, the findings by Baaziz *et al.* (2015) on the debt threshold in South Africa is too low, implying that there is a risk to the economy if the debt level were reaised. Moreover, the estimated threshold level is much lower than the findings reported by Reinhart and Rogoff (2010) and Checherita-Westphal and Rother (2012). Both studies reported a threshold level of 90% of debt-to-GDP ratio for advanced economies. The findings of the study are theoretically plausible since developed countries have more capacity to borrow and repay their long-term debt as compared to developing countries.

Furthermore, the majority of SADC member countries are classified as non-industrialised, and some are considered low/middle income and developing countries. These countries thus share the same economic characteristics and pursue similar macroeconomic policies as other developing regions around the world. Hence, the economic conditions may be different from developed regions such as Europe or United Kingdom. Furthermore, some macroeconomic conditions in the SADC region may thus be similar to the economic conditions of other developing countries elsewhere, such as Asian or South American economies. Therefore, the estimated debt threshold of $60\%$ in the SADC region is considered to be at a reasonable level for a region that consists only of developing economies.

In the low debt regime, the slope coefficients for both EMP and GFCF are statistically significant while PD and GOE are found to be statistically insignificant. Subsequently, in the high debt regime, PD and EMP are statistically significant while GFCF and GOE remain statistically insignificant. The signs of coefficients for EMP are not theoretically justifiable in both low and high regime. The coefficient sign for GOE is theoretically plausible but statistically insignificant, and GFCF has the correct positive sign only in the low regime. Under a low debt regime, the coefficient of public debt is found to be $0.35$ but statistically insignificant. On the other hand, for a high debt regime, the public debt coefficient is estimated to be $-0.33$ statistically significant at $1\%$. This finding implies that the effect of public debt on growth is positive and weak when the debt level is below the threshold of $60\%$. However, the effect becomes negative and severe when the debt level reaches and goes beyond the estimated threshold of $60\%$. This finding is in line with much of the literature (Checherita-Westphal and Rother, 2012; Baum *et al.,* 2013) that show a nonlinear inverted U-Shape between public debt and economic growth across different regions.

A correct positive sign for GFCF is supported by prior empirical studies carried out by Vinayagathasan (2013) and Thanh (2015), and is also in line with the Solow growth model. However, a negative unanticipated sign for GFCF in the high debt regime is not plausible and unexpected since the Solow growth model postulates that investment projects ought to enhance growth. Moreover, the unexpected sign for EMP and GFCF slope coefficients in the high debt regime may be attributable to data quality problems in the SADC region. Government spending is found to have an expected positive impact on growth during both low and high debt regimes. However, these coefficients are statistically insignificant which may also be attributed to data problems. The transition parameter of $\gamma = 20.27$ shows that a transition from a low public debt regime to a high debt regime is smooth but relatively gradual. This estimated low transition parameter suggests that fiscal policymakers in the SADC region ought to act with caution when the debt level approaches the estimated threshold parameter $c = 60.36$.

### 4.6.5 PSTR Evaluation Tests

**Table 4.5: Parameter Constancy**

```
Results of the evaluation tests:
-------------------------------------------------------------------------
Parameter constancy test
  m  LM_X        PV LM_F        PV HAC_X     PV  HAC_F     PV
  1 43.62 6.699e-07 4.68 2.719e-05 8.816 0.3581 0.9458 0.4798
-------------------------------------------------------------------------
No remaining nonlinearity (heterogeneity) test
  m  LM_X        PV  LM_F        PV HAC_X     PV HAC_F     PV
  1 51.39 2.203e-08 5.514 2.444e-06 10.57 0.2275 1.134 0.3419
-------------------------------------------------------------------------
WB and WCB no remaining nonlinearity (heterogeneity) test
  m WB_PV WCB_PV
  1     1      1
```

*Source: Author's own estimation using R Studio*

As mentioned earlier, the study further examined the adequacy of the estimated two-regime PSTR model by applying the misspecification tests for parameter constancy. The above Table 4.5 reports the results of parameter constancy, which indicate that the estimated PSTR model with one threshold on two regimes is adequate. The test for parameter constancy examined the null hypothesis that parameters are constant against the alternative of non-constant parameters. The majority of the above tests, which include HAC, WB and WCB, indicate that the null hypothesis cannot be rejected while the LM test is not informative. Moreover, the findings also show that the WB and WCB tests, which take into account heteroscedasticity and possible within-cluster dependence, suggest that the estimated PSTR model with a single transition and two regimes is adequate.

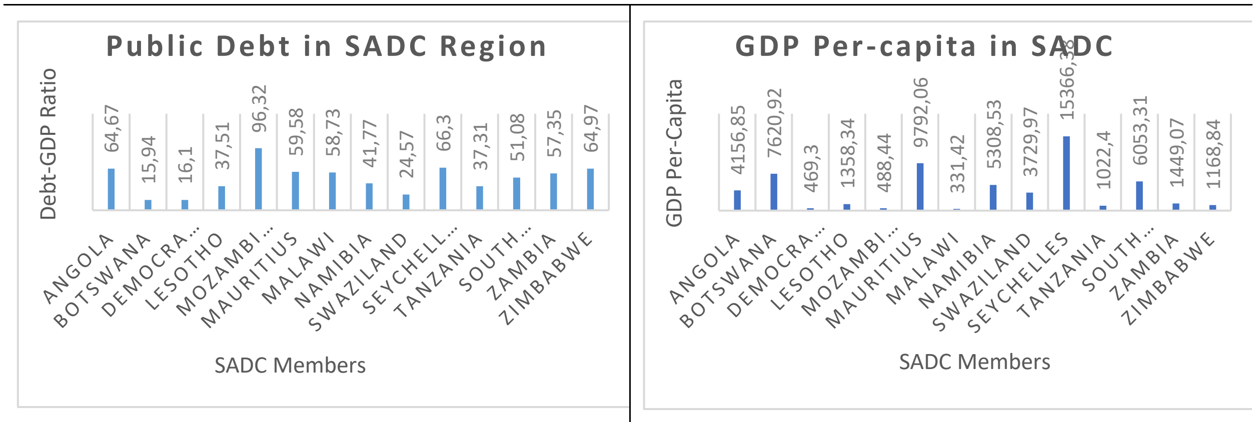
### 4.6.6 Testing for No Remaining Nonlinearity

The results for no remaining linearity test are reported in Table 4.5. Estimating the PSTR requires a to test for no remaining nonlinearity to confirm that the estimated PSTR has a single transition function and two extreme regimes. The study provides strong evidence that the null hypothesis of no remaining nonlinearity ($r = 1$) cannot be rejected by the HAC, WB and WCB test, except the LM test. The rejection of the null hypothesis implies that the PSTR model has one threshold and two extreme regimes in the SADC region. Furthermore, the null hypothesis without threshold ($r = 0$), and the one with at least two thresholds ($r = 2$), are both rejected by all of these tests. This result implies that there is only one transition function which separates the low debt regime from the high debt regime in its relation to economic growth in the SADC region. Therefore, the test for no remaining nonlinearity results indicates that there is no remaining nonlinearity within the estimated PSTR model.

### 4.6.7 Robustness Checks - 5-Year Average Computation

Table 4.5 shows the computed results of a 5-year public debt and GDP per capita average for SADC member countries from 2014 to 2018. Given some concern about the robustness of empirical findings, a 5-year mean values for public debt and GDP per-capita was computed to observe the economic performance of SADC countries that have public debt ratios below the estimated threshold, as well as the ones above the estimated debt threshold of $60\%$. Therefore, this sub-section compares the public debt level of each SADC member state with its GDP per capita to observe these dynamics.

**Figure 4.2: Debt and GDP 5-Year Average**




*Source: Author's own computation*

The majority of the results from the above figure confirms the validity of the estimated debt threshold level in the SADC region. Most of the SADC countries that have public debt-to-GDP ratios greater than the threshold of 60%, which are also classified as low-income countries, are evidently not doing well as those with debt levels below the estimated threshold level. This is shown by the results of countries such as Mozambique and Zimbabwe with the higher debt-to-GDP ratio and yet lower GDP *per-capita*. Over the past five years, Mozambique and Zimbabwe have been the only countries in the SADC that have reported public debt-to-GDP ratios above 70%, which is far above the SADC macroeconomic convergence target of 60% debt-to-GDP ratio. With the lowest GDP per capita, these two member countries become anomalies in the data series. On the other hand, SADC members that are classified as middle-income and developing faster than their counterparts, such as South Africa, Seychelles, Mauritius, Botswana, Namibia and Angola, are doing very well with keeping their debt level below the estimated threshold level. With that said, even though the Seychelles and Angola have debt levels that exceed the threshold, their economic performance has been satisfactory. As previously mentioned, these figures are further supported by the fact that countries that are considered to have the capacity to repay their government debt in terms of development may have public debt levels of up to 90%, as suggested by Reinhart and Rogoff (2010) and Ghosh *et al.* (2013) for advanced economies.

Figure 4.2 clearly shows that both public debt and GDP per-capita belies considerable heterogeneity across the SADC member countries. The majority of SADC members have high public debt-to-GDP ratios even though most remain within the 60% macroeconomic convergence target. The exceptions ae Mozambique, Zimbabwe, Angola and the Seychelles. A study carried out by Rakotonjatovo (2007) points out that the high public debt-to-GDP ratio for the majority of SADC member countries is accounted by the need for government to redirect public expenditure towards the development of social and economic infrastructure investment in the economy. As a result, government expenditure has grown at a higher pace than revenues, leading governments to resort to borrowings to fund public consumption expenditure.

The World Bank classifies Mozambique and Zimbabwe as fragile economies while Angola and the Seychelles are emerging markets. Fragile economies such as Mozambique and Zimbabwe are expected to have lower thresholds, while developing countries would have higher thresholds. Emerging economies would be expected to have yet higher thresholds. The reasoning behind this view is that, as countries grow, their debt servicing capacity grows with the expanding economy. Hence, public debt accumulation is expected to materialise. With that said, the two fragile economies are thus anomalies. Their high debt-to-GDP ratios is unexpected and do not make sense because they are fragile economies who ought to have low debt to GDP thresholds. In light of this, the study conducts the robustness check analysis through the estimation of the STAR technique for each anomaly to support the PSTR estimates. Table 4.6 below provides the STAR estimates to support the PSTR findings on anomalies where the public debt-to-GDP ratio for Mozambique and Zimbabwe are much higher compared to other SADC members with very low GDP *per capita* over the past five years. Hence, these two countries become anomalies from our findings of the PSTR model. To address these anomalies, a STAR model is estimated for each individual country to verify PSTR results.

### 4.6.8 Anomalies (Debt-to-GDP ratio) – Mozambique and Zimbabwe

This section presents the results of the STAR estimates to address the anomaly of Zimbabwe and Mozambique with their high debt-to-GDP rations. The estimation of the STAR model first requires a test for homogeneity to establish whether the relationship among the variables in indeed nonlinear. The linearity test was carried out for each country separately. The linearity test results indicate that the relationship between public debt and economic growth among the selected countries is indeed nonlinear (See: Appendix B, Table B5).

**Table 4.6: STAR Estimates for Anomalies**

| | Mozambique | | Zimbabwe | | South Africa | |
|---|---|---|---|---|---|---|
| | **Coefficients** | **t-stats** | **Coefficients** | **t-stats** | **Coefficients** | **t-stats** |
| Low Debt | -0.25*** | -4.65 | -0.27* | -2.09 | -0.19 | -0.54 |
| High Debt | -0.05 | -1.69 | 0.28*** | 4.04 | -0.31*** | -3.43 |
| Intercept (C) | 9.02*** | 4.29 | 2.39 | 1.16 | 4.01*** | 10.17 |
| EMP | -6.75** | -2.93 | 0.56 | 0.21 | -9.31*** | -4.46 |
| GFCF | 0.05 | 0.35 | 0.68* | 2.20 | 9.60*** | 4.39 |
| GOE | 0.42 | 0.80 | 0.45 | 1.48 | 5.64*** | 5.51 |

*Notes: Asterisks ***, ** and * denotes significance level at 1%, 5%, and 10%, respectively.*

The above Table 4.6 shows the STAR results estimated for the two SADC members that are anomalies in terms public debt-to-GDP ratio. Mozambique and Zimbabwe have an average of 96% and 65% debt-to-GDP ratio respectively, recording the lowest GDP per capita among SADC members for the past 5 years. On the other hand, South Africa is used as a benchmark for the two anomalies. South Africa, as an emerging market, had a public debt level that is within the macroeconomic convergence target of the SADC at the debt average of 51% over the past five years. This is one of the highest GDPs *per capita* among SADC economies, after Seychelles and Botswana.

The unit root testing was carried out for each individual country separately using the Augmented Dickey Fuller (ADF) test, and results indicated that all variables are I(1). As previously mentioned, the robustness checks for the PSTR results were conducted using the STAR model for 3 SADC members to verify the PSTR estimates: Mozambique, Zimbabwe and South Africa. A comparative analysis was conducted between the two countries that are anomalies in terms of public debt-to-GDP ratio, and they were compared with the STAR outputs obtained for South Africa. The results offered by the

STAR model indicates a negative effect of public debt on economic growth in Mozambique during both regimes. However, the debt effect on growth is statistically insignificant during the high debt regime while there is significant negative influence of debt during low debt, suggesting that a 1% rise in debt would contract the economy by 0.25% significant at conventional level. This further insinuates that a rise in public debt deteriorates economic growth in Mozambique.

In Zimbabwe, there is a negative impact of debt on growth during the first regime, implying that a 1% rise in public debt cause a 0.27% decline in the economy of Zimbabwe. During the high debt regime, the results shows that if debt increases by 1%, the economy would grow by 0.28% significant at conventional level. This result indicates that there is a U-shape relationship between public debt and economic growth in Zimbabwe, implying that debt leads to an economic contraction during the first regime while the economy expands during the high debt regime. The STAR results for South Africa indicate that public debt has a negative influence on growth in the nonlinear form since the negative effect in the first regime is statistically insignificant while the nonlinear negative effect of debt is statistically significant at conventional level. The high debt regime in South Africa indicates that if debt increases by 1%, the economy would decline by 0.31%. The STAR results on the nonlinear effect of public debt are in line with the PSTR findings.

The coefficient for EMP indicates that employment has a negative effect on economic growth in both Mozambique and South Africa, while in Zimbabwe it has an insignificant positive effect on growth. Interestingly, the results for GFCF shows that an increase in gross fixed capital formation has a positive impact on growth across 3 SADC members under investigation. However, the relationship between gross fixed capital formation and economic growth is only statistically significant for Zimbabwe and South Africa. This implies that a rise in investment leads to economic expansion in these economies. Furthermore, the GOE coefficient indicates that government expenditure has a positive impact on economic growth for the 3 countries under consideration. However, only South Africa has a statistically significant coefficient of government expenditure. Importantly, the STAR outputs are plausible since all coefficients are consistent with the PSTR estimates.

The estimation procedure of a STAR model dictates that the estimated STAR ought to be subjected to model evaluation tests, which include testing for no remaining nonlinearity and parameter constancy. The Teräsvirta Sequential test results provide evidence that the null hypothesis of no remaining nonlinearity (r = 1) cannot be rejected, thus implying that there is no remaining nonlinearity in the STAR model. Hence, there exists a single transition function separating the low-debt regime from the high-debt regime on the nonlinear relationship between debt and economic growth for 3 SADC members under consideration. Moreover, the misspecification test results for parameter constancy shows that we cannot reject the null hypothesis that parameters are constant and adequate (See: Appendix B, Table B6).

Furthermore, the STAR model was also subjected to the applicable post diagnostic inspection tests to examine the statistical adequacy of the residuals in the model. Our empirical findings revealed that the estimated STAR model satisfies the standard requirements of the Gauss-Markov conditions against the problem of serial correlation, heteroscedasticity and normality. The Breusch-Godfrey serial correlation LM test indicated that there was no autocorrelation among the residuals in the STAR model. Moreover, the Breusch-Pagan-Godfrey heteroskedasticity test revealed that residuals of the STAR are homoscedastic. The Jarque-Bera test shows that the residuals of the estimated STAR are normally distributed (See: Appendix B, Figure B2). Even though this model is employed as a robustness check model, the major shortcomings of the results from the STAR estimates lie in the small sample size used to conduct empirical analysis due to unavailability of large dataset among several SADC members.

## 4.7 CONCLUDING REMARKS

The investigation of a nonlinear effect of public debt on economic growth has not received much attention in the context of African developing countries, particularly the SADC region. Fiscal policymakers in both advanced and developing countries normally resort to government borrowings from financial institutions such as International Monetary Fund (IMF), World Bank (WB) and BRICS Bank etc. to bridge the gap between excessive government spending and low revenue to finance economic activities consistent with economic development. As mentioned earlier, this study examined the nonlinear relationship between public debt and economic growth for through the estimation a PSTR model, which precisely determines the debt threshold level endogenously. The study employed a panel data for SADC countries over the period 2000-2018.

The study estimated the threshold value and the slope coefficient through the use of endogenous regressors, which include GDP per capita, public debt, employment, gross fixed capital formation and government expenditure. The major advantage of the PSTR is that this model is a relatively new panel data estimation technique which has the ability of estimating the smoothness of the transition function that links the low regime with the high regime. The findings of the study provide strong evidence of a nonlinear relationship between public debt and economic growth in the SADC region. The debt threshold level for the SADC region is estimated to be 60%, above which public debt would be detrimental for growth, and statistically significant at the conventional level. The estimated threshold implies the relationship between public debt and growth is in the form of an inverted U-shape. This means that the impact of public debt on growth is positive. However, when the public debt ratio reaches the 60% threshold, it becomes detrimental for economic growth in SADC region.

Moreover, the majority of slope parameters estimated through the PSTR model is consistent with the conventional literature. The speed of transition from the low to a high regime is relatively smooth, even though slow as suggested by PSTR slope parameter of 20.27%. This suggests that there is no strong pressure for fiscal policymakers in SADC to engage in government borrowings as a quick mechanism to restore long-term growth when public debt reaches the estimated threshold level. The results postulate that fiscal policymakers ought to be cautious and curb public debt when it approaches or goes beyond the estimated threshold value to enhance economic growth in the region. The study proposes that SADC fiscal policymakers should consider the level of public debt within the threshold of 60% to spur sustainable economic stability, development and growth. This study provides empirical evidence that SADC members ought to target the threshold level of 60% debt to GDP to achieve the desired macroeconomic objectives within their economies, beyond which high debt will cause more harm than good in the economy through unsustainable public finances.

The STAR estimates support the PSTAR findings on the asymmetric effect of public debt on economic growth among SADC economies. The STAR model was estimated to verify the results of anomalies where the average debt were too high for Mozambique and Zimbabwe, with the lowest GDPs *per capita*. The results indicated that the relationship between public debt and economic growth is indeed nonlinear among these countries, where their GDPs per capita are extremely low and their debt burden exceedingly high. However, such delicate economies have no scope to keep debt levels lower without edging the economy into a recessionary spiral. However, they ought to take lessons from their more successful peer countries in the fragile and non-fragile group. Middle-income SADC members ought to work on addressing excessive public debt and expenditure that are non-stimulative to their economies since they prove to be detrimental for growth. They should keep their debt level within a sustainable macroeconomic convergence target of 60% as stipulated in the SADC treaty and consistent with findings of the study.

# CHAPTER FIVE

# ASYMMETRIC EFFECTS OF PUBLIC DEBT ON ECONOMIC GROWTH: EVIDENCE FROM SELECTED EMERGING AND FRONTIER SADC ECONOMIES

## 5.1 INTRODUCTION

This study intends to analyse asymmetric effects of public debt on economic growth for selected emerging and frontier SADC economies, over the period 2000-2018. These SADC members include South Africa, Botswana, Namibia, Malawi, Zambia, and Zimbabwe, which comprise a useful selection of a combination of emerging and frontier SADC economies. These countries were solely selected to analyse the asymmetric effects of public debt on economic growth for individual countries separately. This chapter is different from the previous chapter due to its scrutiny of the asymmetric effects of public debt on economic growth using advanced dynamic time series techniques involving error correction mechanisms for selected emerging and frontier SADC members to analyse the country-specific effects of public debt on economic growth. Moreover, this chapter complements the previous chapter, which applied a panel data analysis to examine the asymmetric relationships between public debt and economic growth in SADC region.

According to the S&P Dow Jones Index Country Classification (2020), only South Africa is considered an emerging market, while Botswana, Namibia, Malawi, Zambia, and Zimbabwe are classified as frontier economies. These classifications are based on the level of stock market developments and general conditions of their macroeconomic environment (S&P Dow Jones Indices, 2020). This comparative analysis between emerging (South Africa) and frontier (Botswana, Namibia, Zambia, Malawi and Zimbabwe) SADC markets allows for a better understanding of public debt dynamics towards sustainable economic growth among both emerging and frontier SADC economies. The study estimates a Smooth Transition Regression (STAR) to analyse the nonlinear relationship between public debt and economic growth. Furthermore, the study also applied a Nonlinear Autoregressive Distributed Lag (NARDL) methodology to ascertain the robustness of empirical findings. This chapter addresses the third objective of the study, which is to analyse the asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies. This chapter proceeds as follows: Section 5.1 is the introductory section, with a brief background and justification of the study. Section 5.2 gives the motivation of the study while Section 5.3 reviews empirical studies on the relationship between public debt and economic growth across different economies. Section 5.4 outlines the research methodology adopted in the study, and Section 5.5 discusses the empirical findings. Section 5.6 summarises the findings of the study.

The phenomenon of public debt, also known as government debt or sovereign debt, refers to the sum of all outstanding financial liabilities of the public sector in respect of which there is a binding legal responsibility to repay the original amount borrowed (principal debt), including the interest payable (debt servicing) (Black *et al.,* 2005). Several governments primarily borrow from international financial institutions such as the IMF and World Bank. Moreover, SADC economies may acquire public debt from institutions such as the African Development Bank or BRICS Bank. Government debt is generally the results of an inability of government to collect sufficient revenues consistent with desirable government expenditure to maintain various economic activities of the country during different phases of a business cycle. The World Bank (2018) described government debt as the entire outstanding stock of a government's fixed-term contractual obligations for a certain time period. Government debt combines both domestic and foreign liabilities such as currency, money deposits, securities other than shares, and loans. Public debt enables the government to finance other equally important economic sectors where government revenue is inadequate to finance such public goods and services (Bonga *et al.*, 2015).

Over the past decade, government expenditure in the majority of SADC members has been growing at a much faster pace compared to desired revenues, thus translating to high fiscal deficits and unprecedented levels of public indebtedness. This considerable accumulation of public debt in SADC economies over the years were primarily due to expansionary policy measures adopted by these countries, such as infrastructure investment, technology, and development of SMME's among others. A drastic increase in public debt among these developing countries has become a concern to governments and policymakers. The question is whether this rapid rise in public debt complements or hampers long-term economic growth. Several conventional theories advocate that a reasonable level of debt for developing economies would enhance economic growth through effective fiscal policy that aims to accelerate the development of growth-stimulating sectors such as infrastructure, education, and technology (Lee and Ng, 2015).

This study estimates a STAR model to discriminate against contradicting theoretical and empirical perspectives to analyse the asymmetric relationships between public debt and economic growth to provide robust SADC-specific empirical evidence for policy analysis. The macroeconomic variables in question include gross domestic product (GDP), public debt, employment, gross fixed capital formation and government expenditure. A study conducted by Baaziz *et al*., (2015) in South Africa used GDP, public debt, inflation, and trade openness, and found a nonlinear effect of debt with the threshold of 31.37%, at which public debt stifles economic growth. Reinhart and Rogoff (2010) discovered a positive impact of public debt on growth up to a threshold of 90% debt-to-GDP ratio. However, the unprecedented levels of public debt may still jeopardise the pursuit of strategic macroeconomic reforms, especially in developing economies where the state of public finances may vary from being stable to unstable during economic downturns or global economic crises.

This study primarily focuses on public debt dynamics and fiscal policy by including fiscal variables and applying recent data to robustly determine the asymmetric effects of public debt on long-term economic growth among selected SADC economies. As noted in Chapter 4 of the study, several studies such as Reinhart and Rogoff (2010), Checherita-Westphal and Rother (2012), Herndon *et al*., (2013) and Baaziz *et al*., (2015) reported complex results and to a certain extent, ambiguous findings on the nonlinear effects of public debt on economic growth across different global economies. The existing literature provides ambiguous and contradicting findings on the influence of public debt on economic growth. Studies conducted by Reinhart and Rogoff (2010), Baum *et al.,* (2013) and Burhanudin *et al.* (2017) found a positive relationship between public debt and economic growth. On the other hand, Atique and Malik (2012), Teles and Mussolini (2014) and Lee and Ng (2015) discovered an adverse effect of public debt on economic growth.

Perlo-Freeman and Webber (2009) pointed that government debt would bring a positive impact on long-term economic growth if the debt expenditures are utilised toward financing productive sectors such as infrastructure development, education, technology and healthcare systems. The study contributes to the body of knowledge by estimating a sophisticated STAR and NARDL methodology to examine asymmetric relationships between public debt and economic growth among selected emerging and frontier SADC economies, over the period 2000-2018. A NARDL has the ability to analyse asymmetric short-run adjustments and long-run relationships among variables. The study identifies a need to apply an alternative methodology within a time series setup, which is far different from the previous chapter, to determine the country-specific asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies.

Furthermore, whereas Chapter 4 only considered dynamic transitions and threshold effects of public debt on economic growth through the estimation of a PSTR approach, this chapter considers short-run and long-run dynamic asymmetric relationships as well as the adjustment of short-run deviations to the long-run equilibrium relationships through the estimation of a NARDL error correction mechanism. Moreover, the study embarks on this approach to further estimate the Granger causality technique to determine the causal relationships among variables which could not be detected by a PSTR in the previous chapter. This empirical enquiry attempts to fill the gap in the literature by providing new evidence-based insights supported by empirical evidence to better understand the asymmetric effects of public debt on economic growth using advanced and cutting-edge time series techniques among selected emerging and frontier SADC economies.

## 5.2 MOTIVATION FOR THE STUDY

The current study is unique from previous studies in three different ways. Firstly, in this chapter, asymmetric relationships between public debt and economic growth is analysed among selected emerging and frontier SADC economies using a STAR and NARDL methodology. A STAR enables the estimation of a transition function between variables in the system while allowing for regression coefficients to vary smoothly from one regime to another overtime. Secondly, the study estimates a NARDL model which would complement a STAR, and further investigates the asymmetric short-run adjustment dynamics and long-run equilibrium relationships between public debt and economic growth among the SADC countries chosen. The NARDL technique has the ability to determine cointegration among variables through the Bounds cointegration approach. Moreover, NARDL can test causality among variables in the system though the Granger causality test. Thirdly, while the previous chapter employed panel data techniques, this chapter applies advanced time series estimation techniques to analyse country specific asymmetric effects between public debt and economic growth among selected SADC economies. The empirical findings of the study ought to be robust due to the application of a recent dataset and advanced methodology for SADC-specific policy analysis.

## 5.3 REVIEW OF EMPIRICAL LITERATURE

This section reviews empirical studies conducted on the nonlinear relationship between public debt and economic growth across different economies. Several macroeconomic theories advocate that public debt has a significant negative influence on long-term economic growth. Meanwhile, previous studies yield mixed and controversial findings on the nonlinear effects between public debt and economic growth. Perlo-Freeman and Webber (2009) postulates that public debt would have a positive influence on long-term growth if debt expenditure are directed toward productive sectors such as education and healthcare. Investing in education and health would directly benefit the society through educational programs, which would lead to a significant rise in their ability to self-start, increase labour productivity, and enhance output growth in the economy. A persistent accumulation of public debt across several countries has drawn considerable attention from both researchers and policymakers in an attempt to address fiscal challenges brought by souring fiscal deficits and high public debt by providing sound empirical evidence that is supported by conventional theories.

A study carried out by Teles and Mussolini (2014) contend that the impact of public debt would be detrimental to economic growth if the majority of government spending is channelled toward unproductive expenditure such as social security, aids and ineffective subsidies. Baaziz *et al.* (2015) investigates the nonlinear effect of public debt on economic growth in South Africa from the period 1980-2014. They use a logistic smooth transition regression to study the nonlinear relationship between public debt and economic growth.

The study discovered a debt threshold of 31.37% at which public debt transits from a positive to a negative effect on economic growth. Studies that tested the asymmetric effects of public debt on economic growth, among others, include the work of Reinhart and Rogoff (2010). This was among the first studies to discover a nonlinear relationship between public debt and economic growth in 20 advanced economies over the period 1946-2009.

The study by Reinhart and Rogoff (2010) reported a debt threshold of 90% at which debt deters economic growth. However, this study was later criticised by Herndon *et al*., (2013) on the accuracy of a 90% debt threshold, citing that the 90% debt threshold cannot be defended as it would deteriorate long-term economic growth. Herndon *et al*., (2013) corrected for a number of methodological flaws on the same dataset used by Reinhart and Rogoff (2010) and found that the relationship between public debt and economic growth varies substantially from each country to another over-time. Herndon *et al*., (2013) discovered a debt threshold of 30% at which debt hinders economic growth among these advanced economies. The work of Checchetti *et al.,* (2011) reported a debt threshold of 86% of GDP for a sample of 18 OECD countries from 1980-2010.

