THE MISSING LINK: FISCAL SUSTAINABILITY ANALYSIS IN SOUTH AFRICA

by

ELVIS MUNYARADZI GANYAUPFU

submitted in accordance with the requirements for the degree of

MASTER OF COMMERCE

in the subject

ECONOMICS

at the

UNIVERSITY OF SOUTH AFRICA

Supervisor: PROFESSOR Z ROBINSON

NOVEMBER, 2017

ABSTRACT

This study examined whether South African government reacted to its debt positions in a sustainable manner during the period 1999 quarter 1 to 2016 quarter 2. Estimation of the fiscal reaction function was conducted by integrating the exogenous short-run impact of monetary policy stance on both primary balance and public debt positions. The VEC model approach was applied to estimate the fiscal reaction function. Results indicate that fiscal policy in South Africa was sustainable during the respective sample period while monetary policy stance had statistically significant impacts on both primary balance and public debt positions. The significant impacts of monetary policy stance on primary balance and public debt show that monetary policy contributes to ensuring fiscal sustainability in South Africa, hence government needs to harmonize monetary efforts in managing public debt. The estimated impact of the business cycle on primary balance positions indicate that fiscal policy was countercyclical in nature.

Keywords: Fiscal sustainability, public debt, primary balance, monetary policy stance

DECLARATION

I hereby declare that this dissertation submitted in fulfilment for the degree Master's in Economics at University of South Africa is my own original work, and has not hitherto been submitted to any other university or institution of higher education. I further declare that all sources consulted are cited and recognised by means of the reference list provided herein.

FULL NAME: Elvis Munyaradzi Ganyaupfu

DATE: 05th September 2018

DEDICATION

I dedicate this thesis to my dear wife Amanda, daughter Joan, and sons Joel and Josh.

ACKNOWLEDGEMENTS

I meekly extend my gratitude to our Heavenly Father Jehovah Jireh and Lord Jesus Christ whom without their grace, this dissertation could not have seen the light of the day.

This dissertation could not have been completed successfully had I not benefited incalculably from the immense guidance from my supervisor Professor Zurika Robinson. Thank you so much Prof. for your precious support and encouraging me to realise my potential.

My gratitude would be incomplete if I omit to thank my special and lovely wife Amanda, daughter Joan, and sons Joel and Josh, for being incredibly supportive throughout the progression of my studies. I deprived you of incalculable amounts of family time. A very special thank you to you guys for being extremely supportive. May The Lord bless you all!

Finally, I extend my sincere thanks to my dear sister Gloria. Thank you very much for the prodigious support you have always given me in my life. May The Lord bless you!

LIST OF ACRONYMS

AAB	Adjustment Appropriation Bill
ADF	Augmented Dicky Fuller
AGSA	Auditor General of South Africa
AIC	Akaike Information Criteria
ARDL	Auto-Regressive Distributed Lag
ARMA	Auto-Regressive Moving Average
BC	Budget Council
BEA	Bureau for Economic Research
BRR	Budget Review and Recommendations
CAB	Cyclically Adjusted Balance
CAPB	Cyclically Adjusted Budget Balance
CBPR	Central Bank Policy Rate
CCE	Cross-Correlated Effects
CIT	Corporate Income Tax
DGP	Data Generating Process
DOLS	Dynamic Ordinary Least Squares
DORA	Division of Revenue Act
DPME	Department of Planning, Monitoring and Evaluation
DTC	Davis Tax Committee
ECM	Error Correction Model
ENE	Estimates of National Expenditure
EU	European Union
FFC	Financial and Fiscal Commission
FGLS	Feasible Generalised Least Squares
FPE	Final Prediction Error
GDP	Gross Domestic Product
GMM	General Method of Moments
HQIC	Hannan-Quinn Information Criterion
IBC	Inter-temporal Budget Constraint
IGFRA	Inter-Governmental Fiscal Relations Act
IFS	International Financial Statistics
IID	Independent and Identically Distributed
IMF	International Monetary Fund
IRFs	Impulse Response Functions
IV	Instrumental Variable
IYR	In Year Reporting
JB	Jacque Bera

LGBF	Local Government Budget Forum
LM	Lagrangian Multiplier
LR	Likelihood Ratio
MAE	Mean Absolute Error
MBAPRMA	Money Bills Amendment Procedure and Related Act
MEC	Member of Executive Council
MinComBud	Ministers Committee on Budgets
MLE	Maximum Likelihood Estimation
MTBPS	Medium Term Budget Policy Statement
MTEC	Medium Term Expenditure Committee
MTEF	Medium Term Expenditure Framework
MSC	Markov Switching Criteria
MSD	Mean Square Difference
MSPE	Mean Square Prediction Error
NCOP	National Council of Provinces
NPG	Non-Ponzi Game
NSDA	Negotiated Service Delivery Agreement
OBI	Open Budget Index
OECD	Organisation for Economic Cooperation and Development
OIR	Orthogonalized Impulse Response
OIRF	Orthogonalized Impulse Response Function
OLGA	Organised Local Government Act
OLS	Ordinary Least Squares
PBO	Parliamentary Budget Office
PFMA	Public Finance Management Act
PIT	Personal Income Tax
PP	Phillips Perron
PPP	Public Private Partnerships
PRASA	Passenger Rail Agency of South Africa
PVBC	Present Value Budget Constraint
RAF	Road Accident Fund
REER	Real Effective Exchange Rate
RER	Real Exchange Rate
RMSE	Root Mean Square Error
SAA	South African Airways
SAC	Standing Appropriations Committee
SACU	South African Customs Union
SALGA	South African Local Government Association
SANRAL	South African National Roads Agency Limited

SAPO	South African Post Office
SARB	South African Reserve Bank
SARS	South African Revenue Service
SCOPA	Standing Committee on Public Accounts
SDF	Stochastic Discount Factor
SDR	Special Drawing Rights
SGMM	System General Methods of Moments
SIC	Schwartz Information Criterion
SOEs	State Owned Enterprises
StatsSA	Statistics South Africa
STECM	Smooth Transition Error Correction Model
STR	Smooth Transition Regression
SVAR	Structural Vector Auto-Regression
TSLS	Two-Stage Least Squares
UR	Unemployment Rate
VAR	Vector Auto-Regression
VAT	Value Added Tax
VEC	Vector Error Correction
VECM	Vector Error Correction Model
VMA	Vector Moving Average

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1. Introduction

The major constraints encountered by fiscal policies in numerous economies include budget deficits financing, rising public debt levels, and fiscal risks emanating from numerous frontiers. The prime sources of fiscal risks include political instability, weak domestic and global output growth, unpredictable capital markets financing conditions, local labour market unrests, exchange rates volatility, and persistent fluctuations in commodity prices. Like many other countries in the world, the South African economy is likely to continue remaining vulnerable to fiscal pressures in the medium to long-run period due to several factors. The dominant factors putting pressure on the fiscus include constrained financial positions of the country's state owned enterprises (SOEs) and constantly rising demand for sustainable healthcare financing required to meet the goal of universal health coverage (UHC) and fighting against HIV epidemic.

In order to maintain public debt on a sustainable path and simultaneously stimulate economic growth, the role played by monetary policy remains critical towards ensuring macroeconomic stability and creation of employment opportunities. In addition, the effectiveness of fiscal policy instruments cannot be realised exclusively autonomous from monetary policy. Hence, harmonisation of fiscal and monetary policies remains critical towards ensuring fiscal policy sustainability. Given that output growth and macroeconomic stability are the common goals of fiscal and monetary policies, policy stances taken by monetary authorities affect the general price level in the economy and the country's fiscal positions via public borrowing and debt servicing costs.

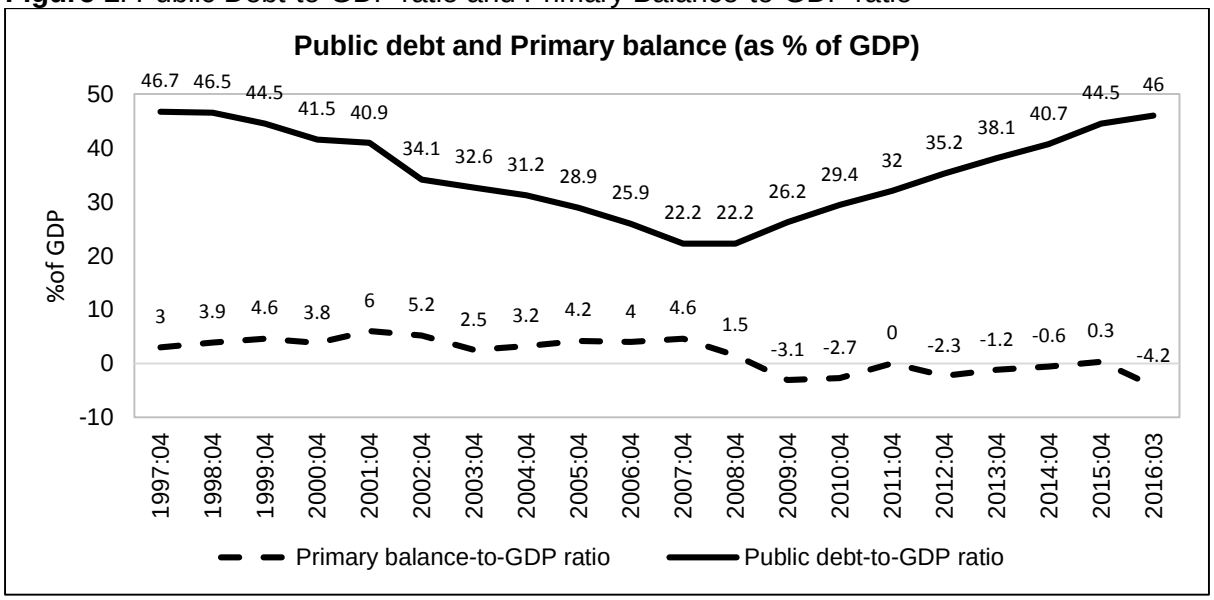
1.2. Context and Background

The manner in which government conducts fiscal policy in an economy plays a key role towards achievement of the broad macroeconomic policy objectives. Since the global economic and financial crisis during 2008/09, the South African economy has experienced prolonged unpredicted fiscal deterioration that has rendered the country into serious challenges that have further adversely affected the level and composition of public debt (Magubu, Maisonnave, Chitiga, and Decaluwé, 2015).

The country's public debt-to-gross domestic product (GDP) ratio sizably increased from 26.5% in 2008 to 47.1% in 2014 (SARB, 2017). While the total balance of public debt in the domestic bond market remains high, the interest payable on government debt remains one of the significant items of annual government expenditure in an environment characterised by remarkably low interest rates (Magubu, et al., 2015). Subsequent to the global economic crisis in 2008, South Africa's real GDP growth plunged from 3.6% in 2008 to -1.7% in 2009 before recovery to 2.9% in 2010, and decline to 1.2% in 2015 (Intenational Monetary Fund (IMF), 2017). Sluggish growth in the country's output was attributed to persistent labour market disruptions mainly in the mining, agriculture and manufacturing sectors, declining business and consumer confidence and weak growth in the nation's major European and North American trading partners (Kumo, Rielander and Omilola, 2014).

The domestic bond market remained as the primary source of new financing, providing about 70% of the annual requirement (Magubu, et al., 2015). Since the 2008/09 global financial crisis, monetary policy in South Africa has retained interest rates low to support fiscal policy towards improving weak domestic aggregate demand and negative output gap in the economy (FFC, 2014). Based on the primary balance-to-GDP ratio, South Africa's fiscal position after the global economic crisis remained depressed with an average of -1.8%. Therefore, the ratio of public debt to GDP has been consistently rising over the period 1998 quarter 2 to 2016 quarter 3.

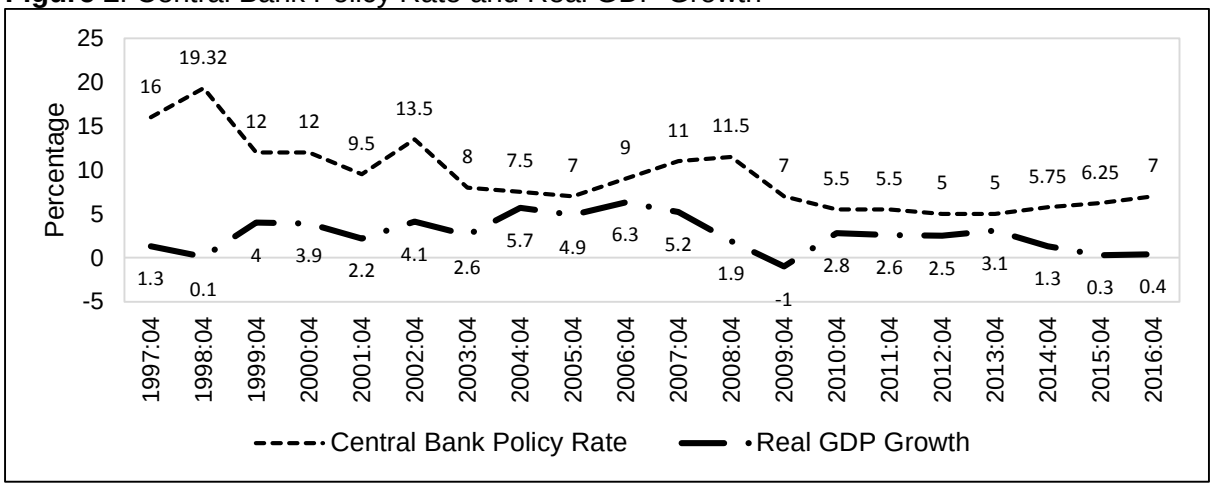
Figure 1: Public Debt-to-GDP ratio and Primary Balance-to-GDP ratio



Source: South African Reserve Bank (2017)

With particular focus on the post-apartheid epoch, Figure 1 shows that South Africa experienced gradual declines in public debt-to-GDP ratio from 46.7% in 1997 quarter 4 to an all-time low record of about 22.2% in 2008 quarter 4. During the respective period, the primary balance-to-GDP ratio improved from 3% in 1997 quarter 4 to an all-time high record of 6% in 2001 quarter 4. Between 2002 quarter 4 and 2008 quarter 4, the country's fiscus recorded an average primary surplus-to-GDP ratio of 3.6%. Subsequently, the country's primary balance positions during 2009 quarter 4 and 2010 quarter 4 recorded primary deficits of -3.1% and -2.7% respectively. During the period 2011 quarter 4 to 2016 quarter 3, the fiscal position remained very weak, recording an average primary balance-to-GDP ratio of -1.3%. Conversely, public debt-to-GDP ratio continuously increased from 22.2% during 2008 quarter 4 to 46 % in 2016 quarter 3.

Figure 2: Central Bank Policy Rate and Real GDP Growth



Source: International Monetary Fund (2017)

With regards to the central bank policy-related interest rate and real output growth, Figure 2 shows that the interest rate generally declined from 19.3% in 1998 quarter 4 to 9.5% in 2001 quarter 4. In addition, real output growth remained positive in the range 0.1% to 3.9% during the same period. Moreover, output growth was moderately volatile over the period 2002 quarter 4 to 2016 quarter 4, with a decline in real GDP of -1% being recorded in 2009 quarter 4 adjacent to recovery. Therefore, the central bank policy rate was moderately stable during the period 2010 quarter 4 to 2013 quarter 4 in the range 5.0% to 5.5% and subsequently increased to 5.75% in 2014 quarter 4 and 7% in 2016 quarter 4.

1.3. Problem Statement

Despite the efforts from both fiscal and monetary authorities to stimulate the economy, fiscal space in the economy has largely remained narrowed. Although the South African economy's total net debt-to-GDP ratio has remained below the 50% notch since 1998, the ratio has been rising from 22.2% in 2008 to 45.3% in 2016 on an annual basis. Congruently, the primary balance-to-GDP ratio has remained in the negative territory, recording -2.4% in 2009, -2.6% in 2012 and -1% in 2016 (SARB, 2017). Such fiscal developments have caused unremitting setbacks on growth prospects of the economy. Although public borrowing is inevitable and interest rates remaining lower on public borrowing, the consistently rising public debt-to-GDP ratio causes substantial negative impacts on economic growth in the country.

The gap noted in previous studies on fiscal sustainability analysis in South Africa is that fiscal policy was regarded as a fiscal issue purely exclusive from monetary policy, while monetary policy affects sustainability of fiscal policy through several channels which include public borrowing costs and seigniorage. Dahan (1998) highlights that a monetary policy stance has several channels through which it certainly affects budget deficit and government debt trajectories in the short-run. In respect of empirical studies conducted to assess fiscal sustainability in South Africa, none of the studies to date considered and examined the potential impact of the central bank's monetary policy stance on primary balance and/or public debt developments in the country.

1.4 Aim of the Study

The primary aim of this research study was to explore and empirically validate the link between fiscal and monetary policies in examining fiscal sustainability in South Africa.

1.5. Research Objectives

- To examine whether fiscal policy in South Africa was historically sustainable during the sample period 1999 quarter 1 to 2016 quarter 2.
- To examine the exogenous short-run impact of monetary policy stance on primary balance-to-GDP ratio and public debt-to-GDP ratio.
- To determine the impact of a one standard innovation in primary balance-to-GDP ratio on itself and on public debt-to-GDP ratio in the system.
- To determine the impact of a one standard innovation in public debt-to-GDP ratio on itself and on primary balance-to-GDP ratio.

1.6. Research Questions

- Was fiscal policy in the South African economy historically sustainable during the sample period 1999 quarter 1 to 2016 quarter 2?
- What was the exogenous short-run impact of monetary policy stance on primary balance-to-GDP ratio and on public debt-to-GDP ratio?
- What was impact of a one standard innovation in primary balance-to-GDP ratio on itself and public debt-to-GDP ratio?
- What was the impact of a one standard innovation in public debt-to-GDP ratio on itself and on primary balance-to-GDP ratio?

1.7. Research Hypotheses

- Fiscal policy in South Africa was historically sustainable during the sample period 1999 quarter 1 to 2016 quarter 2.
- Monetary policy stance had short-run significant positive impact on primary balance-to-GDP ratio and significant negative impact public debt-to-GDP ratio.
- A one standard innovation in primary balance-to-GDP ratio had significant negative impacts on itself as well as on public debt-to-GDP ratio.
- A one standard innovation in public debt-to-GDP ratio had significant positive impacts on itself and on primary balance-to-GDP ratio.

1.8. Scope and Delimitation

This study integrated the impact of monetary policy stance on examination of fiscal policy sustainability in South Africa. Given that the South African government started publishing primary balance data in the late 1990s in the Budget Review, the sample period was restricted to the period 1999 quarter 1 to 2016 quarter 2. In light of such background, the empirical validity of econometric estimations derived from this study remains relevant to the historical fiscal behaviour of the South African government precisely for the sample period 1999 quarter 1 to 2016 quarter 2. Therefore, empirical findings on the historical fiscal behaviour of the South African government reported in this research study cannot be generalised and applied further to other time horizons outside the sample period covered in this research study.

1.9. Format of the Study

Chapter 1: Introduction and Background

This chapter provides the introduction and background to the study, research problem, aim of the study, research objectives, research questions, research hypotheses, significance of the study, scope and delimitation, and format of the research study.

Chapter 2: The South African Fiscal Governance

The governance of the South African fiscal system is discussed in this chapter. The principal elements of the fiscal governance discussed include the Inter-Governmental Fiscal Relations Framework, fiscal management mechanisms, medium term planning framework, budget process, fiscal oversight and fiscal risks.

Chapter 3: The South African Fiscal Framework

This chapter discusses the fiscal framework of the South African economy in terms of the medium-term to long-run trajectories in the broad budgetary aggregates of national government total tax and non-tax revenues, government expenditure, government debt, and fiscal balances. The fiscal risks framework is finally discussed with regards to their diverse sources of such fiscal risks, their relevant significances, disclosure and management in context of the South African economy.

Chapter 4: Theoretical Framework

This chapter defines fiscal policy sustainability and discusses a theoretical framework comprising analytical methods applied in conducting fiscal sustainability analysis. The conceptual approaches discussed in the research study include the static budget constraint, government lifetime budget constraint, present value budget constraint, fiscal stance index, and regime-switching model-based sustainability test.

Chapter 5: Empirical Literature Review

This chapter discusses empirical findings on fiscal sustainability based on empirical literature survey conducted on countries in different continents. In particular, the continents and countries studied include Europe, America, Asia, Africa, mixed-group of countries and South Africa. Lastly, the chapter explores the research gap relating to the missing link between fiscal policy and monetary policy overlooked by previous empirical studies on fiscal sustainability conducted in South Africa.

Chapter 6: Methodology and Estimation Technique

This chapter first discusses the data used in the study and sources from which the data were obtained. The chapter further discusses the methodological procedure as well as estimation technique applied in empirical estimation of the results. The methodological procedure and estimation process are discussed within the framework of econometric modelling of time-series data based on univariate and multivariate approaches.

Chapter 7: Results and Analysis

Empirical findings of the research study are presented in this chapter. The analysis and interpretation of the results was conducted in line with the aim of the study and research objectives specified in the first chapter. The results discussed cover the time series properties of the data in terms of stationarity and cointegration, and findings from the empirical analysis of fiscal policy sustainability in South Africa.

Chapter 8: Conclusions and Recommendations

This chapter provides a summary of the whole study in terms of the aim of the study, research objectives, methodological procedure, estimation technique, and the major findings. Some policy implications are discussed, followed by some major limitations of the study, and ultimately recommendations for further studies.

1.10. Conclusion

This chapter provided the introduction and background to the study. The background briefly discussed developments in the country's fiscal positions around public debt and primary balance, together with developments in central bank policy interest rate and real output growth. The primary aim of the study was further provided together with research objectives, research questions, research hypotheses, scope and delimitation of the study, and format of the main research study.

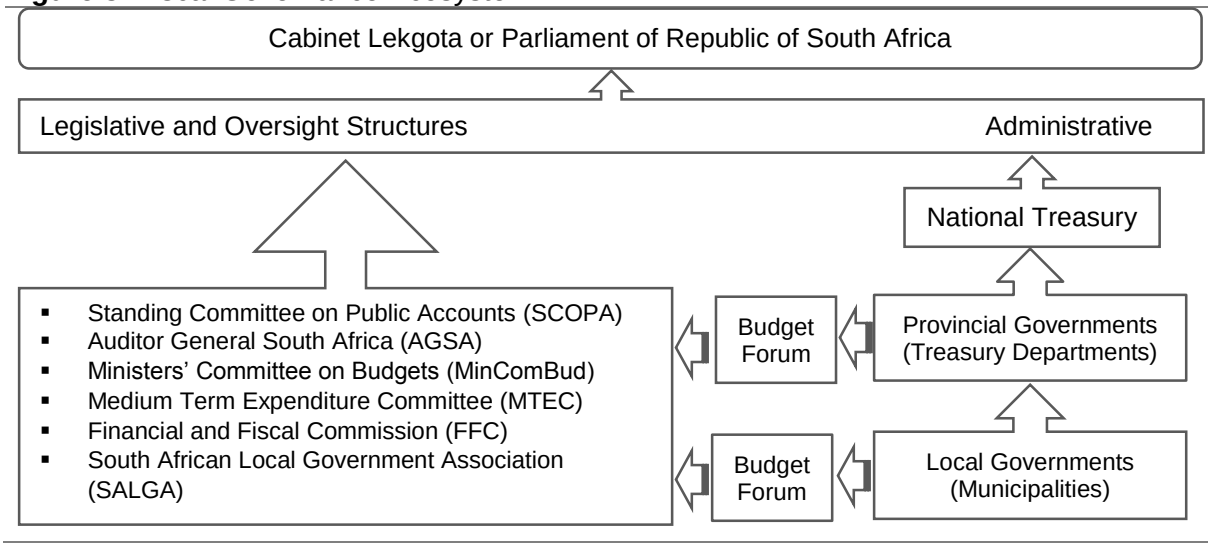
CHAPTER 2

THE SOUTH AFRICAN FISCAL GOVERNANCE

2.1. Introduction

This chapter discusses the governance of the South African fiscal system. The major elements discussed are the Inter-Governmental Fiscal Relations Framework, fiscal management mechanisms, the medium term planning framework, budget process, fiscal oversight, and fiscal rules. Prior to discussing fiscal elements identified herein, a simplified version of the fiscal governance ecosystem is depicted by Figure 3 below.

Figure 3: Fiscal Governance Ecosystem



Source: Author's Compilation

2.2. Inter-Governmental Fiscal Relations (IGFR) Framework

South African government has a decentralised fiscal governance model that promotes effective cooperative decision-making among national, provincial and local spheres of government. The three government spheres are autonomous, distinctive, interrelated and interdependent in decision making, and coordinate budgets and policies on socioeconomic functions that apply to all the three spheres of government. The South African Local Government Association (SALGA) officially represents local government sphere in the National Council of Provinces (NCP), as well as in provincial and national assemblies that deliberate on decisions around programmes and policies.

The Inter-Governmental Fiscal Relations Act, No. 97 of 1997 postulates "*promotion of cooperation between the national, provincial and local spheres of government on*

fiscal, budgetary and financial matters, and prescribes a process for the determination of equitable sharing and allocation of revenue raised nationally". Section 2 subsections 1 and 2 of the IGFR Act stipulate the establishment of a Budget Council that consists of the Minister of Finance, who serves as Chairperson of the Council, and Member of Executive Council (MEC) for finance of each province. Section 3(a) stipulates that the Budget Council is the "*body in which national government and provincial governments consult on any fiscal, budgetary or financial matters affecting the provincial sphere of government*". Section 4(1) obliges the Minister of Finance to convene meetings of the Budget Council at least twice in each financial year. Section 4(2) (a) stipulates that the Chairperson of the Financial and Fiscal Commission (FFC) may attend the meetings, or a delegation of the FFC nominated by the Chairperson of the FFC, and any other persons invited (subsection b).

Section 5(1) provides for the establishment of a Local Government Budget Forum (LGBF), which consists of the "*Minister of Finance, the MEC for finance of each province, five representatives selected by the national organisation recognised in terms of the Organised Local Government Act, 1997, and one representative nominated by each provincial organisation recognised in terms of that Act*". Section 6 stipulates that the Budget Forum, chaired by Minister of Finance, has a constitutional mandate to serve as a "*body through which national government, provincial governments and organised local government consult on any fiscal, budgetary or financial matter affecting the local government sphere* (section 6(a)) *and any matter concerning financial management, or monitoring of the finances of local government sphere* (section 6(c)). Section 7(1) obliges Minister of Finance to convene meetings of the Budget Forum, for which the forum must meet at least once in each financial year. Subsection 2 paragraphs (a) and (b) make provision for attendance of meetings by Chairperson of the FFC, or a delegation of the FFC selected by the Chairperson of the FFC (paragraph "a"), and any other persons invited (paragraph "b").

Section 8 of the IGFR Act, 1997 establishes the process for the sharing of revenue raised nationally among national, provincial and local government spheres in line with section 214(1)(a) of the Constitution of Republic of South Africa, 1996. The latter provides for equitable division of nationally raised revenue among three spheres of government. Section 9(1)(a) of the IGFR Act stipulates that the FFC must submit its

recommendations for the forthcoming financial year regarding equitable division of nationally raised revenue among three spheres of government to the Houses of Parliament and provincial legislatures and to the Minister of Finance. This should be done within a period of at least 10 months or a later date agreed upon between the Minister of Finance and the FFC before commencement of each financial year.

When making its recommendations, the FFC is required by section 9(3) of the IGFR Act to take into consideration the matters listed in section 214(2) (a) to (j) of the Constitution. The matters listed include the following:

- Interest of the nation.
- National debt and other obligations.
- Needs and interests the national government determined by objective criteria.
- Fiscal capacity and efficiency of provinces and municipalities.
- The need to ensure ability of provinces and municipalities to provide basic services and discharge functions allocated to them.
- Economic disparities within a province and among provinces.
- The need to ensure stable and predictable allocations of revenue sharing.

In terms of section 10(1) of the IGRF Act, the Minister of Finance introduces a Division of Revenue Bill, concurrent with the Annual Budget for the relevant financial year to the National Assembly. The Division of Revenue Bill specifies the share for each government sphere of the nationally raised revenue for the relevant financial year (section 10 subsection 2(a)).

2.3. Fiscal Management Mechanism

The fiscal management mechanism in South Africa is anchored on the Public Finance Management Act (PFMA), Division of Revenue raised nationally, and inputs of the FFC on financial and fiscal matters of government spheres.

2.3.1. Public Finance Management

The PFMA, No. 1 of 1999 is the central legislation for fiscal management in South Africa. Public finance management refers to a set of statutes, systems and processes used by the government of a sovereign nation to mobilise revenues, allocate public funds among competing priorities, spend allocated funds, control expenditures, and

account for funds spent. The Act (as amended) was commenced in 2000 to regulate management of public finances in national government and provincial governments. Specifically, the Act stipulates procedures for effective and efficient management of revenues, expenditures and assets and liabilities of the national government and provincial governments, as well as government ministries, public entities, Parliament and provincial legislatures and constitutional institutions.

From a fiscal management standpoint, a necessary condition for the government to put and maintain the economy on a fiscally sustainable path is enactment of a public finance management system that has an effective, efficient and transparent mechanism for allocation and spending of public finances. The financial management system should facilitate the ability to endorse and maintain fiscal discipline to ensure that revenue and expenditure aggregates are consistent with fiscal deficit targets and prevent unsustainable levels of public debt. In South Africa, the PFMA prescribes fiscal transparency through effective monitoring of performance, expenditure control, regular financial reporting and audits, delivery of outputs, accountability and maintenance of sound control systems.

Section 6(1) (a) to (d) of the PFMA stipulate that “promotion of national government’s fiscal policy framework, coordination of macroeconomic policy and inter-governmental financial and fiscal relations, control of budget preparation processes, and exercising of control over adoption of annual national budgets, including adjustments budgets” are constitutional responsibilities of National Treasury. In terms of section 6(1) (e) to (g), National Treasury “facilitates implementation of the annual Division of Revenue Act (DoRA) and monitors provincial budgets, and effectively enforces transparency in management of revenue, expenditure, assets and liabilities of government ministries, public entities, and constitutional institutions”.

Section 27(3) (a) to (d) of the PFMA stipulates obligations that the national budget for a given fiscal year should contain and tabled by the Minister of Finance. Specifically, the national budget must contain “estimates of revenue expected to be raised during the financial year to which the national budget relates, estimates of current and capital expenditures expected to be incurred for that financial year, and estimates of interest and debt servicing costs, and loan repayments”. The PFMA section 28(1) (a) and (b)

provide for preparation of multi-year budget projections of estimated revenue expected to be raised and estimated expenditure (differentiated between current and capital spending) expected to be incurred during each fiscal year of the projected multi-year period. Section 28(2) requires that multi-year budget projects must be supplemented by multi-year macroeconomic projections.

In terms of section 30(2), national adjustment budgets may only be provided for the following exceptions:

- substantial and unanticipated economic and financial occasions affecting fiscal targets set by the annual national budget.
- unpredictable and inevitable expenditure commended by national executive or any committee of Cabinet members to whom this task has been assigned.
- appropriation of funds for expenditure previously announced by the Minister of Finance during the tabling of the national annual budget.
- shifting of funds between and within votes.
- use of savings under a key division of a vote for defrayment of excess spending under another major division of the same vote.
- roll-over of funds not spent from the previous financial year.

With regards to loans by national government, section 71 of the PFMA provides that the Minister of Finance may borrow funds only for the following purposes:

- Financing of national budget deficits.
- Refinancing of maturing debt or a loan paid before redemption date,
- Acquisition of foreign currency.
- Maintenance of credit balances on a bank account of National Revenue Fund.
- Regulation of internal monetary conditions where necessity arises.
- Any other purpose the National Assembly would approve by special resolution.

2.3.2. Division of Revenue

The Division of Revenue Bill for each forthcoming financial year specifies the following:

- The share of revenue raised nationally allocated to each government sphere.
- An equitable share of revenue allocated to each province from the provincial share of revenue raised nationally.

- Allocations to provinces and local governments from the national government's share of revenue raised nationally, and conditions attached to such allocations.

2.3.3. The Financial and Fiscal Commission (FFC)

The Financial and Fiscal Commission (herein after referred to as the Commission) was established in terms of section 198 of the Constitution of the Republic of South Africa as a permanent expert Commission on financial and fiscal matters of the organs of state of three government spheres. Although the Commission regularly interacts with government in its consultation processes to obtain data and information for use in discharge of its functions, it is an organ of state that is separate, impartial, unbiased autonomous, objective and not part of the Government of the Republic of South Africa. In addition, section 220(2) of the Constitution stipulates that the Commission is subject merely to the Constitution of the country and relevant legislations.

2.3.3.1. Role of the Commission

The Commission's prime constitutional role is to make recommendations and provide advice on fiscal and financial matters to organs of state across the three spheres of government of South Africa. In addition, the Commission provides impartial advice on equitable division of nationally raised revenue between three spheres of government (vertical division), as well as equitably between provinces and local government municipalities (horizontal division). In terms of section 4(2) (a) of the IGFR Act, the Commission represented by its Chairperson or a delegation of the Commission nominated by its Chairperson, and any other person invited (subsection b) must attend the meetings of the Budget Council (held at least twice in each financial year) convened by the Minister of Finance in terms of section 4(1) of the IGFR Act. With regards to the Local Government sphere, section 7(2) (a) and (b) of the IGFR Act requires the Chairperson of the Commission or a delegation of the Commission nominated by its Chairperson (paragraph "a") and any other person invited (paragraph "b") to attend meetings of the Budget Forum (held at least once in each financial year) convened by the Minister of Finance in terms of section 7(1) of the IGFR Act.

When submitting its recommendations on division of nationally raised revenue among three government spheres, the Commission in terms of section 9(3) of the IGFR Act

takes into consideration the matters listed in section 214(2) (a) to (j) of the Constitution. Such matters include the following:

- Interest of the nation.
- National debt and other obligations.
- The needs and interests of the national government determined by objective criteria, the fiscal capacity and efficiency of provinces and municipalities.
- The need to ensure ability of provinces and municipalities to provide basic services and discharge functions allocated to them.
- Economic disparities within a province and across provinces.
- The need to ensure stable and predictable allocations of revenue sharing.

The Minister of Finance does submissions of recommendations on equitable division of revenue by the Commission before tabling of the annual budget in the National Assembly or Parliament in February of each financial year in line with section 10(1) of the IGFR Act. In March, following tabling of the annual budget for the upcoming financial year in February, the Commission responds to the tabled budget in its submission of the Division of Revenue Bill to Parliament. Government's responses, via the country's Minister of Finance, to the Commission's proposals are provided in an Annexure to the Division of Revenue Act of the relevant financial year, indicating the extent to which government took account the Commission's recommendations.

2.3.3.2. Contributions by the Commission

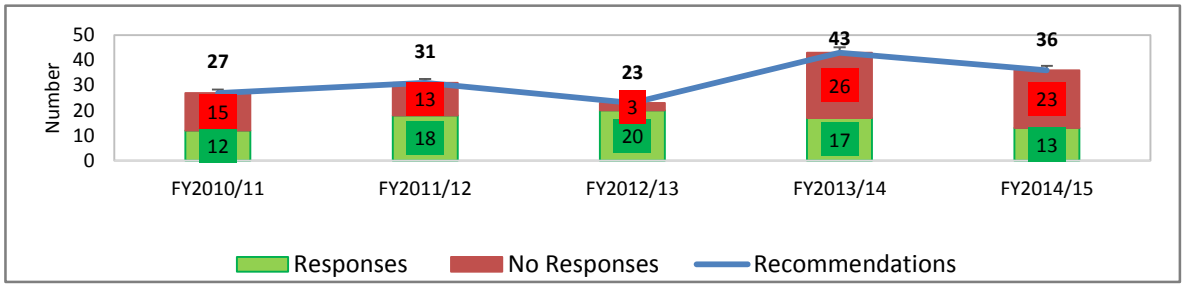
Following Visser and Ayele (2014), contributions made by the Commission in fiscal budget processes are assessed based on output volume, consistency and response rates by National Treasury. These dimensions crudely measure the impact of outputs of the Commission. The *IGFR Framework document* issued in June 1995 was among some of the most influential outputs of the Commission. The first output submission of recommendations was made for the 1996/97 financial year budget. However, recommendations from that submission were not considered in the 1996/97 budget proposal owing to poor timing in release of the submission, which provided inadequate time for sufficient consultations and analysis into the expenditure planning process.

Consistent with Wehner (2003) and Magubu (2009), Visser and Ayele (2014) emphasised that the FFC faced difficulties in the initial years to make submissions of

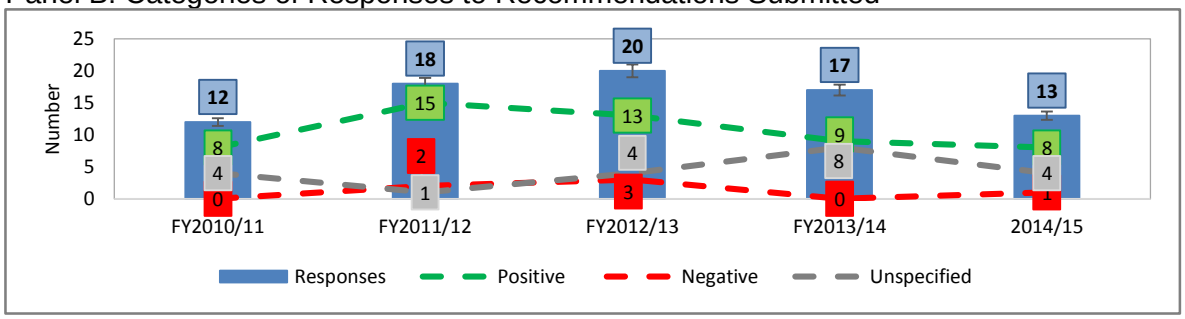
its recommendations in a timely manner. Prior to enactment of the IGFR Act, National Treasury was not required to respond to recommendations from the FFC. Such challenges faced by the FFC were resolved by enactment of the IGFR Act, which led to improvements in protocols the FFC has with the National Treasury and Parliament. Figure 4 Panel A shows numbers of the FFC's submissions of recommendations and responses by government. Panel B shows proportions of the categories of responses relative to total responses by government over the period 2011-2014.

Figure 4: Numbers and Categories of Submissions of Recommendations and Responses

Panel A: Number of Submissions of Recommendations and Responses



Panel B: Categories of Responses to Recommendations Submitted



Source: DoR Bills 2010-2014 (de Visser and Ayele, 2014)

As shown by Figure 4 Panel A, the largest proportions of the FFC's recommendations which the government did not provide responses to stood at 64% (23 out of 36 recommendations) in 2014/15 submissions, and 60% (26 out of 43 recommendations) in the 2013/14 submissions. In overall terms, the government did not respond to 50% (80 out of 160) of the recommendations submitted by the Commission during the sample period 2010/11 to 2014/15 submissions. The statistics reveal that government does not always essentially respond to every recommendation submitted by the Commission (Visser and Ayele, 2014). Conversely, the enormous proportions of responses from the government to the Commission's recommendations submitted stood at 87% (20 out of 23 recommendations) in the 2012/13 submissions, and 58% (18 out of 31 recommendations) in 2011/12 submissions.

The proportions of positive responses from government relative to the total numbers of responses to recommendations submitted were substantially high during 2010/11 to 2014/15 budget years. The largest proportion of positive responses stood at 83% (15 out of 18) in 2011/12 submissions, followed by 67% (8 out of 12 recommendations) in the 2010/11 submissions. In addition, almost two-thirds (65%) were experienced (13 out of 20 recommendations) in the 2012/13 submissions, 62% (8 out of 13 recommendations) in the 2014/15 budget submissions, and 53% (9 out of 17 recommendations) in the 2013/14 submissions. Therefore, the statistics show that government's responses were generally in agreement with the FFC in most instances where National Treasury responded to comments submitted by the FFC.

2.4. The Medium Term Planning Framework

Like other countries in the world, South Africa adopted a "multi-year budgeting and medium-term (three-year) planning" system to improve transparency and predictability in the national budgeting process. The medium term planning framework around budgeting in South Africa consists of the Medium Term Expenditure Framework (MTEF) and Medium Term Budget Policy Statement (MTBPS). The prime rationale of the medium term planning framework is that economic forecasts, spending proposals and fiscal policy parameters that determine the framework indicate the direction of the country's economic policy. The framework further provides the basis on which the economy deals with ad hoc policy changes. The framework upholds the effectiveness of the manner in which government departments and relevant spending entities determine their resource requirements over the long-term horizon (Verwey, 2015).

2.4.1. The Medium Term Expenditure Framework

Introduced during 1997/98 in South Africa, the Medium Term Expenditure Framework (MTEF) refers to a multi-year budget cycle or three-year rolling system of spending plans of the national and provincial governments tabled at the same time of tabling the national budget for the forthcoming financial year (Parliament of the Republic of South Africa, 2011). Although the MTEF covers a period of the next three financial years, only the first year of the framework objectively links to the budget of the forthcoming financial year. Estimates of the other two financial years are subject to change were deemed appropriate through tabling of the MTBPS. Conversely, the framework that has matured as a permanent element of government practice in the fiscal system

aligns budget allocations with key national priorities set out in the MTSF. Therefore, the two major objectives of the MTEF include setting fiscal targets for a period of the next three financial years, and allocating resources to the government's strategic priorities within the limits of the objectively set fiscal targets (Parliament of the Republic of South Africa, 2011).

2.4.2. The Medium Term Budget Policy Statement

In October of each year, the National Treasury issues a MMTBPS to sustain certainty in the nation's medium- to long-term planning. The policy statement provides the government's fiscal framework, expenditure plans and policies, and proposed equitable division of nationally raised revenue among the three government spheres over the three-year financial period. Therefore, MTBPS is a policy document that conveys information about the MTEF (Verwey, 2015). Section 28 of the PFMA requires National Treasury to table multi-year budget forecasts for revenue, expenditure and macroeconomic indicators annually. The MTBPS provides the country's fiscal policy stance, macroeconomic assumptions underpinning the fiscal policy, tax policy, summary of government's primary goals and objectives and the MTEF. Estimates contained in the MTEF for the two outer financial years are used as baseline numbers for the budget of the next financial year. The MTBPS provides a summary of medium term economic outlook, fiscal policy proposals and sectoral budget allocations.

2.5. The Budget Process and Fiscal Oversight

The policy context of the South African national budget framework, which covers the next three financial years, highlights the economic policy, fiscal policy, tax policy, consolidation of government spending, division of revenue, government's borrowing requirement and financial position of public sector bodies. The key role participants in the budget process are the Cabinet, Ministers' Committee on Budgets (MinComBud), Budget Council, Budget Forum, Intergovernmental Technical Forums, departments, relevant entities, legislature, and Financial and Fiscal Commission (National Treasury, 2011). The major documents of the budget process include Estimates of National Expenditure (ENE), Medium Term Budget Policy Statement (MTBPS), Budget Speech, Budget Review, Division of Revenue Bill/Act, and Appropriations Bill/Act.

The National Treasury (2016) specifies that the mechanism in which the budget process allocates resources is anchored on four dimensions described below:

- *Function (outcomes) budgeting*, which classifies activities of institutions (health, education, social protection, safety and security, economic affairs, human settlements, rural development and agriculture, and general public services) around the country's priority policy objectives and/or outcomes.
- *Economic (inputs) allocation*, which creates a balance in the purchase of inputs and spending of resources on compensation of employees, interest payments, capital spending, goods and services, and transfers and subsidies.
- *Intergovernmental (spheres) fiscal planning*, whereby national, provincial and local government collaborate in designing fiscal instruments and allocating resources towards key national priorities.
- *Consolidated budget*, which combines departmental budgets of national and provincial governments with financing of public entities, agencies and relevant institutions that largely depend on funding from the fiscus.

Based on the 2015 survey Open Budget Index (OBI) released by the International Budget Partnership, South Africa was ranked third out of 102 countries in terms of budgetary transparency (Sachs, 2015; Lings, 2016). The country was ranked third after New Zealand and Sweden, showing that South Africa's budgeting process remains remarkably high by global standards (Lings, 2016). The respective index assigns nations covered by Open Budget Survey a transparency score on a 100-point scale calculated based on expert considerations regarding whether the government timely releases comprehensive budget information to the public in line with global standards of good practice. The survey measures the quality of transparency in budgeting, participation by public in the national budget process, and institutional oversight (Sachs, 2015). Improved access to information and prospects to contribute to budget processes by the public and relevant stakeholders strengthens transparency and accountability in allocation and spending of resources.

According to the National Treasury (2016), the main goal of the budget process in South Africa is to attain efficiency in resource allocation to meet national priorities through improved effectiveness in spending of resources within sustainable fiscal limits. From a technical efficiency standpoint, National Treasury (2016) specifies that

the three key goals of the budget processes in South Africa are "*fiscal sustainability*, *effective resource allocation* and *maximization of the value for money*". The fiscal sustainability objective aims to ensure a balance between revenue, expenditure, public debt, and relevant fiscal aggregates in a manner that stimulates economic stability and promotes a sustainable fiscal path. The budget process comprises of technical and political structures that make contributions and present recommendations towards determination of the budget. Table 1 below provides details of the budget process, which is a continual cycle that begins from April through to March every financial year.

Table 1: The Annual National Budget Process in South Africa

Period	Budget process activities
March – April	The National Treasury issues government departments with procedures for application for rollovers of eligible unspent funds from the last financial year. Government departments' submissions for requests for rollovers are made to the National Treasury for assessment.
May – June	Subsequent to approval by the Minister of Finance, the National Treasury issues letters for rollover allocations to government departments. The National Treasury issues the MTEF budget guidelines during this period.
July	Government departments make submissions of their relevant expenditure estimates to the National Treasury for the forthcoming budget. Changes to budget programme structures of departments are evaluated and approved, while policy priorities and considerations for enactment are conferred and approved by Cabinet Lekgota.
August	The preliminary fiscal framework, Division of Revenue and sectoral budget priorities are approved by Ministers' Committee on Budgets (MinComBud).
September	Medium Term Expenditure Committee (MTEC), made up of senior officials from National Treasury, Department of Planning, Monitoring & Evaluation (DPME), Department of Cooperative Governance & Traditional Affairs, and Department of Public Service & Administration, presents recommendations on critical government priorities to the MinComBud. The MTEC advises the Cabinet on budget allocations for inclusion in the national budget, taking into account economic assumptions underpinning the budget, fiscal policy objectives and tax proposals. Cabinet receives final recommendations on allocations for approval. The Adjustments Appropriation process begins and recommendations for unexpected and inevitable spending are made, while adjusted allocations are appropriated in the subsequent month.
October – November	The Adjustment Appropriation Bill, Amended Division of Revenue Bill, MTBPS, and prime allocations for provincial and local governments are all tabled in Parliament. Final allocations to national government departments are presented to Cabinet for approval in November. Following approval by Cabinet, allocation letters are sent out to government departments.
December – February	Parliament sends recommendations reports on MTBPS, fiscal framework and Division of Revenue to the Minister of Finance. Following the response by the Minister of Finance to Parliament on recommendation reports, the National Budget, Appropriation Bill, Division of Revenue Bill, Estimates of National Expenditure and relevant budget information are finalised and tabled in Parliament by the Minister of Finance.

Source: Parliament of the Republic of South Africa (2011)

In terms of oversight of public expenditure by government departments, the PFMA specifies in-year reporting (IYR) requirements government departments must comply with. Within 15 days of the end of each month, accounting officers are required to send monthly reports to the relevant Treasury department. In particular, monthly reports should show details of actual revenue and expenditure allocations, spending of conditional grants, variances, expected revenue and expenditure for the remainder of the relevant financial year, and summary action plan to ensure that revenue and expenditure flows remain within the approved budget. Correspondingly, provincial treasuries are required to send a statement to the National Treasury before 22nd of each month showing details of the state of funds, transactions affecting finances, and corrective actions to be taken. To ensure value for money, the National Treasury holds government departments accountable on their expenditure patterns in relation to budget allocations and policy priorities.

On a quarterly basis, accounting officers and provincial treasuries are required to send quarterly reports within 15 days to the end of each quarter showing details as in monthly reports, as well as information on grants received from Division of Revenue. The National Treasury publishes quarterly financial statements for each province and national sphere in the Government Gazette on its website, as well as progress reports of actual performances against national budget and predetermined objectives for scrutiny by government and civil society. Annual reports are then published showing details on non-performance, losses, misuse of funds, reports of public enterprises where relevant, actual performance against plans, and the budget agreed upon with the legislature at the start of the financial year. In line with section 32 of the PFMA, reports published in the Government Gazette contain information on budgeted versus actual figures of revenue and expenditure, deficit, net borrowing requirement, and deficit financing options; for instance, bonds, loans, and domestic or foreign market.

With regards to auditing of the national budget, the two institutions involved in the audit process are the Auditor General of South Africa (AGSA) and the Standing Committee on Public Accounts (SCOPA). The AGSA audits all government ministries' financial and non-financial performance, and reports findings and matters arising from such audit outcomes to the Parliament's SCOPA for suitable action. Similarly, the Standing Appropriations Committee (SAC) monitors in-year budgets by analysing monthly and

quarterly expenditure statements, compiles reports and submits to Parliament. The reports are required to show information on actual revenues and progress on budget implementation and service delivery. The Parliament's Standing Committees, in collaboration with Ministry of Finance (National Treasury) and Department of Planning, Monitoring and Evaluation (DPME) analyse national government departments' reports on performance progress towards delivery of measurable outcomes upon which budget allocations were made. To ensure good and sound progress on delivery of outputs, government departments are held accountable by the DPME in terms of the Negotiated Service Delivery Agreement (NSDA) signed between the President and each Minister of a national department.

2.6. Fiscal Rules

The IMF (2009) defines fiscal rules as simple and permanent constraints through numerical limits on budgetary aggregates. Since sustainability of fiscal policy largely depends on the general fiscal behaviour of government, four major fiscal rules are used to ensure fiscal sustainability, namely, *budget balance rules, debt rules, expenditure rules* and *revenue rules* (IMF, 2009). Budget balance rules can be based on the overall balance, cyclically adjusted balance (CAB) or structural balance while debt rules commonly target a specific level of debt-to-GDP ratio to ensure debt convergence. Furthermore, expenditure rules are permanent limits to total, primary or current government spending relative to GDP, while revenue rules aim to enhance revenue and/or prevent or at least minimise the burden of tax.

2.6.1. Rationale for Fiscal Rules

Fiscal rules have emerged as a common instrument for circumventing procyclicality and augmenting credibility of fiscal policy. Depending on country-specific institutional arrangements and fiscal policy objectives, a fiscal path characterised by persistent volatility of fiscal aggregates and economic activity validates the merits of fiscal rules. Following Caceres, Cevik, Fenochietto, and Gracia (2015), the basic rationale for optimal designing and implementation of rule-based fiscal frameworks is to manage government spending and maintain public borrowing on sustainable paths to ensure fiscal sustainability and intergenerational equity. Fiscal rules provide a sound medium-term framework for stimulating economic growth and ensuring macroeconomic stability through promotion of countercyclical fiscal policy. According to Magubu and

Marinkov (2011), fiscal rules create a depoliticised policy framework, prevent growth in size of government, promote intergenerational equity, and ensure fiscal discipline. In line with Kennedy and Robbins (2001), Magubu and Marinkov (2011) emphasise that the rationale for fiscal rules include enhancement of macroeconomic stability through a countercyclical fiscal policy, reinforcement of fiscal policy credibility, elimination of budget deficits, and promotion of fiscal sustainability.

