An Estimation of the Effect of Tax Revenue Collection on Public Debt in South Africa

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ABSTRACT

Public debt is one of the most important economic indicators in such a way that if it is unsustainable, higher interest costs would be realized which could negatively affect significant public investments that ensure economic growth. Developing economies including South Africa, are known to be having unsustainable public debt levels coupled with poor economic growth. Irrespective of governments' measures to service the public debt, like selling enough treasury bonds, the taxpayers end up carrying the burden of the debt.

The South African government has not been able to generate enough revenue to finance its financial obligations (capital and current expenditures and public debt). National Treasury (2019) indicates that South African public debt averaged around 62.2 percent of the Gross Domestic Product (GDP), while tax revenue collection averaged around 26.4 percent of the GDP. This implies that the South African public debt is unsustainable as 62.2 percent is greater than the World Bank benchmark of 60 percent of the GDP. Furthermore, 26.4 percent of tax revenue collection to GDP is less than half of level public debt; which infers that the generated tax revenue collection is insufficient to service at least half of the level of public debt. This is because of the fact that the South African economy has barely grown in the past decade due to fiscal missteps and corruption. Hence, the main objective of this study is to estimate the empirical effect of tax revenue collection on public debt in South Africa.

To fulfil the proposed objectives of this study, econometric techniques such as Auto Regressive Distributed Lags (ARDL) and Nonlinear Auto Regressive Distributed Lags (NARDL) are used in this study. Furthermore, to suit the objectives of this study, variables such as tax revenue collection, political instability and corruption are selected as independent variables when public debt is selected as the dependent variable. Yearly time series data of the aforementioned variables for the period 1985 to 2019, is used in this study.

This study is unique in the sense that it is the first to explore the empirical relationship between tax revenue collection, political instability, corruption and public debt in South Africa. Furthermore, this study is the first to test for possible asymmetric (nonlinear) relationship between tax revenue collection, political instability, corruption and public debt in South Africa, using the NARDL technique.

This study finds long and short run negative relationship between the South African tax revenue collection (symmetric relationships). Furthermore, long run positive and negative shocks of political instability and corruption affect the South African public debt positively and negatively (asymmetric) respectively, and these shocks are statistically significant. In the short run, a positive relationship between political instability, corruption and public debt is established in this study (symmetric relationships). Only the short run relationship between corruption and public debt is statistically significant. This study also finds that changes in public debt are affected by changes in tax revenue collection and an increase as well as a decrease in political instability and corruption respectively. Moreover, changes in tax revenue collection are affected by an increase in corruption, and an increase and the decrease in political instability.

The noteworthy implication raised by the results of this study is that if South Africa desires to reduce its public debt, then it must improve its tax revenue collection in both the long and short run. Hence, this study recommends that government ought to re-channel its expenditure programmes by identifying sectors that are more productive (productive expenditures), and invest in them as government would be able to recoup the resources, and consequently generate more income which would possibly be in taxes and/or net received receipts; hence discouraging inclination to borrow. This study further recommends an elimination of political patronage, coupled with the re-adoption of clear and strict ethical standards that show clear and harsh consequences for the perpetrators found to be involved in corruption. Hence, increasing accountability within the public governance.

Keywords: Public Debt, South Africa, Tax Revenue Collection, ARDL/NARDL

DECLARATION

I, Monamodi Nkosinathi Emanuel, student number 23755644, honestly declare that "An estimation of the effect of tax revenue collection on the public debt in South Africa" is my original study, and all the sources that have been referenced in this study are properly identified. This study has never been submitted to any university for an award

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DEDICATION

This thesis is dedicated to my family, and every black young person within and outside the boarders of South Africa.

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LIST OF ABBREVIATIONS

AGSA	Auditor General South Africa
AIC	Akaike Information Criterion
ANC	African National Congress
ARDL	Auto Regressive Distributed Lags
ASGISA	Accelerated and Shared Growth Initiative of South Africa
BB	Budget Balance
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMSQ	Cumulative Sum of Recursive Residuals of Squares
DF-GLS	Dicky Fuller Generalized Least Squares
DGP	Data Generating Process
DoME	Department of Monitoring and Evaluation
DTI	Department of Trade and Industry
ECM	Error Correction Model
ENE	Estimates of the National Expenditure
EU	European Union
FFC	Fiscal and Financial Commission
GDP	Gross Domestic Product
GEAR	Growth, Employment and Redistribution
GEXP	Government Expenditure
GRAP	General Recognized Accounting Practices
HQIC	Hannah Quinn Information Criterion
IMF	International Monetary Fund

JSE	Johannesburg Stock Exchange
MFMA	Municipal Finance Management Act
MO	Measurable Objectives
MTEF	Medium Term Expenditure Framework
NARDL	Nonlinear Auto Regressive Distributed Lags
NGP	New Growth Path
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PDM	Public Debt Management
PDT	Public Debt
PFMA	Public Finance Management Act
POI	Political Instability
POLS	Panel Ordinary Least Squares
QE	Quantitative Easing
RDP	Reconstruction and Development Programme
RSA	Republic of South Africa
SAA	South African Airways
SARB	South African Reserve Bank
SARS	South African Revenue Services
SBIC	Schwarz Bayesian Information Criterion
SENS	Stock Exchange News Service
SOE’s	State Owned Enterprises
TRV	Tax Revenue

US	United States
VAR	Vector Auto Regression
VECM	Vector Error Correction Model
WTO	World Trade Organization

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The three gap model states that fiscal limitations are viewed as major setback to growth prospects in developing economies, because of fiscal deficits which consequently lead to government borrowing (Bacha, 1990). Hence, in a situation where the fiscal gap is realized from the government budget limitations where taxes and other financing resources are not enough to finance government current and capital expenditures, borrowing domestically or abroad plays a significant role.

Existing literature has highlighted a few factors that can either increase or decrease the presence of revenue gaps and poor tax revenue collection. For example, Rimmer (2010) contends that factors like high tax rates, corruption and the complicated nature of tax policy are related to the missing revenue and poor revenue collection since they advance tax avoidance. Again, measures that reduce tax avoidance, which incorporate public trust, a regulation framework and compulsory administration, are considered to prompt a decrease in tax gap and poor tax revenue collection. Palil and Mustapha (2011) as well as Chaudhry and Munir (2010), confirmed the effect of the aforementioned measures on improving the collection of tax revenue, in the case studies of Asian and European countries, and Pakistan, respectively.

Pyle (1989) further suggests that the revenue gap can be affected by the shadow or underground economy, and economic activities that end up being immune to official insights and consequently end up not being taxed by the government. Apart from the shadow economy, there are other economic factors; for example, the degree of economic growth, imports and public debt, inflation and unemployment rates that can have a positive or negative effect on tax revenue collection (Salar et al., 2013).

In principle, revenue gap affects economic growth negatively. This is on the grounds that economic growth prompts economic development, which results not just in more capacity for the consumers and firms to pay taxes, but additionally for the government to impose and collect taxes. Additionally, the relationship between imports and the tax gap is sure to be negative since certain

features of international trade, for example, explicit entry and exit points will in general make tax avoidance troublesome and subsequently, imports are exposed to more taxation than domestic activities. Alternatively, a positive relationship is accepted between revenue gap and public debt because of the way that missing revenue can build the economy's reliance on public debt so as to fund both government current and capital expenditure.

Generally, developing economies collect tax revenue that is lower than what is expected; and such distinction is ascribed to the missing tax revenues and poor tax revenue collection. Consequently, this leads to government having to borrow the difference; at the later stage (Siddiqi and Ilyas, 2011). From the South African perspective, government tax policy after the dawn of democracy in 1994 has focused on controlling tax avoidance, advancing more prominent consistency and guaranteeing an equitable tax system (African Development Bank, 2010). This is on the grounds that the South African government mostly depends on tax revenue collection to run its spending and fund its expenditures, as indicated by National Treasury (2019).

Furthermore, Kantor (2019) emphasizes that the economy has not been doing well for more than ten years. Over the said period, slow economic growth has forced the government to cut expenditure by reducing public servants' salaries. Among other things, in the 2018/19 financial year; the South African government has been borrowing money at the rate of more than R250 billion a year, due to low government revenue because of slow economic growth (National Treasury, 2019). This has consequently led South Africa to incur more than R3 trillion net debt, as of August 2019 (Bernstein, 2019).

One of the main reasons for this debt is the effect of the global financial crisis from 2007 to 2010, since the South African growth rate generally decreased more than it increased. This is supported by the National Treasury (2019) report which shows that the growth rate from 2007 to 2010 was 5.4, 3.2, -1.5 and 3 percent respectively. Furthermore, the redemption of public enterprises is now classified as the nation's greatest liability, as National Treasury (2020) report states that R60 billion is budgeted to bail out these enterprises; which accounts for 15 percent of the South African sovereign debt, for the 2020/21 financial year. This is clear revelation that these enterprises can no longer sustain themselves, and as such; funds that could have been used to enable the government to have resources for other important activities, are used to bail them out. The South African government responded by expanding and increasing expenditure to support the economy. Kantor

(2019) points out that this strategy only contributed significantly in the short term, but due to lack of application of a temporary stimulus, growth in public spending was determined by an increasingly better-paid public service. This approach was implemented on the basis that it was hoped that it would be affordable if growth had returned to pre-crisis levels, which never happened. Furthermore, the government did not respond in time to declining economic growth which led to large and persistent gap between expenditure and revenue. That is, the gap was/is filled by extensive borrowing, which still continues.

As per the secondary objective of this study (to be fully stated in section 1.4), this study intends to explore the effect of political instability and corruption on public debt. The aforementioned factors are currently of great interest in South Africa, yet there is limited literature on how they affect public debt, or rather public finances in general. To add to this, the former Minister of Finance Mr Malusi Gigaba proposed an increment to the rate of Value Added Tax (VAT) from 14 to 15 percent with effect from 1st April 2018 (National Treasury, 2018). This increment of VAT (indirect tax) from the perspective of public economic theory, enables the government to collect more tax revenue (Erero, 2015).

In light of the aforementioned facts regarding South African public finances, this study aims to estimate the empirical effect of tax revenue collection (since it is the main source of government revenue) on public debt, since borrowing comes as the consequence of not having enough government revenue to finance public expenditure and infrastructural investments. Lastly, this study aims to add new information on literature in terms of testing for the empirical effect of tax revenue collection on public debt, and the possibility of asymmetry (nonlinearity) around the empirical effect to be estimated.

1.2 STATEMENT OF THE PROBLEM

South African government relies on foreign direct investments (FDIs) and taxation to boost revenue just like other developing economies (Ugwu, 2018). South Africa has barely grown in the past decade due to fiscal missteps and corruption. This resulted in South Africa not being able to generate enough revenue to finance its financial obligations (capital and current expenditures and public debt). Furthermore, National Treasury (2020) report indicates that South African public debt averaged around 62.2 percent of the Gross Domestic Product (GDP), while tax revenue collection averaged around 26.4 percent of the GDP; which is R135.9 billion from the targeted tax

revenue of R1422.2 billion (R69.3 billion shortfall) for the 2019/20 financial year. This implies that the South African public debt is unsustainable as 62.2 percent is greater than the World Bank benchmark of 60 percent of the GDP. Furthermore, 26.4 percent of tax revenue collection to GDP is less than half of level public debt; which infers that the generated tax revenue collection is insufficient to service at least half of the level of public debt.

Although tax-to-GDP ratio has been increasing marginally between 2015/16 and 2019/20 from 25.9 to 26.3 percent of the GDP due to increased contributions from personal income tax (PIT) and vat added tax (VAT), public debt still increased from 51.5 to 62.2 percent of the GDP during the same period (National Treasury, 2020). This means that as much as government improved its tax revenue, it is still not enough to cover both capital and current expenditure; hence government resorted further to borrowing. South Africa's inability to generate enough tax revenue given the economic activity could not have happened at the worse time, as the other part of government revenue source (profit from the state owned enterprises) is currently less active. Notably, less activity of state owned enterprises' profit does not affect government ability to generate tax revenue but rather forces the government to rely more on tax revenue (principal government revenue source), thus putting pressure on tax revenue (Kantor, 2019). Less activity of state owned enterprises' profits is believed to be attributed to mismanagement and corruption in public owned enterprises such as Eskom, South African Airways and Transnet.

In the midst of generating insufficient tax revenue to service the public debt and under-profitable state owned enterprises, mismanagement and corruption in the South African government departments and municipalities add more strain on the South African public finances (Tshishonga, 2014). This is due to the fact that most of the South African government departments and municipalities are no longer efficient on sustaining themselves as funds go missing or get accounted for different functions that cater for the certain individuals who are closely related to the government officials and/or politicians (Tebele, 2016). This obviously leads to the inefficiency and instability in the public finances since the government will have to fill the budget gap (deficit) by borrowing since the tax revenue and other revenue sources have already reached their full capacity.

As part of cleaning the public sector and reviving the economy, Congressional Research Service (2020) states that President Ramaphosa pledged to end corruption within the government

administration; and also to attract FDIs to help revive the struggling South African economy (investment-led growth). However, the President's initiative has not yet yielded satisfactory progress, as the National Treasury (2019) report further reports that there has been a significant shortfall in government revenue of R42.8 billion in the 2018/19 financial year. This is believed to be due to the fact that government revenue from these FDIs comes later when foreign businesses start paying taxes and other contributions to the government. Hence, the economic rewards of President Ramaphosa's initiative could only be expected later.

1.3 RESEARCH QUESTIONS OF THE STUDY

In order to explore the depth of the problem statement, the following research questions will be used as guideline;

- What is the effect of tax revenue collection, corruption and political instability on public debt in South Africa?
- Is there any possible asymmetric (nonlinear) effect of tax revenue collection, political instability and corruption on the South African public debt?

1.4 OBJECTIVES OF THE STUDY

The main objective of this study is to estimate the empirical effect of tax revenue collection on the public debt.

The following are the specific objectives of this study;

- To investigate the effect of corruption and political instability on public debt in South Africa.
- To test for the possible asymmetric effect of tax revenue collection, political instability and corruption on the South African public debt.
- To articulate cognitive policy recommendations, based on the policy implications emanating from the findings of the study.

1.5 HYPOTHESES OF THE STUDY

The following are the null hypotheses to be tested;

H_0: There is no significant relationship between tax revenue collection and the public debt in South Africa.

H_0: There is no significant relationship between corruption and public debt in South Africa.

H_0: There is no asymmetric relationship between tax revenue collection, political instability, corruption and public debt in South Africa.

1.6 SIGNIFICANCE OF THE STUDY

The current devastating status quo on the public finances of South Africa is really a major concern. As it stands, the level South African public debt is above the World Bank benchmark of 60 percent of the GDP. This means that the current level of the South African public debt poses a dangerous risk to its economic growth prospects and objectives. Furthermore, South Africa's inability to generate enough tax revenue to service the debt is also of great concern, though South African government has been improving its tax revenue for the past five years.

Hence, this study is beneficial to the general population of South Africa in a sense that it provides the extensive knowledge on the South African public debt and tax revenue collection. This study is also beneficial to the government policy makers in a sense that its recommendations can be used to improve tax revenue collection, and possibly decrease the level of public debt without compromising the South African principal macroeconomic prospects and/or objectives.

Lastly, since the level of domestic public debt affect both domestic and foreign investors' confidence remotely, this study is also beneficial to both domestic and foreign investors as this study provide an extensive analysis on the South African public debt. This will help investors to make sound decisions as far as their investments are concerned.

1.7 CONTRIBUTION OF THE STUDY

The studies of De Wet *et al*. (2005), Oche *et al*. (2016), Mothibi and Mncayi (2019) as well as Ncanywa and Masoga (2018) do not recognize tax revenue collection, political instability and corruption within the government administration as the variables that affect the South African public debt, although these variables affect the level of the South African public debt significantly.

Furthermore, these authors used linear methods. Current economic and econometric literature criticize these methods from both technical and theoretical perspective. From the technical side, linear methods have the limitation of failing to recognize the possibility of nonlinear behaviour among the time series of the macroeconomic variables. Generally, running linear methods with nonlinear time series makes the time series of the independent variables curve slowly, so for

innately nonlinear procedures it turns out to be progressively difficult to locate a linear method that fits the data well as the scope of the data increases. As the time series of the independent variables become extreme, the output of the linear method will likewise, in every case, be more extreme. This implies linear methods may not be powerful enough for extrapolating and/or forecasting the results of a process for which data cannot be gathered in the area of interest. Therefore, the time series with nonlinear behaviour cannot be correctly specified in linear methods.

Hence, from the theoretical and practical perspective; Wolswijk (2007) indicates that the sensitivity of tax revenue collection to changes in the macroeconomic climate is a fundamental contribution to the revenue forecasting process. This sensitivity is regularly thought to be constant over time (linear), though in practice this may prompt deliberate underestimation of tax revenue in consistently cyclically-sensitive tax products. Also, Jooste and Naraidoo (2011) contends that an expansionary business cycle underpins tax revenue through programmed stabilizers and an overall improvement in individuals' ability to pay tax. Then again, when the economy is in a downswing stage, tax revenue collection will generally deteriorate.

Evidence of significant revenue forecast errors for the South African case and its consequences are featured in the paper by Calitz *et al*. (2013), who sees that tax forecast errors were generally liable for budget projections digressing from the actual budget balance-to-GDP ratio outcome. All things taken explicitly, tax revenue forecast errors on average contributed 82.1 percent to the general forecasting error of the budget balance-to-GDP ratio over the financial period 2000/01 to 2010/11 (Calitz *et al*., 2013). A comparable trend was seen during the 2011/12 financial year. This necessitates the significance of whether this systematic inclination in tax revenue collection is partly the aftereffect of asymmetric movements in tax revenue comparative to the periods of the business cycle that are definitely not captured through the conventional linear methods. This inquiry has relevance for policy makers given that inability to account for nonlinear or/and asymmetric movements in tax revenue and public expenditure components may compromise the adequacy of fiscal policy measures. Hence, this study is an endeavor to account for the asymmetric effects of tax revenue collection on serving the public debt.

This study attempt this by using the nonlinear method of approach (NARDL) in additional to the linear one (ARDL). Hence, this study contributes new information to the body of the knowledge by exploring the empirical effect tax revenue collection, political instability and corruption on the

South African public debt using both methods. Using these methods, this study makes a contribution of establishing the nature (symmetric/asymmetric) of the empirical effect of tax revenue collection, political instability and corruption on the South African public debt.

1.8 ETHICAL CONSIDERATIONS OF THE STUDY

This study applies quantitative data of secondary nature. That is, the researcher did not collect the data, as it was collected by someone else. Hence, the sample unit can be expected to have less potential harm (because of low ethical impact). This study uses statistical results to fail to reject, or reject the hypotheses under test, while using economic theory and/or overviews as the basis for validation. Lastly, the North West University's Ethics committee for the faculty of Economic and Management Sciences approved this study as a minimum risk on March 20, 2020; and prescribed a one-year of ethics clearance with the number NWU-00604-20-A4.

1.9 LAYOUT OF THE STUDY

This thesis is organized into six chapters. Chapter one introduces the study. Chapter two provides an overview of South African fiscal policy dynamics, tax revenue collection, and public debt between 1985 and 2019. Chapter three classifies the literature review as a theoretical framework and presents an empirical review of previous studies in developing and developed economies, and South Africa. Chapter four provides a description of the data, data source and methods of Linear Auto Regression Distributed Lags (ARDL) and Nonlinear Auto Regression Distributed Lags (NARDL). Chapter five presents, interprets, and discusses the estimated results of the relationship between public debt, tax revenue collection and other selected variables using the ARDL and NARDL methods, respectively. Chapter six concludes the study by summarizing the results of the study, and provides the policy recommendations, limitations of the study, and suggests an area for further research.

CHAPTER TWO
AN OVERVIEW OF THE SOUTH AFRICAN FISCAL POLICY DYNAMICS, TAX REVENUE COLLECTION AND PUBLIC DEBT BETWEEN 1985 AND 2019

2.1 INTRODUCTION

This chapter is about an overview of the South African fiscal policy, and the fiscal policy reforms that the National Treasury has undertaken to make the fiscal policy transparent and sustainable as far as possible. This chapter will also take a look at the trend analysis for the key variables of this study, such as public debt, tax revenue collection, government expenditure, political instability and corruption within the public governance. Lastly, the National Treasury framework on public debt management will also be reviewed.

Hence, section 2.2 presents the background to the South African fiscal policy. Section 2.3 unfolds fiscal policy transparency, objective and rules in South Africa. Section 2.4 discusses fiscal policy reforms in South Africa. Section 2.5 analyses the trends in fiscal policy variables in South Africa. Section 2.6 unfolds South African fiscal policy consolidation and sustainability. Section 2.7 concludes the chapter by providing a discussion of public debt management in South Africa.

2.2 BACKGROUND ON THE SOUTH AFRICAN FISCAL POLICY

Since 1960, numerous developments have contributed to the credibility of the fiscal policy in South Africa. Firstly, firm fiscal compression was endured, mirroring socio-economic development needs and the urgency to suppress racial inequalities in the provision of public goods and services. Such compression became aggravated after 1994 and the adoption of the final Constitution in 1996, which substantially contributed an increased realization of different socio-economic rights (RSA, 1996). Secondly, numerous elements formed firm volatility in the instruments for the South African fiscal policy, including fluctuations in goods/services prices, business cycle and political instability accompanied with conflicts, internal unease and global financial and trade restrictions. Thirdly, financial institutions grew significantly. The period of 1910-1976, when a dual-budget framework was in effect, and had the purpose of ensuring obedience to the golden rule, could not suspend the moderate emergence of Keynesian fiscal activism from the late 1950s until the mid-1970s (Calitz *et al*., 2013). However, from the 1970s onwards, the Keynesian approach was well considered as far as longer-term fiscal orientation is concerned (Calitz and Siebrits, 2003). This

led to an introduction of structural fiscal policy that necessitated the realization of annual and medium-term targets, through Medium Term Expenditure Framework (MTEF), by the National Treasury. MTEF restraints the budgetary system, including financial planning and management.

After 1994, the codification of objectives was combined with a larger promotion of fiscal transparency, particularly after the adoption of the Act on Public Financial Management (Act 1 of 1999) (RSA, 1999). Briefly, the Public Financial Management Act (Act 1 of 1999) emphasizes that the budgetary management of national and provincial governments must be regulated. In other words, all the revenue, expenditure, assets and liabilities of these governments must be managed efficiently and effectively; to contribute to the responsibilities of persons assigned or appointed to oversee the financial management of these governments; and cooperating with related businesses (National Treasury, 2000). This motivated what Siebrits and Calitz (2004) called an increased transparency as far as fiscal discretion is concerned. Therefore, the following section discusses the South African fiscal policy transparency, objective, and rules.

2.3 FISCAL POLICY TRANSPARENCY, OBJECTIVE AND RULES IN SOUTH AFRICA

As discussed above, adherence to the Public Finance Management Act (PFMA) (Act 1 of 1999) prompted the South African government to change from secretive fiscal budgeting system to transparency-enhancing fiscal discretion. This implies that there had to be changes in the goals and rules as far as the fiscal policy framework and system were concerned in South Africa. Notably, the researcher aimed to provide the timeline from the start period of the study projected to be 1985, however, due to the unavailability of reliable information on the budgetary reform between 1985 and 1993, the timeline for South African budget and financial reform was rearranged to start from 1994. Hence, Table 2.1 shows a summary of budget reforms that have taken place in South Africa since 1994.

Table 2.1 Timeline for Budget and Financial Reform in South Africa since 1994

Achieved 1994 - 2000	Achieved 2000 – 2015	Achieved 2016-Current
	-PFMA and Treasury Regulations were introduced in 2000, 2001 and 2005 respectively.	-Enhancing transparency. Government institutions should not "camouflage" expenditure for uncertain projects.

-Decentralised budgeting	New national budget framework. -The Estimates of the National Expenditure (ENE) framework was implemented in 2001.	-Information on the ENE is supposed to be subjected under Parliamentary Monitoring Group (PMG).
-Multi-year budgeting (MTEF) -The Treasury Control Bill (W119/98) which later resulted in PFMA	-Equipping managers (to allow for more discretion). -Enhancing accountability. Linking planning and budgeting.	-Building of competency/capacity. The series of reforms implemented during 2000 and 2014 could not be successfully materialized and managed because of unavailability of capacity.
-Emphasis on outputs, and relaxing the regulations for expenditure -Deepening budgetary systems	-Introduction of service delivery indicators. Performance Budgeting. -One the measurable objective (MO), as per programme of Parliamentary Monitoring Group, was included. -General Recognised Accounting Practices (GRAP).	-Introduction and Implementation of the 2012 Draft Treasury Rules (Government Gazette 20 November 2012) (effective from 1 April 2016). -National Treasury and Department of Monitoring and Evaluation (DoME) has introduced expenditure reviews to verify the programme's performance and value for money (National Treasury, 2014).
Aligning policy and budgets	-Preferential Procurement Policy Framework Act 2000 (Act 5 of 2000)	-The objectives of the National Development Plan, which are linked to the strategic objectives of the departments during the MTEF period, were introduced in the budget and implemented.