A study by Teles and Mussolini (2014) estimated the GMM using unbalanced panel data of 74 countries to assess how the size of the government debt affects long-term economic growth. This study found a negative effect of debt on economic growth. The results also revealed a positive impact of government expenditure on the economic output level. However, the negative effect came with an increased tax burden on consumers and public indebtedness as necessary measures to finance government spending. Another study carried out by Checherita-Westphal and Rother (2012) examines the nonlinear relationship between public debt and growth among 12 European countries over the period 1990-2008. This study revealed a debt threshold of 90% to 100% at which public debt contract economic growth. Baum *et al.* (2013) applied a dynamic panel threshold model to analyse the nonlinear effect of public debt on economic growth from the period 1990-2010 using the same set of countries employed by Checherita-Westphal and Rother (2012). The results reveal a significant positive impact of public debt on growth for debt-to-GDP ratio below the threshold of 67%. Moreover, a negative impact of debt was observed when public debt reaches the threshold level of 95% debt-to-GDP ratio.

Antonakakis (2014) employed dynamic and non-dynamic panel data techniques to examine the nonlinear relationship between sovereign debt and economic growth in 12 European countries over the period 1970-2013. The study found that a non-sustainable debt-ratio above or below 60% debt threshold has a detrimental effect on economic growth in the short-run, while a sustainable debt-ratio below the 90% threshold exerts a positive impact on economic growth in the short-run. Moreover, long-run estimates indicated that both non-sustainable and sustainable debt-ratios above the 90% threshold, and non-sustainable debt-ratios below the 60%, deteriorates long-term economic growth. Another study by Lee and Ng (2015) investigated the contribution of public debt on economic growth in Malaysia using quarterly data for the period 1991-2013. The results revealed a negative association between government debt and economic growth. Moreover, the results found that budget deficits, government consumption and external debt are a decreasing function of real economic growth.

A recent study by Burhanudin *et al.* (2017) estimated an ARDL approach to investigate the effect of government debt on sustainable economic growth in Malaysia for the period of 1970-2015. The results showed a significant positive relationship between government debt and economic growth. Furthermore, there was a unidirectional causality from government debt to sustainable economic growth. The study suggests that government debt is an important driver for economic growth sustainability in Malaysia. However, the study found no evidence to conclude on the threshold level at which government debt brings an adverse effect on sustainable economic growth.

This section provides evidence of the limited literature conducted on the asymmetric effects of public debt on economic growth. From what can be ascertained, this study remains one of the few studies to investigate the asymmetric effect of public debt on economic growth among selected emerging and frontier SADC economies by providing robust, SADC-specific empirical evidence using advanced time series estimation techniques. The observed ambiguity and inconsistency of findings from previous studies requires a cautious empirical investigation on the asymmetric relationship between public debt and economic growth to provide robust empirical evidence specifically from the SADC perspective. The study adopted a STAR methodology to analyse the asymmetric effects of public debt on economic growth among SADC members. A STAR is a sophisticated methodology that allows for the examination of nonlinearity between public debt and economic growth while allowing for parameter coefficients to vary smoothly over time. Furthermore, a NARDL is adopted as a supporting technique to examine asymmetric short-run dynamic adjustments and the long-run relationships among variables in the system. The following section outlines the research methodology adopted in this study to satisfy its objectives and hypotheses.

## 5.4 RESEARCH METHODOLOGY

The methodological section discusses a detailed estimation procedure of all estimation technique s employed during empirical analysis. As previously mentioned, the study adopted a STAR model to analyse the asymmetric effect of public debt on economic growth among selected SADC economies as the primary objective of this chapter. Moreover, the study further estimates a Nonlinear Auto-Redistributed Lag (NARDL) as a supporting model to a STAR to analyse the asymmetric short-run adjustments and long-run relationships among the variables in the system. The findings from this chapter ought to reinforce the findings of the previous chapter on heterogeneity between public debt and economic growth in SADC region. The estimation of these two sophisticated estimation techniques allows for the benchmark of empirical results and provides robust SADC-specific empirical conclusions on the asymmetric effects of public debt on growth.

The STAR and NARDL models are similar in that they have the ability to analyse asymmetric relationships between the regressors and regressands in the system. A STAR model is different in that it examines asymmetric effects among variables during two or more extreme regimes, and further gives the threshold and transition function at which the regressor influences the dependent variable from one regime to another. On the other hand, a NARDL has the ability to test the asymmetric short-run dynamic adjustments consistent with the long-run equilibrium relationships in the system through the error correction mechanism. Furthermore, the findings of STAR and NARDL are expected to complement the PSTR results in Chapter 4 of the study on the asymmetric relationship between public debt and economic growth among SADC economies.

### 5.4.1 Data Sources and Transformation

In this chapter, annual time series data over the period 1960-2018 is employed for South Africa, and for five other SADC members: Botswana, Namibia, Zambia, Malawi and Zimbabwe. The latter five only cover the time period of 2000 to 2018 due to data limitations. The study opted for a larger dataset for South Africa for the generation of more robust results compared to the shorter 2000-2018 dataset.. As previously mentioned, the variables selected for empirical investigation are gross domestic product (GDP), public debt (PD), employment (EMP), gross fixed capital formation (GFCF) and government expenditure (GOE). Among these variables, only GDP was measured in monetary value, i.e., US Dollars. PD, EMP, GFCF and GOE were extracted as percentages. The data series for GDP was then transformed into a natural logarithm to allow for the interpretation of its coefficient as elasticities and to further mitigate possible heteroscedasticity among the residuals in the model. Moreover, the transformation of data into natural logarithms can smooth data series and remove seasonal trends, thus dealing with the issue of non-stationarity in the data series. The data series for all variables under consideration were extracted from the World Development Indicators (WDI), Federal Reserve Economic Data (FRED) and Quantec EasyData through their online database facilities. The study employed Eviews10 software to analyse the data and results for the empirical investigation of the study.

**Table 5.1: List of Variables**

| Variables | Proxy of the Variables | Unit of Measurement | Data Source |
|---|---|---|---|
| Economic growth (GDP) | Gross domestic product (GDP) at constant prices | $ Millions | WDI/Quantec |
| Government expenditure (GOE) | National government expenditure as percentage of GDP | Percentage | WDI/Quantec |
| Gross fixed capital formation (GFCF) | Gross fixed capital formation (Investment) as a percentage of GDP | Percentage | WDI/Quantec |
| Employment (EMP) | Total employment to population ratio | Percentage | FRED |
| Public Debt (PD) | Total loan debt of national government as a percentage of GDP | Percentage | WDI/Quantec |

*Source: Generated by the researcher, WDI/FRED/Quantec EasyData (2019)*

### 5.4.2 Smooth Transition Regression (STAR) Model

This study adopts a Smooth Transition Regression (STAR) model proposed by Teräsvirta (1998) to examine the potential asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies. Baaziz *et al.* (2015) hold that a STAR model is the perfect model to capture asymmetry, heterogeneity and the time-varying effects of public debt on economic growth within a time series setup. Following the work of Teräsvirta (1998), the standard STAR model with two extreme regimes and a single transition function for a nonlinear effect of public debt on economic growth can be written as the following equation:

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_t g(q_t; \gamma, c) + \varepsilon_t \tag{5.1}$$

Here, $Y_t$ represents the endogenous variable (GDP), $X_{it}$ represents a vector of four time-varying exogenous variables (PD, EMP, GFCF and GOE). $t = 1 \ldots, T$ represents the time dimension. $\alpha$ is the coefficient of the intercept, and $\boldsymbol{\varepsilon_{it}}$ represents idiosyncratic errors in the system. The transition function $g(q_t; \gamma, c)$ in equation (5.1) is a continuous function of the observed threshold variable $q_t$ (public debt) and is normalised to be bounded between zero and one. $\gamma$ is the slope parameter that drives the smoothness of the transition from the low-debt regime to a high-debt regime, and $c$ is the threshold parameter (public debt-to-GDP threshold). The value of the transition variable $q_{it}$ determines the value of $g(q_t;\gamma,c)$ and thus the effective regression coefficients $\beta_0+\beta_1 g(q_t;\gamma,c)$ at time. $\beta_0$ measures the effect of public debt on growth when $q_t$ is expected to be below the threshold level $c$. On the other hand, $\beta_1$ measures the effect of public debt on economic growth when the threshold variable ($q_t$) is greater than the threshold value $c$. If $\beta_0=\beta_1$, the STAR model fails heterogeneity, and a STAR falls into a linear regression model. Therefore, a STAR can no longer estimate asymmetric relationships among variables in the system. The work of Teräsvirta (1998) modelled a logistic transition function for a STAR model as follows:

$$g(q_t;\gamma,c)=\left(1+exp\left(-\lambda\prod_{j=1}^{m}\left(q_t-c_j\right)\right)\right)^{-1} \quad with\ \gamma>0 \qquad (5.2)$$

where $c$ is a vector of location parameters, and the slope parameter $\gamma$ determines the smoothness of the transition. This study proceeds with the estimation of a STAR as follows:

$$Y_t=\alpha_0+\beta_0(q_t+EMP_t+GFCF_t+GOE_t)+\beta_1(q_t+EMP_t+GFCF_t+GOE_t)*g(q_t;\gamma,c)+\varepsilon_t \qquad (5.3)$$

In this equation, $q_t$ represents a transition variable ($PD_t$) followed by explanatory variables ($EMP_t, GFCF_t, GOE_t$). Teräsvirta (1998) formulates a stability testing procedure for a STAR to ascertain the stability of the estimated STAR model. The stability diagnostic tests include testing for homogeneity, testing no remaining nonlinearity and evaluating parameter constancy within a STAR. The homogeneity test is conducted to determine the appropriate transition variable $q_t$ and the most suitable form of the transition function within a STAR model. Teräsvirta (1998) proposes a homogeneity test with the null hypothesis $H_0\colon\beta_1=0$. The LM-type test for homogeneity is used to test for this null hypothesis. For a STAR model to be applied, the null hypothesis of linearity must be rejected. The STAR is further subjected to several conventional post-diagnostic inspection tests, such as testing for serial correlation, heteroscedasticity and normality among residuals in the system. Testing for a number of transition functions examines the null hypothesis of no remaining heterogeneity in the transition function $H_0\colon \theta = 0$. If the null hypothesis of no remaining heterogeneity is accepted, then this implies that a STAR model confirms the nonlinear relationship between the two variables under investigation, i.e., public debt and economic growth. Henceforth, the results of the estimated STAR model would be rendered statistically valid and trustworthy.

### 5.4.3 Nonlinear Auto Redistributed Lag (NARDL) Approach

The ARDL approach was proposed by Pesaran *et al.* (2001) to capture the long-run relationships and short-term adjustment coefficients among variables in the model. Shin *et al.* (2014) further formulates the NARDL model to capture short-run and long-run asymmetric dynamic relationships among variables in the system. The purpose of estimating the NARDL model is to verify the STAR estimates to determine robustness of empirical results. The ARDL specification of the study can be formulated as follows:

$$\begin{aligned}\Delta LGDP_t = \beta_0 &+ \sum_{i=1}^{n} \beta_1\, \Delta LGDP_{t-i} + \sum_{i=0}^{n} \beta_2\, \Delta PD_{t-i} + \sum_{i=0}^{n} \beta_3\, \Delta EMP_{t-i} + \sum_{i=0}^{n} \beta_4\, \Delta GFCF_{t-i} \\ &+ \sum_{i=0}^{n} \beta_5\, \Delta GOE_{t-i} + \gamma_1 LGDP_{t-1} + \gamma_2 PD_{t-1} + \gamma_3 EMP_{t-1} + \gamma_4 GFCF_{t-1} \\ &+ \gamma_5 GOE_{t-1} + \varepsilon_t \qquad (5.4)\end{aligned}$$

where $\beta, \gamma$ and $\varepsilon_t$ represents the short-run coefficients of the first differenced variables, long-run coefficients and vector of innovations in the system, respectively. Δ is the first difference operator, $n$ represents the maximum lag of the ARDL model. The short-run coefficients are expressed as first differences while the long-run coefficients are derived by setting the non-first-differenced lagged component in equation (5.4) to zero and normalising $\gamma_2$ to $\gamma_5$ on $\gamma_1$. The study utilises the Akaike Information Criterion (AIC) to determine the optimum number of lags within the ARDL model.

Pesaran *et al*. (2001) suggest that the long-run coefficients are considered valid and reliable if there is cointegration among variables in the model. Cointegration is tested using the standard Wald F-test within the Bounds cointegration technique to check joint significance of the level variables, $\gamma_1$-$\gamma_5$ in equation (5.4). A cointegration test provides two sets of asymptotic critical values, where the first one assume that explanatory variables are purely I(0) and the second assume that explanatory are I(1). The key assumption is that an upper bound critical value can be obtained if variables are I(1), while a lower bound critical value would be eminent if the variables are I(0). The upper bound critical value can also be used if there is a combination of both I(0) and I(1) variables which can all be accommodated by ARDL. The null hypothesis of no cointegration would be rejected if the F-statistic value is greater than the upper bound critical value, i.e., $H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$. Similarly, the null hypothesis of no cointegration cannot be rejected if the F statistic value is less than the lower bound critical value, i.e., $H_0: \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq 0$.

Furthermore, a statistical inference cannot be made if the F-statistic lies between the upper and lower bounds critical values. Therefore, the Bounds cointegration test remains inconclusive, and prior information regarding the integration properties of variables may be useful to draw conclusions. Following the work of Shin *et al.* (2014), this study analyses the dynamic asymmetric interaction between public debt and economic growth as well as other explanatory variables incorporated in the system. This is done by decomposing the fluctuations of each explanatory variable into positive and negative partial sums as shown in the following set of equations:

$$PD_t^+ = \sum_{j=1}^{t} \Delta PD_j^+ = \sum_{j=1}^{t} max\,(\Delta PD_j, 0)$$

$$PD_t^- = \sum_{j=1}^{t} \Delta PD_j^- = \sum_{j=1}^{t} min\,(\Delta PD_j, 0)$$

$$EMP_t^+ = \sum_{j=1}^{t} \Delta PD_j^+ = \sum_{j=1}^{t} max\,(\Delta EMP_j, 0)$$

$$EMP_t^- = \sum_{j=1}^{t} \Delta EMP_j^- = \sum_{j=1}^{t} min\left(\Delta EMP_j, 0\right)$$

$$GFCF_t^+ = \sum_{j=1}^{t} \Delta GFCF_j^+ = \sum_{j=1}^{t} max\,(\Delta GFCF_j, 0)$$

$$GFCF_t^- = \sum_{j=1}^{t} \Delta GFCF_j^- = \sum_{j=1}^{t} min\,(\Delta GFCF_j, 0)$$

$$GOE_t^+ = \sum_{j=1}^{t} \Delta GOE_j^+ = \sum_{j=1}^{t} max\,(\Delta GOE_j, 0)$$

$$GOE_t^- = \sum_{j=1}^{t} \Delta GOE_j^- = \sum_{j=1}^{t} min\left(\Delta GOE_j, 0\right) \qquad (5.5)$$

The above set of equations shows how all explanatory variables were decomposed into positive and negative partial sums, where each of these two partial sums is a series that contains increases or decreases in the effects of the explanatory variables on economic growth. According to Shin *et al*. (2014), to estimate a NARDL model, variables PD, EMP, GFCF and GOE in equation (5.4) need to be replaced by the decomposed partial sum components shown in equation (5.5). Transforming a symmetric ARDL model into an asymmetric ARDL model, as proposed by Shin *et al*. (2014), allows for the examination of the asymmetric effects of public debt on economic growth as indicated in equation (5.6):

$$\begin{aligned} \Delta LGDP_t = \beta_0 &+ \sum_{i=1}^{n1} \beta_1\, \Delta LGDP_{t-i} + \sum_{j=1}^{n2} \beta_2 \Delta PD_j^+ + \sum_{j=1}^{n3} \beta_3 \Delta PD_j^- + \sum_{j=1}^{n10} \beta_4 \Delta EMP_j^+ \\ &+ \sum_{j=1}^{n11} \beta_5 \Delta EMP_j^- + \sum_{j=1}^{n8} \beta_6 \Delta GFCF_j^+ + \sum_{j=1}^{n9} \beta_7 \Delta GFCF_j^- + \sum_{j=1}^{n4} \beta_8 \Delta GOE_j^+ \\ &+ \sum_{j=1}^{n5} \beta_9 \Delta GOE_j^- + \gamma_1 LGDP_{t-1} + \gamma_2 PD_{t-1}^+ + \gamma_3 PD_{t-1}^- + \gamma_4 EMP_{t-1}^+ + \gamma_5 EMP_{t-1}^- \\ &+ \gamma_6 GFCF_{t-1}^+ + \gamma_7 GFCF_{t-1}^- + \gamma_8 GOE_{t-1}^+ + \gamma_9 GOE_{t-1}^- + \varepsilon_t \qquad (5.6) \end{aligned}$$

The NARDL model shown in equation (5.6) demonstrates how nonlinearity is captured by decomposing partial sum components of variables. The NARDL model in equation (5.6) captures the asymmetric effects of public debt (PD), employment (EMP), gross fixed capital formation (GFCF) and government expenditure (GOE) on economic growth (GDP) using a flexible structure for selected emerging and frontier SADC economies. The assumptions underlying the estimation procedure of the NARDL model are similar to the ARDL approach specified in equation (5.4). This study applies the modified Wald F-test and Bounds cointegration test to examine the long-run cointegrating relationships between variables decomposed into positive and negative partial sums in the system, i.e. $LGDP, PD^{+}, PD^{-}, EMP^{+}, EMP^{-}, GFCF^{+}, GFCF^{-}, GOE^{+}, GOE^{-}$.

As stated earlier, the NARDL model can also determine if there is a long-run equilibrium relationship between LGDP, PD, EMP, GFCF and GOE through the use of the Bounds cointegration technique. Moreover, the NARDL model allows for an investigation into the asymmetric effects of PD, EMP, GFCF and GOE on growth (GDP) and the asymmetric adjustments of GDP to any short-run deviations from the long-run equilibrium relationship. Furthermore, to examine the individual asymmetric effects of public debt (PD) on economic growth (GDP), a bivariate model is specified in which public debt remains the only regressor in the model. This can be expressed by the asymmetric equation as follows:

$$\Delta LGDP_t = \beta_0 + \sum_{i=1}^{n1} \beta_1 \, \Delta LGDP_{t-i} + \sum_{j=1}^{n2} \beta_2 \Delta PD_j^{+} + \sum_{j=1}^{n3} \beta_3 \Delta PD_j^{-} + \gamma_1 LGDP_{t-1} + \gamma_2 PD_{t-1}^{+} + \gamma_3 PD_{t-1}^{+} + \varepsilon_t \qquad (5.7)$$

The above asymmetric equation allows for the analysis of how much public debt is able to explain asymmetric variations in economic growth among selected emerging and frontier SADC economies. The above equation (5.7) further enables an assessment of the direction of causality through the Granger causality technique between public debt (PD) and economic growth (GDP). Furthermore, statistically different sum of short-run coefficients of increase and decrease in public debt is obtained or any other explanatory variable in the model, this may further indicate that there is an asymmetric effect of those variables on economic growth. If $\sum_{j=1}^{n2} \beta_2 \neq \sum_{j=1}^{n3} \beta_3$, this would imply that the effect of public debt on economic growth is indeed asymmetric in the short-run. Similarly, it can be concluded that public debt has asymmetric, long-run effects on economic growth if the normalized parameter $\gamma_2 \neq \gamma_3$ in equation (5.7). The major strength of the NARDL is that the model has the ability to estimate asymmetric long-run relationships and short-run dynamic adjustments with the combination of both I(0) and I(1) variables in the system. The empirical findings of the study are expected to be robust due to the application of advanced and recent time series techniques within the SADC context. However, accompanying post-diagnostic tests ought to confirm this assertion. The following section reports the empirical results of the study.

## 5.5 ANALYSIS OF EMPIRICAL RESULTS

This section deals with the discussion and interpretation of the empirical results estimated in this chapter. The empirical investigation was conducted through the estimation of a STAR model developed by Teräsvirta (1998) and later supported by the NARDL model formulated by Shin *et al.* (2014) to examine potential asymmetric relationships between public debt and economic growth among selected emerging and frontier SADC economies.

### 5.5.1 Formal Unit Root Test Results

The study employed the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) test to determine stationarity and the order of integration among variables in the system. The ADF is an extension of the Dickey and Fuller test, which introduces an extra lagged term of the endogenous variable to mitigate any possible serial correlation among residuals. On the other hand, the PP test can eliminate useless parameters when errors are not normally distributed. The unit root tests are conducted on each variable separately. The null hypothesis of the unit root test states that the series has a unit root. The null hypothesis would be rejected if the t-statistic is greater than the t-critical, implying that there is no unit root and that the series is therefore stationary. Conversely, the null hypothesis cannot be rejected if the t-statistic value is less than t-critical. The unit root test results carried out using the ADF and PP test are reported in Table 5.2 below:

**Table 5.2: Unit Root Test Results for South Africa**

| TESTS | GDP | PD | EMP | LGFCF | GOE |
|---|---|---|---|---|---|
| **ADF Test** | | | | | |
| Level | -3.3173* | -2.0552 | -1.6316 | -2.5483 | -2.7238 |
| [*P-value*] | [0.0738] | [0.5589] | [0.7677] | [0.3048] | [0.2313] |
| 1st Difference | -4.6965*** | -4.0567*** | -4.5530*** | -5.2718*** | -6.7725*** |
| [*P-value*] | [0.0019] | [0.0121] | [0.0030] | [0.0003] | [0.0000] |
| **PP Test** | | | | | |
| Level | -2.8847 | -2.1594 | -1.1302 | -1.7459 | -2.6815 |
| [*P-value*] | [0.1749] | [0.5025] | [0.9147] | [0.7178] | [0.2479] |
| 1st Difference | -4.7393*** | -3.9674*** | -5.6026*** | -4.1257*** | -7.8921*** |
| [*P-value*] | [0.0017] | [0.0154] | [0.0001] | [0.0100] | [0.0000] |

*Notes: Asterisks ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.*

*The results for Botswana, Namibia, Zambia, Malawi and Zimbabwe are to be found in Appendix C.*

As previously mentioned, the unit root tests form part of a preliminary examination of data series and allows one to understand the underlying data properties before the estimation of regressions. This section reports the unit root test results for South Africa due to brevity. However, the unit root tests of other SADC members under examination were also conducted and arrived at similar results, i.e., I(1) variables. The full set of unit test results are reported in Appendix C, Table C1. The findings on the unit root tests show that the data series follows a non-stationary process in their level form. The results of the ADF and PP tests reveal that all variables are non-stationary in their level form except for GDP, which is found statistically significant at 10% level of significance under the ADF test, even though this finding contradicts the PP test. However, both ADF and PP tests indicate that all variables become stationary after converting them into first differences.

Therefore, we can draw inferences that all variables are stationary at first differences. The unit root tests result in Table 5.2 reports the equation that include the trend and intercept to determine the order of integration among variables. However, the equations that include the intercept and none were tested and arrived at similar results, i.e., all variables are I(1). As mentioned earlier, it is not compulsory to differentiate data series during the estimation of a STAR model. On the other hand, a NARDL can accommodate both I(0) and I(1) variables. The common practice of conducting stationarity testing enables one to understand data generating processes before estimating proposed models.

### 5.5.2 Smooth Transition Regression (STAR) Estimates

As mentioned earlier, estimating a STAR requires one to first test whether the relationship between variables under investigation is linear or nonlinear using Teräsvirta Sequential Homogeneity Tests. The Teräsvirta Sequential Homogeneity tests examine the null hypothesis, which states that the model is linear against the alternative of nonlinearity. The null hypothesis would be rejected in favour of the alternative if the F-statistic is statistically insignificant, implying that the relationship is nonlinear. In this section, the STAR estimates for South Africa are started with, followed by Botswana, Namibia, Zambia, Malawi and Zimbabwe, respectively. The STAR results for South Africa are anticipated to be more robust compared to its SADC counterparts due to the availability of a larger time series dataset and the fact that South Africa remains one of the leading SADC economies as an emerging market. The point of departure for estimating a STAR model is by addressing homogeneity through Teräsvirta Sequential Tests as demonstrated in Table 5.3 below:

**Table 5.3: Linearity Test Results for South Africa**

| Teräsvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | 0.020012 | (1, 47) | 0.8881 |
| H2: b2=0 \| b3=0 | 2.210034 | (2, 48) | 0.1207 |
| H1: b1=0 \| b2=b3=0 | 10.67550 | (2, 50) | 0.0001 |

All tests are based on the third-order Taylor expansion (b4=0).

Linear model is rejected at the 5% level using H03.

*Note: The results for Botswana, Namibia, Zambia, Malawi and Zimbabwe are to be found in Appendix C.*

The linearity test results based on the Teräsvirta Sequential tests in Table 5.3 show that the null hypothesis of a linear model is rejected at the conventional level using the South African time series dataset. This result implies that the relationship between public debt and economic growth is indeed nonlinear for South Africa. Tthe linearity test was further carried out for other SADC members under investigation, and the results indicated that there is a indeed an asymmetric relationship between public debt and growth among selected SADC economies (See: Appendix C, Table C3.1-C7.1). Therefore, the study proceeds with the estimation of a STAR model to fulfil its primary objective of detecting an asymmetric relationship between public debt and economic growth among selected emerging and frontier SADC members.

**Table 5.4: STAR Estimates for South Africa**

| Variable | Coefficients | $t-Statistic$ |
|---|---|---|
| $PD\_LOW\ DEBT$ | 0.17*** | 9.23 |
| $PD\_HIGH\ DEBT$ | −0.013 *** | −4.56 |
| CONSTANT | 3.53*** | 42.40 |
| $EMP$ | −0.08* | −1.68 |
| $GFCF$ | 0.36*** | 18.54 |
| $GOE$ | −0.31** | −2.5 |
| $SLOPE\ (\gamma)$ | 9.50** | 2.39 |
| $THRESHOLD$ (c) | 5.05*** | 87.17 |
| $Adj. R^2$ | 0.99 | − |

*Notes: 1. - The $PD\_LOW\ DEBT$ and $PD\_HIGH\ DEBT$ denotes slope coefficients for public debt during low-debt and high-debt regime. 2. Asterisks ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.*

*3. The results for Botswana, Namibia, Zambia, Malawi and Zimbabwe are to be found in Appendix C, and are summarised in Table 5.5, below.*

Table 5.4 reports the empirical results estimated through a STAR model. The results show a significant positive impact of public debt on economic growth during the low-debt regime when the relationship is linear. During the high-debt regime, when the relationship is nonlinear, there is a significant negative effect of public debt on economic growth significant at a conventional level. This means that there is a concave relationship between public debt and economic growth. A positive elasticity coefficient of $PD\_LOW\ DEBT$ indicates that if public debt increases by 1%, GDP will expand by 0.17% significant at 1% significance level. This result implies that economic growth responds positively to a positive shock in public debt during the low-debt regime.

This finding is consistent with the Endogenous growth model proposed by Romer (1986), Lucas (1988) and Barro (1989), who argue that the impact of public debt on the real economy would be positive if public debt is channelled towards productive and growth-stimulating sectors such as infrastructure, education and skills development, and technology and innovation rather than financing social consumption (which has little spill-over effect on real economic growth). Over the years, the majority of SADC economies have been focused on strengthening regional integration and development through investment in capital projects, infrastructure, education and technology. The results of a positive effect of public debt on economic growth are further supported by studies such as Perlo-Freeman and Webber (2009), Reinhart and Rogoff (2010), Checherita-Westphal and Rother (2012), and Teles and Mussolini (2014).

The coefficient of $PD\_HIGH\ DEBT$ suggests that a $1\%$ rise in public indebtedness during a high-debt regime would lead to a $0.013\%$ contraction in the economy significant at a conventional level. This result of a negative nonlinear effect of public debt on economic growth during a high-debt regime also makes economic sense because public debt would be expected to have a negative influence on economy during high-debt regime through higher debt servicing costs, and such detrimental effects are likely to prevail in occasions where public debt are channelled towards unproductive and non-stimulating sectors such as social consumption purposes. This finding is consistent with the empirical results reported by Atique and Malik (2012), Teles and Mussolini (2014) and Lee and Ng (2015).

The elasticity coefficient of employment carries an incorrect significant negative sign, albeit a small coefficient magnitude to exert a major influence on growth. This suggests that a 1% increase in employment would cause a 0.08% decline in the economy. This finding is not plausible even though the magnitude of the coefficient is too small to make a significant impact on growth and this finding contradict conventional economic theories.

The GFCF coefficient possesses a correct significant positive coefficient to influence the real economy. This finding implies that a 1% increase in gross fixed capital formation would cause the economy to grow by 0.36%, significant at a conventional level. The result of a significant positive impact of GFCF on economic growth is theoretically plausible as supported by the Solow growth model, which argues that an increase in the level of investment would lead to an increase in output level. This finding is further supported by empirical studies carried out by Taylor *et al*. (2011) and Ocran (2011) among others.