In order to ensure effectiveness of fiscal rules, a number of preconditions need to be effectively put in place and fulfilled. Such preconditions include a sound public finance management system, availability of adequate budgetary aggregates data, technical capacity in forecasting, extensive reporting of budget outcomes, public release of fiscal data, and political commitment to improve fiscal policy credibility. Overall, fiscal rules should not be ambiguous, but should rather be flexible in order to respond to domestic and global shocks. Numerical targets should have a clear link with ultimate goals, while a sound institutional mechanism should be in place to constantly monitor and appropriately address deviations of outcomes from numerical targets.

Nonetheless, one major drawback of fiscal rules is that they sometimes limit the space for fiscal policy to be discretionary during periods where discretionary stances may be required. During times where the scope for fiscal policy to be discretionary is limited, fiscal policy may be forced to be procyclical while countercyclicality may be required (IMF, 2009). For instance, poor timing in implementation of expenditure rules may lead to reductions in capital spending for infrastructure development, which could reduce prospects for economic growth and job creation in the medium-term to long run.

2.6.2. Fiscal Rules for South Africa

Following the global financial crisis during 2008/09, the South African fiscal balance faced considerable pressure like many other developing and emerging economies in the world. Moreover, the restricted capacity of monetary policy to stimulate and sustain economic growth translated into an increase in fiscal deficits and public debt. Despite such fiscal and economic developments, South Africa's fiscal authorities have maintained a good record of fiscal management, transparent budget system and fiscal policy credibility in the absence of fiscal rules (Calitz, Siebrits & Stuart, 2013). In the absence of fiscal rules, government has pursued a credible fiscal policy through

ensuring reductions in primary deficit and increasing national budget surplus in response to rising public debt. Government fiscal management efforts aimed at monitoring fiscal deficits and public debt are anchored on existence and use of the country's sound national budget process and fiscal management mechanisms.

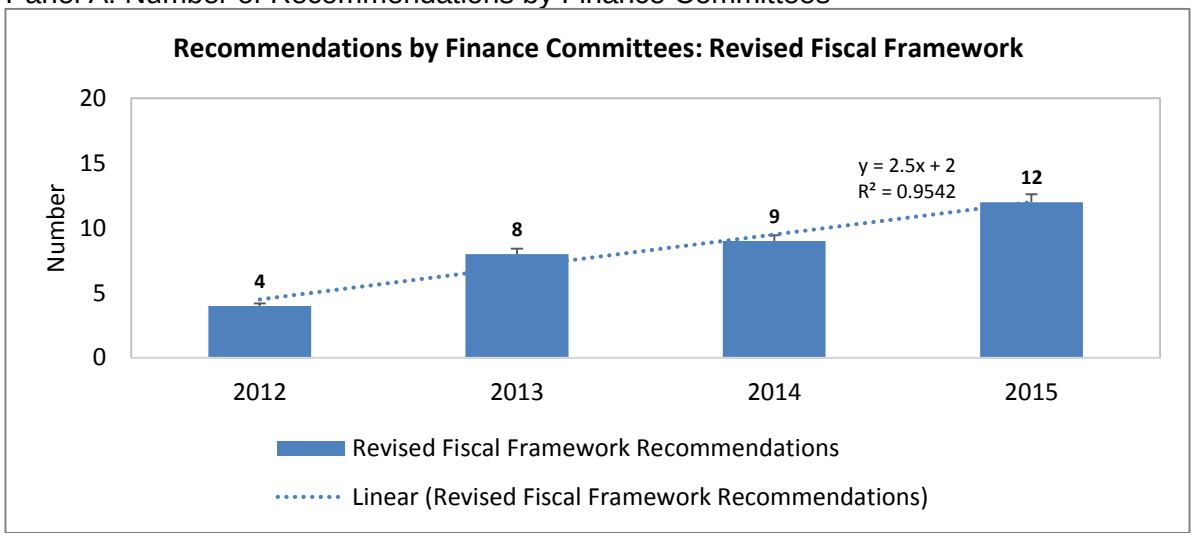
The country's fiscal policy path remains markedly strengthened by a set of legislative instruments and processes coordinated by numerous structures involved in national budgeting and fiscal planning. The fiscal legislative instruments and processes include the PFMA, IGFRA, Money Bills Amendment Procedure and Related Matters Act, MTEF, MTBPS, Budget Review, and Division of Revenue Bill. Concomitantly, the major structures involved in the national budget process and fiscal planning include National Treasury, Minister's Committee on Budget (MinComBud), Budget Council, Budget Committee, Cabinet and relevant Parliament's Standing Committees.

Given the robust fiscal stance, South Africa has maintained over the past years, and the notion that fiscal rules are not essential for a country with a strong standing of fiscal prudence (Magubu and Marinkov, 2011). Nevertheless, South Africa to date does not have basic fiscal rules. The Money Bills Amendment Procedure and Related Matters Act (MBAPRMA) of 2009 provides for strengthening of oversight of the budget-related matters through the Parliamentary Budget Office (Calitz, et al., 2013). Therefore, instead of substantive fiscal rules, the MBAPRMA requires the framework for the budget process to be anchored on Budget Review and Recommendations (BRR) reports, MTBPS, fiscal framework, and revenue laws, Division of Revenue Bill/Act (DoRA), and Appropriation Bill with distinct departmental budgets (FFC, 2016). In terms of section 15(1) of the MBAPRMA, the main role of the Parliamentary Budget Office (PBO) is to provide autonomous, unprejudiced, and expert advice and analysis to Parliament on budget and money bills related matters.

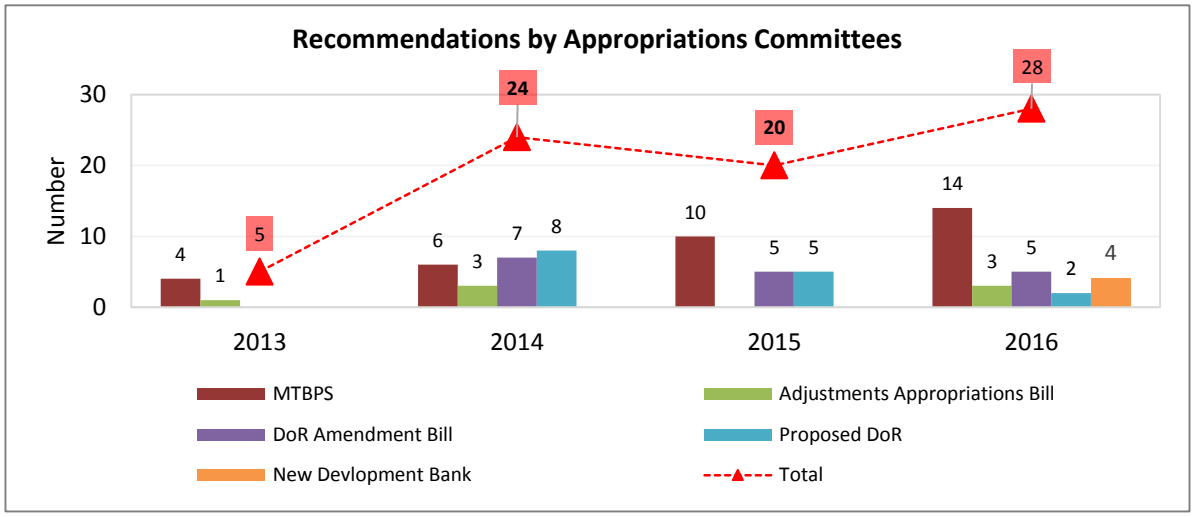
In assessing the progress in Parliamentary fiscal oversight since establishment of Parliamentary Budget Office, the Financial and Fiscal Commission (2016) revealed that the numbers of budget-related recommendations made by Finance Committees and Appropriations Committees improved since 2012, as presented by Figure 5.

Figure 5: Progress of Parliamentary Fiscal Oversight by Parliamentary Budget Office

Panel A: Number of Recommendations by Finance Committees



Panel B: Number of Recommendations by Appropriations Committees



Source: Financial and Fiscal Commission (2016)

As demonstrated by Figure 5 Panel A, the total number of the Finance Committees' recommendations on the revised fiscal framework accepted by the Ministry of Finance generally increased over the period 2012 to 2015. The number of recommendations doubled from four recommendations in 2012 to eight recommendations in 2013, and slightly increased to nine recommendations in 2014 and 12 recommendations in 2015. Similarly, Panel B shows that the total number of recommendations made by the Appropriations Committees drastically increased by 380% from five recommendations in 2013 to 24 recommendations in 2014, but slightly dropped to 20 recommendations in 2015 and improved by 40% to 28 recommendations in 2016.

Categorically, the number of MTBPS recommendations by Appropriations Committees constantly increased from four recommendations on the 2012 MTBPS for the FY2012/13 to six recommendations on the 2013 MTBPS for the FY2013/14, 10 recommendations on 2014 MTBPS for the FY2014/15 and 14 recommendations on 2015 MTBPS for FY2015/16. Additional recommendations made by Appropriations Committees and accepted by National Treasury include Adjustments Appropriation Bill, Division of Revenue (DoR) Amendment, proposed DoR and conditional grant allocations to provincial and local spheres and the new Development Bank Special Appropriations Bill. The increase in the number of recommendations by relevant Committees reveals the significance of the influence of these Committees on the country's fiscal matters.

The MBAPRMA additionally provides an institutional framework for the budget process, which is characterised by the following features:

- Structures of the Finance and Appropriations Committee and PBO.
- Budget processes and timelines with clear procedures and realistic timeframes.
- Symmetrical information flows through numerous financial instruments such as the Budget Review and Recommendations (BRR), MTBPS, Estimates of National Expenditure (ENE), Budget Speech, Budget Review, MTEF and relevant reports released by Statistics South Africa (StatsSA).
- Committee roles – numerous committees actively involved in budget processes.

Concerning the legislative oversight of the budget and fiscal framework, the PBO supports the implementation of the Money Bills Act through research and analysis for the committees on Finance and Appropriations in the National Assembly and National Council of Provinces (NCoP). Accordingly, the relevant Office provides policy advice and analysis on proposed amendments to the fiscal framework, Division of Revenue Bill and Money Bills, revenue and expenditure trends, and analysing budgetary implications of reports tabled in the Cabinet. A response was made to the Parliament's request to the National Treasury during 2010 to examine channels through which government expenditure could be maintained on a sustainable path over the long run. Agaist this background, Sachs (2015) asserts that the National Treasury proposed fiscal policy guidelines in the 2015 MTBPS that should be based on the following three principles:

- Countercyclicality – the budget balance needs to be consistently set in a manner that enhances its capacity to absorb and counteract variations in business cycles.
- Long-term public debt sustainability – government expenditure must be maintained at levels that do not lead to indefinite increases in public debt.
- Inter-generational equity – considerable care must be given to long-term costs of spending programmes.

The fiscal policy guidelines proposed by the National Treasury 2015 MTBPS include:

- Implementation of annual structural budget balance targets linked to long-term growth, preferred level of public debt, and inter-generational equity.
- Making explicit the costs of long-term new and existing programmes.
- Setting out a timeframe to bring the budget back on target level after fiscal shocks.

Given that the computation of structural budget balance remains difficult largely owing to reliance on unobservable assumptions, academic researchers, policy makers, and financial markets investors constantly give considerable attention to observable fiscal measures, specifically primary balance and public debt (Sachs, 2015). In that regard, the National Treasury introduced the MTEF estimate of the main budget non-interest spending as a ceiling in 2012. The key rationale behind introduction of the expenditure ceiling is anchored on its simplicity to calculate and communicate to the public to ensure certainty about fiscal policy path (Sachs, 2015). In practice, the “rule of thumb” for the expenditure ceiling restricts the government to nominal limits on expenditure growth over relevant medium term periods to ensure that government expenditure as a share of GDP remains stable over the long term. Therefore, critical scenarios under which amendments to the ceiling can be made are permanent structural improvements to revenues and large inflation shocks (Sachs, 2015).

Burger and Marinkov (2012) recommend approaches that can be worthwhile taking into consideration when setting fiscal rules for ensuring fiscal sustainability. Instead of setting point targets for the overall deficit and structural budget balance, a realistic approach would be to set target bands for the deficit and debt-to-GDP ratio (Burger & Marinkov, 2012). The budget deficit target band can determine the magnitudes of adjustments in revenue and expenditure that would be required to maintain fiscal sustainability. Similarly, the debt rule determines the size of adjustment in the deficit

that could be desired to maintain the actual debt-to-GDP ratio on the required margin when the ratio moves outside the restricted range. Since fiscal rules are sensitive to fluctuations in economic activity, automatic stabilisers need to be designed properly to enhance implementation of flexible fiscal rules in a simple manner that promotes fiscal sustainability. Burger and Marinkov (2012) suggest that a debt-to-GDP ratio target band should be used as the starting point in implementation of fiscal rules, anchored on a good historical record of accurate fiscal forecasts and policy credibility.

2.7. Conclusion

This chapter discussed the governance of the South African fiscal system. The major aspects of governance of the country's fiscal systems discussed include the IGFR framework, fiscal management mechanisms, the medium term planning framework, budget process and fiscal oversight and fiscal rules.

CHAPTER 3

THE SOUTH AFRICAN FISCAL FRAMEWORK

3.1. Introduction

This chapter discusses the South African fiscal framework comprised of budgetary aggregates of national government total tax- and non-tax revenue, expenditure, public debt, budget balances, tax system, and fiscal risks framework. The interaction of such budgetary aggregates and their relevant impacts on the macroeconomy form the fiscal policy of the economy (Verwey, 2015). In situations where an amendment to the fiscal framework is deemed necessary, only Parliament holds unrestricted power to amend the fiscal framework, tax policy and Division of Revenue allocations in terms of the Money Bills Amendment Procedure and Related Matters (MBAPRM) Act of 2009.

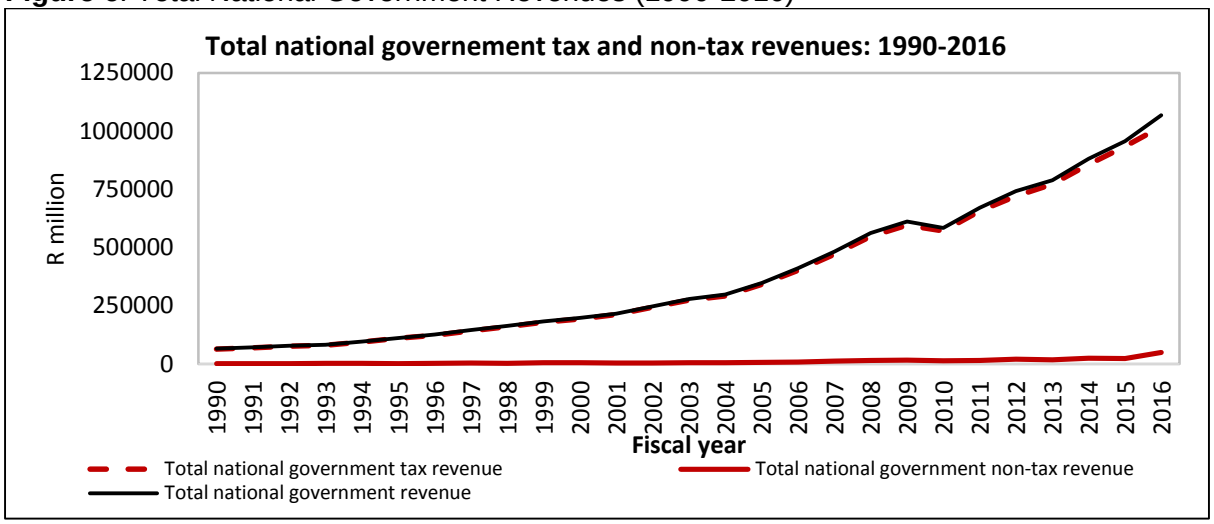
The execution of the amendment is required to follow a formalised procedure and make engagements with relevant strategic role players of the budget to ensure that amendments to allocations are in line with the national fiscal framework. Additional key reasons relating to the requirement for making consultations with relevant key role players of the budget on matters relating to any fiscal adjustments are to ensure that such adjustments do not lead to an unsustainable fiscal path, and do not put the overall sustainability of the national budget at risk (Verwey, 2015). In the 2017 Budget Review, National Treasury (2017) postulates that South Africa's fiscal framework remains devoted towards ensuring fiscal consolidation through a countercyclical approach to sustainably control expenditure, contain the budget deficit and stabilise public debt.

3.2. Revenue Trends

The major categories of total national government revenue are tax revenues and non-tax revenues. Like in many other countries, the South African economy substantially depends more domestic taxation as the primary source through which national government raises revenue required to finance public expenditure requirements. In order to ensure fiscal sustainability and macroeconomic stability, trajectories in public spending should consistently be adjusted in line with developments in tax revenues generated by the fiscus. Therefore, tax revenues are an essential fiscal indicator of a country's economic performance, given the implications they have for budget deficits

and/or public sector borrowing requirements. Figures 6 to 9 depict total national government tax revenue and non-tax revenue (nominal terms and percentage of total revenue), tax revenue versus nominal GDP, and total tax revenue-to-GDP proportion.

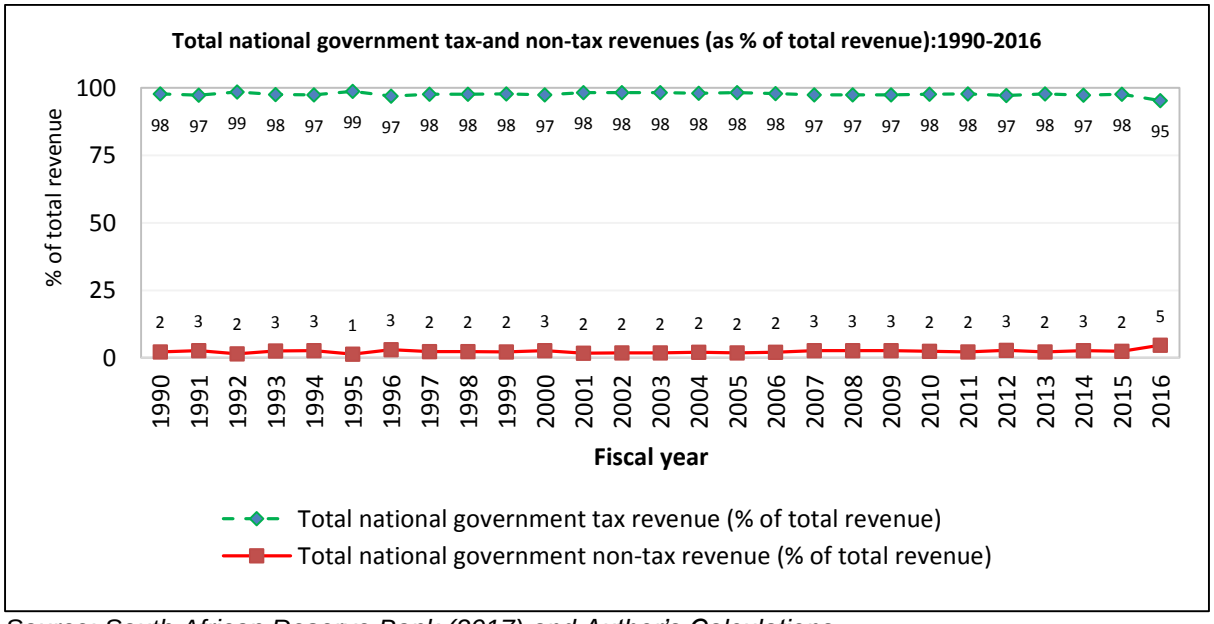
Figure 6: Total National Government Revenues (1990-2016)



Source: South African Reserve Bank (2017)

Figure 6 illustrates that total national government tax revenues remain as the key contributor to the fiscus' total national government revenue between 1990 and 2016. Tax revenue collections in the country dropped by 4.5% between 2009 and 2010. While non-tax revenues contribute very insignificantly to the total revenue of the fiscus, nominal total national government revenue has been rising exponentially.

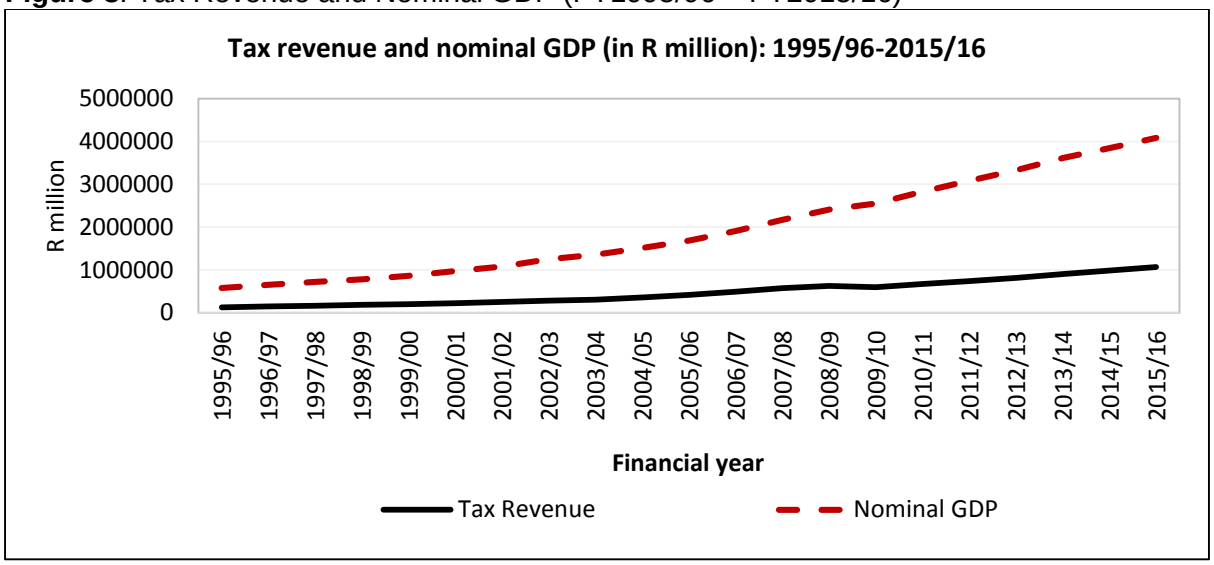
Figure 7: Total National Government Revenues Proportions (1990-2016)



Source: South African Reserve Bank (2017) and Author's Calculations

Figure 7 shows that the proportion of total national government tax revenue-to-total revenue ranged between 97% and 99% from 1990 to 2015, and dropped to 95% in 2016 from 98% in 2015. Concurrently, the contribution of total national government ranged between 1% and 3% between 1990 and 2015, and increased to 5% in 2016. Thus, tax revenues are the key contributor to national government total revenue.

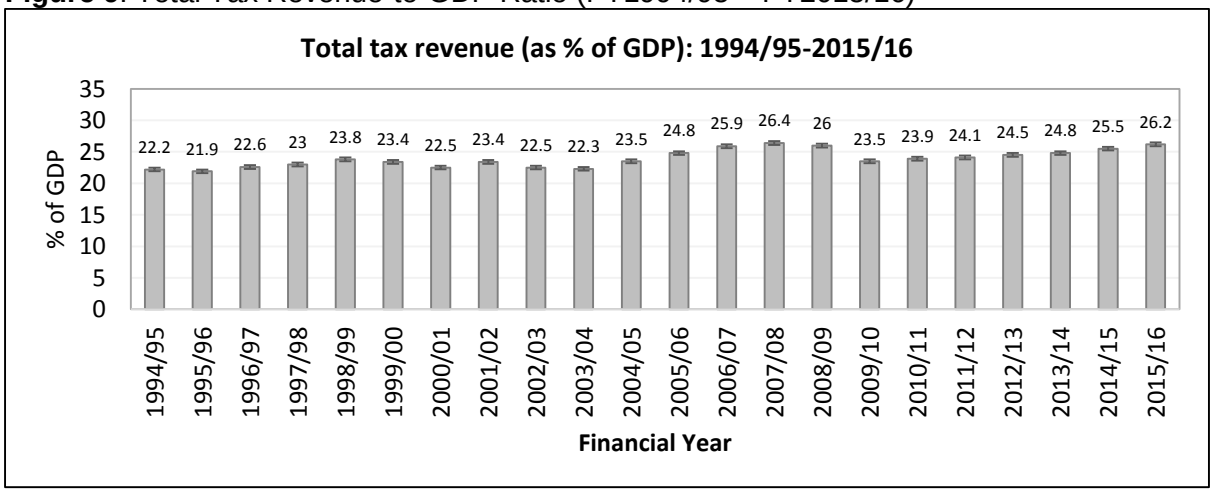
Figure 8: Tax Revenue and Nominal GDP (FY1995/96 – FY2015/16)



Source: South African Revenue Service (SARS) 2015 Tax Statistics

The trends in South Africa's tax revenue and nominal output (GDP) remained close during 1995/96 to 1999/00 (Figure 8). Despite evidence of growths in the respective macroeconomic indicators, nominal GDP increased at a continuously faster pace than the rise in tax revenue between the financial periods 2000/01 and 2015/16.

Figure 9: Total Tax Revenue-to-GDP Ratio (FY1994/95 – FY2015/16)



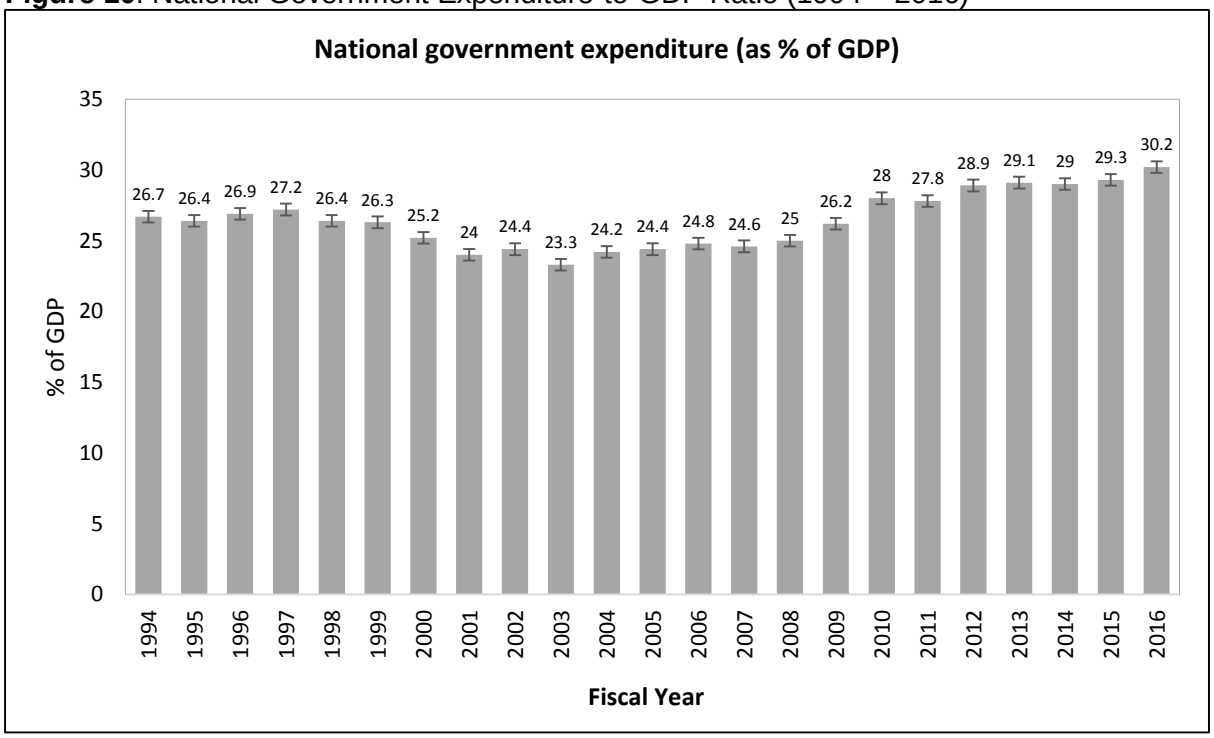
Source: South African Revenue Service (SARS) 2015 Tax Statistics

The level of taxation in an economy can be gauged by the prevailing tax to GDP ratio. Figure 9 shows that during 1994/95 to 2015/16, South Africa's total tax-to-GDP ratio remained in the range of 22.2% during 1994/95 to 26.4% during 2007/08. The proportion of tax revenue to output thus remained high over the period under review.

3.3. Expenditure Trends

Stable government expenditure trends anchored on changes in GDP growth prospects and revenue collections remain as a crucial condition for sustainable public finances. Figure 10 depicts the trend in national government expenditure during 1994 to 2016.

Figure 10: National Government Expenditure-to-GDP Ratio (1994 – 2016)



Source: South African Reserve Bank (2017)

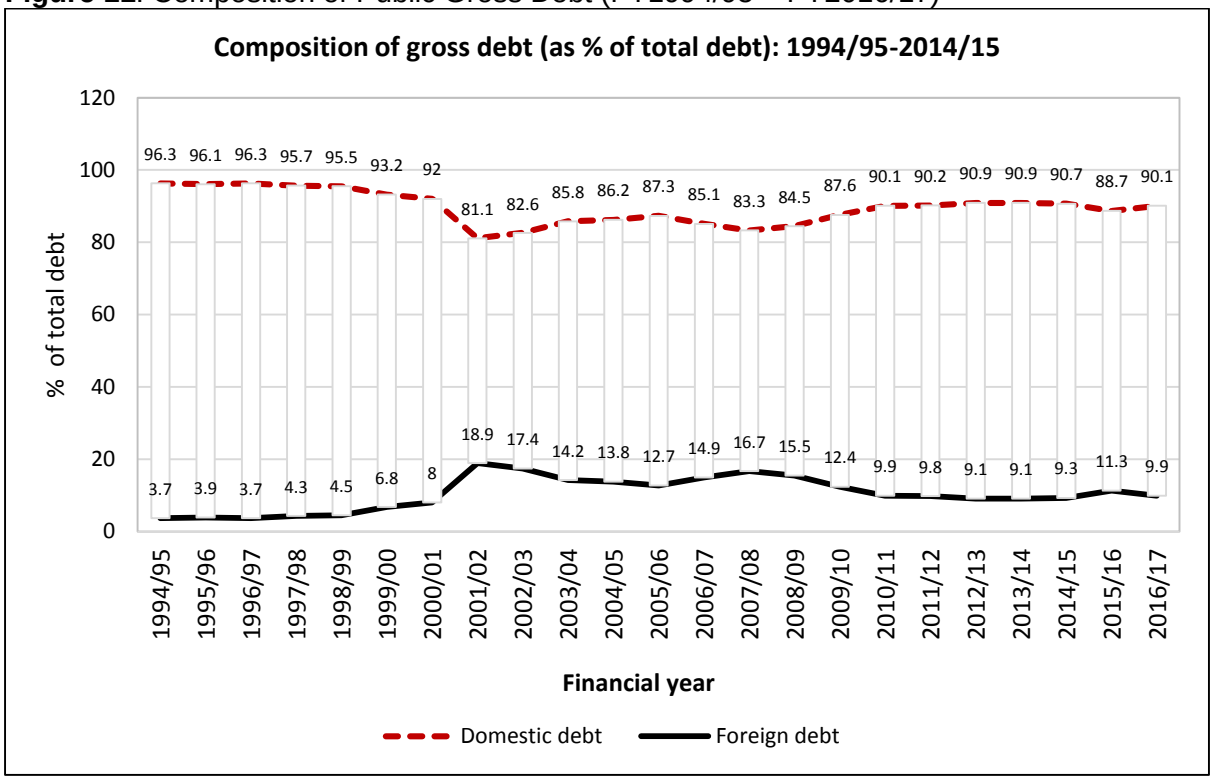
National government spending, as a proportion of GDP, remained stable during the period 1994-2016. Government expenditure-to-GDP ratio levels over the period 1994 to 2016 considerably fluctuated between 23.3% during 2003 and 30.2% during 2016.

3.4. Public Debt Trends

The sources and trends of government debt are essential indicators of the degree to which financial markets accommodate government as a borrowing agent, given the observed and perceived manner in which government manages its sovereign debt.

Subdued economic growth prospects coupled with policy risks place considerable pressure on sustainability of public finances; hence the need for fiscal consolidation that constricts fiscal deficits and stabilise public debt-to-GDP ratio. The National Treasury 2017 Budget Review points out that one of the central objectives of fiscal policy should be stabilisation of public debt through reduction of budget deficit. Figure 11 depicts composition of South Africa's public gross debt during 1994/95 to 2016/17.

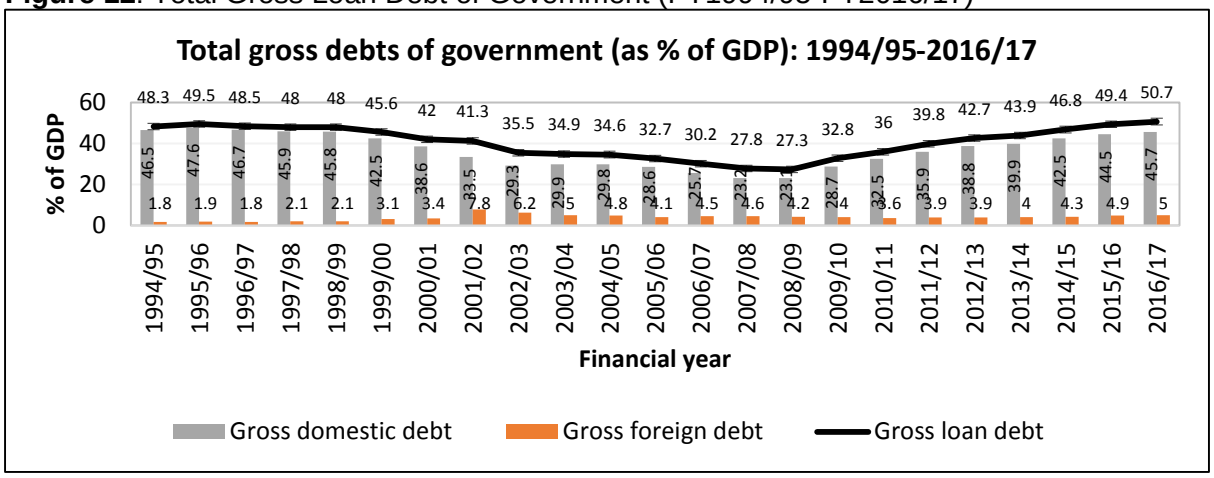
Figure 11: Composition of Public Gross Debt (FY1994/95 – FY2016/17)



Source: National Treasury 2017 Budget Review Statistical Tables

Figure 11 shows that the domestic market remains as the country's major source of government borrowing. From the total public gross debt during the period 1994/95 to 2016/17, the highest proportion of domestic debt stood at 96.3% during 1994/95 while the lowest proportion stood at 81.1% during 2001/02. A substantial increase in the proportion of foreign debt by 10.9 percentage points from 8% during 2000/01 to 18.9% during 2001/02 was realised to compensate for the drop in the proportion of domestic debt by 10.9 percentage points from 92% during 2000/01 to 81.1% during 2001/02. Based on the National Treasury 2017 Budget Review, government debt remains within optimal benchmarks while liquid domestic capital markets remain as the government's main source of borrowing despite volatile market conditions (National Treasury, 2017).

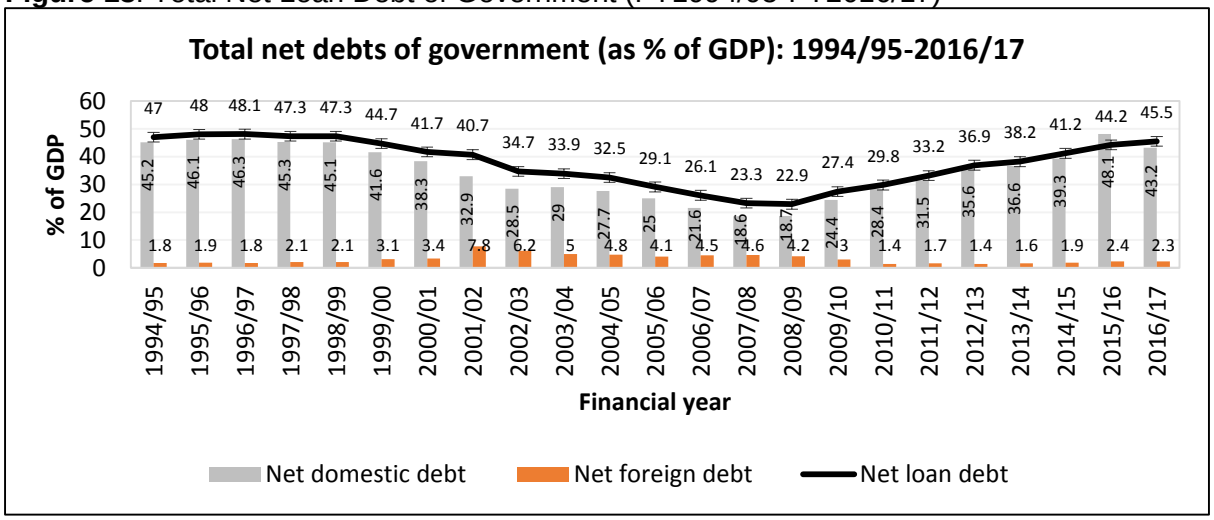
Figure 12: Total Gross Loan Debt of Government (FY1994/95-FY2016/17)



Source: National Treasury 2017 Budget Review Statistical Tables

Figure 12 shows that, gross loan debt-to-GDP ratio consistently declined from 49.5% during 1995/96 to 27.3% during 2008/09, and progressively increased to a projected record of 50.7% during 2016/17. While total foreign loan debt as a proportion of GDP constantly remains below 8% throughout the period 1994/95 to 2016/17, the highest gross domestic debt-to-GDP ratio stood at 47.6% during 1995/96. The ratio steadily rose from lowest mark of 23.1% during 2008/09 to 45.7% during 2016/17.

Figure 13: Total Net Loan Debt of Government (FY1994/95-FY2016/17)

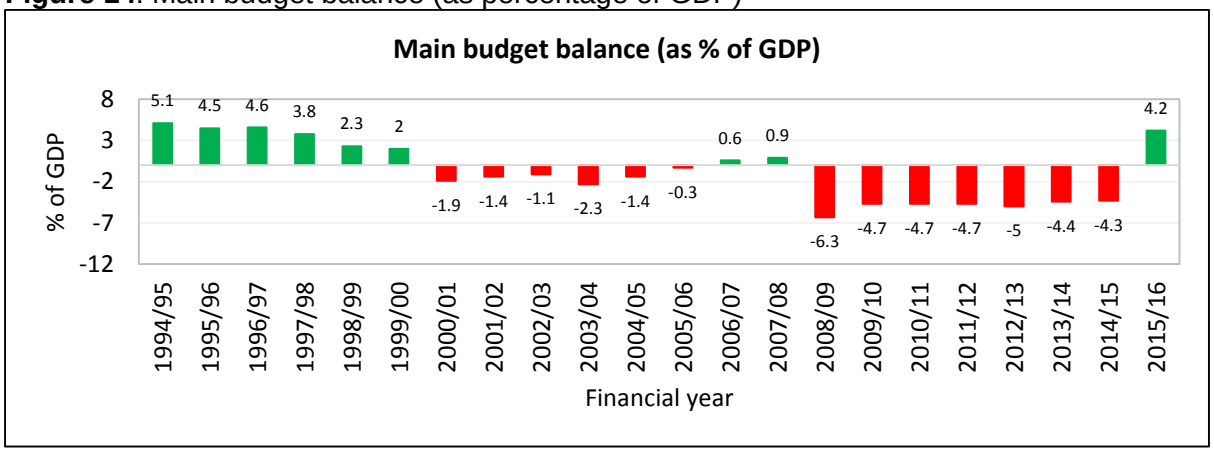


Source: National Treasury 2017 Budget Review Statistical Tables

Figure 13 shows that net loan debt-to-GDP ratio steadily reduced from 48.1% during 1996/97 to 22.9% during 2008/09, and progressively increased to a projected record of 45.5% during 2016/17. Similarly, net domestic debt-to-GDP ratio declined from 46.3% during 1996/97 to 18.6% during 2007/08, and rose to 43.2% during 2016/17.

3.5. Fiscal Balances Trends

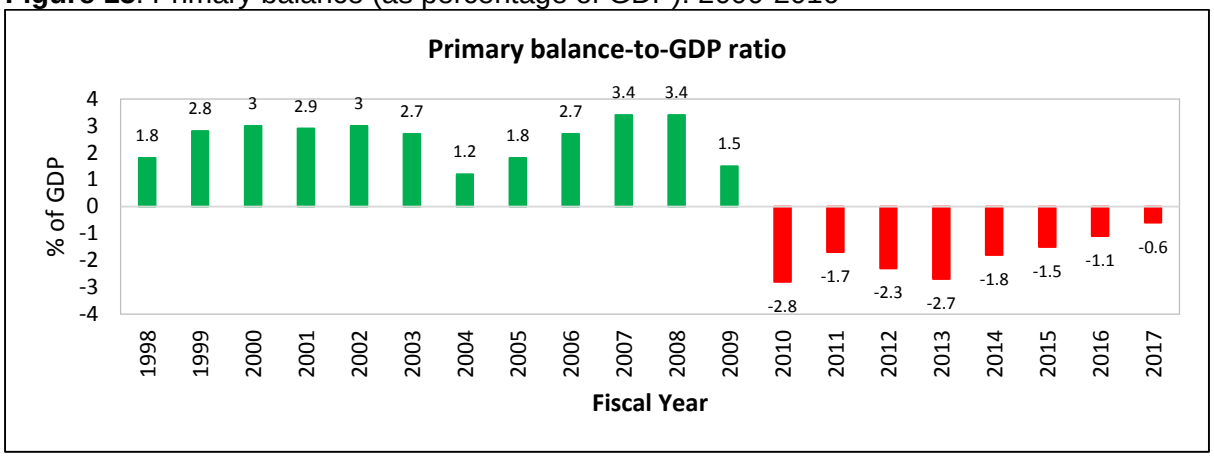
Figure 14: Main budget balance (as percentage of GDP)



Source: National Treasury 2016 Budget Review Statistical Tables

Figure 14 shows that the main budget balance-to-GDP ratio remained in surplus over the period 1994/95 to 1999/00. With the exception of financial years 2006/07 and 2007/08, the main budget balance remained in deficit over the period 2000/01 to 2014/15. The largest budget deficit of -6.3% occurred during 2008/09, remained below -4% during 2009/10 to 2014/15 and improved into a surplus of 4.2% during 2015/16.

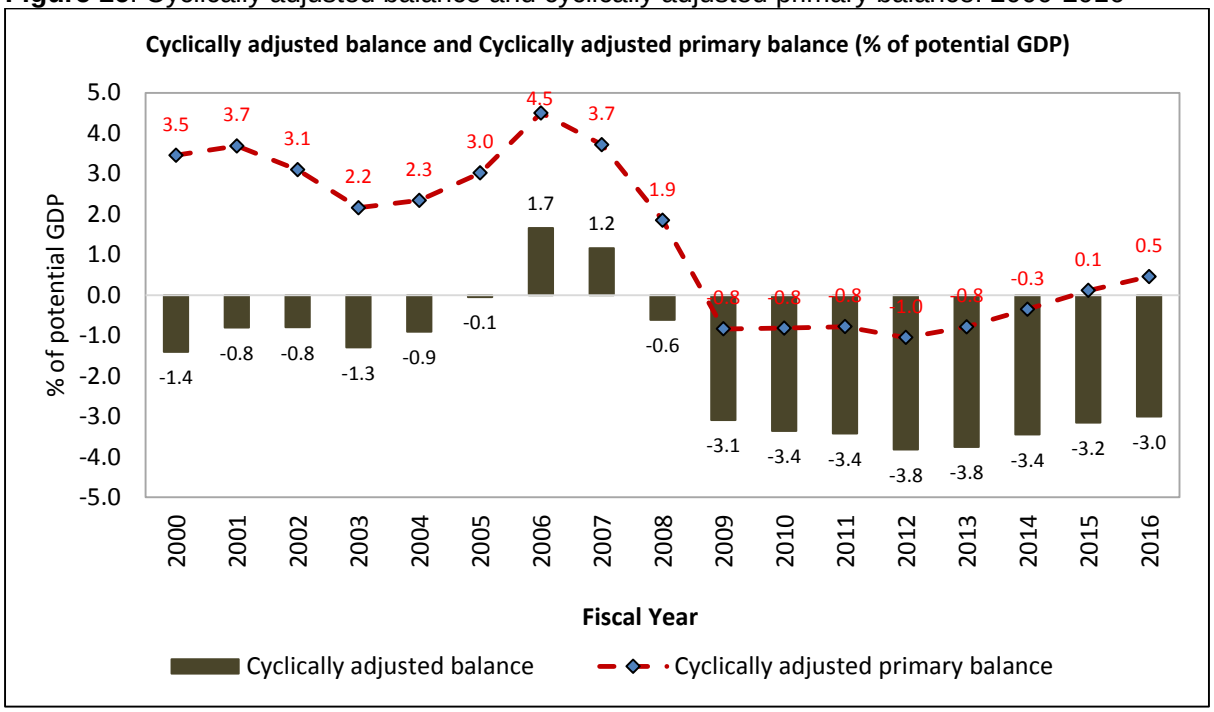
Figure 15: Primary balance (as percentage of GDP): 2000-2016



Source: South African Reserve Bank (2017)

Primary balance-to-GDP ratio remains a crucial determinant of public debt dynamics. Stabilisation of public debt-to-GDP ratio requires adequate primary surpluses to be generated over time. Figure 15 shows that the country maintained primary surplus positions ranging from 1.2% in 2004 to 3.4% in 2007 and 2008 over the period 1998 to 2009. Conversely, the country experienced primary deficits positions over the period 2010 to 2017, steadily narrowing from -2.8% in 2010 to -0.6% in 2017.

Figure 16: Cyclically adjusted balance and cyclically adjusted primary balance: 2000-2016



Source: IMF (2017) Fiscal Monitor

The *cyclically adjusted balance (CAB)*, also called "full employment budget balance" refers to the budget or fiscal balance that would be realised under present policies if the country's output were equal to its full potential. Technically, the cyclically adjusted balance indicates the economy's latent fiscal position when cyclical and/or automatic movements are detached. The cyclically adjusted balance depicted in Figure 16 shows that South Africa's decomposed fiscal position was largely depressed during the period 2000-2016. While cyclically adjusted surpluses of 1.7% and 1.2% were only realised during 2006 and 2007 respectively, the periods 2000-2005 and 2008-2016 recorded average cyclically adjusted balances of -0.9% and -3.1% respectively.

Congruently, the cyclically adjusted primary balance (CAPB) is the cyclically adjusted balance less net interest payments. The interest payments are excluded since their automatic movements are often not correlated with changes in cyclical output. South Africa's cyclically adjusted primary balance was in a surplus territory during the period 2000 to 2008. The surplus varied between 4.5% during 2006 and 1.9% during 2008, recording an average surplus of 3.1% between 2000 and 2008. During the period 2009 to 2014, the cyclically adjusted primary balance varied between -1% and -0.3% and recorded an average of -0.8% during 2009 to 2014.

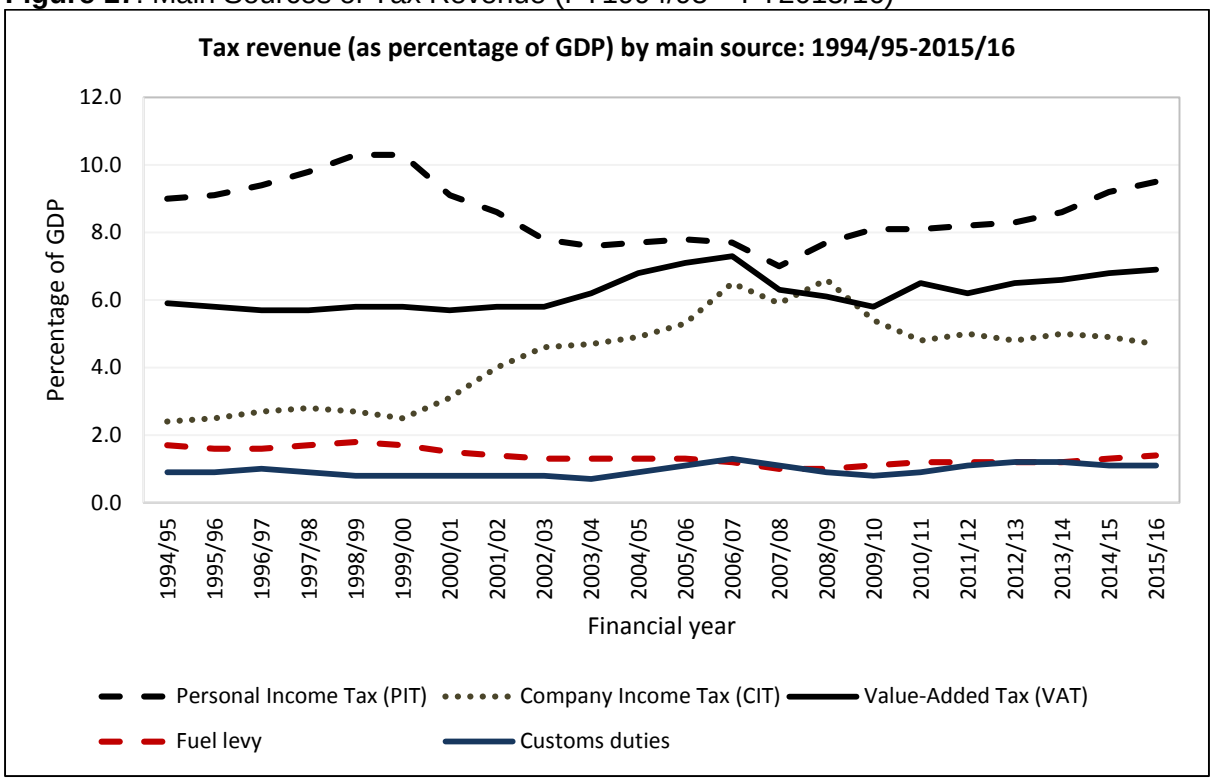
3.6. The South African Tax System

Tax revenue collections in South Africa are largely dependent on economic growth, effectiveness and efficiency of tax administration. The Davis Tax Committee (DTC, 2016) underscores that the country's tax policy framework plays a key role towards supporting fiscal sustainability, among other broad macroeconomic objectives such as investment absorption, economic growth, job creation, and price stability. Following recommendations of the Katz Commission, the South African tax system is regarded as relatively robust and competitive vis-à-vis other countries. The tax system greatly improved from numerous frontiers, which include formation of an autonomous tax and customs administration institution called SARS, intensification of the tax base and lowering of marginal tax rates (DTC, 2016). Although the payment of taxes remains a legal obligation in any given sovereign nation, the effectiveness of the tax system largely depends on the magnitude of willingness and compliance by the nation's natural and corporate citizens (National Treasury, 2017).