Source: Olivier (2016)

There have been three phases of budgetary reform system since 1994. The first phase is the introduction of another intergovernmental in which every one of the three phases needed to

develop and embrace their own decentralized budgetary. The budgetary reform was accomplished by relying in the Management-By-Objective (MBO) framework currently being used in the South African public sector, and the presentation of the Medium Term Expenditure Framework (MTEF) as the framework for improving the government's budgetary system (Pauw *et al*., 2015). Pauw *et al*. (2015) also indicate that MBO is a mechanism for defining objectives in an organization, where the organization's management and personnel agree on the objectives and what each person perceives as an organization. Originally, the expression "management by objectives" was presented in Peter Drucker's 1954 book, The Practice of Management. Since MBO is planned to improve the overall performance of any organization, including government, a comprehensive evaluation framework, for example, should establish performance management. In the second phase, the Public Finance Management Act of 1999 (Act 1 of 1999) was introduced to modernize financial management and improve accountability (National Treasury, 2000).Stage three presents what has occurred from 2016 up to date, as shown above in Table 2.1.

However, strong performance management requires practical and achievable goals that can challenge the organization and its employees (National Treasury, 2000). Budgeting processes are inseparable from performance management, not only for cost management, but also for achieving objectives on low and efficient costs, risk management (also accounting for unapproved, wasteful and inefficient expenditure), and department operations. In its summary of national and provincial audit results, AGSA (2011) states that the main contributors to organizational performance degradation are the unclear performance goals, indicators, and organizational missions of organizations and/or leadership. Hence, AGSA (2011) indicates that setting and continuously improving performance goals could enhance efficiency of performance management, thus effecting productive service delivery.

This situation should be addressed in the case of public accountability. Therefore, the AGSA (2011) suggests that the tone of leadership should be changed, so that the target of a clean audit can be met in 2014 and beyond to turn things around. The recurrence of the audit results should be covered at all costs, which guarantees that key controls, containing leadership, financial and performance management, and governance, are brought to reality and followed. The fiscal year 2013/2014 came to an end and the fiscal year 2014/2015 began, but AGSA did not achieve the goal of a "clean audit 2014" despite continued developments for the 2013/14 fiscal year (AGSA,

2014). In a presentation about the Cooperative Governance on September 2, 2014, the AGSA pointed out that the previous administration had introduced the "Operation Clean Audit 2014" programme. However, municipalities were regularly confused about how to get a clean audit.

The researcher believes that the performance is fundamental for clean audit results. For this situation, the budget is a significant apparatus for evaluating performance against the adequacy of budgetary control needed, as per Section 39 of PFMA. Sadly, the situation (as far as progress) has not changed.

2.3.1 Fiscal policy transparency in South Africa

The fiscal policy was mystery before 1994, so there was no clear framework for the disposal of funds for the country. Once more, as per the literature, the budget was the executive's business. This means that Parliament had less of a role and it was the executive who was responsible for budgeting. The decision made by the executives was a "rubber stamp" in Parliament. Since the budget system was secretive, it was difficult to analyze and investigate the tendency of provision for public goods and services, and construct financial analysis as it was also not easy to obtain budget statements. In this regard, accountability and transparency were tolerated as elements of good and clean governance (Batandwa, 2007).

Former State Expenditure Department and executive committees have decided on budget allocation. These committees were responsible for coordinating budget proposals and various allocations to a particular department, such as health or education (Walker and Mangistu, 1999). This ensured that the executive was a key player when it comes to the budget process; explicit allocations were limited to the participation or involvement of the departments and Parliament.

Factually, the budgeting allocation was not a two-way thing, not comprehensive or participatory. Thus, the budget system was not comprehensive and profoundly concentrated. For instance, executive advisory committees were quite certain in approach and depended on internal control of financing instead of planning the allocation of funds expected to improve service delivery. As a result, in 1995, these committees were dissolved (Walker and Mangistu, 1999).

The above example of past systems is called the line item budgeting system that uses the traditional way of budgeting. Once again, the Finance and Auditing Act of 1975 laid the foundation for cost controls, as the law was never intended to regulate public finances, but rather to keep them under

control. Also, the act was very principled, which meant there was no relief privilege because it supported the rules

Abidian *et al*. (1998) explain that the traditional budgetary system and its scope for managing spending was well defined in order to maintain control over the money spent on government. Given the purpose of the Act, it is clear that the Act was based on input and control rather than results and management. Due to the administrative nature of public finance, management culture was not the order of the day thus making accounting officers inactive within the organization. Furthermore, corporate culture was limited by rules, and there was little flexibility and representation. The provision of service was not public or consumer oriented, and as a result, the value of money was tolerated rather than preferred.

The Finance and Audit Act was effective in both the traditional and the line-item budgetary systems, which was not based on results but on inputs. In the item budgetary system, input-based management and budgeting are focused on the amount of resources, personnel, and facilities available to a programme (Organization for Economic Co-operation and Development, 2002). The OECD's approach to the line-item budgeting system clearly indicated that the traditional approach to budgeting, as stated by the OECD, was not based on the results or outcomes. The latter is essential in modern public administration.

The new constitution under the democratic South Africa requires transparency and accountability government's administration. In 1998/9, a medium-term expenditure framework was acquainted in South Africa to elevate a participatory way to deal with the budget process, transparency, accountability and policy-budget collaboration. The adoption of PFMA additionally advances productive budgetary administration, transparency and accountability. The budget is more decentralized and all areas of government, set up structures and processes are bound to constraint budget related decisions. Research demonstrates that the performance budgetary framework has been embraced around the world, and presented in nations such as Australia and New Zealand. South Africa ought to embrace the public service performance budgetary system, as it delivers an outcomes-enhanced methodology and advances adaptable transparent administration of government resources, according to the lawful system. This will guarantee accountability by the National Treasury and appointed officials.

2.3.2 The objective of the South African fiscal policy

Fundamentally, the objective of the fiscal policy is to enables the government to contribute significantly toward an achievement of its macroeconomic goals and other crucial objectives through budget allocations, tax revenue and government borrowing (Maidi, 2012). These goals include markets development, economic growth and development, eradicating poverty, increase in an employment, price stability and discouraging greater inequality.

Since the mid-1990s, the South African government (fiscal) policy has been based on the claim that apartheid in general suppressed labour markets, international trading of agricultural goods and financial services. Subsequently, the globalization of labour that emerged in the late 1980s was not used for the economy. Insufficient manufacturers and producers participated in the market without the need to improve productivity.

As a result, the government originally developed and implemented a competitive strategy. That is, it has generally been aimed at improving efficiency without directing investment into specific activities or industries, despite the fact that it provided exceptional motivation for the Auto industry and generous funding for some large enterprises is. Instead of such a competitiveness strategy, a reform strategy usually means rebuilding the economy to ensure more equity and employment, as well as local manufacturing firms. The competition strategy guided government intervention in the through the following government functions;

- Deregulation and privatization of the markets

This methodology was sought after most quickly in agriculture, yet in addition reached out to some parts of the financial sector, media communications and transport, among others.

- Eradicating production subsidies and decreasing tariffs, however growing support by the government to support increased efficiency, particularly exports.

This kind of support, permitted by World Trade Organization (WTO) rules, incorporates assistance in work re-association, improved framework, and advancement aptitudes. It is not focused at certain industries, however; offers assistance when required by organizations. Therefore, the Department of Trade and Industry (DTI) declared a progression of "supply-side measures" to support exporters. In 2003, the government announced new investment interests in trade related infrastructure, particularly in ports and the rail network. Since the late 1990s, the Department of

Labour dispatched a thorough strategy to develop skills, which has unfortunately slowed down in the bureaucracy.

- Following traditionalist fiscal and monetary policies with an end goal to pull in foreign investments.

In the late 1990s, the government cut its annual spending by about 1% in real terms. This allowed nominal interest rates to exceed 20% in the late 1990s. In 2003, the real interest rate exceeded 4%.

From the point of view of a competitive methodology, job losses and slow growth/development are the unavoidable outcomes of moving shutter-outs, which are the aftereffect of market start-ups that discipline inefficient firm. This worry makes an unavoidable situation for building up a quickly developing and profitable firms later on. Turnaround times might be vague, however; they definitely continue as the competitive industry and firms adjust. This system can forestall the reconstruction of the poor by defeating poverty. Regardless, they were extras and not a significant piece of the growth strategy. After that, there is essentially no connection between the government's fundamental social projects and the economic sector.

At the time the government implemented this development strategy, it certainly did not envisage a reduction in unemployment and slower growth in previous years. Its Growth, Employment and Redistribution Strategy (GEAR) set forth economic goals for 1996-2000, however; none of the objectives and goals were achieved. The fundamental exemptions were the focuses for policy instruments, for example; government deficits, normal rates and inflation. Advocates of the strategy contend that, regardless of horrible performance at that time, the turnover was close. They emphasize that it was deferred by;

- The new labour market agreement, which causes rigidity in the labor market. Essentially, as the rest of the economy was controlled, the government introduced modern labour relations, which required effective intervention to counter apartheid measures.
- Inferior expertise levels among Africans due to the legacy of apartheid.
- The ambiguity of international trade rules, furthered by the protectionism of the European Union (EU) and the United States (US). As a result, the government sought bilateral trade agreements and accords by uniting the EU, the United States and Mercosur.

- Investors observe that investing in Africa is risky. From this point of view, NEPAD and various activities were initiated with the aim of balancing the continent.

In this case, there are real systemic flaws in the strategy of competitiveness. It basically asserts that capital will inevitably gain profitable activity, not by examining the South African economy, but by the free market hypothesis. The impression of a turnaround reflects the theoretical argument that despite the cyclical crisis or liberalization and any shake-out, reducing the costs of the factor eventually open up new opportunities. It is not clear how much this will happen, which is why Keynes has long been obsessed with it, saying that most of us are dead in the long run. Unpacked, this approach assumes;

- A closed system for capital, not for trade in goods and services.
- Good information is spreading about innovative investment opportunities.

Given an opportunity in which these conditions do not exist, investors may respond to the recession by looking for opportunities in different countries and ignore potential project perceptions for a longer period of time. In fact, obviously, none of these conditions exist. Like all of us, managers have a limited amount of rationality. Faced with a huge market-based restructuring, they may avoid any risk by explicitly exploring low-risk opportunities in different countries.

They can essentially overlook the new opportunities expected to enter new industries with new clients. In fact, since 2003, the shake-out coming about because of market progression have given no indications of accelerated and reasonable development. All things being equal, enormous firms looked for opportunities abroad, bringing about increased capital and profits in South Africa. Under these conditions, increasing efficiency in key sectors, including new foreign investment, is supported to a limited extent by the expansion of hostility and inequality. Basically, another enclave developed, which did little to secure more significant equity, employment or even faster growth. A growth model that rejects African youth has long run unfeasibility.

The competitive model received by the government diverged from the more customary development strategy, which guided the Reconstruction and Development Programme (RDP), embraced by the ANC in 1994 (ANC, 1994).This RDP sought a concerted increase in service delivery and supported fiscal policy in an attempt to limit the economy towards growth (Wiser, 2004). This would be achieved by borrowing or converting resources from sectors such as defense.

In 1996, however, the government considered that the objectives of the RDP policy could not be realized primarily, as the economy had a low savings rate. Consequently, the emerging growth of an economy dependent on borrowing and imports became costly due to domestic demand. Thus, the RDP policy emphasized spending to combat inequality and poverty, but only limited emphasis on fiscal constraints (Van Der Berg, 2006).

This has led to a strategic shift towards Growth, Employment and Redistribution (GEAR) policy aimed at growing the economy at an annual rate of 6% (Maidi, 2012). Therefore, GEAR laid the foundation for future economic development and achieved its annual economic growth target of 3% (Visser, 2004). Meanwhile, economic restructuring allowed the government to adopt an expansionary fiscal policy (Moboni, 2006). Fiscal consolidation has been described as aimed at reducing government deficits and debt accumulation, which are discreetly linked to fiscal policy (Joust and Marinkov, 2012). Again, Alesina and Perotti (1997), cited in Jooste and Marinkov (2012), argued that a fiscal consolidation and adaptive adjustments were important for success probability and macroeconomic outcomes. Sound reforms behind fiscal conslidation include the adoption of a Medium-Term Expenditure Framework (MTEF), a three-year rolling budget system for national and provincial budgets, and tax reform and a modified revenue collection system.

However, when GEAR was in effect, the government realized that an annual growth rate of 3% was not enough to deal with the vast legacy of poverty and unemployment. To end this destruction, the government introduced the South African Accelerated Shared Growth Initiative (ASGISA) in 2006, with the goal of growing the economy at an annual rate of 6% by 2010 (RSA, 2005). With ASGISA, the unemployment rate fell from 27.9% in 2004 to 20.7% at the end of 2008 and to 25.7% at the end of 2009, which created a boom in the economy and created some employment (Statistics South Africa, 2010). The rise in the unemployment rate in 2009 was mainly due to the private impact of the international financial crisis and the slowing of domestic economic growth. At the end of the first quarter in 2012, unemployment stood at 25.2% (Statistics South Africa, 2012).

These programmes generally place enormous demand on the government. In particular, they need the capacity to join the social and economic development strategies together. In addition, government needs to feature approaches for building economically feasible industries that can generate similar employment. At long last, the government should have an ability to implement

projects to generate wealth and income for poor people and reestablish formal production. Accomplishing these objectives requires liberal changes in the acquired institutional structures. Specifically, government administration currently appreciates broad opportunity of general control, and no authority can ensure that the economy upholds equity or employment. Furthermore, the economic policy decision-making framework favors business over the ANC's notable voter demographics. The poor are largely constrained by policymaking processes. Interestingly, government authorities interact with businesses reliably and, for the most part, rely heavily on experts for information and ideas. This in itself works against a solid growth strategy.

2.3.3 The rules for South African Fiscal Policy

In order to achieve transparency and the goals of fiscal policy in South Africa, certain fiscal rules were established to ensure a smooth fiscal policy framework that would yield satisfactory delivery of public goods and services. Therefore, this section discusses the fiscal rules that were set as guidelines for the implementation of effective and sustainable fiscal policy in South Africa.

First of all, rules for fiscal policy are defined in the budgeting system as the direct numerical constraints on budgetary aggregates (IMF, 2009). In order to govern fiscal policy, a fiscal indicator (instrument) is expected to make a rule that is generally simple and can be effectively tested and enforced to the general public. Rules for fiscal policy are generally adopted for the purpose of achieving fiscal stability, yet these rules can have different roles, for example; balancing the economy and limiting the size of government. The following are the different rules defined by the Copts (2001), Kennedy and Robbins (2001) and the IMF (2009);

- Rules for the budget balance, which can be based on the total balance, the structural balance or the cyclically adjusted balance (CAB).
- Debt rules, which focus heavily on a specific level of the debt ratio and are best suited to achieve the debt convergence objective.
- Spending rules that permanently limit, for example, total spending, primary spending, or current spending (standard government budget spending and public investment spending as a percentage of GDP).
- Revenue rules aimed at increasing revenue and/or preventing the tax rate (by limiting the debt ratio).

Despite the above, there must be a distinction between strict rules and more comprehensive rules (Emmerson et al., 2004). Strict rules in the form of security measures can lead to the accumulation of tax reserves, which can lead to a reduction in welfare. More exhaustive rules, on the other hand, set up a central objective with adequate range. The following is a synopsis of the trade-offs related with fiscal guidelines, as initially stressed by Kilpatrick (2001);

- Transparency versus rigidity: The higher the transparency, the less the rule should be inflexible. The thought is that if the fiscal authorities have the opportunity to work in a transparent and feasible way, the fiscal rule can consider the different cyclical costs and ensure some flexibility in the budgetary process.
- Rigidity versus tax/revenue facilitation: the stricter the rule, the less tax/revenue; as the government is able to facilitate.

A stricter rule suggests less opportunity for fiscal policy to adjust to changing economic conditions.

Fiscal policy adaptability is a significant economic system that can withstand general or unexpected shocks through an adjustment in the budget deficit kept up by tax/revenue adaptability. The need to decrease tax/revenue will be met by the shocks to profit public spending brought about by events like the financial crisis of 2008/9. A few rules may turn out to be progressively pertinent at the national level, while others keep on seeming well and good at the semi-national level (Kennedy and Robbins, 2001). Some analysis stresses that fiscal rule is more reasonable for semi-national governments than national governments (Baumi and Eichengreen, 1995; Corsetti and Raubini, 1996; Alessina and Baumi, 1996).

The purpose behind the fiscal rules is to constrain the government to act intentionally, which is typically not for its advantage temporarily. Likewise, fiscal rules can address the issue of time irregularity (Gutiérrez and Revilla, 2010), where government-backed decisions (activity) change after a specific time (for example, fiscal rules increases spending identified with inability to respect past obligations and to promote credibility considering the way that the government embraces rules, defines objectives and sticks to them). Fiscal rules can be essential for a bigger lawful framework (legal preconditions), making them progressively hard to turn around. Policy rules that are not managed are not prohibitive limitations on government (Kennedy and Robbins, 2001).

One of the main problems with fully discretionary fiscal policy is that the overall government's fiscal policy record cannot be assessed without strict rules (Emmerson et al., 2004). In addition, a reasonable number of components are beyond government control, such as position in the business cycle, shocks in the global economy, and debt and deficits in previous years. As discussed in the previous section, fiscal rules are largely inspired to create a de-politicized policy framework (for example, they adapt the government's vision that comes from electoral possibilities). Furthermore, fiscal rules are known to restrict the size of government and promote value between generations, although fiscal rules are linked to improved fiscal performance (in EU economies), it is hard to isolate the direction of the causation from the effect. For example, submitting rules can improve governance, but capable governments need to set additional rules. In terms of fiscal rules promoting the consolidation effort, the world evidence is perfect (IMF, 2010). One of the major disadvantages of fiscal rules is that they impose discretion when it is needed and potentially limit fiscal policy when it should be countercyclical (Kennedy and Robbins, 2001; IMF, 2009). Similarly, fiscal rules and spending rules can lead to a reduction in investment that can affect long-run economic growth. Kennedy and Robbins (2001) cited the following as reasons for adopting fiscal rules;

- Fiscal rules guarantee macroeconomic stability through the promotion of countercyclical fiscal policy.
- Fiscal rules help improve the legitimacy of government fiscal policy and eliminate budget deficits.
- Fiscal rules guarantee long-term stability of fiscal policy.

In South Africa, like different pieces of the constitution, the standards of fiscal responsibility are cherished in the PFMA and the Municipal Finance Management Act (MFMA). The general favorable position of such laws is that they limit the government's capacity to give special consideration to policy, which is best reflected. Regardless, there is a need to build up a more thorough system for accountability, supervision and enforcement with clear compliance costs such as disciplinary endorsement, funding penalties and loss of dignity.

2.4 FISCAL POLICY REFORMS IN SOUTH AFRICA

Fiscal policy has led to a number of reforms in South Africa, including countercyclical fiscal policy and a multilateral budgeting, commonly known as the Medium Term Expenditure Framework

(MTEF). According to Hou (2006), a countercyclical policy is merely speculation that the National Treasury will reduce spending and raise taxes during the recession, while increasing government spending and reducing taxes during economic expansion and boom. Hou (2006) shows that countercyclical fiscal policy and multi-year budgeting have increased fiscal stability throughout South Africa's business cycle. According to Lledo et al. (2009), the shift to countercyclical or less countercyclical, fiscal policy is due to improve economic productivity and structural reforms in developing economies. South Africa still suffers from high unemployment, poverty and inequality, but fiscal policy has played a significant role in achieving significant economic stability and protecting the economy from the negative effects of the global recession.

In 1994, South Africa had just emerged from its international sanction and economic recession, characterized by low levels of investment and growth and frustrated by high levels of unemployment. According to Mboweni (2006), the economy was to a large degree economically insulated from the rest of the world. Mboweni (2006) further established that South Africa developed an unsustainable fiscal state with high fiscal deficits and interest payments. Emphasis was grounded on the renewal of fiscal constancy and the establishment of a firm macroeconomic environment. Its recognition on re-entering the international market constituted pressure and a necessity for fiscal policy reforms and for economic constancy. Maidi (2012) indicates it is because of the aforementioned factors and events that the new government engaged on countercyclical fiscal policy and MTEF.

2.5 FISCAL POLICY VARIABLES' TRENDS IN SOUTH AFRICA

This section presents the South African fiscal policy instruments' trends for the period of 1985 to 2019. That is, this section aims to present and analyze the shocks on key fiscal variables selected in this study. This section will also discuss the events behind the trends for the selected fiscal variables.

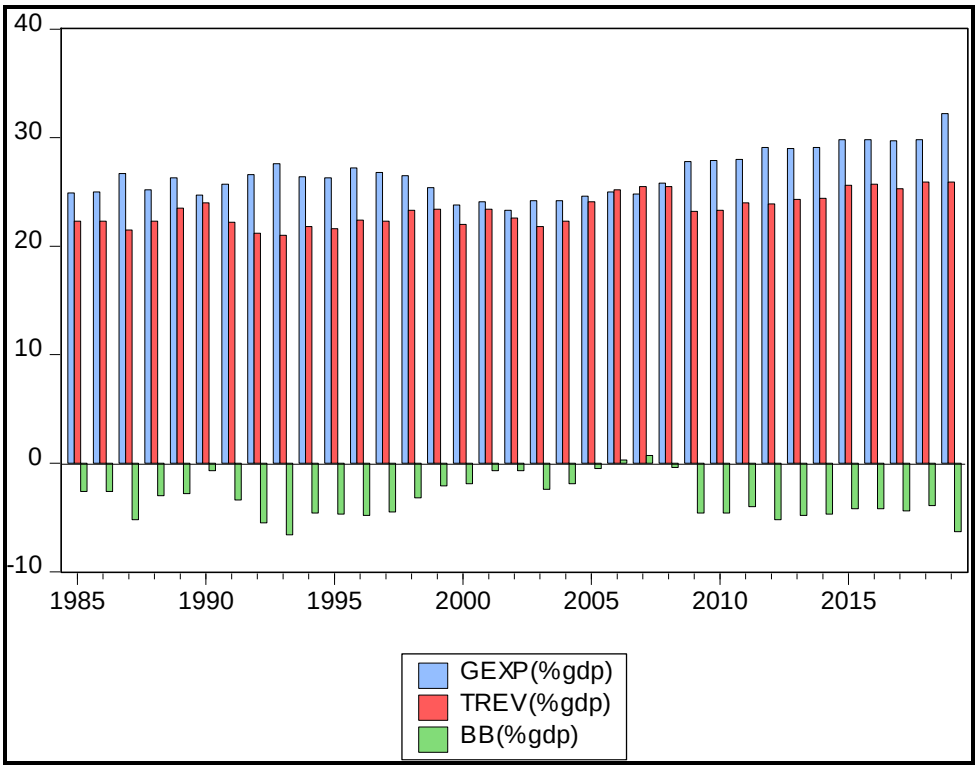
As the main objective of this study is to estimate the effect of tax revenue collection in public debt, the trends on both variables will be discussed. Firstly, the trends for government expenditure and tax revenue collection will presented and discussed, as these variables are the deterministic components for public borrowing. Secondly, following the specific objective of estimating the effect of corruption and political instability on public debt, the trends of these variables will be

compared to that of the public debt. Hence, the trends are mostly analyzed in pairs to suit the objectives of this study, as indicated in the preceding statement.

2.5.1 Analysis for the trends of South African government expenditure, tax revenue collection and budget balance

Just like other developing economy, the South African government spends more than it receives in income. This study will only focus on the income that the South African government receives from the collection of taxes. The reason for focusing only on the tax revenue is on the basis that this study treats tax revenue collection as the key independent variable. Thus, the South African trends for the government expenditure (GEXP) tax revenue (TREV) and budget balance (BB) between 1985 and 2019; are presented in the following figure.

Figure 2.1 Trends for the South African government expenditure, tax revenue collection and budget balance



Source: Author's own calculations using SARB data

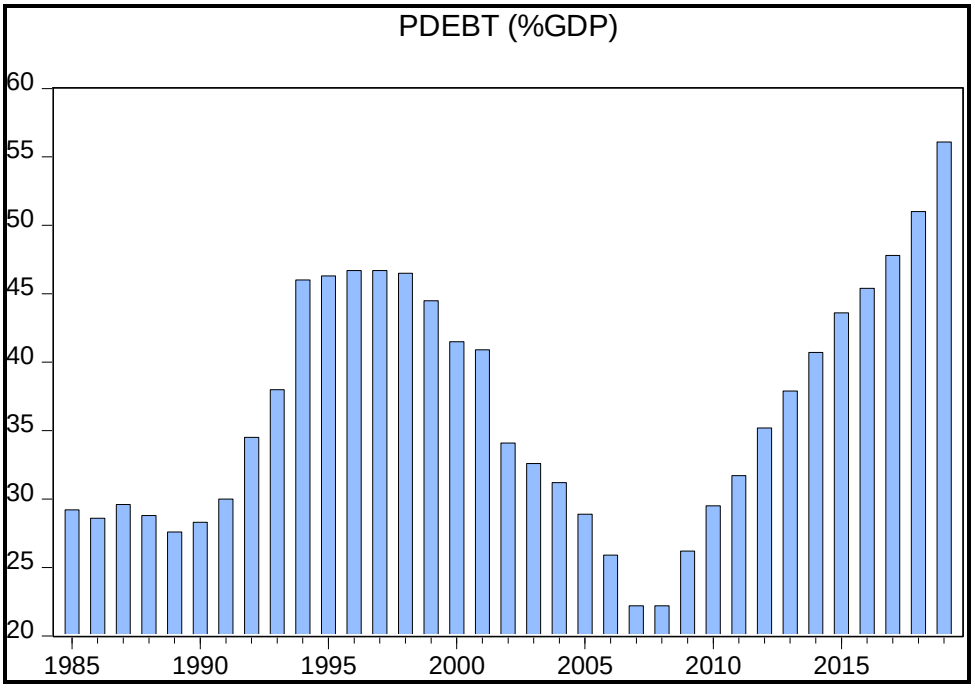
It can be seen in Figure 2.1 that South African government expenditure has been surpassing the tax revenue collection for most of the periods between 1985 and 2019. That is, South Africa has been running on a budget deficit. The motive behind this, is obviously attributed to the apartheid

legacy and the restructuring of the country that the ANC government had to undertake since 1994. For instance, Calitz *et* al. (2009) point out that during the post-apartheid period, the South African government has attempted a critical and continued fiscal adjustment that has been a significant tool in balancing out the economy and making it competitive globally. The national budget deficit was 5 percent in 1994. This is believed to be the result more of sustained increase in government expenditure than that of revenue as shown in Figure 2.1. However, in general, the South African budget deficit decreased significantly between 1994 and 2004. Interestingly, from 2005 to 2008 the budget balance improved to 1 percent (surplus). This was because of the decade-long modification which involved both expenditure cuts and revenue gains, especially from personal income taxes, and has been bolstered by an extensive reform of tax policy and administration. Lastly, from 2009 to 2019, South Africa recorded budget deficits, the highest being 5 percent in 2010, 2013 and 2019. The reason for this is obviously attributed to the under-performance of the South African economy, which led to an insufficient collection of tax revenue by the government while expenditure increased significantly. Muller (2019) insists that tax revenue collection was negatively affected by institutional destabilization of the South African Revenue Collection Services (SARS).