Moreover, the coefficient of GOE suggests that there is a negative relationship between government expenditure and economic growth, significant at 5% level of significance. This result suggests that if GOE increase by 1%, GDP would contract by 0.31%. This result may indicate that the majority of expenditure is channelled towards unproductive sectors, as suggested by Teles and Mussolini (2014). A study carried out by Perlo-Freeman and Webber (2009) insinuated that government debt to fund public consumption ought to bring a positive impact on the real economy only if the expenditure is utilised in productive sectors such as education, healthcare, technology and infrastructure. High debt would have a detrimental effect if expenditure is directed towards non-stimulating sectors. The transition function is represented by a slope coefficient, which indicates the instantaneous rate of change from a low-debt regime to a high-debt regime. A low slope coefficient indicates a gradual rate of change, while a large slope coefficient shows a drastic rate of change in the transition function from a low-debt regime to a high-debt regime. As expected, the transition coefficient parameter carries a correct significant coefficient sign. This estimated low transition parameter indicates that fiscal authorities ought to be cautious and that other effective alternative mechanisms must be in place to deal with excessive public indebtedness that could be detrimental for long-term sustainable economic growth.

**Table 5.5: STAR Estimates for Selected SADC Economies**

| Variables | South Africa | Botswana | Namibia | Zambia | Malawi | Zimbabwe |
|---|---|---|---|---|---|---|
| PD_LOW-DEBT | 0.17*** | -0.58 | -1.5*** | -0.37*** | 0.04 | -0.27* |
| PD_HIGH-DEBT | -0.014*** | 1.28* | 1.29*** | 0.37** | 0.22** | 0.28*** |
| THRESHOLD | 5.05*** | 3.61 | 3.41 | 3.04 | 2.58*** | 2.92*** |
| EMP | -0.08* | 0.90 | 1.89 | -0.08 | 5.65*** | 0.56 |
| GFCF | 0.36*** | 0.44 | -0.48 | -1.03 | 0.69* | 0.68* |
| GOE | -0.31** | -0.71* | 0.89 | 1.73 | 0.26 | 0.45 |

*Notes: Asterisks ***, **, and * indicates the significance level at 1%, 5%, and 10%, respectively.*

*Source: Researcher's own estimation*

As previously mentioned, in this chapter, we estimated a STAR for individual countries to analyse the asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies. The purpose of this comparative analysis is to provide evidence-based insight into the asymmetric effects of public debt on economic growth, and extract lessons that frontier SADC members may learn from emerging SADC economies. Table 5.5 provides a summary of the empirical results obtained from a STAR estimated for selected SADC members, which include South Africa, Botswana, Namibia, Zambia, Malawi and Zimbabwe. The results show strong evidence of a significant, nonlinear relationship between public debt and economic growth for all SADC members under consideration. Findings of a significant, nonlinear effect of public debt on economic growth among selected SADC economies is theoretically plausible and consistent with numerous empirical studies such as Reinhart and Rogoff (2010), Baum *et al.* (2013), and Checherita-Westphal *et al.* (2014) for more advanced economies.

The results reveal the inverted U-Shape effect of public debt on economic growth for South Africa. This implies that debt has a significant positive impact on economic growth during the low-debt regime. However, the positive impact of debt becomes negative during a high-debt regime, leading to economic contraction. The elasticity coefficient for public debt suggests that if debt increases by 1%, the economy would expand by 0.17%

during the low debt-regime significant at conventional level, ceteris paribus. However, once the threshold is reached, i.e., the economy transits into a high debt regime, a 1% rise in public debt would lead to a 0.014% contraction in South Africa's economy. The finding of a concave relationship between public debt and economic growth in South Africa is theoretically plausible and is supported by several empirical studies carried out by Reinhart and Rogoff (2010), Checherita-Westphal and Rother (2014) and Baaziz *et al.* (2015), among others. In the case of South Africa, it suggests that public debt below the threshold realises maximum benefits to the economy, while debt beyond the threshold leads to government perhaps crowding out private investment and engaging in sub-optimal expenditure that causes negative growth.

Conversely, the STAR estimated for Botswana, Namibia, Zambia and Zimbabwe indicate that there is also a U-shape relationship between public debt and economic growth. The elasticity coefficient for public debt indicates that if public debt increases by 1% in the low debt regime, the respective economies Botswana, Namibia, Zambia and Zimbabwe would decrease by 0.58% (not statistically significant), 1.5%, 0.3% and 0.27% (statistically significant at conventional level) for Botswana, Namibia, Zambia and Zimbabwe, respectively. In the high debt regime, the growth rate for Botswana and Namibia are a staggering 128% and 129%, respectively. This may indicate that the governments of these economies are highly efficient with the potential to appropriately allocate and manage infrastructural funds to stimulate high growth rates for their economies, given their endowments at their offshores. Alternatively, there is an impressive 37% and 28% for Zambia and Zimbabwe, respectively. This performance is better than that of Malawi at 22%, under a high-debt regime, respectively. However, relative to the results of Botswana and Namibia, the governments of these economies appear to be less efficient to appropriately allocate infrastructural funds, given their endowments.

The results for these four SADC members are contrary to the results found for South Africa, indicating that public debt has a significant positive impact during the high-debt regime. It also shows that, during the low-debt regime, public debt has a significant negative effect on economic growth in these countries. The empirical results of a U-shape relationship are unexpected for SADC economies, but interesting. It suggests that, for these economies to grow on a sustainable level, public debt must be higher than the transition level. This is perhaps an indication of the lack of diversity and robustness of these economies to attract sufficient private investment for sustainable growth. It may also indicate that government expenditure below the threshold level goes toward consumption expenditure and only beyond the threshold level contributes to infrastructural investment.

Additionally, the STAR estimates for Botswana, Namibia, Zambia and Zimbabwe are somewhat different to that of Malawi concerning the relationship between public debt and economic growth, before the threshold (low debt regime). Malawi might exhibit a S-shaped phenomenon, where a 1% rise in debt causes a 0,04% rise in growth in the low debt regime, although this coefficient is not statistically significant. However, after transitioning to a high debt regime, the growth rate is at 0.22%. This may indicate a marginally higher efficiency in the allocation of government spending in the Malawian economy towards productive investment under low debt regime compare the mentioned countries. While this shows higher returns on growth for Malawi under the high debt regime, the performance of its four counterparts are much better.

The EMP estimate for South Africa revealed that a 1% rise in employment would lead to a 0.08% contraction in the economy. This result is unexpected since, as the number of people employed increases, a complementary growth in output level is expected. However, the magnitude of this coefficient is too small to exert a major influence on the economy. In addition, this result might indicate that the policy choices that the government (with its alliance to trade unions) has made in favouring high wage labour (thus high marginal product) over low wage unskilled/semi-skilled labour, has meant that additions to the employed labour force that are not highly productive would cause a drop in productivity on average. Hence, indicating that we might be in stage three of the production process, despite having a high unemployment rate, which largely comprises unskilled and semi-skilled labour.

Alternatively, the EMP coefficient for Malawi posits that if employment increases by 1%, the economy would grow by 5.65%, significant at conventional level. This finding is plausible as employment growth is expected to correlate with economic growth. The EMP estimates for Botswana, Namibia, Zambia and Zimbabwe were found statistically insignificant to influence growth. These results may verify the validity of jobless growth among the majority of SADC members, implying that the number of jobs that are created do not contribute significantly to long-term economic growth as expected.

The elasticity coefficient for GFCF indicates that if gross fixed capital formation increases by 1%, the economy would expand by 0.36%, 0.69% and 0.68% for South Africa, Malawi and Zimbabwe, respectively. Moreover, South Africa's economy, being a more diversified and sophisticated economy compared to its SADC counterparts, sees lower returns on investment as expected. The finding of a significant positive influence of gross capital formation on growth is theoretically plausible. It is supported by the Solow growth model as well as several previous studies such as Ocran (2011), Taylor *et al.* (2011), and Bi *et al.* (2014) to mention the few. The GFCF estimates for Botswana, Namibia and Zambia were found statistically insignificant. The coefficient for GOE suggests that a 1% increase in government spending would lead to the economy contracting by 0.31% and 0.71% for South Africa and Botswana, respectively. This finding is supported by Perlo-Freeman and Webber (2009) and Teles and Mussolini (2014), who postulated that the impact of government spending would be positive if large a large expenditure is channelled toward growth-stimulating sectors, such as infrastructure investment, education, health and technology etc.

The result of a negative effect of government expenditure on growth may indicate that most of SADC members tend to direct the majority of their public expenditure towards financing unproductive sectors such as social consumption and other non-stimulating sectors. The GOE coefficients for Namibia, Zambia, Malawi and Zimbabwe were found to be statistically insignificant. The STAR model for South Africa was estimated using annual data over the period 1960-2018 while the other SADC members selected had data available for the period between 2000-2018. Therefore, the application of a small dataset is the major limitation of the study during the estimation process of the STAR model, which could explain the divergence of the empirical results on the asymmetric relationships for some of the SADC members that contradicted conventional theoretical foundations.

Interestingly, the public debt threshold coefficients carry plausible coefficient signs across all SADC members under investigation. The results reveal a debt threshold of approximately 70% debt-to-GDP ratio in absolute value for South Africa since we are dealing with log-linear equations. The threshold for Malawi and Zimbabwe is 41% and 47% significant at 1% level of significance. The debt threshold for Botswana, Namibia and Zambia are 58%, 53% and 48% respectively. However, the threshold coefficient for these three member countries were statistically insignificant.

The threshold results among selected SADC members are plausible and strongly support nonlinearity coefficients across selected countries. The high threshold for South Africa indicates that South Africa remains the most advanced economy among SADC countries with the highest debt threshold, sequentially followed by Botswana, Namibia, Zambia, Zimbabwe and Malawi. These findings suggest that frontier SADC economies still need to take lessons from emerging SADC economies in terms of redirecting public debt expenditure towards growth-stimulating sectors such as infrastructure, SMME development, technology and education, which are all instrumental to achieve worthwhile regional integration and economic development among SADC economies as enshrined in the SADC treaty. All SADC members under consideration remain well within the threshold of a 60% macroeconomic convergence target as stipulated in the SADC treaty, except for South Africa. This further indicates that South Africa remains the most advanced emerging market among SADC economies. This suggests that South Africa must focus more on private sector involvement, while other SADC members need to focus more on state involvement, such as attracting foreign direct investment and borrowings from financial institutions such as the IMF, World Bank, BRICS Bank and the African Development Bank, among others.

Furthermore, the asymmetric values estimated by the NARDL model are contrary to the estimates of the more robust and favoured panel smooth transition method in the literature (discussed in Chapter 4) due to the inbuilt robustness of the model in arriving at the transition and threshold coefficients. The NARDL estimates grossly underestimate the threshold values which cannot be defended; hence these results must be viewed with caution. The STAR techniques are more robust and superior in time series asymmetric analysis because they can analyse regime switching behaviour while capturing the rich asymmetric relationships among variables during the low-debt and high-debt regimes. The work of Teräsvirta (1998) formulates a STAR model to scrutinise dynamic asymmetric relationships between two variables during different extreme regimes. Biaaz *et al.* (2015) notes that STAR is an appropriate model to capture rich nonlinear relationships between variables while allowing for parameter coefficients to vary smoothly over time.

#### 5.5.2.1 STAR Stability Diagnostic Tests

**Table 5.6: No Remaining Nonlinearity Test**

Smooth Threshold Remaining Nonlinearity Tests
Date: 12/15/19 Time: 11:37
Sample: 1960 2018
Included observations: 58
Additive nonlinearity tests using PD(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Teräsvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | NA | (0, 45) | NA |
| H2: b2=0 \| b3=0 | 5.991204 | (1, 45) | 0.0183 |
| H1: b1=0 \| b2=b3=0 | 2.388623 | (2, 46) | 0.1030 |

All tests are based on the third-order Taylor expansion (b4=0).
Original model is rejected at the 5% level using H03.

*Note: The results for Botswana, Namibia, Zambia, Malawi and Zimbabwe are reported in Appendix C.*

Table 5.6 presents the results of the no remaining nonlinearity test to ascertain the stability of a STAR model. As stated earlier, estimating the STAR requires one to further test for no remaining nonlinearity to confirm that the estimated STAR has no remaining nonlinearity other than the nonlinearity between the variables of interest under consideration. The results provide strong evidence through the Teräsvirta Sequential tests that the null hypothesis of no remaining nonlinearity ($r = 1$) cannot be rejected. Therefore, we can conclude that the test for no remaining nonlinearity reveals that there is no remaining nonlinearity within the estimated STAR model, implying that there is a single transition function separating the low-debt regime from the high-debt regime on the nonlinear relationship between public debt and growth in the selected SADC economies. This section provides the results of no remaining nonlinearity for South Africa, for the sake of brevity. However, the results of no remaining nonlinearity for other countries under investigation were also tested and found to be similar to these findings, indicating no remaining nonlinearity within the estimated STAR for those SADC members under consideration (See: Appendix C, Table C2.2-C3.2).

**Table 5.7: Parameter Constancy Test**

Smooth Threshold Parameter Constancy Test
Date: 12/15/19 Time: 11:38
Sample: 1960 2018
Included observations: 58
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Parameter Constancy Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 13.72484 | (16, 32) | 0.0000 |
| H03: b1=b2=b3=0 | 16.30472 | (12, 36) | 0.0000 |
| H02: b1=b2=0 | 21.79330 | (8, 40) | 0.0000 |
| H01: b1=0 | 30.24284 | (4, 44) | 0.0000 |

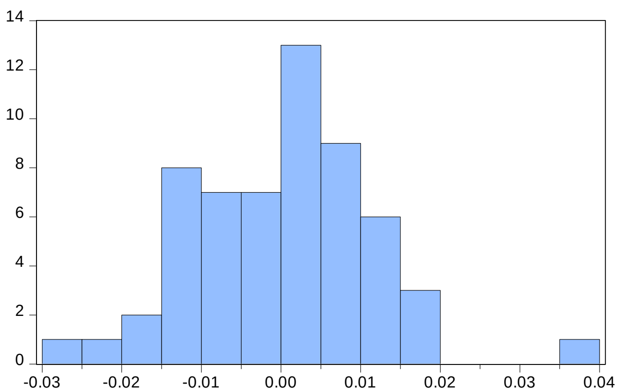
*Notes: The results for Botswana, Namibia, Zambia, Malawi and Zimbabwe are reported in Appendix C.*

The study further examined the parameter adequacy of the estimated STAR by applying the misspecification tests for parameter constancy. Table 5.7 above reports the results of parameter constancy from the estimated STAR model. Testing for parameter constancy examines the null hypothesis, which states that parameters are constant rather than non-constant. The results show the null hypothesis, with STAR parameters constant and adequate, cannot be rejected. Therefore, this result implies that the estimated STAR model has constant and statistically trustworthy parameters. Once again, this part presents parameter constancy results for South Africa for the sake of brevity. The results for the other countries that were tested and found to be the same are displayed in appendixes (See Appendix C, Table C.3.2-C.7.2).

### 5.5.2.2 Residuals Post-Diagnostic Inspection

The results for serial correlation conducted using the Breusch-Godfrey Serial Correlation LM test demonstrated in Appendix C (Tables C4 and C6) reveal that residuals from a STAR model are not serially correlated. Furthermore, the results of heteroscedasticity were tested through the Breusch-Pagan-Godfrey test, which indicates that residuals of the STAR model are homoscedastic. The normality test was carried out using the Jarque-Bera test and the residuals were found normally distributed (See Figure 5.1). The STAR models for the SADC countries under investigation passed all post-diagnostic tests of the residuals, implying that STAR models have independent identical distributed residuals.

**Figure 5.1: STAR Normality Test Results**




| | |
|---|---|
| Series: Residuals | |
| Sample 1961 2018 | |
| Observations 58 | |
| Mean | -1.47e-15 |
| Median | 0.001602 |
| Maximum | 0.036339 |
| Minimum | -0.029328 |
| Std. Dev. | 0.011566 |
| Skewness | 0.103493 |
| Kurtosis | 3.720143 |
| Jarque-Bera | 1.356836 |
| Probability | 0.507419 |

Figure 5.1 shows that the residuals of the estimated STAR model are normally distributed. This section reported post-diagnostic inspection tests for South Africa for the sake of brevity, however, the post-diagnostic inspection test results for other individual countries observed are presented in Appendix C (Tables C3.3-C7.3 and Figures C1-C3). The normality test results through the Jarque-Bera statistics reveal that the residuals of the STAR models for all SADC members under investigation are normally distributed. As expected, the Skewness value is exactly zero and the kurtosis is 3, indicating that residuals from the STAR model are normally distributed. This post-diagnostic inspection test shows that the estimated STAR is statistically valid and trustworthy. The results of the asymmetric effects between public debt and economic growth are further supported by a NARDL model, which is reported on in the following section to verify the robustness of our empirical findings.

### 5.5.3 Nonlinear Autoregressive Distributed Lag (NARDL) Results

The majority of STAR estimates were found theoretically plausible and supported by the literature on the nonlinear relationship between public debt and economic growth among selected SADC economies. Furthermore, this study applied the same dataset to estimate a NARDL model to complement the above analysis by assessing the long-run asymmetric relationship between public debt and growth for each of the selected emerging and frontier SADC members mentioned above. This process aims to support the STAR estimates to provide robust SADC-specific empirical evidence for policy analysis. First, a NARDL Bounds cointegration test was conducted to examine the long-run cointegrating relationship among variables, with the null hypothesis stating that there is no long-run cointegration between variables against the alternative that variables are cointegrated.

The null hypothesis of no cointegration would be rejected if the F-statistic is greater than the upper bound critical values. Conversely, the null hypothesis cannot be rejected if the Wald F-statistic is lower than the lower bound critical values. If the F-statistic lies in-between the critical bounds, then the Bounds test is rendered inconclusive. Thus, the prior point about underlying data generating properties of variables may be used to make robust inferences. This study utilised the Akaike Information Criterion (AIC) to determine the appropriate lag order of first differenced variables from the unrestricted NARDL model. The AIC suggests that the NARDL (1, 0, 0, 0, 0, 0, 0, 1, 1, 0) is the robust model. The Bounds cointegration test results based on the Wald $F$-statistic are reported in Table 5.8:

**Table 5.8: Bounds Cointegration Test Results for South Africa**

| $F - Statistic$ | $\alpha = 0.01$ | | $\alpha = 0.05$ | |
|---|---|---|---|---|
| | Lower Bound | Upper Bound | Lower Bound | Upper Bound |
| 15.15 | 2.14 | 3.61 | 1.98 | 3.04 |

*Notes: The results for Botswana, Namibia, Zambia, Malawi and Zimbabwe are reported in Appendix C.*

*Source: Researcher's own estimation*

The NARDL (1, 0, 0, 0, 0, 0, 1, 1, 0) Bounds cointegration test indicates that there is a long-run cointegrating relationship between economic growth and its regressors. This is shown by the Wald $F$-statistic that is greater than the upper bound critical values at conventional level. Therefore, this result suggests that the null hypothesis of no cointegration among variables is rejected in favour of the alternative hypothesis, which states that there is a long-run cointegrating relationship between the variables in the system. Therefore, the study proceeds with the estimation of a NARDL to analyse the long-run asymmetric relationship between public debt and economic growth. The Bounds test results for SADC members indicate that there is a long-run cointegrating relationship between variables in the system. However, the Bounds test for Botswana and Namibia reveal inconclusive Wald F-test results. The Bounds test results for other SADC members under examination are displayed in the appendices for the sake of brevity (See: Appendix C, Table C10.1-C14.1).

**Table 5.9: NARDL Estimates for South Africa**

| Variable | Coefficients | $t-Statistic$ |
|---|---|---|
| Constant | 5.85*** | 343.55 |
| $PD\_POS$ | 0.06** | 1.99 |
| $PD\_NEG$ | −2.60** | −2.14 |
| $EMP\_POS$ | −0.02 | −0.20 |
| $EMP\_NEG$ | −0.4 *** | −4.07 |
| $GFCF\_POS$ | 0.35*** | 4.91 |
| $GFCF\_NEG$ | −0.07*** | −64.29 |
| $GOE\_POS$ | −0.16 | −0.73 |
| $GOE\_NEG$ | −0.32 * | −1.83 |
| $ECM(-1)$ | −0.41*** | −15.11 |
| $Adj. R^2$ | 0.99 | − |

*Notes: 1. The POS and NEG represents the positive and negative cumulative sums, respectively.*

*2. Asterisks ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.*

*3. The results for Botswana, Namibia, Zambia, Malawi and Zimbabwe are to be found in Appendix C, and are summarised in Table 5.10, below.*

*Source: Researcher's own estimation*

Table 5.9 reports on the empirical results of the long-run asymmetric relationship between public debt and economic growth, estimated through a NARDL model. This section reports the NARDL results for South Africa for the sake of brevity, and the fact that South Africa remains a leading and emerging market among the SADC economies with sufficient time series dataset for estimating a NARDL model. The findings clearly show that a positive shock in public debt has a significant positive influence on economic growth in the long-run. On the other hand, a negative shock shows a severe negative effect of public debt on growth with a substantial coefficient magnitude. This means that when public debt (PD) increases, current debt positively influences economic growth while, during a decline in public debt, the current public debt negatively affects economic growth in South Africa's economy.

Moreover, the impact of declining public debt on growth is greater than the impact of an increase in debt on economic growth, which further supports the existence of asymmetric cointegrating relationship between public debt and growth. A positive shock in public debt has a small positive magnitude of 0.06% on growth, while a negative shock becomes too severe for economic growth with a coefficient of -2.60%, significant at a conventional level. These findings make economic sense because the majority of developing countries that are in sovereign debt crisis, with higher debt servicing costs, take a very long time to repay their debt, causing more uncertainty and instability in public finances that exhaust the fiscal space for other, equally important economic activities. These results are further supported by prior empirical studies conducted by Reinhart and Rogoff (2010), Checherita-Westphal and Rother (2012), and Burhanudin *et al.* (2017) among others.

The elasticity coefficient for employment (EMP) shows that EMP negatively influences economic growth regardless of whether there is a rise or decline in EMP. However, a declining EMP has large and statistically significant effects on economic growth while a rising EMP has an insignificant effect on growth. This implies that a 1% decrease in EMP causes a 0.4% contraction in the economy, *ceteris paribus*, while an increase in employment has an insignificant effect on economic growth. This finding is supported by the concept of a 'Jobless growth' that has been observed over recent decades in several developing countries, including the majority of SADC members as developing economies.

A positive shock in GFCF positively influence economic growth statistically significant at 1% significance level, while a decline in GFCF is found to have a negative and insignificant effect on economic growth. This finding is theoretically plausible because a rise in gross capital formation is expected to bring an increase in the overall output level as argued by the Solow growth model. Likewise, the withdrawal of investments would lead to an economic contraction. The empirical result of a significant positive impact of gross fixed capital formation on economic growth was also reported by empirical studies carried out by Ocran (2011), Taylor *et al.* (2011) and Bi *et al.* (2014).

Government expenditure (GOE) negatively affects economic growth regardless of rising or declining GOE with a very small coefficient magnitude. A decline in GOE has a significant impact on growth, while a rise in GOE is found to have an insignificant effect on economic growth. A decrease in GOE would mean that expenditure on other equally important economic sectors have been cut short, thus leading to a contraction in the economy. The economic logic for a negative impact of government spending on economic growth could be that a majority of the government's expenditure is channeled towards social consumption such as social security, AIDS and the public wage bill. Very little is directed towards growth-stimulating sectors such infrastructure, education and skills development, research and innovation, and technology, which are all important to accelerate long-term sustainable economic growth among developing countries.

As expected, the error correction term possesses a correct negative coefficient, statistically significant at conventional level as prescribed by the theory. The speed of adjustment coefficient of -0.41% suggests that if economic growth overshoots (or undershoots) its long-run cointegrating relationship with the other variables in the previous period, economic growth would be expected to readjust downwards (or upwards) in the subsequent periods to restore the equilibrium. This implies that output is responsive to its covariates in the short-run. The adjusted $R^2$ of $0.99$ shows that the estimated NARDL model is a robust model with an excellent goodness-of-fit, suggesting that $99\%$ of the variations in growth are fully explained by the variations in public debt, employment, gross fixed capital formation and government expenditure. The Wald F-statistic indicates that the overall model is statistically significant at a conventional level, which further verifies the robustness of the NARDL estimates.

**Table 5.10: NARDL Long-run Estimates for Selected SADC Economies**

| Variables | South Africa | Botswana | Namibia | Zambia | Malawi | Zimbabwe |
|---|---|---|---|---|---|---|
| PD_POS | 0.06* | -0.29 | 0.6 | -0.47** | 0.12 | -0.54 |
| PD_NEG | -2.60** | -3.87 | -0.77* | -0.16* | -0.04 | 1.30 |
| EMP_POS | -0.02 | -2.65 | -8.18*** | 0.41 | 5.52 | -7.11 |
| EMP_NEG | -0.44*** | -2.83 | 11.62** | -1.40 | -134* | -8.49 |
| GFCF_POS | 35.12*** | -0.61 | -0.76* | 0.24 | 2.27 | 0.06 |
| GFCF_NEG | -6.79 | 0.83 | -0.002 | -0.53 | -2.30 | -0.28 |
| GOE_POS | -0.16 | 0.14 | 3.06** | 4.28* | -4.11 | 3.14 |
| GOE_NEG | -0.31* | -1.48 | -6.04*** | 0.001 | 3.23 | -0.008 |
| ECM | -0.41*** | -0.61 | -1.24*** | -0.98*** | -0.69*** | -0.43 |

*Notes: Asterisks ***, **, and * indicates the significance level at 1%, 5%, and 10%, respectively.*

*Source: Researcher's own estimation*

The Bounds cointegration test reveales that there is a long-run cointegrating relationship between public debt and economic growth among the SADC members under consideration, except for Botswana and Namibia, which had inconclusive Wald F-test results (See: Appendix C, Table C9.1-C10.1). The NARDL estimates confirm the long-run asymmetric relationships between variables in the system, apart from coefficients for Botswana, Malawi and Zimbabwe, which carry insignificant coefficients. Therefore, the NARDL complements the STAR outputs on the asymmetric relationship between public debt and economic growth in South Africa, Namibia and Zambia. It is worth noting that emerging SADC members show plausible results on the asymmetric relationships among variables in the system, except for Botswana, which had all its coefficients insignificant while frontier SADC countries had statistically insignificant coefficients.

The NARDL estimates indicate that a positive shock in public debt has a positive influence on economic growth, while a negative shock has a negative effect on growth in South Africa. The debt coefficients for Namibia show that a 1% decline in debt has a negative impact on growth, while an increase in debt has an insignificance impact on economic growth. Debt dynamics for Zimbabwe indicate that a 1% increase in public debt would cause the economy to contract by 0.47%, while a 1% decline in debt would lead to a 0.16% shrink in the economy. The asymmetric relationship between debt and economic growth was found statistically insignificant for Botswana, Malawi and Zimbabwe. The majority of NARDL coefficients were statistically insignificant. However, it is noteworthy that several parameter coefficients for South Africa were theoretically plausible together with the error correction mechanism and accompanying post-diagnostic inspections due to the application of a larger dataset compared to other members. Hence, a comparative analysis of STAR and NARDL results for South Africa is further discussed in section 5.5.4, Table 5.11, to address the fourth hypothesis.

The insignificance of the long-run asymmetric effects of public debt on economic growth in Botswana, Malawi and Zimbabwe is attributable to the unavailability of a large dataset to estimate a robust NARDL model. However, the purpose of NARDL was to complement the STAR model, which already offered plausible estimates on the asymmetric relationship between public debt and economic growth. Therefore, amidst controversy in the NARDL results, this study is inclined to rely on the STAR estimates due to the rigour in its estimation process.

The error correction term (ECM) possesses correct, statistically significant coefficients at the conventional level, except for Botswana and Zimbabwe which carry signs but insignificant coefficients. The error correction term represents the speed of adjustment at which the model re-establishes its long-run equilibrium position. The error correction term indicates that if GDP overshoots (or undershoots) its long-run cointegrating relationship while other variables remained in the previous period, GDP would be expected to readjust downward (or upward) in the subsequent periods to restore the long-run equilibrium. This implies that GDP is responsive to its covariates in the short-run. The NARDL reported -0.41 speed of adjustment, which implies that economic growth moves by 41% annually to adjust long-run disequilibrium in the current period as a result of the GDP deviating from the equilibrium by 1% in the previous period in South Africa.