In light of the backdrop of the triple challenge of unemployment, poverty and inequality, the country has been facing since attainment of democracy, consistent review of the tax policy framework has been regarded as a necessary requirement to ensure fiscal sustainability, socio-economic growth and development in the country (DTC, 2016). Essentially, rigorous and appropriate reviews of the tax policy framework have helped the country maintain a progressive and transparent tax structure that ensures equity and efficiency of in collection of tax revenue in a way that does not depress economic growth, international trade, investment and creation of jobs.

Although the success in achieving fiscal sustainability depends on maintaining public debt-to-GDP ratio on a sustainable path, maximisation of growth subject to revenue adequacy and government's intertemporal budget constraint are equally important conditions for tax reform and fiscal prudence (DTC, 2016). Concomitantly, success in tax system reform depends on consistency in fiscal consolidation and the ability of countercyclical fiscal policy to mitigate domestic and global shocks to the economy. Figure 17 below shows the trends of main tax revenue sources as percentage of GDP over the period 1994/95 to 2015/16.

Figure 17: Main Sources of Tax Revenue (FY1994/95 – FY2015/16)



Source: South African Revenue Service (SARS) 2015 Tax Statistics

As shown by Figure 17, the primary sources of national tax revenue in South Africa are personal income tax (PIT), value added tax (VAT) and corporate income tax (CIT). Personal income taxes remain the largest source of tax revenue in the economy. During the period 1994/95 to 2015/16, the lowest proportion of personal income tax revenue as a percentage of GDP stood at 7% during 2007/08, while the highest proportion stood at 10.3% during 1998/99 and 1999/00. Since continued decline in the PIT revenue as a percentage of GDP from 10.3% during 1999/00 to 7.0% during 2007/08, a remarkably stable recovery has been witnessed from 7.7% during 2008/09 to 9.5% during financial year 2015/16.

Given that a tax is basically defined by its rate (percent), and its base (amount actually taxed), South Africa's PIT has a progressive structure where higher incomes are taxed at higher rates. In efforts to mitigate declines in growth of tax revenue collections to maintain current spending programmes, fiscal authorities proposed to raise tax rates mainly at the upper income group during tabling of the 2017/18 Budget Review. The proposal reflects the progressive nature of the country's PIT system to ensure that equity remains observed in the economy's tax system (National Treasury, 2017).

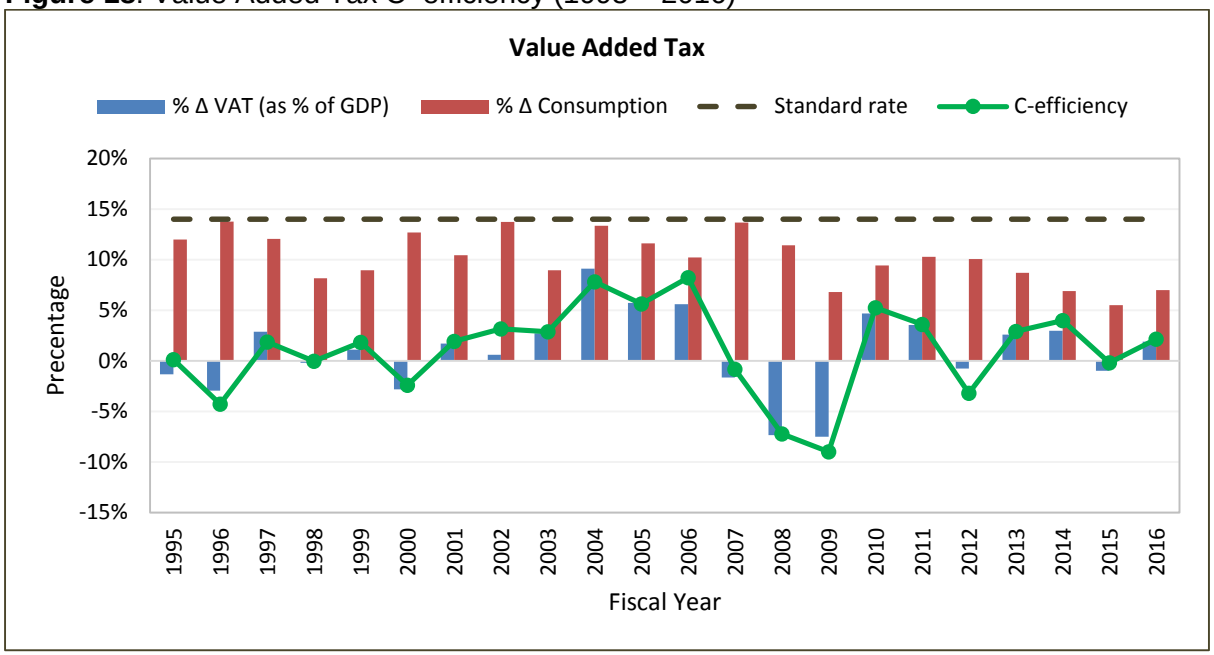
VAT was introduced in South Africa in 1991 to replace General Sales Tax (GST). It is an indirect, mildly progressive, certain and buoyant tax. This tax instrument remains the second main source of tax revenue over the period 1994/95 to 2015/16. Since 1993, VAT in South Africa is levied at a standard rate of 14% on goods and services consumed domestically and imported into the country. According to the DTC (2015), any upward adjustment of the VAT rate would need to be accompanied by enactment of rigorously assessed mechanisms to compensate low-income households and consumers. However, there is a limited range of goods and services that qualify for either a zero rate of VAT and/or VAT exemption in order to bring relief to consumers. Since 1993, a few basic commodities were zero-rated, such as eggs, fresh vegetables, milk and maize meal (DTC, 2016).

Given that VAT is charged at every stage of production and distribution, it is therefore proportional to distinct prices charged for goods and services. Based on Figure 15, VAT remains the main contributor of tax revenue to the fiscus since attainment of democracy in 1994. The VAT-to-GDP ratio progressively remained between 5.7% and 5.8% during 1995/96 to 2002/03, before steadily improving to a peak of 7.3% during 2006/07. However, the proportion plummeted from 7.3% during 2006/07 to 5.8% during 2009/10, before steady recovery to 6.9% during 2015/16. In relation to tax buoyancy, VAT yields are frequently driven by trends in consumption levels in the economy. In South Africa, household consumption is less sensitive to business cycles than firms, reflecting that VAT is minimally affected by business cycles compared to CIT in the country (DTC, 2016). Based on empirical evidence from the analysis conducted by Keen (2013), there are largely two factors which influence changes in VAT revenues, namely, C-efficiency and change in consumption. Figure 16 below shows the trends of changes in VAT yields comparative to changes in consumption and the C-efficiency calculated based on equation (3.7.1) below:

$$C^{eff} = \frac{\Psi}{\pi \Omega} \tag{3.7.1}$$

where C^{eff} denotes C-efficiency, Ψ represents VAT revenues, π signifies the standard rate of VAT, and Ω represents final consumption expenditure less VAT revenues. Computationally, C-efficiency is therefore a ratio of VAT revenue to the product of the standard VAT rate and final consumption expenditure less VAT revenue (Keen, 2013).

Figure 18: Value Added Tax C–efficiency (1995 – 2016)



Source: Author's calculations using data from SARB (2017)

Consistent with empirical findings from the analysis conducted by Keen (2013), annual percentage changes in VAT yields as a percentage of GDP in South Africa are greatly influenced by changes in the C-efficiency factor relative to changes in consumption expenditure. The DTC (2016) defines C-efficiency as an indicator that measures the magnitude of departure of VAT from an impeccably enforced tax levied at a constant rate on all consumption. From a technical stance, the C-efficiency factor indicates gaps in compliance and existing tax policy. Gaps in the existing tax policy primarily include tax refunds and zero-rated or exempted commodities (DTC, 2016). As presented in Figure 18, changes in C-efficiency drastically worsened from -1% in 2007 to -7% in 2008 and -9% in 2009 before convalescing to 5% in 2010. Congruently, variations in VAT yield as a percentage of GDP in South Africa plunged from -2% in 2007 to -7% in 2008 and -8% in 2009 before recuperating to 5% in 2010. The upsurges in the C-efficiency factor after the year 2009 reflect improvements in base broadening and compliance to the tax law in the country.

Concerning CIT, the actual tax rate paid by companies in South Africa varies by sector owing to differentials in tax incentives that are designed to enable and stimulate corporate investment, profitability and demand for labour. Although tax incentives promote investment in a country, a conducive investment environment characterised by policy certainty, institutional capacity and political stability among other measures

of good governance have much larger influence on corporate investment decisions (National Treasury, 2017). Verwey (2015) and National Treasury (2017) concur that CIT in South Africa largely remains elastic with respect to growth. In that regard, improvements in economic growth translates into higher corporate profits that can be taxed by the country. However, the National Treasury (2017) points out that the CIT rate of 28% currently being taxed on corporate entities remains higher compared to the average of 25% for the Organisation for Economic Cooperation and Development (OECD), which potentially exposes the fiscus to base erosion and/or profit shifting vulnerabilities. In order to maintain and increase corporate tax revenues, the most viable option fiscal authorities can be tax base broadening by reducing tax incentives and adopt measures that curb tax avoidance.

The general fuel levy, a component of the three major fuel taxes together with the Road Accident Fund (RAF) levy and customs and excise levy, remains the fourth main source of tax revenue in South Africa. The contribution of fuel levy to total tax revenue as a percentage of GDP sustainably fluctuated between 1% and 2% over the period 1994/95 to 2015/16. Based on the National Treasury 2017 Budget Review, the general fuel levy for 93 octane petrol increased from R2.55/litre during 2015/16 to R2.85/litre during 2016/17 and R3.15/litre during 2017/18. Similarly, the fuel levy for diesel increased from R2.40/litre during 2015/16 to R2.70/litre during 2016/17 and R3.00/litre during 2017/18. In terms of the customs duties, also called import tariffs, the rates have progressively been reduced to enhance trade liberalisation and ensure that industries become more competitive. Since South Africa is a member of the South African Customs Union (SACU), all customs duties collected within SACU are shared among member states of the block according to the designed revenue sharing formula. However, revenues from customs duties do not greatly contribute to the total revenue pool of the South African fiscus relative to other member states.

3.6.1. Tax Revenue Buoyancy

Based on the “certainty, simplicity, administrative efficiency, and equality” four major canons of a good tax system (Musgrave, 1966), tax-revenue buoyancy remains an important indicator and simple criterion extensively used to objectively measure the efficiency of tax system in an economy with regards to revenue mobilisation. Therefore, tax buoyancy objectively assesses the magnitude to which output growth

in an economy can contain and reduce fiscal deficits from the budget revenue side during a given specific period of time (Belinga, Benedek, de Mooij, and Norregaard, 2014). In classic terms, tax buoyancy refers to the total response of tax-revenue to changes in an economy's national income and discretionary adjustments in tax policy over time. From a public finances sustainability standpoint, changes in levels of public spending need to be matched with changes in revenue mobilisation through taxation in order to reduce or avoid large budget deficits.

Following Twerefou, Fumey, Osei-Assibey, and Asmah (2010), the global buoyancy of a country's tax system is measured by the relative change in total tax revenue with respect to the proportional change in national output, defined by the function:

$$\beta_{TY} = \frac{\Delta T}{\Delta Y} \text{ x } \frac{Y}{T} \tag{2.7.2}$$

where β_{TY} represents the buoyancy coefficient, T denotes total tax-revenue, and Y signifies nominal GDP or national income.

Decomposing equation (2.7.2) into individual tax buoyancy elements yields:

$$\beta_{TY} = \frac{T_a}{T_t} B_{T_a Y} + \frac{T_b}{T_t} B_{T_b Y} + ... + \frac{T_n}{T_t} B_{T_n Y} \tag{2.7.3}$$

$$where: T_t = T_a + T_b + ... + T_n \quad and \quad n \quad denotes \quad the \quad number \quad of \quad taxes.$$

The global buoyancy of a tax system is hence given by the weighted sum of distinct tax buoyancy, and used to estimate the elasticities (η_s) of tax revenue with respect to *tax-to-base* and *base-to-income* (Twerefou et al., 2010), defined by the functions:

$$\text{Tax} - \text{to} - \text{base } \eta = \frac{\Delta T}{\Delta B} \text{x} \frac{B}{T} \tag{2.7.4}$$

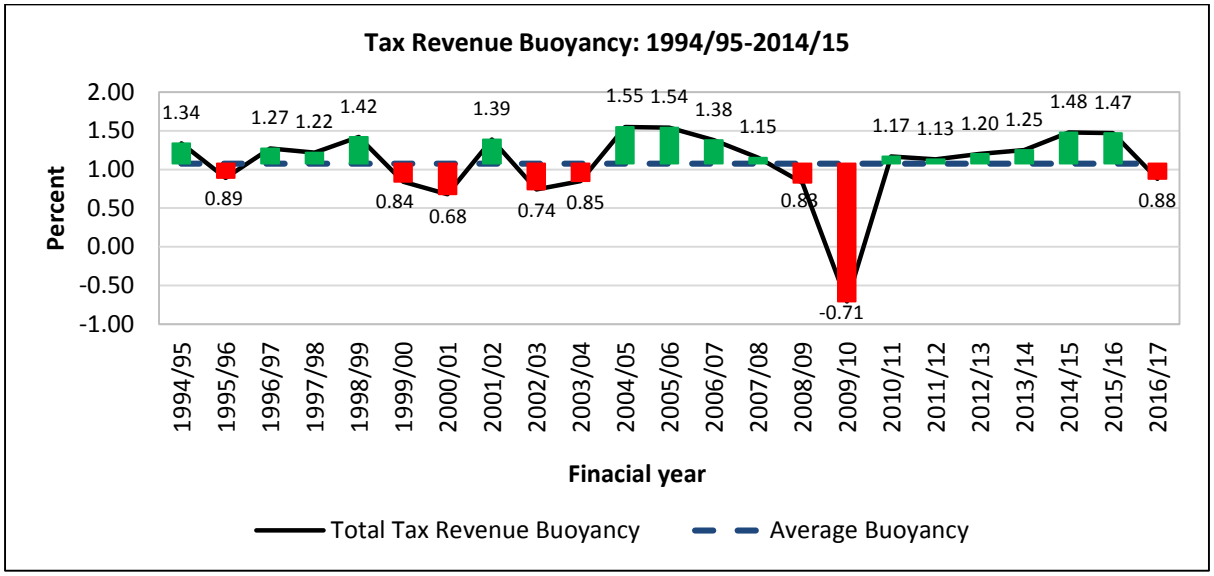
$$\text{Base} - \text{to} - \text{income } \eta = \frac{\Delta B}{\Delta Y} \text{x} \frac{Y}{B} \tag{2.7.5.}$$

Based on equations (2.7.4) and (2.7.5), the global buoyancy is therefore defined as:

$$B_{TY} = \left(\frac{\Delta T}{\Delta B} x \frac{B}{T}\right) x \left(\frac{\Delta B}{\Delta Y} x \frac{Y}{B}\right) \quad (2.7.6)$$

Figure 19 demonstrates the tax revenue buoyancy of the South African economy during the period 1994/95 to 2014/15.

***Figure 19**: Tax Revenue Buoyancy (FY1994/95 – FY2015/16)*



Source: South African Revenue Service (SARS) - 2015 Tax Statistics and National Treasury (2017)

Figure 19 depicts that South Africa's total tax revenue buoyancy statistics (buoyancy coefficients greater than 1) reveal that the country's overall tax system was buoyant for most of periods between 1994/95 and 2014/15. Highest significant buoyancies of the overall tax system were observed for the financial years 2004/05, 2005/06, 2014/15 and 2015/16; with total tax revenue buoyancy coefficients of 1.55, 1.54, 1.48 and 1.47 respectively. Moderate total tax revenue buoyancies were observed for the financial years 1994/95 (buoyancy coefficient = 1.34), 1996/97 to 1998/99 (buoyancy coefficients in the range 1.22 to 1.42), 2006/07 and 2007/08 (buoyancy coefficients of 1.38 and 1.15; respectively), and 2010/11 to 2013/14 (buoyancy coefficients ranged between 1.13 during 2011/12 and 1.25 during 2013/14).

Given that high tax buoyancy reflects built-in flexibility in the country's tax structure, the buoyancy coefficients greater than 1 indicate evidence of South Africa's more than proportionate responses of tax revenues to upsurges in GDP. Therefore, South Africa's total tax system demonstrates high magnitudes of responsiveness over the period 1994/95 to 2016/17. However, South Africa's worst total tax revenue buoyancy

was -0.71 during 2009/10 when the global economy experienced a financial crisis. The country's tax buoyancy in 2016/17 was low at 0.88, down from 1.47 during 2015/16.

3.6.2. Fiscal Forecasts and Fiscal Policy Credibility

In order to optimise the contribution of fiscal rules towards enhancing and maintaining fiscal sustainability, fiscal authorities need to ensure that the fiscal policy demonstrates a good record of credibility and accurate forecasts of fiscal aggregates. Consistent with findings from some studies in other countries (Franke, 2011; Frankel and Schreger, 2012), Calitz, et al. (2016) maintain that the credibility of fiscal policy in South Africa is determined by the magnitude of accuracy of forecasts of fiscal and macroeconomic aggregates used in annual national budget processes. Furthermore, Calitz, et al. (2016) assessed the accuracy of the National Treasury's fiscal forecasts compared to those of other nations, and evaluated whether relevant fiscal forecasts improved over time. The study assessed the accuracy of forecasts of macroeconomic aggregates included in the national budget relative to macroeconomic forecasts of non-government economists.

In terms of fiscal forecasts, Calitz, et al. (2016) assessed the accuracy of National Treasury's official forecasts of national budget revenue (R), national budget expenditure (G) and national budget balance (B). In this regard, these researchers used *budget estimates* (data in the Budget Review during presentation of the National Budget by the Minister of Finance to Parliament in February each year), *revised estimates* (forecasts for a given budget year revised during the course of the same budget year, but appear in the Budget Review for the following budget year) and *final figures*. The forecasting errors are classified into three types, namely, *implementation error, forecast error and revision error*. The implementation error, calculated by subtracting the budget estimate from the revised estimate, measures the magnitude to which the budget design needed to be adjusted based on recent economic data and other relevant information. Forecast error is calculated by subtracting the budget estimate from the final figure. The revision error, calculated by subtracting the revised estimate from the final figure, measures the gap or error that could have remained after adjustments have been made to the budget figures based on recent economic data and relevant updated information.

Using fiscal and GDP data for the period 2000/01 to 2010/11, Calitz, et al. (2016) assessed the accuracy of South Africa's fiscal forecasts based on the orthodox Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) statistical measures of accuracy. The country's budget balance over seven successive years from 2000/01 to 2006/07 have been found to be substantially favourable owing to actual outturns of revenue that largely exceeded the budgeted revenue versus actual expenditure that marginally exceeded the budgeted outlays. On average, the largest proportion of forecast error in the deficit or budget balance as a ratio of GDP was accounted for by 72.1% in revenue forecast errors, followed by 22.1% average forecast errors in expenditure and 5.8% forecast errors in nominal GDP.

In several years over the sample period, the errors partially neutralised each other concerning their impact on the ultimate budget balance-to-GDP ratio. After eliminating the 2009/10 recession year from the sample, the observed upward trend of the budget balance forecast error as a ratio of GDP suggest lack of evidence of improved ability in forecasting (Calitz, et al., 2016). Despite variations in magnitudes of errors in revenue, expenditure and GDP forecasts, the budget balance forecasts by the National Treasury are regarded as relatively accurate by global standards. Furthermore, Calitz, et al. (2016) buttress that findings from the study by Frankel (2011) indicate that the magnitude of official deficit forecast errors for South Africa are comparable to the global average. In the same vein, Frankel (2011) found evidence of the tendency of underestimation of the deficit across 33 countries while South Africa on contrary tends to overestimate its deficit. Over the period 2000/01 to 2010/11, South Africa's national budget average Mean Absolute Error (MAE) was 26% smaller than the mean of 1.83 for 14 countries in the European Union (EU).

3.7. Fiscal Risks Framework

According to the IMF (2009), fiscal risks refer to possible deviations of actual fiscal outturns from outcomes that were expected at the time of tabling the national budget. In practice, fiscal outcomes usually differ largely from budget and fiscal forecasts owing to diverse factors like shocks to key macroeconomic variables, forecasting capacity, political climate, and global economic trends. Given that the sources of fiscal risks vary from one country to another, the manner in which country-specific risks are disclosed has serious implications for fiscal sustainability. Coupled with strong public

financial management system and macroeconomic policy framework, effective identification, evaluation, disclosure and management of fiscal risks are key requisites for safeguarding fiscal policy sustainability in any economy (IMF, 2009).

3.7.1. Sources and Significance of Fiscal Risk

Fiscal risks emanate from different shocks to fiscal and macroeconomic aggregates such as government revenue, expenditure and debt levels, economic growth, interest rates, exchange rates, labour market disruptions, inflation, commodity prices and contingent liabilities (IMF, 2009). The approaches used for disclosure, management and mitigation of fiscal risks should take into account whether fiscal risk are temporary or permanent, the magnitude of deviations of outcomes from official forecasts, and quantification of the risk. Automatic stabilisers may easily correct fiscal risks arising from temporary shocks, while fiscal risks emanating from permanent shocks that affect fiscal sustainability may require a blend of sound policy actions to correct the deficit. The accuracy of forecasts for fiscal and macroeconomic aggregates plays a major role in mitigating fiscal risk since significant forecast errors due to weak forecasting ability reduce the likelihood of reducing fiscal risk.

Disclosure of a fiscal risk in a quantitative or qualitative manner is largely conditional upon the probability of accurately estimating the fiscal cost of the anticipated episode and the likelihood of its occurrence. The IMF (2009) regards circumstances where an episode's anticipated cost cannot be quantified as "uncertainty", and circumstances where the probabilities and costs of events can be quantified as "risk". Since fiscal sustainability is a long-term issue, unexpected changes in fiscal and macroeconomic aggregates such as GDP growth, debt-to-GDP and deficit-to-GDP ratios, calculated as differences between budget estimates and final figures, have implications for fiscal sustainability. Based on findings of the IMF (2009), forward-looking estimates of fiscal risks derived based on standardised bound tests in 19 developed and emerging market economies reveal that a one-half standard deviation shock to GDP growth could lead to an average increase in debt-to-GDP ratio by 6.8 percentage points five years later. Similarly, a one-half standard deviation shock to the primary deficit would lead to 5.2 percentage points rise in debt-to-GDP ratio after five years.

Most unexpected upsurges in public debt-to-GDP ratio in nations that operate floating exchange rate systems are largely attributed to exchange rate depreciations and calls on contingent liabilities (IMF, 2009). In addition, calls on guarantees, public private partnerships (PPPs) on large investment or infrastructure projects and government bailouts on public enterprises and sub-national government spheres are another major source of fiscal risks. In order to effectively manage such fiscal risks, fiscal authorities should publicly disclose information on such risks in a transparent manner to enable government make informed decisions on whether or not to take such risks (IMF, 2009). Reliable public disclosure of fiscal risks enhances fiscal transparency, sovereign bond ratings and access to domestic and foreign capital markets for government borrowing. Cross-country regressions conducted by the IMF (2009) on a sample of 54 nations surveyed at different time periods during 1999 to 2007 report evidence of significant and positive association between overall fiscal transparency (disclosure of fiscal risk) and sovereign bond ratings and access to capital markets, ceteris paribus.

3.7.2. Fiscal Risks Disclosure and Management

Sound macroeconomic policies, fiscal risk regulatory and administrative frameworks, appropriate public debt management strategies, and systematic integration of fiscal risk analysis into medium term fiscal planning and budget processes are prerequisites for cost-effective mitigation of fiscal risks (IMF, 2009). As such, improved transparency in disclosure of information on fiscal risks creates room for additional rigorous analysis, which further improves accountability by government. Essentially, standard practices of fiscal risk disclosure require budget documentation to show an analysis of fiscal sustainability, overall risk mitigation strategy, alternate macroeconomic scenarios and sensitivities of fiscal aggregates to alterations in assumptions, descriptions of the nature and fiscal significance of quasi-fiscal activities and associated risks, public debt management strategy and information on contingent liabilities (IMF, 2009). The identified fiscal risks should systematically be integrated into fiscal analysis and budget process, and macroeconomic policy framework to ensure that such fiscal risks can be rigorously scrutinised and integrated into fiscal sustainability analysis.

Based on guidelines provided by the IMF (2009) with regards to public disclosure of fiscal risks, a single "*Statement of Fiscal Risks*" should be used by countries to present their relevant fiscal risks for each budget year. The probable structure of the respective

statement can be adapted by countries based on their applicable characteristics, such as relevance of shocks and institutional arrangements. The statement could begin with a concise description of how the government's overall fiscal strategy could have reduced fiscal risks to ensure fiscal policy sustainability. The sources of fiscal risks covered in the statement include macroeconomic risks and budget sensitivity, public debt composition, contingent central government expenditures, PPPs, state-owned enterprises (SOEs), and subnational governments.

Depending on country-specific conditions, sound strategies for fiscal deficit or debt reduction are the major approaches used to mitigate fiscal risks. Numerous countries such as Japan, Armenia, Hungary, Italy, Mexico, and Indonesia implemented formal debt management strategies, while some countries such as South Africa adopted explicit targets for public debt durations, maturity profiles of public debt service and proportions of public debt denominated in foreign currency (IMF, 2009). In mitigating fiscal risks linked to PPPs, government can allocate or transfer certain project risks such as design and implementation risks to agents that have the technical capacity to manage those risks, while government manages political and regulatory risks.

3.7.3. Fiscal Risks Disclosure in South Africa

The IMF (2009) guidelines for disclosure of fiscal risks stipulate that "*fiscal risks to which the government is exposed should be identified and disclosed, so as to facilitate an effective conduct of fiscal policy*". Stuart and Dlamini (2015) define fiscal risk as "*possible adverse events that could substantially affect the probability of government to attain its budgetary commitments and long-term fiscal sustainability"*. Since the overall management of the fiscus in a country remains the mandate of the Ministry of Finance, the authority of identification, disclosure, monitoring and management fiscal risks should be assigned to a central unit with sufficient technical capabilities in the respective ministry (IMF, 2009). In South Africa, the National Treasury formed a Fiscal Risks Committee in 2014 to develop a fiscal risks framework that aims to enhance achievement of the nation's fiscal targets (Stuart and Dlamini, 2015). The respective risks are classified into short-term, medium-term and long-term risks. Short-term risks are those that can possibly arise during the current financial year. Conversely, medium-term risks are those that can probably occur during the three-year budgeting

phase. On the contrary, long-term risks are those that are expected to occur during the post-MTEF period (Stuart and Dlamini, 2015).

The combination of overestimated growth projections, sluggish fiscal consolidation and rising public debt resulted in recognition of the need to ensure extensive reporting of fiscal risks as part of efforts to ensure fiscal sustainability through counter-cyclical stimulus, and compelled fiscal authorities to adopt institutional reforms. In the beginning of 2012/13 fiscal year, an expenditure ceiling (explicit limit on main budget non-interest spending) was introduced whereby medium-term expenditure estimates are converted into numerical targets instead of baselines (Stuart and Dhlamini, 2015). Moreover, the modelling of the nation's long-term fiscal outlook was also conducted to assess sustainability of the country's large social programmes. On the contrary, a fiscal risk statement was introduced as an ongoing integral component of the medium-term fiscal planning and budget process.

The 2016 MTBPS Fisk Risk Statement postulates that South Africa is characterised by a number of institutional strengths that promote fiscal sustainability. The National Treasury (2016) points out that the respective strengths include the following:

- The Constitution of the country and the PFMA that embed a centralised framework for fiscal management. National government revenues are all paid into the National Revenue Fund (NRF) and the national budget is tabled in a consolidated manner.
- Reduced debt-refinancing risks in the deep and liquid domestic bond market and long maturity government debt largely denominated in local currency. Subnational governments' loans and guarantees are limited and subject to national legislation.
- Transparent, predictable and open budget process reinforced by the MTEF, and a fiscal framework anchored on credible fiscal and macroeconomic projections. The country's tax system steadily improved, coupled with well-maintained government expenditure ceiling despite emerging spending pressures.
- The nation's record of fiscal sustainability reflected by the government's continued commitment to reduce budget deficit in reaction to rising debt. Complimentarily, SARB supports government's efforts to maintaining fiscal sustainability by operating an inflation targeting system that manages inflation expectations and flexible exchange rate regime, which further ensures absorption of external shocks.

- Adequate capitalisation of financial institutions and sound regulation of the financial sector. The IMF 2014 Financial System Stability Assessment Report indicates that South Africa's financial sector remains in a resilient position to withstand austere shocks owing to sound capitalisation (National Treasury, 2016).

Despite the above-mentioned institutional strengths that support fiscal sustainability in South Africa, the National Treasury 2016 MTBPS also released a Fiscal Risk Statement containing descriptions of fiscal risks that affect the government's efforts to stabilise public debt-to-GDP ratio and ensure fiscal sustainability. The Statement postulates that the major fiscal risks faced by the country over the next years beyond 2016 are "lower than projected economic growth, higher than predicted upsurges in compensation budgets, and perilous finances of some SOEs and public entities" (National Treasury, 2016). In that regard, South African government's fiscal risks framework is mainly organised into the following four main categories outlined below:

a) Macroeconomic risks

These risks emanate from the effect of slower than projected nominal GDP and revenue growth, public debt sustainability under alternate economic scenarios, and impact of macroeconomic outlook on rising debt servicing costs. Since 2011, there have been several downward revisions of South Africa's growth projections following downward revisions of global economic growth projections by the IMF and lower than projected commodity prices, domestic electricity shortages, drought and labour disruptions (National Treasury, 2016). To evaluate the magnitude of fiscal risk arising from macroeconomic channels, the National Treasury developed three probability macroeconomic scenarios. The first scenario points out the likelihood of "*long-term deterioration in potential growth*". Projected output growth over the medium term is likely to remain lower, and expected to remain below 2% in the long-term.

The second scenario points out the likelihood of "*intensified global instability*". Global productivity growth forecasts may be subject to regular downward revisions owing to the observed impact of Britain's departure from European Union and China's transition. Unfortunately, sluggish economic growth in developing countries, shrinking capital flows and unfavourable commodity prices are likely to cause upsurges in local risk premiums, which could imply increases in government borrowing costs. The third

scenario points out the likelihood of "*improved export competitiveness owing to depreciation of the rand"*. South Africa's exports have not improved in line with the significant depreciation of the rand in recent years (National Treasury, 2016).

b) Policy and budget execution risks

Policy risks result from unforeseen and emergency expenditure requests leading to pressure on expenditure ceiling, while budget risks emanate from implementation risks linked to proposed in-year spending estimates and failures by departments and entities to achieve expenditure targets. For instance, budget execution risks attributed to the 2016 MTBPS proposal include public sector wage bill pressures, underspending on infrastructure, and pressures on the exchange rate. Sustained pressure on the wages frontier may lead to crowding out of resources from capital budgets for infrastructure development to compensation.

c) Contingent and accrued liabilities risks

Government guarantees in South Africa are the central government's main explicit contingent liabilities. Deteriorations in financial positions of public entities or SOEs increase the risk of government's guarantee exposure. Based on National Treasury 2016 MTBPS, the primary contingent liability risks to the South African fiscus are government guarantees to the following SOEs:

- Passenger Rail Agency of South Africa (PRASA) for acquisition of new rolling stock and signaling equipment.
- South African National Roads Agency Limited (SANRAL) to enhance the expansion of toll roads portfolio.
- South African Airways (SAA) to sustain operations of the enterprise as a going concern.
- South African Post Office (SAPO) for governance reform.
- Land Bank for expansion.
- Road Accident Fund (RAF) to mitigate insolvency of the enterprise.

To maintain fiscal sustainability, the National Treasury consistently reviews its long-term fiscal model to evaluate the sustainability of the country's large social spending programmes. Currently, the country's large social spending programmes are deemed sustainable over the long-term based on the present assumptions of demographic

changes and growth forecasts (National Treasury, 2016). Changes to the population structure would largely have serious implications on sustainability of social spending programmes, which would put pressures on municipal finances earmarked for service delivery in face of the currently constrained revenue capacity.

3.8. Conclusion

This chapter discussed the fiscal framework of the South African economy in terms of the medium-term to long-run trajectories in the broad budgetary aggregates of national government total tax and non-tax revenues, government expenditure, government debt and fiscal balances. The fiscal risks framework was finally discussed with regards to its diverse sources of such fiscal risks, their relevant significances, disclosure and management in context of the South African economy.

CHAPTER 4

THEORETICAL FRAMEWORK

4.1. Introduction

This chapter consists of three major sections. Section 4.2 provides a brief theoretical economic definition of fiscal policy sustainability. Section 4.3 presents and discusses the analytical framework comprising of diverse approaches used by previous studies in assessing fiscal sustainability. Section 4.4 provides the conclusion to the chapter.

4.2. Defining Fiscal Sustainability

Fiscal sustainability can be defined as either static budget constraint or inter-temporal budget constraint. A static budget constraint is satisfied if a government demonstrates the ability to finance its current spending with revenues and new borrowing in a manner that allows the rolling-over of maturity liabilities. Burnside (2004) asserts that since the concept of fiscal sustainability is linked to the solvency condition, a fiscal policy can be deemed sustainable only if government can service its debt obligations without explicit default. Tshiswaka-Kashalala (2006) and Burger, et al. (2011) argue that a fiscal policy is regarded sustainable if the long-term terminal debt-to-GDP ratio does not exceed its initial ratio. Fiscal becomes sustainable only if government can infinitely pay back its debt without explicit default, and if the present value of future revenue flows exceeds outstanding debt plus the discounted value of future spending.

4.3. Analytical Framework

Following Abdulla, Mustafa and Dahalan (2012), analysis of fiscal sustainability can be conducted based on the static budget constraint and/or inter-temporal budget constraint (IBC). A static budget constraint is satisfied if government exhibits the ability to finance its current spending with its revenue and new borrowing, and rolling over its maturing liabilities. In addition, the IBC hinges on the solvency criterion and requires the present discounted value of upcoming primary balances to be at least equal to the unpaid debt stock value. Prior studies assessed fiscal sustainability (Chalk and Hemming, 2000; Burnside 2004; Polito and Wickens 2005; Kirchgaessner and Prohl 2006; Tshiswaka-Kashalala 2006; Burger, et al. 2011; Calitz, et al. 2013; Ganyaupfu 2014; Aldama and Creel 2016).

4.3.1. The Static Budget Constraint

Conceptualising from the static budget constraint, Chalk and Hemming (2000) propose that the level of future public debt stock should be determined by the discounted initial debt stock and current primary balance, defined by the function:

$$D_{t+1} = R_t D_t + B_t \qquad (4.3.1.1)$$

where D_t represents government's initial debt stock or outstanding bonds, $R_t = 1 + r$ denotes the discount factor between periods t and t + 1, and B_t is the primary balance.

Through forward iteration, equation (4.3.1.1) yields the budget constraint specified as:

$$D_t = -\sum_{n=0}^{\infty} R(t, t+h)^{-1} B_{t+h} + \lim_{T \to \infty} R(t, t+T)^{-1} D_{t+T+1} \qquad (4.3.1.2)$$

$\text{where}: R(t, t+h) = \prod_{k=0}^{h} R_{t+k}$ represents the discount factor between periods t and t + h.

From equation (4.3.1.2), the present value of future primary surpluses must exceed the present value of future primary deficits by an amount sufficient to settle the difference between the initial debt stock and present value of the terminal debt stock.

Consistent with equation (4.3.1.2), the transversality (no-Ponzi) condition specified in equation (4.3.1.3) must hold in order to ensure sustainability of fiscal policy.

$$\lim_{T \to \infty} R(t, t+T)^{-1} D_{t+T+1} \leq 0 \qquad (4.3.1.3)$$

Therefore, current debt must be matched in present value terms, with an excess of future primary surpluses over primary deficits in order to ensure fiscal sustainability.

4.3.2. Government Lifetime Budget Constraint

Burnside (2004) argues that government lifetime budget constraint must be observed as the crucial starting point for analysing fiscal sustainability, based on the identity:

$$\text{Net debt issuance} = \text{interest payments} - \text{primary balance} - \text{seignorage} \qquad (4.3.2.1)$$

Expressing the above identity (4.3.2.1) as a mathematical notation yields the function:

$$D_t - D_{t-1} = I_t - B_t - (M_t - M_{t-1}) \quad (4.3.2.2)$$

where: t denotes time in years, D_t symbolises the amount of government debt at the end of period t, I_t represents interest payments, B_t denotes primary balance (revenue less non-interest spending), and M_t represents local currency denominated monetary base at the end of time period t.

Since sustainability of fiscal policy remains a long-term policy issue, Burnside (2004) considers use of a government's lifetime budget constraint as a suitable approach to assess sustainability of public finances. To derive the government's lifetime budget constraint, Burnside (2004) makes the assumptions that time is discrete, all public debt matures in time period t, debt is measured in real terms and interest rate is constant.

The government's lifetime budget constraint (equation 4.3.2.2) can be rewritten as:

$$d_t = (1+r)d_{t-1} - b_t - \rho_t \quad (4.3.2.3)$$

where: $d_t = D_t/Y_t$ is the end-of-period public debt stock as a ratio of GDP, $b_t = B_t/Y_t$ is primary balance-to-GDP ratio, and $\rho_t = (M_t - M_{t-1})/P_t$ is real value of seigniorage.

Rearranging equation (4.3.2.3) reduces to:

$$d_t = (1+r)d_{t-1} - b_t - \rho_t$$

$$\frac{d_t}{(1+r)} = \frac{(1+r)d_{t-1}}{(1+r)} - \frac{b_t}{(1+r)} - \frac{\rho_t}{(1+r)}$$

$$(1+r)^{-1} d_t = d_{t-1} - (1+r)^{-1} b_t - (1+r)^{-1} \rho_t$$

$$d_{t-1} = (1+r)^{-1} d_t + (1+r)^{-1}(b_t + \rho_t) \quad (4.3.2.4)$$

Updating equation (4.3.2.4) to period t yields:

$$d_t = (1+r)^{-1} d_{t+1} + (1+r)^{-1}(b_{t+1} + \rho_{t+1}) \quad (4.3.2.5)$$

Substituting d_t (equation 4.3.2.5) into the RHS of equation (4.3.2.4) yields:

$$d_{t-1} = (1+r)^{-1}(1+r)^{-1} d_{t+1} + (1+r)^{-1}(b_{t+1} + \rho_{t+1}) + (1+r)^{-1}(b_t + \rho_t)$$

$$d_{t-1} = (1+r)^{-2} d_{t+1} + (1+r)^{-1}(b_{t+1} + \rho_{t+1}) + (1+r)^{-1}(b_t + \rho_t) \quad (4.3.2.6)$$

Substituting d_{t+1} on the RHS of equation (4.3.2.6), and for d_{t+2},…., recursively (after several iterations) yields:

$$d_{t+1} = (1+r)^{-1(j+1)} d_{t+j} + \sum_{i=0}^{j} (1+r)^{-(i+1)} (b_{t+i} + \rho_{t+i}) \quad (4.3.2.7)$$

The mathematical expression in equation (4.3.2.7) describes the correlation between the amounts of debt a government holds at two different time periods t-1 and t + j. In real practice, the amount of debt a government holds at period t+j is therefore a function of the amount of initial debt stock held at period t-1, as well as the amount of primary surplus realised and seigniorage raised between periods t+j and t-1.

The condition $\lim_{j\to\infty} (1+r)^{-(j+1)} d_{t+j} = 0$ has to be imposed in order to derive the government lifetime budget constraint specified by the function:

$$d_{t-1} = \sum_{i=0}^{\infty} (1+r)^{-(i+1)} (b_{t+i} + \rho_{t+i}) \quad (4.3.2.8)$$

The budget constraint specified in equation (4.3.2.8) shows that government finances its initial debt by raising seigniorage revenue and generating primary surpluses in future, whose present value equals initial public debt obligations (Burnside, 2004).

From the fiscal and monetary policy coordination viewpoint, when a set of fiscal and monetary policies maintained indefinitely puts the country on a solvency path, that policy composite can be deemed sustainable (Burnside, 2004). Therefore, analysis of fiscal sustainability should not focus merely on default alone, but also on possible effects of changes to the policy mix required to prevent possible default. Against this

backdrop, Burnside (2004) developed a fiscal sustainability analysis framework that captures the interaction between fiscal policy and monetary policy. The effects of changes to fiscal policy and monetary policy stances are captured by the real version of the government lifetime budget constraint defined as:

$$d_t = (1+r)d_{t-1} - b_t - (M_t - M_{t-1})/P_t \qquad (4.3.2.9)$$

where $d_t = D_t / P_t$ denotes the end of period t real debt stock, r is the real interest rate, $b_t = B_t / P_t$ is the real primary balance and $(M_t - M_{t-1})/P_t$ is real seigniorage revenue.

Rearranging equation (4.3.2.9) to a reduced form yields:

$$P_t(d_t) = P_t(1+r)d_{t-1} - P_t(b_t) - (M_t - M_{t-1})$$

$$P_t(d_t) = P_t(d_{t-1} + r d_{t-1}) - P_t(b_t) - (M_t - M_{t-1})$$

$$P_t(d_t) = P_t(d_{t-1}) + P_t(r d_{t-1}) - P_t(b_t) - (M_t - M_{t-1})$$

$$P_t(d_t) - P_t(d_{t-1}) = P_t(r d_{t-1}) - P_t(b_t) - (M_t - M_{t-1})$$

$$P_t(d_t) - P_t(d_{t-1}) = P_t(r d_{t-1}) - P_t(b_t) - (M_t - M_{t-1})$$

$$P_t(d_t) - P_t(d_{t-1}) = P_t(r d_{t-1}) - P_t(b_t) - (M_t - M_{t-1})$$

$$\underbrace{P_t(d_t - d_{t-1}) + (M_t - M_{t-1})}_{\text{government financing}} = \underbrace{P_t(r d_{t-1} - b_t)}_{\text{government financing requirement}} \qquad (4.3.2.10)$$

The RHS of equation (4.3.2.10) represents the government's financing requirement, given by the nominal value of the sum of real interest payments and primary deficit. Concomitantly, the LHS of equation (4.3.2.10) denotes government's financing, which comprises of the net issuance of debt and net issuance of base money. In scenarios where fiscal authorities determine b_t, then rd_t could be predetermined. In addition, the role of monetary authorities as per equation (4.3.2.10) could fundamentally be defined to be management of government debt.

From a price stabilisation standpoint, fiscal authorities can choose b_t while monetary authorities (central bank) choose M_t and d_t consistent with equation (4.3.2.10). In situations or regimes where government issues debt to finance deficits while money is never printed to finance deficits or monetise government debt $(M_t = M \forall t)$, the government lifetime budget constraint becomes:

$$d_{-1} = \sum_{t=0}^{\infty} (1+r)^{-(t+1)} b_t \qquad (4.3.2.11)$$

Equation (3.3.2.11) implies that the present value of the primary balance remains equal to the initial government debt stock. The scenario that $M_t = M \forall t$ implies that running a primary deficit at time $t = 0; b_0 > 0$ forces fiscal authorities to ensure future primary surpluses in present value terms as specified by the function:

$$\sum_{t=1}^{\infty} (1+r)^{-(t+1)} b_t > 0 \qquad (4.3.2.12)$$

The condition specified by equation (4.3.2.12) characterises a rigid monetary policy stance, which could require future fiscal policy to tighten if the current fiscal stance tends to be become loose as time progresses.

In circumstances where government and central bank coordinate fiscal and monetary policies and pursue an inflation target (π^*), the central bank can determine a growth rate of money stock consistent with the inflation target. Conversely, in situations where fiscal and monetary policies are not coordinated, the central bank would essentially need to set the transactionary motive for money demand constant $Md^T = Md$ to ensure that the real balance remains constant $(M_t / P_t = q/v)$, where "q" denotes real GDP and "v" signifies a constant real value for money velocity. If the growth of money remains constant at some rate θ, the inflation rate can be set at $\pi = \theta$, and the real value of seigniorage becomes constant at $\rho_t = \rho$ such that:

$$\rho = \frac{M_t - M_{t-1}}{P_t} = \frac{(1+\theta)M_t - M_{t-1} - M_{t-1}}{(1+\theta)P_{t-1}} = \frac{\theta}{1+\theta} m \qquad (4.3.2.13)$$

To maintain stability in the general price level from the current period 0 to some future period T, the central bank sets the growth rate of money to some realistically lowest

possible arbitrary value θ. However, if central bank inevitably prints money to ensure government's solvency, the money growth rate could have to be set at constant θ', consistent with government's lifetime budget constraint. To ensure policy coordination, fiscal authorities can set $b_t = b \,\forall\, t$ and $b < rd_{-1}$. As such, some seigniorage revenue can be required to satisfy the government's lifetime budget constraint at some time period T+1 defined by the function:

$$d_T = \sum_{t=T+1}^{\infty} (1+r)^{-(t-T)} (b_t + \rho_t) \tag{4.3.2.14}$$

Since $\rho_t = \theta' m/(1+\theta')$ for $t > T$, and $b_t = b \;\forall\; t$, equation (4.3.2.14) can be rewritten as:

$$d_T = \frac{b + \theta' m/(1+\theta')}{r} \tag{4.3.2.15}$$

Solving for θ' in equation (4.3.2.15) yields:

$$\theta' = \frac{rd_T - b}{m - (rd_T - b)} \tag{4.3.2.16}$$

From equation (4.3.2.16), higher levels of government debt at time period T could imply higher θ' since

$$\frac{\Delta\theta'}{\Delta d_T} = \frac{r\,m}{[m - (rd_T - b)]^2} > 0 \tag{4.3.2.17}$$

The government budget constraint rolled from time period 0 to time period T becomes:

$$d_{-1} = (1+r)^{-(T+1)} d_T + \sum_{t=0}^{T} (1+r)^{-(t+1)} (b_t + \rho_t) \tag{4.3.2.18}$$

Rearranging equation (4.3.2.18) yields:

$$d_T = (1+r)^{T+1} d_{-1} - \frac{(1+r)^{T+1}}{r} \left(b + m \frac{\theta}{(1+\theta)} \right) \tag{4.3.2.19}$$

Such that:

$$\frac{\partial d_T}{\partial T} = \ln(1+r)(1+r)^{T+1}\left[d_{-1} - \frac{1}{r}\left(b + m\frac{\theta}{(1+\theta)}\right)\right] \quad (4.3.2.20)$$

The government can accumulate more public debt when θ is lower. Following Burnside (2004), the mathematical manipulations above exhibit that a tougher monetary stance (lower θ) over a significantly long period (higher T) potentially leads to increased public debt stock (d_T). Burnside (2004) demonstrates that in order to ensure sustainability of fiscal policy, fiscal authorities and the central bank should set paths of primary balance (b_t) and base money supply (M_t) consistent with the government's lifetime budget constraint $d_{t-1} = \sum_{i=0}^{\infty}(1+r)^{-(i+1)}(b_{t+i} + \rho_{t+i})$. Since the central bank cannot stabilise prices indefinitely without support of fiscal authorities, the dual goals of a stable general price level and a sustainable fiscal policy can only be attained through effective coordination of fiscal and monetary policies (Burnside, 2004).

4.3.3. Present Value Budget Constraint

The present value budget constraint (PVBC) is an alternative approach used to assess sustainability of fiscal policy. Furthermore, Yamauchi (2004) elaborates that fiscal policy is deemed sustainable if the present value of the budget constraint remains satisfied without making substantial abrupt adjustments to both revenue and expenditure balances to prevent solvency and liquidity constraints. In order to ensure solvency, the current and future primary expenditure in present value terms should not exceed the analogous current and future revenue (net of interest payments) as given by the function:

$$\sum_{i=0}^{\infty}\frac{PE_{t+i}}{\prod_{h=1}^{i}(1+r_{t+h})} \leq \sum_{i=0}^{\infty}\frac{GDP_{t+i}}{\prod_{h=1}^{i}(1+r_{t+h})} - (1+r_t)D_{t-1} \quad (4.3.3.1)$$

where PE_t is primary expenditure (net of interest payments), GDP is national income, D_t is public debt stock at the start of period t-1, and r_t is the nominal interest rate.

Equation (4.3.3.1) shows that regardless of satisfying the solvency condition, liquidity can be deemed to exist when government holds liquid assets and financing sufficient

to meet or rollover maturing obligations. Based on this condition, fiscal sustainability occurs when the present value budget constraint is satisfied, defined by the function:

$$D_t = \sum_{i=0}^{\infty} \frac{B_{t+i}}{\prod_{h=0}^{i}(1+r_{t+h})} = \sum_{i=0}^{\infty} \frac{Z_{t+h}}{\prod_{h=0}^{i}(1+r_{t+h})} - \sum_{i=0}^{\infty} \frac{PE_t}{\prod_{h=0}^{i}(1+r_{t+h})} \quad (4.3.3.2)$$

where D_t represents government debt stock at the start of period t, B_t denotes primary balance, Z_t signifies government total revenue, PE_t represents primary expenditure (total spending less interest payments), and r_t represents the nominal interest rate.

The condition specified by equation (4.3.3.2) indicates that current government debt must not exceed, or at most equal, the excess sum of future primary surpluses over primary deficits in present value terms. Therefore, government can experience temporary primary deficits as long as such primary deficits can eventually be offset by the total of future primary surpluses. Expressing the variables in equation (4.3.3.2) as ratios of GDP yields the PVBC in the functional form given as:

$$d_t = \sum_{i=0}^{\infty} \frac{\prod_{j=1}^{i}(1+\eta_{t+j})}{\prod_{h=0}^{i}(1+r_{t+h})} b_{t+i} = \sum_{i=0}^{\infty} \frac{\prod_{j=1}^{i}(1+\eta_{t+j})}{\prod_{h=0}^{i}(1+r_{t+h})} b_{t+1} - \sum_{i=0}^{\infty} \frac{\prod_{j=1}^{i}(1+\eta_{t+j})}{\prod_{h=0}^{i}(1+r_{t+h})} e_{t+i} \quad (4.3.3.3)$$

where the lower cases of variables represent the respective variables as ratios of GDP, and η represents the nominal growth of GDP.

Since government debt comprises domestic debt denominated in local currency and external debt denominated in foreign currency, equation (4.3.3.3) can be modified to express domestic debt and external debt components expressed as ratios of GDP:

$$d_t = dd_t + \phi_t ed_t = \sum_{i=0}^{\infty} \left[\frac{(1+\mu_{t+i})}{\prod_{h=0}^{i}(1+r_{t+h})} + \frac{\mu_{t+i}\,\varepsilon_t \prod_{h=0}^{i}(1+\tau_{t+h})}{\prod_{h=0}^{i}(1+r^{f}_{t+i})} \right] \prod_{j=1}^{i}(1+\eta_{t+j}) b_{t+i} \quad (4.3.3.4)$$

where dd_t is the initial government domestic debt stock dominated in local currency at period t, ed_t denotes the initial government external debt stock dominated in foreign

currency, ϕ_t is the nominal exchange rate, μ_t signifies the rate of nominal exchange rate appreciation, and r^f represents the nominal interest rate on external debt.