2.5.2 Analysis for the trend of South African government debt

As seen in the previous section, the South African government has been spending more than it receives in revenue. This simply means that the government has had to finance the difference through borrowing from either domestic or international markets. Hence, Figure 2.2 presents the trend for the South African public debt between 1985 and 2019.

Figure 2.2 Trend for the South African public debt



Source: Author's own calculations using SARB data

While embracing democracy in 1994, the ANC faced a large amount of public debt that was largely ascribed to broad borrowing, and external debt was imposed on South Africa in the 1980s. Therefore, the South African government has made enormous progress in its spending programmes with the Reconstruction and Development Program (RDP) in 1994, the Growth, Employment, Redistribution (GER) policy in 1996, and the Accelerated Distribution to South Africa (ASGISA) in 2005. An important part of these spending programmes was the ANC government's dedication to reducing high levels of government debt. To this end, a judicial settlement of the National Treasury was reached in 1996 as an officially assigned body to handle the nation's fiscal debt (Majam, 2017).

As shown in Figure 2.2, during the execution of the RDP programme between 1994 and 1996, public debt increased from 47% in 1994 to 48% in 1995 and fell back to 47% in 1997, despite the fact that Majam (2017) states that GDP growth rate improved fairly from - 0.4% to 1.6% during a same period. The increase in the level of public debt during these periods is due to poor policy execution and co-assignment under the RDP programme that did not prompt an expected GDP growth rate of over 3%. In any case, following the substitution of the RDP programme by its replacement, the GEAR programme in 1996, there started to be a significant drop in the level of

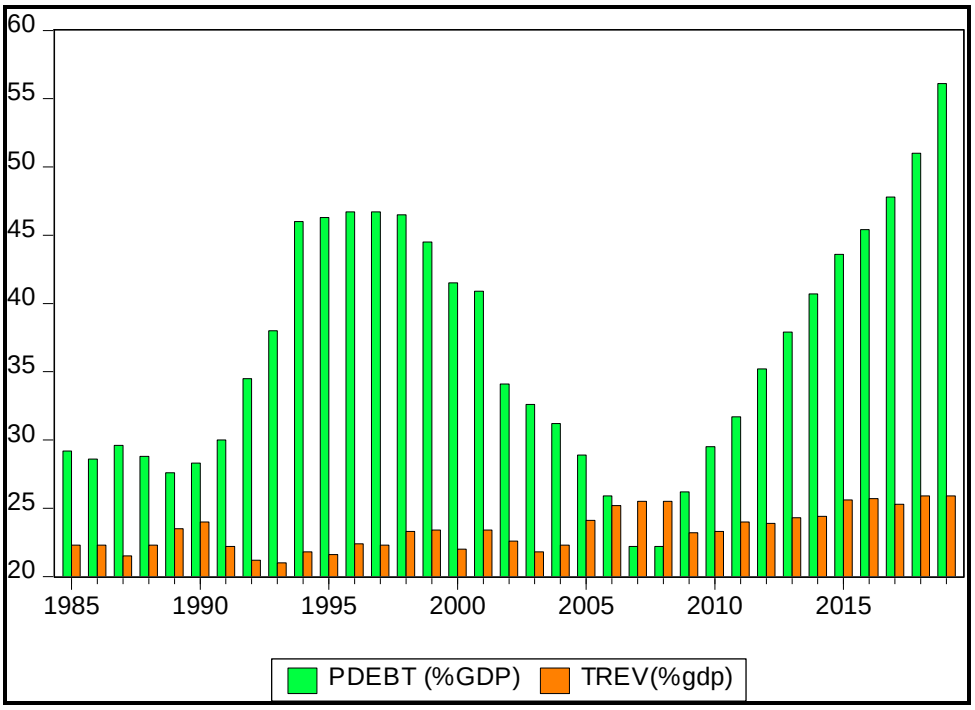
public debt from 49% in 1997 to 36% in 2003. This was accompanied by a slight increase in GDP rate from 1.2% to 2.2%, which was still beneath the targeted GDP growth rate of 3%. Nonetheless, in 2004, the GEAR programme was abandoned for ASGISA programme, contending that it did not consider the microeconomic changes that would take care of more profound social issues, for example, unemployment and income inequality (Phiri, 2017). At first, the economic performance under ASGISA's programme was good, the level of public debt decreased from 34% in 2004 to 27% in 2008.

During this period, GDP growth rate reached 7% between 2005 and 2006, largely due to strong trade growth. Either way, the effect of the recent global financial crisis and the subsequent period of the worldwide recession in 2009 constrained fiscal authorities to increase the level of the debt, bringing about a pattern reliable with weakening macroeconomics, especially economic growth which recorded a negative level of - 6.1% level in mid-2009 (Phiri, 2017). Increasing government financial burdens significantly more, global credit organizations lowered South Africa's sovereign risk rating to a negative viewpoint. Due to this poor economic performance, the government relinquished the ASGISA programme for the National Development Plan (NDP) and NGP strategies, which were brought in implemented in 2013 and 2015 respectively. Regardless of the execution of the NDP and NGP strategies, public debt increased from 38% in 2011 to 52% in 2016, and this level of debt was last known before and after the 1994 democratic elections. Again, despite the fact that economic growth has returned to 2.8% in 2010, it has come down to 0.8% in 2016.

2.5.3 Trend analysis for the South African government debt and tax revenue collection

As the primary objective of this thesis is to estimate the exact quantitative effect of tax revenue collection on the public debt in South Africa, it is of great importance to analyse the movements of fiscal debt and tax revenue collection. Though there has been a volatile correlation between public debt and tax revenue collection in South Africa as shown Figure 2.3, the empirical objective of this study is to test whether these observations can be formally captured using selected quantitative econometric techniques (to be discussed in Chapter 4).

Figure 2.3 Trends for the South African government debt and tax revenue collection



Source: Author's own calculations using SARB data

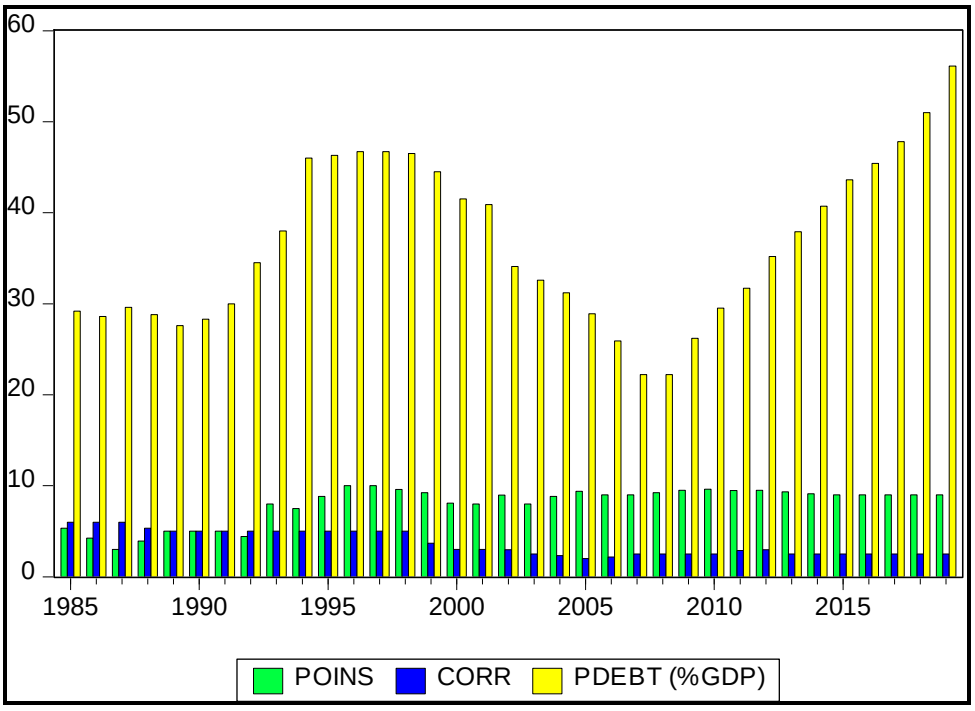
Generally, the public debt and tax revenue collection have been increasing since 1985 as seen and discussed in the latter trend analysis (section 2.5.1 and 2.5.2), although the public debt has been increasing at a higher rate than tax revenue collection. It is notable that public debt slightly decreased between 2008 and 2009 whereas the tax revenue collection increased marginally between 2010 and 2019.

2.5.4 Trend analysis for the South African government debt, political stability and corruption

South Africa is not immune from political factions that impact public finances significantly. In this regard, government institutions face too much political interference which is sometimes viewed as an element of political instability. To some degree, that interference affects the effectiveness and efficiency of those institutions, since some of those political interferences serve the personal interests of the politicians. In such cases, corruption becomes one of the end products. This is evident in South Africa as public enterprises like Eskom, South African Airways (SAA), some of municipalities and provincial governments (like North West) are currently declared inefficient, as the national government has to bail them out frequently. Unfortunately, these bailouts increased

public debt significantly, with no improvements in tax revenue collection (Kantor, 2019). Hence, Figure 2.4 presents the trends for the South Africa's government debt, political stability and corruption within the South African government administration;

Figure 2.4 Trends for the South African government debt and political instability and corruption.



Source: Author's own calculations using SARB data

World Bank (2019) indicates that any value close to or equal to 0 indicates political stability whereas any value close to or equal to 10 indicates strong political instability. Paying attention to the political instability index trend in Figure 2.4, South Africa was not very vulnerable to political instability between 1985 and 1993, as the index values are not reasonably close to 10. Furthermore, most of the political instability index values are closer to 10 between 1994 and 2019. This means that as much as South Africa is a democratic state, it still has a bit of work to do if political stability is to be attained.

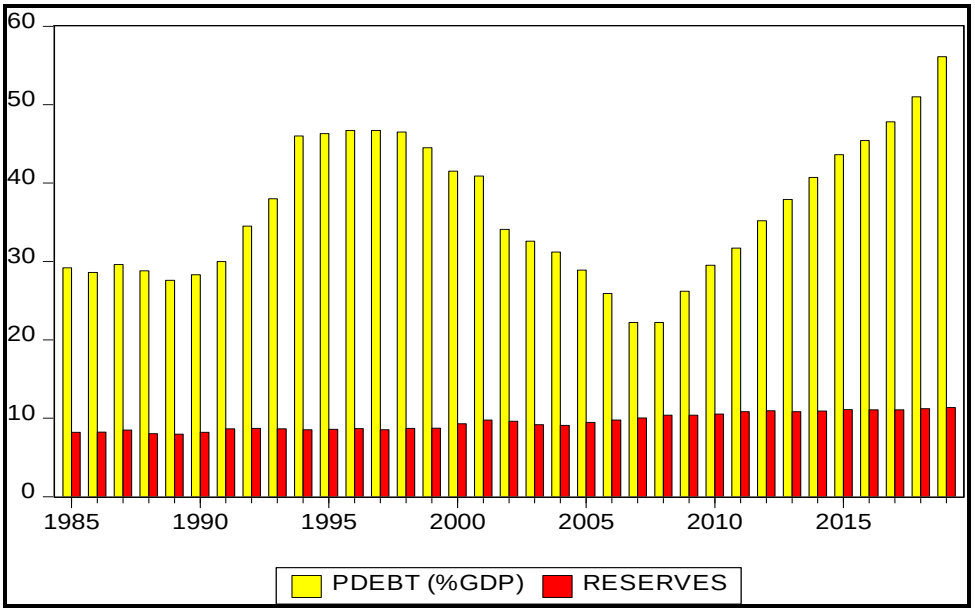
In terms of corruption, the World Bank (2019) stipulates that corruption perceptions index values that are closer to zero indicate that government administrations are not clean but rather corrupted, while those that are closer to 100 indicate that government administrations are clean (no corruption). Figure 2.4 also shows that the corruption perceptions index values are 5 or less

between 1985 and 2019. This means that South Africa's government administrations are corrupt. Obviously the reason for this ordeal is the political factions that South Africa has been experiencing, especially from 1994. Put practically, corruption is seen as a norm in South African government administration. Accounting for the fact that government finances are diverted from their primary purpose through corruption and/or political factions, it does not change or affect expenditure decisions (exogenous). Rather, the government would opt for borrowing from either domestic or external sources to supplement the expenditure (Kantor, 2018). This means that the level of government/public debt will increase, as Figure 2.4 again shows that the public debt levels have been generally increasing between 1985 and 2019.

2.5.5 Trend analysis for the public debt and total reserves in South Africa

Lastly, logically some may argue what might happen if the government uses its reserves to try to finance some portion if not all of its debt. For this reason, the researcher provides some brief analysis on whether this exploration can be realized or not. It should be noted that total reserves data is measured as the percentage of the external debt. This measure is chosen on the basis that external debt includes government debt as one of its constituents. Hence, Figure 2.5 presents the trends for public debt and total reserves;

Figure 2.5 Trends for the South African public debt and total reserves



Source: Author's own calculations using World Bank data

From the above trends, it can be seen that South African reserves growth rate has been consistently lower compared to the public debt growth rate, but has marginally increased between 1985 and 2019. It should also be noted that from the period of the 2008/9 financial crisis period to 2019, the South African reserves growth rate has been consistently recording 10 percent growth rate, while the public debt is also increasing at more than double the growth rate of reserves.

Kantor (2019) states that this is due to the fact that the South African Reserve Bank (SARB) did not apply quantitative easing (QE). QE, in short, is a form of unconventional monetary policy in which a central bank purchases longer-term securities from the open market in order to increase the money supply and encourage lending and investment (Kantor, 2019). Nor did the South African national treasury need to recapitalize the system by buying in to extra shares or debt issued by banks and insurance organizations, as US government and the European Central Bank did. However, the South African banks and other financial institutions were correspondingly harmed by the breakdown in the share prices of banks and financial institutions in the developed world. They were likewise harmed by sharp decreases in the value of corporate and government debt, including South African government debt, as per balance sheets. The rand value of the JSE Banks Index declined by about 43% from its peak of April 2007 to its trough in February 2009 (Kantor, 2019). In light of all this, reserves would be inefficient if they were to be used to finance public debt. As it can be seen in Figure 2.6, the value of public debt is actually far greater than that of the reserves.

2.6 FISCAL POLICY CONSOLIDATION AND SUSTAINABILITY IN SOUTH AFRICA

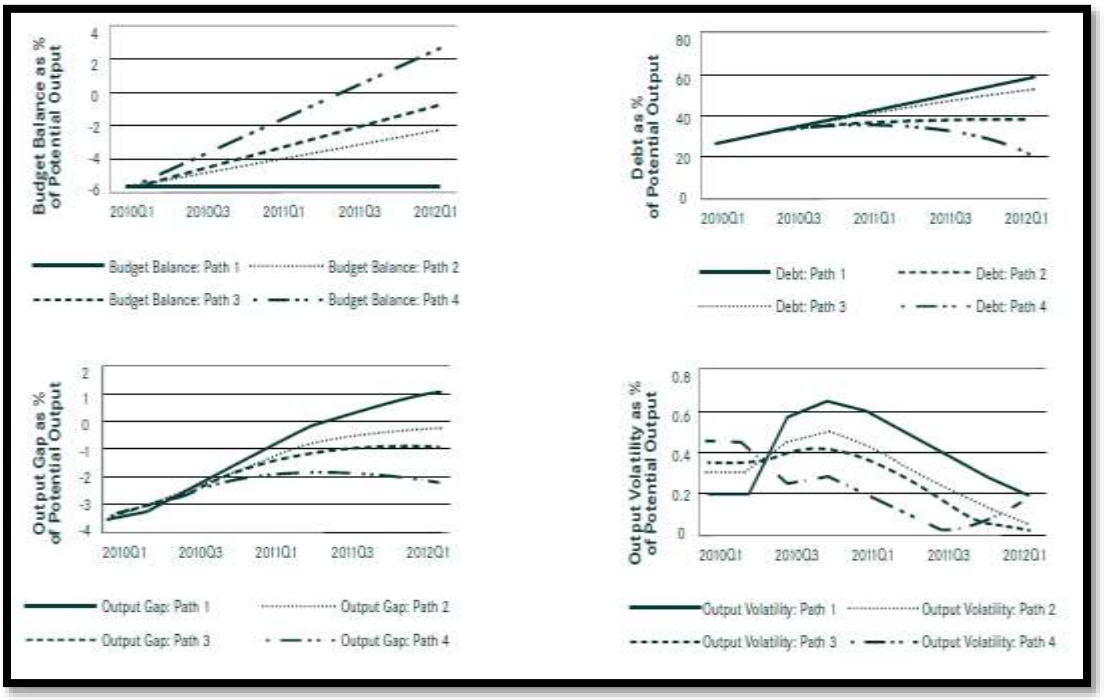
As shown in the previous section, South African fiscal budget has been operating at the persistent deficit which resulted in large and consistent borrowing for the period under study. Hence, this section presents numerical targets that have been achieved by the South African fiscal policy authorities on overall budget balance and consolidated debt. That is, this section will discuss fiscal policy consolidation and sustainability in South Africa. The focus will be on the 2010 medium term estimates framework and the 2020 medium term estimates framework. That is, the researcher aims to do comparison analysis and see if there has been a significant improvement or not, as far as fiscal policy consolidation in concerned.

2.6.1 Fiscal policy consolidation in South Africa

South Africa has a decent track record of fiscal judiciary (OECD, 2010). Since the 2008/09 financial crisis, the budget framework has adjusted the need for short term stimulus with the long run objective of fiscal sustainability (National Treasury, 2010a). Public debt has fundamentally increased to guarantee that spending on public goods and services does not decrease irrespective of a decrease in tax income brought on by the recession. Also, the government has pledged to reduce the deficit so as to bring the budget back into a feasible or sustainable position.

However, 2010-2013 posted higher than expected deficits in the 2009 budget, generally in an attempt to aid employment efforts set out on the New Growth Path (NGP) (National Treasury, 2011). Despite this, the government was determined to keep up with fiscal stability and consolidation policy, as well as delaying efforts to make government policies more viable by updating fiscal rules. The next section examines the effects of various paths of fiscal consolidation on debt sustainability and output in South Africa;

Figure 2.6: The impacts of different fiscal consolidation paths on public debt, output gap and output volatility



Source: Adapted from National Treasury (2010)

Figure 2.6 describes the situation of different methodologies for the South Africa's fiscal policy consolidation. In the upper left corner of the figure, shown are the paths of fiscal consolidation, which are characterized as follows;

- Path 1 (solid line): The ratio of budget balance to projected output remains unchanged over the medium term (Q1 2010-Q1 2012 MTEF).
- Path 2 (dotted line): the proportion of budget balance to potential output diminishes by 0.4 percent each quarter over the medium term.
- Path 3 (dashed line): the proportion of budget balance to potential output diminishes by 0.6 percent each quarter over the medium term.
- Path 4 (dot-dashed line): the proportion of budget balance to potential output diminishes by one percent each quarter over the medium term.

The upper right and lower two fields show how unprecedented economic factors such as output gap and output volatility respond to the specific consolidation paths as per the four points above. The patterns shown in Figure 2.6 relate to the patterns related to the four consolidation paths mentioned above. The dashed line on the lower left field demonstrates the bearing of the output gap in the medium term, which is identified with the consolidation strategy under Path 3 (for example; in the event that the budget balance decreases by 0.6% per quarter with respect to output).

In this analysis, fiscal shocks such as the decreases in the ratio of the budget balance to output are treated as exogenous and have different potential paths. As mentioned above, path 1 keeps the budget deficit consistent through the MTEF. In the lower left field, the output gap is quickly decreasing as indicated path 1 (quickly going to 0). Regardless, the shape of the output gap is bended, proposing that keeping up an enormous budget deficit could prompt a decrease in future output. This is likely because of the impact of inflation in public debt, interest rates and economic growth. The upper right field shows that immediate (direct) fashion for path 1 public debt increased by over 50% in 2011, representing a likely risk to future fiscal policy in South Africa. Taking the second option to decrease losses (path 4, and somewhat path 3) does not ensure the disposal of the output gap, despite the way that the degree of public debt tumbles to an extremely low level in the medium term. (dashed and dot-dashed line in four fields in Figure 2.6) This shows that budgetary augmentation is insignificant and inadequate in tackling poverty issues or avoiding a recession.

Choosing to reduce the budget deficit in the style of Path 2 (dotted line) seems to be an alternative strategy. In this case, in early 2012, the output gap closes and the debt decreases over the same period, which means that the running deficit should decrease with the move in the output gap. In the Path 2 situation, public finance concerns about the social outcome are adjusted as well as about the volatility in the output (which is declining, as shown by the dashing line in the bottom right of Figure 2.6).

Along with the rest of the world, South Africa is facing tough decisions on the size of the deficit and how to reduce it. This analysis suggests the most compelling ideas, for example, ignoring the fiscal deficit the way it is (keeping it fixed), which is basically path 1, or to drastically reduce it (Path 4). In any case, when the deficit is closed at a faster rate (the output gap is faster than the deficit closing rate), a negative output gap is ensured, as it controls the effect of the fiscal multiplier (which slows the closing rate of output gap). Then, if the deficit is kept at the current level, or at a moderate rate, the result will be higher debt levels and consequently higher debt service costs. In the long run, its commitment to the output gap will become negative.

Likewise, the following table presents the 2020 fiscal consolidation by the National Treasury (2020). That is, the researcher aims to do a fiscal consolidation comparative analysis (for performance basis) for the period bounded by the 2008 financial crisis (2010) and a 10-year period after (2020). Hence, Table 2.2 and 2.3 present the South African government's 2020 fiscal consolidation and debt requirement respectively.

Table 2.2 South African fiscal consolidation framework for the financial year 2020

RBillions/% of GDP	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**
	Outcome			**Estimate**	**Medium Term Estimates**		
Revenue	1285.6	1351.4	1445.4	1517.0	1583.9	1682.8	1791.3
% of GDP	29.1	28.8	29.4	29.4	29.2	29.2	29.2
Expenditure	1442.6	1541.9	1642.8	1843.5	1954.4	2040.3	2141
% of GDP	32.6	32.8	33.4	35.7	36.0	35.4	34.9
Budget Bal.	-157	-190.5	-197.4	-326.6	-370.5	-357.5	-349.7
% of GDP	-3.6	-4.1	-6.3	-6.8	-6.8	-6.2	-5.7
GDP	4419.4	4697.8	4921.5	5157.3	5428.2	5759	6126.3

Source: National Treasury (2020)

Table 2.3 South African debt consolidation framework for the financial year 2020

RBillions/% of GDP	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
	Outcome			Budget	Medium Term Estimates		
Debt	157	190.5	197.4	242.7/326.6	370.5	357.5	349.7
% of GDP	3.6	4.1	4.0	4.5/6.3	6.8	6.2	5.7

Source: National Treasury (2020)

On the 2010 medium term expenditure framework (two years after global financial crisis) and 2020 medium term expenditure framework, the South African fiscal position has improved. For instance, Figure 2.7 shows that fiscal budget balance on average improved from -6 % of GDP in 2010 to 2% of GDP in 2012. However, the debt stock as a percent of GDP increased significantly over the 2010 medium term framework. The National Treasury (2010) emphasizes slow economic growth as the cause. To substantiate this, Figure 2.6 shows that output (GDP) gap increased significantly from -3.5% of GDP in 2010 to 1% of GDP in 2012. It should also be noted that the South African economy only recorded a positive output gap in 2012 by a mere 1%, when from 2010 to 2011 it recorded a negative output gap of 3.5% and 1% respectively.

In the 2020 medium term estimates framework, there seems to be an increase in government revenue and expenditure in outcome (2016 to 2019), estimate (2019 to 2020) and medium term estimates (2020 to 2023) respectively. As usual, the expenditure growth is higher than revenue growth which consequently leads to a negative budget balance as shown in Table 2.2 This simply means that the government has to borrow to finance the negative budget balance. Thus, it is for this reason that the value for the debt as shown in Table 2.3 is exactly equal to the value of the budget balance.