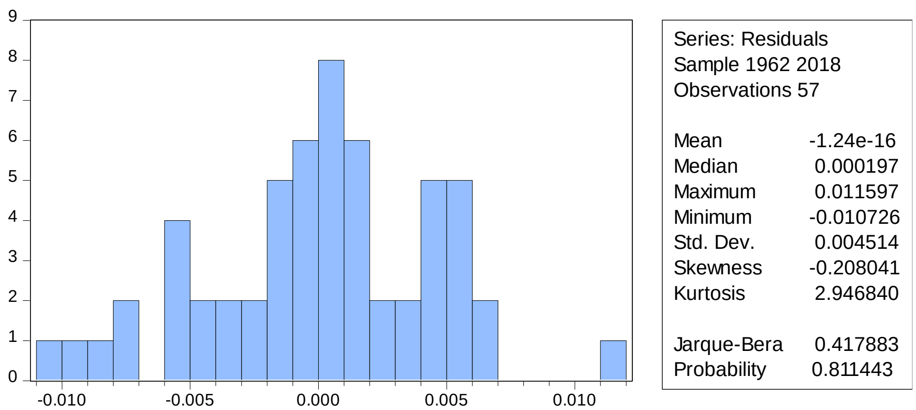
The results indicate a speed of adjustment of -1.24, -0.98 and -0.69 for Namibia, Zambia and Malawi, respectively. This finding suggests that their GDPs adjust by 124%, 98% and 69% annually for Namibia, Zambia and Malawi, respectively, to restore the long-run disequilibrium due to a 1% deviation of GDP from the long-run equilibrium. The speed of adjustment of -0.61 and -0.43 for Botswana and Zimbabwe, respectively, were statistically insignificant. Interestingly, the coefficient signs across all SADC members under investigation are theoretically plausible, as supported by conventional theoretical foundations. The high speed of adjustment among selected SADC members indicate that there is strong pressure on economic growth to restore its long-run equilibrium whenever there is a disturbance through fiscal policy or severing debt shocks in the economy.

#### 5.5.3.1 NARDL Post-Diagnostic Tests

This section reports the post-diagnostic inspection results from the estimated NARDL model to confirm its robustness. The post-diagnostic tests carried out are the serial correlation, heteroscedasticity, Ramsey RESET functional misspecification, and the normality test (See: Appendix C, Table C6). The afore-mentioned, post-diagnostic inspection tests are crucial to assist in ascertaining the statistical worthiness and validity of the estimated NARDL model. The serial correlation was carried out through the autocorrelation LM tests with the null hypothesis stating that there is no autocorrelation among residuals. The results shows that there is no autocorrelation since the probability value is greater than 1%, 5% and 10% level of significance. Therefore, the null hypothesis of no serial correlation among residuals within the NARDL model cannot be rejected. Furthermore, the Durbin-Watson statistic of 2.13 further confirms that the estimated NARDL model is free from any possible serial correlation among residuals.

Heteroscedasticity tests were conducted using the white heteroscedasticity test (with no cross terms). The results revealed that residuals are homoscedastic within the NARDL. The Ramsey RESET for functional misspecification indicates that there is no functional misspecification, thus implying that estimated NARDL models are correctly specified. The Cholesky of covariance (Lutkepohl) normality test was carried out through the Jarque-Bera statistic to test the normality of the residuals in the system. The null hypothesis of the normality test postulates that residuals are normally distributed. The normality test results are demonstrated in Figure 5.3. The results showed that the null hypothesis – that residuals are normally distributed – cannot be rejected. Moreover, this section reported post-diagnostic results for South Africa. However, the post-diagnostic tests for other SADC members were carried out and residuals were found to be independently and identically distributed. Importantly, the post-diagnostic test results reveal that the estimated NARDL passes all post-diagnostic inspection tests against regression pathologies, which include serial correlation, heteroscedasticity, normality and functional misspecification. Therefore, the NARDL conforms to the Gauss-Markov prescriptions.

**Figure 5.2: NARDL Normality Test Results for South Africa**




*Source: Generated by the researcher*

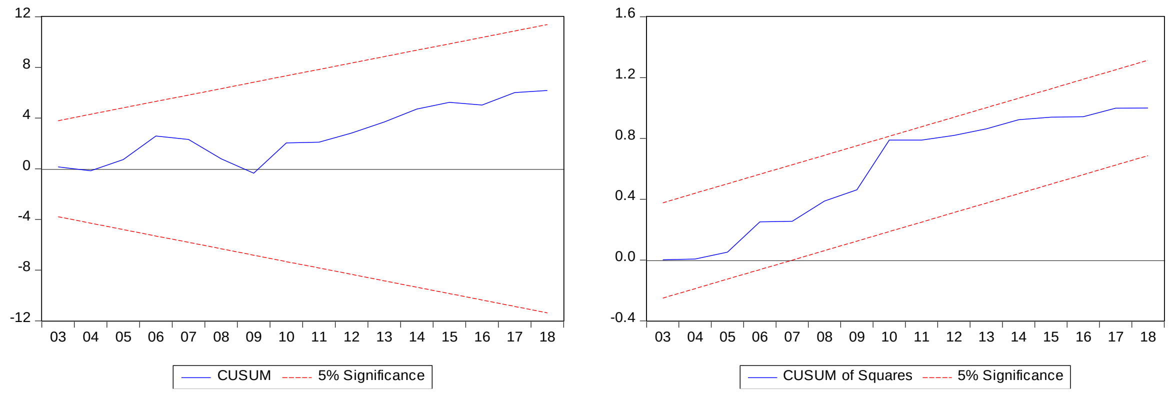
Figure 5.2 above presents the results of the normality test from the estimated NARDL model. As mentioned earlier, the normality test results indicate that the residuals of the NARDL are normally distributed. As expected, the Skewness value is zero and the kurtosis is 2.95, indicating normality of the residuals from the NARDL model. Furthermore, the Jarque-Bera statistic shows that the null hypothesis (that the residuals are normally distributed) cannot be rejected. The post-diagnostic tests for other SADC members are reported in appendices for the sake of brevity. Importantly, the overall post-diagnostic inspection test results reveal that the estimated NARDL models are statistically valid and reliable.

### 5.5.3.2 NARDL Stability Tests

The NARDL estimates indicate that the model is perfectly fitted with a very high adjusted $R^2$ of $0.99\%$. This indicates a robust goodness-of-fit of the NARDL model. The $F$-statistic further shows that the overall model is statistically significant. Importantly, all relevant post-diagnostic inspection tests indicate that the estimated NARDL has a correct functional specification and independently and identically distributed residuals. Therefore, this result implies that the estimated NARDL meets the requirements of the Gauss-Markov regression conditions since the estimated NARDL models pass all the post-diagnostic inspection tests against regression pathologies (See: Appendix C, Table C9.2-C9.3). This section reported diagnostic inspection tests for South Africa for the sake of brevity. However, the results are other countries are displayed in appendixes (See: Appendix C).

The estimated NARDL model was further subjected to structural breaks and stability examination through the recursive residuals inspection, which include the CUSUM and CUSUMSQ tests. The CUSUM and CUSUMSQ stability tests plot the cumulative sum together with the 5% critical value lines. These two tests suggest that the parameters are structurally stable if the cumulative sum lies within the critical value lines. The model parameters are considered unstable if the cumulative sum goes outside of the two critical value lines. The graphical plots of the CUSUM and CUSUMSQ tests are computed using the Akaike Information Criterion (AIC). Figure 5.3 below shows that the cumulative statistics lie between the critical bounds area, as expected, implying that the NARDL passes stability under both the CUSUM and the CUSUMSQ test. The CUSUM and CUSUMSQ plot kept on deviating within the confidence interval band, verifying the structural stability of the NARDL model. The CUSUM and CUSUMSQ tests also indicate some possible structural disturbance in 2008 earmarked by the global financial crisis.

**Figure 5.3: NARDL CUSUM and CUSUM-SQ Stability Tests**




*Source: Generated by the researcher*

Figure 5.3 indicates that the estimated NARDL model is structurally stable. This is shown by the CUSUM and CUSUM-SQ stability plot test that lies within the critical bounds area of 5% significance level throughout the entire period of investigation. Therefore, the NARDL stability test results indicate that the long-run parameters of economic growth and its regressors are structurally stable throughout the period of investigation.

### 5.5.4 Summary of STAR and NARDL Empirical Findings

As mentioned earlier, the primary aim of this chapter was to provide a robust, in-depth empirical analysis on the asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies. This section provides a summarised discussion of empirical results for South Africa for several advantageous reasons. Among others, South Africa has a large time series data set for most economic variables which gave more robust and theoretically plausible findings. Moreover, South Africa remains one of the leading SADC economies and emerging markets in the global economy, allowing for the proposal of valuable policy prescriptions for other SADC economies. Therefore, in line with the objective of the study, a STAR was estimated as the main model, and a NARDL model as a supporting technique to ascertain the asymmetric relationship between public debt and economic growth in South Africa. Table 5.11 reports the summarised results of both STAR and NARDL estimates for the purpose of simplicity, discussion and comparison of empirical findings to fulfil the purpose of the study and determine the status of the respective hypothesis.

**Table 5.11: Summary of STAR and NARDL Results for South Africa**

| Variable | STAR | NARDL |
|---|---|---|
| $PD\_LOW\ DEBT/POS$ | $0.17^{***}$ | $0.06^{**}$ |
| $PD\_HIGH\ DEBT/NEG$ | $-0.013^{***}$ | $-2.60^{**}$ |
| CONSTANT | $3.53^{***}$ | $5.85^{***}$ |
| $EMP$ | $-0.08^{*}$ | $-0.02$ |
| $GFCF$ | $0.36^{***}$ | $0.35^{***}$ |
| $GOE$ | $-0.31^{**}$ | $-0.16$ |
| $Adj.R^2$ | 0.99 | 0.99 |

*Notes: Asterisks ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.*

The estimated empirical results from the STAR and NARDL methods in Table 5.11 provide robust empirical evidence of a nonlinear relationship between public debt and economic growth in South Africa. The findings of the study are consistent with conventional economic theory and are supported by the results of the empirical work presented by Reinhart and Rogoff (2010), Checherita-Westphal and Rother (2012), Antonakakis (2014) and Baaziz *et al*. (2015). The empirical results clearly show that public debt has a positive influence on economic growth during the low-debt regime, and a negative effect on growth during a high-debt regime. The summary of the results in Table 5.11 clearly indicate that the coefficient estimates of the NARDL are consistent with the STAR estimates, albeit that statistically insignificant coefficients for some controlling variables are in the NARDL output. Therefore, these findings accomplish the primary aim and objective of the study and further addresses the respective hypotheses.

Table 5.11 shows that a STAR model generates a significant positive coefficient, capturing the effect of public debt on economic growth during a low-debt regime. The coefficients of public debt estimated by the STAR suggest that if public debt rises by 1%, the economy would expand by 0.17% during the low-debt regime, significant at 1% significance level. The public debt coefficient from the NARDL shows that a 1% increase in debt would cause the economy to grow by 0.06%, significant at 5% level of significance. As expected, the high-debt coefficient indicates that a 1% rise in public debt would cause the economy to contract by 0.017%, statistically significant at 1%. The NARDL output reveal that declining public debt would contract GDP by 2.6%, statistically significant at 5% significance level. These empirical findings are theoretically plausible since they are line with conventional economic theory and supported by the empirical studies carried out by Reinhart and Rogoff (2010), Antonakakis (2014) and Baaziz *et al.* (2015).

The majority of the coefficients from controlling variables estimated through both STAR and NARDL models are strongly supported by conventional theoretical frameworks and intuitive economic logic. However, amidst controversial EMP coefficients, this study relies on the STAR estimates due to rigour in its estimation process. The slope coefficients of EMP, from both STAR and NARDL estimates, reveal that employment exert sa negative influence on economic growth. The result show that a 1% increase in employment would lead to a 0.08% and 0.02% decline in GDP for both STAR and NARDL models respectively. This result is unexpected as it contradicts several conventional theories. However, the magnitude of these coefficients is too small to have any major influence in the system and are only significant at 10% for STAR, and statistically insignificant under the NARDL model. Since these findings conflict with several conventional theories and empirical literature, the intuitive logic behind this finding could be that the majority of private sector companies are targeting more capital-intensive facilities. This subsequently translates to 'jobless growth' rather than labour-intensive workforce, probably due to rigid influential trade unions that have gained more power and prominence over the years in the South African political landscape.

The slope coefficient of gross fixed capital formation shows that a positive shock in capital formation positively influences economic growth. The STAR model shows that if gross fixed capital formation increases by 1%, the economy would grow by 0.36% significant at 1%. Interestingly, the NARDL estimates also reveal that a 1% rise in gross fixed capital formation would promote economic growth by 0.35%, significant at 1% significance level. This finding is theoretically plausible as it is consistent with the Solow growth model as discussed in Chapter 2 of the study, which argues that a rise in investment ought to promote growth through an increase in overall output level in the economy. This result is further supported by previous studies conducted by Ocran (2011) and Taylor *et al.* (2011), who found that a rise in gross capital formation leads to economic expansion.

The STAR and NARDL estimates suggest that government expenditure negatively affects economic growth within the coefficient spectrum of -0.31% and -0.16%, respectively. This STAR result implies that if expenditure increases by 1%, GDP would be expected to contract by 0.31% significant at 1% significance level. The NARDL complements the STAR result, indicating that a 1% rise in expenditure would lead to a 0.16% decline in GDP, albeit insignificant coefficient. This finding is also supported by the empirical study conducted by Fry'McKibbin (2012), who posited that a rise in government spending tends to crowd-out private investment activities, leading to an overall decline in output level. Another study, carried out by Afonso and Sousa (2011) also found that a positive shock in government expenditure has a negative influence on the real economy.

The results produced by a STAR and NARDL are consistent with the *a priori* expectations encapsulated in the study, except for employment that contradicts conventional theory. The empirical results from this chapter fulfill the primary objective of the study, which was to analyse the asymmetric effects of public debt on economic growth among selected emerging and frontier SADC members. Therefore, the empirical findings suggest that the third hypothesis of the study, which states that there is significant asymmetric relationship between public debt and economic growth among selected emerging and frontier SADC economies, cannot be rejected. Furthermore, the fourth hypothesis of an asymmetric effects of public debt on economic growth in South Africa also cannot be rejected. The empirical findings of the study were robust due to the application of sophisticated time series techniques with the accompanying post-diagnostic and stability confirmation tests.

## 5.6 CONCLUDING REMARKS

This chapter provided strong evidence of an asymmetric relationship between public debt and economic growth among selected emerging and frontier SADC economies. The empirical results revealed a significant positive influence of public debt on economic growth during the low-debt regime, while there was a negative effect of debt during the high debt regime. The NARDL, through the Bounds cointegration test, suggested that there is a long-run asymmetric cointegrating relationship between public debt and economic growth among the SADC members under investigation. The findings of the study were found theoretically plausible and consistent with several empirical studies carried out on the asymmetric effects of public debt on economic growth.

The findings of the study provide robust empirical inputs to fiscal policymakers on the importance of monitoring the sustainability of public finances in SADC economies. Over the recent years, the majority of SADC economies saw a drastic accumulation of public debt, initiated by growing fiscal deficits. Therefore, it is important for policymakers to devise well-informed, co-ordinated and prudent fiscal strategies aimed to curb public debt within a sustainable threshold target that would not destabilise the whole economy and undermine the stability of public finances.

This study suggests that public debt ought to be allocated towards productive and growth-stimulating sectors, that would directly contribute to long-term growth to appreciate its stimulative role on economic expansion among emerging and frontier SADC economies. These growth-stimulating sectors in the SADC region may include infrastructure investment, education, training and skills development, technology and innovation, and development of small micro medium enterprises (SMMEs), which would directly contribute to an increase in employment opportunities and equip the majority of citizens with the relevant skills required in a modern labour market. Subsequently, this process would enlarge the tax base for adequate collection of government revenues equivalent to the desired government expenditure on economic activities, and thereby reduce fiscal deficit and sovereign indebtedness among SADC economies.

Furthermore, fiscal policymakers ought to formulate sound fiscal strategies that ensure the accumulated public debt is manageable (within fiscal targets) and avoid the implementation of unconventional, short-term fiscal policies that may lead to excessive government debt that would become a heavy burden to the future generation in SADC region. Moreover, it is also imperative for SADC policymakers to use fiscal and monetary policy in the most effective and efficient approach possible to eliminate the reliance on public debt by the national fiscus as a stabiliser for unstable public finances. This is crucial if key economic objectives of SADC economies are set on achieving a balanced, inclusive and sustainable regional economic integration and development.

# CHAPTER SIX

# SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

## 6.1 INTRODUCTION

This chapter summarises the overall findings of the study and provides policy prescriptions based on the empirical findings. The chapter deliberates on the limitations of the study and provide recommendations for prospective research. Chapter 6 is divided into five sections. Section 6.1 is the introductory section that outlines the structure of the chapter. Section 6.2 provides the summary of empirical findings of the study. Section 6.3 discusses the summarised empirical findings of the entire study. Policy implications and recommendations are presented in Section 6.4. Finally, Section 6.5 outlines the limitations of the study and further provides recommendations for future research.

## 6.2 SUMMARY OF THE STUDY AND EMPIRICAL RESULTS

The primary purpose of the study was to investigate the role of fiscal policy and public indebtedness on economic growth on SADC economies using a combination of panel data and time series analyses. The study selected macroeconomic variables consistent with the conventional theoretical framework and empirical studies carried out on the relationship under examination. The macroeconomic variables employed for empirical investigation include gross domestic product (GDP), government expenditure, public debt, and employment and gross fixed capital formation. Despite numerous empirical studies conducted on the impact of fiscal policy on economic growth across different economies, there are still several contradictions and arguments in the literature as to whether an increase or a reduction in government expenditure or indebtedness would augment or hamper economic activities, and thereby address policy shortfalls among these developing economies. This study contributed to the body of literature through the dissemination of robust, SADC-specific empirical evidence on the role of fiscal policy and asymmetric effects of public debt on economic expansion among SADC economies.

Pursuant to the purpose of the study, empirical investigation sought to eloquently address the following key objectives:

i. To critically investigate the role of fiscal policy and sovereign indebtedness on economic growth among SADC economies.
ii. To empirically analyse asymmetric effects of public debt on economic growth in SADC region.
iii. To examine the asymmetric relationships between public debt and economic growth among selected emerging and frontier SADC economies.
iv. To analyse the asymmetric effects of public debt on economic growth in South Africa.

**Table 6.1 Summary of the Study**

| Objectives | Methodology | Chapter |
|---|---|---|
| Exploring the Role of Fiscal Policy and Sovereign Debt Shocks on Economic Growth in SADC Region. | • Panel Vector Autoregressive (PVAR), Fixed and Random Effects, Panel analysis | Chapter 3 |
| Assessing Asymmetric Relationships Between Public Debt and Economic Growth in SADC Region. | • A Panel Smooth Transition Regression (PTR), Panel data analysis | Chapter 4 |
| Investigating the Asymmetric Effects of Public Debt on Economic Growth: Evidence from Emerging and Frontier SADC Economies. | • Smooth Transition Regression (STAR), Time series analysis | Chapter 5 |
| Analysis of asymmetric effects of public debt on economic growth in South Africa. | • Smooth Transition Regression (STAR), Nonlinear Autoregressive Redistributed Lag (NARDL) | Chapter 5 |

This study has three different analytical chapters carried out to fulfil the key objectives displayed in Table 6.1. The study addresses these objectives through the estimation of various sophisticated methods, using a combination of cutting-edge panel data and time series techniques within the SADC perspective. The empirical models estimated are consistent with the theoretical foundations outlined in chapter two of the study. Each analytical chapters applied a unique research methodological framework in line with the underlying theoretical frameworks and characteristics of the data used for empirical analysis. The first analytical chapter (Chapter 3) employed a Panel Vector Autoregressive (PVAR) approach to investigate the impact of fiscal policy and sovereign debt on economic growth in the SADC region. Chapter 4 estimated a Panel Smooth Transition Regression (PSTR) to examine asymmetric relationships between public debt and economic growth among SADC members. The last empirical chapter (Chapter 5) applied a Smooth Transition Regression (STAR) and Nonlinear Autoregressive Redistributed Lag (NARDL) approach within time series analysis to scrutinise asymmetric effects of public debt on economic growth among selected emerging and frontier SADC economies.

## 6.3 STUDY CONTRIBUTION AND VALUE ADDITION

The empirical evidence of the study was presented and discussed in three separate analytical chapters (chapter three, four and five). The first empirical study (Chapter 3) applied a PVAR technique to empirically analyse the dynamic interactions between fiscal policy variables and economic growth in SADC. The empirical results revealed that government expenditure, employment and public debt exerts a significant positive influence on economic growth, while gross fixed capital formation brings an adverse effect on economic growth in SADC. With the exception of gross fixed capital formation (GFCF) coefficient estimates that contradict conventional economic theory, the empirical findings of the study are theoretically plausible and consistent with several empirical literature. Interestingly, the results for the other variables, except GFCF, remained robust even when alternative estimation techniques were applied, which includes Fixed (FE) and Random Effects (RE), Fully Modified Least Squares (FMOLS) and Dynamic Least Squares (DOLS) estimators. Additionally, the latter models generated statistically significant coefficients with plausible magnitude coefficients for GFCF, consistent with the underpinning theoretical foundations.

The second technical chapter (Chapter 4), motivated by accumulating public debt level in SADC economies and possible asymmetric effects thereof, estimated a PSTR model to analyse asymmetric effects of public debt on economic growth among SADC members. The empirical findings revealed that there is a significant asymmetric relationship between public debt and economic growth in SADC. The results further pointed to a debt threshold of 60% at which beyond this threshold, public debt would compromise economic activity in SADC. The study discovered a U-shape relationship between debt and growth in SADC, implying that public debt has a positive influence on economic activities during the low-debt regime, while there is a negative effect of public debt on economic growth during the high-debt regime as debt level reaches the 60% debt threshold. These empirical findings are consistent with the results reported by Reinhart and Rogoff (2010); Baum *et al.,* (2013), and Checherita-Westphal *et al.,* (2014) on the nonlinear relationship between public debt and economic growth for advanced economies. It is also consistent with Baaziz *et al*., (2015), whose study was carried out in South Africa.

The third empirical study (Chapter 5) analysed the asymmetric relationship between debt and economic growth among selected emerging and frontier SADC economies using the STAR and NARDL methodology within time series analysis. The findings revealed that there is a significant asymmetric relationship between public debt and economic growth among selected SADC members. The results revealed a debt threshold of 70%, 47% and 41% for South Africa, Zimbabwe and Malawi, significant at conventional level, respectively. The debt threshold levels for Botswana, Namibia and Zambia were 58%, 53% and 48%, respectively. However, these threshold coefficient for three members were statistically insignificant. Importantly, the results on the debt threshold were plausible in practical terms for all SADC members under consideration. Furthermore, NARDL error correction term possessed correct coefficient signs for all SADC members under scrutiny. Interestingly, the NARDL approach supported a STAR output on the long-run asymmetric relationships between public debt and economic growth among selected SADC members as the primary objective of the study. Moreover, the empirical findings in Chapter 5 complemented and reinforced the PSTR estimates reported in Chapter 4 of the study.

These results indicate that South Africa, since the COVID-19 imposed lockdown, has found itself in a precarious position with public debt having reached 88% of GDP and is expected to climb to 98% within the next two years. Moreover, the STAR results, in the case of South Africa, suggest that public debt below the threshold realises maximum benefits to the economy while debt beyond the threshold leads to the government crowding out private investment and engaging in sub-optimal expenditure, resulting in negative growth. It is therefore advised that the South African authorities reign in debt to within the 60% range as indicated by the findings of this study. Similar prescriptions hold for other SADC countries that have exceeded the 60% threshold. However, the findings of Chapter 5 demonstrated that the less developed but relatively efficient economies of Namibia and Botswana might gain higher economic growth rates under a higher debt regime if the debt is allocated to infrastructural investment as the theory advises. Moreover, this analysis also applies to Zambia, Malawi and Zimbabwe, who may also experience relatively high growth rates.

The three empirical chapters were conducted to fulfil the primary aim and objectives of the study, and to further address respective hypotheses outlined in Chapter 1. A PVAR and PSTR methodology was applied in Chapter 3 and Chapter 4 respectively, which are considered as advanced estimation techniques within a panel framework. Moreover, STAR and NARDL approaches (which remains advanced estimation techniques within a modern time series analysis) were estimated in Chapter 5 to provide rigorous empirical evidence on the asymmetric effect of public debt on economic expansion among selected emerging and frontier SADC members. The study also estimated various benchmarking models within both a panel and time series setup to ascertain the robustness of empirical findings of the study. As previously mentioned, the empirical results in Chapter 5 reinforced the findings in Chapter 4, pointing to a significant asymmetric relationships between public debt and economic activities among SADC economies. The empirical results from both system equations and single-equation models were theoretically plausible and consistent across applied estimators. Moreover, the empirical chapters of the study contributed both empirically and methodologically to the body of literature. The findings of the study were able to complement each other from one empirical chapter to another, consistent with the conventional theoretical foundations discussed in Chapter 2.

Importantly, there are three new critical empirical insights that can be identified from the three different empirical studies. First, Chapter 3 sought to establish the influence of fiscal policy and sovereign indebtedness on the economies of SADC countries. The results of the study showed that fiscal policy and sovereign indebtedness has a significant positive influence on economic activities in SADC economies. Second, Chapter 4 aimed at addressing the second objective of the study, which was to analyse asymmetric effects of public debt on economic growth among SADC economies. The findings revealed that there is a significant asymmetric relationship between public debt and economic growth in SADC. The study found a concave relationship between public debt and economic growth among SADC countries. Furthermore, the study found a debt threshold of 60% at which public debt hampers economic activities in SADC region. These findings were supported by conventional theoretical foundations and numerous empirical studies on the same subject matter under examination. Lastly, Chapter 5 focused on establishing an asymmetric relationship between public debt and economic growth among selected emerging and frontier SADC economies. In this chapter, six SADC countries, classified as emerging and frontier economies, were selected. This study estimated a STAR and NARDL model. The results found a significant nonlinear effect of public debt on economic growth among selected SADC members. These empirical findings were theoretically plausible and further supported the results of nonlinearity in the fourth chapter. However, there were some insignificant asymmetric coefficients on NARDL estimates for Botswana, Malawi and Zimbabwe. Such results were anticipated to be driven by the unavailability of large datasets in SADC region. This remained as one of the limitations of the study.

## 6.4 POLICY IMPLICATIONS AND RECOMMENDATIONS

The findings of the study have significant policy implications for fiscal policy and sovereign indebtedness in SADC region. Fiscal policy is a crucial macroeconomic stabilisation policy that addresses several macroeconomic objectives, such as steering sustainable economic growth, employment, poverty alleviation, income inequality and raising the living standard of citizens. As previously mentioned, the findings from the first empirical chapter revealed that government expenditure, employment and public debt has a significant positive influence on economic activity, while gross fixed capital formation exerts a negative effect on long-term economic expansion. This implies that government expenditure, employment and public debt are important drivers of economic growth in the SADC region. The empirical findings suggest that policymakers ought to efficiently use government expenditure, public debt and employment-enhancing programmes to boost long-term sustainable economic growth among SADC economies.

The South African government gazetted a policy plan known as ‘National Development Plan (NDP) Vision 2030’, which stipulates that fiscal policy is expected to play an instrumental role in stimulating economic activities and further mitigate any possible unanticipated macroeconomic challenges that may arise in the near future (NPC, 2011). Furthermore, the NDP contends that fiscal policy would also be expected to address not only macroeconomic stability but also steer inclusive economic growth and development, create employment opportunities, alleviate poverty, and reduce income inequality. The result of a positive influence of government expenditure associated with economic expansion in SADC is strongly supported by classical economic theory. Over the past decade, several SADC economies have been investing more in growth-stimulating sectors such as infrastructure, education, technology and capital investment projects. This explains the positive spill-over of government expenditure on the economy.

The study proposes that policymakers ought to formulate prudent fiscal mechanisms that channels expenditure toward growth-stimulating sectors that would enhance sustainable economic activities without hampering consumption patterns and the economic well-being of the society over the long-term. This can be possible through financing employment initiatives and creating an enabling and conducive environment that would induce both labor-intensive and capital-intensive projects and investments to enable individuals to start their own enterprises independent from government subsidies. This process would subsequently generate job opportunities and contribute to revenues that the government earns through taxes consistent with expenditure to reduce soaring fiscal deficit and public indebtedness. Furthermore, the study suggests that fiscal authorities may consider formulating investment-friendly and employment-enhancing policies that would enable small micro medium enterprise (SMMEs) to thrive and further ensure that stable public finances that are aligned with sustainable economic expansion.

Moreover, policymakers may focus on improving debt management strategies with a greater focus on balanced and sustainable public finances. Reducing public indebtedness would require policymakers to properly formulate prudent fiscal policies that would address soaring fiscal deficit and create an investment-friendly environment that would assist small businesses and investments to thrive in the economy. This process would ensure that there are several streams from which government can collect tax and, at the same time, create employment opportunities that boost economic output. Furthermore, the expenditure ceiling would be reduced and redirected toward other productive and growth-stimulating sectors such as infrastructure, healthcare, education and skills development, and technology. The empirical findings for Namibia, Botswana, Malawi, Zambia and Zimbabwe suggest that higher debt regimes with spending directed to the mentioned sectors would lead to a much desired economic growth.