The function expressed by equation (4.3.3.4) indicates that the main determinants of public finance sustainability are government revenue, primary expenditure, domestic, and foreign debt stocks with corresponding nominal interest rates, nominal exchange rate and real GDP growth (Yamauchi, 2004). The exchange rate implicitly influences fiscal sustainability via the effect it directly transmits on the external debt component of the total government debt stock. The fluctuations in GDP remain critical to ensuring fiscal sustainability given the effect output trends have on developments of the primary constituent indicators of fiscal policy sustainability.

4.3.4. Intertemporal Budget Constraint

Kirchgaessner and Prohl (2006) posit that sustainability of government's budget deficit is anchored on the statistic and intertemporal budget constraints of government. Derivation of the intertemporal budget constraint follows the statistic budget constraint:

$$G_t + (1+r_t)D_{t-1} = R_t + D_t \qquad (4.3.4.1)$$

where G_t is government expenditure (excluding interest payments), D_t represents government debt stock, R_t is government revenues, and r_t denotes interest rate on government debt. Through forward substitution, the government intertemporal budget constraint is given by the mathematical function:

$$D_t = \sum_{n=1}^{\infty}\left[\prod_{h=0}^{n}\frac{1}{(1+r_{t+h})}(R_{t+n} - G_{t+n})\right] + \lim_{n\to\infty}\prod_{h=1}^{n}\frac{1}{(1+r_{t+h})}D_{t+n} \qquad (4.3.4.2)$$

Assuming a constant real interest rate, the government budget constraint becomes:

$$D_t = \sum_{n=1}^{\infty}\left[\frac{1}{(1+r)^{n+1}}(R_{t+n} - G_{t+n})\right] + \underbrace{\lim_{n\to\infty}\frac{1}{(1+r)^{n+1}}D_{t+n}}_{\lambda} \qquad (4.3.4.3)$$

Sustainability of fiscal policy depends on progression of the second term of equation (3.3.4.3) represented by λ. In cases where the transversality condition holds $(\lambda = 0)$, the government's present value budget constraint reduces to:

$$D_t = \sum_{n=1}^{\infty}\left[\frac{1}{(1+r)^{n+1}}(R_{t+n} - G_{t+n})\right] \qquad (4.3.4.4)$$

The transversality condition $\lambda = 0$, also called the "no-Ponzi game" rule for government debt requires that the growth of government debt must not be greater than real interest rate. Escolano (2010) defines transversality condition as a scenario where government does not service its principal debt and interest by issuing new debt on a regular basis. The condition is deemed necessary and sufficient for fiscal sustainability only if the real interest rate is greater than the real growth rate.

If current and discounted future surpluses sufficiently pay-off the current public debt, fiscal policy can be regarded to be consistent with the present value budget constraint. To determine whether fiscal policy remains consistent with the transversality condition, Kirchgaessner and Prohl (2006) follow the proposition by Hamilton and Flavin (1986) that stationarity properties of the primary deficit (excluding interest payments on public debt) can be tested. In addition, Hamilton and Flavin (1986) regard stationarity of the primary deficit as a sufficient condition for the validity of the present value budget constraint, such that $\lambda = 0$ implies stationary public debt.

Kirchgaessner and Prohl (2006) also elaborate that an alternative to the stationarity test approach proposed by Hamilton and Flavin (1986) in measuring the intertemporal budget constraint (IBC) is cointegration test between government debt and budget deficit series, particularly when such series has the same order of integration. Hakkio and Rush (1991) introduced a cointegration approach between government revenues and expenditures (instead of public debt and primary balance) given by the function:

$$Z_t = G_t + rD_{t-1} = R_t + \sum_{n=1}^{\infty}\left[\frac{1}{(1+r)^{n+1}}(\Delta R_{t+n} - \Delta G_{t+n})\right] + \lim_{n\to\infty}\frac{1}{(1+r)^{n+1}}D_{t+n} \qquad (4.3.4.5)$$

where Z_t denotes aggregate government expenditure.

In order for the ΔR and ΔZ to be stationary, R and G series must be integrated of order one, yielding the fiscal condition:

$$Z_t = \alpha + R_t + \lim_{n\to\infty} \frac{1}{(1+r)^{n+1}} D_{t+n} + \varepsilon_t \qquad (4.3.4.6)$$

As the term D_{t+n} approaches zero at the limit, equation (4.3.4.6) becomes:

$$R_t = \alpha + \beta Z_t + \varepsilon_t \qquad (4.3.4.7)$$

The cointegration between Z and R is considered as a necessary condition for the present value budget constraint to hold, conditional upon both Z and R being I(1). In that regard, the condition $0<\beta\leq 1$ must hold in order for the term D_{t+n} to approach zero. Based on the cointegration approach, Quintos (1995) argues that a distinction should be made between "strong" and "weak" sustainability. Using the regression function specified in equation (4.3.4.7), strong sustainability requires cointegration between government expenditures and revenues to have a cointegrating vector [1 -1], whereas weak sustainability occurs when $0<\beta\leq 1$. To validate the "strong" and "weak" conditions for fiscal policy sustainability, Quintos (1995) reformulates the transversality condition $\lim_{n\to\infty} \frac{1}{(1+r)^{n+1}} \Delta D_{t+n} = 0$ in terms of the first difference, yielding:

$$E_t\left[\lim_{n\to\infty} \frac{1}{(1+r)^{n+1}} \Delta D_{t+n}\right] = 0 \qquad (4.3.4.8)$$

If the interest rate r remains constant and ΔD is a stationary process, the trend of the limit of the term in equation (4.3.4.8) can be derived conditional upon stochastic characteristics of ΔD. The presence of stationarity in ΔD leads to evolution of the term at the limit given by the function specified below:

$$E_t\left[\lim_{n\to\infty} e^{-\gamma n} \Delta D_{t+n}\right] = 0 \qquad (4.3.4.9)$$

where γ remains constant $(\gamma \geq 0)$

Similarly, a unit root ΔD gives a path of the limit term in equation (3.3.4.8) defined by:

$$E_t\left[\lim_{n\to\infty} e^{-\gamma n}\sqrt{n\,\Delta D_{t+n}}\right]=0 \qquad (4.3.4.10)$$

The stationarity of D_t is regarded as a sufficient condition for the term in equation (4.3.4.8) to approach zero. Since the term in equation (4.3.4.9) approaches zero faster than the term in equation (4.3.4.10), equation (4.3.4.9) is deemed a “strong” condition, while equation (4.3.4.10) is regarded as a “weak” condition for fiscal sustainability.

An alternative fiscal sustainability analysis approach used by Doi, Hoshi and Okimoto (2011) involves computation of a minimum tax rate the government has to impose to stabilise debt-to-GDP ratio given future government expenditures. The computation of the minimum amount of tax revenue-to-GDP ratio that can ensure sustainability of fiscal policy follows the method used by Broda and Weinstein (2005) and Doi (2009). The approach specifies that a fiscal policy can be regarded sustainable if it stabilises the debt-to-GDP ratio at the level in the base year in line with the government IBC:

$$D_t - D_{t-1} = G_t - T_t + iD_{t-1} \qquad (4.3.4.11)$$

where D_t denotes public debt outstanding at the end of time period t, G_t is government expenditures during time period t, G_t is government expenditures during time period t, T_t is government tax revenues for time period t, and i denotes constant interest rate. Expressing the fiscal variables in equation (4.3.4.11) as proportions of output yields:

$$\frac{D_t}{Y_t} = \frac{G_t - T_t}{Y_t} + \frac{1+i}{1+\eta}\frac{D_{t-1}}{Y_{t-1}} \qquad (4.3.4.12)$$

$$d_t = g_t - \tau_t + \frac{1+i}{1+\eta}d_{t-1} \qquad (4.3.4.13)$$

where d_t, g_t, and τ_t are the public debt, government revenues and tax revenues (as ratios of GDP) respectively, and η represents the constant GDP growth rate such that the $\eta > i$ in the long-run ensures fiscal policy sustainability.

Deriving the debt-to-GDP ratio as a function of future debt-to-GDP ratio and future primary balance (surplus) by rearranging equation (4.3.4.13) yields:

$$d_{t-1} = \frac{1+\eta}{1+i} d_t + \frac{1+\eta}{1+i}(\tau_t - g_t) \quad (4.3.4.14)$$

Solving equation (4.3.4.14) further yields:

$$d_0 = \left(\frac{1+\eta}{1+i}\right)^T d_T + \sum_{t=1}^{T}\left(\frac{1+\eta}{1+i}\right)^t (\tau_t - g_t) \quad (4.3.4.15)$$

where d_0 denotes debt-to-GDP ratio at the initial period zero, and T is the future date.

Equation (4.3.4.15) indicates that the current debt-to-GDP ratio must be equal to the present value of the future debt-to-GDP ratio and the future primary surpluses. Since fiscal sustainability requires the debt-to-GDP ratio at some future point in time to revert to the level at the initial period, the constant tax rate that makes $d_0 = d_T$ computation:

$$\tau^* = \begin{cases} \dfrac{i-\eta}{1+\eta}\left[d_0 + \left\{1 - \left(\dfrac{1+\eta}{1+i}\right)^T\right\}^{-1} \sum_{t=1}^{T}\left(\dfrac{1+\eta}{1+i}\right)^t g_t \right] & \text{if } i > \eta \\ \dfrac{1}{T}\sum_{t=1}^{T} g_t \quad \text{if } i = \eta \end{cases} \quad (4.3.4.16)$$

From equation (3.3.4.16), the tax rate required to ensure fiscal sustainability becomes high under four scenarios, namely (i) high initial debt-to-GDP ratio, (ii) high levels of future government expenditure, (iii) high interest rate, and (iv) low output growth rate.

For purposes of comparative analysis, Doi, et al. (2011) emphasise use of the method established by Bohn (1998) for examining fiscal policy sustainability. The estimation approach defines primary balance-to-GDP ratio as a linear function of public debt-to-GDP ratio at the end of the previous period, defined as:

$$b_t = \alpha + \beta d_{t-1} + \theta b_{t-1} + \pi Z_t + \mu_t \quad (4.3.4.17)$$

where b_t represents primary surplus-to-GDP ratio, d_{t-1} denotes debt-to-GDP ratio in previous period, Z_t is a vector of stationary fundamental variables that influence the primary balance, μ_t is the Gaussian white noise with variance σ^2. The first variable contained in vector Z is the transitory deviation of government expenditure from its

trend level, as a proportion of GDP $\left(G_t^{dev} = G_t - G_t^*\right)/Y$, where G_t^* signifies the trend level of government spending computed using the Hodrick-Prescott (1997) approach. Output gap computed using Hodrick-Prescott is incorporated into vector Z to capture variations of primary balance emanating from the budget automatic stabiliser function.

Assuming constant interest rate and growth rate, the relation between primary balance and public debt (as ratios of GDP) gets defined as:

$$d_t = (1+i-\eta)d_{t-1} - b_t \qquad (4.3.4.18)$$

Substituting equation (3.3.4.17) into equation (3.3.4.18) yields:

$$d_t = (1+i-\eta-\beta)d_{t-1} - \theta b_{t-1} - \alpha - \pi Z_t - \mu_t \qquad (4.3.4.19)$$

Realizing that $b_{t-1} = (1+i-\eta)\, d_{t-2} - d_{t-1}$, the function for d_t becomes:

$$d_t = (1+i-\eta-\beta+\theta)d_{t-1} - \theta(1+i-\eta)d_{t-2} - \alpha - \pi Z_t - \mu_t \qquad (4.3.4.20)$$

Expressing d_t in the ADF regression yields:

$$\Delta d_t = [(i-\eta)(1-\theta)-\beta]d_{t-1} + \theta(1+i-\eta)\Delta d_{t-1} - \alpha - \pi Z_t - \mu_t \qquad (4.3.4.21)$$

Therefore, d_t becomes stationary if $\beta \geq (i-\eta)(1-\theta)$. The public debt-to-GDP ratio tends to stabilise in the long run if the primary surplus positively responds significantly to a rise in the debt-to-output ratio, assuming $i > \eta$. In scenarios where the primary balance follows the process defined by equation (4.3.4.17), the long-run primary balance-to-GDP ratio can be given by $\beta/(1-\theta)d_t$. Therefore, government debt can be considered sustainable if $\beta/(1-\theta)$ exceeds the interest rate less the growth rate $(\beta/(1-\theta) > i - \eta)$.

4.3.5. Fiscal Stance Index

In recognition of the interdependence between fiscal policy and monetary policy, Polito and Wickens (2005) proposed the construction of a fiscal stance index for analysis of fiscal policy sustainability. The index is therefore regarded as suitable for conducting an empirical analysis of possible implications for fiscal sustainability of monetary policy formulated based on the Taylor's rule. Although a fiscal stance is deemed sustainable

if it satisfies the intertemporal budget constraint condition, it fails to solve the problem if the policy stance is analysed from a progressive angle over an infinite time horizon. Polito and Wickens (2005) recommended an intertemporal budget constraint based sustainability index of the current fiscal policy stance.

The index is computed from comparing the existing debt level with a forecast of the present value of the current and future deficits and surpluses derived from the economy's VAR forecasting model. An index exceeding unity indicates a sustainable fiscal stance while an index less than unity indicates absence of fiscal sustainability, and hence implies the need to adjust the fiscal stance. Nonetheless, based on the Lucas critique, any policy switch would have to be evaluated to determine whether it would achieve fiscal sustainability without altering the model of the economy. The main strength of the fiscal stance index is that the index is both informative and realistic.

Instead of merely exploring the stationarity and/or cointegration properties of budget deficits and public debts, the fiscal stance index nullifies the assumption that interest rate and GDP growth rate are constant, either in the past or over a given forecast period. Both the interest rate and GDP growth rate are modelled in the simple VAR together with public debt, government expenditures and tax revenues (Polito and Wickens, 2005). As such, the conceptual framework of government budget constraint proposed and used by Polito and Wickens (2005) follows the function:

$$\frac{g_t}{y_t} + \frac{1+R_t}{(1+\pi_t)(1+\eta_t)}\frac{d_{t-1}}{y_{t-1}} = \frac{T_t}{y_t} + \frac{d_t}{y_t} + \frac{m_t}{y_t} - \frac{1}{(1+\pi_t)(1+\eta_t)}\frac{m_{t-1}}{y_{t-1}} \qquad (4.3.5.1)$$

where g_t is real government expenditure, y_t is real GDP, R_t is average interest rate on debt at the end of period t-1, d_t is government debt, π_t is inflation rate $(\Delta P_t / P_{t-1})$, η denotes GDP growth rate, T_t / y_t is the average tax rate, and m_t real money stock. Therefore, government's deficit in nominal terms is defined as:

$$P_t G_t^{def} = P_t g_t + R_t D_{t-1} - P_t T_t - \Delta M_t \qquad (4.3.5.2)$$

where G_t^{def} represents government budget deficit.

Expressing equation (4.3.5.2) as a proportion of GDP yields:

$$\frac{G_t^{def}}{y_t} = \frac{g_t}{y_t} + \frac{R_t}{(1+\pi_t)(1+\eta_t)}\frac{d_{t-1}}{y_{t-1}} - \frac{T_t}{y_t} - \frac{m_t}{y_t} + \frac{1}{(1+\pi_t)(1+\eta_t)}\frac{m_{t-1}}{y_{t-1}}$$

$$= \underbrace{\frac{d_t}{y_t} - \frac{1}{(1+\pi_t)(1+\eta_t)}\frac{d_{t-1}}{y_{t-1}}}_{\text{Net Borrowing Requirement}} \qquad (4.3.5.3)$$

Concomitantly, the nominal primary deficit $(P_t\, b_t)$ is defined as:

$$P_t\, b_t = P_t\, G_t^{def} - R_t\, D_{t-1} \qquad (4.3.5.4)$$

$$\Rightarrow \frac{b_t}{y_t} = \frac{G_t^{def}}{y_t} - \frac{R_t}{(1+\pi_t)(1+\eta)}\frac{d_{t-1}}{y_{t-1}} \qquad (4.3.5.5)$$

Therefore, the primary deficit-to-GDP ratio becomes:

$$\frac{b_t}{y_t} = \frac{g_t}{y_t} - \frac{T_t}{y_t} - \frac{m_t}{y_t} + \frac{1}{(1+\pi_t)(1+\pi_t)}\frac{m_{t-1}}{y_{t-1}} \qquad (4.3.5.6)$$

Defining $1+\varphi_t = \frac{1+R_t}{(1+\pi_t)(1+\eta_t)}$, where $\varphi_t = R_t - \pi_t - \eta_t = r_t - \eta_t$ (the real interest rate adjusted for economic growth), equation (4.3.5.6) can be expressed as:

$$\frac{d_t}{y_t} = (1+\varphi_t)\frac{d_{t-1}}{y_{t-1}} + \frac{b_t}{y_t} \qquad (4.3.5.7)$$

From equation (4.3.5.7), the primary deficit-to-GDP ratio becomes:

$$\frac{b_t}{y_t} = \frac{d_t}{y_t} - (1+\varphi_t)\frac{d_{t-1}}{y_{t-1}} \qquad (4.3.5.8)$$

The reaction specified in equation (4.3.5.7) remains key to determining sustainability of fiscal policy. Since fiscal sustainability examines the evolution of debt-to-GDP ratio (d_t / y_t) and whether such government debt remains finite or explodes, fiscal policy can be deemed sustainable only if the debt-to-GDP ratio remains finite while financial

markets demonstrate willingness to hold the amount of debt that emerges. In respect of this background, Polito and Wickens (2005) underscore that when conducting fiscal sustainability analysis, it is important to differentiate between two scenarios. The first scenario assumes that the discount rate φ_t (and thus R_t, π_t, η_t) are constant, and the second scenario observes the discount rate as time varying in nature.

Scenario 1: Constant discount rate

In a scenario where φ_t is observed to be constant, the evolution of debt-to-GDP ratio (d_t / y_t) from equation (4.3.5.7) follows the difference equation:

$$\frac{d_t}{y_t} = (1+\varphi)\frac{d_{t-1}}{y_{t-1}} + \frac{b_t}{y_t} \tag{4.3.5.9}$$

where $1+\varphi = \dfrac{1+R}{(1+\pi)(1+\eta)}$, or $\varphi = R - \pi - \eta$.

Since the solution for the debt-to-GDP ratio (d_t / y_t) depends on whether equation (4.3.5.9) is either stable or unstable, both conditions should essentially be considered as elaborated by the following conditions.

- *Condition 1.1:* $\varphi < 0$ *(stable condition)*

In this condition, $\dfrac{1}{(1+\pi)(1+\eta)} < 1$ and equation (4.3.5.9) is a stable difference function solved backwards through successive substitution. The expected value of the debt-to-GDP ratio (d_t / y_t) at time period n conditional upon information at time t is defined as:

$$E_t\left(\frac{d_{t+n}}{y_{t+n}}\right) = (1+\varphi)^n \frac{d_t}{y_t} + \sum_{s=0}^{n-1}(1+\varphi)^{n-s} E_t\left(\frac{b_{t+s}}{y_{t+s}}\right) \tag{4.3.5.10}$$

Taking the limit as $n \to \infty$ yields the transversality condition:

$$\lim_{n\to\infty}(1+\varphi)^n \frac{d_t}{y_t} = 0 \tag{4.3.5.11}$$

In circumstances where equation (4.3.5.11) holds, the expected value of government debt (as a ratio of GDP) over a certain horizon is defined as:

$$\lim_{n\to\infty} E_t\left(\frac{d_{t+n}}{y_{t+n}}\right) = \lim_{n\to\infty}\sum_{s=1}^{n}(1+\varphi)^{n-s}\,E_t\left(\frac{b_{t+s}}{y_{t+s}}\right) \tag{4.3.5.12}$$

Therefore, based on equation (4.3.5.12), the evolution of debt-to-GDP ratio depends on evolution of primary balance-to-GDP ratio. If b_t/y_t exhibits stochastic tendencies and expected to grow at the rate ω, the expected value of b_t/y_t gets defined as:

$$E_t\left(\frac{b_{t+s}}{y_{t+s}}\right) = (1+\omega)^s\,\frac{b_t}{y_t} \tag{4.3.5.13}$$

Proceeding further from equation (4.3.5.13), it therefore follows that:

$$\lim_{n\to\infty} E_t\left(\frac{d_{t+n}}{y_{t+n}}\right) = \lim_{n\to\infty}\sum_{s=1}^{n}(1+\varphi)^{n-s}(1+\omega)^s\,\frac{b_t}{y_t}$$

$$= \lim_{n\to\infty}(1+\omega)\left(\frac{(1+\omega)^n-(1+\varphi)}{\omega-\varphi}\right)\frac{b_t}{y_t} \tag{4.3.5.14}$$

$$= -\frac{1}{\varphi}\,\frac{b_t}{y_t},\ \text{if}\ \omega = 0 \tag{4.3.5.15}$$

The formulation above (equation 4.3.5.15) implies that the $\lim_{n\to\infty} E_t\left(\frac{d_{t+n}}{y_{t+n}}\right) = 0$ if $\varphi, \omega = 0$ and explode if $\omega > 0$. Therefore, the debt-to-GDP ratio remains finite and positive if the primary balance-to-GDP ratio $(-d_t/y_t)$ does not explode. Likewise, a $\omega < 0$ implies a primary balance-to-GDP ratio characterised as an I(0) process, and an expected value of debt-to-GDP ratio equal to zero. Where $\omega = 0$, primary balance-to-GDP and debt-to-GDP ratios become non-stationary I(1) processes. Therefore, the primary balance

and debt (as ratios of GDP) can be cointegrated with a cointegrating vector $\left[1,\ \frac{1}{\varphi}\right]$, implying a sustainable fiscal policy, as long as the debt-to-GDP ratio does not explode.

- *Condition 1.2:* $\varphi > 0$ *(unstable condition)*

In this condition, $0 < \frac{(1+\pi)(1+\eta)}{1+R} < 1$, and equation (4.3.5.16) is considered to be an unstable difference function solved by forward iterations defined by the function:

$$\frac{d_t}{y_t} = \frac{1}{1+\varphi} E_t \left(\frac{d_{t+1}}{y_{t+1}} - \frac{b_{t+1}}{y_{t+1}} \right)$$

$$= (1+\varphi)^{-n} E_t \left(\frac{d_{t+n}}{y_{t+n}} \right) - \sum_{s=1}^{n} (1+\varphi)^{-s} E_t \left(\frac{b_{t+s}}{y_{t+s}} \right) \qquad (4.3.5.16)$$

Applying the limits as $n \to \infty$ yields the transversality condition

$$\lim_{n\to\infty} (1+\varphi)^{-n} E_t \left(\frac{d_{t+n}}{y_{t+n}} \right) = 0 \qquad (4.3.5.17)$$

$$\Rightarrow \frac{d_t}{y_t} = \underbrace{\sum_{s=1}^{\infty} (1+\varphi)^{-s} E_t \left(\frac{-b_{t+s}}{y_{t+s}} \right)}_{\Omega} \qquad (4.3.5.18)$$

The R.H.S. of equation (4.3.5.18) is the expected present value of current and future primary balance-to-GDP ratio. The equation reflects that the current and future primary surpluses can be adequate to offset current government debt. If the primary balance-to-GDP ratio is expected to evolve according to the function $E_t \left(\frac{b_{t+s}}{y_{t+s}} \right) = (1+\omega)^s \frac{b_t}{y_t}$ (equation 4.3.5.13), the debt-to-GDP ratio becomes:

$$\frac{d_t}{y_t} = \sum_{s=1}^{\infty}(1+\varphi)^{-s}(1+\omega)\left(\frac{-b_t}{y_t}\right) \qquad (4.3.5.19)$$

$$= \frac{1+\omega}{\varphi+\eta}\left(\frac{-b_t}{y_t}\right), \qquad \text{if } -1<\omega<\varphi;\ \varphi>0$$

Therefore, fiscal policy can be regarded sustainable as along as the current level of public debt-to-GDP ratio (L.H.S) does not exceed the R.H.S of equation (4.3.5.19), and the debt-to-GDP ratio can grow at the rate ω, the same rate as $-b_t/y_t$. Hence, a stationary $-b_t/y_t \Rightarrow -1<\omega<0$ and d_t/y_t that is stationary. If $\omega=0$, $-b_t/y_t$ becomes an I(1) non-stationary process, resulting into a condition in equation (4.3.5.15):

$$\frac{d_t}{y_t} = \frac{1}{\varphi}\left(\frac{-b_t}{y_t}\right) \qquad (4.3.5.20)$$

Based on equation (4.3.5.20), d_t/y_t becomes I(1) and cointegrated with $-b_t/y_t$.

Scenario 2: Time-varying discount rate

In standard practice, φ is time-varying rather than constant. Reverting to the original budget constraint, the function $\frac{b_t}{y_t} = \frac{d_t}{y_t} - (1+\varphi_t)\frac{d_{t-1}}{y_{t-1}}$ given by equation (4.3.5.7) can be solved through forward iterations, yielding:

$$\frac{d_t}{y_t} = E_t\left[\left(\prod_{s=1}^{n}\frac{1}{1+\varphi_{t+s}}\right)\frac{d_{t+n}}{y_{t+n}}\right] - E_t\left[\sum_{s=1}^{n}\left(\prod_{i=1}^{s}\frac{1}{1+\varphi_{t+i}}\right)\frac{d_{t+s}}{y_{t+s}}\right] \qquad (4.3.5.21)$$

$$\text{if } \gamma_{t,s} = \prod_{i=1}^{s}\frac{1}{1+\varphi_{t+i}} \le 1, \qquad \forall\ s \ge 1$$

Based on equation (4.3.5.21), fiscal solvency depends on the transversality condition:

$$\lim_{n\to\infty} E_t\left[\left(\prod_{s=1}^{n}\frac{1}{1+\varphi_{t+s}}\right)\frac{d_{t+n}}{y_{t+n}}\right] = 0 \qquad (4.3.5.22)$$

$$\Rightarrow \frac{d_t}{y_t} = E_t\left[\sum_{s=1}^{\infty}\left(\prod_{i=1}^{s}\frac{1}{1+\varphi_{t+i}}\right)\left(\frac{-b_{t+s}}{y_{t+s}}\right)\right] \tag{4.3.5.23}$$

Similar to equation (4.3.5.18), equation (4.3.5.23) indicates that the present value of the current and future primary surpluses must be sufficient to pay-off current debt. For purposes of determining the sustainability of fiscal policy, variables x_t and z_t are introduced into the system and defined as:

$$\left.\begin{aligned} x_t &= \gamma_{t,n}\frac{d_t}{y_t} \\ z_t &= \gamma_{t,n}\frac{d_t}{y_t} \end{aligned}\right\} \tag{4.3.5.24}$$

In order to attain fiscal sustainability, the transversality condition specified in equation (4.3.5.25) is required to be present:

$$\lim_{n\to\infty} E_t\left(x_{t+n}\right) = 0 \tag{4.3.5.25}$$

From the condition specified in equation (4.3.5.25), x_t is defined as:

$$x_t = -\lim_{n\to\infty} E_t\left[\sum_{s=1}^{n} z_{t+s}\right] \tag{4.3.5.26}$$

Following Wilcox (1989), fiscal sustainability is achieved if x_t becomes a zero-mean stationary process. However, Uctum and Wickens (2000) contend that x_t does not necessarily need to be stationary, and argue that fiscal sustainability can be attained if z_t becomes a zero-mean stationary process while x_t is an I(1) process.

4.3.6. Regime-Switching Model-Based Sustainability Test

Given that fiscal sustainability is a long-run policy issue, Aldama and Creel (2016) propose that analytical approaches to fiscal sustainability should address stochastic switches between fiscal regimes to separate sustainable regimes from unsustainable regimes. Building on Bohn's (1998) Model-Based Sustainability framework and some literature on Markov-switching fiscal rules, Aldama and Creel (2016) introduce a

Regime-Switching Model-Based Sustainability test for examining fiscal sustainability. The construction of the test begins from the government budget constraint defined as:

$$(1+r_t)^{-1} d_t = (g_t - \tau_t) + d_{t-1} \quad (4.3.6.1)$$

where d_t signifies the stock of public debt-to-GDP ratio at the end of period t, g_t is the government non-interest expenditure-to-GDP ratio at the end of period t, τ_t signifies tax revenues-to-GDP ratio at the end of period t.

The government budget constraint defined by equation (4.3.6.1) reflects that government non-interest expenditure (g_t) is financed by national tax revenues (τ_t) or by issuing public debt (d_t) at price $(1+r_t)^{-1}$. If the price of a government bond that matures j-periods ahead of time period t is represented by $(1+r_{t,j})^{-1} = \prod_{i=1}^{h} (1+r_{t+i-1})^{-1}$, then $(1+r_{t,1})^{-1} = (1+r_t)^{-1}$ and iteration of equation (4.3.6.1) yields:

$$d_{t-1} = b_t^s + \sum_{i=1}^{+\infty} E_t \left[\frac{b_{t+j}^s}{1+r_{t,i}} \right] + \lim_{T \to +\infty} E_t \left[\frac{d_{t+T}}{1+r_{t,T+1}} \right] \quad (4.3.6.2)$$

where b_t^s represents the primary surplus-to-GDP such that $b_t^s \equiv \tau_t - g_t$.

In order to consider fiscal policy as sustainable, the standard solvency condition must be satisfied according to which the initial public debt stock must be sufficiently backed by future expected primary surpluses in present value terms defined by the PVBC:

$$d_{t-1} \leq b_t^s + \sum_{i=1}^{+\infty} E_t \left[\frac{b_{t+i}^s}{1+r_{t,i}} \right] \quad (4.3.6.3)$$

From equation (4.3.6.2), the PVBC can be equivalent to the transversality condition on the expected present value government debt stock defined as:

$$\lim_{T \to +\infty} E_t = \left[\frac{d_{t+T}}{1+r_{t,T+1}} \right] \leq 0 \quad (4.3.6.4)$$

Equation (4.3.6.4) reflects the No-Ponzi Game (NPG) condition. The PVBC (equation 4.3.6.3) equals to the NPG condition (equation 4.3.6.4) at equilibrium, thus preventing lenders and government from playing a Ponzi-scheme (Aldama and Creel, 2016).

To address gaps associated with fiscal sustainability frameworks that do not capture the NPG condition and debt-stabilising condition, Aldama and Creel (2016) introduce a necessary and sufficient condition on the regime-switching fiscal policy rule for which the debt-to-GDP ratio is stabilised by fiscal policy in the long-run. From a real practice standpoint, the economy is considered to be stochastic and comprises consumers and government such that the monetary authority holds complete control over the inflation dynamics in the economy. Therefore, government intertemporal budget constraint is required to hold for any given general price level, such that total national output (Y) at time period t characterised by a unit root with drift is given by the function:

$$\ln Y_t = \eta + \ln Y_{t-1} + \varepsilon_t^{\eta} \qquad (4.3.6.5)$$

where $\eta > 0$ denotes the long run growth rate of output, and ε_t^{η} represents the random shock to the long-run output growth rate.

To prevent the government from running a Ponzi scheme against lenders, and account for uncertainty and risk-aversion by lenders, a stochastic discount factor is integrated into the public debt function, yielding the present value budget constraint:

$$d_t = \sum_{i=0}^{+\infty} E_t \left[\Psi_{t,i} \; b_{t+i}^{s} \right] \qquad (4.3.6.6)$$

where Ψ represents the stochastic discount factor (SDF); such that $\Psi \equiv \alpha \dfrac{u'(C_{t+1})}{u'(C_t)}$, where α signifies the subjective discount factor, u represents the consumer's (lender's) preferences such that the utility function $u(\bullet)$ strictly increases $(u'(\bullet) > 0)$, and C is the consumption by consumers (lenders) who purchase public bonds d_t at price $(1+r_t)^{-1}$ to maximise $E_0 \sum_{t=0}^{\infty} \alpha^t u(C_t)$ subject to the budget constraint $C_t + (1+r)^{-1} d_{t-1} + Y_t - \tau_t$ and transversality condition $\lim_{T \to \infty} E_t \dfrac{d_{t+T}}{1+r_{t,T+1}} \geq 0$.

The PVBC specified by equation (3.3.6.6) is equivalent to the transversality condition:

$$\lim_{T \to +\infty} E_t \left[\Psi_{t,T+1} \; d_{t+T} \right] = 0 \qquad (4.3.6.7)$$

The equivalence of the PVBC and transversality condition reflects that the government cannot run a Ponzi scheme following the Markov switching fiscal policy rule given by:

$$b_t^s = \kappa(z_t) d_{t-1} + \sigma_t(z_t) \qquad (4.3.6.8)$$

where $\kappa(z_t)$ is the regime-switching parameter that represents the feedback effect of the initial public debt-to-GDP ratio d_{t-1} on primary surplus-to-GDP ratio conditional on fiscal regime z_t. Therefore, fiscal regime is defined as:

$$\kappa(z_t) \begin{cases} \kappa\varpi > 0 & \text{if } z_t = 1 \quad \text{(sustainable regime)} \\ \kappa\phi \leq 0 & \text{if } z_t = 0 \quad \text{(unsustainable regime)} \end{cases} \qquad (4.3.6.9)$$

where ϖ and ϕ signify sustainable regime and unsustainable regime, respectively.

Upsurges in debt lead to improvements in the primary balance during sustainable regimes $(\kappa\varpi > 0)$. Conversely, primary balance neither improves nor worsens during unsustainable regimes $(\kappa\phi \leq 0)$. Finally, $\sigma_t(z_t)$ is defined by the function:

$$\sigma_t(z_t) = \beta(z_t) + \beta\eta(z_t)\hat{\eta}_t + \beta_g(z_t)\hat{g}_t + \lambda(z_t)\varepsilon_t^s \qquad (4.3.6.10)$$

where $\hat{\eta}_t$ denotes output gap, $\hat{g}_t$ represents temporary government spending, $\beta(z_t)$ signifies a regime-switching constant, $\lambda(z_t)$ represents the regime-switching standard error associated to an IID shock $\varepsilon_t^s \sim N(0,1)$.

The regime switching is considered to be stochastic and exogenous rather than being deterministic and endogenous. Therefore, $\kappa = (\kappa\varpi \;\; \kappa\phi)$ is defined as a row vector

containing regime-specific parameters while $Z_t = (z_t \;\; 1 - z_t)^T$ is defined as a column vector related to the Markov process z_t. The scalar $\kappa(z_t)$ is then defined by:

$$\kappa(z_t) \equiv \kappa(Z_t) = \begin{bmatrix} \kappa\varpi & \kappa\phi \end{bmatrix} \begin{bmatrix} z_t \\ 1 - z_t \end{bmatrix} \tag{4.3.6.11}$$

The Markov process z_t is associated to a transition matrix H with elements $h_{ij} \equiv H(z_t = i \,|\, z_{t-1} = j) \;\forall\; (i,j) \in \{0,1\}$ such that:

$$Z_t = H Z_{t-1} + \Gamma_t, \;\; \text{with } \Gamma_t \equiv Z_t - E_{t-1}[Z_t] \tag{4.3.6.12}$$

The assumption that z_t is an ergodic Markov process implies that $E_t Z_{t+j} = H^j Z_t$ converges to unique ergodic distribution ϑ such that:

$$H^j Z_t \underset{j \to +\infty}{\longrightarrow} \vartheta \tag{4.3.6.13}$$

where $\vartheta = (\vartheta\varpi \;\; \vartheta\varphi)^T$ is the column vector of ergodic probabilities related to each fiscal policy regime.

Following Hamilton (1994), Aldama and Creel (2016) highlight that the Markov process remains ergodic as long as $h_{ii} < 1$ and $h_{ii} + h_{jj} > 0 \;\forall (i,j) \in \{0,1\}$. Computationally, the ergodic probabilities are defined by the function:

$$\vartheta_i = \frac{1 - h_{jj}}{(1 - h_{ii}) + (1 - h_{jj})} \tag{4.3.6.14}$$

Based on equations (4.3.6.11) and (4.3.6.13), the conditional expectation of the feedback parameter $\kappa(z_t)$ at time period t converges to its unconditional expectation that is ergodic (long-run) value:

$$E_t[\kappa(z_{t+j})] = \kappa H^j Z_t \underset{j \to +\infty}{\longrightarrow} \kappa\vartheta \tag{4.3.6.15}$$

Following Aldama and Creel (2016), a necessary and sufficient condition is derived on the sequence $\left\{\kappa\left(z_{t+i}\right)\right\}_{i=0}^{\infty}$ such that equations (4.3.6.6) and (4.3.6.7) hold. In an economy where dynamic efficiency exists with bounded innovations σ_t, a necessary and sufficient condition accompanied with the transversality condition is defined as:

$$\kappa\vartheta > 0 \tag{4.3.6.16}$$

where $\kappa\vartheta \equiv \kappa\varpi\vartheta\varpi + \kappa\phi\vartheta\phi$ represents an unconditional expectation $\kappa\left(z_t\right)$.

The conditional defined by equation (4.3.6.16) specifies that a regime-switching fiscal policy must satisfy the No-Ponzi-Game condition, implying that the frequencies and deviations of sustainable regimes must be sufficient to compensate for unsustainable regimes in the long-run (Aldama and Creel, 2016). Based on the definition of ergodic probabilities (equation 4.3.6.14), and denoting the expected duration of fiscal regimes by $q = \frac{1}{1-h_{ii}}$, the condition given by equation (4.3.6.16) is defined as:

$$\kappa\varpi > \left|\kappa\phi\right|\frac{q_\phi}{q_\varpi} \tag{4.3.6.17}$$

Longer unsustainable regimes characterised by larger primary deficits require larger reactions of primary surpluses to public debt trajectories during sustainable regimes. Nonetheless, provided the condition defined by equation (4.3.6.17) holds, fiscal policy can periodically be unsustainable while at the same time satisfying the PVBC. Since the stronger constraint on fiscal policy requires a stationary public debt-to-GDP ratio, an upper bound on primary surplus-to-GDP ratio such that $b_t^s \leq b^{s,max}$ implies presence of the maximum level (fiscal limit) of public debt (as a ratio of GDP ratio) such that:

$$d^{max} = b^{s,max}\sum_{i=0}^{+\infty}E_t\left[\Psi_{t,i}\right] \tag{4.3.6.18}$$

Therefore, fiscal policy would essentially be considered to be running a Ponzi scheme against lenders whenever $d_t > d^{max}$. Since a condition defined by equation (4.3.6.17) does not rule-out the likelihood of an explosive path for debt-to-GDP ratio, a necessary and sufficient condition for fiscal sustainability could be a debt-stabilising rule around

a steady-state level below a given fiscal limit. Therefore, the debt-to-GDP ratio must follow a Markov-switching autoregressive process defined by the function:

$$d_t = \varphi(z_t) d_{t-1} + u(z_t) \tag{4.3.6.19}$$

$$\text{where } \varphi(z_t) = \frac{1+r_t}{1+\eta}\left(1-(1+\eta_t)\kappa(z_t)\right) \text{ and } u_t(z_t) = -(1+r_t)\sigma_t(z_t)$$

A necessary and sufficient condition for *strict* stationarity of the process defined by equation (4.3.6.19) requires that:

$$\kappa\vartheta > r - \eta \tag{4.3.6.20}$$

In order to stabilise government debt in the long-run, a regime switching fiscal policy must ensure that the condition specified by equation (4.3.6.21) holds:

$$\kappa\varpi > |\kappa\phi|\frac{q_\phi}{q_\varpi} + (r-\eta)\frac{q_\varpi + q_\phi}{q_\varpi} \tag{4.3.6.21}$$

Provided the conditions defined by equations (4.3.6.20) and (4.3.6.21) hold, the debt to GDP ratio converges to its unconditional mean defined as:

$$E[d_t] = \frac{-(1+r)E[\beta(z_t)]}{(1+r)\kappa\vartheta - \frac{r-\eta}{1+\eta}} \tag{4.3.6.22}$$

$$\text{where } E[\beta(z_t)] < 0 \text{ represents the ergodic value of } \beta(z_t).$$

So long as the growth-adjusted real interest rate remains positive, the debt-stabilising condition remains tighter than the NPG condition. Therefore, Aldama and Creel (2016) elucidate that the response of primary surplus to initial public debt during sustainable regimes must be sufficient to compensate for primary deficits that could have been experienced during unsustainable regimes. Conversely, when $(r < \eta)$, the condition defined by equation (4.3.6.21) could ultimately imply violation of the NPG condition by government, which is a minimum requisite for fiscal sustainability. Since a stationary debt-to-GDP ratio does not always invalidate the Ponzi scheme, the NPG condition and debt-stabilising condition thus provide as complements rather than substitutes.

4.4. Conclusion

Theoretical literature covered the definition of fiscal policy sustainability and the theoretical framework consisting of analytical approaches which can be applied in conducting fiscal sustainability assessment. The conceptual approaches discussed in this research study include the static budget constraint, government lifetime budget constraint, present value budget constraint, fiscal stance index, and regime-switching model-based sustainability test.

CHAPTER 5

EMPIRICAL LITERATURE REVIEW

5.1. Introduction

This chapter discusses empirical findings on fiscal sustainability based on empirical literature survey conducted on countries in different continents. The chapter comprises six sections that distinctly discuss empirical findings on countries in Europe, America, Asia, Africa, mixed-group of countries and South Africa. The major issues discussed in this chapter include the data used, methodological procedures applied; estimation techniques used and major empirical findings from the studies. Discussed further are the research gap relating to the missing link between fiscal policy and monetary policy overlooked by previous empirical studies on fiscal sustainability conducted in South Africa. The last section provides the conclusion to the chapter.

5.2. Frequencies of Empirical Studies Reviewed

Table 2 below provides a summary of total numbers of empirical fiscal sustainability studies reviewed in this research study.

Table 2: Numbers of Studies Reviewed

Continent/Region/Country	Number of studies (n)	Relative proportion (%)
Europe	11	26%
America	9	21%
Asia	5	12%
Africa	8	19%
Mixed-group of countries	4	10%
South Africa	5	12%
Total	***42***	***100%***

Source: Compilations from various empirical publications

From the total 42 empirical studies on fiscal sustainability reviewed in this study, the largest proportions of 26% (n=11) and 21% (n=9) related to countries in the European and American continents, respectively. Related studies explored in South Africa and Asian countries accounted for equal proportions of 12% (n=5), while the least quota of 10% (n=4) of the studies comprised the group of countries from different regions.

5.3. Empirical Findings from European Countries

This sub-section discusses empirical findings on fiscal policy sustainability obtained from empirical literature survey conducted on European countries.

Table 3: Empirical Findings from European Countries

Author(s), year and country/region	Nature of data and time span	Regressand	Regressor(s)	Estimation technique	Main findings
Kirchgaessner, G. and Prohl, S. (2006). Switzerland	Time-series (annual) 1900–2002	Revenue-to-GNP ratio	Expenditure-to-GNP ratio	Cointegration (Engle-Granger)	Sustainable
	1900–1939				Unsustainable
	1946–2002				Sustainable
	1900–2002			Cointegration (Johansen)	Sustainable
	1900–1939				Sustainable
	1946–2002				Unsustainable
	1930–2002	Primary deficit-to-GNP ratio	Public debt-to-GNP ratio, Output gap, Expenditure, Inflation and Money growth rate	OLS	Unsustainable
Antonevich, K. (2010); Sweden	Time-series (quarterly); 1994q1–2009q4	GDP growth	Revenue, Expenditure and Debt of the general government	VAR	Fiscal policy effectiveness-mixed results
Potrafke, N. and Reischmann, M. (2012); German states	Panel data (annual); 1974–2010 for West German states and 1992–2010 for East German states	Primary balance (as a ratio of GDP)	Debt-to-GDP ratio, and Institutional setting (fiscal equalisation schemes), Output gap and Public spending	FGLS	Mixed results
Tantos, S. (2012). Greece	Time-series (annual); 1980–2009	Public debt-to-GDP ratio	Primary deficit-to-GDP ratio, Growth rate, and Real interest rate	2SLS	Sustainability
Stoian, A. M. (2016). 5 European countries	Time-series (annual); 1995–2013	Primary balance (as a ratio of GDP)	Debt-to-GDP ratio, Inflation, Interest rate, and Firms production	OLS	Mixed results
Bi, H. and Leeper, E. M. (2013). Greece and Sweden	Time-series (annual data for Sweden); 1980–2007	Expenditure, Transfers and Debt (% GDP)	Productivity	Transition probabilities calibrations	Sustainable
Rajlakshmi, D. (2013). 14 OECD countries	Panel data (annual); 1974–2010	Revenue-to-GDP ratio, and Expenditure-to-GDP ratio		Cointegration	Mixed results
Burret, H. T., Feld, L. P. and Kohler, E. A. (2014). 16 German states	Panel data (annual); 1950–2011	Government revenue	Government expenditure	Cointegration	Mixed results
Piergallini, A. and Postigliola, M. (2016). Italy	Time-series (annual); 1862–2012	Primary balance-to-GDP ratio	Debt-to-GDP ratio, Government spending gap and Output gap	STR	Sustainable
Aldama, P. and Creel, J. (2016). France	Time-series (annual); 1963–2012	Primary balance-to-GDP ratio	Public debt-to-GDP ratio, Temporary public government spending and Output gap	OLS	Unsustainable
	Time-series (annual); 1963–2013			RS-MBS	Mixed results
Afflatet, N. (2016). EU countries	Panel data (annual); 1995–2013	Primary surplus	Interest rates, Growth rate, RER, and UR	FE	Sustainable

Kirchgaessner and Prohl (2006) performed unit root and cointegration tests to analyse whether fiscal policy in Switzerland was sustainable during the period 1900-2002. In order to take into account World War II-related structural shifts in budgetary processes, sub-samples tests were conducted for the pre- and post-World War II sub-periods. Unit root tests in levels and first differences were performed using the ADF and PP methods to examine stationarity properties of the federal primary budget deficit-to-GNP ratio, total budget deficit, government debt, revenues, and expenditures. Based on the necessary condition that sustainability of the budget balance requires primary budget deficit to be stationary, unit root tests results provided evidence of stationarity of the primary deficit to-GNP ratio for the entire sample period 1900-2002.

For the sub-sample periods, the null hypothesis of presence of unit root in the primary balance-to-GNP ratio was not rejected for the 1900-1939 pre-World War II sub-period. This indicates that fiscal policy was unsustainable during that period. Conversely, the null hypothesis on unit root in the primary balance-to-GNP ratio was rejected in respect of the 1946-2002 post-World War II sub-period, but indicated evidence of weak fiscal sustainability. Given that fiscal sustainability tests based on unit root tests of primary deficit are equivalent to tests for cointegration between revenues and expenditures conditional upon such variables having the same order of integration, cointegration tests were conducted between revenues and expenditures. Stationarity properties of revenue- and expenditure-to-GNP ratios were first examined. The null hypothesis of unit root in the series was rejected and variables demonstrated the same order of integration. Engle-Granger cointegration tests between revenue- and expenditure-to-GNP ratios were then conducted for the entire period 1900-2002, as well as for sub-periods 1900-1939 pre-World War II period and 1946-2002 post-World War II period.

Findings of the Engle-Granger cointegration tests reveal that the Swiss fiscal policy was sustainable during the entire sample period 1900-2002 based on evidence of the presence of a cointegrating relationship found between revenue-to-GNP ratio and expenditure-to-GNP ratio. However, findings for the sub-samples periods reveal no evidence of presence of fiscal sustainability during 1900-1939 pre-World War II sub-period. On the contrary, there was evidence of weak fiscal policy sustainability during 1946-2002 post-World War II sub-period. Analogous findings from Johansen multivariate cointegration tests based on the Maximum Eigenvalue statistic and Trace

statistic confirm evidence of a cointegrating relationship between revenue- and expenditure-to-GNP ratios during the entire sample period 1900-2002. Results for the 1900-1939 pre-World War sub-period show no evidence of cointegration between revenue and expenditure-to-GNP ratios, while evidence of a cointegrating relationship between the respective series was found during 1946-2002 post-World War II sub-period. The study concluded that the federal budget deficit was consistent with the IBC condition during the complete sample period 1900-2002. However, the IBC condition was violated during 1900-1939 pre-World War II sub-period while evidence of weak sustainability of fiscal policy was found during the post-World War II sub-period.

Antonevich (2010) analysed the effectiveness of Sweden's fiscal policy using time-series data during the period 1994q1–2009q4. The effects of general government revenue, expenditure and central government debt on GDP growth were examined using the Vector Auto-Regressive (VAR) model. The estimated results indicate that GDP growth demonstrated positive responses to increases in government expenditure and shocks in central government debt. However, the study points out that the positive response of output to an increase in revenue was in contradiction to economic theory, although similar findings were obtained by previous empirical studies.

Potrafke and Reischmann (2012) introduced and examined the effect of institutional setting in fiscal policy formulation on sustainability of public finances in German states. With fiscal equalisation schemes considered as one of the institutional settings in fiscal policy making in the federal states, the study examined whether governments of the German states pursued sustainable fiscal policies, taking into consideration fiscal equalisation transfers. Panel annual data for the sample period 1974-2010 for West German states, and 1992-2010 for East German States were collected on the series primary balance-to-GDP ratio, public debt-to-GDP ratio, fiscal equalisation transfers, government spending and output gap. Using the Feasible Generalised Least Squares (FGLS) technique with fixed state and fixed period effects, fiscal sustainability was assessed by examining the effect of public debt on primary surplus, all as GDP ratios. Results from the estimated model for all the German states reveal the presence of a statistically significant positive association between primary balance-to-GDP ratio and government debt-to-GDP ratio. Similar results were found for West German states and the study concluded that governments as a whole panel and governments of West

German states pursued sustainable fiscal policies. The study found strong evidence that fiscal equalisation transfers enhanced sustainability of the states' fiscal policies. Nonetheless, fiscal equalisation was found to have had a potential effect of providing governments with an incentive to increase their public expenditure levels, which would eventually render the entire equalisation scheme fiscally unsustainable.

Tantos (2012) examined whether Greek public debt-t-GDP ratio would be sustainable up to fiscal year 2020 by estimating a system of four equations for the sample period 1980-2009. The equations formulated for estimation include the growth rate, public debt-to-GDP ratio, primary deficit-to-GDP ratio, and real interest rate. Regressors of the growth rate equation included public debt-to-GDP ratio, external balance-to-GDP ratio, real interest payments-to-GDP ratio, and real interest rate. On the contrary, explanatory variables of the public debt-to-GDP ratio included the growth rate and real interest rate. Regressors of the primary deficit-to-GDP ratio included the growth rate, primary expenditure-to-GDP ratio, tax revenue-to-GDP ratio, and money supply.

Explanatory variables in the real interest equation included the growth rate, primary deficit-to-GDP ratio, government debt-to-GDP ratio, and money supply-to-GDP ratio. ARDL model estimations were conducted to test for presence of long-run relationships in each equation. Subsequent to determination of suitable ARDL estimates, a system of equations was solved using the 2SLS approach. Simulated results indicate that increases in the tax revenue-to-GDP ratio led to reductions in primary deficit-to-GDP ratio at 1 percent significance level while public debt-to-GDP ratio plunged when primary deficit-to-GDP ratio decreased and/or when the growth rate increased.