Lastly, as the fundamental idea of fiscal consolidation is to decrease the debt by ensuring competitive performance for government revenue and expenditure, Table 2.3 shows that public debt is bound to decrease in the medium term (2021 to 2023). This is obviously on the basis that government revenue is expected to grow by R108.5 billion when government expenditure is expected to grow by R100.7 billion over the medium term period. Furthermore, an increase in

GDP as shown in Table 2.2 may also give a great explanation as to why there might be a larger increase (as per 2020 medium term expenditure framework) in government revenue.

2.6.2 Fiscal policy sustainability in South Africa

A few developments have influenced the sustainability of fiscal policy in South Africa since 1960. Firstly, there have been sustained fiscal pressures, reflecting socio-economic and basic development needs to reduce racial disparities in the delivery of public goods and services. This pressure has intensified since the establishment of a fully democratic system in 1994 and the adoption of the final Constitution in 1996, which takes into account the dynamic recognition of various socio-economic rights (RSA, 1996). Secondly, several elements have contributed to the significant volatility of the fiscal variables that explain the changes in the prices of commodities; business cycles; and political insecurity, internal unrest, and international financial and trade sanctions. Thirdly, fiscal institutions have developed significantly. The dual budget framework, which was in effect from 1910 to 1976 and had the inspiration to ensure consistence with the golden rule, could not forestall the reformist development of Keynesian fiscal activity from the late 1950s to the mid-1970s. Thus, since the late 1970s, the Keynesian framework has been consistently replaced by long-term fiscal direction (Calitz and Siebrits, 2003).

This refers to a constructive framework for fiscal policy, which includes the embracing annual and medium-term targets by government. These goals have never been formalized by formal statistical principles (Seibritz and Calitz, 2003). After 1994, following the enactment of Public Financial Management (Act 1 of 1999), goal setting was linked to increased fiscal transparency (RSA, 1999). This reflected a change in regulation identified by Sabers and Colts (2004) as increasing transparency of fiscal discretion.

From 1961 to 2008, South Africa's basic budget balance fluctuated between -6% and + 2% of GDP, while the national debt ranged between 23.8% and 50.4% of GDP (Calitz *et al*., 2009). At face value, these balances and the debt burden were discreet. For example, the maximum value and the period average (39% of GDP) of the debt ratio were well below the Maastricht standard of 60% of GDP. Hidden economic considerations (in particular the level of interest rates and the long term reasonable rate of GDP growth) may in any case have shown different standards for the sustainability of public finances in South Africa. In addition, a proper assessment of household performance requires a formal assessment of the sustainability of the results.

Since the 2008 financial crisis, the world's largest credit rating agencies, Standard & Poor's, Moody's, and Fitch have downgraded South Africa's public debt, with weak corporate governance quality, weak economic performance, labor pressures with high unemployment and imbalances as external risks for fiscal consolidation.

Although there is evidence of moderately stable fiscal outcomes over the past decades, South Africa has generally recorded higher levels of debt, with net debt in general terms, from 140 percent in 1900 to 120 percent (as the percentage of the GDP) during the World War II, relying on the data from Carmen Reinhart and Rogoff (Maidi, 2012). In April 2013, the International Monetary Fund World Financial Outlook Database showed that the net debt for South Africa averaged about 2.0 percent to the GDP over the period of 2003-2013, while net public debt has averaged 34.5 percent to the GDP. While it was expecting a slight improvement in general government debt, it remained skeptical about the government's net debt going forward, noting that it could reach 44.8 percent in 2016, which happened.

If the current estimate of all future revenue streams exceeds the special debt estimate, in addition to the limited estimate of all future government spending, then the government is solvent. This is basic, but not a sufficient condition for fiscal stability. The idea of fiscal stability includes the prerequisite of a reputation related to revenue generation and expenditure management (Perotti, 2007).

In practice, it is difficult to pass the judgment on the solvency and stability of public finances and/or fiscal policy. The idea of fiscal stability can be gradually implemented by claiming that if the government is seen as solvent without the need for changes in the current state of fiscal policy, states will maintain fiscal stability.

2.7 PUBLIC DEBT MANAGEMENT IN SOUTH AFRICA

Ayadi and Ayadi (2008) point out that developing countries like South Africa are heavily dependent on borrowing to improve their economies. However, external debt weighs heavily on the economy and even supports it. In recent years, South Africa has borrowed more and more externally, resulting to lower economic growth and higher unemployment. This may be due to the fact that the country's financial assets are low and therefore heavily dependent on external institutions. However, Pereira and Rodriguez (2001) believe that this situation puts pressure on

future taxpayers who have to pay higher taxes in addition to interest. Hence, the effect of interest rates on public debt needs to be considered.

Public Debt Management (PDM) refers to the steps taken by the national government to collect and authorize a scheme aimed at managing the debt incurred by the government (Siswana, 2017). It assists in financing and assisting the needs of the government, expenditure and government targets and measures of risk. Furthermore, it is used as an essential tool for the national government to achieve the objectives of accelerating, supporting and ensuring economic growth. Krinau (2006) agrees, stating that there is a way to develop and operate a mechanism for managing public debt so that the required amount of borrowing is increased, its expenses and risk targets are pursued to compliment other PDM objectives set by the government.

The International Monetary Fund (2014) indicates that it should be at a price lower than the appropriate risk in the medium to long term. Johnick and Preston (2006) found that PDM approaches government debt management; this management depends on the measures and the capacity of the government to constraint money efficiently. Therefore, PDM centers around the measures involved in creating a compelling strategy to manage the productive and prudent public debt management. The process, which the government has completed, focuses on formulating and implementing strategies to help it meet its responsibilities by obtaining the necessary funds at the insignificant costs. The IMF (2014) recognizes that this should not be done to deliver the above results and should be in line with the goals that the government should play in fulfilling its obligations through its debt securities, by keeping its trading operations through debt securities, and developing them efficiently. Public debt management effectively promotes the goal of trust and confidence in the work of the government, while also making long-term plans to support the debt and strengthen investors' incentive to accept the loan.

Such control on the public debt will help the government authorities to repay long-term borrowings and limit its reliance on domestic and foreign investors in the process. Thus, eliminating the consequences of repurchasing such debt (International Organization of Supreme Audit Institutions, 2007). Debt management should take precedence over financial policies, structures and strategies that oppose any minor impact of subsidy incentives and priorities.

Obviously, PDM should be performed in a service-friendly manner. In fact, the government borrows money regularly to support government initiatives and to stimulate the economy, and

accordingly, increasing debt. When successful and stable policies, and procedures are in place and the right goals are set for debt management, sustainable public debt management is essential. The International Monetary Forum (2014) also agrees that public debt regulators, such as financial authorities, must actively cooperate to achieve this goal.

2.7.1 Public debt stock market

The main debt market began before the major stock market (Floor, 2013). Evidence of transferring credits or such game plans within the Hammurabi Act can be traced back to ancient Babylon. China's debt market played an important role in achieving China's regimes, and ancient Greek and Roman debt market was used during foreign economic activity and war. Debt market in various countries is used to finance war and shipping practices. In South Africa, the elected democratic government needed to accumulate debt during the apartheid era. Despite the fact that South Africa's capital market was well established at that time, it was fundamental to introduce new strategies to deal with public debt management. Launching new strategies to manage and achieve PDM objectives would attract both domestic and external investments. IMF and World Bank (2003) emphasize that the Comprehensive Debt Management Framework is a scientific study conducted to meet and guide South Africa in addressing the challenges of PDM policy, and it additionally empowered relentless abandonment of debt management policy and adoption of a strategic approach to debt management. This included recognizing political issues, shifting from key to strategic means of monitoring government debt, and setting PDM goals in chronological order of significance. The IMF and the World Bank (2003) further express that;

> "The vital debt management policy took a look at the general structure and usage of the debt management program. This incorporates how primal issuance is structured and managed, how debt instruments are planned and traded, and how liquidity is given. Strategic debt management policies focus on effectively dealing with the accrued stock of debt and its synthesis to diminish the cost of debt to within adequate risk limits"

According to Mabugu *et al*. (2015), the South African government has begun to regulate debt management strategies since 1994 using macroeconomic frameworks. In 1996, appropriate bond exchange was established to boost the capital debt market and enable self-regulation. The government has taken steps to avoid further increases in the debt level and has begun to repay the debt level as a percentage of the GDP. The main purpose of the PDM was to build an internal

market and promote a fair maturity profile. Since 1999, the emphasis has been on raising the cost of the debt to the sufficient risk limits, ensuring government admittance to domestic and global financial markets, and extending financial tools. These objectives are as yet addressed to by PDM strategies in South Africa today. In such manner, Nene (2015) draws attention to the way that good macroeconomic policies (fiscal and monetary policy), engage the government authority to actualize its infrastructure programmes at the lowest cost. This establishment has prompted improvements in macroeconomic security and in the nation's credit scores. Nene (2015) keeps on expressing that;

> "By mid 2000s, the government had paid off its debt from 38 percent of GDP to 22 percent of GDP. So when the financial crisis hit in 2008, the government had fabricated enough fiscal space to have the option to react to the crisis in a countercyclical way"

As confirmed by the 2015 budget review, the situation in South Africa is that the net government debt in 2014/2015) was R180 billion, R1.1 billion more than the 2014 financial budget forecast. It got reduced to R173.1 billion in 2015/16, and to R155.5 billion in 2017/2018. Admittance to South Africa's domestic liquid capital markets and foreign borrowing keeps on giving government budgetary assets. In 2015, three new bonds were offered. These instruments have extended financing alternatives, postponed the public debt development profile and reduced current refinancing risk. At long last, net government debt, provisions, and unanticipated costs increased to 58.1% of GDP in 2015/16 and to 57.3% of GDP in 2017/18.

As Nene (2015) points out, South Africa's economic recuperation from the crisis has been much more slow than anticipated. Gross domestic product growth was estimated at 2%, yet in the first quarter of 2015 it was just 1.3%. This circumstance has been exacerbated by the negative effect of the energy crisis. Regardless, Nene (2015) showed that South Africa focused on progressing basic structural reforms important to invigorate economic growth and development, and oversee long run public debt challenges. It lies in the medium term key system of the government. The above mirrors the government's confirmation to steadily and generally reduce total public debt. Notwithstanding the moderate growth of the economy, government strategies should be overseen in a maintainable way to adapt to rising spending on both economic development and social issues. It ought to likewise conform to global benchmarks.

In most cases, governments borrow money for spending and investments. Governments can get to run on expansionary policies pointed toward invigorating the economy by either expanding spending or decreasing taxes, and decreasing unemployment by expanding the money supply. The South African government borrows money by giving government bonds and offering them to private investors around the world and locally (Fiscal and Financial Commission, 2015). In recent years, the South African government has stretched out its borrowing programmes because of difficult economic conditions.

Weak economic growth has brought about revenue collection failing to meet expectations, increasing public debt to support the fiscal position. As a degree of GDP, the net public debt expanded to 40.8% in 2014/15 (Budget Review, 2015). This gives a test to the South African government, as it must guarantee that the net public debt is sufficiently and reliably kept up. The South African government has formulated a medium-term borrowing methodology to diminish the sharp increase in the public debt. The 2015 Budget Review additionally proposes that the medium-term borrowing methodology would show how the government could fund the debt from 2015 to 2018. This methodology incorporates debt levels, primary budget balance, financing tools and methods, cash flow necessities, investors' needs, risks and costs of the domestic market reform and alternative strategies.

2.7.2 The function of the South African National Treasury

The National Treasury is answerable for South Africa's public government finances. Supporting profitable and sensible public finance management is basic for economic growth and development, and the improvement of good governance (National Treasury, 2015). Obviously, the head of the National Treasury, the Minister of Finance, is answerable for four essential tasks. To be specific; dealing with the economy through fiscal and monetary policy, plan and present the yearly budget speech to Parliament, public debt management and controlling public funds (Visser and Erasmus, 2002).

According to the PDM, the Minister of Finance has the "authority to finance budget deficits on behalf of the government by borrowing money, acquire foreign currency; and to control the local financial conditions in order to establish financial and economic stability" (Visser and Erasmus, 2002). The National Treasury is regarded as an approved body for borrowing. These include

government financing, limiting costs, improving financing resources, and maintaining a balanced maturity structures (Fiscal and Financial Commission, 2015).

Therefore, the National Treasury monitors the national debt and liquidity by necessitating that government borrowing needs are met annually in both local and global financial markets. In this way, the borrowing programmes need to be put together continuously. Liquidity requirements are reliably covered by a compelling cash management system by continuously generating solid cash flows (National Treasury, 2014). Persuasive cash management includes a comparison of coupon payment and collection cash flows; ensuring a normal predictable emission plans; reducing the risk for turnover; smooth maturity profile; strengthening the implementation of successful monetary policy; improving the efficiency of the forecasts for the interest cost (Commonwealth Secretariat Debt Management Forum, 2008).

PDM is also typically related to risk management, where risk management involves the evaluation of debt scores. Hence, debt management requires a sound risk management framework to reduce risk (National Treasury, 2014). The National Treasury plays a significant role in the effective monitoring of the risks associated with the debt portfolio. It involves the development of debt management methods focused on paying off past liability costs with adequate risk. The National Treasury is committed to ensuring that debt is maintained at an adequate level. Different activities have been created to keep up the economic degree of public debt, and debt management methods are imperative to help these activities. The National Treasury must embrace sound fiscal and monetary policies and back up economic growth. Accordingly, the government's authority can accomplish its objectives and goals and satisfactorily fulfill its political needs.

2.7.3 Legal and Regulatory Framework for Public Debt Management

The legal framework is upheld by the Public Financial Management Act No.29 of 1999 (PFMA) and the South African Constitution. Thus, Table 2.4 presents the legal framework supporting the public debt management in South Africa.

Table 2.4 Legal framework supporting public debt management in South Africa

	Instructs the National Treasury to ensure: • Transparency • Accountability

Constitution of the Republic of South Africa (Chapter 13)	• Sound financial controls in the management of public finances
Public Finance Management Act (PFMA) 29 of 1999	The Minister of Finance is regulated by Section 66 (2) (a) to present future budgetary commitments to the National Revenue Fund by borrowing money, providing collateral, reimbursement or security, or conducting some other official transaction. The Minister of Finance can borrow to; Financing for the national budget deficit • Financing of debt or debt paid before the date of recovery • Receive foreign currency • Maintain credit balance on the National Revenue Fund ledger • Regulates internal financial position

Source: Adapted from Mabugu *et al.* (2015)

Similarly, the regulatory framework is decentralized and consists of, among others, the South African Reserve Bank (SARB), the Fiscal and Financial Commission (FFC) and the Johannesburg Stock Exchange (JSE). Therefore, Table 2.5 presents the regulatory framework that supports the management of public debt in South Africa.

Table 2.5 Regulatory framework supporting public debt management in South Africa.

South African Reserve Bank (SARB)	National Bank of South Africa. Regulated in accordance with SARB Act No. 90 of 1989. The mandate is as follows; • Provide banknotes and coins. • Monitor and ensure the internal and external value of the Rand. • Maintain financial stability and support economic growth. • Manage short-term capital markets and buy treasury bills. • Managing public debt by controlling inflation, informing the Finance Minister of public debt status, determining the strategy of allocating government securities and accounting to the public debt service.

Fiscal and Financial Commission (FFC)	Independent organization that is objective, fair and unprejudiced. Capacities include: • Provision of advisory services to government agencies on monetary and budgetary matters. • Identify PDM challenges, create reasonable economic progress and make proposals. • Reduce public debt by implementing methodological strategies to eliminate PDM challenges.
Johannesburg Stock Exchange (JSE)	Self-managed organization that offers listing requirements and trading platforms in a direct, efficient and orderly market. The listing includes stocks, bonds, commodities and currency derivatives. The new requirements for listing JSE debt include: • All issuers, including the National Treasury, must select a sponsor for the debt • If there are specific details regarding the listing, the JSE must be consulted to investigate such characteristics. • The issuer will distribute service in real time on the Stock Exchange News (SENS) which contains details on new issues and correspondence with investors. • Issuers are required to provide placements and various entries for the listing of debt instruments. • Debt securities listed on the JSE are processed via the head office and settled securities accounts (CSDPs) and fully electronic transactions (STRATE)

Source: Mabugu *et al.* (2015)

With this legal and regulatory framework, the South African government is guaranteed the ability to deal with its debt in a sustainable and pragmatic way. The challenges associated with maintaining adequate public debt are reinforced by this solid structure.

2.7.4 National Treasury's Challenges

The National Treasury faces many challenges to properly and effectively monitor public debt. Serious public debt makes it difficult for a country to operate successfully. After poor economic output and high unemployment, governments need to spend more on infrastructure and economic development to tackle the issue. In doing as such, the government need to spend more money to guarantee its prosperity. This is a significant level of public debt that can prompt bankruptcy. As indicated by the Fiscal and Financial Commission (2015), increased levels of public debt can hinder the government's capacity to meet its spending programmes. In such manner, it is hard for both policy-makers and the National Treasury to react properly and viably to changes in tax base, economy and interest rate conditions as they adversely affect public debt levels.

For this purpose, there is a challenge of high borrowing rates. The government borrows for a variety of reasons, including economic growth, housing, defense, infrastructure, healthcare and research. As per Fiscal and Financial Commission (2015), some borrowed funds are for spending and others for the purpose of investment. Accumulating debt can help the government to restore the economy during a recession, or account long run investment projects that can support the economy at a later stage. Regardless, the government does not generally increase taxes or cut expenditure to maintain the debt, prompting an increase in government debt. Likewise, when the government borrows for current spending purposes, this sort of borrowing does not give any future economic advantage and makes it hard for the government to meet debt commitments.

Interest rate is the costs of borrowing, hence; Mabungu *et al*. (2015) clarify that interest payable on public debt is a vital part of the government's yearly expenditure and was assessed to be R100 billion for 2014/2015 fiscal year. Depending mainly on the likelihood of an increase in interest rates, the impact on the government's ability to meet other required expenditures can be minimized. This can lead to an increase in government spending, forcing other spending. Mabungu *et al*. (2015) further added that the repayment of borrowed funds puts pressure on the local bond market and increases the spread of long-term bonds over short-term ones, which further puts pressure on financing the long-term debt. Nene (2015) states that government borrowing has expanded the degree of public debt, which ultimately debilitates fiscal policy.

As suggested by the International Monetary Fund and World Bank (2003), the National Treasury faced another challenge, with an approach to maintaining an effective, transparent and liquid

government bond market with borrowing requirements. The decline in government paper supplies due to the declining liquidity of the bond market is often understood, particularly in economies whose securities markets are still in a critical phase. It may be that without leaving liquidity in the bond market, South Africa has reduced its paper stock to suit the government's low borrowing requirements.

The IMF (2014) identifies several challenges that depend on the facilitators of the PDM; to be specific, an over-reliance on transitory debt to exploit low short-term interest rates can leave the government unstable and helpless in the face of rising debt service costs and risk of default, should the government has to pay its public debt at any cost. Subsequent volatility could affect the achievement of the SARB's monetary targets.

Distortion of public debt is a reality and may be due to lack of coordination, lack of credit details, inadequate authority over non-financial credit, and the responsibilities of public-private partnerships. Leasing debts and making payments can lead to bad government advice. These include negligence in filing accrued interest on long-term interest-free loans, lack of a parliamentary report on the debt account, and insufficient restrictions on the amount of outstanding debt.

2.7.5 Measures taken to address Public Debt Management challenges

As shown above, the National Treasury assumes a critical part in the PDM. In tending to address these issues, the National Treasury needs to find a way to address the degree of public debt. Above all else, the National Treasury must build up a PDM strategy. The PDM strategy is a plan that understands the objectives of debt management. This speaks to an ideal cut of the public debt portfolio, mirroring the government's inclination to trade costs and risks. It should focus explicitly on the risky characteristics in the debt portfolio, with specific accentuation on potential differences in the service costs of the debt and their impacts on the level of the budget and public (IMF, 2014). It ought to be checked on and assessed persistently.

The value of the strategy of such nature, as featured at the Commonwealth Secretariat's Debt Management Forum (2008), incorporates guaranteeing that debt management goals are accomplished; making a reason for new budgetary decisions; guarantee coordination between debt management and macroeconomic and monetary policy; political support for the strategy; and help improve domestic debt markets. Accordingly, Krynauw (2006) believes that cabinet members

should be included in the formulation of this strategy, that macroeconomic and financial stability should prevail, that the government should become more important as an issuer, and that there should be sound fiscal and monetary policies, creation and implementation of an appropriate legal framework, setting of credit targets and alignment of PDM strategies with monetary policy

Like the medium-term financing strategy, the PDM's strategy should be outlined in the previous year. The risks associated with the global economic outlook, market growth, economic and fiscal policies, domestic market recovery, and debt portfolios need to be considered. Similarly, it must be verified by the Minister of Finance, then presented to Parliament and published as an important aspect of the budget document (Federal Secretariat Debt Management Forum, 2008).

Some measures are needed to improve the validity of the strategy. According to the Fiscal and Financial Commission (2015), policy instruments that address high public debt levels incorporate financial adjustments, debt rebuilding, economic growth and development, and budget constraints. Firstly, fiscal consolidation includes utilizing tax and spending cuts to reimburse public debt. Taxing a company in such a way that increases corporate taxes is one approach to do monetary restructuring. The government's authority can reimburse public debt by expanding government revenue. This decreases the current deficit and positively affects the decrease in public debt. The IMF (2014) concurs with the above mentioned and adds that these fiscal consolidation procedures must be sound, reasonable, and legitimate to execute. Notwithstanding, for fiscal consolidation to be successful, it must be in the medium term (Fiscal and Financial Commission, 2014). It tends to be said that fiscal consolidation should be an answer if tax hikes and expenditure cuts are conveyed with caution. Cognizance must be taken not to overburden the taxpayer or the corporate or, then again; not to cut fundamental expenditure that may hamper economic growth and lead to more severe unemployment.

Secondly, debt restructuring refers to the reactivation of debt that is overly managed and oppressive to the borrower. It suggests giving progressively permissible rules on how the debt will be repaid. This implies a decrease in the outstanding balance. Debt restructuring helps governments reduce debt burdens and restrict their taxpayers' estimates of forced consolidation (Fiscal and Financial Commission, 2015). The following is how Ingham (1995) identifies debt reduction and compensation;

> "Debt reduction is any measure which reduces the debt owed by the government. For instance, debt can be swapped for equity and profits as opposed to interest paid to creditor. Debt relief is any measure which decreases the current value of payable instalments. For instance, rescheduling a debt may decrease instalments in the short run"

Hence, basic tools to constraint the debt without raising the rates of interest and/or unemployment; can be found.

Thirdly, economic growth permits the government to decrease the size of its debt to the size of its economy. Essentially, lower levels of government spending will build tax revenues and decrease the cost of public debt (Fiscal and Financial Commission, 2015). The Fiscal and Financial Commission (2014) has said that in such manner, public debt will decrease over the long run and real GDP will decrease comparatively, yet marginally. This shows that it is conceivable to pay off public debt without harming the GDP and its future growth. The Fiscal and Financial Commission (2014) further said that the government expenditure shortage would be decreased in a manner that would positively affect the decrease in public debt. Nonetheless, caution is encouraged; on the grounds that attempting to support economic growth can squeeze socio-economic outcomes, and people's development and prosperity at risk (Fiscal and Financial Commission, 2014).

Fourthly, financial suppression includes the utilization of government policies to help or initiate domestic investors to purchase government securities at misleadingly low interest rates. Financial suppression can be alluring given that it keeps up a strategic distance from loopholes such as austerity measures. In any case, following 20 years of financial freedom, it would be truly hard for the South African government to return to the capital controls necessary to execute such a policy. These controls can subvert a country's capacity to pull in foreign investors and cutoff investment opportunities (Fiscal and Financial Commission 2015). Financial restraint must be viewed as a invaluable measure.

Nene (2015) states;

> "A couple non-negotiables that incorporate reasonable macroeconomic policies; fiscal and monetary control; establishing a solid and liquid local; currency bond markets; and advancing policies that make a country an investment-friendly environment"

Notwithstanding the fundamental sound and practical exclusive macroeconomic policies, a well performing security/bond market is significant for economic growth as it advances household savings, budgetary stability and compelling initiation of market-based monetary policy (Nene, 2015).

Mabugu *et al*. (2015) contend that fiscal changes are expected to address debt components. In this manner, another measure that the government as of late embraced is a fiscal position dependent on three guidelines. The essential standard is countercyclical, which implies that spending increases comparative to GDP during the times of economic weakness and less during the times of strong economic growth. The subsequent standard is long run debt manageability, which implies that spending levels do not consistently build the debt, interest rates, and debt service costs. The last standard is intergenerational equity, which suggests that future generations ought not to be burdened with the expenses of the current spending and that the real cost of infrastructure capital resources ought to be spent over their lifetime.

Nene (2015) concurs with the abovementioned, expressing that;

> "Government has invested in narrowing the budget deficit and balancing out debt by acquainting and staying with expenditure ceilings and taking measures to raise revenue"

The Fiscal and Fiscal Commission (2014) states that it is appropriate to take caution on borrowing. If borrowing is managed adequately, it is a significant and fitting option accessible to the government to fund sustainable infrastructure and development needs in accordance with the goals of the National Development Plan (NDP). This, regardless, should be accepted that the PDM has kept on pursuing the objective of pulling in the necessary funds at the least cost within the given risk tolerance. As needs be, as the IMF (2014) points out, the ability to control and borrow ought to be plainly defined in legislation. The reasonable PDM policy, by portraying the policy in detail and executing the above measures, the National Treasury, with its prevalence, can overcome different issues emerging in the supervision of the public debt.