The public finance management mechanisms that are formulated ought to ensure that fiscal deficits do not translate to unprecedented levels of public indebtedness. These unprecedented levels would cause unnecessary fiscal risks and crowd-out expenditure on essential public services, and further limit the ability of the fiscus to mitigate unanticipated future economic shocks, destabilising the underlying fiscal policy for the entire economy. The findings of the study are robust since all benchmarking estimators that were estimated complement the estimates of the main models across all analytical chapters on the relationship between economic growth and its regressors. The policy implications and recommendations of the study ought to be valuable to fiscal authorities in the SADC due to the application of recent and cutting-edge panel data and time series techniques that yield SADC-specific policy analysis.

## 6.5 LIMITATIONS OF THE STUDY AND RECOMMENDATIONS FOR FUTURE RESEARCH

This study produced theoretically plausible findings that are consistent with the underlying theoretical frameworks discussed in the literature review as well as other empirical studies conducted on the relationship under scrutiny. However, like any other empirical work, this study has its own limitations. The main limitation of the study is that the NARDL asymmetric and threshold values of Chapter 5 are inconsistent with the PSTR estimates in Chapter 4. Future studies may consider addressing such inconsistencies.

Another weakness of this study is that the macroeconomic time series data for several SADC economies remains sparse, thus offering a limited number of observations for the estimation of robust empirical results. More often than not, empirical undertakings of this kind would ideally require large datasets to produce robust results for empirical analysis. The time series data applied was extracted from the World Development Indicators (WDI), FRED and Quantec EasyData, covering the period 2000-2018. Future studies may consider extending the sample size to improve empirical findings of the current study.

The empirical investigations of this study were narrowed to a focus on SADC countries, while other chapters delved into selected emerging and frontier SADC economies. Prospective research may consider a comparative analysis that incorporates other developing regions either in Africa, Asia or South America, ideally expanding the dataset by over two or three decades. Prospective studies may also include other developing or emerging market in Sub-Saharan African (SSA) to establish the role of fiscal policy and sovereign indebtedness on economic growth within a larger context. Moreover, future studies may also consider the application of other recently developed alternative sophisticated estimation techniques such as Dynamic Stochastic General Equilibrium (DSGE), Bayesian Vector Autoregressive (BVAR), Global Vector Autoregressive (GVAR) methodology etc. to improve the empirical findings of the current study.

Further investigations employing larger datasets would be more robust to emulate the current empirical findings. Furthermore, it would also be valuable to incorporate the role of monetary policy to identify the key agents of economic development during different phases of the business cycle. Therefore, the researcher proposes that prospective studies may consider the analysis of both fiscal and monetary policy on economic growth in SADC. This can be also carried out at an individual country level as done in Chapter 5 of the study. In light of the above-stated limitations and recommendations for future research, such studies would be more relevant for SADC-specific policy analysis aimed to foster sustainable economic integration and development in SADC economies.

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# APPENDICES

## APPENDIX A - PANEL VECTOR AUTOREGRESSIVE (PVAR) MODEL

Appendix A reports the results of unit roots tests in Table A1-Table A2. The PVAR lag selection, PVAR estimates, Granger causality, Stability tests and Variance decomposition are displayed in Table A3-Table A7. The IRFs are shown in Figure A1. The robustness of results was confirmed through the estimation of FE, RE, FMOLS and DOLS estimator demonstrated in Table A8-Table A13 with accompanying post-diagnostic inspection tests.

### Table A1: Panel Unit Root Testing - Level Form

```
. xtunitroot ips LGDP, trend
Im-Pesaran-Shin unit-root test for LGDP
---------------------------------------
Ho: All panels contain unit roots            Number of panels  =     13
Ha: Some panels are stationary                Number of periods =     19
AR parameter: Panel-specific                  Asymptotics: T,N -> Infinity
Panel means:  Included                        sequentially
Time trend:   Included
ADF regressions: No lags included
------------------------------------------------------------------------------
                                             Fixed-N exact critical values
                    Statistic      p-value        1%      5%      10%
------------------------------------------------------------------------------
 t-bar               -1.9794                    -2.710  -2.550  -2.460
 t-tilde-bar         -1.4116
 Z-t-tilde-bar       -0.1213        0.4517
```

```
. xtunitroot llc LGDP, trend
Levin-Lin-Chu unit-root test for LGDP
-------------------------------------
Ho: Panels contain unit roots              Number of panels  =     13
Ha: Panels are stationary                  Number of periods =     19
AR parameter: Common                       Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included
ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -7.3198
 Adjusted t*         -1.3803        0.0837
```

```
. xtunitroot fisher LGDP, dfuller trend lags(0)
Fisher-type unit-root test for LGDP
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: At least one panel is stationary        Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Included
Drift term:   Not included                  ADF regressions: 0 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(26)   P        75.6717       0.0000
 Inverse normal            Z         1.8664       0.9690
 Inverse logit t(69)       L*       -1.5208       0.0664
 Modified inv. chi-squared Pm        6.8882       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot ips GOE, trend
Im-Pesaran-Shin unit-root test for GOE
--------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: Some panels are stationary              Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                        sequentially
Time trend:   Included
ADF regressions: No lags included
------------------------------------------------------------------------------
                                              Fixed-N exact critical values
                    Statistic      p-value          1%      5%      10%
------------------------------------------------------------------------------
 t-bar               -1.8978                     -2.710  -2.550  -2.460
 t-tilde-bar         -1.7515
 Z-t-tilde-bar       -1.7216        0.0426
```

```
. xtunitroot llc GOE, trend
Levin-Lin-Chu unit-root test for GOE
------------------------------------
Ho: Panels contain unit roots               Number of panels  =     13
Ha: Panels are stationary                   Number of periods =     19
AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included
ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -8.5986
 Adjusted t*         -3.0433        0.0012
```

```
. xtunitroot fisher GOE, dfuller trend lags(0)
Fisher-type unit-root test for GOE
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: At least one panel is stationary        Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Included
Drift term:   Not included                  ADF regressions: 0 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(26)   P        13.4224       0.9799
 Inverse normal            Z         1.4219       0.9225
 Inverse logit t(69)       L*        1.3274       0.9056
 Modified inv. chi-squared Pm       -1.7442       0.9594
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot ips GFCF, trend

Im-Pesaran-Shin unit-root test for GFCF
---------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: Some panels are stationary              Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                          sequentially
Time trend:   Included
ADF regressions: No lags included
------------------------------------------------------------------------------
                                              Fixed-N exact critical values
                    Statistic      p-value         1%      5%      10%
------------------------------------------------------------------------------
 t-bar               -2.1598                   -2.710  -2.550  -2.460
 t-tilde-bar         -1.8729
 Z-t-tilde-bar       -2.2932        0.0109
```

```
. xtunitroot llc GFCF, trend
Levin-Lin-Chu unit-root test for GFCF
-------------------------------------
Ho: Panels contain unit roots               Number of panels  =     13
Ha: Panels are stationary                   Number of periods =     19
AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included
ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -8.4270
 Adjusted t*         -3.4834        0.0002
```

```
. xtunitroot fisher GFCF, dfuller trend lags(0)
Fisher-type unit-root test for GFCF
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: At least one panel is stationary        Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Included
Drift term:   Not included                  ADF regressions: 0 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(26)   P        24.7482       0.5333
 Inverse normal            Z         0.1202       0.5478
 Inverse logit t(69)       L*        0.1239       0.5491
 Modified inv. chi-squared Pm       -0.1736       0.5689
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot ips EMP, trend
Im-Pesaran-Shin unit-root test for EMP
--------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: Some panels are stationary              Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                       sequentially
Time trend:   Included
ADF regressions: No lags included
------------------------------------------------------------------------------
                                              Fixed-N exact critical values
                    Statistic      p-value         1%      5%      10%
------------------------------------------------------------------------------
 t-bar               -1.9740                     -2.710  -2.550  -2.460
 t-tilde-bar         -1.6825
 Z-t-tilde-bar       -1.3967        0.0812
```

```
. xtunitroot llc EMP, trend
Levin-Lin-Chu unit-root test for EMP
------------------------------------
Ho: Panels contain unit roots               Number of panels  =     13
Ha: Panels are stationary                   Number of periods =     19
AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included
ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -10.3190
 Adjusted t*         -5.0823       0.0000
------------------------------------------------------------------------------
```

```
. xtunitroot fisher EMP, dfuller trend lags(0)
Fisher-type unit-root test for EMP
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: At least one panel is stationary        Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Included
Drift term:   Not included                  ADF regressions: 0 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(26)   P        21.3106       0.7258
 Inverse normal            Z         0.9587       0.8311
 Inverse logit t(69)       L*        0.9964       0.8387
 Modified inv. chi-squared Pm       -0.6503       0.7423
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

```
. xtunitroot ips PD, trend
Im-Pesaran-Shin unit-root test for PD
-------------------------------------
Ho: All panels contain unit roots           Number of panels  =     13
Ha: Some panels are stationary              Number of periods =     19
AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                       sequentially
Time trend:   Included
ADF regressions: No lags included
------------------------------------------------------------------------------
                                              Fixed-N exact critical values
                    Statistic      p-value         1%       5%      10%
------------------------------------------------------------------------------
 t-bar               -1.4571                     -2.710   -2.550   -2.460
 t-tilde-bar         -1.2645
 Z-t-tilde-bar        0.5709       0.7160
------------------------------------------------------------------------------
```

```
. xtunitroot llc PD, trend
Levin-Lin-Chu unit-root test for PD
-----------------------------------
Ho: Panels contain unit roots              Number of panels  =     13
Ha: Panels are stationary                  Number of periods =     19
AR parameter: Common                       Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included
ADF regressions: 1 lag
LR variance:     Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t        -8.6857
 Adjusted t*         -5.1083        0.0000
------------------------------------------------------------------------------------
```

```
. xtunitroot fisher PD, dfuller trend lags(0)
Fisher-type unit-root test for PD
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots          Number of panels  =     13
Ha: At least one panel is stationary       Number of periods =     19
AR parameter: Panel-specific               Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Included
Drift term:   Not included                 ADF regressions: 0 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(26)   P        10.2725       0.9975
 Inverse normal            Z         2.4637       0.9931
 Inverse logit t(64)       L*        2.3320       0.9886
 Modified inv. chi-squared Pm       -2.1810       0.9854
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------------
```

## Table A2: Panel Unit Root Testing - First Differences

```
. xtunitroot ips D.LGDP, trend
Im-Pesaran-Shin unit-root test for D.LGDP
-----------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: Some panels are stationary       Number of periods =   18
AR parameter: Panel-specific       Asymptotics: T,N -> Infinity
Panel means: Included                   sequentially
Time trend:  Included
ADF regressions: No lags included
------------------------------------------------------------------------------
                       Fixed-N exact critical values
          Statistic   p-value     1%   5%   10%
------------------------------------------------------------------------------
 t-bar        -4.3484           -2.710 -2.550 -2.460
 t-tilde-bar     -2.8135
 Z-t-tilde-bar    -6.7957    0.0000
```

```
. xtunitroot llc D.LGDP, trend
Levin-Lin-Chu unit-root test for D.LGDP
---------------------------------------
Ho: Panels contain unit roots        Number of panels =   13
Ha: Panels are stationary          Number of periods =   18
AR parameter: Common           Asymptotics: N/T -> 0
Panel means: Included
Time trend:  Included
ADF regressions: 1 lag
LR variance:   Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
          Statistic   p-value
------------------------------------------------------------------------------
 Unadjusted t    -16.3884
 Adjusted t*     -6.7750    0.0000
```

```
. xtunitroot fisher D.LGDP, dfuller trend lags(0)
Fisher-type unit-root test for D.LGDP
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: At least one panel is stationary    Number of periods =   18
AR parameter: Panel-specific       Asymptotics: T -> Infinity
Panel means: Included
Time trend:  Included
Drift term:  Not included         ADF regressions: 0 lags
------------------------------------------------------------------------------
                                 Statistic   p-value
------------------------------------------------------------------------------
 Inverse chi-squared(26)   P    162.6789       0.0000
 Inverse normal            Z    -8.6732        0.0000
 Inverse logit t(69)       L*   -12.4399       0.0000
 Modified inv. chi-squared Pm    18.9540       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot ips D.GOE, trend
Im-Pesaran-Shin unit-root test for D.GOE
----------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: Some panels are stationary       Number of periods =   18
AR parameter: Panel-specific       Asymptotics: T,N -> Infinity
Panel means: Included                   sequentially
Time trend:  Included
ADF regressions: No lags included
------------------------------------------------------------------------------------
                       Fixed-N exact critical values
                    Statistic   p-value     1%   5%   10%
------------------------------------------------------------------------------------

 t-bar             -4.0042          -2.710 -2.550 -2.460
 t-tilde-bar       -2.8386
 Z-t-tilde-bar     -6.9142    0.0000
------------------------------------------------------------------------------------
```

```
. xtunitroot llc D.GOE, trend
Levin-Lin-Chu unit-root test for D.GOE
--------------------------------------
Ho: Panels contain unit roots        Number of panels =   13
Ha: Panels are stationary          Number of periods =   18
AR parameter: Common            Asymptotics: N/T -> 0
Panel means: Included
Time trend:  Included
ADF regressions: 1 lag
LR variance:   Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------------

          Statistic   p-value
------------------------------------------------------------------------------------
 Unadjusted t    -13.0441
 Adjusted t*     -5.1182    0.0000
------------------------------------------------------------------------------------
```

```
. xtunitroot fisher D.GOE, dfuller trend lags(0)
Fisher-type unit-root test for D.GOE
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: At least one panel is stationary    Number of periods =   18

AR parameter: Panel-specific       Asymptotics: T -> Infinity
Panel means: Included
Time trend:  Included
Drift term:  Not included         ADF regressions: 0 lags
------------------------------------------------------------------------------------
                                 Statistic   p-value
------------------------------------------------------------------------------------

 Inverse chi-squared(26)   P    136.8782       0.0000
 Inverse normal            Z    -8.4006        0.0000
 Inverse logit t(69)       L*   -10.3274       0.0000
 Modified inv. chi-squared Pm    15.3760       0.0000
------------------------------------------------------------------------------------

 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------------
```

```
. xtunitroot ips D.GFCF, trend
Im-Pesaran-Shin unit-root test for D.GFCF
--------------------------------------------------------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: Some panels are stationary       Number of periods =   18
AR parameter: Panel-specific       Asymptotics: T,N -> Infinity
Panel means: Included                   sequentially
Time trend:  Included
ADF regressions: No lags included
--------------------------------------------------------------------------------------
                       Fixed-N exact critical values
                    Statistic   p-value     1%   5%   10%
--------------------------------------------------------------------------------------
 t-bar              -4.2080          -2.710 -2.550 -2.460
 t-tilde-bar        -2.9234
 Z-t-tilde-bar      -7.3154    0.0000
```

```
. xtunitroot llc D.GFCF, trend
Levin-Lin-Chu unit-root test for D.GFCF
---------------------------------------
Ho: Panels contain unit roots        Number of panels =   13
Ha: Panels are stationary          Number of periods =   18
AR parameter: Common            Asymptotics: N/T -> 0
Panel means: Included
Time trend:  Included
ADF regressions: 1 lag
LR variance:   Bartlett kernel, 8.00 lags average (chosen by LLC)
--------------------------------------------------------------------------------------
          Statistic   p-value
--------------------------------------------------------------------------------------
 Unadjusted t    -13.9341
 Adjusted t*     -5.9607    0.0000
```

```
. xtunitroot fisher D.GFCF, dfuller trend lags(0)
Fisher-type unit-root test for D.GFCF
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: At least one panel is stationary    Number of periods =   18
AR parameter: Panel-specific       Asymptotics: T -> Infinity
Panel means: Included
Time trend:  Included
Drift term:  Not included         ADF regressions: 0 lags
--------------------------------------------------------------------------------------
                                 Statistic   p-value
--------------------------------------------------------------------------------------
 Inverse chi-squared(26)   P    152.6080       0.0000
 Inverse normal           Z    -9.2987       0.0000
 Inverse logit t(69)      L*   -11.6825       0.0000
 Modified inv. chi-squared Pm    17.5574       0.0000
--------------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot ips D.EMP, trend
Im-Pesaran-Shin unit-root test for D.EMP
--------------------------------------------------------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: Some panels are stationary       Number of periods =   18
AR parameter: Panel-specific       Asymptotics: T,N -> Infinity
Panel means: Included                   sequentially
Time trend:  Included
ADF regressions: No lags included
--------------------------------------------------------------------------------------
                       Fixed-N exact critical values
                           Statistic   p-value     1%   5%   10%
--------------------------------------------------------------------------------------
 t-bar             -2.3993          -2.710 -2.550 -2.460
 t-tilde-bar       -2.0588
 Z-t-tilde-bar     -3.2266    0.0006
```

```
. xtunitroot llc D.EMP, trend
Levin-Lin-Chu unit-root test for D.EMP
--------------------------------------
Ho: Panels contain unit roots       Number of panels =   13
Ha: Panels are stationary         Number of periods =   18
AR parameter: Common            Asymptotics: N/T -> 0
Panel means: Included
Time trend:  Included
ADF regressions: 1 lag
LR variance:   Bartlett kernel, 8.00 lags average (chosen by LLC)
--------------------------------------------------------------------------------------
          Statistic   p-value
--------------------------------------------------------------------------------------
 Unadjusted t    -9.0010
 Adjusted t*     -4.0213    0.0000
```

```
. xtunitroot fisher D.EMP, dfuller trend lags(0)
Fisher-type unit-root test for D.EMP
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: At least one panel is stationary    Number of periods =   18
AR parameter: Panel-specific       Asymptotics: T -> Infinity
Panel means: Included
Time trend:  Included
Drift term:  Not included         ADF regressions: 0 lags
--------------------------------------------------------------------------------------
                                  Statistic   p-value
--------------------------------------------------------------------------------------
 Inverse chi-squared(26)   P    36.4795       0.0832
 Inverse normal            Z    -0.9989       0.1589
 Inverse logit t(69)       L*    -1.1488       0.1273
 Modified inv. chi-squared Pm    1.4532       0.0731
--------------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot ips D.PD, trend
Im-Pesaran-Shin unit-root test for D.PD
---------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: Some panels are stationary       Number of periods =   18
AR parameter: Panel-specific        Asymptotics: T,N -> Infinity
Panel means: Included                    sequentially
Time trend:  Included
ADF regressions: No lags included
------------------------------------------------------------------------------
                       Fixed-N exact critical values
                    Statistic   p-value     1%   5%   10%
------------------------------------------------------------------------------

 t-bar              -4.1729          -2.710 -2.550 -2.460
 t-tilde-bar        -2.8264
 Z-t-tilde-bar      -6.8567    0.0000
```

```
. xtunitroot llc D.PD, trend
Levin-Lin-Chu unit-root test for D.PD
-------------------------------------
Ho: Panels contain unit roots        Number of panels =   13
Ha: Panels are stationary          Number of periods =   18
AR parameter: Common            Asymptotics: N/T -> 0
Panel means: Included
Time trend:  Included
ADF regressions: 1 lag
LR variance:   Bartlett kernel, 8.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
          Statistic   p-value
------------------------------------------------------------------------------
 Unadjusted t    -13.2883
 Adjusted t*     -5.1892    0.0000
```

```
. xtunitroot fisher D.PD, dfuller trend lags(0)
Fisher-type unit-root test for D.PD
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots      Number of panels =   13
Ha: At least one panel is stationary    Number of periods =   18
AR parameter: Panel-specific        Asymptotics: T -> Infinity
Panel means: Included
Time trend:  Included
Drift term:  Not included         ADF regressions: 0 lags
------------------------------------------------------------------------------
                                 Statistic   p-value
------------------------------------------------------------------------------
 Inverse chi-squared(26)   P    164.0009       0.0000
 Inverse normal            Z    -8.8704        0.0000
 Inverse logit t(69)       L*   -12.4295       0.0000
 Modified inv. chi-squared Pm    19.1373       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
```

## Table A3: PVAR Lag Length Order Selection

```
. pvarsoc LGDP GOE GFCF EMP PD, maxlag(3) pvaropts(instl(1/6))
Running panel VAR lag order selection on estimation sample

 Selection order criteria
 Sample:  2006 - 2017                              No. of obs      =       156
                                                   No. of panels   =        13
                                                   Ave. no. of T   =    12.000

  +--------------------------------------------------------------------------+
  |   lag |    CD          J      J pvalue     MBIC       MAIC       MQIC    |
  |-------+------------------------------------------------------------------|
  |     1 |  .9999998   126.4534   .4468167  -504.7786  -123.5466  -278.3865 |
  |     2 |  .9999998   94.32337   .6412739  -410.6622  -105.6766  -229.5486 |
  |     3 |  .9999995   62.13668   .8558537  -316.6025  -87.86332  -180.7673 |
  +--------------------------------------------------------------------------+
```

## Table A4: Panel Vector Autoregression (PVAR) Model Estimates

```
. pvar LGDP GOE GFCF EMP PD, instl(1/6)
Panel vector autoregresssion
GMM Estimation
Final GMM Criterion Q(b) =      .811
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                   No. of obs      =       156
                                                   No. of panels   =        13
                                                   Ave. no. of T   =    12.000
------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LGDP         |
        LGDP |
         L1. |   .6645398   .0217474    30.56   0.000     .6219157    .7071639
             |
         GOE |
         L1. |    .010939   .0006493    16.85   0.000     .0096665    .0122115
             |
        GFCF |
         L1. |  -.0034472   .0003584    -9.62   0.000    -.0041497   -.0027448
             |
         EMP |
         L1. |   .0038031   .0012699     2.99   0.003     .0013141    .0062921
             |
          PD |
         L1. |   .0003212   .0001474     2.18   0.029     .0000323    .0006101
-------------+----------------------------------------------------------------
GOE          |
        LGDP |
         L1. |  -1.822849   1.104799    -1.65   0.099    -3.988216    .3425171
             |
         GOE |
         L1. |   .3962465   .0364895    10.86   0.000     .3247283    .4677646
             |
        GFCF |
         L1. |   .1873217   .0210633     8.89   0.000     .1460385     .228605
             |
         EMP |
         L1. |  -.5675088   .1023489    -5.54   0.000     -.768109   -.3669086
             |
          PD |
```

```
         L1. |  -.0209026   .0085089    -2.46   0.014    -.0375796   -.0042255
-------------+----------------------------------------------------------------
GFCF         |
        LGDP |
         L1. |   6.629634   1.369157     4.84   0.000     3.946136    9.313132
             |
         GOE |
         L1. |   .1733293   .0424543     4.08   0.000     .0901204    .2565382
             |
        GFCF |
         L1. |   .5489513   .0406833    13.49   0.000     .4692134    .6286891
             |
         EMP |
         L1. |   .0195537   .0868885     0.23   0.822    -.1507446     .189852
             |
          PD |
         L1. |  -.0073465   .0124703    -0.59   0.556    -.0317878    .0170948
-------------+----------------------------------------------------------------
EMP          |
        LGDP |
         L1. |  -1.417692   .2543162    -5.57   0.000    -1.916142   -.9192411
             |
         GOE |
         L1. |  -.0150793    .005983    -2.52   0.012    -.0268058   -.0033529
             |
        GFCF |
         L1. |   .0081135   .0038844     2.09   0.037     .0005002    .0157269
             |
         EMP |
         L1. |   .7990564   .0113866    70.18   0.000     .7767391    .8213737
             |
          PD |
         L1. |   .0091208   .0014264     6.39   0.000     .0063252    .0119165
-------------+----------------------------------------------------------------
PD           |
        LGDP |
         L1. |   59.15074   3.753738    15.76   0.000     51.79355    66.50793
             |
         GOE |
         L1. |  -1.016936   .0800084   -12.71   0.000     -1.17375   -.8601222
             |
        GFCF |
         L1. |   .5104695   .0483606    10.56   0.000     .4156845    .6052544
             |
         EMP |
         L1. |   .5681097   .1639026     3.47   0.001     .2468664    .8893529
             |
          PD |
         L1. |   .7763178    .026146    29.69   0.000     .7250726    .8275629
------------------------------------------------------------------------------
Instruments : l(1/6).(LGDP GOE GFCF EMP PD)
```

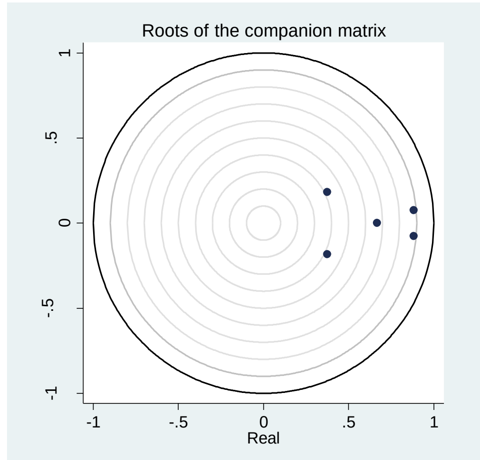
## Table A5: PVAR Granger Causality Wald Test

panel VAR-Granger causality Wald test
Ho: Excluded variable does not Granger-cause Equation variable
Ha: Excluded variable Granger-causes Equation variable

| Equation \ Excluded | chi2 | df | Prob > chi2 |
|---|---|---|---|
| LGDP | | | |
| GOE | 283.866 | 1 | 0.000 |
| GFCF | 92.523 | 1 | 0.000 |
| EMP | 8.968 | 1 | 0.003 |
| PD | 4.748 | 1 | 0.029 |
| ALL | 308.403 | 4 | 0.000 |
| GOE | | | |
| LGDP | 2.722 | 1 | 0.099 |
| GFCF | 79.091 | 1 | 0.000 |
| EMP | 30.745 | 1 | 0.000 |
| PD | 6.035 | 1 | 0.014 |
| ALL | 132.303 | 4 | 0.000 |
| GFCF | | | |
| LGDP | 23.446 | 1 | 0.000 |
| GOE | 16.669 | 1 | 0.000 |
| EMP | 0.051 | 1 | 0.822 |
| PD | 0.347 | 1 | 0.556 |
| ALL | 158.241 | 4 | 0.000 |
| EMP | | | |
| LGDP | 31.075 | 1 | 0.000 |
| GOE | 6.352 | 1 | 0.012 |
| GFCF | 4.363 | 1 | 0.037 |
| PD | 40.889 | 1 | 0.000 |
| ALL | 140.682 | 4 | 0.000 |
| PD | | | |
| LGDP | 248.309 | 1 | 0.000 |
| GOE | 161.553 | 1 | 0.000 |
| GFCF | 111.418 | 1 | 0.000 |
| EMP | 12.014 | 1 | 0.001 |
| ALL | 545.627 | 4 | 0.000 |

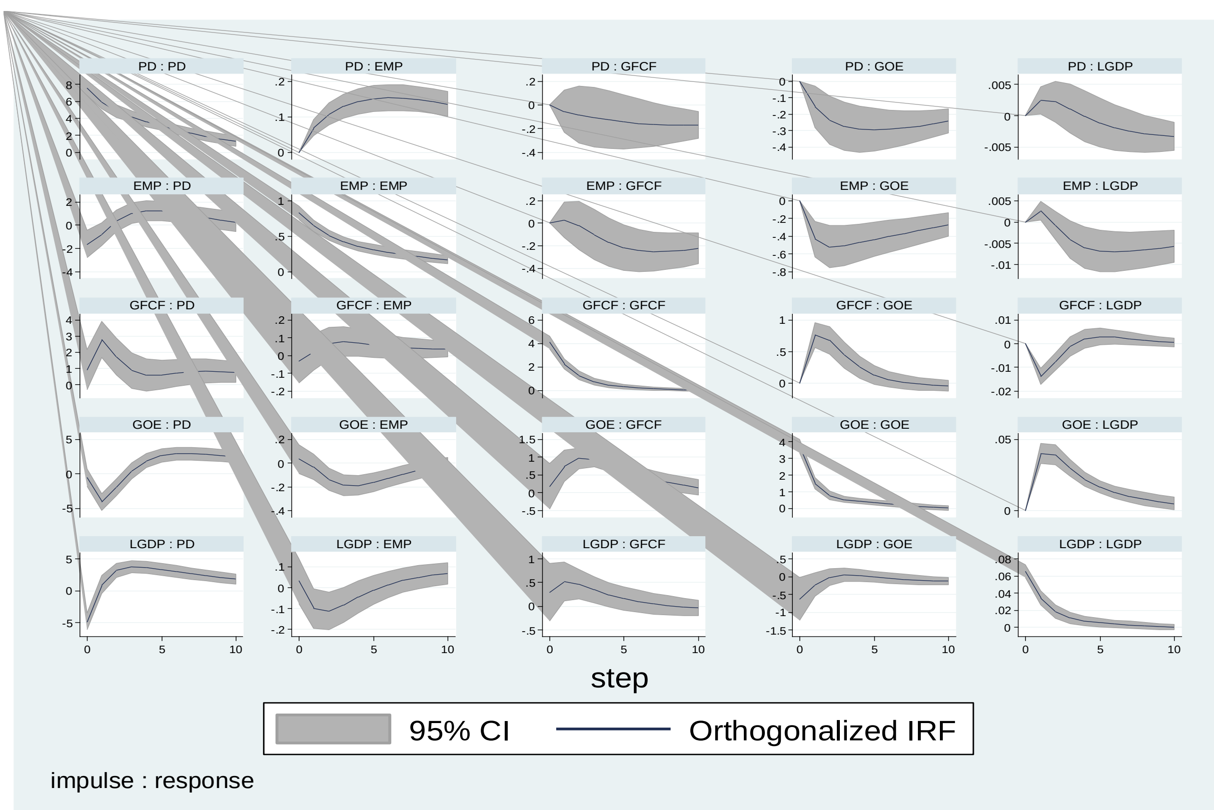
## Table A6: PVAR Stability Test