Stoian (2016) conducted country-specific analysis of five different European countries that were regarded to be most affected by sovereign debt and economic meltdown. The countries included Greece, Ireland, Italy, Portugal, and Spain. Based on annual time-series data for the sample period 1995-2013, the OLS technique was applied to estimate the fiscal reaction function, which measured the response of primary balance-to-GDP ratio to fluctuations in debt-to-GDP ratio. Furthermore, results reveal that governments of Italy and Portugal fulfilled the conditions of fiscal sustainability. The reaction of primary balance in response to shocks to shocks in public debt was statistically significant and positive, and immediate in the two respective nations.

Conversely, increases in public debt-to-GDP ratio led to reductions in primary surplus-to-GDP ratio in Ireland. Therefore, fiscal policy in Ireland was deemed unsustainable during the period 1995-2013. Though positive, the impact of public debt-to-GDP ratio on primary surplus-to-GDP ratio Greece and Spain was statistically insignificant. Hence, no conclusion could be reached as to whether fiscal policies were sustainable or not in Greece and Spain.

Bi and Leeper (2013) analysed the implications of fiscal policy behaviour on sovereign risk in Greek and Sweden during the period 1980-2007. Annual time-series data on expenditure-to-GDP ratio, transfers-to-GDP ratio and public debt-to-GDP ratio and productivity series were analysed using transition probabilities calibrations within a framework of fiscal limit. Parameter calibrations of the model to annual data for the Greek and Sweden economies showed that Greek and Swedish fiscal policies were countercyclical. Therefore, fiscal policies in Greece and Sweden were regarded sustainable during the sample period 1980-2007.

Rajlakshmi (2013) examined whether fiscal trends were sustainable or unsustainable in 15 selected OECD countries during the sample period 1974-2010. Annual panel data series on revenue-to-GDP ratio and expenditure-to-GDP ratio was analysed using unit root tests, cointegration and multicointegration frameworks, and employing sustainability criteria to assess fiscal practices in the respective countries. Results provide evidence of fiscal sustainability in eight countries, namely, Austria, Belgium, Canada, Denmark, Finland, Norway, Sweden, and Portugal during the sample period 1974-2010. However, fiscal policies in France, Italy, Japan, Netherlands, United Kingdom, USA, and Spain were deemed unsustainable during the period 1974-2010.

In German, Burret, Feld and Kohler (2014) examined sustainability of public finances in 16 selected German states using annual data on government revenue and spending for the sample period 1950-2011. Second generation error correction-based panel cointegration tests were applied in empirical estimation. The tests explored both the cross-sectional dimension and cross-sectional variation among states in the East German Laender and West German Laender. For the West German Laender panel, the null hypothesis of no cointegration was rejected in both the unrestricted case and restricted short-term dynamics. Although revenues and expenditures of some Laender

states were cointegrated, panel tests reveal that the entire panel was not cointegrated. Expenditures and revenues of West German Laender were deemed not cointegrated. Hence, fiscal policy was considered unsustainable. Panel cointegration tests on the West German first sub-panel rejected the null hypothesis of no cointegration while the respective null hypothesis was not rejected for the second sub-sample. In addition, the nature and magnitude of cointegration coefficients in each panel were examined using Cross Correlated Effects (CCE) to determine sustainability conditions. The estimated cross-section beta coefficient less than provided evidence for rejection of the null of strict sustainability, though a significant and stable long-run relationship was detected.

Piergallini and Postigliola (2016) investigated whether Italy's primary surpluses were compatible with public debt to sustainability. Using annual time-series data for the period 1862-2012, the association between primary balance-to-GDP ratio and public debt-to-GDP ratio was tested using the Smooth Transition Regression (STR) model. Government expenditure and output gap were integrated into the model as additional regressors. The STR approach was used to allow for the switching mechanism that captures the transition from one economic phase to another. Given that economic variables do not respond promptly to current prevailing economic conditions; a logistic function was employed to connect relevant economic variables. Controlling for output gap, government spending and World War periods, both linear and non-linear STR tests were conducted to examine the relationship between primary surplus and debt.

Empirical findings from the study show that the null hypothesis of nonlinearity in the relationship between primary surplus-to-GDP ratio and public debt-to-GDP ratio substantially outperformed the null hypothesis of linearity in the relationship between the respective fiscal indicators. The statistically significant negative effect of temporary government spending gap on the country's primary surplus-to-GDP ratio supports the tax-smoothing theory. The positive but statistically insignificant effect of output gap reflects countercyclicality in the behaviour of fiscal policy. The significant positive reaction of primary surplus-to-GDP ratio to public debt-to-GDP ratio provides evidence of fiscal sustainability in Italy during the sample period 1862-2012.

Aldama and Creel (2016) examined whether fiscal policy was sustainable in France during the period 1963-2013. In order to consider the effect of fiscal regimes on fiscal sustainability in application to France, Aldama and Creel (2016) introduced a Regime-Switching Model Based Sustainability approach to allow for periodic violations of the fiscal sustainability condition. In searching for a strictly positive and statistically significant feedback effect between one-period lagged public debt-to-GDP ratio and primary balance-to-GDP ratio, seven distinct models were estimated using the OLS technique. Findings obtained from five models that were employed in estimation of constant-parameters fiscal policy rules revealed no evidence of fiscal sustainability. Results showed statistically insignificant negative feedback effects between one-period lagged debt-to-GDP ratio and primary surplus-to-GDP ratio. After controlling for deterministic time trends confirmed by unit root tests, two models revealed evidence of significant and positive reaction of primary surplus response to initial public debt.

To assess the effect of switches in fiscal regimes, the Markov-switching fiscal rule was examined based on the Regime-switching Model-Based Sustainability test using data for the sample period 1965-2013. Accordingly, findings reveal that initial debt had a significant and positive effect on primary surplus in the first regime, indicating strong evidence of fiscal sustainability. Nonetheless, the second regime showed a statistically significant and negative correlation between primary balance-to-GDP ratio and initial public debt-to-GDP ratio, indicating that fiscal policy was unsustainable in France during that regime. The estimated long-run coefficients computed using ergodic transition probabilities reveal that both regimes were persistent, with primary surplus-to-GDP ratio being positively correlated with initial public debt-to-GDP ratio.

Based on the hypothesis of market discipline, Afflatet (2016) analysed the interaction between public debt and financial markets by estimating the reaction of governments' primary surpluses to changes in borrowing costs. Using panel data of European Union countries for the period 1995-2013, the Fixed Effects model was applied to estimate the reaction of primary surplus to changes in two distinct forms of borrowing costs. The borrowing costs are (i) effective (perceived) interest rates general governments have to pay on unpaid debt, and (ii) effective interest rates central governments have to pay on outstanding debt. Empirical results reveal strong evidence that governments indeed raise primary surpluses in reaction to higher interest rates.

5.3. Empirical Findings from American Countries

This sub-section discusses findings on fiscal policy sustainability obtained from related empirical literature survey conducted on countries in the American continent.

Table 4: Empirical findings from American countries

Author(s), year and country/region	Nature of data and time span	Regressand	Regressor(s)	Estimation technique	Main findings
Hamilton, J. D. and Flavin, M. A. (1986). USA	Time-series (annual); 1960–1982	Primary deficit and public debt		ADF test	Sustainable
Wilcox, D. W. (1989). USA	Time-series (annual); 1960 – 1982	Primary deficit and public debt		ADF test	Unsustainable
Bohn, H. (1998); USA	Time-series (annual); 1916– 1995	Primary surplus -to-GDP ratio	Public debt-to-GDP ratio, Government spending, and Output variation	OLS (linear, quadratic and cubic)	Sustainable
MacDonald, R. (1992). USA	Time-series (quarterly); 1951q1–1984q4	Primary deficit and public debt		Cointegration tests (Engle-Granger and Johansen)	Unsustainable
Bohn, H. (2005). USA	Time-series (annual); 1792–2003	Primary surplus -to-GDP ratio	Public debt-to-GDP ratio, Temporary output and outlays	OLS	Sustainable
Daude, C., Melguizo, A. and Neut, A. (2011). Latin America	Panel data (annual); 2000-2009	Adjusted budget balances (as ratios of GDP) – adjusted for deviations of output and commodity prices		OECD methodology	Fiscal policy cyclicality – Mixed results
Luporini, V. (2015). Brazil	Time-series (monthly); 1991–2011	Primary surplus-to-GDP ratio	Net debt-to-GDP ratio; Output gap; and Indexed Federal securities	VECM	Sustainable
Carvalho, L., Diniz, A., Pedrosa, I., and Rossi, P. (2016). Brazil	Time-series (monthly); Dec 2006–Jan 2014	Net debt-to-GDP ratio	Monetary policy interest rate	VAR	Unsustainable
Alberola, E., Katarynuk, I., Melguizo, A. and Orozco, R. (2016). Latin America	Panel data (annual); 1990-2014	Fiscal policy stance (structural primary balance)	Financing conditions (spreads, threshold balances, debt dynamics and output gap); and Fiscal rules	Panel estimation – FE, IV, OLS, and 2SLS with FE	Mixed results

Hamilton and Flavin (1986) assessed fiscal sustainability in USA during the sample period 1960-1982 using annual time-series data series on primary deficit and public debt. Following the proposition made by Hamilton and Flavin (1986) that stationarity of primary deficit is a sufficient condition for the validity of the present value budget constraint (PVBC), the study tested for unit root on government budget deficit using the ADF test. The study finds evidence of stationarity on public debt and primary deficit levels and concludes that the US federal budget deficit was balanced in present value terms. Hence, fiscal policy was deemed sustainable during the period 1960-1982.

However, Wilcox (1989) criticised use of the unit root approach in assessing fiscal sustainability based on stationarity of public debt and primary balance in present value terms. Using the same data on public debt and primary deficit, Wilcox (1989) criticised the assumption of a constant real interest rate and proved that the PVBC can be satisfied even if the primary deficit is non-stationary. In light of such findings, Wilcox (1989) established that fiscal policy should be deemed sustainable only if the discounted value of public debt converges to zero. Using public data for the period 1960-1982, Wilcox (1989) allowed for time-varying real interest rate, discounted the public debt series back to the initial time period and applied the ADF test to the discounted series. Findings from the analysis provide evidence of unsustainability of the US fiscal policy during the respective sample period.

Bohn (1998) assessed whether fiscal policy was sustainable in USA during the period 1916-1995. Using annual time-series data, the reaction of primary surplus-to-GDP ratio to changes in public debt-to-GDP ratio, government spending, and output cyclical variation was estimated using the Ordinary Least Squares (OLS) estimator linear, quadratic and cubic models. Results show that US fiscal policy was sustainable during the respective sample period. Moreover, Bohn (2005) conducted another long-series study to assess whether fiscal policy in USA was sustainable during the period 1792-2003. The OLS method was used to estimate the response of primary surplus-to-GDP ratio to changes in debt-to-GDP ratio, temporary output, and temporary outlays. Findings show that US fiscal policy was sustainable during the relevant sample period.

Macdonald (1992) introduced the cointegration test as an alternative to the unit root test approach used by Hamilton and Flavin (1986). Using US quarterly fiscal data on public debt and primary deficit for the sample period 1951 quarter 1 to 1984 quarter 4, Macdonald (1992) applied Engle-Granger (1987) and Johansen (1988) cointegration methods. Empirical results from the analysis found evidence of cointegration between public debt and budget deficit, and concludes that the US fiscal policy or budget deficit was not consistent with the intertemporal budget deficit (IBC).

Daude, Melguizo and Neut (2011) analysed whether fiscal policy in several selected Latin American countries was countercyclical and sustainable during the period 2000-2009. Using annual panel data, original estimates of cyclically adjusted revenues for

eight countries (Argentina, Brazil, Colombia, Chile, Mexico, Costa Rica, Uruguay, and Peru) were presented using the standardised OECD methodology. The methodology was extended to assimilate the direct and statistically significant effect of commodity cycles on fiscal balances of numerous economies in Latin America. Results provide evidence that primary budget balances (as ratios of GDP), adjusted for deviations in output and commodity prices, were in equilibrium or surplus in all the eight countries. The graphical exposition produced to perform a comparative analysis of variations in adjusted primary balance and output gap levels to assess the cyclicality of fiscal policy indicate that the discretionary fiscal policy in Latin America was procyclical during the period 2000-2009. The estimated negative coefficient for correlation between adjusted primary balance and output gap confirm evidence of pro-cyclicality of the discretionary fiscal policy in Latin America.

Luporini (2015) estimated a fiscal reaction function for the Brazilian economy to assess the manner in which the government's fiscal reaction evolved over time using time-series monthly data for sample period 1991-2011. The government's average fiscal response measured by the reaction of primary surplus-to-GDP ratio to fluctuations in net debt-to-GDP ratio was estimated using the VECM approach. Two control variables were added to the fiscal reaction function, namely output gap and the percentage of government securities. The output gap captured the effect of the economic cycle, while the percentage of government securities was indexed to the baseline interest rate.

Empirical results of the long-run section of the cointegrating vector showed a positive and statistically significant response of the primary surplus-to-GDP ratio to fluctuations in the net debt-to-GDP ratio, indicating that the Brazilian fiscal policy was sustainable. Similarly, results on the short-run dynamics primary surplus equation indicate that net public debt had a negative and statistically significant impact on primary surplus. Such results suggest that transitory deviations of the long-run primary surplus and net public debt relationship were compensated by fluctuations in the primary surplus.

Carvalho, Diniz, Pedrosa, and Rossi (2016) conducted a study to assess the fiscal cost of an upsurge in monetary policy interest rate in the Brazilian economy. The indirect effects were estimated on the yield of public bonds that are indexed to the inflation and the exchange rate, and net public debt stock adjusted for international

reserves measured in the Brazilian currency. A Vector Auto-Regressive Model (VAR) model was used to estimate relationships between the interest rate, inflation and exchange rate to incorporate the indirect effects of the respective variables on the reaction of net public debt to shocks in the implicit interest rate. Findings reveal that monetary policy tightening based on diverse scenarios of GDP growth and primary surplus-to-GDP ratio led to an increase in net public debt-to-GDP ratio. The presence of a substantial foreign reserves stock intensified the fiscal costs of a tight monetary policy stance via the nominal exchange rate channel, thus leading to unsustainability of fiscal policy. Results indicated the need for consistent macroeconomic coordination between fiscal, monetary and exchange rate policies to ensure fiscal sustainability.

Alberola, Katarynuk, Melguizo, and Orozco (2016) analysed the effect of changes in financing conditions and fiscal rules on structural primary balance in eight Latin American countries using annual data for the sample period 1990-2014. The variables used as indicators of changes in the financing conditions include changes in spreads (Δspreads), threshold balance (Δtb) and market-based threshold balance (Δtb-mb). A positive effect of a specific financing condition indicator on structral primary balance implied that fiscal policies were restrained in response to deteriorations in financing conditions. Since fiscal policy reacts to dynamics in public debt and output gap, the respective variables were incorporated into the model as regressors. Accordingly, the Fixed Effects (FE) model was employed for estimation and took account of omitted variables bias emanating from presence of unobserved country heterogeneity. In order to address potential endogeneity between financial conditions variables and fiscal impulse, an instrumental variable (IV) estimator was applied for estimation.

Results from the FE model show that changes in the implied threshold balance had statistically significant positive effect on changes in the structural primary balance while government did not react to changes in spreads. Correspondingly, results obtained from the IV (2SLS with FE) estimator provide strong evidence that changes in the implied threshold balance had a signifcant positive effect on changes in the structural primary balance. Results from both FE and IV estimators provide evidence that financing conditions indeed a significant determinant of fiscal stance during the sample period studied. Public debt had a significant negative effect on structural

primary balance, which showed enhancement of the fiscal position. The FE and IV methods also integrated fiscal rules and assesed their effect on fiscal stance, and showed that structural primary balance positively and significantly reacted to changes in financing conditions. Therefore, fiscal rules had a significant effect, but with an indication that fiscal rules potentially induced some endogenity in the bahaviour of financial variables. Overall, results show that the bahaviour of fiscal policy was countrcyclical during the crisis period but later became procyclical. Financing conditions were deemed a significant determinant of fiscal stance, while fiscal rules had a stabilising effect on fiscal policy.

5.4. Findings on Fiscal Sustainability in Asian Countries

This sub-section discusses findings on fiscal sustainability based on relevant empirical literature survey conducted on countries in the Asian continent.

Table 5: Empirical findings from Asian countries

Author(s), year and country/region	Nature of data and time span	Regressand	Regressor(s)	Estimation technique	Main findings
Adams, C., Ferrarini, B. and Park, D. (2010). Developing Asia	Panel data (annual); 1990–2008	Primary balance-to-GDP ratio	Public debt-to-GDP ratio, GDP gap, Government expenditure gap	FGLS, OLS FE and SGMM	Sustainable
Doi, T., Hoshi, T. and Okimoto, T. (2011). Japan	Time-series (quarterly); 1980q1–2010q1	Primary balance-to-GDP ratio	Public debt-to-GDP ratio, Government expenditure-to-GDP ratio, and GDP gap	MLE and MSC	Unsustainable
Kuncoro, H. and Sebayang, K. D. A. (2013). Indonesia	Time-series (quarterly); 1999q1–2009q4	Primary surplus-to-GDP ratio	Debt-to-GDP ratio, Interest rate ratio, Inflation rate, Output gap, Exchange rate depreciation, Relative change in real money supply, and Oil price	OLS	Sustainable
Munawar-Shah, S., Abdul-Majid, M. and Hussain-Shah, S. (2014). 10 Asian countries	Panel data (annual); 1990–2010	Primary balance-to-GDP ratio and Public debt-to-GDP ratio Revenue-to-GDP ratio and Expenditure-to-GDP ratio		Panel Unit Root, and Cointegration tests	Mixed results
Dalgıc, B., İyidogan, P. V. and Balıkcıoglu, E. (2014). Turkey	Time-series (quarterly); 2006q1–2013q3	Tax revenues	Government expenditures	ARDL	Weak sustainability

Adams, Ferrarini and Park (2010) empirically examined whether public finances in the developing Asia were sustainable during the sample period 1990-2008. The study used annual panel data on the primary balance-to-GDP ratio, public debt-to-GDP ratio,

GDP gap, and government expenditure gap. Fiscal reaction functions measuring the adjustment of primary fiscal balance to fluctuations in debt-to-GDP ratio positions were estimated using numerous panel estimation approaches. The latter include the Feasible Generalised Least Squares (FGLS), Ordinary Least Squares Fixed Effects (OLS FE), and System General Methods of Moments (SGMM). Empirical results obtained from fiscal reaction functions estimated using the abovementioned panel estimators show evidence of fiscal sustainability in the whole region. The average response of primary balance to current and lagged public debt positions show that fiscal behaviour in the region was consistent with the intertemporal budget constraint.

Doi, et al. (2011) used a three-step procedure in analysing sustainability of fiscal policy in Japan over the period 1980q1-2010q1. The first step calculated the minimum tax rate the government had to impose to stabilise the public debt-to-GDP ratio based on the approach used by Broda and Weinstein (2005) and Doi (2009). Estimated results from the first approach show that government revenue-to-GDP ratio had to increase permanently by the range 40%-47% to stabilise public debt-to-GDP ratio. The second step involved estimation of the response of primary balance-to-GDP ratio to an increase in public debt-to-GDP ratio between two regimes using maximum likelihood estimation (MLE) and Markov switching criterion (MSC) methods. However, findings from second step estimation reveal that primary surplus-to-GDP ratio did not respond positively to debt fluctuations, signifying that the process was explosive. The final step estimated fiscal and monetary policies functions using the Markov switching model.

Estimation of the monetary policy function was performed in respect of the rationale that in a country with a sound macroeconomic framework. The behaviour of fiscal policy also depends on how the central bank conducts monetary policy taking into account the inflation rate, output gap and real exchange rate variations. Based on the Markov switching model, estimation of the fiscal policy function focused on analysing the manner in which tax revenues responded to fluctuations in public debt-to-GDP ratio. The tax revenue-to-GDP ratio was estimated as a function of the public debt-to-GDP ratio, government expenditure and output gap. Findings reveal that tax revenues did not rise in response to increases in debt-to-GDP ratio, while tax revenues slightly increased in response to upsurges in government expenditures. Fiscal dynamics in

Japan during 1980q1-2010q1 suggest that tax revenues did not adjust accordingly to enhance a sustainable fiscal path, hence fiscal policy was unsustainable.

In empirically analysing the dynamic interaction between monetary and fiscal policies in Indonesia, Kuncoro and Sebayang (2013) estimated a monetary reaction function and a fiscal reaction function using quarterly time-series data for the period 1999q1–2009q4. Therefore, the monetary policy interest rate and primary balance-to-GDP ratio were identified as the main determinants of the interaction between monetary and fiscal policies. Public debt-to-GDP ratio was included as a regressor in both monetary and fiscal policies reaction functions to determine whether the respective policies react to public debt positions. In respect of the fiscal reaction function, additional variables that accompanied debt-to-GDP ratio as regressors of the primary surplus-to-GDP ratio include monetary policy interest rate relative to the US interest rate, inflation rate, output gap, exchange rate depreciation, relative change in real money supply and oil price. With the interest rate specified as the regressand in the monetary policy reaction function, the interaction between monetary and fiscal policies was explained by the coefficients of primary surplus and lagged government debt, as ratios of GDP.

Results for the monetary reaction function estimated using the OLS approach show that the coefficients for primary surplus and lagged debt were positive and statistically significant. Increases in primary surplus and public debt led to positive adjustments in monetary policy interest rate. The respective findings provide evidence that monetary policy in Indonesia was certainly responsive to the fiscal policy, thereby enabling the government to maintain a sustainable fiscal path. With regards to estimates of the fiscal reaction function, the statistically significant and positive coefficient of lagged public debt-to-GDP ratio reveals that the government increased the primary balance surplus in response to an increase in public debt stock. Therefore, results suggest that fiscal policy in Indonesia was sustainable during period 1999q1-2009q4. However, the positive and statistically insignificant estimated coefficient of monetary policy interest rate of the fiscal reaction function shows provide evidence that fiscal policy was not responsive to monetary policy. Findings suggest violation of the necessary condition that in order to maximise utility, fiscal authorities should also consider monetary policy.

Munawar-Shah, Abdul-Majid and Hussain-Shah (2014) assessed fiscal sustainability for 10 Asian countries. The analysis was also conducted for two sub-panels of countries, grouped as SAARC* and IMT-GT* nations. The IMT-GT* group consisted of four high income countries, while the SAARC* group consisted of six low income countries. Using annual panel data for the sample period 1990-2010, panel unit root and cointegration tests were applied to examine cointegration properties between primary-balance-to-GDP ratio and public debt-to-GDP ratio. Similar empirical tests were also performed between revenue-to-GDP ratio and expenditure-to-GDP ratio. Fischer ADF, Fischer PP, and Im, Pesaran and Shin (IPS) unit root tests were used to examine stationarity properties of data, while the Pedroni (1999; 2004) Engle-Granger cointegration approach was applied to data series with the same order of integration.

The Pedroni Engle-Granger panel cointegration results on primary surplus-to-GDP ratio and debt-to-GDP ratio rejected the null hypothesis of no cointegration for the group of all 10 countries, and SAARC* group of low income countries while the null hypothesis could not be rejected for countries in the IMT-GT* group of high income countries. Based on panel cointegration tests of primary surplus and public debt, results show that fiscal policy was sustainable in the region as a whole, and in the SAARC* group of four low income countries. Conversely, fiscal policy was deemed unsustainable in the IMT-GT* group of six high income countries. Similarly, results of panel cointegration test for revenue and expenditure show that the null hypothesis of no cointegration was rejected for the SAARC* group while the null hypothesis could not be rejected for the IMT-GT* group. Findings further confirm that fiscal policy was sustainable in SAARC* group of four low income countries, but unsustainable in the IMT-GT* group of six high income countries during the sample period of the study.

Dalgıc, İyidogan, and Balıkcıoglu (2014) examined sustainability of fiscal policy in Turkey using quarterly time-series data for the sample period 2006q1-2013q3. Accordingly, the long-run relationship between fiscal tax revenues and government expenditures was analysed using the cointegration test and Auto-Regressive Distributed Lag (ARDL) model. Cointegration test was performed within the framework of the bounds testing methodology of Pesaran, et al. (2001). The respective methodology tests determined whether series were I(0), 1(1) or mutually cointegrated.

To validate the estimates from the cointegration test and determine the degree of fiscal sustainability, the ARDL model of revenues and expenditures was estimated. Though statistically significant, the estimated coefficients smaller than one indicate evidence of weak sustainability of fiscal policy in the country during period 2006q1-2013q3.

5.6. Findings on Fiscal Sustainability in African Countries

This sub-section discusses findings on fiscal sustainability based on relevant empirical literature survey conducted on countries in the African continent.

Table 6: Empirical findings from African countries

Author(s), year and country/region	Nature of data and time span	Regressand	Regressor(s)	Estimation technique	Main findings
Mohamed, A. H. (2014). 6 member states of the WAMZ	Panel data (annual); 1985–2013	Primary balance (as a ratio of GDP)	Public debt-to-GDP ratio	Cointegration	Mixed results
Asiama, J., Akosah, N. and Owusu-Afriyie, E. (2014). Ghana	Time-series (quarterly); 2000q1–2014q1	Primary balance (as a ratio of GDP)	Public debt-to-GDP ratio, Output gap, Exchange rate depreciation, CPI, and Commodity prices	Bounds Testing ARDL	Sustainable
Oyeleke, O. J. and Adebisi, D. G. (2014). Ghana	Time-series (annual); 1980–2010	Revenue-to-GDP ratio	Expenditure-to-GDP ratio	2-Step Engle-Granger ECM	Sustainable (weak)
Mafusire, A. (2015). Swaziland	Time-series (annual); 1986–2009	Primary balance-to-GDP ratio	Public debt-to-GDP ratio, and Output gap	OLS	Sustainable
Caceres, C., Cevik, S. Fenochietto, R. and Gracia, B. (2015). Lybia	Time-series (annual); 2003–2010, Projections (annual); 2011–2024	Overall balance-to-GDP ratio, Primary expenditure-to-GDP ratio, Net asset accumulation	Numerical fiscal rules (structural balance rule, augmented growth based rule, expenditure rule and an enhanced structural fiscal balance rule)	Unrestricted VAR and Monte Carlo Simulations of fiscal rules	Unsustainable
Nzaramba, L. (2015). 10 African countries	Panel data (annual); 1970–2012	Primary balance-to-GDP ratio	Public debt-to-GDP ratio, Government spending gap, Output gap, FDI-to-GDP ratio, and Remittances-to-GDP ratio	OLS	Mixed results
Mutuku, C. (2015). Kenya	Time-series (annual); 1970-2013	Primary balance (as a ratio of GDP)	Public debt-to-GDP ratio, Output gap, REER, CPI, and Political dummy	VAR and VECM	Unsustainable
Jibrilla, A. A. (2016). Nigeria	Time-series (annual); 1961–2014	Real government revenue, Real government expenditure, and Budget deficit		Cointegration, ARDL and DOLS	Sustainable (weak)

Mohamed (2014) analysed the fiscal policy framework in six member countries of the West African Monetary Zone over the sample period 1985-2013. The countries include Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone. The PVBC of fiscal policy in the region was tested using annual panel data for the variables primary balance-to-

GDP ratio and total public debt-to-GDP ratio analysed using unit root and cointegration tests. Findings on the unit root tests rejected the null hypothesis of presence of unit root in the series primary balance-to-GDP ratio and total debt-to-GDP ratio. Therefore, results from cointegration tests show that fiscal policy was sustainable in Gambia, Ghana, Guinea, Nigeria, and Sierra Leone. On the contrary, fiscal policy in Liberia was regarded to be unsustainable during the sample period under review.

Asiama, Akosah, and Owusu-Afriyie (2014) assessed sustainability of fiscal policy in Ghana using quarterly time-series data over the period 2000q1–2014q1. The fiscal behaviour of government in terms of its reaction to rising public debt was assessed through estimation of a fiscal reaction function. The primary balance-to-GDP ratio was specified as the regressand in the fiscal reaction function, government debt-to-GDP ratio at the end of the preceding period was the independent variable. In order to account for the influence of economic factors on fiscal sustainability, output gap, exchange rate depreciation, CPI inflation, and oil commodity prices were integrated into the model as additional regressors of the primary balance position.

Output gap captured the effect of business cycles while exchange rate depreciation accounted for the effect of persistent currency depreciation on the economy's fiscal position pertaining external debt service costs. Similarly, CPI inflation accounted for the effect of inflation on the fiscal balance while oil commodity prices accounted for the effect of price fluctuations on the fiscal position. Accordingly, the fiscal reaction function was estimated using unit root tests and the Bounds Testing ARDL model. Estimates from estimation of the ARDL model show existence of significant linear and non-linear relationships between primary balance and public debt in the previous period. Results demonstrate strong evidence that government systematically reacted to rising public debt in both short-run and long-run periods by generating future primary surpluses. Findings indicate that the fiscal behaviour of the government was consistent with the IBC, hence fiscal policy was sustainable during the period 2001q1-2014q1.

Oyeleke and Adebisi (2014) assessed the sustainability of Ghana's fiscal policy during the period 1980-2010. Specifically, time-series annual data on government revenue-to-GDP ratio specified as the regressand, and government expenditure-to-GDP ratio specified as the regressor were analysed using the OLS Engle-Granger 2-step ECM.

Stationarity test results show that both series demonstrated presence unit roots in levels and became stationary at first difference; hence, the variables were integrated of order one. The first-step results of the Engle-Granger 2-step cointegration test procedure indicate that the crucial condition of presence of a long-run (cointegrating) relationship between government revenue and government spending was satisfied. the Engle-Granger step-2 procedure for cointegration test was conducted to determine whether the sufficient condition for fiscal sustainability was satisfied.

Following Quintos (1995), a fiscal deficit is deemed strongly sustainable if and only if government revenue and expenditure are I(1) and $\beta = 1$. Concurrently, a fiscal deficit is regarded as weakly sustainable if fiscal revenue and expenditure are cointegrated but $0<\beta<1$, while fiscal policy is deemed unstainable if $\beta=0$. In addition, the second step of the Engle-Granger 2-step procedure was performed to test for presence of long-run cointegrating relationship between fiscal revenue and expenditure using the OLS estimation method. The ADF and PP tests of unit roots on the residuals show that residuals were stationary in levels, confirming presence of a long run relationship between fiscal revenue and spending. Results of the Wald coefficient restriction test show a statistically significant positive β coefficient but significantly less than one, indicating that the fiscal deficit in Ghana was weakly sustainable.

Mafusire (2015) assessed the sustainability of Swaziland's fiscal policy, and analysed the impacts of fiscal adjustments on economic growth, inflation and sectoral resource allocation during the period 1986-2009. Eventually, the study evaluated whether fiscal sustainability was potentially endangered, and if so, intended to explore relevant policy options for adoption. Based on annual time-series data, the reaction of primary deficit-to-GDP ratio to fluctuations in public debt-to-GDP ratio was analysed using the OLS technique. Output gap, interest and economic growth series were also included in the primary surplus function as relevant explanatory variables influencing primary surplus. Results from the estimated model indicate that lagged public debt and primary deficit rationally explained variations in the present primary deficit, indicating sustainability of fiscal policy in Swaziland during the given sample period. However, the computed finite horizon tax gap and primary gap indicators suggest that fiscal sustainability was endangered, hence government revenues and expenditures needed to be readjusted while resources allocation had to focus on stimulating growth.

Given the background of the bulk of Libya's government revenues greatly dependent on volatile hydrocarbon resources, Caceres, Cevik, Fenochietto, and Gracia (2015) assessed the cyclically adjusted fiscal stance, and further examined sustainability of fiscal policy in Libya within the framework of the permanent income hypothesis (PIH). Several fiscal policy rules were simulated with the main objective of designing a rule-based fiscal strategy that promotes and maintains fiscal sustainability, macroeconomic stability and intergenerational equity. Fiscal rules simulated are the *expenditure rule*, *structural balance rule*, *enhanced structural balance rule*, and *augmented growth-based balance rule*. The rationale behind the design of a rule-based fiscal strategy originated from the practical realisation that a fiscal framework anchored on fiscal rules and strong institutional arrangements enhance the credibility of fiscal policy and its ability to maintain fiscal sustainability and macroeconomic stability.

To account for the effects of uncertainties in fiscal projections, stochastic simulation methods were used to assess the effectiveness of alternate fiscal rules in response to calibrated macroeconomic shocks. In addition, joint distributions of shocks were calibrated to fit statistical properties of historical time-series data for the period 2003-2010 using the unrestricted VAR model to describe co-movements in endogenous variables, namely, the real interest rate, real effective exchange rate and output gap. Furthermore, annual projections for the forecasting period 2011-2024 were generated for growth, domestic real interest rate, output gap, and real exchange rate via Monte Carlo simulations. Projections for fiscal aggregates under each fiscal rule were computed for each year of the predicting period. Since budgetary aggregates of commodity-export nations are determined by global price fluctuations, oil price shocks were included in the model as an exogenous variable to capture the impact of global demand and supply conditions.

Results from simulation analysis conducted show that fiscal rules (expenditure rule, structural balance rule, and augmented growth-based balance rule) anchored on the cyclically adjusted balance are effective in dealing with output shocks and commodity price shocks. The structural balance rule produces the narrowest spectrum for primary expenditure in response to output and commodity price shocks, with low variability in automatic deviations from targets to accommodate exogenous shocks. Moreover, simulations of fiscal rules under numerous shocks show that net asset accumulation

consistently follow a downward path in the long-term. The augmented growth-based balance yields the narrowest continuums for the overall fiscal balance and net asset accumulation. The enhanced structural balance and expenditure rules produce wider and declining trends for net asset accumulation during the 2011-2024 forecast horizon. In terms of the present value of future accumulated net assets, the primary budget deficit drifting above equilibrium level raises concerns about long-term sustainability of the nation's public finances. However, constraints related to institutional capacity may render implementation of the fiscal rule ineffective in the short-to medium term.

Nzaramba (2015) examined fiscal sustainability in each of the 10 countries in Africa during the period 1970-2012. The countries covered in the study are Algeria, Ivory Coast, Ghana, Kenya, Nigeria, Rwanda, South Africa, Tanzania, Tunisia, and Zambia. Fiscal response functions were estimated for each of the countries where the response of primary surplus-to-GDP ratio to fluctuations in public debt-to-GDP ratio was estimated using the OLS technique. Temporary government spending, output gap, FDI-to-GDP ratio, and remittances-to-GDP ratio were integrated into the fiscal reaction functions as exogenous variables to primary surplus. Therefore, results from estimated fiscal reaction functions provide evidence that fiscal policies were sustainable in Algeria, Ghana, Rwanda, South Africa, Tanzania, and Rwanda, while public debt was unsustainable in the remaining countries during the sample period under review.

The study conducted by Mutuku (2015) examined whether fiscal policy was consistent with the inter-temporal budget constraint and sustainable during the period 1970-2013. Based on annual time-series data, a fiscal reaction function was estimated to assess the response of primary surplus to fluctuations in public debt using the VAR and VECM techniques. Accordingly, the VAR model was applied in light of the rationale that macroeconomic variables are often potentially endogenous and allow for dynamic interaction among variables without explicitly enforcing theoretical structures on estimates (Sims, 1980). In addition to public debt-to-GDP ratio, other variables included in the models include output gap, consumer price index (CPI), real effective exchange rate (REER), and the dummy for political elections. Following Bohn (1998), output gap captured the effect of business cycles on primary surplus while the CPI operated as a proxy of commodity prices to capture the influence of commodity price fluctuations on the fiscal position.

The real exchange rate was included in the model to capture the influence of persistent depreciation of the country's currency on its fiscal positions via the external debt-servicing channel. The ADF and PP tests for stationarity, and cointegration tests for long-run relationship among variables (Johansen and Julius, 1990) indicate that all variables were integrated of order one and cointegrated at 5% significance level. Results of the long-run segment of the VEC model show that public debt-to-GDP ratio had a negative and statistically insignificant effect on primary balance-to-GDP ratio. In addition, results show that the reaction of government to accumulating public debt was non-systematic. Hence, fiscal policy was unsustainable during the period 1970-2013.

Jibrilla (2016) investigated the sustainability of Nigerian fiscal policy by estimating the influence of government revenues and expenditures on budget deficit over the period 1961-2014. Time-series annual data on real government revenue, real government expenditure and budget deficit were analysed using the Bounds Test ARDL approach and DOLS estimator by allowing for structural breaks. Cointegration test results show evidence of a cointegrating relationship between government's real revenue and real spending, indicating budget deficit sustainability. The bounds test ARDL cointegrating method was used to test robustness of estimates from a Johansen cointegration test.

Results from the ARDL bounds test indicate presence of a cointegrating relationship between government revenues and expenditure, suggesting evidence of fiscal policy sustainability. In order to assess the degree of sustainability of the budget deficit, long-run coefficients of the government revenues and spending series estimated using the DOLS method to check the robustness of estimates. Results showing the coefficient of government spending significantly less than one suggests that public debt stock grew faster than growth in output, signifying that fiscal policy was weakly sustainable.

5.7. Findings on Fiscal Sustainability in Mixed-Groups Countries

This sub-section discusses findings on fiscal sustainability based on relevant empirical literature survey conducted on countries in the mixed-groups of countries.

Table 7: Findings on Fiscal Sustainability in Mixed-Groups of Countries

Author(s), Year and Country/Region	Nature of Data and Time Span	Regressand	Regressor(s)	Estimation technique	Main findings
Polito, V. and Wickens, M. (2005). US, UK and Germany	Time-series (quarterly); 1960q1–2005q4	Fiscal Sustainability Index (FSI)	Monetary rule (interest rate), debt, revenue, GDP growth and disbursements	VAR	Mixed results
Papadamou, S., Sidiropoulos, M. and Spyromitros, E. (2017). 22 countries	Panel data (annual); 1992–2000	Public debt-to-GDP ratio	Primary deficit-to-GDP ratio, Government bond yield, GDP growth rate (adjusted for Central Bank independence)	System GMM	Unsustainable
Greenlaw, D., Hamilton, J. D., Hooper, P. and Mishkin, F. S. (2013). 20 advanced nations	Panel data (annual); 2000–2011	Sovereign interest rate or borrowing cost	Gross debt and Net debt (as % of GDP); and BOP Current Account deficit	FE model	Increased debt and BOP CA deficit cause Unsustainability
Camarero, M., Carrion-i-Silvestre, J. and Tamarit, C. (2013). 17 OECD countries	Panel data (annual); 1970–2012	Real government revenue	Real government expenditure and real public debt	DOLS and cointegration tests	Weak sustainability

In assessing fiscal sustainability of the US, UK and Germany, Polito and Wickens (2005) developed an index of fiscal stance and conducted a counter-factual analysis of possible implications for fiscal sustainability of using a Taylor rule to set monetary policy over a period of 25 years. Though a fiscal stance is considered sustainable if it satisfies the government's inter-temporal budget constraint (IBC), Polito and Wickens (2005) underscore that the condition does not solve the problem if the policy stance is examined from a forward-looking standpoint over an infinite horizon. Therefore, Polito and Wickens (2005) proposed an IBC-based sustainability index of the current fiscal stance derived from comparison of the existing public debt level with a forecast of the present value of the current and future deficits and surpluses computed from the economy's VAR forecasting model. An index exceeding unity indicates a sustainable fiscal stance, and vice-versa. In UK and US, the fiscal sustainability index fluctuated substantially, with periods of unsustainability followed by episodes of sustainability.

Papadamou, Sidiropoulos and Spyromitros (2012) empirically analysed the effect of the level of central bank independence on the impacts budget deficits, government bond yields and GDP growth discretely have on net domestic government bond issues and net public debt (as a ratio of GDP). The study was conducted on a group of 22 developed countries using data for the period 1992-2000. Two different models were estimated, where net domestic government bond issues were the regressand in one model while public debt-to-GDP ratio was a dependent variable in the other model.

The same set of regressors comprised primary deficit-to-GDP ratio, government bond yield and GDP growth rate was used in both models. The stated regressors were interacted with central bank independence to determine the effect of the level of central bank independence on the impact of each of the specified regressor on net public debt-to-GDP ratio. Empirical estimates were computed using the dynamic panel data Arellano-Bover/Blundell-Bond system GMM estimator.

Results for the net stock of government debt securities-to-GDP ratio model show that domestic government bond issues were not the primary source of financing budget deficits. In addition, government bond yields in the previous period positively and significantly affected the net stock adjustment of bond securities. On the contrary, GDP growth negatively and significantly led to decreases in the government's stock of domestic debt securities-to-GDP ratio. Such results indicate that economic growth can assist in significantly reducing debt issues under certain given market conditions. The level of central bank independence significantly affected the effects of borrowing cost measured by 10-year government bond yield, deficits and economic growth on net government bond issues. Results indicate that high levels central bank independence significantly affected pricing of debt securities in the markets, leading to constrained financing of deficits through bond issues while GDP growth reduced the likelihoods of issuing debt securities. Higher levels of central bank independence greatly influenced the effects of securities market conditions on government bond issues.

Concomitantly, results for the public debt-to-GDP ratio model indicate that lagged debt had a significant positive impact on the current level of debt. However, Papadamou, Sidiropoulos and Spyromitros (2012) accentuate that such an impact depends on the prevailing level of central bank independence, pointing out that higher levels of central bank independence reduce the likelihood of monitisation of debt. The government can meet its debt obligations by issuing new public debt. Growth in output significantly reduced public debt while GDP growth had a significant positive effect on debt issues in countries that required their central banks to execute the mandate of price stability. Results show that the pursuance of an inflation aversion goal cogently leads to a restrictive monetary policy stance characterised by higher interest rates.

Greenlaw, Hamilton, Hooper, and Mishkin (2013) examined the effect of debt loads on the sovereign interest rate in a group of 20 advanced economies during the sample period 2000-2011. The response of sovereign interest rate to changes in gross debt and net debt (% of GDP) and BOP current account deficit was estimated using the FE estimator. The study found that increased debt above 80% of GDP and persistent BOP current account deficits lead to rapid fiscal vulnerability and deterioration of the fiscal position, causing fiscal unsustainability. In addition, Camarero, Carrion-i-Silvestre, and Tamarit (2013) applied the stock flow approach and analysed fiscal sustainability in a group of 17 OECD countries using data for the period 1970-2012. The impacts of government expenditure and debt on revenues were estimated using cointegration and DOLS methods. In order to obtain robust estimates, the presence of structural breaks was tested by analysing cointegration between revenue and spending without imposing any restriction, thus indicating evidence of weak fiscal sustainability.

5.8. Findings on Fiscal Sustainability in South Africa

This sub-section discusses findings on fiscal sustainability based on related empirical literature survey conducted in context of South Africa.

***Table 8**: Findings on Fiscal Sustainability in South Africa*

Author(s) and Year	Nature of data and time span	Regressand	Regressor(s)	Estimation technique	Main findings
Tshiswaka-Kashalala, G. (2006).	Time-series (quarterly); 1990q1–2005q4	Revenues	Government spending, and Interest payments	VECM	Sustainable
Burger, P., Stuart, I., Jooste, C. and Cuevas. A. (2011).	Time-series (annual); 1974–2008	Primary balance (as a ratio of GDP)	Public debt-to-GDP ratio, and Output gap	OLS, VAR, GMM, TAR, VECM, and State Space	Sustainable
Jibao, S. S., Schoeman, N. J. and Naidoo, R. (2011).	Time-series (quarterly)' 1960q1–2008q4	Revenue (as a ratio of GDP)	Expenditure-to-GDP ratio	LSTECM	Sustainable
Calitz, E., Du Plessis, S. and Siebrits, S. (2013).	Time-series (annual); 1984–2010	Primary balance-to-GDP ratio, Public debt-to-GDP ratio, Real interest rate and Real GDP growth		SVAR	Sustainable
Ganyaupfu, E. M. (2014).	Time-series (quarterly); 1990q1–2013q3	Primary balance-to-GDP ratio	Public debt (as a ratio of GDP), and Output gap	VECM	Sustainable

Tshiswaka-Kashalala (2006) assessed sustainability of the South African fiscal policy during the period 1990q1-2005q4 by analysing the reaction of revenues to variations

in government spending and interest payments. Unit root and cointegration tests were first conducted to determine stationarity and cointegration properties of the data series. On the contrary, the VECM approach was applied to determine whether government fiscal policy was consistent with the inter-temporal budget constraint (IBC) where the present value constraint (PVC) was the key instrument for empirical analysis. Findings from the study show that the country's fiscal policy was consistent with the PVC and pointed out that the country's fiscal policy was sustainable over the sample period.

Studies conducted by Burger, Stuart, Jooste, and Cuevas (2011), and Ganyaupfu (2014) assessed whether fiscal policy was historically sustainable in South Africa by examining the response of primary balance-to-GDP ratio to variations in public debt-to-GDP ratio. Furthermore, Burger, et al. (2011) used annual time-series data for the period 1974-2008, while Ganyaupfu (2014) used quarterly time-series data for the sample period 1990q1-2013q3. The studies applied the VECM approach while Burger, et al. (2011) further employed the OLS, VAR, TAR and State Space modelling techniques in estimating the fiscal reaction function. Results from studies show that fiscal policy was sustainable during the given sample periods.

Jibao, Schoeman and Naidoo (2011) examined whether South Africa's fiscal policy was sustainable using quarterly time-series data for the period 1960q1-2008q4. The study applied Linear Smooth Transition Error Correction Model (LSTECM) using the Non-linear Least Squares (NLS) method in analysing the response of revenue-to-GDP ratio to variations in expenditure-to-GDP ratio during the period 1960q1-2008q4. Therefore, findings from the study reveal that fiscal policy in South Africa was consistent with the IBC, and hence sustainable over the period 1960q1-2008q4. Fiscal sustainability in the country was achieved through reduction in expenditure-to-GDP ratio. On the contrary, fiscal reaction was quicker when the fiscal budget was in a deficit relative to when it was in a surplus. Similarly, Calitz, et al. (2013) analysed fiscal sustainability using annual time-series data for the period 1984–2010. The study applied the SVAR approach to assess interactions among primary balance-to-GDP ratio, debt-to-GDP ratio, real interest rate, and real GDP growth, and found evidence of fiscal poicy sustainability.

5.8.1. The Missing Link in Fiscal Sustainability Analysis in South Africa

Gurkaynak (2015) points out that fiscal sustainability cannot be regarded as a fiscal issue purely exclusive from monetary policy, given that monetary policy in reality also affects sustainability of a country's fiscal policy through public borrowing costs and seigniorage. This orthodox premise follows Dahan (1998) who emphasises that a monetary policy stance has several channels through which it essentially influences budget deficit and government debt in the short-run. In respect of the empirical studies conducted to assess fiscal sustainability in South Africa, none of the studies to date considered and examined the potential impact of the central bank's monetary policy stance on primary surplus and/or public debt trajectories in the country.

Since the broad macroeconomic objectives of monetary policy are to control inflation, ensure financial stability and promote economic growth, adjustments of the respective policy's instruments have direct impacts on the country's budget deficit (Dahan, 1998). The several channels through which monetary policy stance affects the budget deficit include prices, interest rate, exchange rate, seigniorage, and sterilization. In scenarios where the central bank consistently maintains a tight monetary policy stance, such an action conventionally leads to increased budget deficit and improved government debt in the short- to medium-term periods (Dahan, 1998).

In highlighting the importance of coordination of monetary and fiscal policies, Laurens and de la Piedra (1998) note that the relationship between monetary and fiscal policies derives from the link between fiscal deficit and its financing sources, which include government bonds (domestic and foreign) and central bank credit to government. Under scenarios where the central bank remains dominant, the monetary authority can determine the growth of monetary base *autonomously* of the financing needs of the fiscus. In addition, the financing conditions in the domestic and external financial markets can cause constraints to the government in raising finances. Inevitably, the government can be compelled to reduce its budget deficit in line with available financing, which can further negatively affect spending on priority social and economic goals. Therefore, the ability of government to place public debt at low borrowing costs depends to a larger degree on the stance of monetary policy (Laurens and de la Piedra, 1998). In the presence of expansionary monetary policy, the government can

place public debt in the financial market at low interest rates. According to Togo (2007), low interest rates potentially stimulate economic growth, improve the fiscal position and help to reduce fiscal deficit and debt burden. However, if inflation follows, the budget deficit can grow rapidly and lead to increases in the real interest rate.

To compensate for perceived risks from inflationary pressures, investors may demand higher interest rates, which can lead to increases in debt service costs thereby forcing government to reduce the fiscal deficit to match available financing (Laurens and de la Piedra, 1998). Conversely, if the central bank takes a restrained policy stance without optimal coordination with fiscal policy, the economy can experience slow growth in output. Therefore, continued decline in economic activity potentially leads to reduced tax revenues and an upsurge in public debt-to-GDP ratio, which can further result in undermined sustainability of fiscal policy (Laurens and de la Piedra, 1998).

Following Dahan (1998), monetary policy affects budgetary developments and overall fiscal positions (budget balance and public debt) in an economy through numerous channels. Accordingly, the framework developed by Dahan (1998) explores numerous channels through which a tight monetary policy stance might potentially have on the primary balance (budget deficit). The individual effect of a tight monetary policy stance on budget deficit might be insignificant. However, the cumulative effect can be significant, whereby the effect commonly comes in form of increased budget deficit or deterioration primary balance position. In short-run periods, the expansionary impact of a tight monetary policy stance on fiscal deficit normally is accompanied by improvements in public debt developments.

Togo (2007) notes that if volatile, high interest rates can potentially reduce government revenue via slowed private sector economic activity. Hence, consistent policy mix between monetary and fiscal policies remains vital in public debt management if fiscal sustainability is to be maintained (Togo, 2007). Correspondingly, Goodhart (2012) underscores that consistent mix of monetary and fiscal policies remains critical in public debt management given the connection between output growth and interest rates (either in nominal or real terms) in ensuring macroeconomic stability. Under conditions where the economy experiences low and depressed output growth relative to interest rates, public debt frequently becomes unsustainable, unless if there are

enough primary surpluses. Following Dahan (1998), the effect of monetary policy stance on the fiscal position thus becomes more profound if there is at least one kind of nominal rigidity such that money remains non-neutral in the short run period.

Following IMF (2015), developments in the banking sector influence the transmission of banking sector risks to sovereign debt. Accordingly, banking sector vulnerabilities emanating from conditions related to increased leverage, balance sheets expansions and external funding create substantial risks that lead to worsening fiscal primary balance and government debt positions. The 2008/09 global economic and financial crisis demonstrates the long-run relationship between banking sector developments and public debt trajectories and related fiscal outcomes. According to the IMF (2015), impaired banking regulatory and macroprudential policies lead to lower economic growth and increased fiscal risks, which subsequently lead to weaker fiscal balance positions and reduced aggregate investment and consumption in the economy. The IMF (2015) analysis on fiscal dynamics during business cycles established that during booms, banking expansions lead to reductions in public debt. However, increases in public debt experienced during recessions outweigh the gains that could have been realised from decreases in public debt during severe banking expansions.

In analysing fiscal sustainability in Eritrea, Yamauchi (2004) observes the critical role played by monetary policy and highlights the direct influence monetary policy has on fiscal policy sustainability via the credit to government. Indirectly, fiscal sustainability is influenced by monetary policy through management of public debt and monitoring of supply conditions of credit to the private sector, as well as stances taken to maintain stability in the country's financial system in the medium to long term.