2.8 CONCLUSION

Fiscal policy in South Africa has played an important role in providing and sustaining better standards of living for ordinary citizens of South Africa since 1994. It was through fiscal policy that programmes like RDP, GEAR, ASGISA and NDP were realized in South Africa. These

programmes made remarkable efforts as far as economic growth and development are concerned in South Africa though they had their drawbacks. It is for this reason that South Africa went through more than one growth and development programmes.

Just like any other economy in the world, the South African economy took a knock from the 2008/9 global financial crisis. The National Treasury adopted a countercyclical fiscal policy reform which has made the South African fiscal position stronger as shown in the trends for South African fiscal variables.

Central to the main objective of this study, this chapter has shown that tax revenue in South Africa has been increasing by unstable and small amounts compared to public debt between 1985 and 2019. Instability on the South African tax revenue over the said period makes it difficult to tell whether the public debt has been increasing or decreasing because of it. It is for this reason that this study applies a nonlinear modelling technique in addition to the linear one.

On some of the specific objectives of this thesis, this chapter showed that corruption within the public governance leads to debt accumulation in the sense that the funds that were meant for public service delivery has been used for personal interests by politicians. This forces the government to go and look for the funds they had budgeted for in the first place.

Lastly, the National Treasury is doing the best in its capacity to constraint the public debt within the sustainable brackets, subject to the volatile South African economic atmosphere. This is on the grounds that public debt is expected to decline as per 2020/23 medium term estimates framework. This is because government revenue growth rate is expected to surpass the government's expenditure growth rate.

CHAPTER THREE
LITERATURE REVIEW

3.1 INTRODUCTION

The main focus in this study is to estimate the effect of tax revenue collection on the public debt in South Africa. It is therefore important to understand the nature of the theoretical link between these two variables. Furthermore, since the secondary objective of this study is to determine the extent to which political instability and corruption affect public debt in South Africa, economic theories underpinning the relationship between these variables will also be reviewed.

Hence, this chapter is arranged as follows; section 3.2 unfolds the debate on the common philosophies underpinning public debt and taxation. Section 3.3 discusses the economic theories and models linking tax revenue collection and public debt. Section 3.4 discusses the economic theories and models underpinning the relationship between corruption, political instability and public debt. Section 3.5 reviews the empirical studies carried out in developing and developed countries, and South Africa. Section 3.6 concludes the chapter by providing the general summary on the analysis of empirical literature.

3.2 DEBATE ON THE COMMON PHILOSOPHIES UNDERPINNING PUBLIC DEBT AND TAXATION

This section aims to explore the debate on philosophies underpinning public debt and taxation. The focus of the debate in this study is on the Public Principles of Public Debt, Keynesian theory for public debt, Ricardian equivalence and Burro's theory of public debt. The reason for this debate is to understand the impact of public debt's burden on both the current and future tax payers (tax revenue).

3.2.1 Buchanan's Perspectives on Public Debt

Buchanan (1958) presents the main thoughts of the Keynesian orthodoxy and argues its views with reasonable contrast in its philosophy, commonly known as the Principles of Public Debt. The first and most fundamental objective of the debate is whether the burden of public debt can be transferred to future generations. The Keynesians believe that the burden of public debt cannot be passed on to future generations. Rather, the burden of public debt is a real sacrifice of private goods and services that require public expenditure, and this sacrifice will certainly be made by the present generation (Buchanan, 1958). Therefore, there should be no burden on future generations, as future

interest costs and taxes will come from the debt itself (productive borrowing), which means that the debt will service itself. Tax collection costs for future income are adjusted by the profit from the interest payments, hoping that future public debt will be what we consider to owe ourselves as a country.

Buchanan raised questions on these premises and the end that Keynes established, arguing for the possibility of future burdens from the introduction of public debt. According to Buchanan (1958), future taxpayers are obliged to pay as much as possible without public debt, and they do so without offering investors future assets. Therefore, the burden of public debt is not carried by current investors, but by future taxpayers.

Buchanan (1958) contends that the reaction to the occurrence of the burden for public debt was clear after a simple inquiry; "Who suffers when public borrowing is rash and government spending is futile?" Even if such a grievous situation emerges, the current investor will not be harmed a lot. They would still have interest payments to make up for changes in their income streams that they would get with ideal and sensible public expenditure. In this sense, future taxpayers should bear the burden of public debt, as current taxpayers do not need to shoulder the burden of government expenditure. An expansion in the income streams, when the future taxpayer's personal balance sheet is reduced by tax payments and only increased by the personal value of all social or monetary assets made distinctly from public debt (Wagner, 2014). In this way, Buchanan dismissed the Keynesian othordoxy for evaluating the burden of public debt, thus; improving the degree of analysis, and inspecting the possibility of investor's sacrifice.

3.2.2 Keynesians Response to Buchanan

Firstly, Buchanan's comments were answered on the Public Principles of Public Debt. Keynesian's review of this work as a prominent article added many flaws to his claims. Keynesians strongly dismissed Buchanan's central claims made by Rolf (1959) in the *American Economic Review Journal*. Rolf (1959) insisted that Buchanan's work was controversial in nature and questionable in tone, distinguishing it from good academic literature. Rolf (1959) argues that Buchanan's use of the term "new methodology" is inappropriate and detrimental to a group of economists whom Rolf (1959) considered diverse and varied.

This is because Rolf (1959) did not see any clear policy proposals or criteria and therefore supported the Keynesian claim about shifting the public debt burden. Thus, Rolph (1959)

maintained the position of Buchanan on the new orthodoxy without abandoning the Keynesian orthodoxy completely. Another Keynesian rebuttal, along with Tobin's (1965) review of Public Debt and Future Generations, an angiology edited by Ferguson (1964), which includes three articles after Buchanan's main claims. Just like Rolph (1959), Tobin (1965) maintained the debt burden at the present time, pointing out this as Buchanan' real point of attack. Conversely, Tobin (1965) expressed that "The debt cannot be a burden, since future interest payments or principal of the taxpayers to the investors will be transfers that will not include a project of resources in general" (Tobin, 1965). In general, Tobin (1965) suggested that only Buchanan's prepositional structure of taxes is inherently difficult but yet an adequate individualization a degree of analysis, among all the contribution to volume which could alter the economic orthodoxy on public debt.

The final issue of the attack on Buchanan's work is revealed in an article by Mishan (1963). Mishan's work, entitled "How to Make a Burden of the Public Debt", was transparently focused on Buchanan's attempt to oppose the Keynesian methodology. Mishan (1963) has clearly shown that the publication of Public Principles of Public Debt was the beginning of a movement he described as the "new heretics." Mishan (1963) reviews Buchanan's work in a general and explicit way. Firstly, Mishan (1963) argues that future taxes are certainly not important if the issuance of government bonds generates profitable assets. Secondly, Mishan (1963) objected that a change in individual tastes indicates a lack of confidence in the well-being of investors. For example, today an investor may lean towards a certain degree of current consumption and future income. However, in ten years, the priority ratio may change so completely that the investor will realize the lost profit, regardless of the way they prefer their past activity at that time.

Mishan's (1963) allegations include a reexamination of the possibility that governments will not spend inefficiently and that government spending may provide "significant social benefits over private spending" (Schwartz, 2018). Accepting this claim and considering that important alternatives, as Buchanan (1958) achieves through his work should support public finances. In other areas of the new orthodoxy, Mishan (1963) essentially made the following comments on the objections to Buchanan's internal and external debt; "Buchanan cannot reduce the simple suggestion that if the current debt is internal, we owe it to ourselves, while when it held externally, we owe it to foreigners". Pigau's (1949) long statements would strengthen his argument significantly. Given the impact of the government bond issue on private savings, Buchanan's

methodology is flawed on this past scholarly hypothesis, as it ignores Ricardian equivalence, resulting inflation, and additional adjustments to savings as a result of the bond issue, a notion Keynesianism anticipates. (Schwartz, 2018). Mishan's conflict is the most frequent when he acknowledges Buchanan's views, although he notes that Keynesianism or the "new methodology" now embrace these points wholeheartedly. For example, Mishan (1963) admits that if the private sector could be more profitable, the government certainly should not spend if current public spending has a higher social return than if it were left to the private sector. Mishan's article illustrates various efforts to protect the Keynesian consensus on public finance, while examining Buchanan's perception of tax collection as a burden and government spending as uninteresting productive.

Neither to such an extent nor to the power of these critiques reflects the general modern agreement against Buchanan's ideas, especially when viewed against the background of various studies. Alvis (1959) presents this work as an insight with real input that should be read by anyone who is really concerned about the politics of public debt. Elliott (1959) paid little attention to his discourse, preferring to elaborate further on Buchanan's arguments. Elliott (1959) challenged Buchanan's third hypothesis, that domestic and external debt were not strictly recognized, and argued that organizations in the United States may not give a feasible platform to certain components of Buchanan's thoughts. However, Elvis (1959) did not generally agree with Buchanan's work.

Staig (1958), in her review of *The Social Science Quarterly*, agreed with critics of Rolf (1959) that Buchanan's position would lead to "volatile controversy", but similarly presented his arguments as "carefully consistent" and "distrustful"(Schwartz, 2018). Like Elvis, her work had little protection or introduction to the opposing Keynesian approach, and had a great thoughtful introduction to the position argued in the Public Principles of Public Debt. Staig (1958) further argued that Buchanan's arguments were available outside the field of economics, though they are sufficiently understood in any case.

In general, the reviews may show some consensus that Public Principles of Public Debt is seen as key contribution, which is important in a holistic framework for understanding public debt in the context of full employment or unemployment. It is too far-fetched to even think of this argument that all reviewers considered Buchanan's analysis to be equally prudent, solid, legitimate and impartial, calling it a revolutionary contradiction of the prevailing economic theory. However,

some have undoubtedly come to this conclusion, and the key points of understanding for both supporters and rivals of Buchanan's early work were that they were able to strongly disagree with the prevailing ideology that, if precise, had serious ramifications for the field of public debt.

3.2.3 Robert Barro and Ricardian Equivalence Perspectives on Public Debt

The publication of an article by Barro (1974) opened another part in the existence of Buchanan's (1958) contribution to public debt. The article "Are Government Bonds Net Wealth?" attempted to address the new methodology of the Keynesian that sought to draw attention to the same expansionary fiscal policy that Buchanan (1958) drew attention to. Nevertheless, the methodology used by Barro (1974), with its decision, raised controversy over Buchanan's previous integration. Barro's article and the resulting defense generally contradict Buchanan's concerns about the actual and current economic and political structure of public debt by limiting public debt to its net wealth rather than burdens. Barro (1974) argues in his keynote article that government bonds are the net wealth if the government has a monopoly on bond liquidity management, or if the government is more productive in margins than the market. He starts with proposing a solid format equivalent to the Ricardian Equivalence;

Households equate deficit financing to taxation. Issuing government bonds to cover expenditure carries the risk of future interest payments and the possibility of extreme repayment of principal, so future taxes are not important if the expenditure is funded from current tax collection (Barro, 1974). The level at which absolute tax revenue is set is irrelevant unless it is excluded that the future tax liabilities inherent in the deficit financing are accurately predicted. The behavior of the households is, in reality, the same as if the budget was always in equilibrium (Bailey, 1962).

Therefore, Barro (1974) argued that Ricardian equivalence prevents equivalent government bonds from being viewed as additional national wealth; householders change their spending and saving structure to compensate for the effects of sovereign debt. In addition, Barro (1974) presents two possible counter measures against the use of the Ricardian equivalence in public finance. Firstly, taxpayers will face positive present value of government bonds on future tax costs due to their limited lifetime. Secondly, taxpayers have a higher discount rate on future tax payments than related interest payments. Although Barro (1974) does not refer to Buchanan (1958) in relation to both of these statements, the latter author used both 15 years prior in Public Principles of Public Debt.

In the first case, Buchanan wrote that "if people live an infinite life, the Ricardian equivalent controversy will suffice, but you have to work within the sensory restricted time horizon. In the event that this is acknowledged, the Ricardian equivalence argument falls" (Buchanan, 1958). Secondly, Buchanan argued that "a simillar absence of the market would similarly underestimate an individual's future tax payments (from a related point of view) that are important in supporting debt financing on current capital expenditures." (Buchanan, 1958). Barro's article seems to reject these two critics of Ricardian equivalence in the nature of expansionary fiscal policy, as they propose a net positive current wealth effect on government bonds that require debt issuance to expand aggregate demand.

These two critiques of Ricardo's equivalence recommend the impact of net current wealth on government bonds as a key issue in expanding aggregate demand as expansionary fiscal policy trusts. On account of these recommendations, Barro's (1974) article invalidates Buchanan's critiques. Barro (1974) showed that aggregate demand sway is invalid, thus criticizing Keynesianism and further discrediting Buchanan's essential assumptions. To begin his criticism of the controversy of limited lives, Baro (1974) expects an overlapping generations' model in which people maximize their utility dependent on their current consumption and that of their offspring. Therefore, after the issuance of government bonds, people modify their inheritance to add and create an equivalence that balances the tax payments for future generations (Barro, 1974). Similarly, government spending on educational infrastructure will reduce discretionary transfers to families. To avoid the possibility of this happening in relation to individual decisions, Barro (1974) writes;

> "In the event that, preceding the government bond issue, an individual from the old generation had effectively chose a positive inheritance, unmistakably this individual previously had the choice of shifting resources from his descendant to himself, yet he had established that such shifting, at the margin was non ideal. Since the adjustment in B does not change the significant opportunity set in this sense, it follows that through the appropriate change of the inheritance, the estimations of current and future consumption and accomplished utility will be unaffected" (Barro, 1974).

Barro summarizes these results as a summary of generations further removed from the underlying debt problem and legitimizing the contention of equivalence for mathematical equality. After

criticizing the primary attack on Ricardian equivalence, he moves the second assumption of imperfect capital markets. This he rejects by stating that the government may be a more efficient lender than the private market in a particular area of lending behavior. As a result, "to some extent, the influence of government bonds on net wealth is zero despite the persistence of imperfect private capital markets" (Barro, 1974).

In light of these results, Barro (1974) came to a firm conclusion on the general impact of government bonds on public debt. He wrote that;

> "An adjustment in the stock of government debt would have no impact on capital formation, and fiscal impacts including changes in the general amount of tax and debt finance for a given amount of public expenditure would have no impact on aggregate demand, interest rates, and capital formation" (Barro, 1974).

On this basis, Buchanan's (1958) contributions to the public debt's burden seems outdated in light of the fact that debt finance, totally or comparative, with tax finance, has substantially minimal effect on basic economic fundamentals. Its essential effect on behavior is primarily to combine reaction with the goal that neither party is better or worse than the other option (alternative).

Barro (1974) admits that some of his modeling assumptions are impractical. For example, Barro (1974) acknowledges that given the fact that households cannot make a difference, the effect of public debt issuance depends on domestic inclinations and makes the inheritance scenario a reality. Furthermore, Barro (1974) argues that his model of equivalence assumes a balanced utility that people will plan to improve the estate. However, not all people share their inheritance or wealth. However, he was persuaded to present the model and its consequences, and decided to back it up in later articles. One such contribution was the "Federal Deficit Policy and the Effect of the Public Debt Shocks" written in 1980. In this article, Barro (1980) argues that the effective part of the federal deficit policy was reasonable in line with the government's objective of balancing expected tax rates over time. The following is basically the summary of what he wrote;

> "The significant developments in privately held and interest bearing government debt can be clarified as aspects of a policy for accomplishing an inter-temporally proficient collection of net revenues even with fluctuations in government expenditures, national income, and inflation. There is additionally some sign that the irregular takeoffs of debt changes from the regular

pattern have added to developments in the unemployment rate and output. In any case, the fluctuations from this source have directly been disengaged and they are considerably smaller than those related with monetary unsettling influences" (Barro, 1980).

Due to this proposal, where public debt is perceived to be shifting, as has been the case with skilled and productive policy-making with long-term objectives, Barro (1980) expressed skepticism about the size and mechanism of public debt. He commented that the pressure on a constitutionally balanced government budget was troubling to see that the resulting inefficiencies would benefit government financial officials.

At the time, Buchanan was engaged in a certain type of political activity, which Barro criticized. Given their view that debt is a burden for future generations, the economics of public choice and previous work on public finances have led them to the plan of action for balanced budget adjustment and can stimulate existing taxpayers with the limitation of lives. However, regardless of Buchanan's prudent approach, Barro criticized on experimental grounds, arguing that the Buchanan regime's policies could slightly reduce the size of the public sector due to the increasing waste of resources per unit of government expenditure. Obviously, this policy is indicated by direct restrictions on the amount of government spending, especially in the transport sector, as well as other direct restrictions on the size of government forces. Barro clearly favours efficiency over criticism, and because his article promotes the current effectiveness of public debt solutions, intense activity was meaningless.

This study supports Buchanan's (1958) contentions on the burden of the public debt. Put practically, Buchanan (1958) emphasizes that the rising levels of public debt will not harm the current investors and tax payers but future tax payers. That is, the burden of public debt shifts to future generations. As much as Keynesian economists have good and valid contributions in the field of public debt, to establish that public debt burden does not shift to future generations is not practical, especially in developing economies. This is due to the fact that most of the developing economies are known to be coupled with 'unproductive' expenditures, and high unemployment rates, which make it difficult for the economy to look forward for future interest instalments and tax payments.

3.3 EXPLORATION OF THE THEORETICAL LINK BETWEEN TAX REVENUE COLLECTION AND PUBLIC DEBT.

The following are the economic theories and models establishing the relationship between tax revenue collection and public debt, as the primary objective of this study is to estimate the effect of tax revenue collection on public debt. There are many theories establishing the relationship between tax revenue collection and public debt. However, this study focuses on Keynesian theory, classical theory, three-gap model (with fiscal gap) and the debt service in tax competition model of fiscal policy.

3.3.1 Classical Economists' Theory for Public Debt

Adam Smith, Jean-Baptiste Say, David Ricardo, Thomas Malthus and John Stuart Mill established the classical economics between the late eighteenth and mid nineteenth century. This philosophy is a wide framework for explaining and comprehending the drive of goods in a market. National governments also have an enthusiasm for economic theory. Politicians depend on research of government consumption and/or expenditure, taxation, money stream, and private consumption data necessary for making laws or setting policies (Adams, 2012).

Kneebone and McKenzie (2003) state that the classical economic model in general tends to advocate for a free market structure. Thus, a little government intervention is expected to help in bolstering the general society. The primary thought of the classical economic theory is that governments should be in control of the mainstream of economic resources. Hence, governments give resources, offer occupations to specific stakeholders, and control the economy through robust taxation. The reallocation of wealth attempts to guarantee an equal standard for all people living under the government's position and authority (Mitullah, 2004).

The classical economists saw public debt as a capital injection that necessitates investment's production as opposed to the consumers' consumption (Say, 1880). Hence, this suggested that any method of borrowing to fund government expenditure would be inefficient, irrespective of the circumstances at that time. Besides, the current public debt ought to be successfully managed promptly (Churchman, 2001; Medeiros et al., 2005; Mohanty and Mishira, 2016). The concern was the limitation of monetary policy due to the nature and size of the public debt. Governments view borrowing as an option for taxes, which can increase expenditure without increasing tax rates and/or revenues accordingly (Pascal, 2012).

According to Kneebone and McKenzie (2003), classical theory is mostly criticized for two reasons. Firstly, most of government expenditures are generally unproductive, so public debt is not seen as a constant burden on the economy, and the traditional view of the burden incidence of the public debt is inappropriate. Resources cannot be withdrawn from private use and real debt must be borne in the period when public expenditures are realized through government borrowing programmes, as they are only on public projects. Future generations will lack the basic burden. Future generations receive not only interest payments and principal payment from the liabilities, but also inherit assets, as the privilege of accepting interest and the principal on the payment side alongside interest and the principal on the receipt side belong to the same generation. There is no transfer between the generations but a transfer within the same generation.

The view of the classical economists is contrary to public borrowing. Dedicated to "laissez-faire" rule and the regulatory activities of market forces, classical economists played the role of ensuring smooth economic interaction for the state, without allowing public authorities to interfere with the economy. Assuming that public expenditure is ineffective, consistent with the primary allocation assumed by the state (public order, national defense, discretionary relations, etc.), and those assets inefficient in the public sector than in the private sector, classical economists blame public borrowing for the fact that it locks private capital from its productive capacity to non-productive spending. Therefore, it affects the accumulation of capital (and therefore the stock) and the growth and development of the economy in general.

3.3.2 Keynesian Theory for Public Debt

The Keynesian model was originally developed by Keynes (1936), stating that high public debt leads to an increase in taxes, though discouraging private investment, reducing private consumption, and reducing both employment and the growth rate of the economy. Nevertheless, public debt at a moderate level can promote economic growth (Kamudia, 2015). Governments can use the accumulation of debt to make profitable investments that can increase national output and stimulate economic growth. If the public debt is not otherwise coordinated, it can create some difficulties.

For example, increases in public spending restrict domestic economic activity by crowding out private investment due to increasing real interest rate (Biza *et al*., 2013). However, as the Keynesian closed economic theory hypothesized; increases in public spending are associated with

higher national output, which induces employment (Makin, 2015). In any case, access to investment can be completed with higher public spending. The need to fill the savings-investment gap proposed by the Keynesian model is by foreign investment or foreign aid (Mangale *et al*., 2013). The disadvantages for the Keynesian theory for public debt include the following, among other;

- Borrowing causes higher interest rates and financial crowding out. Keynesian economics supported increasing the budget deficit in recession. However, it is contended that this causes crowding out. For government to obtain more borrowing, the interest rate on bonds rises. With higher interest rates, this disheartens investment by the private sector.
- Resource crowding out. In the event that the government borrows to fund higher investment, the government is borrowing from the private sector and consequently, the private sector has fewer resources to back up private sector investment.
- Inflation. An issue of expansionary fiscal policy is that it frequently comes past the point when the economy is recovering anyway, and causes inflation.
- If the government pursue expansionary fiscal policy, for example, cutting taxes financed by borrowing, then people will not spend the tax cut on the grounds that they believe that taxes will rise later on (in the future) to take care of the debt, hence, expansionary fiscal policy has no effect.
- Encourages large governments. In recession, governments tend to increase spending, however, after a recession, government spending remains prompting high tax and spend systems. Friedman (1978) joked “nothing was permanent as a temporary government program". Government spending projects might be intended for the short term, yet once started they make amazing political pressure groups who campaign the government to seize them.

Regarding the economic effects of public debt, the Keynesian view points to a more basic level than that of classical economists, because public debt is responsible for its detrimental consequences, and in the near future, as can be expected, it proves its commitment to the smooth running of the economy (without significant disequilibrium). Two notable arguments support the weakness of this distinction.

Firstly, by increasing the size of government, thus tolerating public expenditure (which contributes to public debt) ceases to represent complete, decisive and irreversible consumption of resources, which negatively impacts the national wealth and the prosperity of the general economy (Biza *et al*., 2013). The contribution of public authorities makes it possible to avoid negative effects (losses), in contrast to value-added activities (public works, suggested by Keynes) and promotes economic growth and development. Secondly, the reassessment of the role assigned to public authorities gives new implications for public borrowing, in the spirit of handling a commitment to disrupt economic and social phenomena, as a means of intervention to deal with disequilibrium, and guarantees an upward growth of the economy (Mankin, 2015).

From this point of view, it would seem appropriate to describe the effects of certain Keynesian supporters on public debt in structuring fiscal policy on the demand side to get the economy going again during a recession or to promote balanced economic growth. Due to the real consequences of the global economic crisis of 1929-1933, and depending on the general theoretical developments of Keynes, such a policy involves constant interaction with the state through its financial methods to support economic recovery and unemployment in the midst of a recession or when it occurs too slowly or the economy is stale. In particular, the measures taken indicate mainly an increase in government consumption or capital expenditure, but without excluding tax measures (tax cuts, tax exemptions, etc.) (Filip, 2010). Such measures help to increase aggregate demand and therefore promote an increase in the supply of goods and services, GDP growth and employment.

Often these measures involve the tolerance of erratic features between a lower level of regular budget resources (primarily taxes) and a higher level of budget spending, for example the tolerance of budget deficits which are financed, with other extraordinary resources, through public borrowing which results to higher public debt. Although, for some Keynesians, the issue of inflationary currency has not been avoided, public debt can put the unused revenue of some social groups into economic circulation, especially savings not employed in investments, so to support public spending. According to the Keynesian theory, for these reasons, public debt is known to be an important means of ensuring reasonable economic growth.

While the Keynesian perspective generally attributes positive effects to public borrowing, its use is subject to strict constraints. These constraints are the result of a "controlled" increase in the budget deficit only in times of economic slowdown or stagnation, not allowing them during growth

(to be constant). In this regard, it appears to be relevant to the standard theory of deficits established by Beveridge (1930), from Keynes' point of view; that despite the fact that it must be recognized that "the way out of the crisis depends heavily on public loans to support increased public spending, and thusly the budget deficit", once a deteriorating economy recovers, the public budget should bounce back (Filip, 2010). In turn, Duverger (1975) pointed out that the budget deficit should cease when full employment is achieved.