```
. pvarstable, graph
   Eigenvalue stability condition
  +----------------------------------+
  |       Eigenvalue       |          |
  |   Real      Imaginary |  Modulus |
  |----------------------+-----------|
  |  .8837326  -.0761423 |  .8870067 |
  |  .8837326   .0761423 |  .8870067 |
  |   .667121          0 |   .667121 |
  |  .3752628   .1824351 |  .4172586 |
  |  .3752628  -.1824351 |  .4172586 |
  +----------------------------------+
All  the  eigenvalues  lie  inside  the  unit
circle.
   PVAR satisfies stability condition.
```




## Figure A1: PVAR Impulse Response Function (IRF)

. pvarirf, mc(200) oirf byopt(yrescale)



## Table A7: PVAR Variance Decomposition (FEVD)

```
. pvarfevd, mc(200)
Forecast-error variance decomposition
-------------------------------------------------------------------------------------
Response |
variable |
and      |
Forecast |          Impulse variable
horizon  |    LGDP     GOE    GFCF     EMP      PD
-------------------------------------------------------------------------------------

LGDP    |
    0 |     0      0      0      0      0
    1 |     1      0      0      0      0
    2 | .7493333 .2224059  .026513 .0009388 .0008091
    3 | .6283415 .3423859 .0272646 .0008329 .0011752
    4 | .5764833 .3952606 .0246357 .0024419 .0011786
    5 | .5508633 .4186224  .02373  .005668 .0011164
    6 | .535971  .429411 .0237794 .0096464 .0011921
    7 | .5262025  .434629 .0239555  .013726  .001487
    8 | .519299 .4371127  .024015 .0175718 .0020015
    9 | .5142139 .4380798 .0239674 .0210427 .0026962
    10 | .5103869 .4381374 .0238676  .024091 .0035171
-------------------------------------------------------------------------------------
```

## Table A8: Regress Fixed Effects and Random Effects Model

```
. regress LGDP GOE GFCF EMP PD
      Source |       SS           df       MS      Number of obs   =       247
-------------+----------------------------------   F(4, 242)       =     76.01
       Model |  35.4835045         4  8.87087613   Prob > F        =    0.0000
    Residual |  28.2447374       242  .116713791   R-squared       =    0.5568
-------------+----------------------------------   Adj R-squared   =    0.5495
       Total |   63.728242       246  .259057894   Root MSE        =    .34163
------------------------------------------------------------------------------
        LGDP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GOE |  -.0015627   .0026916    -0.58   0.562    -.0068647    .0037394
        GFCF |    .012517   .0026208     4.78   0.000     .0073544    .0176795
         EMP |  -.0191374   .0016935   -11.30   0.000    -.0224732   -.0158016
          PD |  -.0045562   .0006478    -7.03   0.000    -.0058322   -.0032802
       _cons |   4.299323   .1394206    30.84   0.000      4.02469    4.573956
```

## Table A9: Fixed Effects Model

```
. xtreg LGDP GOE GFCF EMP PD, fe
Fixed-effects (within) regression               Number of obs     =        247
Group variable: ID                              Number of groups  =         13
R-sq:                                           Obs per group:
     within  = 0.5130                                         min =         19
     between = 0.3970                                         avg =       19.0
     overall = 0.2489                                         max =         19
                                                F(4,230)          =      60.58
corr(u_i, Xb)  = -0.8645                        Prob > F          =     0.0000
        LGDP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GOE |   .0071666   .0017736     4.04   0.000      .003672    .0106611
        GFCF |    .005942   .0015021     3.96   0.000     .0029823    .0089017
         EMP |    .033699   .0033449    10.07   0.000     .0271085    .0402896
          PD |  -.0031344    .000278   -11.28   0.000    -.0036821   -.0025867
       _cons |   .9108501   .2203691     4.13   0.000     .4766499     1.34505
-------------+----------------------------------------------------------------
     sigma_u |  .87412778
     sigma_e |    .129507
         rho |  .97852135   (fraction of variance due to u_i)
F test that all u_i=0: F(12, 230) = 121.17                   Prob > F = 0.0000
```

## Table A10: Random Effects Model

```
. xtreg LGDP GOE GFCF EMP PD, re
Random-effects GLS regression                   Number of obs     =        247
Group variable: ID                              Number of groups  =         13
R-sq:                                           Obs per group:
     within  = 0.4882                                         min =         19
     between = 0.3161                                         avg =       19.0
     overall = 0.1553                                         max =         19
                                                Wald chi2(4)      =     161.67
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000
        LGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GOE |    .007073   .0019568     3.61   0.000     .0032378    .0109082
        GFCF |   .0050087   .0016561     3.02   0.002     .0017627    .0082547
         EMP |   .0214737   .0032733     6.56   0.000     .0150581    .0278894
          PD |  -.0031047   .0003091   -10.05   0.000    -.0037104   -.0024989
       _cons |    1.68066   .2397542     7.01   0.000      1.21075    2.150569
-------------+----------------------------------------------------------------
     sigma_u |  .32181002
     sigma_e |    .129507
         rho |  .86062045   (fraction of variance due to u_i)
```

## Table A11: Hausman Test

```
. hausman fe re
                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
         GOE |    .0071666      .007073        .0000936               .
        GFCF |     .005942     .0050087        .0009333               .
         EMP |     .033699     .0214737        .0122253        .0006881
          PD |   -.0031344    -.0031047       -.0000297               .
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg
    Test:  Ho:  difference in coefficients not systematic
                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      275.02
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

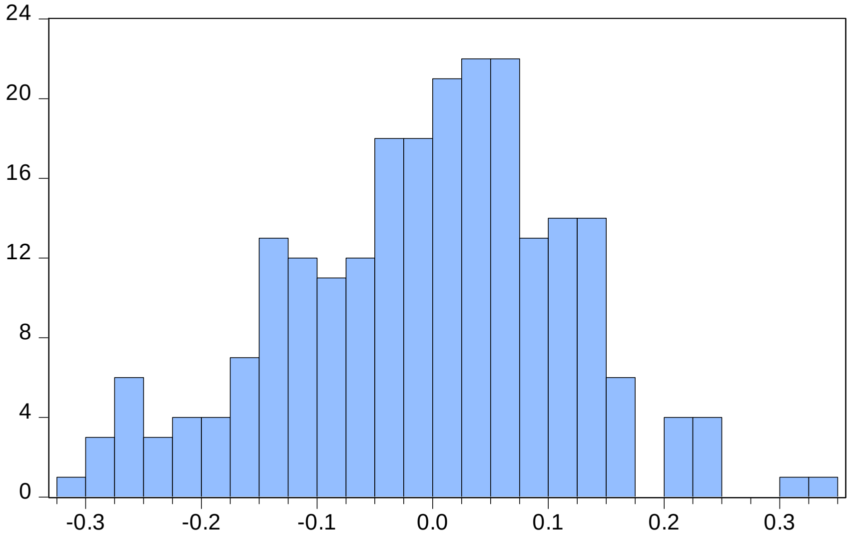
## Table A12: Panel Fully Modified Least Squares (FMOLS) Model

Dependent Variable: LGDP
Method: Panel Fully Modified Least Squares (FMOLS)
Date: 11/19/19 Time: 13:48
Sample (adjusted): 2001 2018
Periods included: 18
Cross-sections included: 13
Total panel (balanced) observations: 234
Panel method: Pooled estimation
Cointegrating equation deterministics: C
Coefficient covariance computed using default method
Long-run covariance estimates (Bartlett kernel, Newey-West fixed bandwidth)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| GOE | 0.008691 | 0.002493 | 3.485292 | 0.0006 |
| GFCF | 0.006726 | 0.002089 | 3.220241 | 0.0015 |
| EMP | 0.032823 | 0.004653 | 7.053547 | 0.0000 |
| PD | -0.003114 | 0.000425 | -7.322795 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.943752 | Mean dependent var | 3.173351 |
| Adjusted R-squared | 0.939605 | S.D. dependent var | 0.509658 |
| S.E. of regression | 0.125251 | Sum squared resid | 3.404244 |
| Long-run variance | 0.027746 | | |

## Figure A2: FMOLS Normality test




Series: Residuals
Sample 2001 2018
Observations 234

| | |
|---|---|
| Mean | -0.006251 |
| Median | 0.003479 |
| Maximum | 0.328915 |
| Minimum | -0.312792 |
| Std. Dev. | 0.120711 |
| Skewness | -0.205362 |
| Kurtosis | 2.894303 |
| Jarque-Bera | 1.753698 |
| Probability | 0.416092 |

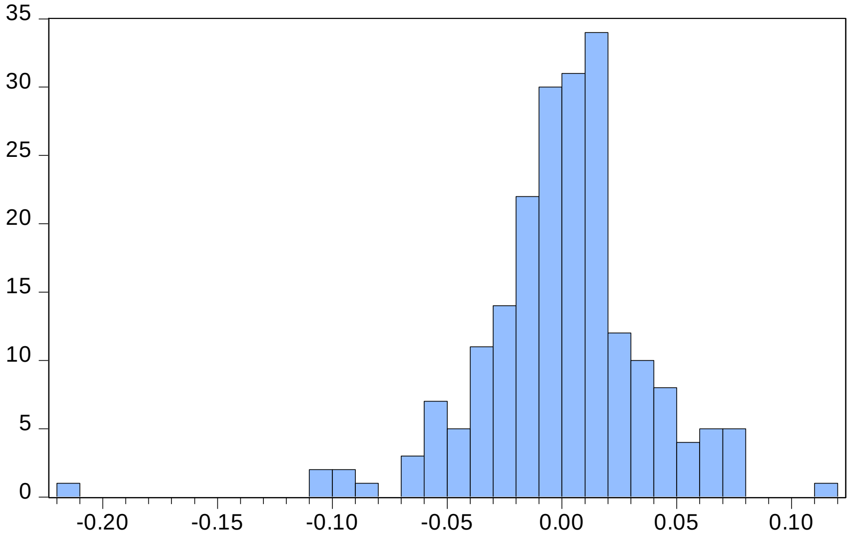
## Table A13: Panel Dynamic Least Squares (DOLS) Model

Dependent Variable: LGDP
Method: Panel Dynamic Least Squares (DOLS)
Date: 11/19/19 Time: 13:51
Sample (adjusted): 2002 2017
Periods included: 16
Cross-sections included: 13
Total panel (balanced) observations: 208
Panel method: Pooled estimation
Cointegrating equation deterministics: C
Fixed leads and lags specification (lead=1, lag=1)
Coefficient covariance computed using default method
Long-run variance (Bartlett kernel, Newey-West fixed bandwidth) used for coefficient covariances

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| GOE | 0.007674 | 0.005183 | 1.480514 | 0.1477 |
| GFCF | 0.006834 | 0.004772 | 1.431965 | 0.1610 |
| EMP | 0.037395 | 0.006834 | 5.471580 | 0.0000 |
| PD | -0.004404 | 0.000791 | -5.569563 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.994669 | Mean dependent var | 3.183286 |
| Adjusted R-squared | 0.968473 | S.D. dependent var | 0.507378 |
| S.E. of regression | 0.090089 | Sum squared resid | 0.284059 |
| Long-run variance | 0.001326 | | |

**Figure A3: DOLS Normality**



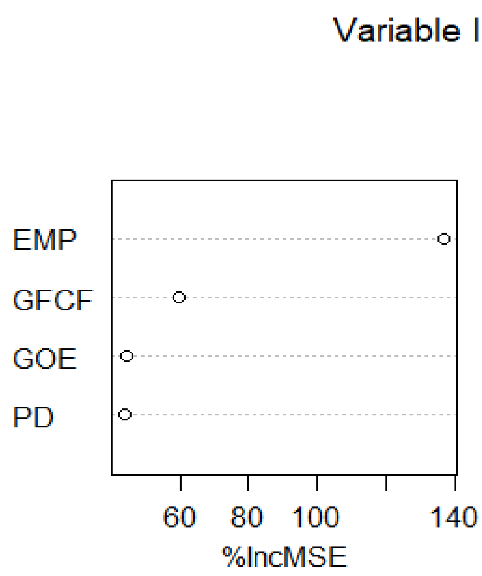

Series: Residuals
Sample 2000 2018
Observations 208

| | |
|---|---|
| Mean | -4.11e-17 |
| Median | 0.001256 |
| Maximum | 0.115016 |
| Minimum | -0.212348 |
| Std. Dev. | 0.037044 |
| Skewness | -1.000093 |
| Kurtosis | 8.248520 |
| | |
| Jarque-Bera | 273.4135 |
| Probability | 0.000000 |

## APPENDIX B – PANEL SMOOTH TRANSITION REGRESSION (PSTR) MODEL

Appendix B provide the results of a PSTR estimates accompanied by model evaluation tests in Table B1-Table B4. The results for the variable of importance are shown in Figure B1. The results for anomalies that were estimated through a STAR model discussed in section 4.6.8 are reported in Table B5-Table B7 with accompanying post-diagnostic tests.

**Figure B1: Variable of Importance**




```
main = "Variable Importance")
> importance(rf)
        %IncMSE IncNodePurity
PD     43.92204      4.897730
EMP   137.15397     32.684665
GFCF   59.62644      5.264868
GOE    44.11685      5.454566
```

## Table B1: Homogeneity Test

```
Results of the linearity (homogeneity) tests:
-------------------------------------------------------------------------
LM tests based on transition variable 'PD'
  m  LM_X        PV  LM_F        PV HAC_X     PV HAC_F     PV
  1 34.01 7.423e-07 7.573 9.847e-06 3.561 0.4686 0.793 0.5308
*************************************************************************
Sequence of homogeneity tests for selecting number of switches 'm':
-------------------------------------------------------------------------
LM tests based on transition variable 'PD'
  m  LM_X        PV  LM_F        PV HAC_X     PV HAC_F     PV
  1 34.01 7.423e-07 7.573 9.847e-06 3.561 0.4686 0.793 0.5308
*************************************************************************
#########################################################################

Results of the linearity (homogeneity) tests:
------------------------------------------------------------------------
LM tests based on transition variable 'PD'
  m  LM_X        PV  LM_F        PV HAC_X     PV HAC_F     PV WB_PV WCB_PV
  1 34.01 7.423e-07 7.573 9.847e-06 3.561 0.4686 0.793 0.5308     0    0.5
************************************************************************
Sequence of homogeneity tests for selecting number of switches 'm':
------------------------------------------------------------------------
LM tests based on transition variable 'PD'
  m  LM_X        PV  LM_F        PV HAC_X     PV HAC_F     PV WB_PV WCB_PV
  1 34.01 7.423e-07 7.573 9.847e-06 3.561 0.4686 0.793 0.5308     0    0.5
************************************************************************
########################################################################
```

## Table B2: PSTR Estimates

```
Results of the PSTR estimation:
-------------------------------------------------------------------------
Transition variable 'PD' is used in the estimation.
-------------------------------------------------------------------------
Parameter estimates in the linear part (first extreme regime) are
         PD_0     EMP_0   GFCF_0     GOE_0
Est  0.003508 -0.021810 0.009863 0.0006187
s.e. 0.004316  0.006518 0.005483 0.0079990
-------------------------------------------------------------------------
Parameter estimates in the non-linear part are
          PD_1    EMP_1    GFCF_1      GOE_1
Est  -0.006845 0.006447 -0.010440 -0.0007272
s.e.  0.004783 0.002796  0.005806  0.0098280
-------------------------------------------------------------------------
Parameter estimates in the second extreme regime are
      PD_{0+1} EMP_{0+1} GFCF_{0+1}  GOE_{0+1}
Est  -0.003338 -0.015360 -0.0005794 -0.0001085
s.e.  0.001154  0.007232  0.0045880  0.0078140
-------------------------------------------------------------------------
Non-linear parameter estimates are
      gamma      c_1
Est  20.270 60.36000
s.e.  3.624  0.03156
-------------------------------------------------------------------------
Estimated standard deviation of the residuals is 0.1837
*************************************************************************
#########################################################################
```

## Table B3: PSTR Model Evaluation Tests

```
Results of the evaluation tests:
------------------------------------------------------------------------
Parameter constancy test
  m  LM_X        PV LM_F        PV HAC_X     PV  HAC_F     PV
  1 43.62 6.699e-07 4.68 2.719e-05 8.816 0.3581 0.9458 0.4798
------------------------------------------------------------------------
No remaining nonlinearity (heterogeneity) test
  m  LM_X        PV  LM_F        PV HAC_X     PV HAC_F     PV
  1 51.39 2.203e-08 5.514 2.444e-06 10.57 0.2275 1.134 0.3419
************************************************************************
########################################################################

Results of the evaluation tests:
-------------------------------------------------------------------------
Parameter constancy test
  m  LM_X        PV LM_F        PV HAC_X     PV  HAC_F     PV
  1 43.62 6.699e-07 4.68 2.719e-05 8.816 0.3581 0.9458 0.4798
-------------------------------------------------------------------------
No remaining nonlinearity (heterogeneity) test
  m  LM_X        PV  LM_F        PV HAC_X     PV HAC_F     PV
  1 51.39 2.203e-08 5.514 2.444e-06 10.57 0.2275 1.134 0.3419
-------------------------------------------------------------------------
WB and WCB no remaining nonlinearity (heterogeneity) test
  m WB_PV WCB_PV
  1     1      1
*************************************************************************
#########################################################################
```

## Table B4: Panel Regression with Fixed Effects

```
A linear panel regression with fixed effects is estimated.
-------------------------------------------------------------------------
Parameter estimates are
             PD        EMP     GFCF      GOE
Est  -0.0033320 -0.019830 0.003566 0.001496
s.e.  0.0008287  0.006957 0.004581 0.006411
-------------------------------------------------------------------------
Estimated standard deviation of the residuals is 0.1983
*************************************************************************
#########################################################################
```

## Table B5: Mozambique STAR Model

Dependent Variable: GDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 11/03/20 Time: 07:18
Sample (adjusted): 2002 2018
Included observations: 17 after adjustments
Threshold variable: GDP(-2)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 6 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Threshold Variables (linear part) | | | | |
| LPD | -0.250306 | 0.053793 | -4.653097 | 0.0012 |
| Threshold Variables (nonlinear part) | | | | |
| LPD | -0.051502 | 0.030423 | -1.692847 | 0.1247 |
| Non-Threshold Variables | | | | |
| EMP | -0.067452 | 0.022955 | -2.938374 | 0.0165 |
| GFCF | 0.000490 | 0.001397 | 0.351024 | 0.7336 |
| GOE | 0.004232 | 0.005275 | 0.802409 | 0.4430 |
| C | 9.020131 | 2.101402 | 4.292436 | 0.0020 |
| Slopes | | | | |
| SLOPE | 28.74287 | 17.79592 | 1.615139 | 0.1407 |
| Thresholds | | | | |
| THRESHOLD | 2.556505 | 0.027883 | 91.68551 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.928303 | Mean dependent var | 2.637795 |
| Adjusted R-squared | 0.872539 | S.D. dependent var | 0.111039 |
| S.E. of regression | 0.039643 | Akaike info criterion | -3.312631 |
| Sum squared resid | 0.014144 | Schwarz criterion | -2.920531 |
| Log likelihood | 36.15736 | Hannan-Quinn criter. | -3.273655 |
| F-statistic | 16.64700 | Durbin-Watson stat | 1.781604 |
| Prob(F-statistic) | 0.000176 | | |

### Table B5.1: Linearity Tests

Smooth Threshold Linearity Tests
Date: 11/03/20 Time: 11:02
Sample: 2000 2018
Included observations: 17
Test for nonlinearity using GDP(-2) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Terasvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | 3.235971 | (1, 9) | 0.1056 |
| H2: b2=0 \| b3=0 | 0.021260 | (1, 10) | 0.8870 |
| H1: b1=0 \| b2=b3=0 | 0.444236 | (1, 11) | 0.5188 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is not rejected at the 5% level using H03.

### Table B5.2: Parameter Constancy Test

Smooth Threshold Parameter Constancy Test
Date: 11/03/20 Time: 10:59
Sample: 2000 2018
Included observations: 17
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Parameter Constancy Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 3.360238 | (8, 1) | 0.3997 |
| H03: b1=b2=b3=0 | 1.352700 | (6, 3) | 0.4339 |
| H02: b1=b2=0 | 3.072364 | (4, 5) | 0.1249 |
| H01: b1=0 | 0.418760 | (2, 7) | 0.6733 |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

### Table B5.3: Serial Correlation and Heteroskedasticity Test

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 1.828981 | Prob. F(2,7) | 0.2296 |
| Obs*R-squared | 5.834638 | Prob. Chi-Square(2) | 0.0541 |

| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 0.734248 | Prob. F(4,12) | 0.5860 |
| Obs*R-squared | 3.342631 | Prob. Chi-Square(4) | 0.5022 |
| Scaled explained SS | 0.543929 | Prob. Chi-Square(4) | 0.9691 |

## Table B6: Zimbabwe STAR Model

Dependent Variable: LGDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 01/07/21 Time: 10:13
Sample (adjusted): 2001 2018
Included observations: 18 after adjustments
Threshold variable: LGDP(-1)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 12 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Threshold Variables (linear part) | | | | |
| PD | -0.002694 | 0.001292 | -2.085364 | 0.0636 |
| Threshold Variables (nonlinear part) | | | | |
| PD | 0.002752 | 0.000681 | 4.043427 | 0.0023 |
| Non-Threshold Variables | | | | |
| C | 2.392411 | 2.059819 | 1.161467 | 0.2724 |
| EMP | 0.005593 | 0.026647 | 0.209878 | 0.8380 |
| GFCF | 0.006794 | 0.003083 | 2.204058 | 0.0521 |
| GOE | 0.004451 | 0.002999 | 1.484036 | 0.1686 |
| Slopes | | | | |
| SLOPE | 151.5687 | 311.5392 | 0.486516 | 0.6371 |
| Thresholds | | | | |
| THRESHOLD | 2.924495 | 0.018611 | 157.1384 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.963069 | Mean dependent var | 2.927431 |
| Adjusted R-squared | 0.937217 | S.D. dependent var | 0.128850 |
| S.E. of regression | 0.032285 | Akaike info criterion | -3.727306 |
| Sum squared resid | 0.010423 | Schwarz criterion | -3.331585 |
| Log likelihood | 41.54575 | Hannan-Quinn criter. | -3.672741 |
| F-statistic | 37.25367 | Durbin-Watson stat | 1.613967 |
| Prob(F-statistic) | 0.000002 | | |

## Table B6.1: Linearity Test

Smooth Threshold Linearity Tests
Date: 01/07/21 Time: 10:41
Sample: 2000 2018
Included observations: 18
Test for nonlinearity using LGDP(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Terasvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | NA | (0, 11) | NA |
| H2: b2=0 \| b3=0 | 7.783352 | (1, 11) | 0.0176 |
| H1: b1=0 \| b2=b3=0 | 5.229216 | (1, 12) | 0.0412 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is rejected at the 5% level using H03.

## Table B6.2: Parameter Constancy Test

Smooth Threshold Parameter Constancy Test
Date: 01/07/21 Time: 10:42
Sample: 2000 2018
Included observations: 18
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Parameter Constancy Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 6.334150 | (2, 9) | 0.0192 |
| H03: b1=b2=b3=0 | 6.334150 | (2, 9) | 0.0192 |
| H02: b1=b2=0 | 1.171549 | (1, 10) | 0.3045 |
| H01: b1=0 | NA | (0, 11) | NA |

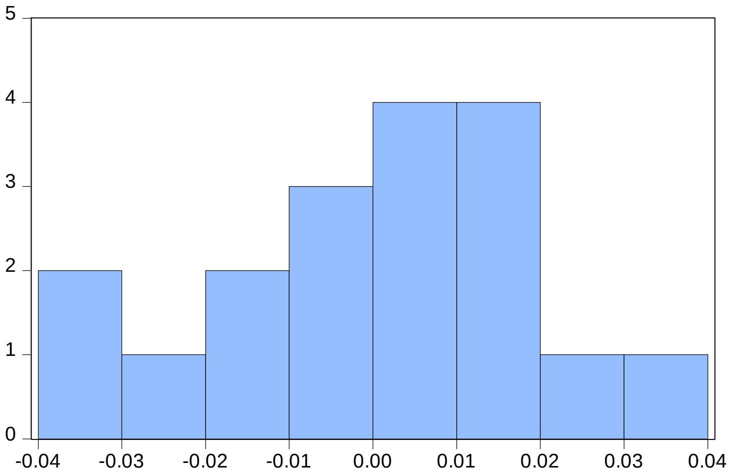
The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

## Table B6.3: Serial Correlation and Heteroskedasticity Test

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 0.273499 | Prob. F(2,8) | 0.7675 |
| Obs*R-squared | 1.151978 | Prob. Chi-Square(2) | 0.5621 |

| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 0.843774 | Prob. F(4,13) | 0.5219 |
| Obs*R-squared | 3.710007 | Prob. Chi-Square(4) | 0.4467 |
| Scaled explained SS | 0.963908 | Prob. Chi-Square(4) | 0.9152 |

## Figure B2: Normality Test




| Series: Residuals | |
|---|---|
| Sample 2001 2018 | |
| Observations 18 | |
| Mean | 7.16e-16 |
| Median | 0.001623 |
| Maximum | 0.032935 |
| Minimum | -0.035858 |
| Std. Dev. | 0.018683 |
| Skewness | -0.295703 |
| Kurtosis | 2.467111 |
| Jarque-Bera | 0.475298 |
| Probability | 0.788479 |

## Table B7: South Africa STAR Model

Dependent Variable: GDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 11/03/20 Time: 11:10
Sample (adjusted): 2002 2018
Included observations: 17 after adjustments
Threshold variable: GDP(-2)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 43 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Threshold Variables (linear part) | | | | |
| PD | -0.001857 | 0.003460 | -0.536769 | 0.6044 |
| Threshold Variables (nonlinear part) | | | | |
| PD | -0.003074 | 0.000896 | -3.431341 | 0.0075 |
| Non-Threshold Variables | | | | |
| EMP | -0.093130 | 0.020842 | -4.468299 | 0.0016 |
| GFCF | 0.096017 | 0.021862 | 4.391856 | 0.0017 |
| GOE | 0.056391 | 0.010216 | 5.519923 | 0.0004 |
| C | 4.006311 | 0.394128 | 10.16501 | 0.0000 |
| Slopes | | | | |
| SLOPE | 4257.586 | 2.72E+15 | 1.56E-12 | 1.0000 |
| Thresholds | | | | |
| THRESHOLD | 3.780337 | 4.29E+09 | 8.81E-10 | 1.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.926974 | Mean dependent var | 3.757162 |
| Adjusted R-squared | 0.870177 | S.D. dependent var | 0.120032 |
| S.E. of regression | 0.043249 | Akaike info criterion | -3.138504 |
| Sum squared resid | 0.016834 | Schwarz criterion | -2.746403 |
| Log likelihood | 34.67728 | Hannan-Quinn criter. | -3.099528 |
| F-statistic | 16.32065 | Durbin-Watson stat | 2.166755 |
| Prob(F-statistic) | 0.000191 | | |

## Table B7.1: Linearity Tests

Smooth Threshold Linearity Tests
Date: 11/03/20 Time: 11:11
Sample: 2000 2018
Included observations: 17
Test for nonlinearity using GDP(-2) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Teräsvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | NA | (0, 10) | NA |
| H2: b2=0 \| b3=0 | 5.765182 | (1, 10) | 0.0372 |
| H1: b1=0 \| b2=b3=0 | 0.636445 | (1, 11) | 0.4419 |

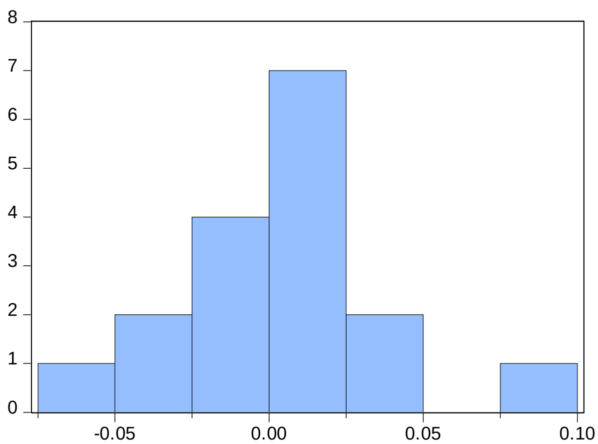
All tests are based on the third-order Taylor expansion (b4=0).
Linear model is not rejected at the 5% level using H03.