Greenlaw, Hamilton, Hooper and Mishkin, (2013) buttress that the crucial role monetary policy plays towards ensuring fiscal consolidation during periods of fiscal imbalances. In analysing the fiscal experiences of advanced economies with high public debt loads, Greenlaw et al. (2013) note that nations with high public debt levels (as ratios of GDP) require the support of monetary policy to mitigate vulnerabilities to fiscal deteriorations. Government fiscal consolidation efforts therefore need to be complemented by monetary policy in a manner that stimulates output growth to enhance success in fiscal consolidation.

From a practical standpoint, an accommodating monetary policy is regarded as an effective policy stance that increases the probability of success in fiscal consolidation since goverment makes it default for it to less likely occur. Using time-series data for the period 1978-2009, Hellebrandt, Posen and Tolle (2012) found evidence that an accommodating monetary policy leads to successful fiscal consolidation.

The study conducted by Allard, Catenaro, Vidal, and Wloswijk (2012) highlights that communications by central banks on fiscal policy matters reflects that the reaction of monetary policy to fiscal developments plays a critical role in ensuring that fiscal policy achieves its target objectives. Using data for the period 1999 quarter 1 to 2011 quarter 4, Allard, et al. (2012) empirically analysed the intensity of fiscal communications by five central banks (US Federal Reserve, European Central Bank, Bank of England, Bank of Japan, and Swedish Riksbank). The study developed a fiscal indicator that measures fiscal-related communication in central banks' introductory statements or minutes of monetary policy meetings.

Central banks' statements containing fiscal elements were classified into six mutually exclusive groups, namely, monetary policy stance, normative element, forecasts, monetary policy instrument, fiscal policies in other relevant countries and government representative. Empirical findings estimated using the OLS method show that changes in general government budget balances and gross debt positions (as percentages of GDP), output gaps, official interest rates, inflation and exchange rates significantly influence central bank communication on fiscal policy issues. Since government debt instruments are used in monetary policy operations, developments in government budget deficit and public debt ratios therefore influence reactions by the central bank represented by monetary policy stance taken to safeguard functioning of the financial system. Given the instant impact monetary policy announcements have on financial markets, the central bank's monetary policy stance in turn influences developments in government budget deficit and public debt levels in the short-run epoch.

The independence of central bank plays a crucial role in restraining deficit spending. Bodea and Higashijima (2015) elucidate that a balanced budget remains the primary preference of independent central banks, given the association that exists between budget deficits and inflation. In practice, the preference of an independent central bank

is generally reflected by the monetary policy stance a central bank pursues through changing the interest rate and controlling credit to government. Empirical findings by Bodea and Higashijima (2015) from OLS with PCSEs and GMM regressions on a panel dataset of 78 countries over the period 1970-2007 show that legal independence of central bank reduces fiscal deficits largely in nations with the rule of law, democracy free press and impartial contract enforcements. A monetary policy stance pursued by a central bank depicts its independence and transmits important signals to government in terms of the central bank's position on management of fiscal deficits and public debt.

Robinson (2015) empirically validated the underlying implications of fiscal positions on sovereign risk premium in South Africa. To account for possible significant breaks in the data, monthly time-series data used spans for three periods, namely December 1994 to December 2006, January 2006 to December 2011, and January 2006 to September 2015. The relative impacts of distinct major fiscal variables, among other economic exogenous variables, were estimated using the Vector Error Correction (VEC) model. The fiscal determinants captured in the model are government revenue, government expenditure, public debt, and net borrowing requirement. Results from the empirical estimation conducted show that increases in government expenditure and government debt led to widening sovereign risk spread. The statistically significant and positive effects of government spending and government debt on sovereign risk spreads show strong evidence of sensivity of investors to fiscal developments. In order to mitigate potential negative effects fiscal positions might have on price stability, the central bank takes appropriate monetary policy stances by adjusting the interest rate.

Afflatet (2016) analysed the estimated reaction of governments' primary surpluses to changes in borrowing costs. Based on panel data of European Union countries for the period 1995-2013, regression estimates from the Fixed Effects model results reveal strong evidence that governments indeed raise primary surpluses in reaction to higher interest rates. Therefore, the findings confirm that the monetary policy stance pursued by central banks in financial markets potentially has disciplining effect on the manner in which governments adjust their primary balances.

5.9. Conclusion

This chapter discussed literature on fiscal sustainability from an empirical standpoint. In addition, the empirical literature survey discussed findings on fiscal policy sustainability studies conducted on countries in different continents. The continents covered include Europe, America, Asia, Africa, mixed-group of countries in diverse continents, and ultimately South Africa. The main issues discussed include the data used, estimation methods applied, and major findings reported. Based on findings explored from such countries, this research study ultimately addressed the research gap relating to the missing link between monetary policy stance and fiscal policy overlooked in previous empirical studies conducted on fiscal sustainability analysis in South Africa. The following chapter discusses the methodological procedure and estimation technique applied in this study.

CHAPTER 6

METHODOLOGY AND ESTIMATION TECHNIQUE

6.1. Introduction

This chapter presents the methodology and estimation technique applied in line with research objectives, research questions and research hypotheses. The description of the methodology and estimation technique applied cover the sources of data used for estimation, time-series properties of the data (unit root or stationarity and cointegration tests), Vector Autoregressive (VAR) lag order selection criteria, VAR framework, Vector Error Correction (VEC) model, VEC Granger Causality/Block Exogeneity Wald test, Impulse Response Functions (IRFs), and Cholesky variance decompositions.

6.2. Data and Sources

Quarterly time-series data on primary balance-to-GDP ratio (B/Y) and public debt-to-GDP ratio (D/Y) for the sample period 1997q4 to 2016q3 was sourced from South African Reserve Bank (SARB) historical macroeconomic indicators online database. The relatively short dataset time span of 1997q4 to 2016q3 used was chosen subject to availability of data. Data on real gross domestic product (Y) and central bank policy rate (r) for the respective time period was collected from the International Monetary Fund (IMF) International Financial Statistics (IFS) online data portal.

6.2.1 Variables Description

This section provides brief descriptions of time-series fiscal variables and exogenous economic variables that influence sustainability of fiscal policy.

6.2.1.1. Primary balance

Primary balance, also referred as primary net lending/borrowing (as % of GDP), refers to the overall balance excluding net interest payments (interest expenditure less interest revenue). The IMF's Government Finance Statistics Manual (GFSM) 2001 edition defines conventional/overall balance or net borrowing/lending (as percentage of GDP) as the difference between total revenue and total expenditure; and current balance indicates the difference between total current, non-capital expenditure and total current revenue.

6.2.1.2. Public debt

Public debt refers to total debt by the entire public sector, including financial and non-financial public enterprises and the central bank. Public debt can be either gross debt (as percentage of GDP) or net debt (as percentage of GDP). The IMF's GFSM and Public Sector Debt Statistics Manual 2001 edition defines gross debt as total liabilities that require future payment of interest and/or the principal by general government to the lender. The debt instruments that constitute total gross debt liabilities include debt securities, pension and guarantee schemes, special drawing rights (SDRs), loans, currency and deposits, insurance, and other accounts payable. Based on the concept of residence, total debt liabilities owed by government to residents of the same country are called domestic debt. On the contrary debt liabilities owed by government to non-residents are referred to as external or foreign debt. In net terms, net public debt refers to gross debt less financial assets corresponding to debt instruments. National Treasury (2015) delimits net debt as total domestic and foreign debt less cash balances of the National Revenue Fund.

6.2.1.3. Central bank policy rate

The central bank policy rate (CBPR) provides as a signal for central bank's monetary policy stance in the economy (IMF, 2017). In an analytic paper that quantified the rigidity and looseness of monetary policy in South Africa, Heever and Meyer (2016) accentuate that the central bank policy rate remains the central bank's key policy interest rate barometer, which reflects the central bank's monetary policy stance in the economy. In South Africa, determination of the central bank policy rate by the South African Reserve Bank hinges on repurchase agreements in national currency between the central bank and private sector banks (IMF, 2017).

The central bank policy rate was integrated as an exogenous variable in the short-run component of the VEC model used to estimate the fiscal reaction function. Integration of the respective variable in estimation of the fiscal reaction function was centred on the premise that monetary policy measures fundamentally have several channels through which they influence the budget deficit and public debt in the short-run (Dahan, 2003). Moreover, Goodhart (2012) underscores that monetary policy implicitly gets integrated into public debt management when the government becomes indebted to such an extent that the country's fiscal sustainability gets potentially at risk.

6.2.1.4. Output gap

The output gap variable, which measures the deviation of the actual output (Y*) from potential output (Y_f), was generated using the univariate Hodrick-Prescott (HP) filter to capture the cyclical behaviour of fiscal policy. In addition, a negative output gap, also referred to as a recessionary gap, occurs when the economy produces below its full capacity. Conversely, a positive output gap occurs when the economy's actual output exceeds its potential output. In order to account for seasonal fluctuations that occur in economic production, seasonally adjusted real GDP data was used to reflect accurate patterns in economic activity (BEA, 2016). Technically, the classical HP filter extracts a trend by taking the time series y_t and decomposes it into a trend component τ_t and cyclical component c_t; and solves the minimisation problem:

$$\min \sum_{t=1}^{\tau} \left(y_t - \nu_t\right)^2 + \lambda \sum_{t=3}^{\tau} \left(\nu_t - 2\nu_{t-1} + \nu_{t-2}\right)^2 \qquad (6.2.1)$$

With the difference between the observed data (y_t) and the trend being the cyclical component (ν_t); the positive parameter λ controls the smoothness of the series. To ensure a suitable value of the smoothing parameter λ, the time-series (y, ν) should satisfy the linear mixed model specified as:

$$\begin{cases} \mathbf{y} = \boldsymbol{\nu} + \boldsymbol{\omega} \\ \boldsymbol{\Gamma}\boldsymbol{\nu} = \boldsymbol{\kappa} \end{cases} \qquad (6.2.2)$$

where : $\omega \sim N(0, \sigma_\omega^2 I_\tau)$ and $\kappa \sim N(0, \sigma_\kappa^2 I_{\tau-2})$: I_τ and $I_{\tau-2}$ denote the $\tau \times \tau$ and $(\tau-2) \times (\tau-2)$ identity matrices; respectively and Γ is the second order differencing operator $(\Gamma\Gamma\nu(t) = \nu_t - 2\nu_{t-1} + \nu_{t-2}; t = 3, ..., \tau.$

Based on this model, the suitable smoothing parameter, also called the signal-to-noise (SNR) ratio, given by the function $\lambda^* = \sigma_\omega^2 / \sigma_\kappa^2$ satisfies the conditional expectation:

$$E\left[\nu \mid y\right] = \nu\left(\frac{\sigma_\omega^2}{\sigma_\kappa^2}, y\right) \qquad (6.2.3)$$

The mean square difference (MSD) between the ideal signal $\nu(\lambda, y)$ and conditional expectation $E\left[\nu \mid y\right]$ is minimised by the smoothing parameter such that:

$$\sigma_{\omega}^{2}/\sigma_{\kappa}^{2} = \arg\min \left\{ \left\| \mathrm{E}\left[\nu \middle| \mathrm{y} \right] - \nu(\lambda\lambda \mathrm{y}) \right\|^{2} \right\} \quad (6.2.4)$$

Proceeding further, stationarity and cointegration properties of the data series were examined prior to performing multivariate macroeconometric estimation of the results.

6.3. Unit Root Processes and Stationarity Tests

Stationarity of variables remains a critical property in time-series econometric analysis. In practice, consideration has to be given to the distinction between weak/covariance stationarity and strong stationarity. Nonetheless, since strong stationarity is practically complex to evaluate, focus was given to assessment of weak stationarity. In order for a series to be weakly stationary, three conditions outlined below have to be satisfied:

(i) $$\mathrm{E}(\mathrm{x}_{\mathrm{t}}) = \mathrm{E}(\mathrm{x}_{\mathrm{t-k}}) = \mu \quad (6.3.1)$$

The series should have a constant mean over the given time horizon, hence the transitory deviation of the mean reverts to the long-run mean.

(ii) $$\mathrm{E}(\mathrm{x}_{\mathrm{t}} - \mu)^{2} - \mathrm{E}(\mathrm{x}_{\mathrm{t-k}} - \mu) = \sigma^{2} \quad (6.3.2)$$

The variance should be both constant and finite over time.

(iii) $$\mathrm{E}(\mathrm{x}_{\mathrm{t}} - \mu)(\mathrm{x}_{\mathrm{t-k}} - \mu) = \mathrm{E}(\mathrm{x}_{\mathrm{t-h}} - \mu)(\mathrm{x}_{\mathrm{t-h-k}} - \mu) = \sigma_{\mathrm{k}} \quad (6.3.3)$$

Covariance between variables strictly depends on selected lag length, not on time.

Assuming an autoregressive process of order one, AR (1), the series $\mathrm{X}_{\mathrm{t}} = \pi \mathrm{X}_{\mathrm{t-1}} + \mathrm{u}_{\mathrm{t}}$ becomes stationary for values of $|\pi| < 1$. Hence, the model satisfies the conditions of expected mean equal to zero, the variance $\sigma_{\mathrm{e}}^{2} \big/ \left(1 - \pi^{2}\right)$ and covariance $\pi^{\mathrm{k}} \left(\sigma_{\mathrm{e}}^{2} \big/ \left(1 - \pi^{2}\right) \right)$.

Extending the series to a general ARMA (p, q) process yields:

$$\mathrm{X}_{\mathrm{t}} = \sum_{\mathrm{i}=1}^{\mathrm{p}} \pi_{1} \mathrm{X}_{\mathrm{t-i}} + \mathrm{u}_{\mathrm{t}} + \sum_{\mathrm{i}=1}^{\mathrm{q}} \psi \, \mathrm{u}_{\mathrm{t-i}}, \quad (6.3.4)$$

Applying the lag operators yields:

$$\left(1-\pi_1 L-...-\pi_p L^p\right)X_t=\left(1-\psi_1 L-...-\psi_q L^q\right)u_t$$

$$\Pi(L)X_t=\Psi(L)u_t \qquad (6.3.5)$$

Since the MA (q) component of the ARMA (p, q) process remains stationary quite often, stationarity of the model thus depends on the AR (p) component. Technically, the model becomes stationary when all roots of the characteristic equation $\Pi(z)=0$ exist outside the unit circle. Therefore, ARMA (p, q) process is a partial version of the ARIMA (p, d, q) process in which the order of integration I(d) equals zero. In practice, most time-series are integrated and become stationary when differenced d times. An integrated series that becomes stationary when differenced d times is regarded to be integrated of order d. However, not all series that are integrated become stationary when differenced. Therefore, the two properties of stationary and integration both play a critical role in examining cointegration of data series.

Given that the actual data generation process was not known in respect of this study, the univariate unit root tests were conducted to determine the order of integration of the data series. The Augmented Dickey-Fuller (ADF) test and Phillips Perron (PP) test techniques were applied for the series in levels, as well as first differences at intercept, trend and intercept, and none. Selections of proper lag lengths of the ADF unit root tests were determined automatically in EViews based on Akaike Information Criterion (AIC) for the ADF test. The Bandwidth for the PP test was automatically selected based on the Newey-West criterion anchored on the Bartlett kernel spectral estimation method. In recognition of the premise that the ADF criterion performs satisfactorily even when the sample size is fairly small (Hamilton, 1994), the order of integration of the series was finally assessed based on the ADF unit root test technique. The ADF technique considers the general AR (p) process given by the function:

$$X_t=\pi+\gamma_1 X_{t-1}+\gamma_2 X_{t-2}+...+\gamma_p X_{t-p}+\varepsilon_t \qquad (6.3.6)$$

Assuming the data generating process to be an AR (1), equation (6.3.6) reduces to:

$$X_t=\pi+\gamma_1 X_{t-1}+\nu_t \qquad (6.3.7)$$

$$\Rightarrow \nu_t=\gamma_2 X_{t-2}+...+\gamma_p X_{t-p}+\varepsilon_t,$$

The autocorrelations of υ_t and $\upsilon_{t-i}\ (\text{for i} > 1) = 0$ due to presence of lagged X terms. To extend the Dickey-Fuller test to an AR process > 1, consider the AR (2) process:

$$\begin{aligned} X_t &= \pi + \gamma_1 X_{t-1} + \gamma_2 X_{t-2} + \varepsilon_t \\ &\equiv \\ X_t &= \pi + (\gamma_1 + \gamma_2) X_{t-1} - \gamma_2 (X_{t-1} - X_{t-2}) + \varepsilon_t \end{aligned} \tag{6.3.8}$$

Eliminating X_{t-1} from both sides of equation (3.3.8) yields:

$$\Delta X_{t-1} = \pi + \beta X_{t-1} - \alpha_1 \Delta X_{t-1} + \varepsilon_t \tag{6.3.9}$$

where β and α_1 are defined as:

$$\beta = \gamma_1 + \gamma_2 - 1 \text{ and } \alpha_1 = -\gamma_2 \tag{6.3.10}$$

Based on functions specified in equations (6.3.9) and (6.3.10), the unit root tests were performed to examine whether the difference between non-stationary series become stationary when the same variables move together in the long-run. Therefore, unit root test on an AR(p) process modelled the regression based on the specification:

$$\Delta X_t = \pi + \beta X_{t-1} - \sum_{i=1}^{p-1} \alpha_i \Delta X_{t-i} + \varepsilon_t \tag{6.3.11}$$

where ε_t denotes a pure white noise error term, $\Delta X_{t-i} = X_{i-1} - X_{i-2}$ and p denotes the class of autoregression; the null hypothesis being β = 0. The computed β coefficients and corresponding t-statistics determine the decision to either reject or not reject the null hypothesis of presence of a unit root in a given series. The ADF tests with trend variable were performed based on the function:

$$\Delta X_i = \delta_1 + \delta_2 t + \beta X_{t-1} + \sum_{i=1}^{p-1} a_i \Delta X_{t-i} + \varepsilon_t \tag{6.3.12}$$

where t signifies the time or trend variable; with the null hypothesis being β = 0.

6.4. VAR Lag Order Selection Criteria

The importance of optimal lag length remains a critical factor in empirical research that involves use of vector autoregressive (VAR) models in modelling time series data. Since inferences made from estimated VAR models depend on correct specification of the models, determination of the ideal lag order plays a critical role towards ensuring

precision of estimates, as well as the impulse response functions (IRFs) and variance decompositions produced from estimates of VAR models. In standard practice, use of a lag length higher than the optimal order leads to higher mean square forecast errors (MSFE) of the VAR while use of lag length lower than the correct order regularly leads to computation of autocorrelation errors (Lutkepohl, 1993). Therefore, use of incorrect lag lengths leads to inaccurate estimation of IRFs and variance decompositions, and further adversely affects examination or estimation of cointegration properties of data.

Selection of optimal lag lengths was performed based on the VAR lag order selection criteria using the Likelihood Ratio (LR) statistic, Akaike Information Criterion (AIC), Final Prediction Error (FPE), Schwarz Information Criterion (SIC) and Hannan-Quinn Information Criterion (HQIC); with standard functional forms described as below.

6.4.1. Likelihood Ratio (LR) statistic

This standard approach tests the goodness of fit of two (null and alternative) models. Based on the likelihood ratio, the test measured the number of times data were under one model relative to other models. Therefore, the decision to either reject or not reject the null hypothesis, comparative to the alternative hypothesis, depends on comparison of the computed LR statistic relative to the critical value and corresponding p-value.

Inference about the parameter θ was drawn from realisations of the data observations $x_1, x_2, x_3, ..., x_n$ of random variables (rv) $X_1, X_2, X_3, ..., X_n$, whose distribution depends on the parameter θ. The null hypothesis (H_0) holds/assumes that the parameter θ takes on values that are in an interval Θ (parameter space) while the alternative hypothesis (H_1) restricts θ to the Θ_1 of Θ. The H_0 was therefore the complement of Θ_0 wrt Θ .

The test of the H_0 versus H_1 was based on random sample $X_1, X_2, X_3, ..., X_n$ independent and identically distributed (IID), $\sim f(x, \theta)$. Assuming that H_0 holds, the likelihood function upon which inference about the θ relies on was specified as:

$$L(\theta) = \prod_{i=1}^{n} f(x, \theta), \qquad (6.4.1)$$

where: L represents the likelihood

θ denotes the parameter space

x_i represents a set of observations $x_1, x_2, x_3, ..., x_n$

Π symbolises Pi

In scenarios where H_0 holds, the likelihood should be large when appraised at θ_0, such that the maximum likelihood over the entire Θ becomes:

$$L\left(\hat{\theta}\right) = \max_{\theta \in \Theta} \prod_{i=1}^{n} f\left(x_i, \theta\right)$$
$$\Rightarrow L\left(\hat{\theta}\right) \geq L\left(\theta_0\right) \text{appraised at a given value } \theta_0 . \quad (6.4.2)$$

Therefore, the LR test was based on the likelihood ratio:

$$\eta = \frac{L\left(\theta_0\right)}{L\left(\hat{\theta}\right)} = \frac{\prod_{i=1}^{n} f\left(x_1; \theta_0\right)}{\max_{\theta \in \Theta} \prod_{i=1}^{n} f\left(x_i; \theta\right)} \quad (6.4.3)$$

The decision rule requires rejection of the null hypothesis ($H_0: \theta = \theta_0$) when η is small.

6.4.2. Akaike Information Criterion (AIC)

Following Akaike (1973), the AIC compares distinct models on given outcomes. Since misspecification of the model owing to either under-fitting or over-fitting leads to spurious regressions, the AIC provides the basis for selecting the model that best determines relationships among given variables. To address drawbacks associated with under-fitting the model (which potentially provides an incorrect picture of variability in the response variable) and over-fitting the model (which can potentially lead to loss of generality), Akaike values were used to select the best model given by the function:

$$AIC = 2\omega - 2\log\left(L\left(\hat{\theta}|z\right)\right) \quad (6.4.4)$$

where: ω represents the number of estimable parameters (d.f)

$\log L\left(\hat{\theta}|z\right)$ denotes the maximum log-likelihood (ML) of the estimated model

L represents the likelihood function

$\hat{\theta}$ denotes the maximum likelihood of θ

2ω measures the variance

$-2\log\left(L\left(\hat{\theta}|z\right)\right)$ measures the amount bias

To correct for small samples, the above function is modified as:

$$AIC_m = AIC + \frac{2\omega(\omega+1)}{n-\omega-1} \tag{6.4.5}$$

where: n represents the sample size, and $n-\omega-1$ denotes bias-correction, which depends on type of the model. Since a larger sample (n) w.r.t. estimable parameters (ω) yields a sufficient AIC, the parsimonious model that best revealed the true relationship among given variables (goodness of fit) was the model with the lowest AIC or AIC_m value (Akaike, 1973).

6.4.3. Final Prediction Error (FPE)

The FPE criterion measures the quality of the model by testing the data that follow a strictly stochastic autoregressive process for which the innovations are stationary and independent in nature. The FPE, also referred to as the Mean Square Prediction Error (MSPE), was specified by the function:

$$FPE = \det\left(\frac{1}{n}\sum_{1}^{n} u\left(t,\hat{\pi}_n\right)\left(u\left(t,\hat{\pi}_n\right)\right)^T\right)\left(\frac{1+\omega/n}{1-\omega/n}\right) \tag{6.4.6}$$

where: n represents the number of observations in the dataset

$u(t)$ is an mn x 1 vector of prediction errors

$\hat{\pi}_n$ denotes the estimated parameters

ω represents the number of estimated parameters

6.4.4. Schwarz Information Criterion (SBIC)

The SIC criterion prefers the model with the lowest or minimum value from a finite set of models (Schwarz, 1978). Computationally, the criterion was given by the function:

$$\begin{aligned} SIC &= \omega.\ln(z) - 2.\ln\hat{M} \\ &= \omega.\ln(z) - 2\ln\left(p\left(x\middle|\hat{\varphi},H\right)\right) \end{aligned} \tag{6.4.7}$$

where: ω represents the number of estimable parameters, including intercept

z denotes the number of observations or sample size

$\hat{M}$ represents the maximised value of the likelihood function of model H

$\hat{\varphi}$ denotes the parameter values that maximise the likelihood function

p symbolises the prior probability distribution

x represents the observed data

Derivation of the asymptotic SIC was based on the notion that data are exponentially distributed such that the integral of the product of the likelihood function and the prior probability distribution over the parameter that maximises the likelihood function of model H for observed data was estimated by the function:

$$\int p(x|\varphi,H) \bullet p(\varphi|H) \tag{6.4.8}$$

$$\Rightarrow -2 \bullet \ln p(x|H) \approx \text{SIC} = \omega(\ln(z) - \ln(2\lambda)) - 2 \bullet \ln \hat{M} \tag{6.4.9}$$

The function specified by equation (6.4.8) reveals that the criterion penalises complex models and prefers simple models.

6.4.5 Hannan-Quinn Information Criterion (HQIC)

Following Hannan and Quinn (1979), this criterion provides as a measure of strong consistency for models that are autoregressive in nature, given by the function:

$$\text{HQIC} = 2\omega \ln(\ln(z)) - 2L \tag{6.4.10}$$

where: ω represents the number of estimable parameters

Z denotes the number of observations or sample size

L symbolises the likelihood function

6.5. Vector Autoregressive (VAR) Model

Like most other macroeconomic variables, primary balance as a ratio of output (B/Y) and public debt as a ratio of output (D/Y) are endogenous rather than exogenous. Sims (1980) accentuates that time-series macroeconomic variables are potentially endogenous; hence they implicitly exhibit joint dynamic behaviour. However, models that explicitly demonstrate causality have great potential of being mis-specified. As an

alternative, a VAR model was used based on the rationale that VAR allows variables to interact without imposing theoretical structures on estimates. Also, a VAR model treats variables as endogenous, describes dynamic behaviour, and efficiently captures both short-run and long-run interrelations among such variables. This study applied a standard VAR model in modelling interrelations of a system of multivariate equations for (B/Y) and (D/Y), and the variables were treated as endogenous. The unstructured VAR framework for the basic fiscal reaction function was therefore specified as:

$$X_t = [(B/Y), (D/Y), Z] \tag{6.5.1}$$

where: X_t is a vector containing primary balance (B/Y), public debt (D/Y) as ratios of GDP and a set of exogenous economic variables that have short-run influence on fiscal policy behaviour. Explicitly, vector Z comprises central bank policy rate (r), proxy for monetary policy stance by the central bank, and output gap $\left(\hat{y}_t\right)$, computed using the Hodrick-Prescott filter approach to capture the influence of business cycles on sustainability of fiscal policy. As such, a bivariate standard VAR model containing equations for (B/Y) and (D/Y) was specified in VAR levels as:

$$\left(\frac{B}{Y}\right)_t = \alpha_{11} + \pi_{12}\left(\frac{B}{Y}\right)_{t-1} + \theta_{13}\left(\frac{D}{Y}\right)_{t-1} + \gamma_{12}(r_t) + \delta_{13}\left(\hat{y}_t\right) + \varepsilon_{11t}$$

$$\left(\frac{D}{Y}\right)_t = \alpha_{21} + \pi_{22}\left(\frac{B}{Y}\right)_{t-1} + \theta_{23}\left(\frac{D}{Y}\right)_{t-1} + \gamma_{22}(r_t) + \delta_{23}\left(\hat{y}_t\right) + \varepsilon_{21t}$$

$$\equiv \tag{6.5.2}$$

$$\begin{bmatrix}\left(\frac{B}{Y}\right)_t \\ \left(\frac{D}{Y}\right)_t\end{bmatrix} = \begin{bmatrix}\alpha_{11} \\ \alpha_{21}\end{bmatrix} + \begin{bmatrix}\pi_{12} & \theta_{13} \\ \pi_{22} & \theta_{23}\end{bmatrix}\begin{bmatrix}\left(\frac{B}{Y}\right)_{t-1} \\ \left(\frac{D}{Y}\right)_{t-1}\end{bmatrix} + \begin{bmatrix}\gamma_{12} \\ \gamma_{22}\end{bmatrix}[r_t] + \begin{bmatrix}\delta_{13} \\ \delta_{23}\end{bmatrix}\begin{bmatrix}\hat{y}_t\end{bmatrix} + \begin{bmatrix}\varepsilon_{11t} \\ \varepsilon_{21t}\end{bmatrix}$$

The unrestricted VAR(p) model (equation 6.5.2) specified above was a seemingly unrelated regression (SUR) with lagged (B/Y) and (D/Y) as endogenous variables while central bank policy rate (r) and output gap (y) are exogenous variables.

6.6. Cointegration Test

In line with the theoretical economic postulation that variables that are integrated of order one can have a cointegrating relationship, the dynamic multivariate Johansen's procedure was applied to test for presence of cointegrating relationship between (B/Y) and (D/Y). This implies existence of long-run equilibrium upon which (B/Y) and (D/Y) fluctuate. In situations where cointegration exists, shocks to the equilibrium could be transitory since stationarity ensures mean-reversion that restores long-run equilibrium.

The Johansen's procedure, which largely relies on the relationship between the matrix rank and analogous characteristic roots, was selected relative to the Engle-Granger and Phillip's-Quliaris approaches. The Johansen procedure was selected in light of the rationale that the method can estimate more than one cointegrating relationship where the time-series dataset contains equal to or more than two variables. In order to establish the number of cointegrating vectors, five assumptions provided by EViews were considered. The assumptions revolve around presence or absence of linear and non-liner trends in the data, and whether intercepts or no intercepts are considered. The summary descriptions of the respective five assumptions are given herein below.

Assumption 1 holds that level data (y_t) have no deterministic trends and cointegrating equations do not have intercepts ($H_2 : \Pi y_{t-1} + Bx_t = \alpha\beta' y_{t-1}$). Assumption 2 states that level data (y_t) have no deterministic trends and cointegrating equations have intercepts; $H_1^*(r) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0)$). Assumptions 3 holds that the (y_t) have linear trends but cointegrating equations have only intercepts ($H_1(r) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha_\perp \gamma_0$). Assumption 4 establishes that the level data $(y_t)$and cointegrating equations have linear trends ($H^*(r) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$). Assumption 5 states that the level data (y_t) have quadratic trends and the cointegrating equations have linear trends such that $H(r) : \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp(\gamma_0 + \gamma_1 t)$. In practice, assumptions 1 and 5 are not usually used, hence assumpions 2, 3 and 4 were used in this study by considering assumptions made on unit root tests in selecting the trend assumption.

Given that the Johansen's procedure requires the VAR (p) as the starting point, the vector X_t containing endogenous variables (B/Y) and (D/Y) ratios was specified as:

$$X_t = \Phi_1 X_{t-1} + \Phi_2 X_{t-2} + ... + \Phi_p X_{t-p} + u_t \quad (6.6.1)$$

where: X_t is a 2x1 vector of (B/Y) and (D/Y) variables that are I(1), u_t is a 2x1 vector of innovations, and Φ_1 through Φ_p represents 2x2 coefficient matrices. Reparameterising equation (6.6.1) by subtracting X_{t-1} from both sides yields:

$$\Delta X_t = \Psi_1 \Delta X_{t-1} + \Psi_2 \Delta X_{t-2} + ... + \Psi_p \Delta X_{t-p} - \Phi X_{t-p} + u_t \quad (6.6.2)$$

where: $\Psi_1 = \Phi_1 - I, \Psi_2 = \Phi_2 - \Psi_1$, and $\Phi = I - \Phi_1 - \Phi_2 - ... - \Phi_p$

The impact matrix Φ determines the magnitude of cointegration of the system. Therefore, the Maximum Eigenvalue and Trace likelihood ratio (LR) statistics were used to test for existence of vector cointegration.

6.6.1. Maximum Eigenvalue Test

The maximum eigenvalue statistic tests the null hypothesis (H_0) that the number of cointegrating vectors equals to r_0 versus the alternative hypothesis (H_1) that the number of cointegrating vectors equals to $r_0 + 1$, specified by the function:

$$\lambda_{max}(r_0, r_0 + 1) = -T \ln(1 - \lambda_{r_0 + 1}) \quad (6.6.3)$$

where: λ_{max} represents the maximum eigenvalue statistic, T symbolises the sample size, and λ denotes the canonical correlation. The $\lambda_{max}(r_0, r_0 + 1)$ likelihood ratio statistic tests the H_0 that the rank $(\Pi) = r_0$ against the H_1 that the rank $(\Pi) = r_0 + 1$.

6.6.2. Trace Test

The trace statistic tests the H_0 that the number of cointegrating vectors is $\leq r_0$, versus the H_1 that the number of cointegrating vectors is > r_0, which implies cointegrating relationship > r_0. Correspondingly, the null and alternative hypotheses are stated as:

$$\left.\begin{array}{l} H_0 : r_0 < \text{rank}(\Pi) \leq n \\ H_1 : r_0 + 1 < \text{rank}(\Pi) \leq n \end{array}\right\}$$ where n denotes the number of cointegrating vectors.

The Trace LR test statistic therefore becomes:

$$\lambda_{\text{trace}} = -\mathrm{T}\sum_{\mathrm{i}=\mathrm{r}_0+1}^{\mathrm{n}}\ln\left(1-\lambda\right) \tag{6.6.4}$$

where: T represents the sample size, n denotes the maximum number of possible cointegrating vectors, and λ represents the biggest canonical correlation.

The cointegrating vectors provided as an indication of the number of cointegrating equations that had to be estimated using the Vector Error Correction (VEC) model. Assuming the IBC, the cointegrating relationship was specified as:

$$\left(\mathrm{B/Y}\right)_{\mathrm{t}} = \alpha + \beta\left(\mathrm{D/Y}\right)_{\mathrm{t}} + \mu_t \tag{6.6.5}$$

Based on the cointegration approach, Martin (2000) highlights that a fiscal policy can be deemed strongly sustainable if and only if the I(1) processes of (B/Y) and (D/Y) are cointegrated and β=1. Conversely, the policy can be deemed weakly sustainable if (B/Y) and (D/Y) are cointegrated and 0 < β < 1. If the null of cointegration gets rejected, μ_t must be stationary. If the endogenous variables (B/Y) and (D/Y) are I(1), the relevant variables could be cointegrated. Presence of cointegration between the endogenous variables (B/Y) and (D/Y) substantiated application of the VEC model.

6.7. Vector Error Correction (VEC) Model

Denoting the primary balance-to-GDP ratio by (B/Y) and public debt-to-GDP ratio by (D/Y), the government's basic fiscal reaction function was formulated as:

$$\left(\mathrm{B/Y}\right)_{\mathrm{t}} = \beta_1 + \beta_2\left(\mathrm{B/Y}\right)_{\mathrm{t-1}} + \beta_3\left(\mathrm{D/Y}\right)_{\mathrm{t-1}} + \varepsilon_{\mathrm{t}} \tag{6.7.1}$$

The one period lag of (B/Y) was added (equation 6.7.1) to capture the inertia in government behaviour. Given the VAR representation specified in equation (6.5.2) and the procedure followed in estimating the VEC model, a system of two equations was specified to estimate both short-run and long-run parameters of the model:

$$\Delta\left(\frac{\mathrm{B}}{\mathrm{Y}}\right)_{\mathrm{t}} = \alpha_{11} + \pi_{12}\left[\left(\frac{\mathrm{B}}{\mathrm{Y}}\right)_{\mathrm{t-1}} - \theta_{12}\left(\frac{\mathrm{D}}{\mathrm{Y}}\right)_{\mathrm{t-1}} - \theta_{13}\right] + \varphi_{11}\Delta\left(\frac{\mathrm{B}}{\mathrm{Y}}\right)_{\mathrm{t-1}} + \varphi_{12}\Delta\left(\frac{\mathrm{D}}{\mathrm{Y}}\right)_{\mathrm{t-1}} + \gamma_4\left(\mathrm{r_t}\right) + \delta_5\left(\hat{\mathrm{y}}_{\mathrm{t}}\right) + \varepsilon_{11\mathrm{t}} \tag{6.7.2}$$

$$\Delta\left(\frac{\mathrm{D}}{\mathrm{Y}}\right)_{\mathrm{t}} = \alpha_{21} + \pi_{13}\left[\left(\frac{\mathrm{B}}{\mathrm{Y}}\right)_{\mathrm{t-1}} - \theta_{12}\left(\frac{\mathrm{D}}{\mathrm{Y}}\right)_{\mathrm{t-1}} - \theta_{13}\right] + \varphi_{21}\Delta\left(\frac{\mathrm{B}}{\mathrm{Y}}\right)_{\mathrm{t-1}} + \varphi_{22}\Delta\left(\frac{\mathrm{D}}{\mathrm{Y}}\right)_{\mathrm{t-1}} + \gamma_4\left(\mathrm{r_t}\right) + \delta_5\left(\hat{\mathrm{y}}_{\mathrm{t}}\right) + \varepsilon_{21\mathrm{t}} \tag{6.7.3}$$

The parameters $(B/Y)_{t-1} - \theta_{12}(D/Y)_{t-1} - \theta_{13}$ in both equations (6.7.2) and (6.7.3) denote the deviation from the long-run equilibrium specified by the function:

$$(B/Y)_{t-1} = \theta_{12}(D/Y)_{t-1} + \theta_{13} \qquad (6.7.4)$$

The exogenous variables, central bank policy rate and output gap were included in the short-run components of both equations (6.7.2) and (6.7.3) to capture distinct effects of central bank monetary policy stance on changes in primary balance and public debt; respectively. The effect of central bank policy rate was integrated in short-run components of equations (6.7.2) and (6.7.3) in respect of the characterisation that monetary policy announcements essentially affect the macroeconomy in the short-run comparative to fiscal policy whose impact lags are longer than those of monetary policy. Given the government's efforts to pursue short-run demand stabilisation, output gap was exogenously added to short-run dynamics of equations (6.7.2) and (6.7.3) to capture the feasible reaction of fiscal policy to business cycles.

Given the structure of the VEC model, empirical estimation was conducted as a model consisting of two functions given by equations (6.7.2) and (6.7.3). The parameter π_{12} in equation (6.7.2) denotes the error correction term (ECT), which measures the fiscal reaction to the public debt-to-GDP position. Therefore, the ECT that captures the reaction of primary balance to deviations from the long-run equilibrium was itemised in equation (6.7.4). Therefore, the VEC method estimated the fiscal reaction function given by equation (4.7.1) as a model containing equations (6.7.2) and (6.7.3); yielding:

$$\Delta Z_t = \varpi Z_{t-1} + \sum_{t=i}^{k} \xi_i \Delta Z_{t-1} + \sum_{t=j}^{n} \Phi_j X_{t-j} + c_t + \varepsilon_{kt} \qquad (6.7.5)$$

where: Z_t denotes a 3x1 vector comprising I(1) endogenous variables ((B/Y), (D/Y), and a constant),

X_t denotes a 2x1 vector consisting of I(1) exogenous variables (r and y),

ξ_i symbolises 2x2 short-run coefficient matrices,

Φ_j signifies a 2x1 vector comprising coefficients of exogenous variables,

c_t is a vector comprising constants and ε_{kt} designates IDD error terms.

The parameter ϖ was decomposed into τ and ϑ' matrices; yielding:

$$\varpi Z_{t-1} = \tau \vartheta' Z_{t-1} = \begin{bmatrix} \tau_{11} \\ \tau_{21} \end{bmatrix} \begin{bmatrix} 1 - \vartheta_{12} - \vartheta_{13} \end{bmatrix} \begin{bmatrix} (B/Y)_{t-1} \\ (D/Y)_{t-1} \\ 1 \end{bmatrix} \tag{6.7.6}$$

where: τ denotes a 2x1 matrix of two variables with ≥ 1 cointegrating relationship(s) that contain the long-run equilibrium adjustment parameter, and ϑ' represents a 1x3 matrix containing long run parameters, including a constant.

6.8. VEC Granger Causality/Block Exogeneity Wald Test

To test for existence of short run causality between primary balance-to-GDP ratio and public debt-to-GDP ratio, the VEC Granger causality/Block Exogeneity Wald test was conducted. Based on the null that all lags of one given variable can be excluded from each equation in the system, the scalar random variable $(D/Y)_t$ can be deemed not to Granger cause $(B/Y)_t$ if and only if:

$$E\left[\left(\frac{B}{Y}\right)_t \middle| \left(\frac{D}{Y}\right)_{t-1}, \left(\frac{B}{Y}\right)_{t-1}, \ldots\right] = E\left[\left(\frac{B}{Y}\right)_t \middle| \left(\frac{B}{Y}\right)_{t-1}, \ldots\right] \tag{6.8.1}$$

Therefore, $(D/Y)_t$ does not Granger cause $(B/Y)_t$ if the forecast of $(B/Y)_t$ remains the same whether or not conditioned upon the past values of $(D/Y)_t$. Given the standard bivariate VAR(p), Granger causality was tested based on the specification:

$$\begin{bmatrix} \left(\frac{D}{Y}\right)_t \\ \left(\frac{B}{Y}\right)_t \end{bmatrix} = \begin{bmatrix} \vartheta_{11,1} & \vartheta_{12,1} \\ \vartheta_{21,1} & \vartheta_{22,1} \end{bmatrix} \begin{bmatrix} \left(\frac{D}{Y}\right)_{t-1} \\ \left(\frac{B}{Y}\right)_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \vartheta_{11,p} & \vartheta_{12,p} \\ \vartheta_{21,p} & \vartheta_{22,p} \end{bmatrix} \begin{bmatrix} \left(\frac{D}{Y}\right)_{t-p} \\ \left(\frac{B}{Y}\right)_{t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \tag{6.8.2}$$

From the above model (equation 6.8.2), if $\vartheta_{21,1} = \vartheta_{21,p} = 0$, then $(D/Y)_t$ does not Granger cause $(B/Y)_t$. Moving forward, $(B/Y)_t$ can be modelled using the function:

$$\left(\frac{B}{Y}\right)_t = \vartheta_{22,1}\left(\frac{B}{Y}\right)_{t-1} + \vartheta_{22,p}\left(\frac{B}{Y}\right)_{t-1} + \varepsilon_{2,t} \tag{6.8.3}$$

In the scenario that $(D/Y)_t$ does not Granger cause $(B/Y)_t$, where $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are not contemporaneously correlated, then $(B/Y)_t$ can be deemed to be weakly exogenous,

and can be modelled completely independent of $(D/Y)_t$. However, if $(D/Y)_t$ does not Granger cause $(B/Y)_t$, it remains equally crucial to find out whether $(B/Y)_t$ Granger causes $(D/Y)_t$. Since the frequency at which data are collected remains critical to detection of causality, inefficient collection of data leads to deduction of instantaneous causality. Following Granger (1969), if $(D/Y)_t$ and $(B/Y)_t$ demonstrate stationarity in respect of spectral systems, then $(D/Y)_t$ can be expressed in form of the function $\left(\frac{D}{Y}\right)_t = \int_{-\vartheta}^{\vartheta} e^{it\theta}\, d\Phi_{(D/Y)}(\pi)$, where: $\Phi_{(D/Y)}(\pi)$ denotes a complex random process $E\left[d\Phi_{(D/Y)}(\pi)\overline{d\Phi_{(D/Y)}(\varpi)}\right] = dF_{(D/Y)}(\pi)$, if $\pi = \varpi$; or else $E\left[d\Phi_{(D/Y)}(\pi)\overline{d\Phi_{(D/Y)}(\varpi)}\right] = 0$, where $dF_{(D/Y)}(\pi)$ can be written as $dF_{(D/Y)}(\pi) = f_{(D/Y)}(\pi)d\pi$. The cross spectrum between $(D/Y)_t$ and $(B/Y)_t$ gets defined by $\Xi(\pi)$ composed as $E\left[d\Phi_{(D/Y)}(\pi)\overline{d\Phi_{(D/Y)}(\pi)}\right] = \Xi(\pi)d\pi$ if $\varpi = \pi$. Successively, the covariance between $(D/Y)_t$ and $(B/Y)_t$ could therefore by given by:

$$\mu_t^{db} = E\left[\left(\frac{D}{Y}\right)_t \overline{\left(\frac{B}{Y}\right)_{t-\tau}}\right] = \int_{-\vartheta}^{\vartheta} e^{i\tau\theta}\, \Xi(\pi)d\pi \qquad (6.8.4)$$

Following Enders (2003), the Granger causality/Block Exogeneity Wald test statistic in this study was subsequently defined as:

$$(T-3p-1)\left(\log|\Sigma_{re}| - \log|\Sigma_{un}|\right) \sim \chi^2(2p) \qquad (6.8.5)$$

where: T denotes the number of observations; $\sum_{un}$ is the variance/covariance matrices of the unrestricted VAR system; $\sum_{re}$ denotes the variance/covariance matrices of the restricted system when the lag of a variable was excluded from the system, p denotes the number of lags of the variable that was excluded from the system.

6.9. Impulse Response Functions

Impulse response functions (IRFs) assess the effect of a shock to a given endogenous variable (X) on itself and the other given endogenous variable (Y). However, the VEC Granger Causality/Block Exogeneity Wald test does not provide information on the direction of the effect of the endogenous variable (X) on other endogenous variable (Y); as well as the time horizon it takes variable (Y) to return to long-run equilibrium

path owing to a shock in variable (X). To yield such evidence, analysis of IRFs was performed to examine impacts of shocks on the adjustment path of endogenous variables in the dynamic system. In order to explore the time path of the effects of the shocks on the regressand in the model, an unstructured VAR was first transformed into a vector moving-average (VMA) representation. Transformation of unstructured VAR into an infinite VMA representation followed the property that for every stationary VAR(p), for instance X_t, there exists an infinite VMA which follows the decomposition:

$$X_t = \varepsilon_t + \zeta_1 \varepsilon_{t-1} + \zeta_2 \varepsilon_{t-2} + ... = \sum_{i=0}^{\infty} \zeta_i \varepsilon_{t-i} \tag{6.9.1}$$

The matrix ζ_s can further be interpreted as $\zeta_s = \frac{\partial X_{t+s}}{\partial \varepsilon'}$. Assuming the initial element of ε_t gets changed by ρ_1, the second element by ρ_2, the third element by ρ_3, and so on, then the joint effect of the vector X_{t+s} could be summarised as:

$$\Delta X_{t+s} = \frac{\partial X_{t+s}}{\partial \varepsilon_{1,t}} \rho_1 + \frac{\partial X_{t+s}}{\partial \varepsilon_{2,t}} \rho_2 + \frac{\partial X_{t+s}}{\partial \varepsilon_{3,t}} \rho_3 + ... + \frac{\partial X_{t+s}}{\partial \varepsilon_{n,t}} \rho_n = \zeta_s \rho \tag{6.9.2}$$

The parameter $\rho = (\rho_1, \rho_2, \rho_3, ..., \rho_n)'$, for which the row i and column j element of ζ_s as a function of s yields the IFR given by:

$$\frac{\partial X_{i,t+s}}{\partial \varepsilon_{j,t}} \tag{6.9.3}$$

The IFR given in equation (6.9.3) depicts the dynamic multiplier or response of $X_{i,t+s}$ to a one-time previous impulse or shock in ε_{jt}, ceteris paribus. Returning to the standard VAR containing endogenous variables (B/Y) and (D/Y), exogenous variables interest rate (r) and output gap (y_gap) were eliminated from the system in order to focus on the AR structure of the model, and re-introduced the unstructured VAR matrix:

$$\begin{bmatrix} \left(\frac{B}{Y}\right)_t \\ \left(\frac{D}{Y}\right)_t \end{bmatrix} = \begin{bmatrix} \alpha_{11} \\ \alpha_{21} \end{bmatrix} + \begin{bmatrix} \pi_{12} & \theta_{13} \\ \pi_{22} & \theta_{23} \end{bmatrix} \begin{bmatrix} \left(\frac{B}{Y}\right)_{t-1} \\ \left(\frac{D}{Y}\right)_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{11t} \\ \varepsilon_{21t} \end{bmatrix} \tag{6.9.4}$$

Rewriting the matrix of the unstructured VAR (equation 6.9.4) in simple form and more compactly into an infinite VMA representation yields:

$$X_t = H_0 + H_1 X_{t-1} + e_t \;\Rightarrow\; X_t = \frac{H_0}{I - H_1 L} + \frac{e_t}{I - H_1 L} \tag{6.9.5}$$

Solving the first component on the RHS of equation (equation 6.9.5) provides:

$$\frac{H_0}{I - H_1} = (I - H_1)^{-1} H_0 = \frac{(I - H_1)^a H_0}{|I - H_1|} = \frac{\begin{bmatrix} 1-\pi_{12} & -\theta_{13} \\ -\pi_{12} & 1-\theta_{23} \end{bmatrix} H_0}{\begin{vmatrix} 1-\pi_{12} & -\theta_{13} \\ -\pi_{22} & 1-\theta_{23} \end{vmatrix}}$$

$$= \frac{\begin{bmatrix} 1-\theta_{23} & \pi_{22} \\ \theta_{13} & 1-\pi_{12} \end{bmatrix} \begin{bmatrix} \alpha_{11} \\ \alpha_{21} \end{bmatrix}}{(1-\pi_{12})(1-\theta_{23}) - \pi_{22}\theta_{13}} = \frac{1}{\Delta} \begin{bmatrix} (1-\theta_{23})\alpha_{11} + \pi_{22}\alpha_{21} \\ \theta_{13}\alpha_{11} + (1-\pi_{12})\alpha_{21} \end{bmatrix} = \begin{bmatrix} \overline{\frac{B}{Y}} \\ \overline{\frac{D}{Y}} \end{bmatrix} \tag{6.9.6}$$

In order for the VAR model to satisfy the stability condition, the roots of $I - H_1 L$ are required to exist outside the unit circle. Assuming that the respective requirement is satisfied, the second component of the VMA representation was specified as:

$$\frac{e_t}{I - H_1 L} = \sum_{i=0}^{\infty} H_1^i e_{t-i} = \sum_{i=0}^{\infty} \begin{bmatrix} \pi_{12} & \theta_{13} \\ \pi_{22} & \theta_{23} \end{bmatrix} \begin{bmatrix} e_{11,t-i} \\ e_{21,t-i} \end{bmatrix} \tag{6.9.7}$$

The VAR system was thus written as a VMA with standard VAR's error terms as:

$$\begin{bmatrix} \left(\frac{B}{Y}\right)_t \\ \left(\frac{D}{Y}\right)_t \end{bmatrix} = \begin{bmatrix} \left(\overline{\frac{B}{Y}}\right) \\ \left(\overline{\frac{D}{Y}}\right) \end{bmatrix} + \sum_{i=0}^{\infty} \underbrace{\begin{bmatrix} \pi_{12} & \theta_{13} \\ \pi_{22} & \theta_{23} \end{bmatrix}^i}_{H^i} \begin{bmatrix} e_{11,t-i} \\ e_{21,t-i} \end{bmatrix} \tag{6.9.8}$$

The error terms of the VMA representation (equation 6.9.8) are composite errors comprising structural innovations. Following Shin and Pesaran (1998), the impulse response function in this study was then specified by the function:

$$IR(m, h, Z_{t-1}) = E(y_{t+m} | e_t = h, Z_{t-1}) - E(y_{t+m} | = Z_{t-1}) \tag{6.9.9}$$

where m symbolises time, h ($h_1,\ldots,h_m$) denotes n x 1 vector that represents the size of shock, Z_{t-1} signifies accumulative information about the economy from the past period up to time period t-1.