Reducing the budget deficits and bringing the budget back to positive balances is reasonably understandable due to state activities, bringing in proper production, revenue and thus fiscal resources. Ideally, Keynes stated, "to manage unemployment, on the basis that the budget will deal with itself, the debt itself will decrease" (Keynes, 1982).

3.3.3 The two gap model with fiscal gap (three gap model)

From the spirit of Chinery and Strout (1966) on the two gap model, Bacha (1990) augmented the two gap model by including the fiscal gap, due to the fact that fiscal limitations are viewed as a major disadvantage to the growth prospects of developing economies, because of fiscal deficits which consequently lead to significant borrowing by the government. Bacha (1990) derived the fiscal gap from government budget limitations where the taxes and other financing sources are not enough to finance expenditures. Borrowing from abroad in such instances plays a very important role in financing government expenditures. Furthermore, Barro (1979), on the theory of public spending, taxation and debt, adds that government should finance temporary shocks by debt whereas the permanent shocks in the economy should be financed by taxation. The special feature of this theory is the distinction between temporary and permanent shocks in government expenditure.

To develop the three gap model, Bacha (1990) started from the following fundamental equation of aggregate demand, in which I is treated as the dependent variable;

$$I = (Y_d - C) + (M - X) \qquad 3.1$$

Where Y_d is GDP or total disposable income, I is total investment or gross fixed capital formation, C is the total of private and public consumption, M is import of goods and non-elemental services, X is export of goods and non-elemental services.

Making use of the balance of payments (BoP) accounts, Bacha (1990) deduced that;

$$M - X = F - J \quad 3.2$$

When imports exceed exports, the trade deficit is supported by the difference between net capital inflows (F) and net income from external factor income (J). Thus, the substitution of equation 3.2 in 3.1 yields;

$$I = (Y - C) + (F - J) \quad 3.3$$

With regards to the two gap model, IS is characterized by;

$$IS = (Y^* - C) + (F - J) \quad 3.4$$

The first expression in the parenthesis in equation 3.4 is called domestic savings, which is the second expression of foreign transfers. Thus, when income reaches its potential threshold Y*, and private consumption is determined externally, equation 3.4 gives the level of investment constrained by domestic savings (domestic savings gap). Substituting J in the first parenthesis of equation 3.4 yields;

$$IS = (Y^* - J - C) + F \quad 3.5$$

Equation 3.5 shows that the term within parenthesis is national savings and F is foreign savings. This is due to the assumption that the effects of capital outflows (short-term variations in J) are not controlled by the government of the country receiving the net investment/capital because these variations are not subject to the country's decision-making process. Thus, foreign transfer (F - J) is a variable outside the control of the country's authorities

Elimination of private savings means that the national income must be divided into government income (T) and private income (Yp). The consumption is divided into private consumption (Cp) and government spending (G). Therefore, based on equation 3.4, the following expression is obtained;

$$IS = Sp^* + (T - G) + (F - J) \quad 3.6$$

Where $Sp^* = Yp^* - Cp$, hence, it can be finally concluded that;

$$I = S^P + S^G + S^T \quad 3.7$$

When disposable income is at the threshold limit Y_d*, and private consumption is provided exogenously, maximum investment can be derived. This is achieved by taking into account the total savings gap known as IS and later the potential product growth rate (constrained by savings). In this sense, Bacha (1990) assumes the situation of *coeteris paribus* as the relationship between capital and products grows increasingly.

To express foreign savings, Bacha (1990) acknowledged the model represented by equation 3.2 as a starting point; dividing imports into capital goods imports (M_k) and other imports (M_O), and define net exports as the difference between the total exports and total imports including commodities and non-commodity services (X). Thus;

$$E = M - X_o \qquad 3.8$$

M_k is determined by the following function;

$$M_k = mI \qquad 3.9$$

Where m is imported content of investments ($0 < m < 1$). Articulating equation 3.8 and 3.9 and substituting the resulting equation in 3.2, and rearranging the terms, yields;

$$I = \frac{1/M}{E+(F-J)} \qquad 3.10$$

Assuming that the level of net exports has reached the maximum level according to E*, and this is due to variable being affected by the global demand, the maximum investment from the supply of foreign reserves (IE) is limited. Hence, the expression of this level is deduced as follows;

$$IE = \frac{1/M}{E^*+(F-J)} \qquad 3.11$$

A critical understanding of the three-gap model suggests the fact that m <1. Therefore, the contrast between equation 3.6 and equation 3.11 shows the same conclusions reached by Chenery and Stout (1966), which infers that foreign transfers have the unique effect on the growth rates of economies with foreign trade constraints more than the economies that lack aggregate savings. To find the fiscal gap, Bacha (1990) began with the idea that government investment in infrastructure and essential industries dominates the developing economies. In this sense, Bacha (1990) divided capital formation into two classes: government investment (I_G) and private investment (I_P). Therefore, total capital formation is determined as follows;

$$I = I_G + I_P \quad 3.12$$

Equation 3.13, shows that private investment is characterized as a function of public investment with the coefficient K* that gauges the crowding-in effect. Hence, the government spending budget can be obtained by substituting equation 3.12 in equation 3.6;

$$I_Y = (S_P - I_P) + (T - G) + (F - J) \quad 3.13$$

In general, it is accepted that private investment depends on government spending, and, thus, is provided at its maximum value which is given by;

$$I_P = K^*.I_G \ , K^x > 0 \quad 3.14$$

As Bacha (1990) points out, equation 3.14 suggests the possibility that the development of lagging economies is described by the central role of their governments' investment in infrastructure and basic industry, which creates a ceiling on private investment worth the pain. Given the absence of a long-term market for government securities, monetary issuance is becoming the main way to finance public debt. Thus, the government can simply seize excess reserve funds through seigniorage. Seigniorage arises as two variables which are inflation rate π and the marginal propensity to save h. Thus;

$$S_P - I_P = \frac{dh}{P} = f(\pi, h) \quad 3.15$$

Substituting equation 3.15 in equation 3.13, and thereafter the outcomes in equation 3.12, and also substituting equation 3.14 in equation 3.12, the level of investment under fiscal constraint (IT) can be characterized as follows;

$$IT = (I + K^*).[(f(\pi, h) + (T - G) + (F - J)] \quad 3.16$$

Given the three-gap interaction, Bacha (1990) emphasizes that it tends to take into account that equations 3.14 and 3.15 can be read differently. In particular, equation 3.15 must agree with equation 3.14 about the possibility that private savings is a slack variable for any inflation rate. However, under constant private consumption speculation, this will not happen when the good is at its potential level, that is, the point at which the savings gap exists. In this context, equation 3.15 does not explain private savings, but the required level of private investment, which would be less

than $K^*.I_G$ at that time. This means that private investment is forced out of the financial market when savings constraint exists (Bacha, 1990).

The existence of a fiscal gap limits government efforts to stimulate private investment as a result of debt service and excessive domestic borrowing which crowds out private sector investment. Conversely, if a more noteworthy level of foreign aid is as loans and not grants, it might have adverse impacts on domestic savings funds, foreign exchange and fiscal gaps over the long run and for the macroeconomic performance in general. Hence, high debt service bring about unreasonable pressure on foreign currency and government revenue in general. Hence, Kabete (2008) asserts that a loan aid inflow may fill the trade gap today, yet requires a faster rate of export development later on for the country to be independent of foreign inflows.

In addition, high debt repayments have a negative impact on the government's import capacity, thus, reducing government investment, especially in the areas of infrastructure, education and healthcare. Restricted public investment in infrastructure and social services reduces the capacity of the economy to generate substantial output, and slows economic growth in the long run.

Adam Smith's vision is relevant to this point of view. One of the allegations that lead to attest to the rejection of the state's right to acquire debt being that indebtedness slows down the normal progress of a country towards wealth and prosperity, in this way, the resources that achieve productive goals in the private sector are captured by the state to cover its ineffective expenditure, with no hope of future reproduction.

The effect of contraction in public debt as far as capital accumulation (and therefore on long-term economic growth) is considered more harmful than that of taxes, as public borrowing reduces existing production capacity through the reduction of some segment of the yearly production that was previously associated with the support of productive labour towards that of unproductive labour (Smith, 1904). Negative consequences on the accumulation of productive capital in the economy are also confirmed by Ricardo (2005), who expresses that for the cost of one year of war, twenty million dollars are raised as a loan, it is twenty million which are drawn back from productive capital of the country.

In particular, a budget constraint may apply when the inflation rate starts from a certain incremental limit and reaches another threshold, resulting in a hyperinflation event. In this

situation, further increases in the rate of inflation are associated with unemployment and lower savings and investment rates.

3.3.4 Debt service in tax competition model of fiscal policy

This model was originally developed by Zodrow and Mierzkowski (1986). Capital is initially considered to be stable, but then it is fully internationalized, and no economy is expected to be powerful enough to impact international after tax return to capital with perfect capital mobility. Subsequent assumption stresses the effects of debt service obligations on the indebted economies, rather than spiraling out the major responses of competing economies. Each economy has three sectors: manufacturing, household (designated citizen) and government. There are two ways to deal with production; Capital and labour. The household possesses the production process and does a specific measure of labour. Capital comes in with diminishing marginal productivity;

$$f(k), f_k > 0, f_{kk} < 0 \qquad 3.17$$

Where k represents the units of capital invested in domestic production. The household's budget constraint is;

$$x = f(k) - f_k.k + \sigma.\bar{k} \qquad 3.18$$

Where $\bar{k}$ represents the household's savings of capital and σ is the international after-tax return to capital. The household's utility function is given by;

$$u(g, x), u_g, u_x > 0, u_{gg}, u_{xx} < 0, u_{gx}, u_{xg} = 0 \qquad 3.19$$

Note that the assumption that the utility function can be separated into two contentions enormously simplifies the analysis and makes the model simpler to oversee. A comparative conclusion would be reached without this assumption, however; it would require a few assumptions about the size of the cross-derivatives, accordingly, complicating the nature of the model.

Up to this point, the structure of the model follows Zodrow and Mierskowski (1986). With the introduction of public debt, the level of public debt is believed to be stagnant, and competitors have transitioned to economic unions in the process of depositing public debt, which accommodates perfect capital mobility, and specifies a balanced budget. Hence, the effect of an adjustment in payee on a budget item is proposed to change spending and taxation to guarantee that the primary balance is equivalent to the debt repayment commitment. Authoritatively, the

government has the D amount of debt held by the foreign lenders. Therefore, assuming that all or part of public debt is domestic, and the interest rate on the public debt is accepted to be equal to that of savings, then the conclusions remain the same for the perfect mobility case. However, in a case where it is part of the goal that domestic households do not have more investment than households in competing countries, then conclusions would change. In addition, without admittance to the global capital markets, domestic production would have guaranteed a lost capital limited by government securities/bonds.

The government has borrowed at the world interest rate and reimbursed obligation σD debt from debt service commitments, reimburses σD debt, and appropriates public goods, all financed by an uncommon source tax t on private invested capital. Clearly, the government will decide not to accept any control over any debt (the equilibrium stage), since there is no inspiration to do as such in a model where tomorrow and the future do not make a difference. Thus, ΔD is equivalent to zero. In this manner, the public budget constraint is described as;

$$t.k = g + \sigma D \qquad 3.20$$

The government will benefit and choose the tax rate that maximizes the household's utility, as shown in equation 3.19, subject to the significant resources and behavioural conditions of the economy. Equation 3.20 shows that debt service commitments have a budget constraint between tax revenues and necessary expenditures. Note that the debt service component may represent a budget constraint or other aggregate transfer, which is an independent tax rate and does not provide utility to households. For example, it could represent the incompetence of the country's public administration, income from oil assets, or some lucrative profit. Therefore, the following sections explore debt service in the context of the tax competition model in the case of zero capital mobility and capital mobility, respectively

3.3.4.1 The case for zero capital mobility

Assuming that from the outset a country is in economic independence, capital portability is zero. However, assuming further that the reasonable budget position regardless of everything applies; the households can just put resources in domestic production, contrasted with different countries that have domestic after-tax return to capital. Private total income has been reduced to;

$$x = f(k) - t.\bar{k} \qquad 3.21$$

Hence, the capital source tax does not affect the investment decision of the owners of the capital, also, the elasticity of capital to the tax rate is zero. This suggests that the base cost of public funds is solidarity (for instance, increasing the government's general tax revenue by increasing the tax rate prompts a fair decrease in the general private income). The essential taxation on the capital is not distorted in this nature, and the primary condition for the government's problem is found by maximizing equation 3.19, subject to equation 3.18 and equation 3.21, becomes;

$$\frac{u_g(g,x)}{u_x(g,x)} = 1 \qquad 3.22$$

Clearly differentiating the first order condition with respect to debt servicing obligations yields the partial derivatives of the equilibrium capital tax rate and government expenditure;

$$\frac{\partial t^n}{\partial \sigma D} = \frac{\varepsilon^n g}{k.(\varepsilon^n g + \varepsilon^n x)} > 0 \qquad 3.23$$

$$\frac{\partial g^n}{\partial \sigma D} = \frac{\varepsilon^n g}{(\varepsilon^n g + \varepsilon^n x)} - 1 > 0 \qquad 3.24$$

$$\varepsilon_x{}^n = \frac{\partial u_x}{\partial t} = \frac{t^n}{u_x} = -\frac{u_{xx}}{u_x}.k^n.t^n > 0 \qquad 3.25$$

$$\varepsilon_g{}^n = -\frac{\partial u_g}{\partial t} = \frac{t^n}{u_g} = -\frac{u_{gg}}{u_g}.k^n.t^n > 0 \qquad 3.26$$

Superscript *n* denotes the balanced values of the financial autarky system. This essential model of fiscal policy generally affirms the pattern of how public debt service administration influence two distinct parts of the budget; one would expect countries with high debt service duties to see a mixture of lower government spending and more significant levels of tax collection, all other things being equivalent. The division of public debt service costs into taxes and basic expenditures restricts the utility deficit related with public debt service costs, because of the assumption that private net income and public spending will diminish marginal utilities. The impact on taxes relative to the impact on fundamental spending of debt service is demonstrated by the parameters of the model as follows. In the case of supply of public goods (private total income) at the tax rate, the stagnation (least) of marginal utility will be higher, in this manner, less required costs will be changed and taxes will be additionally increased because of higher debt service.

3.3.4.2 The case for allowing capital mobility

Assuming that capital is fully mobile, households can invest capital in foreign markets and obtain the overall after-tax return on capital if the after-tax return on capital is below the threshold level. The equilibrium condition for the financial market then becomes;

$$f_k - t = \sigma \qquad 3.27$$

Where the left hand represents the internal after-tax return to capital. As a result, the tax rate is affected by, for example, investment decisions of investors in domestic production. Hence, taxes are being distorted. Thus, the marginal cost of public funds is greater than one. Maximizing equation of 3.19, subject to equations 3.18, 3.20 and 3.26 gives the first order condition for the government problem with fully mobile capital;

$$\frac{u_g(g,x)}{u_x(g,x)} = MCPF > 1 \qquad 3.28$$

Where MCPF = $\frac{1}{1-\varepsilon_k}$ presents marginal cost of public funds, and ε_k is the elasticity of capital invested in the domestic financial market. The equilibrium public expenditure's marginal utility is more noteworthy than the marginal utility of private consumption in light of the fact that the general cost of provision of public good is higher, under zero capital mobility. This leads to government setting a tax rate that is lower than the optimal tax rate under zero capital mobility, and equilibrium public expenditure contrasted with private spending from the perspective of social welfare.

The accompanying analysis comes when an asymmetric debt-free tax competition model examines how the equilibrium of the economy's central variables changes when the debt in an economy goes from zero to positive, permitting a single economy into having a positive public debt from zero public debt, while remaining effective and solvent. Differentiating as a first order condition with respect to debt service yields the derivative of the equilibrium tax rate with respect to the debt service under perfect mobility;

$$\frac{\partial t^p}{\partial \sigma D} = \frac{{\varepsilon^p}_g}{k.(1-{\varepsilon^p}_k).({\varepsilon^p}_g+{\varepsilon^p}_x+{\varepsilon^p}_m)} > 0 \qquad 3.29$$

Where, ${\varepsilon^p}_x = \frac{\partial u_x}{\partial t}.\frac{t}{u_x} = -\frac{u_{xx}}{u_x}.k.t > 0$ 3.30

$$\varepsilon^p{}_g = \frac{\partial u_g}{\partial t}.\frac{t}{u_g} = -\frac{u_{gg}}{u_g}.k.t(1-\varepsilon^p{}_k) > 0 \quad 3.31$$

$$\varepsilon^p{}_m = \frac{\partial mcpt}{\partial t}.\frac{t}{mpct} = -\frac{\varepsilon^p{}_k}{1-\varepsilon^p{}_k}(1+\varepsilon^p{}_k+\varepsilon^p{}_k.k.\frac{f_{kkk}}{f_{kk}}) > 0 \quad 3.32$$

The superscript p represents the values of equilibrium in the perfect capital mobility system. If equations 3.30 and 3.31 are consistently positive, then equation 3.32 can take both positive and negative values. However, the quotient of equation 3.29 becomes positive when the second condition is met. The second order condition is;

$$\varepsilon_{ug} + \varepsilon_{ux} + \varepsilon_{mcpf} > 0 \quad 3.33$$

Equating the third derivative of the production function to zero, as an adequate condition to fulfill the second order condition, which considers the third derivative to take some positive values.

Equation 3.29 shows that an increase in the level of debt will increase the tax rate. The mechanism is clear. Given the equilibrium tax rate without any debt, debt-servicing commitments will increase immediately (before the policy response) to reduce public spending without making any changes to the tax rate and tax revenue. The result of u_g is higher than that of non-indebted countries, while u_x and MCPF are equal as in no debt situation. Raising the tax rate to the level of no debt equilibrium, as a result, shifting resources from private to public spending will increase utility until the first order condition is re-satisfied for the optimum.

To analyze the impact of an increase in the level of public debt on the essential public expenditure, the government's budget constraint is completely differentiated with respect to debt service, and equations 3.28 and 3.29 are used to get;

$$\frac{\partial g^p}{\partial \sigma D} = \frac{\varepsilon^p{}_g}{\varepsilon_g{}^p+\varepsilon_x{}^p+\varepsilon_m{}^p} - 1 < 0 \quad 3.34$$

The assumption that the elasticity of the marginal cost of public funds is positive is a reasonable condition for ensuring that the sign of the derivative of public spending on debt service is negative. Notwithstanding, it should be seen that this hypothesis is satisfactory yet repetitive, and forces a fairly higher upper limit on the third derivative of the production function than effectively contemplated by the second order condition.

In spite of the impact of debt service on zero capital mobility with the impact of debt service on the tax rate under perfect capital mobility, one can envision that the higher marginal expenditure of public funds would suggest that the liability of the debt service inconclusively influences the tax base in a manner that influences ordinary individuals. Regardless, the model considers more than something contrary to conditions, as the resilience of the LHS to the first order position changes with the appearance of mobile capital. Subsequently, it is generally indicated that;

$$\frac{\partial t^p}{\partial \sigma D} < \frac{\partial t^n}{\partial \sigma D} \; if \begin{cases} {\varepsilon_g}^p + {\varepsilon_x}^p + {\varepsilon_m}^p > \emptyset . ({\varepsilon_g}^n + {\varepsilon_x}^n) \\ \emptyset = \frac{u^p gg}{u^n gg} . \frac{{u_g}^n}{{u_g}^p} . \frac{t^p}{t^n} > 1 \end{cases} \quad 3.35$$

Equation 3.35 is best understood when it comes to first-order conditions under zero and perfect capital mobility. The sum of the tax elasticities of the three components that make up the first order condition shows the magnitude of the tendency to equilibrium; the more prominent is one of the three elasticities, to a lesser extent an increase in the tax rate is expected to return to equilibrium after of an increase in debt service commitments. The transition from zero to perfect capital mobility increases the elasticity of the marginal cost of public funds from zero to positive, but also changes ε_g and ε_x. If there is little chance that ε_g or ε_x will be reasonably lower in perfect capital mobility than in zero, one could consider the odd situation in which increased debt service leads to a more noticeable increase in taxes in the perfect capital mobility system contrasted to the case of zero capital mobility.

Considering any motivation to do so, suppose the debt adjustment is zero or positive. With zero capital mobility, increased debt guarantees higher taxes and lower costs, and its overall impact on two different aspects of the budget depends on the parameters of the model. With perfect mobility, increased debt service has two different effects, both related to the distorted effect of tax collection. In any case, the effect is marginal. When the marginal value of public funds and, consequently, the distorted effect of taxes increases, the effect of debt increases on the tax side of public spending, the effect of debt on taxes decreases and the negative impact of debt on public spending increases.

The second effect is the extraordinary effect. As shown by the equations 3.23 and 3.29, taxes are higher in a country that is more indebted contrasted to the country the low indebted country, without accounting the level of capital mobility. Thus, a highly indebted economy results in higher levels of distortion with lower levels of investment capital, and consequently lower levels of

general domestic production. Thus, the economy has limited resources to divide between public spending and private spending. The isolated infra-marginal effect is therefore that the effect of debt has a more significant effect on both expenditure and taxes when the capital mobility increases, due to the distortion of the general production.

Both marginal and infra-marginal effects will increase the pressure on large public spending under debt service commitments. However, the first effect decreases the effect of the debt service commitments on taxes, while the subsequent effect increases effect of the debt service commitments on taxes. Hence, regardless of whether the effects of debt on taxes increases or decreases in the transition from zero to perfect capital mobility depends on the general importance of marginal and infra-marginal effects, when the impact of debt service obligations on public expenditure is accelerated from zero to perfect capital mobility;

$$\frac{\partial g^p}{\partial \sigma D} < \frac{\partial g^n}{\partial \sigma D} \qquad 3.36$$

Therefore, tax competition can be seen as decreasing the asymmetries between countries of the tax burden on capital induced by asymmetric levels of public debt, when the condition presented by equation 3.35 is met. Subsequently, asymmetries between countries will continue to increase cross-country asymmetries in essential expenditure due to debt asymmetries.

The disadvantage of the tax competition model is that it does not take into account the existence of other, less mobile tax bases. Extending the model to corporate taxation from a stable tax base should be possible by simply allowing the citizen representative to assign some fixed units of lobour to the domestic production process and taxing this labour supply at source. In this situation, both tax rates are not distorting if the capital is expected to be internationally stable. Hence, the general significance of the two tax rates is irrelevant to the total income of a representative citizen, as both tax rates take their income away.

Assuming that other things are being equal, the government wants to set equivalent tax rates for transparency or fairness reasons, the impact of debt service on taxes and expenditures in this model is the same as shown above, the main difference is that the adjustment in the general tax rate will be equally divided between labour and capital tax collection. In the event that capital is allowed to flow openly across borders, taxes on capital are, in any case, distorting and consequently more expensive than taxes on labour as a method of raising public funds. As a result, capital mobility

will shift the entire tax burden onto labour taxation. For the same reason, the part of public funds that is spent to pay for the debt service will change from being paid with labour and capital to a sum of taxes on labour. Therefore, the capital income tax related to debt service will increase from positive to zero, while the labour tax rate will increase to take over the full financing of the debt service.

The labour supply can be considered elastic with respect to the tax rate by remembering that the labour is not useful for the utility function of the representative citizen. Taking into account the elastic labour supply will lead to the above result with the ultimate goal that capital mobility does not lead to a complete transition to labour taxation. However, in principle, the result will be the same. The greater the capital mobility, the greater the tax burden that is passed on to the next factor and the lower the increase in debt service that will be paid through capital taxation compared to the labour taxation.

3.4 THEORETICAL EXPLORATION OF THE NEXUS BETWEEN POLITICAL INSTABILITY, CORRUPTION AND PUBLIC DEBT

Following the specific objective of investigating the effect of political instability and corruption on public debt, the following are the economic theories and models underpinning the nexus relationship between these variables and public debt.

3.4.1 Exploration of the theoretical link between political instability and public debt

Strategic considerations by politicians can lead to highly inefficient levels of public deficits which may consequently result in debt accumulation. The theory of debt accumulation articulates that the current policy makers can limit the future policy and decision-makers' expenditure by increasing debt levels (Chumiya and Nicolaidou, 2013). Tabellini and Alesina (1990) suggest that at different times, different governments can make use of this strategic possibility to their advantage and play political games. This will ultimately push the debt levels above the optimal level.

Strategic behaviour by politicians can be one of the main sources of debt accumulation in many African countries as these countries move through political transitions from non-democratic regimes to democratic regimes, which consequently leads to different governments occupying office from time to time. Again, these governments could take advantage of this strategic possibility and be tempted to over-spend to limit the expenditure by future governments. In African countries, governments may accumulate more debts during transitions, hence leaving the debt

burden to the future government. This is mostly true for democratic governments where the possibilities of re-election are not certain, and this pushes politicians to limit the available resources for new governments leading to debt accumulation during government transitions.

Political parties in government have different ideologies which could also lead to debt accumulation (Chimiya and Nicolaidou, 2013). The theory of political budget cycle by Houdhauns (1975) falls under this category as it is classified into opportunistic policy-makers and partisan models. Model of opportunistic policy-making are based on the assumptions that voters do not take into account the government's inter-temporal budget constraints; policy-makers are looking for opportunities and take advantage of voters and use budget deficits to increase their chances of being re-elected. Voters are believed to be more likely to anticipate the benefits of current spending and consider less the future tax burdens and opportunistic politicians who raise the level of public expenditure without accounting for the capacity of taxes in the pre-election period to please the voters. This framework can explain the expansionary fiscal policy during electoral season as voters do not punish politicians for policies that lead to extreme deficit and extensive debt.