## Table B7.2: Serial Correlation and Heteroskedasticity Test

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 0.238817 | Prob. F(2,7) | 0.7937 |
| Obs*R-squared | 1.085874 | Prob. Chi-Square(2) | 0.5810 |

| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 0.611772 | Prob. F(4,12) | 0.6622 |
| Obs*R-squared | 2.879509 | Prob. Chi-Square(4) | 0.5782 |
| Scaled explained SS | 1.147126 | Prob. Chi-Square(4) | 0.8867 |

## Figure B3: Normality Test




Series: Residuals
Sample 2002 2018
Observations 17

| | |
|---|---|
| Mean | -5.22e-16 |
| Median | 0.002673 |
| Maximum | 0.080670 |
| Minimum | -0.060733 |
| Std. Dev. | 0.032437 |
| Skewness | 0.382699 |
| Kurtosis | 3.842728 |
| Jarque-Bera | 0.918018 |
| Probability | 0.631909 |

## APPENDIX C – SMOOTH TRANSITION REGRESSION (STAR) AND NONLINEAR AUTOREGRESSIVE REDISTRIBUTED LAG (NARDL) MODEL

Appendix C contains the results of unit root tests in Table C1. The unit root test results for South Africa were already presented in section 5.5.1, Table 5.2. The STAR estimates for South Africa, Botswana, Namibia, Zambia, Malawi and Zimbabwe are reported in Table C2-Table C7 with accompanying model evaluation tests and post-diagnostic tests. The results for a NARDL are displayed in Table C8-Table C14 together with the Bounds cointegration tests and accompanying post-diagnostic inspection tests.

**Table C1: Unit Root Test for Botswana, Namibia, Zambia, Malawi and Zimbabwe.**

| TESTS | GDP | PD | EMP | LGFCF | GOE |
|---|---|---|---|---|---|
| **ADF Test** | | | | | |
| Level | 1.8479 | -2.2363 | -3.7556** | -1.5266 | -3.9809** |
| [*P-value*] | [0.6389] | [0.4405] | [0.0481] | [0.7810] | [0.0312] |
| 1st Difference | -3.8144** | 0.0327** | -3.3366** | -3.3603** | -3.6201** |
| [*P-value*] | [0.0417] | [0.0176] | [0.0293] | [0.0280] | [0.0199] |
| **PP Test** | | | | | |
| Level | -1.8898 | -1.7565 | -2.7955 | -1.5266 | -2.3904 |
| [*P-value*] | [0.6181] | [0.6828] | [0.2161] | [0.7810] | [0.3712] |
| 1st Difference | -4.1206** | -3.5997** | -3.2790** | -3.3168** | -2.6779** |
| [*P-value*] | [0.0243] | [0.0176] | [0.0327] | [0.0304] | [0.0107] |

*Notes: Asterisks ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.*

**Unit Root Test Results for Namibia**

| TESTS | GDP | PD | EMP | LGFCF | GOE |
|---|---|---|---|---|---|
| **ADF Test** | | | | | |
| Level | -1.1112 | -0.6262 | -4.0938** | -3.7044 | -1.8736 |
| [*P-value*] | [0.8983] | [0.9637] | [0.0255] | [0.0548] | [0.6262] |
| 1st Difference | -3.0070* | -4.1952** | -3.7187*** | -5.1285*** | -3.7470** |
| [*P-value*] | [0.0543] | [0.0213] | [0.0010] | [0.0040] | [0.0470] |
| **PP Test** | | | | | |
| Level | -1.5612 | -0.6088 | -1.8962 | -3.0536 | -1.8736 |
| [*P-value*] | [0.4809] | [0.9651] | [0.6148] | [0.1459] | [0.6262] |
| 1st Difference | -5.4951*** | -4.3933** | -2.4464** | -5.1708*** | -3.7470** |
| [*P-value*] | [0.0021] | [0.0149] | [0.0179] | [0.0037] | [0.0470] |

*Notes: Asterisks ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.*

## Unit Root Test Results for Zambia

| TESTS | GDP | PD | EMP | LGFCF | GOE |
|---|---|---|---|---|---|
| **ADF Test** | | | | | |
| Level | -1.9362 | -1.4504 | -3.6617** | -1.7858 | -1.4548 |
| [*P-value*] | [0.3097] | [0.8061] | [0.0156] | [0.3748] | [0.5326] |
| 1st Difference | -3.1820** | -2.3216** | -4.2362*** | -5.9960*** | -4.8591*** |
| [*P-value*] | [0.0392] | [0.0235] | [0.0055] | [0.0002] | [0.0015] |
| **PP Test** | | | | | |
| Level | -0.7526 | -1.7760 | -2.3084 | -1.7858 | -1.6949 |
| [*P-value*] | [0.9516] | [0.6736] | [0.1799] | [0.3748] | [0.4168] |
| 1st Difference | -3.1685** | -2.3426** | -3.7227** | -6.3515*** | -4.7330*** |
| [*P-value*] | [0.0402] | [0.0225] | [0.0138] | [0.0001] | [0.0019] |

*Notes: Asterisks ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.*

## Unit Root Test Results for Malawi

| TESTS | GDP | PD | EMP | LGFCF | GOE |
|---|---|---|---|---|---|
| **ADF Test** | | | | | |
| Level | -1.5673 | -5.7910*** | -1.0751 | -2.1162 | -3.4804** |
| [*P-value*] | [0.4779] | [0.0004] | [0.7001] | [0.2411] | [0.0213] |
| 1st Difference | -3.7623** | -3.4852*** | -3.0579* | -3.0856** | -4.2357*** |
| [*P-value*] | [0.0128] | [0.0017] | [0.0521] | [0.0470] | [0.0050] |
| **PP Test** | | | | | |
| Level | -1.5673 | -2.5094 | -0.7118 | -1.8627 | -3.8458** |
| [*P-value*] | [0.4779] | [0.1297] | [0.8194] | [0.3407] | [0.0102] |
| 1st Difference | -3.7527** | -3.5101** | -1.7939* | -3.0813** | -4.4232*** |
| [*P-value*] | [0.0130] | [0.0209] | [0.0699] | [0.0474] | [0.0035] |

*Notes: Asterisks ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.*

## Unit Root Test Results for Zimbabwe

| TESTS | GDP | PD | EMP | LGFCF | GOE |
|---|---|---|---|---|---|
| **ADF Test** | | | | | |
| Level | -1.9362 | -1.9834 | -3.6617** | -1.7858 | -1.4548 |
| [*P-value*] | [0.3097] | [0.2904] | [0.0156] | [0.3748] | [0.5326] |
| 1st Difference | -3.1820** | -2.3216** | -4.2362*** | -5.9960*** | -4.8591*** |
| [*P-value*] | [0.0392] | [0.0235] | [0.0055] | [0.0002] | [0.0015] |
| **PP Test** | | | | | |
| Level | -1.8975 | -3.5866** | -2.3084 | -1.7858 | -1.6949 |
| [*P-value*] | [0.3258] | [0.0173] | [0.1799] | [0.3748] | [0.4168] |
| 1st Difference | -3.1685** | -2.3426** | -3.7227** | -6.3515*** | -4.7330*** |
| [*P-value*] | [0.0402] | [0.0225] | [0.0138] | [0.0001] | [0.0019] |

*Notes: Asterisks ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.*

## Table C2: Smooth Transition Regression (STAR) Estimates for South Africa

Dependent Variable: LGDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 12/15/19 Time: 12:01
Sample (adjusted): 1962 2018
Included observations: 57 after adjustments
Threshold variable: PD(-2)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 23 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Threshold Variables (linear part) | | | | |
| PD | 0.166357 | 0.018022 | 9.230555 | 0.0000 |
| Threshold Variables (nonlinear part) | | | | |
| PD | -0.013836 | 0.003032 | -4.563368 | 0.0000 |
| Non-Threshold Variables | | | | |
| C | 3.530548 | 0.083250 | 42.40887 | 0.0000 |
| GOE | -0.003141 | 0.001214 | -2.587511 | 0.0128 |
| GOR | 0.004418 | 0.002089 | 2.115061 | 0.0396 |
| GFCF | 0.357770 | 0.019296 | 18.54147 | 0.0000 |
| EMP | -0.000801 | 0.000477 | -1.678825 | 0.0997 |
| Slopes | | | | |
| SLOPE | 9.502247 | 3.960875 | 2.399027 | 0.0204 |
| Thresholds | | | | |
| THRESHOLD | 5.047055 | 0.057894 | 87.17821 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.996761 | Mean dependent var | 6.208646 |
| Adjusted R-squared | 0.996221 | S.D. dependent var | 0.185876 |
| S.E. of regression | 0.011427 | Akaike info criterion | -5.961727 |
| Sum squared resid | 0.006268 | Schwarz criterion | -5.639140 |
| Log likelihood | 178.9092 | Hannan-Quinn criter. | -5.836359 |
| F-statistic | 1846.149 | Durbin-Watson stat | 0.734144 |
| Prob(F-statistic) | 0.000000 | | |

## Table C2.1: Linearity Test

Smooth Threshold Linearity Tests
Date: 12/15/19  Time: 11:35
Sample: 1960 2018
Included observations: 58
Test for nonlinearity using PD(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Teräsvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | 0.020012 | (1, 47) | 0.8881 |
| H2: b2=0 \| b3=0 | 2.210034 | (2, 48) | 0.1207 |
| H1: b1=0 \| b2=b3=0 | 10.67550 | (2, 50) | 0.0001 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is rejected at the 5% level using H03.

## Table C2.2: Remaining Linearity Test

Smooth Threshold Remaining Nonlinearity Tests
Date: 12/15/19  Time: 11:37
Sample: 1960 2018
Included observations: 58
Additive nonlinearity tests using PD(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Additive Nonlinearity Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 3.762267 | (3, 45) | 0.0171 |
| H03: b1=b2=b3=0 | 3.762267 | (3, 45) | 0.0171 |
| H02: b1=b2=0 | 3.762267 | (3, 45) | 0.0171 |
| H01: b1=0 | 2.388623 | (2, 46) | 0.1030 |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

| Teräsvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | NA | (0, 45) | NA |
| H2: b2=0 \| b3=0 | 5.991204 | (1, 45) | 0.0183 |
| H1: b1=0 \| b2=b3=0 | 2.388623 | (2, 46) | 0.1030 |

All tests are based on the third-order Taylor expansion (b4=0).
Original model is rejected at the 5% level using H03.

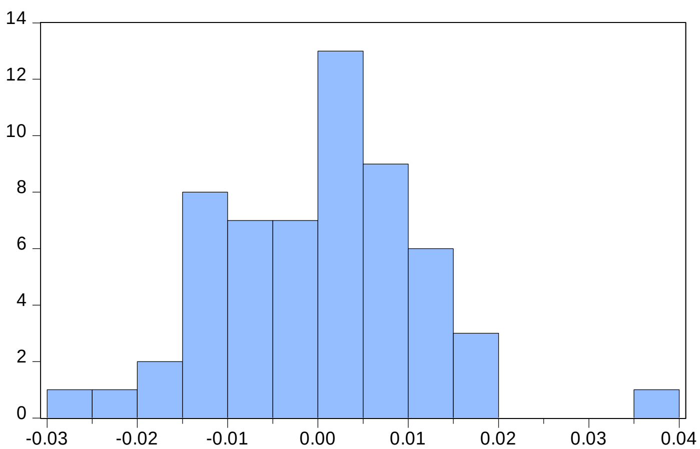
## Table C2.3: Parameter Constancy Test

Smooth Threshold Parameter Constancy Test
Date: 12/15/19 Time: 11:38
Sample: 1960 2018
Included observations: 58
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Parameter Constancy Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 13.72484 | (16, 32) | 0.0000 |
| H03: b1=b2=b3=0 | 16.30472 | (12, 36) | 0.0000 |
| H02: b1=b2=0 | 21.79330 | (8, 40) | 0.0000 |
| H01: b1=0 | 30.24284 | (4, 44) | 0.0000 |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

## Figure C1: STAR Normality Test




| | |
|---|---|
| Series: Residuals | |
| Sample 1961 2018 | |
| Observations 58 | |
| Mean | -1.47e-15 |
| Median | 0.001602 |
| Maximum | 0.036339 |
| Minimum | -0.029328 |
| Std. Dev. | 0.011566 |
| Skewness | 0.103493 |
| Kurtosis | 3.720143 |
| Jarque-Bera | 1.356836 |
| Probability | 0.507419 |

## Table C3: STAR Estimates for Botswana

Dependent Variable: LGDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 01/07/21 Time: 08:45
Sample (adjusted): 2001 2018
Included observations: 18 after adjustments
Threshold variable: LGDP(-1)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence not achieved after 500 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| | Threshold Variables (linear part) | | | |
| PD | -0.005755 | 0.006628 | -0.868274 | 0.4056 |
| | Threshold Variables (nonlinear part) | | | |
| PD | 0.012780 | 0.006483 | 1.971387 | 0.0770 |
| | Non-Threshold Variables | | | |
| C | 3.335437 | 0.465728 | 7.161772 | 0.0000 |
| EMP | 0.009078 | 0.006481 | 1.400770 | 0.1915 |
| GFCF | 0.004404 | 0.006369 | 0.691448 | 0.5050 |
| GOE | -0.007108 | 0.003426 | -2.074346 | 0.0648 |
| | Slopes | | | |
| SLOPE | 213.6760 | 2.41E+08 | 8.87E-07 | 1.0000 |
| | Thresholds | | | |
| THRESHOLD | 3.605241 | 10813.97 | 0.000333 | 0.9997 |

| | | | |
|---|---|---|---|
| R-squared | 0.909852 | Mean dependent var | 3.765704 |
| Adjusted R-squared | 0.846748 | S.D. dependent var | 0.133593 |
| S.E. of regression | 0.052298 | Akaike info criterion | -2.762613 |
| Sum squared resid | 0.027351 | Schwarz criterion | -2.366892 |
| Log likelihood | 32.86352 | Hannan-Quinn criter. | -2.708048 |
| F-statistic | 14.41838 | Durbin-Watson stat | 2.058020 |
| Prob(F-statistic) | 0.000172 | | |

## Table C3.1: Linearity Tests

Smooth Threshold Linearity Tests
Date: 01/07/21 Time: 09:19
Sample: 2000 2018
Included observations: 18
Test for nonlinearity using LGDP(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Terasvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | NA | (0, 11) | NA |
| H2: b2=0 \| b3=0 | 4.731460 | (1, 11) | 0.0523 |
| H1: b1=0 \| b2=b3=0 | 0.004462 | (1, 12) | 0.9478 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is not rejected at the 5% level using H03.

## Table C3.2: Parameter Constancy Test

Smooth Threshold Parameter Constancy Test
Date: 01/07/21 Time: 09:21
Sample: 2000 2018
Included observations: 18
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Parameter Constancy Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 16.86684 | (6, 8) | 0.0004 |
| H03: b1=b2=b3=0 | 7.701712 | (5, 9) | 0.0045 |
| H02: b1=b2=0 | 10.41466 | (4, 10) | 0.0014 |
| H01: b1=0 | 13.07846 | (2, 12) | 0.0010 |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

## Table C3.3: Serial Correlation and Heteroskedasticity Test

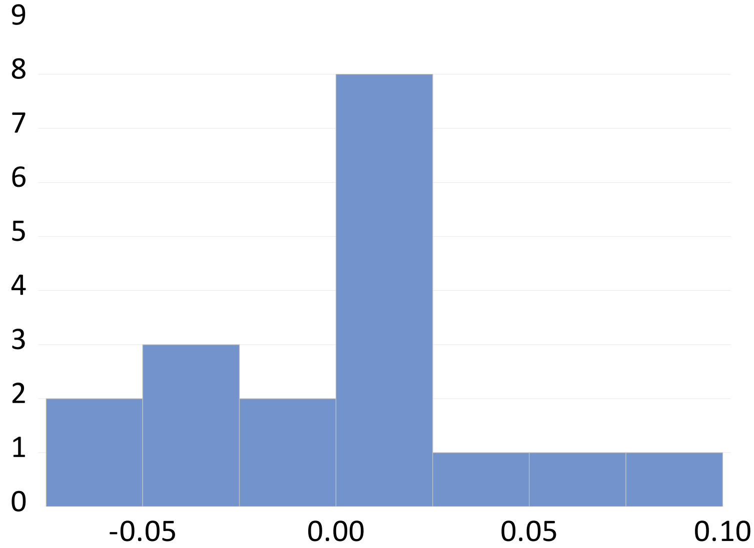
**Breusch-Godfrey Serial Correlation LM Test:**
Null hypothesis: No serial correlation at up to 2 lags

| | | | |
|---|---|---|---|
| F-statistic | 1.322174 | Prob. F(2,7) | 0.3258 |
| Obs*R-squared | 4.661168 | Prob. Chi-Square(2) | 0.0972 |

**Heteroskedasticity Test: Breusch-Pagan-Godfrey**
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 1.387162 | Prob. F(4,13) | 0.2921 |
| Obs*R-squared | 5.384526 | Prob. Chi-Square(4) | 0.2501 |
| Scaled explained SS | 1.741168 | Prob. Chi-Square(4) | 0.7832 |

## Figure C2: Normality Test




| | |
|---|---|
| Series: Residuals | |
| Sample 2001 2018 | |
| Observations 18 | |
| Mean | 9.62e-16 |
| Median | 0.000384 |
| Maximum | 0.091930 |
| Minimum | -0.069215 |
| Std. Dev. | 0.040111 |
| Skewness | 0.394776 |
| Kurtosis | 3.095405 |
| Jarque-Bera | 0.474372 |
| Probability | 0.788845 |

## Table C4: STAR Estimates for Namibia

Dependent Variable: LGDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 01/07/21 Time: 09:12
Sample (adjusted): 2001 2018
Included observations: 18 after adjustments
Threshold variable: LGDP(-1)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 37 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Threshold Variables (linear part) | | | | |
| PD | -0.014619 | 0.003326 | -4.395017 | 0.0013 |
| Threshold Variables (nonlinear part) | | | | |
| PD | 0.012998 | 0.002197 | 5.917421 | 0.0001 |
| Non-Threshold Variables | | | | |
| C | 2.669357 | 0.609608 | 4.378808 | 0.0014 |
| EMP | 0.018884 | 0.015438 | 1.223265 | 0.2493 |
| GFCF | -0.004770 | 0.004084 | -1.168145 | 0.2698 |
| GOE | 0.008934 | 0.005525 | 1.617182 | 0.1369 |
| Slopes | | | | |
| SLOPE | 200.9215 | 27940637 | 7.19E-06 | 1.0000 |

Thresholds

| | | | | |
|---|---|---|---|---|
| THRESHOLD | 3.410351 | 825.2084 | 0.004133 | 0.9968 |

| | | | |
|---|---|---|---|
| R-squared | 0.903165 | Mean dependent var | 3.624337 |
| Adjusted R-squared | 0.835380 | S.D. dependent var | 0.159645 |
| S.E. of regression | 0.064773 | Akaike info criterion | -2.334738 |
| Sum squared resid | 0.041956 | Schwarz criterion | -1.939017 |
| Log likelihood | 29.01264 | Hannan-Quinn criter. | -2.280174 |
| F-statistic | 13.32403 | Durbin-Watson stat | 2.329984 |
| Prob(F-statistic) | 0.000243 | | |

## Table C4.1: Linearity Tests

Smooth Threshold Linearity Tests
Date: 01/07/21 Time: 09:57
Sample: 2000 2018
Included observations: 18
Test for nonlinearity using LGDP(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Null Hypothesis | Linearity Tests F-statistic | d.f. | p-value |
|---|---|---|---|
| H04: b1=b2=b3=b4=0 | 10.06157 | (3, 10) | 0.0023 |
| H03: b1=b2=b3=0 | 10.06157 | (3, 10) | 0.0023 |
| H02: b1=b2=0 | 15.22841 | (2, 11) | 0.0007 |
| H01: b1=0 | 30.32905 | (1, 12) | 0.0001 |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

| Null Hypothesis | Terasvirta Sequential Tests F-statistic | d.f. | p-value |
|---|---|---|---|
| H3: b3=0 | 0.662465 | (1, 10) | 0.4346 |
| H2: b2=0 \| b3=0 | 0.752727 | (1, 11) | 0.4041 |
| H1: b1=0 \| b2=b3=0 | 30.32905 | (1, 12) | 0.0001 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is rejected at the 5% level using H03.

## Table C4.2: Parameter Constancy Test

Smooth Threshold Parameter Constancy Test
Date: 01/07/21 Time: 09:59
Sample: 2000 2018
Included observations: 18
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Parameter Constancy Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 5.271462 | (6, 5) | 0.0442 |
| H03: b1=b2=b3=0 | 7.117129 | (5, 6) | 0.0166 |
| H02: b1=b2=0 | 6.717190 | (4, 7) | 0.0152 |
| H01: b1=0 | 2.887417 | (2, 9) | 0.1075 |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

## Table C5: STAR Estimates for Zambia

Dependent Variable: LGDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 01/07/21 Time: 10:11
Sample (adjusted): 2001 2018
Included observations: 18 after adjustments
Threshold variable: LGDP(-1)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 27 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Threshold Variables (linear part) | | | | |
| PD | -0.003739 | 0.000688 | -5.437381 | 0.0003 |
| Threshold Variables (nonlinear part) | | | | |
| PD | 0.003722 | 0.001389 | 2.678959 | 0.0231 |
| Non-Threshold Variables | | | | |
| C | 3.197834 | 1.598263 | 2.000819 | 0.0733 |
| EMP | -0.000808 | 0.023209 | -0.034802 | 0.9729 |
| GFCF | -0.010305 | 0.005809 | -1.774027 | 0.1065 |
| GOE | 0.017341 | 0.011869 | 1.461046 | 0.1747 |
| Slopes | | | | |
| SLOPE | 1626.598 | 4.23E+10 | 3.85E-08 | 1.0000 |
| Thresholds | | | | |
| THRESHOLD | 3.042776 | 596.8863 | 0.005098 | 0.9960 |

| | | | |
|---|---|---|---|
| R-squared | 0.955522 | Mean dependent var | 3.014729 |
| Adjusted R-squared | 0.924388 | S.D. dependent var | 0.236514 |
| S.E. of regression | 0.065036 | Akaike info criterion | -2.326648 |
| Sum squared resid | 0.042297 | Schwarz criterion | -1.930927 |
| Log likelihood | 28.93983 | Hannan-Quinn criter. | -2.272083 |
| F-statistic | 30.69009 | Durbin-Watson stat | 1.851749 |
| Prob(F-statistic) | 0.000006 | | |

## Table C5.1: Linearity Tests

Smooth Threshold Linearity Tests
Date: 01/07/21 Time: 10:35
Sample: 2000 2018
Included observations: 18
Test for nonlinearity using LGDP(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Terasvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | 1.916289 | (1, 10) | 0.1964 |
| H2: b2=0 \| b3=0 | 4.526544 | (1, 11) | 0.0568 |
| H1: b1=0 \| b2=b3=0 | 0.799920 | (1, 12) | 0.3887 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is not rejected at the 5% level using H03.

## Table C5.2: Serial Correlation and Heteroskedasticity Test

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

| | | | |
|---|---|---|---|
| F-statistic | 0.221303 | Prob. F(2,8) | 0.8062 |
| Obs*R-squared | 0.943655 | Prob. Chi-Square(2) | 0.6239 |

**Heteroskedasticity Test: Breusch-Pagan-Godfrey**
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 0.811257 | Prob. F(4,13) | 0.5400 |
| Obs*R-squared | 3.595592 | Prob. Chi-Square(4) | 0.4635 |
| Scaled explained SS | 0.654958 | Prob. Chi-Square(4) | 0.9568 |

## Table C6: STAR Estimates for Malawi

Dependent Variable: LGDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 01/07/21 Time: 08:56
Sample (adjusted): 2001 2018
Included observations: 18 after adjustments
Threshold variable: LGDP(-1)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 10 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Threshold Variables (linear part) | | | | |
| PD | 0.000444 | 0.000641 | 0.692473 | 0.5044 |
| Threshold Variables (nonlinear part) | | | | |
| PD | 0.002220 | 0.000722 | 3.074838 | 0.0117 |
| Non-Threshold Variables | | | | |
| C | -1.794208 | 1.171074 | -1.532104 | 0.1565 |
| EMP | 0.056498 | 0.015937 | 3.545131 | 0.0053 |
| GFCF | 0.006947 | 0.003453 | 2.011750 | 0.0720 |
| GOE | 0.002587 | 0.005291 | 0.488949 | 0.6354 |
| Slopes | | | | |
| SLOPE | 149.0882 | 644.7521 | 0.231233 | 0.8218 |
| Thresholds | | | | |
| THRESHOLD | 2.583848 | 0.114142 | 22.63715 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.836884 | Mean dependent var | 2.508172 |
| Adjusted R-squared | 0.722703 | S.D. dependent var | 0.086313 |
| S.E. of regression | 0.045452 | Akaike info criterion | -3.043234 |
| Sum squared resid | 0.020659 | Schwarz criterion | -2.647513 |
| Log likelihood | 35.38911 | Hannan-Quinn criter. | -2.988670 |
| F-statistic | 7.329444 | Durbin-Watson stat | 2.187551 |
| Prob(F-statistic) | 0.002824 | | |

## Table C6.1: Linearity Tests

Smooth Threshold Linearity Tests
Date: 01/07/21 Time: 09:42
Sample: 2000 2018
Included observations: 18
Test for nonlinearity using LGDP(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Terasvirta Sequential Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H3: b3=0 | 3.896311 | (1, 10) | 0.0766 |
| H2: b2=0 \| b3=0 | 0.879818 | (1, 11) | 0.3684 |
| H1: b1=0 \| b2=b3=0 | 7.026734 | (1, 12) | 0.0211 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is rejected at the 5% level using H03.