In light of the important role played by h in the relations of properties of the IRF, the orthogonalised impulse response (OIR) was established by identifying the shock h through m time horizon using Cholesky decomposition of $\sum e = PP$; where P denotes n x n lower triangular matrix. Borrowing from Sim (1980), OIRFs were defined as:

$$IR_{ij}^{0}(m) = Q_m P\varepsilon_j \quad : m = 0,1,2,...,k \tag{6.9.10}$$

where: $m = 0,1,2,...,k; \quad Q_m = A_1 Q_{m-1} + A_2 Q_{m-2} + ... + A_p Q_{m-p}; \; Q_o = I_n$

6.9.1. Impact Multipliers

To measure the impact effect of a one unit change in a structural innovation or shock, impact multipliers were computed. Replacing the error terms $e's$ with $\varepsilon's$, the impact effect of $\varepsilon_{(D/Y)\ t}$ on (B/Y) and (D/Y) was, for instance, computed as:

$$\frac{d\left(\frac{B}{Y}\right)_t}{d\varepsilon_{(D/Y),\,t}} = \Omega_{12}(0) \qquad \frac{d\left(\frac{D}{Y}\right)_t}{d\varepsilon_{(D/Y),\,t}} = \Omega_{22}(0) \tag{6.9.11}$$

The impact effect of one period ahead on $(B/Y)_{t+1}$ and $(D/Y)_{t+1}$ was calculated as:

$$\frac{d\left(\frac{B}{Y}\right)_{t+1}}{d\varepsilon_{(D/Y),\,t}} = \Omega_{12}(1) \qquad \frac{d\left(\frac{D}{Y}\right)_{t+1}}{d\varepsilon_{(D/Y),\,t}} = \Omega_{22}(1) \tag{6.9.12}$$

Congruently, the impact effect expressed above (equation 6.9.12) was the same effect on $(B/Y)_t$ and $(D/Y)_t$ of a structural innovation one period ago calculated as:

$$\frac{d\left(\frac{B}{Y}\right)_t}{d\varepsilon_{(D/Y),\,t-1}} = \Omega_{12}(1) \qquad \frac{d\left(\frac{D}{Y}\right)_t}{d\varepsilon_{(D/Y),\,t-1}} = \Omega_{22}(1) \tag{6.9.13}$$

Furthermore, the IRF of (B/Y) to a unit change in the shock to (D/Y) therefore equal to $\Omega_{12}(0), \Omega_{12}(1), \Omega_{13}(2), \ldots$. The sum of the IRFs (cumulated effect), was thus computed as $\sum_{i=0}^{\infty}\Omega_{12}(i)$, while the long-run cumulated effect was specified as $\lim_{n\to\infty}\sum_{i=0}^{n}\Omega_{12}(i)$.

6.9.2. Stability of the Model

Following Hamilton (1994) and Lutkepohl (2005), a VEC model derived from the VAR representation can be deemed stable only if all the moduli of the given companion matrix can be specified by the function:

$$\bar{M}=\begin{bmatrix} M_1 & M_2 & \ldots & M_p & M_{p-1} \\ I_j & 0_j & \ldots & 0_j & 0_j \\ 0_j & I_j & \ldots & 0_j & 0_j \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0_j & 0_j & \cdots & I_j & 0_j \end{bmatrix} \tag{6.9.14}$$

Stability of the model technically implies that that the specified VAR is invertible and has an infinite VMA representation. Since the innovations (e_{it}) of the IFRs are regularly characterised by contemporaneous correlation, a shock to one variable can most likely get accompanied by shocks to other variables in the system.

6.10. Cholesky Variance Decomposition

In order to examine the relative significance of the random error terms to endogenous variables in the model, Cholesky variance decomposition was conducted in which the variance of the forecast error for each variable was broken down into components. In simple terms, variance decomposition measures the amount of change in a given variable owing to its own shock as well as shocks of other variables in the model. Accordingly, each variable was explained as a linear combination of its own current innovations and lagged innovations of other variables in the VEC model. Therefore, variance decompositions were computed from OIRF specified in equation (4.9.10). Considering the endogenous variables (B/Y) and (D/Y) in the model, the variance of each given variable's n-step ahead forecast error was computed as:

$$\sigma^2_{(B/Y),n} = \underbrace{\sigma^2_{(B/Y)}\left(\Omega^2_{11,0} + \Omega^2_{11,1} + \ldots + \Omega^2_{11,n-1}\right)}_{\substack{\text{proportion of variance in (B/Y) due to own shock} \\ \downarrow \\ \text{Decreases over time}}} + \underbrace{\sigma^2_{(D/Y),n}\left(\Omega^2_{21,0} + \Omega^2_{21,1} + \ldots + \Omega^2_{21,n-1}\right)}_{\substack{\text{proportion of variance in (B/Y) due to shock in (D/Y)} \\ \downarrow \\ \text{Increases over time}}} \quad (6.10.1)$$

$$\sigma^2_{(D/Y),n} = \underbrace{\sigma^2_{(D/Y)}\left(\Omega^2_{21,0} + \Omega^2_{21,1} + \ldots + \Omega^2_{21,n-1}\right)}_{\substack{\text{proportion of variance in (D/Y) due to own shock} \\ \downarrow \\ \text{Decreases over time}}} + \underbrace{\sigma^2_{(B/Y),n}\left(\Omega^2_{11,0} + \Omega^2_{11,1} + \ldots + \Omega^2_{11,n-1}\right)}_{\substack{\text{proportion of variance in (D/Y) due to shock in (B/Y)} \\ \downarrow \\ \text{Increases over time}}} \quad (6.10.2)$$

In practice, where $\varepsilon_{(D/Y)}$ explains none of the forecast error variance of $(B/Y)_t$ all through the forecast horizon $\left(\partial \sigma^2_{(B/Y),n} \Big/ \sigma^2_{(D/Y)} \approx 0\right)$, then $\left(\frac{B}{Y}\right)_t$ is deemed exogenous. Exogeneity involves the concurrent value of a given endogenous variable and the contemporaneous error term of another variable. Hence, it should not be treated to be the same as Granger-Causality. Conversely, if $\varepsilon_{(D/Y)}$ explains most of the forecast error variance of $(B/Y)_t$ during the course of the forecast horizon $\left(\partial \sigma^2_{(B/Y),n} \Big/ \sigma^2_{(D/Y)} \approx 0.9\right)$, then $\left(\frac{B}{Y}\right)_t$ is deemed endogenous. In the short-run, most of the variance in a variable result from own shock while the proportion of the effect of a shock to another variable in the model increases over time.

6.11. Conclusion

This chapter presented the methodology and estimation technique applied in the study with regards to the research objectives, research questions and research hypotheses. The chapter discussed the sources of data used for econometric estimation of results, unit root and cointegration properties of time-series data, the Vector Autoregressive (VAR) lag order selection criteria, VAR representation, Vector Error Correction (VEC) model, VEC Granger Causality/Block Exogeneity Wald test, Impulse Response Functions (IRFs), and Cholesky variance decompositions. The next chapter presents analyses and interprets results of the fiscal reaction function derived from econometric modelling conducted in line with research objectives of the study.

CHAPTER 7

RESULTS AND ANALYSIS

7.1. Introduction

This section presents results of the study estimated using EViews 8 econometric modelling software. Section 7.2 presents descriptive statisticswhile results on the ADF unit root tests, and Johansen cointegration tests are presented in Section 7.3 and Section 7.4 respectively. Results of the VAR order selection criteria are provided in Section 7.5. VEC estimates together with VEC Granger Causality/Block Exogeneity Wald tests results are presented in Section 7.6. Section 7.7 provides estimates of the VEC model stability tests while Section 7.8 presents results on the VEC residual diagnostic tests. Section 7.9 discusses the graphical impulse response functions (IRFs). Section 7.10 presents results on Cholesky variance decompositions. Lastly, Section 7.11 provides the overall conclusion on the results of the study.

7.2. Descriptive Statistics

Table 9: Summary Statistics

Test Statistic	B/Y	D/Y	CBPR	Output gap
Mean	0.763158	34.93026	9.140658	2.64E-13
Median	1.000000	33.85000	7.750000	0.373482
Maximum	7.300000	47.30000	21.85000	2.126260
Minimum	-6.000000	21.60000	5.000000	-4.930092
Std. Dev.	3.309415	7.830556	3.827137	1.328102
Skewness	-0.203313	-0.045769	1.169594	-1.621608
Kurtosis	2.096235	1.831220	4.138043	6.475744
Jarque-Bera	3.110096	4.352349	21.42864	71.56427
Probability	0.211179	0.113475	0.000022	0.00000
Observations	76	76	76	76

Source: Author's Computations using EViews

Descriptive statistics in Table 9 show that the average debt-to-GDP ratio (D/Y) was about 34.9% relative to the average primary balance-to-GDP ratio (B/Y) of merely 0.76%. The average central bank policy rate (CBPR) stood at 9.1% relative to the real output gap of 2.6×10^{13} due to substantial skewness of the series. JB statistics and p-values indicate that primary balance and public ratios followed normal distributions, while central bank policy rate and real output gap did not follow normal distributions.

7.3. ADF and PP Unit Root Tests

The unit root tests results are conducted at 1%, 5% and 10% levels of significance in levels and first differences using the ADF and PP techniques. Three models choices in EViews were applied in conducting and computing estimates of the stationarity tests, namely, constant, trend, constant, and none.

Table 10: ADF and PP Stationarity Tests Statistics in Levels†

Data	Model	ADF					PP				
		Lag length	α=1%	α=5%	α=10%	t-stat τ_c, τ_{tc}, τ_n	Band	α=1%	α=5%	α=10%	t-stat $Ø_c$, $Ø_{tc}$, $Ø_n$
(B/Y)	Constant	7	-3.530	-2.904	-2.589	-1.320	0	-3.520	-2.900	-2.587	-5.719**
	Trend and Constant	7	-4.098	-3.477	-3.166	-2.333	4	-4.085	-3.470	-3.162	-7.987***
	None	7	-2.599	-1.945	-1.613	-1.481	1	-2.596	-1.945	-1.613	-5.507***
(D/Y)	Constant	8	-3.531	-2.905	-2.590	-1.907	5	-3.520	-2.900	-2.587	-1.044
	Trend and Constant	8	-4.100	-3.478	-3.166	-1.250	0	-4.085	-3.470	-3.162	0.618
	None	8	-2.599	-1.945	-1.613	0.151	5	-2.596	-1.945	-1.613	-0.271
CBPR	Constant	1	-3.521	-2.901	-2.587	-2.143	1	-3.520	-2.900	-2.587	-1.965
	Trend and Constant	1	-4.086	-3.471	-3.162	-3.225*	0	-4.085	-3.470	-3.162	-1.924
	None	3	-2.577	-1.945	-1.613	-2.486**	1	-2.596	-1.945	-1.613	-1.507
Y_gap	Constant	9	-3.533	-2.906	-2.590	-3.399**	2	-3.520	-2.900	-2.587	-3.186**
	Trend and Constant	9	-4.103	-3.479	-3.167	-3.368*	2	-4.085	-3.470	-3.162	-3.174**
	None	9	-2.600	-1.945	-1.613	-3.432***	2	-2.596	-1.945	-1.613	-3.198***

† denotes testing of unit root hypothesis based on MacKinnon (1996) one sided p-values
[***] (**) * represent significance at 1 percent, (5) percent levels and [10] percent levels; respectively
τ_c, τ_{tc}, τ_n and $Ø_c$, $Ø_{tc}$, $Ø_n$ represent ADF and PP test results computed using constant, trend and constant, and none; respectively
Selections of proper lag lengths of ADF unit root tests were determined automatically by EViews based on the AIC, while selection of Bandwidths of PP unit root tests were determined automatically in EViews based on the Newey-West Bandwidth criterion performed using Bartlett kernel spectral estimation method

Source: Author's Computations using EViews

Although the time series properties of fiscal data provide critical information that guides estimation of fiscal reaction functions, the respective statistical properties themselves should not be regarded as indicators of fiscal sustainability. Results of stationarity tests in levels conducted using three models, namely, constant, trend and constant, and none, at 1%, 5% and 10% significance levels show that public debt-to-GDP ratio (D/Y) had a unit root based on ADF and PP methods. While output gap exhibits stationarity based on both ADF and PP tests, primary balance-to-GDP ratio (B/Y) was stationary based on the PP test criterion only while central bank policy rate (CBPR) demonstrated stationarity based on the ADF test criterion at 5%level of significance.

Table 11: ADF and PP Stationarity Tests Statistics in First Differences

Data	Model	ADF					PP				
		Lag length	α=1%	α=5%	α=10%	t-stat τ_c, τ_{tc}, τ_n	Band	α=1%	α=5%	α=10%	t-stat $Ø_c$, $Ø_{tc}$, $Ø_n$
(B/Y)	Constant	6	-3.530	-2.904	-2.589	-3.496**	13	-3.521	-2.901	-2.587	-23.834***
	Trend and Constant	6	-4.098	-3.477	-3.166	-3.462*	13	-4.086	-3.471	-3.162	-23.618***
	None	6	-2.599	-1.945	-1.613	-3.449***	13	-2.596	-1.945	-1.613	-23.192***
(D/Y)	Constant	7	-3.531	-2.905	-2.590	-1.073	0	-3.521	-2.901	-2.587	-5.635***
	Trend and Constant	7	-4.100	-3.478	-3.166	-2.211	5	-4.086	-3.471	-3.162	-7.077***
	None	7	-2.599	-1.945	-1.613	-1.133	0	-2.596	-1.945	-1.613	-5.678***
CBPR	Constant	11	-3.538	-2.908	-2.591	-4.614***	6	-3.521	-2.901	-2.587	-5.316***
	Trend and Constant	11	-4.110	-3.482	-3.169	-4.984***	7	-4.086	-3.471	-3.162	-5.196***
	None	11	-2.602	-1.946	-1.613	-4.110***	6	-2.596	-1.945	-1.613	-5.357***
Y_gap	Constant	8	-3.533	-2.906	-2.590	-3.181**	3	-3.521	-2.901	-2.587	-4.983***
	Trend and Constant	8	-4.103	-3.479	-3.167	-3.147	3	-4.086	-3.471	-3.162	-4.948***
	None	8	-2.600	-1.945	-1.613	-3.209***	3	-2.596	-1.945	-1.613	-5.017***

† denotes testing of unit root hypothesis based on MacKinnon (1996) one sided p-values
[***] (**) * represent significance at 1 percent, (5) percent levels and [10] percent levels; respectively
τ_c, τ_{tc}, τ_n and $Ø_c$, $Ø_{tc}$, $Ø_n$ represent ADF and PP test results computed using constant, trend and constant, and none; respectively
Selections of proper lag lengths of ADF unit root tests were determined automatically by EViews based on the AIC, while selection of Bandwidths of PP unit root tests were determined automatically in EViews based on the Newey-West Bandwidth criterion performed using Bartlett kernel spectral estimation method

Source: Author's Computations using EViews

The ADF and PP unit root test in first differences results show that primary balance-to-GDP ratio, central bank policy rate and output gap were stationary at 1% significance based on the model with neither a constant nor trend and constant. Central bank policy rate exhibited stationarity at 1% significance for all three models (constant, trend and constant, and none) at 1% significance level based on both the ADF and PP tests. The debt-to-GDP ratio remained non-stationary at 10% significance level based on ADF test criterion, and rejected the null hypothesis of unit root at 1% significance level based on the PP test criterion. Generally, all variables demonstrated stationarity at first difference based on the ADF and PP tests.

7.4. Cointegration Test

The assessment of cointegrating relationships between endogenous series primary balance (B/Y) and public debt (D/Y) as ratios of GDP; and exogenous series central bank policy rate (CBPR) and seasonally adjusted real output gap (Y_gap) was conducted based on the Johansen Trace statistic and Max-Eigen statistic methods.

Table 12: Cointegration Test with Linear Deterministic Trend-Lag Interval: 1 to 1

Null hypothesis (H_0) Alternative hypothesis (H_1)	r = 0 r = 1	r ≤ 1 r = 2
Trace statistic Critical value (0.05) Prob.**	49.656* 15.494 0.000	1.073 3.841 0.300
Maximum-Eigen statistic Critical value (0.05) Prob.**	48.583* 14.264 0.000	1.073 3.841 0.3002

* denotes rejection of the null hypothesis at 5% significance level

** MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Computations using EViews

The Johansen Trace test and Maximum-Eigen test statistics both indicate existence of 1 cointegrating equation. Rejection of the null hypothesis of no presence of a cointegrating relationship (r=0) between endogenous variables primary balance and public debt (as ratios of GDP) at 5% significance level was demonstrated by the computed Trace statistic (= 49.65697) greater than the critical value (= 15.49471; $p < 0.05$) and Max-Eigen statistic (= 48.58367) larger than the analogous computed critical value (= 14.26460; $p < 0.05$). The presence of a cointegrating relationship between fiscal endogenous series primary balance-to-GDP ratio and public debt-to-GDP ratio confirmed suitability of conducting fiscal sustainability analysis using the VEC model. The third assumption regarding deterministic trends in the data was chosen based on the rationale that the data series were trending, and the trends were stochastic.

7.5. VAR Lag Order Selection Criteria

Results on the optimum lag lengths presented in Table 13 were determined based on computed results of the LR, FPE, AIC, SIC, and HQ lag length selection methods.

Table 13: Optimum Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-219.3167	NA	2.589133	6.626963	6.822801	6.704560
1	-215.9140	6.305080	2.636116	6.644529	6.970927	6.773858
2	-208.2165	13.81025	2.366680	6.535778	6.992736	6.716839
3	-204.6251	6.232059	2.399277	6.547797	7.135314	6.780589
4	-164.8684	**66.65103***	**0.840388***	**5.496128***	**6.214204***	**5.780652***
5	-161.0411	6.191206	0.847877	5.501208	6.349843	5.837463
6	-157.9167	4.870321	0.874548	5.526962	6.506157	5.914949

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; and HQ: Hannan-Quinn information criterion

Source: Author's Computations using EViews

Results presented in Table 13 indicate that the optimum lag length of 4 was selected based on all the methods LR, FPE, AIC, SC, and HQ.

7.6. Vector Error Correction Model (VECM) Estimates

This section presents estimates of the VEC model, fiscal policy cyclicality measured based on variations of primary balance-to-GDP ratio and output gap levels and VEC Granger Causality/Block Exogeneity Wald tests.

Table 14: VECM Estimates

Cointegrating Equation:		
Primary balance-to-GDP (-1))	1	
d(Debt-to-GDP ratio (-1))	1.627 (0.666) [2.441]***	
Constant	*0.854*	
Error Correction:	d(Primary balance-to-GDP)	d(Debt-to-GDP, 2)
Cointegrating Equation	-0.696 (0.114) [-6.095]***	0.218 (0.043) [4.982]***
d(Primary balance-to-GDP(-1))	-0.176 (0.121) [-1.449]	-0.199 (0.046) [-4.272]***
d(Debt-to-GDP(-1),2)	-1.377 (0.327) [-4.210]***	-0.226 (0.125) [-1.803]*
Constant	*-10.133* *(2.613)* *[-3.878]*	*3.104* *(1.004)* *[3.091]*
Central Bank Policy Rate	4.744 (1.226) [3.868]***	-1.463 (0.471) [-3.105]***
Output gap	0.748 (0.261) [2.859]***	-0.152 (0.100) [-1.519]
R-squared	0.486	0.386
Adj. R-squared	0.446	0.338
Sum sq. resids	434.505	64.197
S.E. equation	2.605	1.001
F-statistic	12.133	8.066
Log likelihood	-163.225	-96.297
Akaike AIC	4.835	2.922
Schwarz SC	5.027	3.115
Mean dependent	-0.065	0.015
S.D. dependent	3.502	1.231

( ) and [ ] represent standard errors and t-statistics; respectively
*** denotes significance at 5 percent significance level**

Source: Author's Computations using EViews

Estimates presented in the first segment of the VEC model were computed based on the first-step Johansen procedure to identify all cointegrating relations, and reflect the nature and magnitude of the effect of debt-to-GDP ratio on primary balance-to-GDP ratio. Results of the long-run component show a positive relationship between public debt ratio and primary balance and suggest that for every 1% increase in public debt-to-GDP ratio, the primary balance-to-GDP ratio increased by an average of 1.62% over the period 1999q1 to 2016q2. The statistically significant positive coefficient of the long-run segment of the cointegrating equation demonstrates a significant positive relationship between primary balance and public debt ratio on which the vector was normalised. The cointegrating vector results reveal strong evidence of a significant positive and systematic reaction of primary balance to variations in public debt.

Findings indicate evidence of consistency of South African government's behaviour with the inter-temporal budget constraint and fiscal policy sustainability in the country. Concomitantly, results presented in the second segment of the model were computed based on the second-step of VAR in first and/or second differences, including the error correction term estimated from the first-step Johansen procedure. The error correction or cointegration term shows speed of adjustment at which a deviation by endogenous variables primary balance and public debt ratios from the long-run equilibrium path gradually corrects through a sequence of partial short-run adjustments. In other words, the error correction term shows the long-run behaviour of primary balance and public debt ratios towards convergence to their long-run cointegrating relationship.

The occurrence of steady adjustment to the long-run equilibrium through the short-run partial adjustment mechanism was substantiated by the significant fiscal response to deviations from the long-run equilibrium path equal to -0.69. Results of the short-run dynamics of the primary balance-to-GDP ratio equation show that about 0.69% of the temporary deviation from long-run equilibrium relationship between primary balance and public debt was corrected through reductions in the primary balance ratio during the first quarter after occurrence of the deviation. Primary balance ratio deviations from the long-run equilibrium relationship were corrected by 0.69% reductions in primary balance ratio in the current quarter to restore the cointegrating relationship. The short run dynamics debt-to-GDP ratio equation results show that public debt-to-GDP ratio, on average, had to increase by 0.21% in the current period to restore the equilibrium.

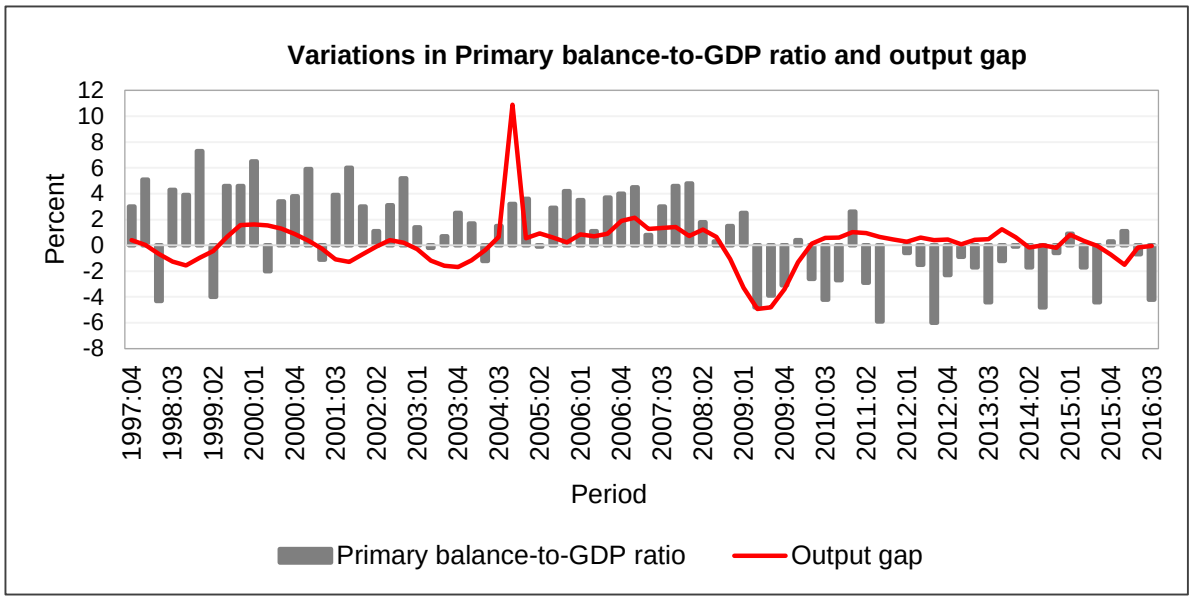
Previous empirical studies (Tshiswaka-Kashalala, 2006; Burger, et al., 2011; Jibao, Schoeman & Naidoo, 2011; Calitz, Du Plessis, & Siebrits, 2013; Ganyaupfu, 2014) which assessed historical fiscal sustainability in South Africa overlooked the role played by monetary policy in influencing conditions in borrowing markets from which government finances its deficits through bond issues. To capture the exogenous effect of monetary policy stance on primary balance and public debt (as ratios of GDP), the central bank policy rate (CBPR) was integrated into the VEC model. Accordingly, the respective variable provided as a proxy for monetary policy stance.

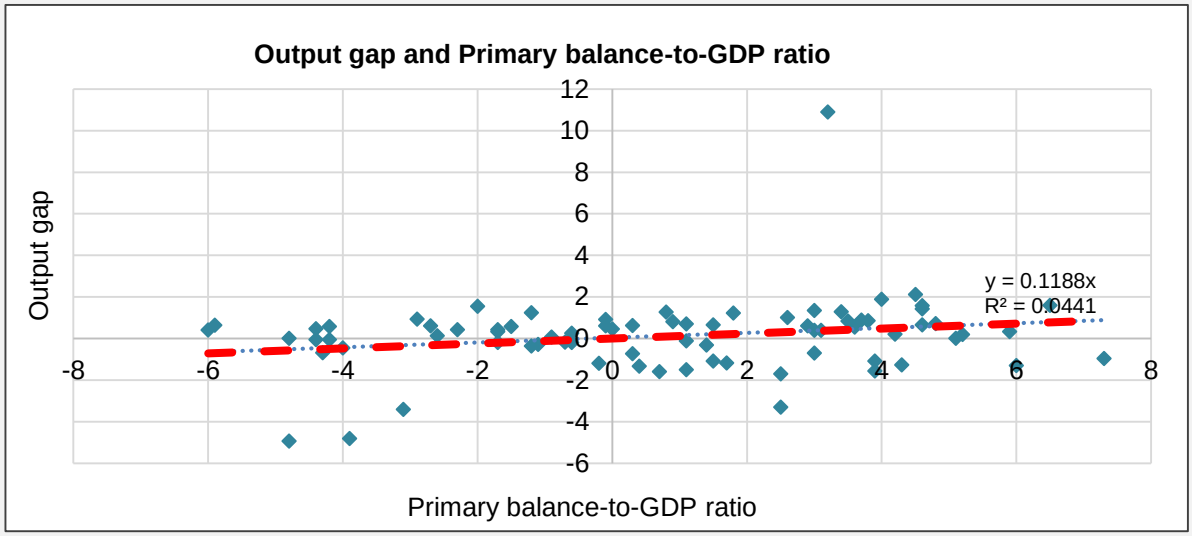
Results of the primary balance-to-GDP ratio equation show that central bank policy rate had statistically significant impacts on both primary balance-to-GDP ratio and debt-to-GDP ratio. Therefore, findings show that an increase or tightening in central bank policy rate by 1 percentage point led to about 4.7% upsurge in primary balance-to-GDP ratio while public debt decreased by about 1.4% of GDP during the sample period 1999q1-2016q2. Since the largest proportion of government budget deficits are financed through borrowing from the domestic market, results suggest that monetary policy stance significantly influenced government behaviour and fiscal authorities' efforts towards maintaining fiscal sustainability during the sample period under review.

The short-run dynamics estimates show that output gap had a statistically substantial impact on primary balance-to-GDP ratio while the impact was insignificant on public debt-to-GDP ratio. Though statistically insignificant, the negative output gap coefficient in the short-run dynamics of the debt-to-GDP ratio equation indicates that positive output gap levels moderately reduced the average change in public debt-to-GDP ratio. Correspondingly, the statistically significant and positive output gap coefficient in the primary balance-to-GDP equation indicates that positive output gap levels significantly increased the average change in primary balance as a ratio of GDP.

Findings indicate evidence of countercyclicality behaviour of fiscal policy, implying that fiscal policy had an automatic stabilisation effect on debt accumulation. In conditions of destabilising shocks, effects of such shocks were possibly prevented from becoming distortive to macroeconomic stability during the period 1999q1-2016q2. Figure 20 validates the cyclicality of discretionary fiscal policy by comparing variations between primary balance and output gap levels during the sample period under review.

Figure 20: Fiscal Policy Cyclicality





Source: Author's computations

Figure 20 explores the cyclicality of South Africa's fiscal policy over the period 1997q4 to 2016q3 as demonstrated by variations and scatter plot between primary balance-to-GDP ratio and output gap levels. Fiscal policy is regarded as counter-cyclical if primary deficit decreases (surplus increases) in periods with positive output gaps or if primary surplus decreases (deficit increases) in periods with negative output gaps. The Figure shows that South Africa experienced moderate down swings in productivity over the period 1997q4-2004q3. The economy noticeably experienced volatile primary surplus during the period 19947q4-2009q1, and persistent volatile primary deficit over the period 2009q1-2016q3. Output gap considerably remained negative during the period 1997q4-2004q2, vis-à-vis volatile primary surplus during the respective period.

The economy experienced a shock in production when output gap explosively grew from 0.66% in 2004q3 to 10.9% in 2004q4, and radically declined to 0.55% in 2005q1. Output gap remained positive and relatively stable during the period 2005q1-2008q3. The primary surplus-to-GDP ratio decreased from 2.5% in 2009q1 to -4.8% deficit level in 2009q2 following negative changes in output gap from 0.64% in 2008q3 to -4.93% in 2009q2. The output gap grew from -4.93% in 2009q2 to 0.14% in 2010q2 and remained marginally positive and stable while largely coupled with primary deficit during the period 2010q2-2016q3. The positive correlation coefficient equal to 0.217 between primary balance-to-GDP ratio and output gap confirms that discretionary fiscal policy showed a tendency of counter-cyclicality over the period 1997q4-2016q3.

The primary balance-to-GDP ratio and public debt-to-GDP ratio equations VEC model estimates (Table 14) in VAR representation are provided in Table 15.

Table 15: VAR Model - Substituted Coefficients

Equation: Primary balance-to-GDP ratio

$$d(B/Y) = -0.696 * [(B/Y(-1)) + 1.627 * d(D/Y(-1)) + 0.854] - 0.176 * d(B/Y(-1)) - 1.377 * d(D/Y(-1),2) - 10.133 + 4.744 * CBPR(-2) + 0.748 * Y\_gap(-2) \quad \text{(eqn 6.7.2)}$$

Equation: Public debt-to-GDP ratio

$$d(D/Y,2) = 0.218 * [(B/Y(-1)) + 1.627 * d(D/Y(-1)) + 0.854] - 0.199 * d(B/Y(-1)) - 0.226 * d(D/Y(-1),2) + 3.104 - 1.463 * CBPR(-2) - 0.152 * Y\_gap(-2) \quad \text{(eqn 6.7.3)}$$

Source: Author's Computations using EViews

The VAR representation of the primary balance and debt equations (as ratios of GDP) presented in Table 15 show that a 1% increase in debt-to-GDP ratio led to an average increase in the primary balance ratio by about 1.62% of GDP in the long-run. Given a constant of 85.4%, a debt-to-GDP ratio of 45% leads to a long-run primary balance-to-GDP ratio of 12.18%. Furthermore, a public debt-to-GDP ratio of 50% leads to long-run primary balance ratio of 4.4%. The short-run dynamics of the primary balance ratio equation show that approximately 0.69% of the transitory deviation from the long-run equilibrium relationship between primary balance and debt ratios was corrected by reductions in primary balance ratio in the first quarter. In addition, a 1 percentage point increase in central bank policy rate led to about 4.74% average increase in primary balance ratio and about 1.46% average decline in debt ratio. The significant positive coefficient of output gap demonstrates that fiscal policy was indeed counter-cyclical. Following VEC estimation, system specification by variable yielded the functions.

Table 16: System Specification by Variable

$$d(B/Y) = \pi_{12} * (B/Y(-1) + 1.627 * d(D/Y(-1)) + 0.854) + \varphi_{11} * d(B/Y - 1)) + \varphi_{12} * d(D/Y(-1, 2) + \alpha_{11} + \gamma_{12} * CBPR(-2) + \delta_{13} * Y\_gap(-2) \quad \text{eqn (6.7.2)}$$

$$d(D/Y, 2)) = \pi_{13} * (B/Y(-1) + 1.627 * d(D/Y(-1)) + 0.854) + \varphi_{21} * d(B/Y - 1)) + \varphi_{22} * d(D/Y(-1, 2) + \alpha_{21} + \gamma_{22} * CBPR(-2) + \delta_{23} * Y\_gap(-2) \quad \text{eqn (6.7.3)}$$

Source: Author's Computations using EViews

The system coefficients of equations (6.7.2) and (6.7.3) presented in Table 17 were estimated using the Least Squares method. Parameters $-\theta_{12} = 1.627$ and $-\theta_{13} = 0.854$ of equations (6.7.2) and (6.7.3) measure the deviation from the long-run equilibrium.

Table 17: System Estimation

Estimation Method: Least Squares – Total system (balanced) observations 146				
Parameter	Coefficient	Std. Error	t-Statistic	Prob.
π_{12}	-0.696	0.114	-6.095	0.000
φ_{11}	-0.176	0.121	-1.449	0.149
φ_{12}	-1.377	0.327	-4.210	0.000
α_{11}	-10.133	2.613	-3.877	0.000
γ_{12}	4.744	1.226	3.868	0.000
δ_{13}	0.748	0.261	2.859	0.005
π_{13}	0.218	0.043	4.982	0.000
φ_{21}	-0.199	0.046	-4.272	0.000
φ_{22}	-0.226	0.125	-1.803	0.073
α_{21}	3.104	1.004	3.091	0.002
γ_{22}	-1.463	0.471	-3.105	0.002
δ_{23}	-0.152	0.100	-1.519	0.131

Panel A: Primary balance-to-GDP ratio

*Equation: d(B/Y) = π_{12} *(B/Y(-1) + 1.627*d(D/Y(-1)) + 0.854) + φ_{11} *d(B/Y(-1)) + φ_{12} *d(D/Y(-1),2) + α_{11} + γ_{12} *CBPR(-2)+ δ_{13} *Output gap(-2)*

Adj. R-squared	0.446	Mean dependent var	-0.065
S.E. of regression	2.605	S.D. dependent var	3.502
Durbin-Watson stat	1.858	Sum squared resid	434.505

Panel B: Public debt-to-GDP ratio

*Equation: d(D/Y,2) = π_{13} *(B/Y(-1) + 1.627*d(D/Y(-1)) + 0.854) + φ_{21} *d(B/Y(-1)) + φ_{22} *d(D/Y(-1),2) + α_{21} + γ_{22} *CBPR(-2) + δ_{23} *Output gap(-2)*

Adj. R-squared	0.338	Mean dependent var	0.015
S.E. of regression	1.001	S.D. dependent var	1.231
Durbin-Watson stat	1.918	Sum squared resid	64.197

Source: Author's Computations using EViews

The Least-Squares system estimation version of the VEC model indicates that the coefficient of the error correction term equal to -0.696 was statistically significant at

1% level. In the short-run dynamics component of the model, estimated coefficients in the primary balance-to-GDP ratio equation were statistically significant at 1% level with the exception of the coefficient of the one-period lagged primary balance-to-GDP ratio. Similarly, coefficients in the debt-to-GDP ratio equation were statistically significant at 1% level with the exception of the coefficients of the one-period lagged debt-to-GDP ratio and output gap. The adjusted R-squared values show that about 45% and 34% variations in primary balance and debt equations respectively were accounted for by variables captured in the respective equations. The Durbin Watson statistic for the primary balance and public debt ratios equations indicate absence of serial correlation.

Following estimation of the fiscal reaction function using the VECM approach, the VEC Granger causality/Block Exogeneity test was conducted to determine the short run causality between primary surplus and public debt, as ratios of GDP.

Table 18: VEC Granger Causality/Block Exogeneity Wald Tests

Panel A – Dependent variable: d(Primary balance-to-GDP ratio)			
Excluded	Chi-square	df	Prob.
d(Debt-to-GDP ratio,2)	17.729	1	0.000
All	17.729	1	0.000
Panel B – Dependent variable: d(Debt-to-GDP ratio,2)			
Excluded	Chi-square	df	Prob.
d(Primary balance-to-GDP ratio)	18.256	1	0.000
All	18.256	1	0.000

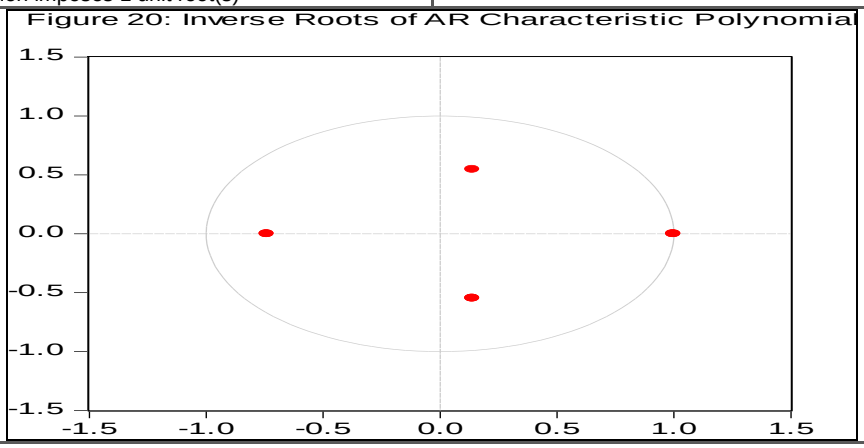
Source: Author's Computations using EViews

Results presented in Table 18 on joint tests p-values for each equation of primary balance-to-GDP ratio and public debt-to-GDP ratio show that the respective variables were endogenous in nature. Panel A estimates indicate that the null hypothesis that public debt-to-GDP ratio does not Granger cause primary balance-to-GDP ratio in the short run was rejected at 1% significance level. The finding implies that the lagged difference of the debt-to-GDP ratio could not be excluded in the estimated differenced primary balance-to-GDP equation. Similarly, Panel B estimates indicate that null hypothesis that primary balance-to-GDP ratio does not Granger cause public debt-to-GDP ratio in the short run was rejected at 1% significance level. Furthermore, results suggest that the lagged difference of the primary balance-to-GDP ratio could not be excluded in the differenced debt-to-GDP equation. Therefore, the short-run dynamics of the VEC model could not be estimated without lags of the endogenous variables.

Though results demonstrate evidence of short-run causality between primary balance and public debt, no information was provided on the impact of a shock or one-standard innovation in each of the variables on itself and another variable. To obtain such evidence, impulse response functions and variance decomposition analysis were conducted subsequent to tests of stability and residual properties of the VEC model. The roots characteristic polynomial VEC model stability test results are presented in Table 19 embedded with a diagrammatic representation depicted by Figure 20.

Table 19: Roots of Characteristic Polynomial†

Root	Modulus
1.000	1.000
-0.738	0.738
0.141 - 0.546i	0.564
0.141 + 0.546i	0.564
† VEC specification imposes 1 unit root(s)	



Source: Author's Computations using EViews

Results in Table 19 indicate that all roots have modulus less than one and generally lie inside the unit circle (Figure 20). The presence of 1-unit root satisfies the condition that when a VEC model has been estimated from a single cointegrating relation with two variables, then the characteristic polynomial should have 1 root equal to a unity. Thus, the moduli less than one inside the unit circle satisfied the stability condition.

7.7. VEC Residual Diagnostic Tests

Results on residual diagnostic tests examined to determine robustness of the model are presented in Table 20. The null hypothesis of no serial correlation was tested at lag order 3 while the joint Jacque-Bera test of the null hypothesis of model residual multivariate normality was tested based on Cholesky (Lutkepohl) Orthogonalization.

Table 20: VEC Residual Tests

H_1	H_0	Test	Statistic	df	Prob
Serial correlation	No serial correlation	LM-(χ^2)	3.289	4	0.510
Multivariate normality	Normally distributed error term	JB-Joint	5.456	4	0.065
Heteroskedasticity	No heteroskedasticity	χ^2	33.960	30	0.282

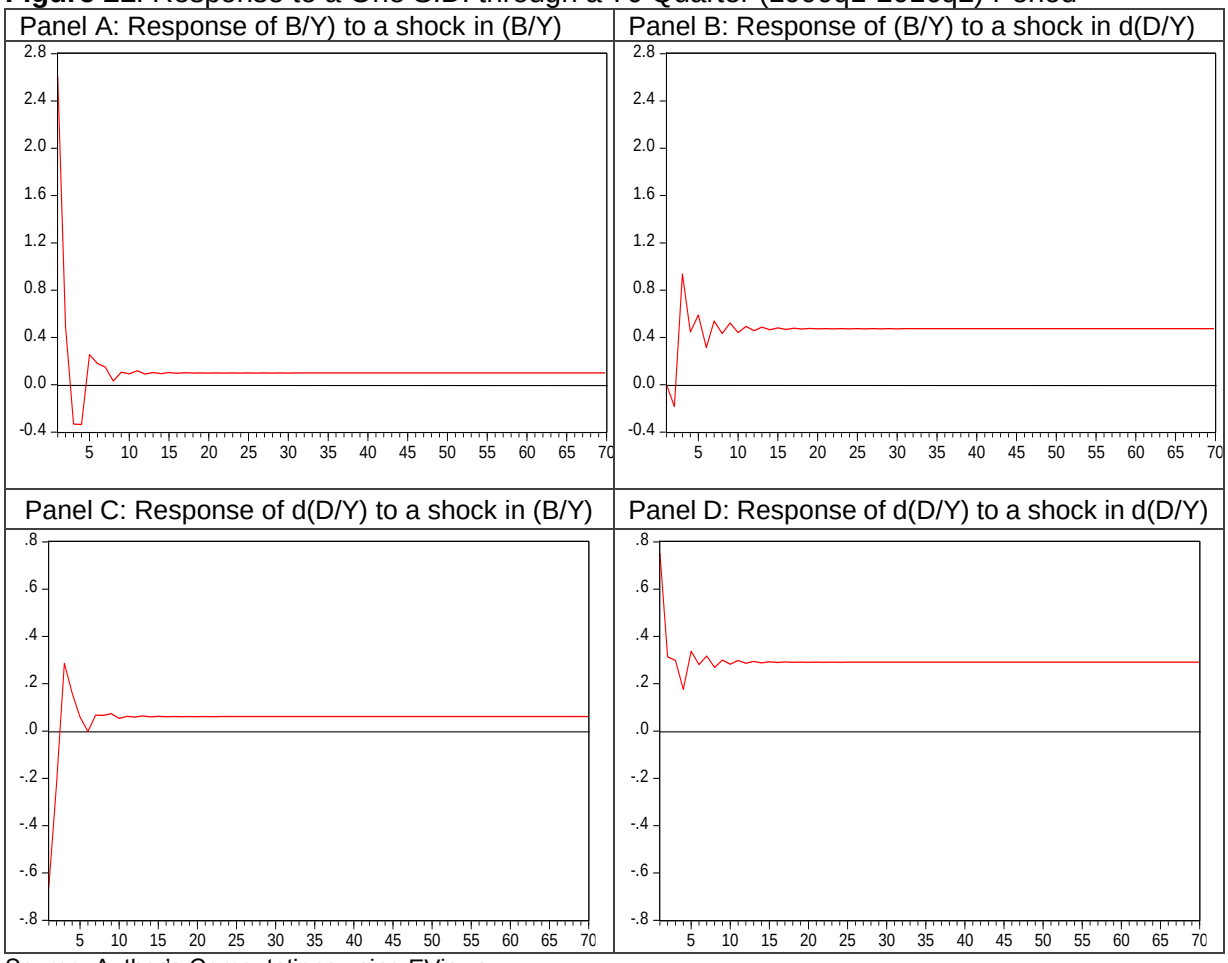
Source: Author's Computations

The estimated VEC model passed the residual diagnostic tests on serial correlation and heteroskedasticity. The computed Lagrangian Multiplier statistic value equal to 3.28 (p>0.5) was consistent with null hypothesis of no serial correlation while the VEC residual normality test conducted using the Cholesky (Lutkepohl) Orthogonalization method indicate that residuals were multivariate normal at 5% significance level.

7.8. Impulse Response Functions

The impulse responses of endogenous variables primary balance (B/Y) and debt (D/Y) ratios derived using orthogonalized Cholesky decomposition are shown in Figure 21.

Figure 21: Response to a One S.D. through a 70 Quarter (1999q1-2016q2) Period



Source: Author's Computations using EViews

Panel A shows that a shock to primary balance-to-GDP ratio had a significant negative impact on future primary balance-to-GDP ratio during the first two quarters. The impact of the shock caused profound deterioration in primary surplus from 2.6% in the 1st quarter to -0.34% in the 4th quarter. A statistically significant positive impact of 0.25% was realised from the 5th quarter in the short-run. The impact remained significantly positive with marginal variability through to the 13th quarter during the short- to medium term period. The long-run impact of a shock in primary surplus-to-GDP ratio on itself remained significantly positive at 0.1% along the equilibrium in the long-run.

Panel B shows that a one standard innovation in public debt-to-GDP ratio initially had a statistically significant negative impact of -0.18% on future primary balance ratio during the 1st quarter in the short-run period. The impact became significantly positive at 0.93% in the 3rd quarter and fluctuated between 0.31% and 0.58% from quarter 4 through to the 16th quarter in the medium term. Findings confirm results of Granger causality tests that provided strong evidence of existence of causality between the respective endogenous fiscal variables in the short-run period. From the 17th quarter, the long-run impact of a shock in public debt-to-GDP ratio on future primary balance-to-GDP ratio remained significantly positive and constant at 0.47% in the long-run.

Panel C demonstrates strong evidence that a shock emanating from primary balance-to-GDP ratio had a statistically significant positive impact on future public debt-to-GDP ratio from -0.66% in the 1st quarter to 0.28% in the 3rd quarter during the short-run. The positive impact noticeably deteriorated from 0.16% in the 4th quarter and became insignificant to -0.00% in the 6th quarter. From the 7th quarter, the positive impact of a shock in primary balance to debt rebounded with minimal variation between 0.05% and 0.07% through to the 10th quarter in the short-run. The impact reverted to the equilibrium and remained significantly positive and constant at 0.06% in the long-run.

Panel D indicates that a one standard innovation to debt-to-GDP ratio had a profoundly declining positive impact on debt-to-GDP ratio from 0.75% in the 1st quarter to 0.17% in the 4th quarter in the short-run. The impact remained positive and varied between 0.26% and 0.33% through the period quarter 5 to quarter 16 in the medium term. From

the 17th quarter, the long-run impact of a shock in debt-to-GDP ratio on its future path remained significantly positive and constant at 0.29% in the long-run.

7.9. VAR Cholesky Variance Decompositions

Results on the VAR Cholesky variance decompositions of endogenous variables used in estimation of the VEC model are shown in Table 21 and Table 22.

Table 21: Cholesky Variance Decomposition of Primary balance-to-GDP ratio

Period	S.E.	(B/Y)	d(D/Y)
1	2.605	100.000	0.000
5	2.962	83.372	16.627
10	3.146	74.692	25.307
15	3.329	67.158	32.841
20	3.500	61.157	38.842
25	3.664	56.186	43.813
30	3.821	52.016	47.983
35	3.971	48.465	51.534
40	4.116	45.405	54.594
45	4.256	42.742	57.257
50	4.391	40.401	59.598
55	4.523	38.329	61.670
60	4.651	36.482	63.517
65	4.775	34.824	65.175
70	4.896	33.328	66.671

Cholesky ordering: (B/Y), d(D/Y)

Source: Author's Computations using EViews

The variance decomposition of the primary balance-to-GDP ratio results presented in Table 21 show that fluctuations in the primary balance-to-GDP ratio were explained predominantly by shocks to primary balance-to-GDP ratio in the long-run. Primary balance-to-GDP shock accounted for 100% variation in itself in the first quarter while its proportion in the variance of primary balance-to-GDP ratio progressively decreased over time. The variance reached 67% in the 15th quarter, 52% in the 30th quarter, 42% in the 45th quarter, 36% in the 60th quarter, and 33% in the 70th quarter.

The contribution of a shock to public debt-to-GDP ratio on variance of primary balance-to-GDP ratio substantially increased over time from 0% in the first quarter to about 25% in the 10th quarter in the short-run. The proportion of variance in primary balance-to-GDP ratio emanating from a shock in debt-to-GDP ratio progressively increased over time to about 38% in the 20th quarter and 48% in the 30th quarter. The respective proportion breached the 50% mark through to 54% in the 40th quarter, 59% in the 50th quarter, 63% in the 60th quarter, and 67% in the 70th quarter. Therefore, the variance

in primary balance ratio in South Africa progressively became explained by the shock to public debt as a ratio of GDP in the long-run.

Table 22: Cholesky Variance Decomposition of d(Debt-to-GDP ratio)

Period	S.E.	(B/Y)	d(D/Y)
1	1.001	43.484	56.515
5	1.223	39.948	60.051
10	1.391	31.760	68.239
15	1.543	26.608	73.391
20	1.680	23.106	76.893
25	1.807	20.549	79.450
30	1.926	18.602	81.397
35	2.037	17.071	82.928
40	2.143	15.834	84.165
45	2.244	14.814	85.185
50	2.340	13.959	86.040
55	2.433	13.232	86.767
60	2.522	12.606	87.393
65	2.608	12.061	87.938
70	2.692	11.583	88.416

Cholesky ordering: (B/Y), d(D/Y)

Source: Author's Computations using EViews

Results of variance decomposition of public debt ratio presented in Table 22 indicate that the variation in public debt-to-GDP ratio was progressively explained largely by shocks to public debt ratio in the long-run. In the first quarter, a shock to public debt-to-GDP accounted for about 57% variation in itself while the remaining proportion of approximately 43% was explained by primary balance-to-GDP ratio. The proportion of variance in public debt-to-GDP ratio emanating from a shock in public debt-to-GDP ratio consistently increased over time to about 77% in the 20th quarter, 84% in the 40th quarter; 87% in the 60th quarter and slightly to 88% in the 70th quarter.

Conversely, the contribution of a shock to primary balance-to-GDP ratio on variance of public debt-to-GDP ratio moderately diminished over time from about 43% in the first quarter to approximately 32% in the 10th quarter. In addition, the proportion of variance in public debt ratio emanating from a shock in the primary surplus ratio consistently decreased as time progressed to approximately 23% in the 20th quarter, 19% in the 30th quarter, and 16% in the 40th quarter. The proportion declined to 14% in the 50th quarter, 13% in the 60th quarter and ultimately 11% in the 70th quarter.

7.11. Conclusion

This chapter provided econometric results of the fiscal reaction function estimated to assess whether the South African fiscal authorities historically reacted to public debt positions in a sustainable manner. Furthermore, the chapter took into account the exogenous short-run impact of monetary policy stance on positions of primary balance and public debt ratios during the sample period 1999q1-2016q2. The fiscal reaction function was estimated within the framework of the Vector Error Correction (VEC) model to evaluate whether the government's historical fiscal conduct was in line with the intertemporal budget constraint. The VEC model results indicate that fiscal policy was sustainable while monetary policy stance had significant impact on both primary balance and public debt positions during the sample period under review. Simulations of the impulse response functions provide strong evidence that the macroeconomy can correct itself from transitory deviations in the short-run to the medium term, and return to the long-run equilibrium path after occurrence of a shock. The next chapter provides the summary of major findings, conclusion, limitations of the research study, and recommendations for further research.