However, these models have been criticized due to the fact that voters do not always underestimate future tax burdens since they understand that an increment in spending or debt prior to elections will be transferred to them in future. Opportunistic models provide an insight on how debt is accumulated in a pre-election season, as they could reflect ideologies of politicians emphasizing the significance of political factors in determining the debt accumulation in the economy.

Furthermore, there are theories that reflect government fragmentation in decision-making that may result in delayed stabilization, which could also be another source of accumulating debt in the economy. Lack of agreement between politicians, especially in cases where there are several political agents, and the interaction between them can lead to inefficient budget deficits, which can worsen if a group of politicians postpone accepting the fiscal reform, hoping that others will bear most of the burden. Alesina and Drazen (1991) argue that negotiating parties can postpone a deal in order to try to get a better deal for themselves and, consequently, the choice of deferral can improve the expected result of the group to the detriment of the overall economic situation.

The latter results delay stability, although there are policies that are designed to improve the lives of all. In coalition governments, where different parties represent different groups of voters, the greater the number of different policies to implement, the higher the amount of expenditures

generated, and the higher level of revenue needed to finance those expenditures which also leads to debt accumulation.

3.4.2 Exploration of the theoretical link between corruption and public debt

Current economies' budgets are so complex, sometimes unnecessarily so (Bastida *et al*., 2015). This complexity takes into account the execution of practices planned for concealing the real budget balance. The fiscal illusion and the principal agent theories show that politicians are not approached to adopt the most transparent strategies. The fiscal illusion hypothesis depends on the failure of the taxpayer to camouflage the full cost of public programmes and/or projects. This theory suggests that officials are encouraged to maximize public spending benefits and hide tax and government liabilities (which require future taxes). This trend towards budget deficits thus leads to an inclination towards greater government provision of goods and services. Deficit financing makes indications for taxpayers that public goods and services have become moderately cheaper. As a result, voters will request more public goods and services (Buchanan & Wagner, 1977). This fiscal illusion exacerbates the common pool resource problem, as policy-makers have incentives to increase public spending, as additional costs are shared by all while the benefits are generally concentrated (Weingst *et al*., 1981).

Nisken (1974) argues that the lack of transparency is related to the theory of bureaucratic behaviour and fiscal illusion theory. Firstly, bureaucratic management hides inefficiencies with poor financial reporting. Secondly, fiscal illusion can be achieved by making proper use of information asymmetry, by ignoring the announcement of future consequences of current expenditure policies. In the context of principal agent theory, a lack of transparency can also create favourable conditions for politicians to achieve goals related to their personal interests; officers (agents) may have their own interests, which generally do not improve the welfare of voters. Alt *et al*. (2002) show that transparency reduces the asymmetry of information among politicians, financial markets and voters. Bastida *et al*. (2015) show that, in addition to the principal agent theory, there is another argument explaining budget transparency, the rule of law theory, which considers both mandatory publicity and transparent administration as the basics of public administration.

According to Matheson and Kwon (2003), inadequate and inconsistent compliance with accounting and reporting standards, lack of accounting and reporting standards, are positively associated with the risk of corruption. Tanzi (1998) argues that a lack of transparency creates a

fertile ground for corruption. Similarly, Hood (2001), Fozard and Foster (2001), and Alt *et al* (2002) assert that government transparency is a fundamental issue to address issues such as fiscal irregularities, rising public debt, corruption and to ensure public accountability. Therefore, transparency in government administration makes it difficult for politicians and bureaucrats to engage in any corrupt practices that can lead to highly unproductive public spending, ineffective tax collection and debt accumulation (Matheson and Kwon, 2003). Furthermore, Alt *et al*. (2002) show that increasing transparency in fiscal institutions requires more visible efforts on the part of politicians who are more trusted by voters. Voters additionally respond by trusting politicians with financial resources where fiscal institutions are becoming more transparent.

3.5 EMPIRICAL LITERATURE

This section is about empirical studies on the effect of tax revenue collection and the associating macroeconomic variables on public debt in developing and developed economies. Most of the empirical evidence comes from developing economies rather than developing economies. Furthermore, there is scarce empirical evidence in the South African case study. In this study, the empirical literature is first classified by developing and developed economies, followed by the method of analysis. A review of the empirical literature it of paramount significant in the sense that it serves a perception to examine whether the hypotheses expressed by the implications of economic theories and/or models are valid or not.

3.5.1 Empirical literature in developing countries

Using the Panel Ordinary Least Squares (POLS), Gupta (2007) examined key determinants of tax revenue performance in developing economies, using an extensive dataset and attributing some of the econometric issues not considered in previous studies. The results show that structural factors such as per capita GDP, the share of agriculture in GDP, trade openness and foreign aid affect the tax revenue of the economy. Other factors, such as corruption, political instability, and public debt, negatively affect tax revenue collection, but the share of direct and indirect taxes has a positive effect on tax revenue collection.

Similar results on the effect of corruption was realized by Rimmer (2010) in the case study of Ukraine. In addition to corruption having an adverse effect on tax revenue collection, the study also established that a complicated taxation structure affected tax revenue collection negatively via tax avoidance. Rimmer (2010) also emphasizes that because of these effects, the government

saw itself having to accumulate debt to fund public expenditure and investment. OLS method was used to realize these results for the period of 1994 to 2009.

In the Namibian case study, Salar *et al*. (2013) also conducted a study to find empirical determinants of tax collection using OLS technique. The study shows that macroeconomic factors such as economic growth, imports, public debt, inflation and unemployment have a mixed relationship with the tax revenue. Similarly, Crivelli *et al*. (2016), using POLS, investigated the impact of political stability on government debt in developing countries during the period 1975-2015. The study found that political instability has a significant negative relationship to public debt. The study also found that the effect of political instability was more severe when corruption is considered to be higher. Contrary to these findings, Ellis and Schansberg (2004) found that political instability was not important to explain the accumulation of government debt in 52 developing economies, using POLS. Therefore, the results of Ellis and Schansberg (2004) do not support the hypothesis established by the models of political economy.

Using the POLS method, Swamy (2015) conducted an econometric study of the macroeconomic determinants of public debt between 1980 and 2009 in 46 developing countries. The study found that real GDP growth, FDI, government spending, inflation and population growth have a negative impact on government debt. Variables such as gross fixed capital formation, consumption expenditure and trade openness had a positive effect on debt. Comparing the results on inflation, Akitobi *et al* (2014) found that inflation supports the reduction of public debt by reducing the real value of public debt. However, Forslund *et al*. (2011) did not find any statistical significance of inflation, although the effect of inflation on government debt was similar to that of Akitobi *et al*. (2014).

Bonga *et al*. (2015) used the OLS method to investigate the origin of the debt crisis in Zimbabwe, the nature of debt, the causes, consequences and possible ways of reducing the debt for the period of 1980-2013. The study found a significant negative relationship between public debt and government expenditure. The study recommended that the government should not take out unnecessary borrowing, and that funds borrowed should be used for investment projects rather than consumer spending. Using the same method and timeframe, Uguru (2016) found opposite results in a case study of Nigeria. This study found the relationship between government debt and government spending to be positive. Uguru (2016) further recommended that the Nigerian

government should cut operating costs and increase capital spending. Additionally, the Nigerian economy needs to be diversified to reduce reliance on crude oil revenues. Implementation of the diversification programme will definitely reduce the government's tendency to borrow.

Alawneh (2017) used OLS method to investigate the impact of capital and current expenditure, and external and internal public debt on taxes in Jordan for the period of 2001 to 2014. The study established a significant and positive effect of both capital and current expenditures on taxes. The study also found a positive and significant relationship between internal and external public debt on taxes in Jordan. The study recommended that there is a need to use unconventional alternatives to finance investment rather than resorting to external and internal borrowing. The study also recommended that tax revenue should be used to finance existing current expenditures.

The findings of the study are helpful in a sense that they give an indication that current and capital expenditure for the Jordanian government were productive as long as they were financed by borrowing. This is on the basis that positive shocks on both domestic and external debt increased the tax revenue collection. Therefore, this study aims to see whether the South African debt is used to finance 'productive' expenditure which would yield increased tax revenue in the short and/or long run.

As shown above, authors used the OLS/POLS method, which is mostly criticized in econometrics literature. For example, the OLS/POLS method is known to give optimal estimates of the unknown parameters, however, it is very sensitive to the presence of outliers in the data used to fit a model. Moreover, the OLS/POLS model has poor extrapolation properties since it makes assumptions over the long ranges.

The following are the studies that used different techniques such as VAR/VECM and ARDL. These methods have greater advantages over OLS. For example, the VAR/VECM framework treats all variables as endogenous, hence allowing the variables to have interactive relationships among themselves; in other words, they are multivariate. Furthermore, the VAR/VECM framework allows one to choose the most optimal lags at which the efficient parameters may be estimated. Lastly, for testing for cointegration, the VECM framework requires all the variables to be integrated to the order of 1.

On the other hand, ARDL is almost similar to VECM, with the exception of producing robust and efficient estimates in small sample size, limiting the number of cointegrating vectors to 1, limiting the order of integration for all the variables to the maximum of 1, and allowing the dependent variable to be lagged to *P* lags order, for cointegration analysis. That is, variables integrated to order 2 are not allowed in an ARDL framework.

Using vector error correction (VECM) and vector auto-regression (VAR) methods, Palil and Mustupha (2011), in a case study of Asian and European countries and Pakistan respectively obtained the same results as Rimmer (2010), who used the OLS method. The results shows that corruption has an adverse effect on tax revenue collection. The study also established that a complicated taxation structure affected tax revenue collection negatively via tax avoidance.

For the period of 1976 to 2009, Siddigi and Llyas (2011) and Mazhar and Pierre-Guillaime (2011) also got the same results for some of the macroeconomic factors in the case of India and Pakistan respectively. However, these authors did not use the same modelling techniques as Salar *et al*. (2013) but used VAR and ARDL modelling techniques respectively. In comparing the methods used by the authors, Mazhar and Pierre-Guillaime (2011) used the best method (ARDL) in the sense that it is more efficient, and produces robust results especially in small samples like the one selected by the authors (33 observations).

Using VAR, Pirtea *et al*. (2013) found that the real interest rates on government bonds, the exchange rate and the rate of growth of GDP significantly determined Romania's public debt significantly between 2000 and 2011. Using ARDL, in the case study of Tunisia; Between 1986 and 2015, Belguith and Omrane (2017) found similar results in terms of real interest rates, budget deficits and trade openness, as these factors increased Tunisian public debt, for the period under consideration. As in the previous discussion on the studies of Siddigi and Llyas (2011), and Mazhar and Pierre-Guillaime (2011), utilization of the ARDL method in smaller samples provided more efficient and robust parameter estimates than the VAR method. Given this, the results obtained by Belguith and Omrane (2017) seem to be more reliable than those of Pirtea *et al*. (2013).

The selected studies show mixed effects of public debt on tax revenue collection and other associating variables, as fully discussed below. It should also be noted that the authors used linear modelling techniques like OLS/POLS, VAR, VECM and ARDL.

As much as there are studies that have used the method that this study is proposing (ARDL), it is still relevant to utilize it on the basis that this study covers the period of 1985 to 2019 (35 observations), which makes this study classified as a 'small sample' size study. As emphasized by econometric literature, the ARDL method is known to produce the most efficient and unbiased estimates for the small sample size data sets. Furthermore, the methods used by the authors are linear in nature, which are criticized by modern literature because they are not intending to address nonlinear relationships existing between the time series variables. It is for this reason that this study proposes Nonlinear ARDL (NARDL) in addition to the linear ARDL method.

3.5.2 Empirical literature in developed countries

Chicherita and Rother (2010) carried out the study to examine the impact of high and growing public debt on economic growth in three-euro area economies (Germany, Great Britain and Italy). The study used the POLS fixed effects method (public debt as a quadratic explanatory variable). The study found the non-linear effect of public debt on economic growth. One of the study's key findings was the fact that the debt tipping point indicated that the negative impact of high debt on the growth rate could be as low as 70 to 80 percent of GDP, which requires more prudent borrowing policies. In addition, the study shows that the annual variation of the public debt ratio and the budget deficit / GDP ratio are negatively and linearly related to the growth of GDP per capita. Private savings, low tax revenues, public investment, total factor productivity and nominal and real long-term sovereign interest rates are the channels through which public debt impacts economic growth. This study lays the foundation for this study since it has established a non-linear relationship between public debt and economic growth rates, although this study aims to establish the nonlinear relationship between public debt and tax revenue collection rather than economic growth.

Creel *et al*. (2013) investigated the long term sustainability of France's fiscal position. The authors used trend analysis on historical government's tax receipts and expenditures payments. It was found that France's public expenditure level was higher than the rest of the Euro area economies, and it was comparable to its neighbours. The study also revealed that due to high levels of taxation, net public borrowing was under control. However, the France tax system was found to be unfair and insufficiently progressive, and too complicated. The study has a significant implication for the relationship to be estimated in this study, as the revelations of the study imply that if the level of

tax revenue collection is high, then reliance on public borrowing to finance public expenditure is minimized. Furthermore, in attempting to estimate the relationship between public debt and tax revenue collection, this study applies econometric methods of analysis (ARDL and NARDL) compared to trend analysis.

Huffman (2013) empirically tested how public debt affects future growth and interest rates in the American economy. A continuous time model using Bernoulli differential equations, was used in the study. The study also introduced a "Debt Trigger" that prohibits government debt from exceeding a specific share of GDP. The study reveals that the impact of government debt on economic growth is highly dependent on the inter-temporal elasticity of substitution of consumption and the level of tax revenue. The study initially emphasized that high levels of government debt can temporarily increase economic growth, but in the long run they can slow economic growth. The study also established whether lowering the capital tax rate would increase economic growth based on the values of certain parameters, especially on the inter-temporal elasticity of substitution of consumption. The study also showed that temporary tax cuts can have a greater impact on growth than permanent tax cuts of the same magnitude.

The study of Huffman (2013), lays a foundation of the relationship to be estimated in this study. The study emphasizes that the impact of public debt on economic growth relies critically on the level of tax revenue collection. However, the study used a mathematical modelling method rather than an econometric method. This may be a serious concern since mathematical methods are not theoretical, and therefore fail to conform to economic assumptions. Hence, it is for this reason that econometric and some statistical methods are highly recommended, rather than mathematical methods, when dealing with economic issues.

Unlike in developing economies, most of the selected studies in developed economies (subject to availability) did not utilize common econometric methods, but instead used trend analysis and continuous time model (mathematical modelling method). As discussed below, all the selected studies established that high levels of public borrowing due to inefficient levels of tax revenue, is to the detriment of economic growth in the long run, and higher levels of tax revenue decrease the governments' incentives to borrow. The studies also established that the effect of size of government debt on economic growth critically depends on the elasticity of the substitution of the level of consumption and tax revenue.

3.5.3 Empirical literature in South Africa

De Wet *et al.* (2005) explored the South African tax mix and economic growth. Time series data between 1969 and 2003 was used on variables such as government expenditure, direct and indirect taxes, and real GDP growth rate. Dummy variables for isolation (before and after 1994) and recession were also incorporated in the model, and VECM was used as an estimation method. The results indicated that direct taxes revenues and government expenditures affected economic growth negatively. The study further emphasized that this was because of a significant increase in the size of the government after 1994. The results are not in line with Keynesian theory which advocates for government intervention through taxation and expenditure, but support the critics of the models for political economy in terms of the increased size of the government impacting public finances negatively which affect economic growth negatively at later stage.

Mothibi and Mncayi (2019) studied the main variables that drive public debt in South Africa between 1994 and 2017. The study found that there is a long run relationship between public spending, real GDP, inflation, real interest rates and public debt. The Auto Regressive Distribution Lags (ARDL) method was used. Public spending, real GDP and real interest rates have also been found to be the main drivers of the South African public debt. The study also discovered real GDP and inflation as the only variables that affected the government debt negatively. The same results on inflation driving public debt negatively were obtained by the study of Oche *et al.* (2016), which used Vector Error Correction Model (VECM) to investigate the impact of public debt on foreign direct investment (FDI) in South Africa between 1983 and 2013. The study also established a positive and significant relationship between the interest rate, FDI, and public debt, respectively.

Ncanywa and Masoga (2018) looked at the effect public debt on public investment and economic growth using the ARDL method, Granger causality, impulse response functions, and the variance decompositions. The study found a long run negative relationship between public debt and public investment, leading to an inverse relationship between public debt and economic growth, as investment is directly linked to economic growth. The study motivated an economy with scarce capital resources to borrow in order to increase its capital. However, a later stage of borrowing, marked by high levels of public debt, will lead to inefficient economic growth.

As in the case of developing economies, the results of the selected studies (subject to availability), in the case study of South Africa were constrained under the assumption of linearity, as authors

applied linear methods such as VECM and ARDL. It is also of great importance to note that these studies did not necessarily establish the empirical effect of tax revenue collection on public debt though it has been established as per the discussed theoretical frameworks, that public borrowing (external or internal) is the consequence of not having enough government revenue (mostly taxes) to finance both current and capital/investment expenditures.

3.6 GENERAL SUMMARY ON THE ANALYSIS OF EMPIRICAL LITERATURE

In summarizing the selected literature in developed and developing economies, most studies show that the main drivers of public debt are government spending, government revenue, inflation, political instability, corruption, and economic growth. It should also be noted that researchers (excluding studies in developed economies) utilized linear modelling techniques which have some limitations as discussed above.

Relying on the presented empirical work in South Africa, there seems to be no evidence of the exploration of the effect of tax revenue collection, political instability and corruption on public debt. Also, the researchers applied linear modelling techniques to obtain the results. This means that the researchers relied upon the linearity assumption. This is a reason for real concern given the increasing literature on the emphasis on the nonlinear dynamic structure of macroeconomic data. The studies that used nonlinear methods often suggest that traditional linear models are not accurately defined. In addition, the time period covered by the selected empirical studies envelops a number of key factors such as political factors and tax as well as economic policies' reforms, which contribute to potentiality of significant nonlinear relationships between economic, financial, structural and institutional variables.

In light of the above information, this study aims to contribute to literature by exploring further the empirical effect of tax revenue collection, political instability and corruption on public debt in South Africa. This study also intends to contribute new information in literature on testing for the best approach between linear Auto Regression Distributed Lags (ARDL) and Nonlinear Auto Regression Distributed Lags (NARDL).

3.7 CONCLUSION

James Buchanan's work on public debt has taken a conclusive turn in the field of public finance, reestablishing a warmed conversation of the most fitting theoretical methodology and the most precise empirical tools. His argument has changed the views of economists in numerous territories,

particularly about the effect of public debt burden on future generation (taxpayers). In any case, in the economic literature it is commonly pertinent to draw a sensible differentiation among internal and external debt. It has not yet been fused sufficiently in the current economic literature.

Central to the primary objective of this thesis, the selected theories mostly established an inverse relationship between tax revenue collection and public debt, since debt accumulation is mostly associated with having insufficient tax revenue to finance public expenditures and investments. As far as the specific objectives are concerned, this chapter, with the aid of the selected theories, established that political instability and corruption are also positively related to public debt. It has also been established that public debt negatively affects the credit worthiness of the economy and consequently discourages both domestic and foreign investments.

The selected empirical literature in both developing and developed economies indicate that corruption and political instability increase the level of public debt, subject to utilization of different econometric and mathematical models. The selected empirical literature also indicate that unsustainable public debt affects investors' decisions negatively, hence, discouraging both domestic and foreign investments.

Narrowing down to the empirical literature provided in South Africa, there seems to be no empirical exploration of the effect of tax revenue collection, corruption and political instability on public debt, though the discussed economic theories and models establish a strong correlation between taxation, political instability, corruption and public debt. Hence, this thesis aims to add more information on this exploration using different estimation methods.

CHAPTER FOUR
METHODOLOGY

4.1 INTRODUCTION

This chapter discusses the methods and procedures necessary to fulfill the objectives of this study. The methods and procedures are based on the empirical literature in the previous chapter. That is, the methodology of the study is presented in this chapter. This chapter is structured as follows; section 4.2 presents the philosophy ground of this study. Section 4.3 discusses the theoretical framework establishing the relationship between public debt and tax revenue collection. Section 4.4 unfolds the empirical model specification to be followed in this study. Section 4.5 explains the key variables of this study, and their respective priory signs. Section 4.6 describes the data measures, and sources. Section 4.7 discusses the econometric techniques to be used in this study. Section 4.8 concludes the chapter by discussing both ARDL and NARDL modelling procedures required to build econometric models wherein statistical and economic inferences will be made to validate or nullify the hypotheses to be tested in this study.

4.2 PHILOSOPHICAL GROUND OF THE STUDY

This study is grounded on the pragmatic philosophical assumption. Pragmatism as a perspective is about applications and solutions for issues. It is inclined toward 'what works'. Various techniques or pluralistic methodologies are frequently highly plausible and suitable for one study, and one single perspective can never give the whole picture as numerous realities may exist (Creswell, 2014; Saunders *et al*., 2016).

Hence, this study makes use of both linear and nonlinear ARDL methods (quantitative methods) to address, comprehend and deal with the issue. The motivation for applying both linear and nonlinear methods is on the basis that researchers have only relied on linear methods as far as establishing the effect of tax revenue collection and the associating macroeconomic variables on public debt in South Africa, as shown in the empirical literature.

As much as the selected empirical literature gives a decent premise to research the relationship between public debt and associating variables in South Africa, it is recognizable that the researchers' utilization of linear (symmetric) modelling in their empirical analysis leaves the studies inclined to limitations and/or criticisms of not intending to address possible nonlinear relationships that may exist between the time series of the variables. This is a reason for real

concern given the increasing literature on the emphasis of the nonlinear dynamic structure of macroeconomic data.

Reliance on linear methods might have been creditable in the past; however, time period used by past South African studies envelops various significant economic and political factors as well as policies' reforms, which may insinuate possible asymmetric (nonlinear) relationships among financing, economic, structural and institutional variables.

In addition, econometric literature alludes that nonlinear methods mostly infer that the conventional linear models are not correctly specified. Incorrect specification in this case refers to including non-linear terms/independent variables in the linear methods which generally curve slowly, making it increasingly difficult for essentially non-linear procedures to find a linear method that fits the data as the range of the data increases. When the independent variable becomes extreme, the output of the linear method also becomes more extreme in all cases. This means that linear methods may not be powerful enough to estimate the outcome of a process for which data cannot be gathered in the area of interest. However, extrapolation is considered dangerous and little attention is paid to the type of method.

In light of the above information, this study aims to provide insight on the best approach between linear and nonlinear ARDL methods, to explain the relationships between the aforementioned variables in South Africa between 1985 and 2019.

4.3 THEORETICAL FRAMEWORK

The economic theoretical framework for building an empirical model of this study is based on the three gap model. The model suggests that fiscal limitations are viewed as a major setback to growth prospects in developing economies, because of fiscal deficits which consequently lead to government borrowing. Bacha (1990) demonstrated the fiscal gap from government budget limitations where taxes and other financing resources are not enough to finance government current and capital expenditures. In such instances, borrowing domestically or abroad plays a significant role. That is, the three gap model establishes a negative relationship between public debt and tax revenue collection.

4.4 EMPIRICAL MODEL SPECIFICATION

This study adopts the model by Casalin *et al*. (2020) where public debt is modelled as the function of inflation, public expenditure and the real interest rate. Hence, the following presents the mathematical representation for the afore narrated empirical model;

$$PDT = f(INF, EXP, RIN) \quad 4.1$$

Where PDT is the public debt measured by debt-GDP ratio, EXP public expenditure and RIN real interest rate.

This study modifies the Casalin *et al*. (2020) empirical model by replacing public expenditure by tax revenue collection and adding corruption and political instability (institutional variables) as additional predictor variables. Replacing public expenditure by tax revenue is motivated by the core objective of this study, of which the grounding theoretical relationship is fully discussed in the theoretical framework of the study (previous section). Additional motivation is also from theoretical perspective, where the government budget constraint is expressed as the difference between government expenditure and taxes with all other incorporated general government revenues.

Lastly, the motivation on adding institutional variables like corruption and political instability is on the basis that these factors are currently severe in the government departments and municipalities. Corruption and political instability in the latter mentioned government fragments are so severe to such a point that these government fragments are no longer able to sustain themselves, as funds go missing or get accounted for different functions which cater for the benefits of certain individuals who are closely related to the government officials and/or politicians. Furthermore, the current South African political atmosphere is critical or rather conflicted, especially since the existence of Economic Freedom Fighters (EFF), the new opposition party to African National Congress (ANC). Hence, Tebele (2016) indicates that there have been significant political conflicts which in some cases delay materialisation of some emergency government and macroeconomic policies needed to respond to the declining economic activity; and increasing budget deficits, internal and external debt, and loss of investors' confidence.

In addition, there are some studies in economic literature that have established corruption and political instability as the drivers of public debt. For example, the study of Monte and Pennacchio

(2020) which empirically indicates that corruption has detrimental effect on public debt in OECD countries. The study of Briceno and Perote (2020) also indicates corruption as one of the drivers of public debt in the Euro zone countries. On the side of political instability, Miller (1997) established that political instability increases the public debt and the expected cost of public debt through uncertainty which causes the term structure to steepen. Tabellini and Ozler (2000) also supported this notion as the study indicates that higher political instability increases the equilibrium level of both domestic and external debt accumulation.