## Table C6.2: Parameter Constancy Test

Smooth Threshold Parameter Constancy Test
Date: 01/07/21 Time: 09:44
Sample: 2000 2018
Included observations: 18
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Parameter Constancy Tests | | | |
|---|---|---|---|
| Null Hypothesis | F-statistic | d.f. | p-value |
| H04: b1=b2=b3=b4=0 | 1.149118 | (2, 10) | 0.3555 |
| H03: b1=b2=b3=0 | 2.501072 | (1, 11) | 0.1421 |
| H02: b1=b2=0 | 2.501072 | (1, 11) | 0.1421 |
| H01: b1=0 | NA | (0, 12) | NA |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

## Table C7: STAR Estimates for Zimbabwe

Dependent Variable: LGDP
Method: Smooth Threshold Regression
Transition function: Logistic
Date: 01/07/21 Time: 10:13
Sample (adjusted): 2001 2018
Included observations: 18 after adjustments
Threshold variable: LGDP(-1)
Starting values: Grid search with concentrated regression coefficients
Ordinary standard errors & covariance using outer product of gradients
Convergence achieved after 12 iterations

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| | Threshold Variables (linear part) | | | |
| PD | -0.002694 | 0.001292 | -2.085364 | 0.0636 |
| | Threshold Variables (nonlinear part) | | | |
| PD | 0.002752 | 0.000681 | 4.043427 | 0.0023 |
| | Non-Threshold Variables | | | |
| C | 2.392411 | 2.059819 | 1.161467 | 0.2724 |
| EMP | 0.005593 | 0.026647 | 0.209878 | 0.8380 |
| GFCF | 0.006794 | 0.003083 | 2.204058 | 0.0521 |
| GOE | 0.004451 | 0.002999 | 1.484036 | 0.1686 |
| | Slopes | | | |
| SLOPE | 151.5687 | 311.5392 | 0.486516 | 0.6371 |
| | Thresholds | | | |
| THRESHOLD | 2.924495 | 0.018611 | 157.1384 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.963069 | Mean dependent var | 2.927431 |
| Adjusted R-squared | 0.937217 | S.D. dependent var | 0.128850 |
| S.E. of regression | 0.032285 | Akaike info criterion | -3.727306 |
| Sum squared resid | 0.010423 | Schwarz criterion | -3.331585 |
| Log likelihood | 41.54575 | Hannan-Quinn criter. | -3.672741 |
| F-statistic | 37.25367 | Durbin-Watson stat | 1.613967 |
| Prob(F-statistic) | 0.000002 | | |

## Table C7.1: Linearity Tests

Smooth Threshold Linearity Tests
Date: 01/07/21 Time: 10:41
Sample: 2000 2018
Included observations: 18
Test for nonlinearity using LGDP(-1) as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Null Hypothesis | Linearity Tests<br>F-statistic | d.f. | p-value |
|---|---|---|---|
| H04: b1=b2=b3=b4=0 | 7.984268 | (2, 11) | 0.0072 |
| H03: b1=b2=b3=0 | 7.984268 | (2, 11) | 0.0072 |
| H02: b1=b2=0 | 7.984268 | (2, 11) | 0.0072 |
| H01: b1=0 | 5.229216 | (1, 12) | 0.0412 |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

| Null Hypothesis | Terasvirta Sequential Tests<br>F-statistic | d.f. | p-value |
|---|---|---|---|
| H3: b3=0 | NA | (0, 11) | NA |
| H2: b2=0 \| b3=0 | 7.783352 | (1, 11) | 0.0176 |
| H1: b1=0 \| b2=b3=0 | 5.229216 | (1, 12) | 0.0412 |

All tests are based on the third-order Taylor expansion (b4=0).
Linear model is rejected at the 5% level using H03.
Recommended model: first-order logistic.
. Pr(H3) <= Pr(H2)

## Table C7.2: Parameter Constancy Test

Smooth Threshold Parameter Constancy Test
Date: 01/07/21 Time: 10:42
Sample: 2000 2018
Included observations: 18
Encapsulated nonlinearity test using trend as the threshold variable
Taylor series alternatives: b0 + b1*s [ + b2*s^2 + b3*s^3 + b4*s^4 ]

| Null Hypothesis | Parameter Constancy Tests<br>F-statistic | d.f. | p-value |
|---|---|---|---|
| H04: b1=b2=b3=b4=0 | 6.334150 | (2, 9) | 0.0192 |
| H03: b1=b2=b3=0 | 6.334150 | (2, 9) | 0.0192 |
| H02: b1=b2=0 | 1.171549 | (1, 10) | 0.3045 |
| H01: b1=0 | NA | (0, 11) | NA |

The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

## Table C7.3: Serial Correlation and Heteroskedasticity Test

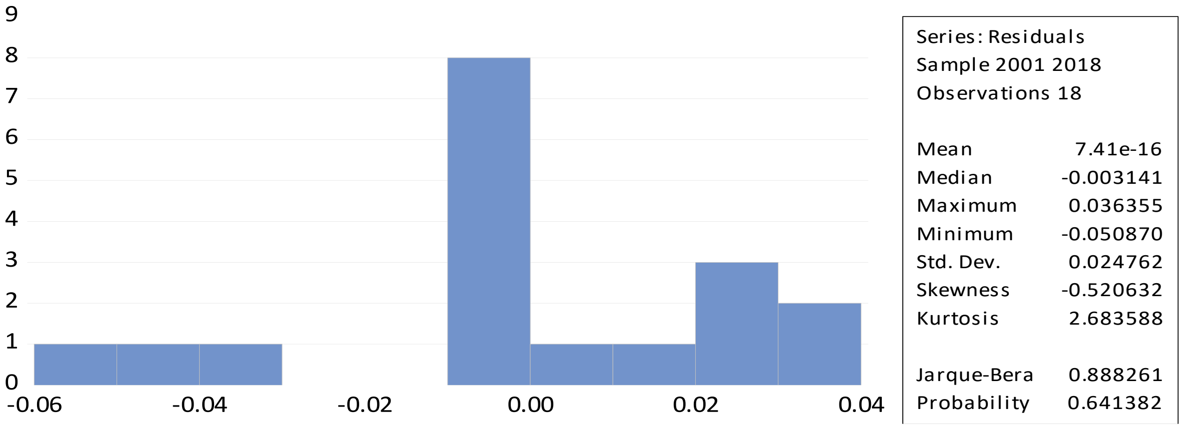
**Breusch-Godfrey Serial Correlation LM Test:**
Null hypothesis: No serial correlation at up to 2 lags

| | | | |
|---|---|---|---|
| F-statistic | 0.273499 | Prob. F(2,8) | 0.7675 |
| Obs*R-squared | 1.151978 | Prob. Chi-Square(2) | 0.5621 |

**Heteroskedasticity Test: Breusch-Pagan-Godfrey**
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 0.843774 | Prob. F(4,13) | 0.5219 |
| Obs*R-squared | 3.710007 | Prob. Chi-Square(4) | 0.4467 |
| Scaled explained SS | 0.963908 | Prob. Chi-Square(4) | 0.9152 |

## Figure C3: Normality Test



## Table C8: NARDL Estimates for South Africa

Dependent Variable: LGDP
Method: ARDL
Date: 11/24/19 Time: 17:54
Sample (adjusted): 1962 2018
Included observations: 57 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): PD_POS PD_NEG GOE_POS GOE_NEG GFCF_POS GFCF_NEG EMP_POS EMP_NEG
Fixed regressors: C
Number of models evaluated: 1024
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 1, 1, 0)

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| LGDP(-1) | 0.592905 | 0.092579 | 6.404340 | 0.0000 |
| PD_POS | 0.025587 | 0.012194 | 2.098378 | 0.0418 |
| PD_NEG | -1.059032 | 0.486595 | -2.176415 | 0.0351 |
| GOE_POS | -0.000632 | 0.000829 | -0.762482 | 0.4499 |
| GOE_NEG | -0.001288 | 0.000648 | -1.988168 | 0.0532 |
| GFCF_POS | 0.142985 | 0.041061 | 3.482246 | 0.0012 |
| GFCF_NEG | 0.094256 | 0.061262 | 1.538571 | 0.1312 |
| GFCF_NEG(-1) | -0.121885 | 0.062287 | -1.956823 | 0.0569 |
| EMP_POS | 0.002539 | 0.000842 | 3.017645 | 0.0043 |
| EMP_POS(-1) | -0.002629 | 0.000839 | -3.131907 | 0.0031 |
| EMP_NEG | -0.001782 | 0.000658 | -2.707639 | 0.0097 |
| C | 2.383966 | 0.536012 | 4.447599 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.999410 | Mean dependent var | 6.208646 |
| Adjusted R-squared | 0.999232 | S.D. dependent var | 0.185876 |
| S.E. of regression | 0.005151 | Akaike info criterion | -7.489764 |
| Sum squared resid | 0.001141 | Schwarz criterion | -6.987962 |
| Log likelihood | 227.4583 | Hannan-Quinn criter. | -7.294746 |
| F-statistic | 5605.360 | Durbin-Watson stat | 2.135904 |
| Prob(F-statistic) | 0.000000 | | |

*Note: p-values and any subsequent tests do not account for model selection.

## Table C9: NARDL Long-run Estimates for South Africa

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LGDP)
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 11/24/19 Time: 18:06
Sample: 1960 2018
Included observations: 57

Conditional Error Correction Regression

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 2.383966 | 0.536012 | 4.447599 | 0.0001 |
| LGDP(-1)* | -0.407095 | 0.092579 | -4.397280 | 0.0001 |
| PD_POS** | 0.025587 | 0.012194 | 2.098378 | 0.0418 |
| PD_NEG** | -1.059032 | 0.486595 | -2.176415 | 0.0351 |
| GOE_POS** | -0.000632 | 0.000829 | -0.762482 | 0.4499 |
| GOE_NEG** | -0.001288 | 0.000648 | -1.988168 | 0.0532 |
| GOR_POS** | -0.000169 | 0.001417 | -0.118988 | 0.9058 |
| GOR_NEG** | 0.004940 | 0.001842 | 2.682166 | 0.0103 |
| GFCF_POS** | 0.142985 | 0.041061 | 3.482246 | 0.0012 |
| GFCF_NEG(-1) | -0.027629 | 0.041133 | -0.671712 | 0.5054 |
| EMP_POS(-1) | -8.97E-05 | 0.000428 | -0.209401 | 0.8351 |
| EMP_NEG** | -0.001782 | 0.000658 | -2.707639 | 0.0097 |
| D(GFCF_NEG) | 0.094256 | 0.061262 | 1.538571 | 0.1312 |
| D(EMP_POS) | 0.002539 | 0.000842 | 3.017645 | 0.0043 |

* 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. |
|---|---|---|---|---|
| PD_POS | 0.062853 | 0.031647 | 1.986066 | 0.0534 |
| PD_NEG | -2.601439 | 1.213335 | -2.144041 | 0.0377 |
| GOE_POS | -0.001553 | 0.002120 | -0.732398 | 0.4679 |
| GOE_NEG | -0.003164 | 0.001727 | -1.832591 | 0.0738 |
| GOR_POS | -0.000414 | 0.003484 | -0.118882 | 0.9059 |
| GOR_NEG | 0.012135 | 0.004387 | 2.765924 | 0.0083 |
| GFCF_POS | 0.351234 | 0.071605 | 4.905177 | 0.0000 |
| GFCF_NEG | -0.067870 | 0.105558 | -0.642962 | 0.5237 |
| EMP_POS | -0.000220 | 0.001076 | -0.204691 | 0.8388 |
| EMP_NEG | -0.004378 | 0.001074 | -4.076318 | 0.0002 |
| C | 5.856050 | 0.017046 | 343.5540 | 0.0000 |

EC = LGDP - (0.0629*PD_POS -2.6014*PD_NEG -0.0016*GOE_POS
-0.0032*GOE_NEG -0.0004*GOR_POS + 0.0121*GOR_NEG + 0.3512
*GFCF_POS -0.0679*GFCF_NEG -0.0002*EMP_POS -0.0044
*EMP_NEG + 5.8561 )

## Table C9.1: Bounds Cointegration Test

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| F-statistic | 15.15682 | 10% | 1.76 | 2.77 |
| k | 10 | 5% | 1.98 | 3.04 |
| | | 2.5% | 2.18 | 3.28 |
| | | 1% | 2.41 | 3.61 |
| | | | Finite Sample: | |
| Actual Sample Size | 57 | | n=60 | |
| | | 10% | -1 | -1 |
| | | 5% | -1 | -1 |
| | | 1% | -1 | -1 |
| | | | Finite Sample: n=55 | |
| | | 10% | -1 | -1 |
| | | 5% | -1 | -1 |
| | | 1% | -1 | -1 |

## Table C9.2: Serial Correlation and Heteroscedasticity Test

Breusch-Godfrey Serial Correlation LM Test:

| | | | |
|---|---|---|---|
| F-statistic | 0.455447 | Prob. F(2,41) | 0.6373 |
| Obs*R-squared | 1.238841 | Prob. Chi-Square(2) | 0.5383 |

Heteroskedasticity Test: Breusch-Pagan-Godfrey

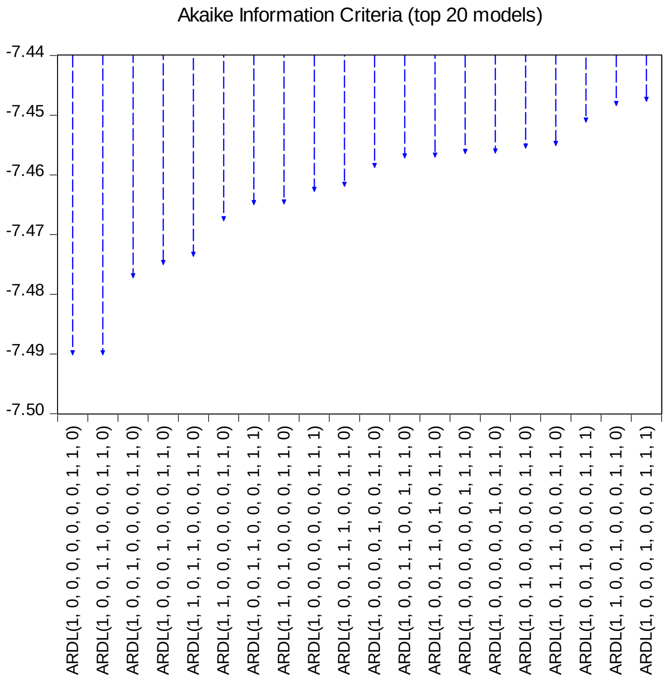
| | | | |
|---|---|---|---|
| F-statistic | 1.132857 | Prob. F(13,43) | 0.3597 |
| Obs*R-squared | 14.54163 | Prob. Chi-Square(13) | 0.3368 |
| Scaled explained SS | 8.055652 | Prob. Chi-Square(13) | 0.8400 |

## Table C9.3: Ramsey RESET Test

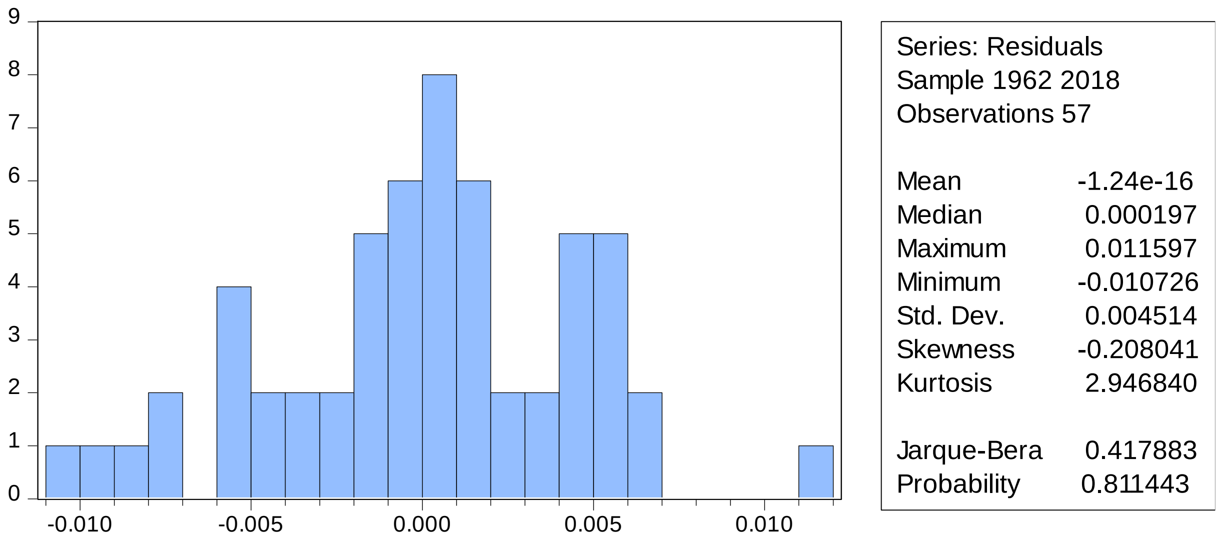
**Ramsey RESET Test**
Equation: NARDL01
Specification: LGDP LGDP(-1) PD_POS PD_NEG GOE_POS GOE_NEG GOR_POS GOR_NEG GFCF_POS GFCF_NEG GFCF_NEG(-1) EMP_POS EMP_POS(-1) EMP_NEG C
Omitted Variables: Squares of fitted values

| | Value | df | Probability |
|---|---|---|---|
| t-statistic | 0.365388 | 42 | 0.7167 |
| F-statistic | 0.133508 | (1, 42) | 0.7167 |
| Likelihood ratio | 0.180902 | 1 | 0.6706 |

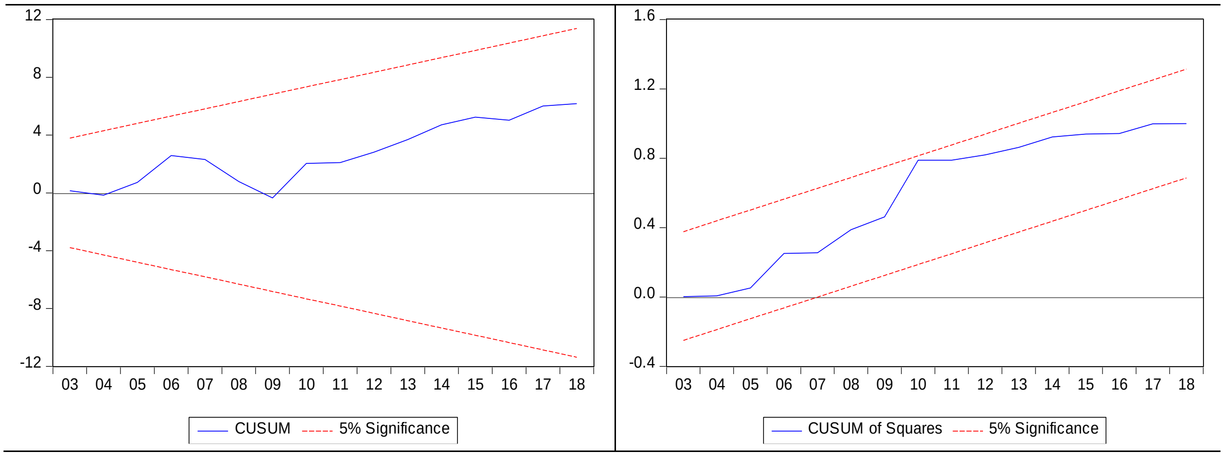
## Figure C4: NARDL Model Selection Summary




## Figure C5: NARDL Normality Test



## Figure C6: CUSUM and CUSUM of Squares Stability Test




## Table C10: NARD Long-Run Estimates for Botswana

ARDL Cointegrating And Long Run Form
Dependent Variable: LGDP
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0, 0)
Date: 02/22/21 Time: 14:26
Sample: 2000 2018
Included observations: 18

| Cointegrating Form | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(PD_POS) | -0.001809 | 0.007014 | -0.257918 | 0.8030 |
| D(PD_NEG) | -0.023424 | 0.029995 | -0.780909 | 0.4573 |
| D(EMP_POS) | -0.016049 | 0.016531 | -0.970847 | 0.3601 |
| D(EMP_NEG) | -0.017149 | 0.043607 | -0.393275 | 0.7044 |
| D(GFCF_POS) | -0.003720 | 0.010712 | -0.347244 | 0.7374 |
| D(GFCF_NEG) | 0.005045 | 0.014095 | 0.357906 | 0.7297 |
| D(GOE_POS) | 0.000836 | 0.007069 | 0.118194 | 0.9088 |
| D(GOE_NEG) | -0.008952 | 0.012363 | -0.724086 | 0.4896 |
| CointEq(-1) | -0.605981 | 0.863290 | -0.701943 | 0.5026 |

Cointeq = LGDP - (-0.0030*PD_POS -0.0387*PD_NEG -0.0265*EMP_POS
-0.0283*EMP_NEG -0.0061*GFCF_POS + 0.0083*GFCF_NEG + 0.0014
*GOE_POS -0.0148*GOE_NEG + 3.4738 )

| Long Run Coefficients | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| PD_POS | -0.002985 | 0.012868 | -0.231978 | 0.8224 |
| PD_NEG | -0.038654 | 0.023236 | -1.663566 | 0.1348 |
| EMP_POS | -0.026485 | 0.059793 | -0.442944 | 0.6695 |
| EMP_NEG | -0.028300 | 0.105058 | -0.269379 | 0.7945 |
| GFCF_POS | -0.006138 | 0.017485 | -0.351063 | 0.7346 |
| GFCF_NEG | 0.008325 | 0.012590 | 0.661244 | 0.5270 |
| GOE_POS | 0.001379 | 0.011461 | 0.120306 | 0.9072 |
| GOE_NEG | -0.014773 | 0.018546 | -0.796539 | 0.4487 |
| C | 3.473839 | 0.138972 | 24.996668 | 0.0000 |

## Table C10.1: Bounds Cointegration Test Results

| $F-Statistic$ | $\alpha = 0.01$ | | $\alpha = 0.05$ | |
|---|---|---|---|---|
| | Lower Bound | Upper Bound | Lower Bound | Upper Bound |
| 2.23 | 2.79 | 4.1 | 2.22 | 3.39 |

Notes: $\alpha$ denotes the level of significance.

## Table C11: NARDL Long-Run Estimates for Namibia

ARDL Cointegrating And Long Run Form
Dependent Variable: LGDP
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0, 0)
Date: 02/22/21 Time: 15:08
Sample: 2000 2018
Included observations: 18

Cointegrating Form

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(PD_POS) | 0.007539 | 0.004520 | 1.667978 | 0.1339 |
| D(PD_NEG) | -0.009538 | 0.005648 | -1.688743 | 0.1297 |
| D(EMP_POS) | -0.101359 | 0.022150 | -4.576039 | 0.0018 |
| D(EMP_NEG) | 0.144024 | 0.041056 | 3.507983 | 0.0080 |
| D(GFCF_POS) | -0.009384 | 0.005158 | -1.819448 | 0.1063 |
| D(GFCF_NEG) | -0.000018 | 0.009473 | -0.001920 | 0.9985 |
| D(GOE_POS) | 0.037967 | 0.015738 | 2.412526 | 0.0423 |
| D(GOE_NEG) | -0.074807 | 0.020775 | -3.600890 | 0.0070 |
| CointEq(-1) | -1.239128 | 0.306257 | -4.046038 | 0.0037 |

Cointeq = LGDP - (0.0061*PD_POS -0.0077*PD_NEG -0.0818*EMP_POS
+ 0.1162*EMP_NEG -0.0076*GFCF_POS -0.0000*GFCF_NEG + 0.0306
*GOE_POS -0.0604*GOE_NEG + 3.2781 )

Long Run Coefficients

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| PD_POS | 0.006084 | 0.003850 | 1.580388 | 0.1527 |
| PD_NEG | -0.007697 | 0.003856 | -1.996216 | 0.0810 |
| EMP_POS | -0.081799 | 0.020960 | -3.902645 | 0.0045 |
| EMP_NEG | 0.116230 | 0.036181 | 3.212452 | 0.0124 |
| GFCF_POS | -0.007573 | 0.003486 | -2.172482 | 0.0616 |
| GFCF_NEG | -0.000015 | 0.007647 | -0.001919 | 0.9985 |
| GOE_POS | 0.030640 | 0.009324 | 3.286277 | 0.0111 |
| GOE_NEG | -0.060371 | 0.009993 | -6.041069 | 0.0003 |
| C | 3.278108 | 0.030633 | 107.013435 | 0.0000 |

## Table C11.1: Bounds Cointegration Test Results

| $F-Statistic$ | $\alpha = 0.01$ | | $\alpha = 0.05$ | |
|---|---|---|---|---|
| | Lower Bound | Upper Bound | Lower Bound | Upper Bound |
| 2.12 | 2.79 | 4.1 | 2.22 | 3.39 |

Notes: $\alpha$ denotes the level of significance.

## Table C12: NARDL Long-Run Estimates for Zambia

ARDL Cointegrating And Long Run Form
Dependent Variable: LGDP
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0, 0)
Date: 02/22/21 Time: 15:17
Sample: 2000 2018
Included observations: 18

Cointegrating Form

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(LPD_POS) | -0.455933 | 0.150294 | -3.033616 | 0.0162 |
| D(LPD_NEG) | -0.151778 | 0.078916 | -1.923286 | 0.0907 |
| D(EMP_POS) | 0.003984 | 0.020219 | 0.197042 | 0.8487 |
| D(EMP_NEG) | -0.013713 | 0.010262 | -1.336277 | 0.2182 |
| D(GFCF_POS) | 0.002350 | 0.007449 | 0.315431 | 0.7605 |
| D(GFCF_NEG) | -0.005194 | 0.010581 | -0.490861 | 0.6367 |
| D(GOE_POS) | 0.041944 | 0.017753 | 2.362726 | 0.0458 |
| D(GOE_NEG) | 0.000008 | 0.011249 | 0.000736 | 0.9994 |
| CointEq(-1) | -0.979198 | 0.267570 | -3.659589 | 0.0064 |

Cointeq = LGDP - (-0.4656*LPD_POS -0.1550*LPD_NEG + 0.0041 *EMP_POS -0.0140*EMP_NEG + 0.0024*GFCF_POS -0.0053 *GFCF_NEG + 0.0428*GOE_POS + 0.0000*GOE_NEG + 2.2079 )

Long Run Coefficients

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LPD_POS | -0.465619 | 0.177582 | -2.621994 | 0.0306 |
| LPD_NEG | -0.155002 | 0.078324 | -1.978981 | 0.0832 |
| EMP_POS | 0.004069 | 0.020215 | 0.201263 | 0.8455 |
| EMP_NEG | -0.014005 | 0.010153 | -1.379394 | 0.2051 |
| GFCF_POS | 0.002400 | 0.007536 | 0.318422 | 0.7583 |
| GFCF_NEG | -0.005304 | 0.010262 | -0.516826 | 0.6193 |
| GOE_POS | 0.042836 | 0.020997 | 2.040072 | 0.0757 |
| GOE_NEG | 0.000008 | 0.011487 | 0.000736 | 0.9994 |
| C | 2.207866 | 0.155392 | 14.208324 | 0.0000 |

### Table C12.1: Bounds Cointegration Test Results

| $F-Statistic$ | $\alpha = 0.01$ | | $\alpha = 0.05$ | |
|---|---|---|---|---|
| | Lower Bound | Upper Bound | Lower Bound | Upper Bound |
| 4.06 | 2.79 | 4.1 | 2.22 | 3.39 |

Notes: $\alpha$ denotes the level of significance

### Table C13: NARDL Long-Run Estimates for Malawi

ARDL Cointegrating And Long Run Form
Dependent Variable: LGDP
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0, 0)
Date: 02/22/21 Time: 14:52
Sample: 2000 2018
Included observations: 18

Cointegrating Form

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(LPD_POS) | 0.080450 | 0.221119 | 0.363832 | 0.7254 |
| D(LPD_NEG) | -0.024443 | 0.047752 | -0.511878 | 0.6226 |
| D(EMP_POS) | 0.038101 | 0.087957 | 0.433175 | 0.6763 |
| D(EMP_NEG) | -0.926005 | 0.434194 | -2.132699 | 0.0655 |
| D(GFCF_POS) | 0.015674 | 0.012918 | 1.213334 | 0.2596 |
| D(GFCF_NEG) | -0.015936 | 0.012468 | -1.278092 | 0.2371 |
| D(GOE_POS) | -0.028387 | 0.018854 | -1.505602 | 0.1706 |
| D(GOE_NEG) | 0.022355 | 0.008744 | 2.556735 | 0.0338 |
| CointEq(-1) | -0.690760 | 0.202307 | -3.414422 | 0.0092 |

Cointeq = LGDP - (0.1165*LPD_POS -0.0354*LPD_NEG + 0.0552
*EMP_POS -1.3406*EMP_NEG + 0.0227*GFCF_POS -0.0231
*GFCF_NEG -0.0411*GOE_POS + 0.0324*GOE_NEG + 2.5139 )

Long Run Coefficients

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LPD_POS | 0.116466 | 0.310147 | 0.375519 | 0.7170 |
| LPD_NEG | -0.035386 | 0.067599 | -0.523463 | 0.6148 |
| EMP_POS | 0.055158 | 0.128638 | 0.428783 | 0.6794 |
| EMP_NEG | -1.340559 | 0.629146 | -2.130760 | 0.0657 |
| GFCF_POS | 0.022691 | 0.018727 | 1.211631 | 0.2602 |
| GFCF_NEG | -0.023070 | 0.018160 | -1.270379 | 0.2396 |
| GOE_POS | -0.041095 | 0.025753 | -1.595750 | 0.1492 |
| GOE_NEG | 0.032363 | 0.012555 | 2.577785 | 0.0327 |
| C | 2.513919 | 0.125983 | 19.954383 | 0.0000 |

## Table C13.1: Bounds Cointegration Test Results

| $F-Statistic$ | $\alpha = 0.01$ | | $\alpha = 0.05$ | |
|---|---|---|---|---|
| | Lower Bound | Upper Bound | Lower Bound | Upper Bound |
| 4.92 | 2.79 | 4.1 | 2.22 | 3.39 |

Notes: $\alpha$ denotes the level of significance

## Table C14: NARDL Long-Run Estimates for Zimbabwe

ARDL Cointegrating And Long Run Form
Dependent Variable: LGDP
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0, 0)
Date: 02/22/21 Time: 15:29
Sample: 2000 2018
Included observations: 18

Cointegrating Form

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(PD_POS) | -0.002336 | 0.001378 | -1.695226 | 0.1285 |
| D(PD_NEG) | 0.005613 | 0.004353 | 1.289514 | 0.2332 |
| D(EMP_POS) | -0.030692 | 0.026101 | -1.175873 | 0.2735 |
| D(EMP_NEG) | -0.036665 | 0.121774 | -0.301087 | 0.7710 |
| D(GFCF_POS) | 0.000240 | 0.008681 | 0.027666 | 0.9786 |
| D(GFCF_NEG) | -0.001196 | 0.004105 | -0.291231 | 0.7783 |
| D(GOE_POS) | 0.014719 | 0.009997 | 1.472324 | 0.1791 |
| D(GOE_NEG) | -0.000032 | 0.003800 | -0.008485 | 0.9934 |
| CointEq(-1) | -0.431647 | 0.241124 | -1.790145 | 0.1112 |

Cointeq = LGDP - (-0.0054*PD_POS + 0.0130*PD_NEG -0.0711
*EMP_POS -0.0849*EMP_NEG + 0.0006*GFCF_POS -0.0028
*GFCF_NEG + 0.0341*GOE_POS -0.0001*GOE_NEG + 2.9605 )

Long Run Coefficients

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| PD_POS | -0.005413 | 0.005075 | -1.066643 | 0.3173 |
| PD_NEG | 0.013004 | 0.015788 | 0.823649 | 0.4340 |
| EMP_POS | -0.071103 | 0.062349 | -1.140408 | 0.2871 |
| EMP_NEG | -0.084941 | 0.303467 | -0.279901 | 0.7867 |
| GFCF_POS | 0.000556 | 0.020196 | 0.027550 | 0.9787 |
| GFCF_NEG | -0.002770 | 0.009459 | -0.292834 | 0.7771 |
| GOE_POS | 0.034099 | 0.025639 | 1.329942 | 0.2202 |
| GOE_NEG | -0.000075 | 0.008821 | -0.008468 | 0.9935 |
| C | 2.960465 | 0.099110 | 29.870492 | 0.0000 |

## Table C14.1: Bounds Cointegration Test Results

| $F-Statistic$ | $\alpha = 0.01$ | | $\alpha = 0.05$ | |
|---|---|---|---|---|
| | Lower Bound | Upper Bound | Lower Bound | Upper Bound |
| 8.57 | 2.79 | 4.1 | 2.22 | 3.39 |

Notes: $\alpha$ denotes the level of significance.