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8.1. Introduction

This chapter provides a summary of the primary findings from the study, conclusion, limitations of the study, and recommendations for further study. In line with the primary aim and research objectives of this study, Section 8.2 summarises the major findings of the study, Section 8.3 presents some policy implications, while Section 8.4 outlines key limitations of the study. Section 8.5 provides recommendations for further studies on fiscal sustainability, and Section 8.6 provides the overall conclusion to the study.

8.2. Major Findings

The Johansen cointegrating test results for the relationship between endogenous series primary balance-to-GDP ratio and debt-to-GDP ratio, and exogenous variables central bank policy rate and seasonally adjusted real output gap provided evidence of existence of a cointegrating relationship. Findings from the estimated VEC model's long-run component computed based on the first-step Johansen procedure indicated that for every 1% increase in public debt-to-GDP ratio, the primary balance-to-GDP ratio increased by an average of about 1.62% during the sample period 1999 quarter 1 to 2016 quarter 2. Findings indicate evidence of a significant positive relationship between the primary balance-to-GDP ratio and public debt-to-GDP ratio. Therefore, the primary balance-to-GDP ratio had a significant positive and systematic reaction to variations in the public debt-to-GDP ratio during the sample period under review.

Results indicate evidence of consistency of South African government's behaviour with the inter-temporal budget constraint and fiscal policy sustainability in the country. Concomitantly, results of the VEC model's second segment computed based on the second-step of VAR, including the error correction term estimated from the first-step Johansen procedure, show that about 0.69% of the temporary deviation from the long-run equilibrium relationship between primary balance and debt ratios was corrected by variations in primary balance in the first quarter after occurrence of the deviation.

Empirical results in this research study are consistent with findings from preceding similar studies (Tshiswaka-Kashalala, 2006; Burger, et al. 2011; Jibao, Schoeman and Naidoo, 2011; Ganyaupfu, 2014). Nonetheless, the respective previous studies did not integrate the exogenous impact of monetary policy stance in analysing the historical sustainability of fiscal policy in South Africa. In order to validate such a link between monetary policy and fiscal sustainability empirically, the exogenous effect of central bank policy rate (proxy for monetary policy stance) on primary surplus and public debt ratios were captured in the fiscal reaction function.

Results of the primary balance-to-GDP ratio equation show that monetary policy stance had statistically significant impacts on both primary balance-to-GDP ratio and debt-to-GDP ratio. Furthermore, findings provided evidence that an increase in central bank policy rate by 1 percentage point led to about 4.7% increase in the primary balance ratio, while public debt decreased by about 1.4% of GDP during the sample period 1999q1-2016q2. Since the largest proportion of government budget deficits are financed through borrowing from the domestic market, results suggest that monetary policy stance significantly influenced government behaviour and fiscal authorities' efforts towards maintaining fiscal sustainability during the sample period under review.

The short-run dynamics estimates show that output gap had a statistically significant impact on the primary surplus ratio, while the impact was insignificant on public debt ratio. Although statistically insignificant, the negative coefficient of output gap in the short-run dynamics of the debt-to-GDP ratio equation indicates that positive output gaps reduced the average change in debt-to-GDP ratio. Congruently, the significantly positive output gap coefficient on primary balance-to-GDP suggests that positive output gap levels significantly increased the average change in primary balances-to-GDP ratio. Such findings provide evidence of countercyclicality nature of fiscal policy, signifying that fiscal policy had an automatic stabilisation effect on debt accumulation.

The cyclicality of the country's discretionary fiscal policy was validated by comparing variations between primary balance and output gap levels during the respective sample period. Graphical expositions were used to explore cyclicality of the country's fiscal policy by exploring variations between primary balance-to-GDP ratio and output gap levels during the period 1997q4 to 2016q3. Findings show that the South Africa

economy experienced marginal down swings in productivity during the period 1997q4-2004q3. The economy considerably experienced volatile primary surplus during the period 1997q4-2009q1 and persistent volatile primary deficit during 2009q2-2016q3. However, the output gap remained significantly negative during the period 1997q4 to 2004q2 vis-à-vis volatile primary balance-to-GDP ratio over the same period.

As time progressed, the economy experienced a shock in production when output gap explosively grew from 0.66% in 2004q3 to 10.9% in 2004q4, and drastically declined to 0.55% in 2005q1. Output gap remained positive and relatively stable during the period 2005q1-2008q3. The primary balance-to-GDP ratio decreased from 2.5% in 2009q1 to -4.8% deficit level in 2009q2 following negative changes in output gap from 0.64% in 2008q3 to -4.93% in 2009q2. Output gap grew from -4.93% in 2009q2 to 0.14% in 2010q2 and remained marginally positive and stable while largely coupled with primary deficit over the period 2010q2-2016q3. The estimated positive correlation coefficient between primary balance-to-GDP ratio and output gap confirms that fiscal policy was counter-cyclical in nature in South Africa over the period 1997q4-2016q3.

Results of the VEC Granger causality/Block Exogeneity test conducted to determine the short-run causality between primary balance and public debt ratios show that null hypotheses of no Granger-causality between the respective variables was rejected for both equations. Findings indicated that the lagged difference of the debt-to-GDP ratio could not be excluded in the estimated differenced primary balance-to-GDP equation while the lagged difference of the primary balance ratio could also not be excluded in the differenced debt-to-GDP equation. Results show that the short-run dynamics of the model could not be estimated without lags of the respective endogenous variables.

Results of impulse response functions and variance decomposition conducted after confirmation of the model stability show that a shock to primary balance-to-GDP ratio had a significant negative impact on future primary balance-to-GDP ratio during the first two quarters. The impact of the shock caused profound deterioration in primary balance from 2.6% in the first quarter to -0.34% in the fourth quarter. Therefore, a statistically significant positive impact of 0.25% was realised from the fifth quarter in the short-run. The impact remained significantly positive with marginal variability through to the 13th quarter during the short- to medium term period. Finally, the long-

run impact of a shock in primary balance ratio on itself remained significantly positive at 0.1% along the equilibrium path in the long-run.

A shock to public debt-to-GDP ratio initially had a significant negative impact of -0.18% on future primary balance during the first quarter in the short-run. The impact became significantly positive at 0.93% in the third quarter and fluctuated between 0.31% and 0.58% from quarter 4 through to quarter 16 in the medium term. From the seventh quarter, the long-run impact of a shock in debt-to-GDP ratio on future primary balance-to-GDP ratio remained significantly positive and constant at 0.47% in the long-run.

A shock to primary balance-to-GDP ratio had a statistically significant positive impact on future public debt-to-GDP ratio from -0.66% in the first quarter to 0.28% in the third quarter in the short-run. The positive impact noticeably deteriorated from 0.16% in the fourth quarter and became insignificant to -0.00% in the sixth quarter. From the seventh quarter, the positive impact of a shock in primary balance to public debt rebounded with minimal variation between 0.05% and 0.07% through to the 10th quarter in the short-run period. The impact reverted to the equilibrium path and remained significantly positive and constant at 0.06% in the long-run.

The impulse response functions further show that a shock to public debt-to-GDP ratio had a profoundly deteriorating positive impact on debt-to-GDP ratio from 0.75% in the first quarter to 0.17% in the fourth quarter in the short-run. In addition, the impact remained positive and fluctuated between 0.26% and 0.33% through the period quarter 5 to quarter 16 in the medium term. From the seventh quarter, the long-run impact of a shock in public debt-to-GDP ratio on its future path remained significantly positive and constant at 0.29% in the long-run.

The variance decomposition of the primary balance-to-GDP ratio results show that fluctuations in the primary balance-to-GDP ratio were explained predominantly by shocks to primary balance-to-GDP ratio in the long run. Primary balance-to-GDP shock accounted for 100% variation in itself in the first quarter while its proportion in the variance of primary balance-to-GDP ratio progressively decreased over time. Concomitantly, the contribution of a shock to public debt-to-GDP ratio on variance of primary balance-to-GDP ratio substantially increased over time from 0% in the first

quarter to about the highest level of 67% in the 70th quarter. Therefore, variance in primary balance ratio progressively became substantially explained by the shock to public debt ratio in the long-run.

Results of variance decomposition of public debt-to-GDP ratio indicate that variation in debt-to-GDP ratio was progressively explained largely by shocks to debt-to-GDP ratio in the long run. In the first quarter, a shock to public debt-to-GDP accounted for about 57% variation in itself. The proportion of variance in public debt-to-GDP ratio emanating from a shock in the same variable consistently increased over time to about 88% in the last 70th quarter of the sample period. Conversely, the contribution of a shock to the primary balance ratio on variance of the debt ratio moderately diminished over time from about 43% in the first quarter to about 11% in the 70th quarter.

8.3. Policy Implications

The findings of this research study on sustainability of the country's fiscal policy have some considerable policy implications for both fiscal and monetary authorities. Based on the mainstream postulation on fiscal sustainability, the government is considered similarly as a household that faces budget constraints and maximise utility subject to budget constraint by smoothing spending throughout the lifecycle. The mainstream concept underscores that some adjustable optimum levels of savings are incessantly required to maximise utility of households. Linking the same concept to government fiscal behaviour faced with given investment and production functions, interest rates higher than the growth rates ($r > g$) imply low levels of savings while interest rates lower than growth rates ($r < g$) imply higher levels of savings required for investment.

The unceasingly widening differential between the interest rate and real GDP growth rate (Figure 1.2) since the fourth quarter of 2013 triggers serious concerns about sustainability of the country's fiscal policy in the long-run. Since an explosion in public debt commonly occurs when $r > g$, the consistent upsurge in public debt-to-GDP ratio from an all-time low of 22% in 2008 quarter 4 to 46% in 2013 quarter 3 coupled with primary deficits signifies a potential risk to sustainability of South Africa's fiscal policy. Unremittingly rising government debt levels have a substantial crowding-out effect on investment and production in the economy. In light of the backdrop of such economic developments of interest rates higher then growth rates ($r > g$) and incessantly rising

public debt levels, it is necessary for the fiscal authorities to closely monitor changes in interest rates and growth, and determine the need to run a primary surplus or deficit.

Though South Africa's fiscal supervision framework is anchored on sound institutional arrangements, the country's fiscus is faced with contingent and accrued liabilities risks attributed to government guarantees of funding to numerous State Owned Enterprises (SOEs) with weak financial positions. The presence of a significant number of public enterprises currently in need of financial bailouts to meet operating cost and debt obligations, and working capital requirements has heightened the country's fiscal risk of guarantee exposure. The weak financial positions of SOEs, coupled with sustained pressure on social spending programmes, require fiscal authorities to implement and consistently monitor fiscal austerity measures in order to maintain fiscal sustainability. Although the scope for government expenditure cuts remains much limited in respect of South Africa, the government need to consider public spending priorities carefully and avoid populist spending in order to ensure economic growth and development.

The finding that a tight monetary policy stance led to increases in primary balance-to-GDP ratio, and reduced public debt-to-GDP ratio suggest that government need to coordinate with the monetary authorities in managing sovereign debt to ensure fiscal sustainability. Since the broad macroeconomic objectives of monetary policy are to ensure price stability and promote growth, fiscal authorities should consistently give attention to changes in monetary policy stances when making fiscal adjustments. Monetary authorities should prudentially determine the growth of monetary base independently of financing needs of the fiscus through influencing financing conditions in domestic capital market where the bulk of government borrowing occurs. Therefore, such monetary policy measures can induce government to reduce its budget deficit in line with available financing and help to reduce the debt burden in the economy.

The statistically significant short-run exogenous effect monetary policy stance has on primary surplus and public debt further demonstrates that need for harmonisation of fiscal and monetary policies to contain pressure on inflation and interest rates. Lack of coordination between fiscal and monetary policies can cause the nation to experience slow output growth which can further lead to declining tax revenues and rising public debt, thereby undermining sustainability of fiscal policy. Hence, consistent policy mix

between monetary and fiscal policies remains vital in public debt management if both fiscal sustainability and price stability are to be consistently maintained.

8.4. Limitations of the Study

The major limitation encountered in this research study was unavailability of a longer period data for the primary balance-to-GDP ratio series. In addition, the relatively small sample period 1997q quarter 4 to 2016 quarter 4 covered in the study was restricted to the starting date from which data for primary balance ratio and public debt ratio was available from SARB and IMF historical time-series data sources. The South African government started publishing primary balance data in quarter 4 of 1997 in the Budget Review. However, for this study, the time series sample epoch was restricted to the period 1999 quarter 1 to 2016 quarter 2. In light of such background, the empirical validity of findings of this study are only restricted to the system-adjusted sample period 1999 quarter 1 to 2016 quarter 2. Therefore, results reported in this research study cannot be generalised in other time horizons outside the sample period covered in this research study.

8.5. Recommendations for Further Research

Consistent with numerous previous empirical studies conducted across countries in different continents and regions, further studies on fiscal sustainability in South Africa should estimate several models using different fiscal indicators. Specifically, the numerous fiscal indicators that can be computed and used include government revenue, expenditure, public debt, primary balance, net asset accumulation, overall balance, adjusted budget balance, structural balance, fiscal stance, and fiscal sustainability index. Since fiscal sustainability is not a fiscal issue purely exclusive from monetary policy, a number of monetary policy-related variables that influence the fiscal behaviour of government should be incorporated as exogenous variables in fiscal policy sustainability models. Such variables include inflation, real exchange rate, money growth rate, monetary policy interest rate, financing conditions (spreads and threshold balances) and dummy variables such as central bank independence and changes in political developments.

The studies should also apply different time-series estimation techniques in assessing historical sustainability of fiscal policy. Different linear and nonlinear techniques that can be applied include the following:

- Engle-Granger and Johansen cointegration tests.
- Ordinary Least Squares (OLS).
- Two-Stage Least Squares (2SLS).
- Regime-Switching Model Based Sustainability (RS-MBS).
- Smooth Transition Regression (STR).
- Maximum Likelihood Estimation (MLE).
- Auto-Regressive Distributed Lag (ARDL) model.
- Markov Switching Criterion (MSC).
- Vector Auto-Regression (VAR).
- Two-Step Engle-Granger Error Correction Model (ECM).
- Monte Carlo Simulations.
- Bounds Testing ARDL.
- Bayesian VAR.
- Structural VAR.
- Linear Smooth Transition Error Correction Model (LSTECM).
- Generalised Methods of Moments (GMM).

8.6. Conclusion

This research study estimated a fiscal reaction function using a Vector Error Correction (VEC) model approach to examine whether the South African government historically reacted to its public debt positions in a sustainable manner. The fiscal reaction function empirically explored the link between fiscal policy and monetary policy stance in ensuring fiscal policy sustainability in context of South Africa. In order to explore such link, which was overlooked by previous empirical studies on fiscal policy sustainability in South Africa, the “central bank policy rate” was incorporated as an exogenous variable in the fiscal reaction function to assess the exogenous impact of monetary policy stance on primary balance and public debt ratios positions during the sample period 1999q1-2016q2.

The overall findings indicate that fiscal policy in the country was sustainable while monetary policy stance had significant impacts on both primary balance-to-GDP ratio

and public debt-to-GDP ratio positions during the sample period under review. Thus, the discretionary fiscal policy demonstrated a tendency of countercyclicality and had an automatic stabilisation effect on public debt accumulation. Simulations of impulse response functions provide strong evidence that the economy can correct itself from temporary deviations in the short-run, and revert to the long-run equilibrium path after occurrence of a shock.

REFERENCES

Abdulla, H., Mustafa, M. M. and Dahalan, J. (2012). An Empirical Study on Fiscal Sustainability in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 2(1):72-90.

Adams, C., Ferrarini, B. and Park, D. (2010). Fiscal sustainability in developing Asia. No. 205, ADB Economics Working Paper Series. pp: 1-48.

Afflatet, N. (2016). Public Debt and Borrowing: Are Governments Disciplined by Financial Markets? *Cogent Economics & Finance*, 4:1-14.

Aldama, P. and Creel, J. (2016). Why Fiscal Regimes Matter for Fiscal Sustainability Analysis: An Application to France. Paris School of Economics, Université Paris 1 and OFCE-Sciences Po and ESCP-Europe.

Alberola, E., Katarynuk, I., Melguizo, A. and Orozco, R. (2016). Fiscal Policy and the Cycle in Latin America: The Role of Financing Conditions and Fiscal Rules. BIS Working Paper No. 543, Monetary and Economic Department, Bank for International Settlements.

Allard, J., Catenaro, M., Vidal, J-P., and Wloswijk, G. (2012). Central Bank Communication on Fiscal Policy. European Central Bank, Working Paper No. 1477/12.

Antonevich, K. (2010). Fiscal policy in Sweden: Analyzing the effectiveness of fiscal policy during the recent business cycle. Master's Thesis in Economics, Jönköping International Business School, Jönköping University.

Asiama, J., Akosah, N. and Owusu-Afriyie, E. (2014). An Assessment of Fiscal Sustainability in Ghana. Working Paper WP/BOG-2014/09, Bank of Ghana.

Belinga, V., Benedek, D., de Mooij, R. A. and Norregaard, J. (2014). Tax Buoyancy in OECD Countries. IMF Working Paper, WP/14/110. International Monetary Fund.

Frankel, J. A. (2011a). A solution to overoptimistic forecasts and fiscal procyclicality: The structural budget institutions pioneered by Chile. *HKS Faculty Research Working Paper Series RWP11-012*, Cambridge, MA: Harvard University, John F. Kennedy School of Government.

Bi, H. and Leeper, E. M. (2013). Analyzing Fiscal Sustainability. Working Paper 2013-27. Bank of Canada.

Bodea, C. and Higashijima, M. (2015). Central Bank Independence and Fiscal Policy: Can the Central Bank Restrain Deficit Spending? *B.J.Pol.S*. 47: 47-70. Cambridge University Press.

Bohn, H. (1998). The Behaviour of U.S. Public Debt and Deficits. *The Quarterly Journal of Economics*, 113(3): 949-963.

Bohn, H. (2005). The Sustainability of Fiscal Policy in the United States. CESifo *Working Paper*, No. 1446.

Broda, C. and Weinstein, D. E. (2005). Happy News from the Dismal Science: Reassessing the Japanese Fiscal Policy and Sustainability", in Takatoshi Ito, Hugh, Patrick, and David E. Weinstein, ed., *Reviving Japanese Economy*, 39-78, MIT Press.

Bureau of Economic Analysis (2016). US Department of Commerce. [Online] Available at: https://www.bea.gov/faq/index.cfm?faq id=1069.

Burger, P. and Marinkov, M. (2012). Fiscal rules and regime-dependent fiscal reaction functions: The South African case. *OECD Journal on Budgeting*, 12(1):19-37.

Caceres, C., Cevik, S. Fenochietto, R. and Gracia, B. (2015). The Day After Tomorrow: Designing an Optimal Fiscal Strategy for Lybia. *Journal of Banking and Financial Economics*, 2(4):19-37.

Burger, P., Stuart, I., Jooste, C. and Cuevas, A. (2011). Fiscal sustainability and the fiscal reaction function for South Africa. IMF Working Paper WP/11/69, IMF.

Burnside, C. (2004). *Assessing New Approaches to Fiscal Sustainability Analysis*. Duke University and NBER.

Burnside, C. (2005). Fiscal Sustainability in Theory and Practice: A Handbook. The World Bank, Washington D.C.

Burret, H. T., Feld, L. P. and Kohler, E. A. (2014). Panel Cointegration Tests on the Fiscal Sustainability of German Laender. CESifo Working Paper No. 4929.

Calitz, E., Du Plessis, S. and Siebrits, K. (2013). Fiscal sustainability in South Africa: Will history repeat itself? Stellenbosch Economic Working Papers: 07/13, Stellenbosch University and Bureau of Economic Research.

Calitz, E., Siebrits, K. and Stuart, I. (2013). Enhancing the Credibility of Fiscal Forecasts in South Africa: Is a Fiscal Council the Only Way? Stellenbosch Economic Working Papers: 25/13. University of Stellenbosch and Bureau for Economic Research.

Calitz, E., Siebrits, K. and Stuart, I. (2016). Enhancing the accuracy of fiscal projections in South Africa. *South African Journal of Economic and Management Sciences*, 19(3): 330-343.

Carvalho, L., Diniz, A., Pedrosa, I. and Rossi, P. (2016). Fiscal Costs of Monetary Policy: Indirect Effects of an Interest Rate Shock on Brazilian Public Net Debt. *Brazilian Journal of Political Economy*, 36(144):557-579.

Camarero, M., Carrion-i-Silvestre, J. and Tamarit, C. (2013). Global imbalances and the Intertemporal External Budget Constraint: A multicointegration approach. *Journal of Banking and Finance*, 37:5357-5372.

Cebotari, A., Davis, J., Lusinyan, L., Mati, A., Mauro, P., Petrie, M. and Velloso, R. (2009). Fiscal Risks: Sources, Disclosure and Management. Fiscal Affairs Department, International Monetary Fund, Washington, D.C.

Chalk, N. and Hemming, R. (2000). Assessing Fiscal Sustainability in Theory and Practice. IMF Working Paper No. 00/81, International Monetary Fund, Washington, DC.

Cuddington, J. (1996). Analyzing the Sustainability of Fiscal Deficits in Developing Countries. Washington, DC, United States: Georgetown University and World Bank. Mimeographed document.

Dahan, M. (1998). The Fiscal Effects of Monetary Policy. Monetary and Exchange Affairs Department, IMF Working Paper. IMF, Washington, D. C.

Dalgıç, B., İyidoğan, P.V. and Balıkçıoğlu, E. (2014). Sustainability of fiscal policy: an empirical examination for Turkish economy. *Journal of Business Economics and Finance*, 3:13-137.

Daude, C., Melguizo, A. and Neut, A. (2011). Fiscal Policy in Latin America: Countercyclical and Sustainable? *Economics: The Open-Access, Open-Assessment E-Journal*, 5: 1-29.

Davis Tax Committee (2016). Macro Analysis of the Tax System and Inclusive Growth in South Africa. Macro Analysis Final Report, Davis Tax Committee.

De Mello, L. (2005). Estimating a fiscal reaction function: The case of debt sustainability in Brazil. OECD Economics Department, Working Paper No. 423. OECD, Paris.

Deyshappriya, N. P. R. (2012). Debt and Fiscal Sustainability in Sri Lanka. *International Journal of Scientific and Research Publications*, 2(3):1-8.

Doi, T. (2009). *The Public Sector in Japan: Past Developments and Future Prospects.* Cheltenham, UK: Edward Elgar.

Doi, Hoshi and Okimoto (2011). Japanese Government Debt and Sustainability of Fiscal Policy. National Buareu of Economic Research, NBER Working Paper No. 17305.

Escolano, J. (2010). A Practical Guide to Public Debt Dynamics, Fiscal Sustainability, and Cyclical Adjustment of Budgetary Aggregates. Technical Notes and Manuals. Fiscal Affairs Department, International Monetary Fund, Washington, D.C.

Frankel, J. A. (2011b). Over-optimism in forecasts by official budget agencies and its implications. *Oxford Review of Economic Policy*, 27(4): 536-562.

Frankel, J. A. and Schreger, J. (2013). Over-optimistic official forecasts in the Eurozone and fiscal rules. *Review of World Economics*, 149(2): 247-272.

Financial and Fiscal Commission (2009). Annual Report 2008-2009, Pretoria.

Financial and Fiscal Commission (2016). Briefing on the 2016 Appropriation Bill. For an Equitable Sharing of National Revenue. South Africa.

Financial and Fiscal Commission (2014). Budget Consolidation in South Africa: Balancing Growth and Socioeconomic Rights. Submission for the 2014/15 Division of Revenue.

Ganyaupfu, E. M. (2014). Fiscal Sustainability in South Africa: Recent Evidence. *Journal of Social Economics*, 1(4):159-167.

Greenlaw, D., Hamilton, J. D., Hooper, P. and Mishkin, F. S. (2013). Crunch Time: Fiscal Crisis and the Role of Monetary Policy. Working Paper, National Bureau of Economic Research.

Greenlaw, D., Hamilton, J. D., Hooper, P. and Mishkin, F. (2013). Crunch Time: Fiscal Crises and the Role of Monetary Policy. U.S. Monetary Forum, New York City.

Goodhart, C. (2012). Monetary Policy and Public Debt. Financial Stability Review No. 16, Banque de France, London School of Economics, Financial Markets Group.

Goyal, R., Khundrakpam, J. K. and Ray, P. (2004). Is India's public finance unsustainable? Or, Are the Claims Exaggerated? *Journal of Policy Modeling*, 26(3):401-420.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3):424-438.

Gurkaynak, R. S. (2015). Monetary Policy Responsibility for Fiscal Sustainability. Bilkent University/CEPR/CFS/CESIfo, Research Institute of Economy, Trade and Industry (RIETI).

Hakkio, C. S. and Rush, M. (1991). Is the Budget Deficit Too Large? *Economic Inquiry*, 29(3)429-445.

Hamilton, J. D. and Flavin, M. (1986). On the limitations of government borrowing: a framework for empirical testing. *American Economic Review*. 76(4):809-19.

Heever, J. and Meyer, D. (2016). Quantifying the tightness or looseness of monetary policy in South Africa. Pretoria: South African Reserve Bank.

Inter-Governmental Fiscal Relations Act, No. 97 (1997). Republic of South Africa.

International Monetary Fund (2009). Fiscal rules – Anchoring expectations for sustainable public finances. Fiscal Affairs Department. Washington D. C. Accessed online from: www.imf.org.

International Monetary Fund (2015). From Banking to Sovereign Stress: Implications for Public Debt. IMF Working Paper. IMF, Washington D. C.

International Monetary Fund (2017). Prices, Production, Labour & Population. International Financial Statistics (IFS). [Online] Available at: http://data.imf.org/?sk=6AC22EA7-E792-4687-B7F8-C2DF114D9FDC&ss=1390030341854

International Monetary Fund (2017). What is Central Bank policy rate? Concepts and Definitions. Washington D. C. [Online] Available at:: http://datahelp.imf.org/knowledgebase/articles/484375-what-is-the-central-bank-policy-rate

Jibao, S. S., Schoeman, N. J. and Naidoo, R. (2011). Fiscal Regime Changes and the Sustainability of Fiscal Imbalance in South Africa: A Smooth Transition Error-Correction Approach. *South African Journal of Economic and Management Science*, 15(2): 112-127.

Jibrilla, A. A. (2016). Fiscal Sustainability in the presence of structural breaks: Does overconfidence on resource exports hurt government's ability to finance debt? Evidence from Nigeria. *Cogent Economics & Finance*, 4: 21-27.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control*, 12(2-3): 231-254.

Keen, M. (2013). The Anatomy of the VAT. IMF Working Paper, Fiscal Affairs Department, International Monetary Fund.

Keen, M. (2013). The Anatomy of the VAT. *National Tax Journal*, 66(2): 423-446.

Kennedy, S. and Robbins, J. (2001). The Role of Fiscal Rules in Determining Fiscal Performance. Working Paper. Department of Finance, Canada.

Khumalo, B. (2016). Fiscal Oversight by Legislatures and the Role of Parliamentary Budget Offices. African Parliamentary Budget Office Conference, Fiscal and Fiscal Commission.

Kirchgaessner, G. and Prohl, S. (2006) Sustainability of Swiss Fiscal Policy. CESifo Working Paper Series No. 1689. Social Science Research Network (SSRN). Available at: https://ssrn.com/abstract=894212

Kumo, W. L., Rielander, J., and Omilola, B. (2014). South Africa 2014, African Economic Outlook. AfDB, OECD and UNDP.

Kuncoro, H. and Sebayang, K. D. A. (2013). The Dynamic Interaction between Monetary and Fiscal Policies in Indonesia. *Romanian Journal of Fiscal Policy*, 4(6):47-66.

Laurens, B. and de la Piedra, E. G. (1998). Coordination of Monetary and Fiscal Policies. Monetary and Exchange Affairs Department, IMF Working Paper. IMF, Washington D. C.

Lings, K. (2016). South Africa's National Budget 2016/2017, STANLIB, South Africa.

Luporini, V. (2015). Sustainability of Brazilian Fiscal Policy, Once Again: Corrective Policy Response over Time. *Estud. Econ., Sao Paulo*, 45(2):437-458.

Magubu, R. and Marinkov, M. (2011). Submission for the 2012/13 Division of Revenue Technical Report. Financial and Fiscal Commission.

Mabugu, R., Maisonnave, H., Chitiga, M. and Decaluwé, B. (2015). Real Effects of Public Debt on National Development. Financial and Fiscal Commission. Submission for the 2015/16 Division of Revenue.

Mafusire, A. (2015). Assessing Swaziland's Fiscal Sustainability and Policy Options. Hindawi Publishing Corporation, *Economics Research International*, 2015:1-10.

Mohamed, A. H. (2014). Fiscal Policy Framework in West African Monetary Zone (WAMZ): The Matter of Debt Sustainability. *International Journal of Economics and Finance*, 6(11):60-71.

Musgrave, R. (1966). Principles of Budget Determination in Public Finance: Selected Reading, eds Cameron, H. and Henderson, W., Random House, NY, pp.15-27.

Munawar-Shah, S., Abdul-Majid, M. and Hussain-Shah, S. (2014). Assessing fiscal sustainability for SAARC and IMT-GT countries. *Romanian Journal of Fiscal Policy*, 5: 26-40.

Mutuku, C. (2015). Assessing Fiscal Policy Cyclicality and Sustainability: A Fiscal Reaction Function for Kenya. *Journal of Economics Library*, 2(3):173-191.

Nzaramba, L. (2015). Measuring Fiscal Sustainability of African Economies. Master's Dissertation, School of Economic and Business Sciences at the University of the Witwatersrand, South Africa.

Oyeleke, O. J. and Adebisi, D. G. (2014). Econometric Analysis of Fiscal Deficit Sustainability of Ghana. *Journal of Economics and Sustainable Development*, 5(28): 34-40.

Papadamou, S., Sidiropoulos, M. and Spyromitros, E. (2017). Is There a Role for Central Bank Independence on Public Debt Dynamics? *Journal of Applied Finance & Banking*, 7(1):103-117.

Parliament of the Republic of South Africa (2011). Budget Analysis Manual. Research Unit, Finance and Public Accounts Cluster, Republic of South Africa.

Piergallini, A. and Postigliola, M. (2016). The Sustainability of Fiscal Policy in Italy: A Nonlinear Perspective. University of Rome Tor Vergata and Sapienza University of Rome.

Polito, V. and Wickens, M. R. (2005). Measuring Fiscal Sustainability. CEPR Discussion Paper No. 5312. Available at SSRN: https://ssrn.com/abstract=872867

Potrafke, N. and Reischmann, M. (2012). Fiscal Equalization Schemes and Fiscal Sustainability. Ifo Working Paper, No. 141.

Quintos, C. E. (1995). Sustainability of the Deficit Process with Structural Shift. *Journal of Business and Economic Statistics*, 13(4):409-417.

Rajlakshmi, D. (2013). Fiscal Multicointegration and Sustainability in OECD Economies. Duke University Durham, North Carolina.

Republic of South Africa. 2017. *Budget Review 2017*. Pretorai: National Treasury.

Republic of South Africa. (2009). *Money Bills Amendment Procedure and Related Matters (MBAPRM) Act*. Pretoria: Government Printer.

National Treasury (2011). South African Budget Process. Republic of South Africa.

National Treasury (2016). Fiscal Risk Statement. Medium Term Budget Policy Statement. Republic of South Africa.

National Treasury (2016). Process and Structures for the 2016 Budget. Republic of South Africa.

Robinson, Z. (2015). An Analysis of Sovereign Risk in South Africa with the Focus of Fiscal Determinants. *Southern African Business Review*, 19(3):154-173.

Sachs, M. (2015). The new fiscal guidelines and a “rule-of-thumb”. National Treasury proposals in the 2015 MTBPS. National Treasury, Republic of South Africa.

South African Reserve Bank (2017). Historic Macroeconomic Timeseries Information. [Online] Available at: https://www.resbank.co.za/Research/Statistics/Pages/OnlineDownloadFacility.aspx

South African Revenue Service (2015). 2015 Tax Statistics. [Online] Available at: http://www.sars.gov.za/About/SATaxSystem/Pages/Tax-Statistics.aspx

Stoina, A. M. (2016). The Study of Fiscal Sustainability for the Case of Overindebted European Countries, *Financial Studies*, 4(58):43-62.

Stuart, I. and Dhlamini, K. (2015). A fiscal risk framework for South Africa. National treasury, Paper presented at the Bi-Annual Conference of the Economic Society of South Africa.

Tantos, S. (2012). Public Debt Sustainability: The Case of Greece. *Journal of Reviews on Global Economics*, 1:27-40.

Togo, E. (2007). Coordinating Public Debt Management with Fiscal and Monetary Policies: An Analytical Framework. World Bank. Policy Research Working Paper 4369.

Twerefou, D. K., Fumey, A., Osei-Assibey, E. O. and Asmah, E. E. (2010). Buoyancy and Elasticity of Tax: Evidence from Ghana. *Journal of Monetary and Economic Integration*, 10(2):36-60.

Uctum, M. and Wickens, M. R. (2000). Debt and deficit ceilings, and sustainability of fiscal policies: an intertemporal analysis. *Oxford Bulletin of Economics and Statistics*, 62(2): 197-222.

Verwey, L. (2015). Budget Guide for Members of Parliament, ISS Guide. Institute for Security Studies, South Africa.

Visser, J. and Ayele, Z. (2014). Intergovernmental Fiscal Relations in South Africa and the Role of the Financial and Fiscal Commission: A 20 Year Review. Community Law Centre.

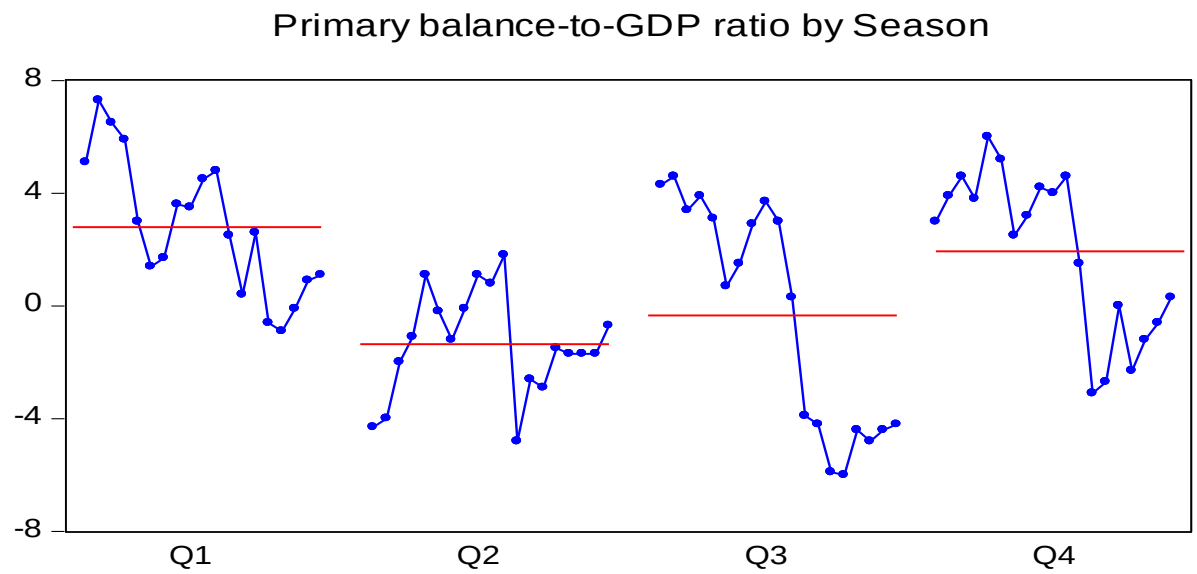
Wehner, J. (2003). The institutional sharing of revenue sharing in South Africa. *Regional and Federal Studies*, 13(1): 1-30.

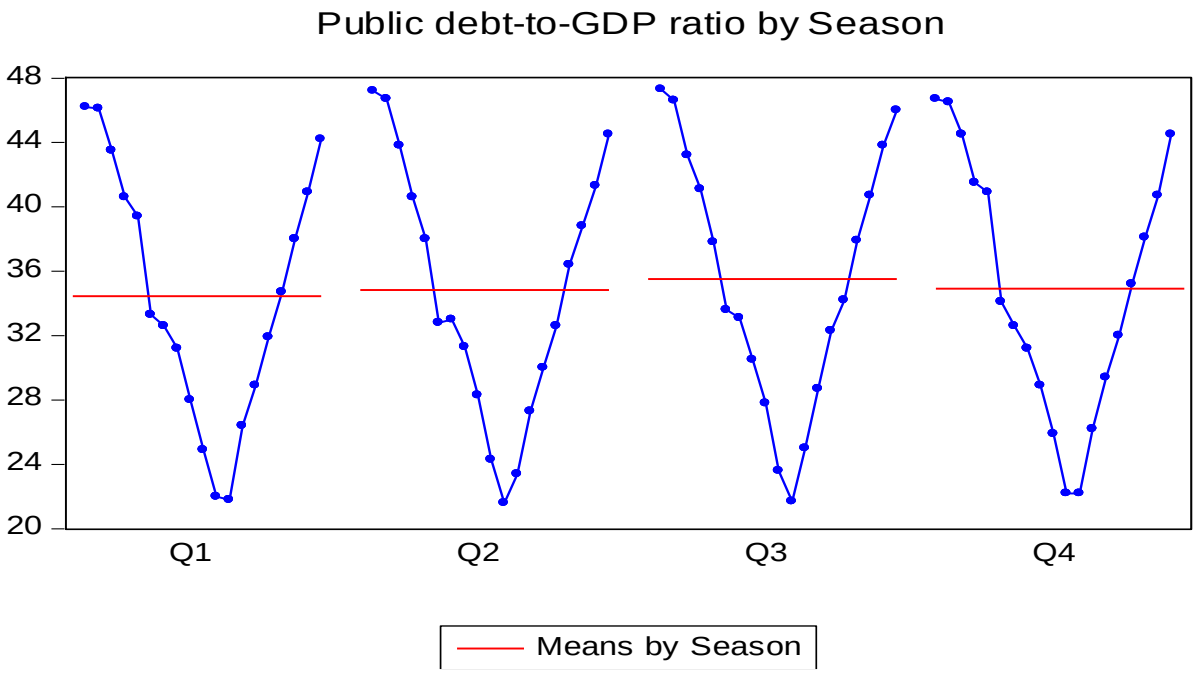
Wilcox, D. (1989). The Sustainability of Government Deficits: Implications of the Present-Value Borrowing Constraint. *Journal of Money, Credit and Banking*, 21(3):291-306.

Yamauchi, A. (2004). Fiscal Sustainability – The Case of Eritrea. International Monetary Fund. IMF Working Paper WP/04/7. African Department, IMF, Washington D.C.

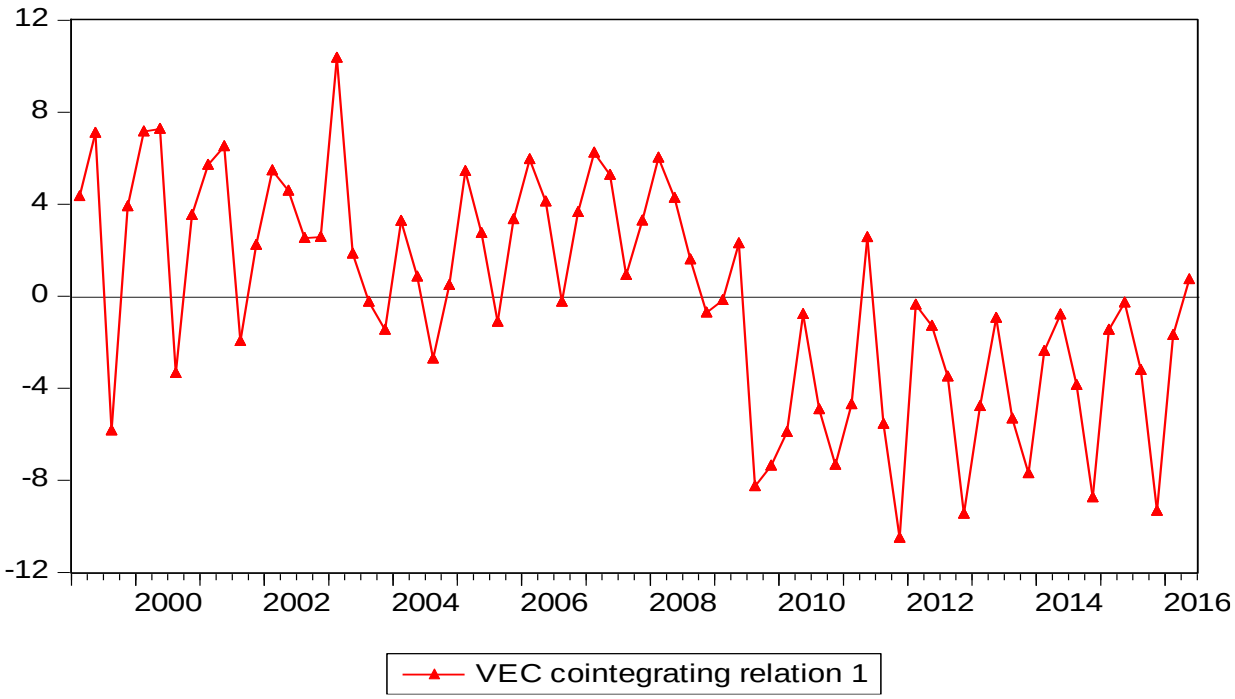
APPENDICES

Appendix 1: Seasonal Graphs - Primary balance and Public debt (as % of GDP)

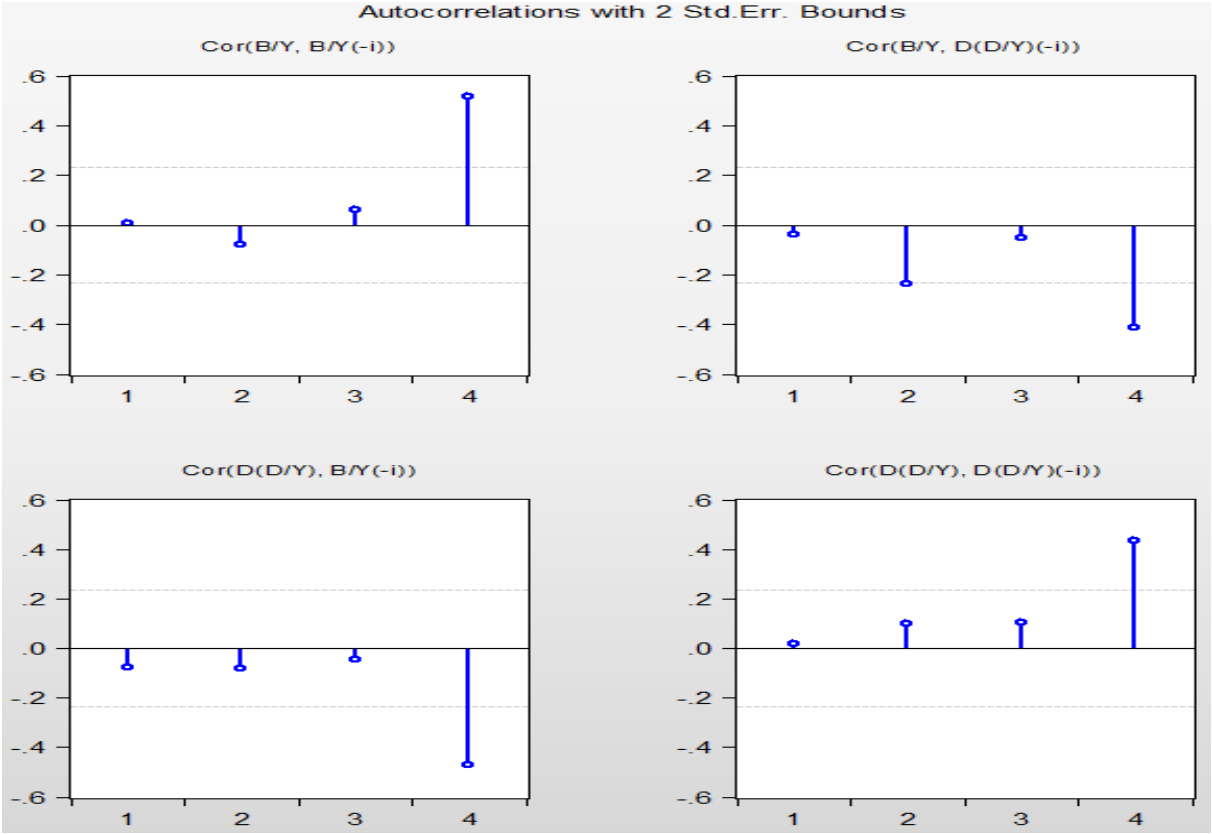




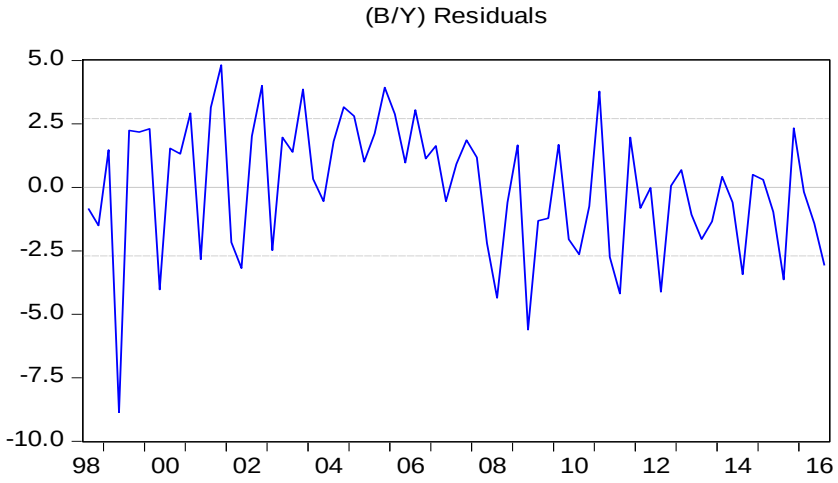
Appendix 2: VEC Cointegrating Graph

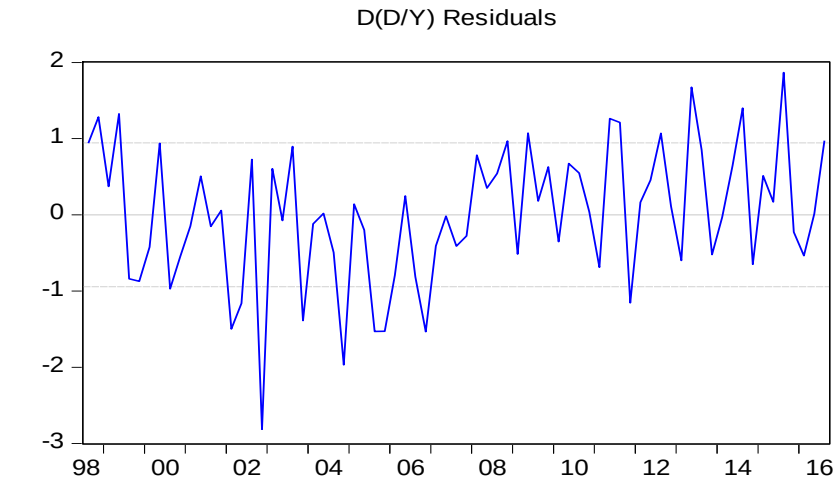


Appendix 3: Correlograms

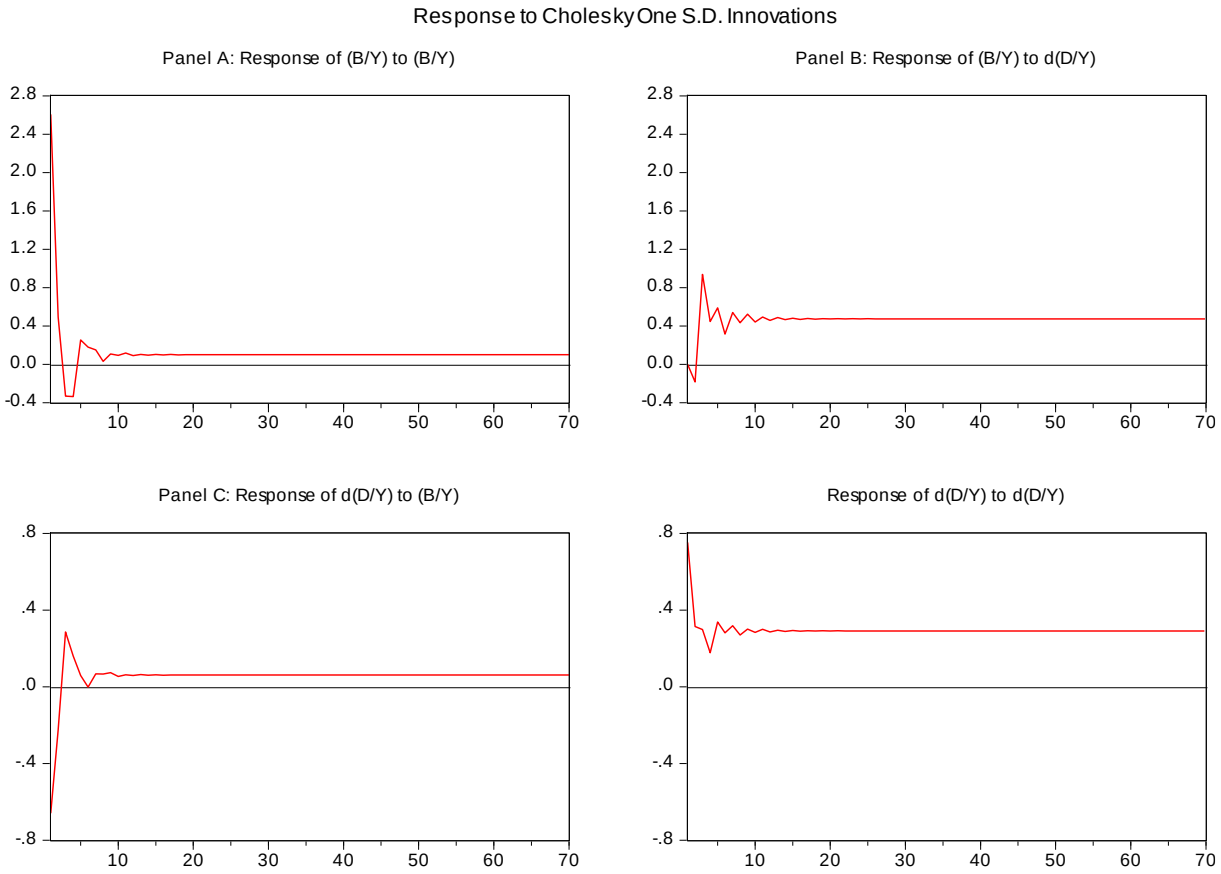


Appendix 4: Residual Graphs – Primary balance and Public Debt (as % of GDP)





Appendix 5: Cholesky Impulses Response Function (Cholesky – dof adjusted)



Appendix 6: Cholesky Variance Decomposition