Hence, the following equation presents the fundamental empirical model of this study;

$$PDT_t = f(TRV_t, INF_t, RIN_t, POI_t, COR_t) + \varepsilon_t \quad 4.2$$

The model presented by equation 4.2 simply implies that this study models South African public debt as a function of the South African tax revenue, official inflation rate, real interest rate, political instability and corruption in general by public servants and/or politicians. ε_t denotes the error term at time period *t*.

4.5 DEFINITION AND PRIORI SIGNS OF VARIABLES

This section defines variables presented by the fundamental model of this study explained in the previous section. Furthermore, this section also discusses the priori signs of the selected independent variables relative to the dependent variable of this study, depending on the grounding economic theories, models and/or hypotheses.

4.5.1 Public Debt (PDT)

Public debt is realized when government expenditure exceeds government revenue. That is, the government will have to borrow domestically or from overseas to fund the difference (Basirat *et al.*, 2014). This simply means that if the government could generate enough revenue to finance its expenditure, then there would be no need for government to borrow. However, since developing economies are characterized by a low savings rate and high unemployment rates, governments do not generate enough revenue through taxation (among other sources of government revenue) to cover expenditure (including infrastructural investments) which prompts borrowing. Public debt in this study will be measured by the debt-GDP ratio as it gives more precise indication on the country's ability to pay back its debt, since it compares a country's public debt to its annual economic activity. Public debt in this study is treated as the dependent variable.

4.5.2 Government Tax Revenue (TRV)

Government tax revenue is defined as monetary income received by the government through taxes. As an important variable of fiscal policy, it is mainly made up of taxes levied on various tax bases, such as consumer gross income, gross corporate profits, and wealth accumulated by consumers and profit-maximizing firms (Shim, 2003). Governments generate additional revenue from the income/profits of state-owned enterprises (SOEs) that do not pay taxes, central bank income, and capital income normally derived from external loans and/or debts in global financial markets. Governments use these revenues to meet their economic growth and development goals. Thus, if the government does not generate enough revenue through other sources because of any structural or institutional imperfection, there will be more pressure on tax revenue collection, since it is the most essential component of government revenue. And obviously, the tax revenue collection alone can never be enough to finance public debt and other government obligations. However, the stronger the capacity of tax revenue collection, the lower government's tendency to borrow, as emphasized by the fiscal gap model of Bacha (1990). Therefore, the relationship between government tax revenue and public debt should be negative.

4.5.3 Inflation (INF)

Inflation refers to a sustained increase in the general price level of goods and services in an economy at the specific time and is normally computed through consumer price index (CPI) (Fourie and Burger, 2011). Due to increasing levels of government expenditure, demand for goods and services increases which consequently increases the level of general prices. Due to this, business fundamentals would be eroded via increasing the cost of doing business, more particular if the firms cannot easily shift the price increments to the consumers. This may prompt tax evasion and avoidance which may lead to government collecting smaller portion of tax revenue. This infers that the government would be inclined to borrowing (negative relationship). However, if inflation is reasonably low and does not change some time soon, business profits will increase in relation to an increment in inflation in general. The impact is further more harmonized when governments do not increase tax threshold rates for corporates. This will not decrease the public debt, but it will lower pressure of the interest payable on the overall consolidated public debt (positive relationship).

4.5.4 Real Interest Rate (RIN)

A real interest rate is a debt/loan fee that has been accordingly adjusted to eliminate the impacts of inflation to mirror the real cost of funds to the borrower. It also mirrors the real costs to the lend or to an investor, contrast to the nominal interest rate which does not take into account the effects of inflation (Fourie and Burger, 2011). Hence, the relationship between the real interest rate and public debt should be positive.

4.5.5 Political Instability (POI)

Political instability alludes to abrupt and critical change in government leadership, policies, and state of a country (Shim, 2003). Political instability regularly shortens policymakers' horizon prompting problematic macroeconomic policies (Barro, 1979). It might likewise cause frequent switch of policies, opening the space for volatility and thus, negatively influencing macroeconomic performance which subsequently prompts debt accumulation, since systematic tax revenue collection would be compromised. Therefore, the relationship between public debt and political instability should be positive.

4.5.6 Corruption (COR)

Corruption is defined as an unethical act that is done by public officials using their position to receive a bribe, directly or indirectly from a family member or associate, in exchange for making a benefit available to the tax payer (Ajaz and Ahmad, 2010). In this thesis, corruption is measured by the “Corruption Perceptions Index”. Tax revenue collection may be negatively influenced by corruption as tax payers may be encouraged to practice tax avoidance (due to complicated tax structures and/or frameworks). This may lead to a decrease in the tax revenue collected by the government. Furthermore, corruption within the government by the public servants or politicians to serve personal interests by looting state money leads to government having insufficient funds to carry out its functions. Consequently, the government would then be forced find the funds through borrowing, as hypothesized by the models of political economy. That is, a positive relationship can be expected between corruption and public debt.

4.6 DATA MEASURES AND SOURCES

The following table presents the measurements and data sources for the variables discussed in the previous section;

Table 4.1 Data Measures and Sources

Variable	Data Measure	Data Source
Public Debt	Debt-GDP ratio (percentage)	World Bank
Tax Revenue Collection	Tax-GDP ratio (percentage)	World Bank
Inflation	Official inflation rate (percentage)	World Bank
Real Interest Rate	Percentage	World Bank
Political Instability	Political Instability Index	World Bank
Corruption	Corruption Perceptions Index	World Bank

Annual data for the above mentioned variables is obtained from the South African Reserve Bank (SARB) and World Bank. South Africa is sampled for the period of 1985 - 2019.

Since the study covers the period of 1985 to 2019, the key variables may have structural breaks (due to government's transition from 1994). Should structural breaks be present, then the researcher will introduce the dummy variable where from 1985 to 1993; 0's will be allocated to indicate "no structural breaks", and from 1994 to 2019; 1's will be allocated to indicate the presence of structural breaks. Thereafter, all predictor variables will be multiplied to the dummy variable to estimate the new ARDL/NARDL model with no structural breaks.

4.7 ESTIMATION TECHNIQUES

This study uses the Auto Regressive Distributed Lags (ARDL) method to model the linear relationship between dependent and independent variables of this study. Compared to studies that used linear modeling techniques in South Africa, ARDL which is originally developed by Pesaran and Smith (2001) has several advantages. Given below are the advantages of the ARDL model. It provides compatible and reliable results for cointegrating relationships, even when the sample size is small, and the variables can be integrated to the order of 0 or 1, or a combination of both, to test for short and long run relationships. That is, variables that are integrated to the order of 2 are not allowed.

Following the objective of testing the possibility of nonlinear relationship between dependent and independent variables of this study, the nonlinear ARDL method (NARDL) is used. NARDL essentially decomposes the variables under study studied into their partial sums. Granger and Yoon

(2002) suggest that if the positive and negative components of the time series are cointegrated, then they have a latent cointegration, and a linear cointegration is a special example of the latent cointegration that is part of a nonlinear cointegration. That is, Shin *et al*. (2014) developed a nonlinear ARDL method consisting of the decomposed partial sum components.

NARDL has significant advantages over existing modeling techniques, such as; Error Correction Model (ECM), Threshold ECM, Markov Switched ECM, and the Smooth Transition ECM in modelling jointly the dynamics and asymmetries of the cointegration. In addition to the ease of estimation, the NARDL model provides greater flexibility to weaken the assumption that the time series must be integrated in the same order, despite the ECM which is authoritative in this regard. Furthermore, NARDL allows one to accurately distinguish between the absence of cointegration, linear cointegration and nonlinear cointegration (Katrakilidis and Trachanas, 2012).

4.8 MODELLING PROCEDURE

This section discusses the modelling procedure necessary for building efficient ARDL and NARDL models. Discussed first, is the modelling procedure for ARDL model, followed by NARDL modelling procedure.

4.8.1 Modelling Procedure for ARDL (linear) model

The section discusses the steps, in their chronological order, for building an efficient ARDL model.

4.8.1.1 ARDL Model Specification

The following equation presents the ARDL model to be estimated on determining the effect of tax revenue collection and the selected macroeconomic variables on public debt in South Africa;

$$PDT_t = \gamma_0 + \sum_{i=1}^{n1} \gamma_{1i}\, \Delta PDT_{t-i} + \sum_{i=1}^{n2} \gamma_{2i}\, \Delta TRV_{t-i} + \sum_{i=1}^{n3} \gamma_{3i}\, \Delta INF_{t-i} + \sum_{i=1}^{n4} \gamma_{4i}\, \Delta RIN_{t-i} + \sum_{i=1}^{n5} \gamma_{5i}\, \Delta POI_{t-i} + \sum_{i=1}^{n6} \gamma_{6i}\, \Delta COR_{t-i} + \gamma_7 PDT_{t-1} + \gamma_8 TRV_{t-1} + \gamma_9 INF_{t-1} + \gamma_{10} RIN_{t-1} + \gamma_{11} POI_{t-1} + \gamma_{12} COR_{t-1} + v_t \quad 4.3$$

Where PDT is public debt, TRV tax revenue, INF inflation, RIN real interest rate, POI political instability and COR the corruption. Furthermore, Δ operator denotes difference, γ_{ni} short run coefficients, γ_i long run coefficients and $\sum_{i=1}^{n}$. lags order.

4.8.1.2 Descriptive Statistics Analysis

Descriptive statistics refers to the analysis of data that is useful for describing, showing or summing up data in a significant manner such that, for instance, patterns may be seen to emerge from the data (Brooks, 2008). However, Descriptive statistics analysis does not permit a researcher to make conclusions past the data which have been analyzed, or arrive at conclusions with respect to any hypotheses which may have been made. It is basically an approach to describe the data used (William, 2006).

4.8.1.3 Multicollinearity Analysis

Multicollinearity refers to the situation where there is perfect linear relationship among the independent variables (Brooks, 2008). An assumption for the ARDL model is that the regressors should have imperfect linear relationships among themselves. That is, there should be an evidence of imperfect multicollinearity among the regressors. Otherwise, the model may have the ill effects of multicollinearity. Therefore, if it is the correlation among the regressors is greater than ±0.80, then the regressors are said to be highly correlated (Pesaran *et al*., 1999).

To undertake the task of multicollinearity analysis, this study makes use of the correlation matrix method. As much as the correlation matrix method is used for detecting multicollinearity among the independent variables, it can also be used to gauge the correlation between the dependent variable and the independent variables. That is, in addition to using the correlation matrix method for detecting multicollinearity among the independent variables, the researcher will also use the correlation matrix for analysing the correlation between the dependent variable and the independent variables of this study.

Looking at the principal empirical model of this study, independent variables such as inflation and the real interest rate are more likely to be collinear. This is because of the theoretical link of these two variables. Fourie and Burger (2011) clearly indicates that the real interest rate debt/loan fee that has been adjusted for inflation. That is, the debt/loan fee take into an account the expected (future) and unexpected (immediate) increment in the general price level. However, from econometric and statistics perspective, collinearity is not a problem when it imperfect since most of economic variables have interdependency among each other. Hence, an acceptable multicollinearity between or among economic variables is anything less than ±80% (Pesaran *et al*., 1999).

4.8.1.4 Stationarity and Stationarity Testing

According to Rehman (2019), stationarity is observed when the trend of the variable/time series do not change over time. In a situation where the trend of the variable/time series is non-stationary, the trend is normally sloping upward or downward. An econometric model built with such variables/time series could give the researcher incorrect forecasts, hence producing unreliable and inconsistent predictions which can offer misinformation and/or wrong economic policy advice to the policy makers. The following are the general tests used for testing the time series against stationarity;

- **Informal Stationarity Test**

Visualizing the trend of the variables/time series against stationarity by observing the plot of the time series helps in determining whether the time series/variable is stable or not, across the time period under study. If the trend of the variable/time series is unstable across the time period under study, then the variable/time series is non-stationary. Non-stationarity simply means that the mean, variance and covariance of the variable/time series change across the time period under study (Rehman, 2019).

- **Formal Stationarity Tests**

This study employs standard tests like DF - GLS, and Ng-Perron to ensure stationarity on the key variables of this study. The researcher has established that Dickey and Fuller (1979) and Phillips and Perron (1988) tests have been utilized broadly so as to discover the order of integration, yet due to poor size and power characteristics, both tests are unreliable for small sample sizes (DeJong *et al*., 1992). These tests over-reject the true null hypothesis and do not reject it if it is false. Hence, this study uses the recent supported unit root tests (as per econometric literature) such as Dicky-Fuller generalized least square (DF-GLS) de-trending test established by Elliot *et al*. (1996), and the Ng-Perron test following Ng and Perron (2001). These tests appear to correct the issues related to the standard Augmented Dickey and Fuller (ADF) and Phillips and Perron (PP) unit root tests.

a. Dickey-Fuller Generalized Least Square (DF-GLS) test

The DF-GLS unit root test is the modified version of the traditional ADF unit root test by Elliot *et al*. (1996), as mentioned above. First, the traditional Augmented Dickey Fuller (ADF) test model is presented below by equation 4.4.

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \cdots + \sigma_{p-1}\Delta Y_{t-p+1} + \varepsilon_t \quad 4.4$$

Where Δ denotes the difference operator and ($\alpha+\beta t$) is a deterministic part; α presents a constant term for level-stationary models while for trend-stationary models, βt presents a linear trend. The ADF test is built on the t-statistic on γ in a regression model presented by equation 4.5. The lagged differences of Y_t are included to control for serial correlations such that there is no serial correlation in error terms ε_t if an appropriate ρ is used.

From the traditional ADF unit root test model expressed in equation 4.4, the *t* statistic is modified to establish the DF-GLS unit root test presented by equation 4.5. The modification in the test model is transformed via generalized least squares regression, hence, improving the power of the traditional ADF unit root test (Wu, 2010). The following is the DF-GLS unit root test model;

$$\Delta \tilde{Y}_t = \alpha + \beta_t + \gamma \tilde{Y}_{t-1} + \cdots + \sigma_{p-1}\Delta \tilde{Y}_{t-p+1} + \varepsilon_t \quad 4.5$$

For any series, x_t from *t=0* to *t=T*, assumed is an expression that $({x_0}^{\bar{\omega}}, {x_t}^{\bar{\omega}}) = (x_0, (1-\bar{\omega}L)x_t)$ for $\bar{\omega} = 1 + \frac{\bar{c}}{T}$, where L is the lag operator. The modified part on the new ADF test (DF-GLS) is the *t* statistic on γ in the ADF regression using the GLS-detrended data$\tilde{Y}_t$. Hence, the GLS-detrended series $\tilde{Y}_t$ is given by;

$$\tilde{Y}_t = Y_t - \hat{\alpha}\beta_t \quad 4.6$$

Where $\hat{\alpha}$ minimizes $S(\bar{\omega}, \alpha) = (Y^{\bar{\omega}} - \alpha'\beta^{\bar{\omega}})'(Y^{\bar{\omega}} - \alpha'\beta^{\bar{\omega}})$. The value of $\bar{c}$ is chosen such that the asymptotic local power function of the test is tangent to the power envelope at 50 percent power (Wu, 2010).

Assuming an AR(1) process on the basis that the maximum order of integration under the ARDL/NARDL is 1, the following are the DF-GLS test models for the key variables of this study using the general representation of DF-GLS test model presented by equation 4.5;

$$\Delta \widetilde{PDT}_t = \alpha + \beta_t + \gamma \widetilde{PDT}_{t-1} + \varepsilon_t \quad 4.7$$

$$\Delta \widetilde{TRV}_t = \alpha + \beta_t + \gamma \widetilde{TRV}_{t-1} + \varepsilon_t \quad 4.8$$

$$\Delta \widetilde{INF}_t = \alpha + \beta_t + \gamma \widetilde{INF}_{t-1} + \varepsilon_t \quad 4.9$$

$$\Delta \widetilde{RIN}_t = \alpha + \beta_t + \gamma \widetilde{RIN}_{t-1} + \varepsilon_t \quad 4.10$$

$$\Delta\widetilde{\mathrm{POI}}_t = \alpha + \beta_t + \gamma\widetilde{POI}_{t-1} + \varepsilon_t \quad 4.11$$

$$\Delta\widetilde{\mathrm{COR}}_t = \alpha + \beta_t + \gamma\widetilde{COR}_{t-1} + \varepsilon_t \quad 4.12$$

PDT denotes public debt, TRV tax revenue collection, INF inflation, RIN real interest rate, POI political instability and COR corruption.

This test tests the null hypothesis(H_0) that $\gamma = 0$. This null hypothesis infers that a unit root exists in the above mentioned key variables, meaning that these variables are not stationary. However, when $\gamma < 0$ (alternative hypothesis), the variables are stationary. If the test statistic for the DF-GLS test is less than the critical value of any level of significance, then the variables are not stationary.

b. Ng-Perron test

The Ng and Perron (2001) test is based on detrended data ${Y_t}^*$ obtained using the ADF-GLS and adjusted the Phillips-Perron (PP) test approaches. Consider the following equation;

$$Y_t = d_t + \beta_1 Y_{t-1} + \sum_{i=1}^{P-1} \theta_i \Delta Y_{t-1} + \varepsilon_t \quad 4.13$$

This test utilizes test statistic Z from the PP test that had been adjusted by Ng and Perron (2001) into the form;

$$\overline{MZ_a} = \left(T^{-1}{Y_t}^* - {S_{AR}}^2\right)\left(2T^{-2}\sum_{t=1}^{T}{Y_{t-1}}^*\right)^{-1} \quad 4.14$$

$$\overline{MSB} = \left(T^{-2}\sum_{t=1}^{T}\frac{{Y_{t-1}}^*}{{S_{AR}}^2}\right)^{\frac{1}{2}} \quad 4.15$$

$$\overline{MZ_T} = \overline{MZ_a} * \overline{MSB} \quad 4.16$$

Where ${S_{AR}}^2 = \left(\sum_{t=p+1}^{T}{\varepsilon_t}^2\right)\left((T-K)\left(1-\sum_{t=1}^{P}\widehat{\delta_\iota}\right)^2\right)^{-1}$, and marked as M tests.

Hence, the standard form for the Ng-Perron unit root test is characterized as;

$$\Delta\tilde{Y}_t = \alpha + d_t + \gamma\tilde{Y}_{t-1} + \varepsilon_t \quad 4.17$$

Following the Ng-Perron unit root test model presented by equation 4.17, and assuming an AR(1) process on the basis that the maximum order of integration under the ARDL/NARDL is 1, the following are the Ng-Perron test models for the key variables of this study;

$$\Delta\widetilde{\mathrm{PDT}}_t = \alpha + d_t + \gamma\widetilde{PDT}_{t-1} + \varepsilon_t \quad 4.18$$

$$\Delta\widetilde{\mathrm{TRV}}_t = \alpha + d_t + \gamma\widetilde{TRV}_{t-1} + \varepsilon_t \quad 4.19$$

$$\Delta\widetilde{\mathrm{INF}}_t = \alpha + d_t + \gamma\widetilde{INF}_{t-1} + \varepsilon_t \quad 4.20$$

$$\Delta\widetilde{\mathrm{RIN}}_t = \alpha + d_t + \gamma\widetilde{RIN}_{t-1} + \varepsilon_t \quad 4.21$$

$$\Delta\widetilde{\mathrm{POI}}_t = \alpha + d_t + \gamma\widetilde{POI}_{t-1} + \varepsilon_t \quad 4.22$$

$$\Delta\widetilde{\mathrm{COR}}_t = \alpha + d_t + \gamma\widetilde{COR}_{t-1} + \varepsilon_t \quad 4.23$$

The null hypothesis that a variable is non-stationary is rejected if the calculated values for MZ_T, MZ_a, MSB and MPT are less than the critical values at 10, 5 and 1 percent level of significance. The critical values for the Ng-Perron test for 10%, 5% and 1% are -14.2,-17.3 and -23.8 respectively for MZ_a, -2.62, -2.91 and -3.42 respectively for MZ_T, 0.185, 0.168, 0.143 respectively for MSB and 6.67, 5.48 and 4.030 respectively for MPT.

4.8.1.5 Optimal Lags Selection

Using the Vector Auto Regression (VAR) approach, one must select the optimal lags for the ARDL/NARDL model. This study makes use of the basic information criteria such as Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC), and Hannah Quinn Information Criterion (HQIC). In addition, the likelihood ratio test can also be used to select the optimal lags for independent variables and explanatory variables (Brooks, 2008).

- **Description of the Basic Information Criteria**

The most common method of selecting the optimal lag length is to use the information criterion. Information criteria do not require compliance with normality in the distribution of the residuals. Instead, the criteria deduce the sum of squares of each residual equation (RSS) as additional lags are added. Therefore, the value of the penalty period increases. The univariate criteria can be used independently for each equation and it is generally considered necessary to re-establish the lag number in each equation. This requires the use of multivariate versions of information criteria; such as Akaike Information Criterion (AIC), Bayesian Schwarz Information Criterion (SBIC) and Hannah Quinn Information Criterion (HQIC). The following are the mathematical expression of the above mentioned information criteria;

$$\text{AIC} = \text{Ln}\left|\hat{\Sigma}\right| + 2\frac{k'}{N} \quad 4.24$$

$$\text{SBIC} = \text{Ln}\left|\hat{\Sigma}\right| + \frac{k'}{N}\text{Ln}(N) \quad 4.25$$

$$\text{HQIC} = \text{Ln}\left|\hat{\Sigma}\right| + \frac{k'}{N}\text{Ln}(\text{Ln}(N)) \quad 4.26$$

Where $\hat{\Sigma}$ denote the variance- covariance matrix of the residuals, N is the sample size and k' represents the sum of all the regressors in all equations which will be equal to $P^2k + P$ for P equations in VAR system, each with k lags of the P variables, including a constant in each equation (Brooks, 2008).

The optimal lags to be selected on both the dependent and independent variables, must have the smallest value of the above discussed information criteria (Brooks, 2008).

- **Description of the Likelihood ratio test**

The Likelihood Ratio (LR) test is a statistical tool that can be used to analyze the fitness power of two models, where one has superior characteristics than the other. It is a convenient test to perform naturally, but it has limitations. Basically, one of the two VARs has superior characteristics than the other and, more importantly, only pairwise comparisons are allowed. The following equation represents the test statistic of the likelihood ratio test;

$$\text{LR} = \text{T}\left[\text{Ln}\left|\widehat{\Sigma\text{r}}\right| - \text{Ln}\left|\widehat{\Sigma\mu}\right|\right] \quad 4.27$$

Where$\left|\widehat{\Sigma r}\right|$represents the determinant of the variance-covariance matrix of residuals for the constrained model, with 4 lags. $\left|\widehat{\Sigma\mu}\right|$ represents the determinant of the variance -covariance matrix of the residuals, for an infinite VAR with 8 lags. N is the sample size.

LR test approach is disadvantaged in the sense that the χ^2 test is entirely asymptotic only under the assumption that the residuals from every equation follow a white noise process (normally distributed).

4.8.1.6 Cointegration and ARDL Cointegration Bound Test Approach

- **Conceptualizing Cointegration**

In a simple linear regression model, the dependent variable is Y and the independent variable is X, and if both variables are non-stationary at level but stationary at first difference (I (1)), then X and Y have long run relationship (cointegration). This is shown in the following equation, where β_1 takes a linear combination (raised to the power of one, as a variable X).

$$Y_t = \hat{\beta}_0 + \hat{\beta}_1 X_t + \hat{\mu}_t \qquad 4.28$$

Where $\hat{\beta}_0$ and $\hat{\beta}_1$ are the estimates for the true values of β_0 and β_1, and $\hat{\mu}$ is the estimate for error term at time period *t*. Hence, $\hat{\mu}_t$ is estimated by the following equation through the OLS method;

$$\hat{\mu}_t = Y_t - \left[\hat{\beta}_0 + \hat{\beta}_1 X_t\right] \qquad 4.29$$

Variables X and Y have the long run relationship if the trend of the estimated residuals at time period *t* ($\hat{\mu}_t$) does not change (stationary) at level. Hence, $\hat{\mu}_t \sim I(0)$ process.

In economics, this statistical method was introduced by Granger (1981). Basically, this method establishes the cointegrating relationship between economic variables. Briefly, cointegration in economics suggests that variables X and Y move simultaneously over time in such a way that if there are any deviations, the equilibrium relationship becomes normal again due to the presence and effectiveness of economic shocks.

- **ARDL Cointegration Bounds Test Approach**

The ARDL bounds test approach is preferred over other traditional cointegration tests because Monte Carlo simulation shows that the ARDL cointegration approach has several significant advantages over other traditional cointegration tests (Emran *et al*., 2007). The ARDL method adequately corrects for the assumed endogeneity of the explanatory variables, and the estimates demonstrate attractive properties from a small sample. Another significant advantage of the ARDL approach is that one can be exempted from the hassles of testing for the unit root, as the approach can be applied regardless of whether the time series are I (0) or I (1), and therefore, avoid vulnerabilities that could be imposed by unit root testing procedure. Another characteristic of this approach is that, unlike other conventional cointegration approaches, it can be applied to studies

with a small sample size (Narayan, 2005). Furthermore, both short and long run relationships can be evaluated simultaneously.

Khamfula (2004) emphasizes that the ARDL method should only be applied when there is only one cointegrating vector. That is, all the variables need to be tested endogenously for cointegration using the ARDL bounds test. Hence, this study estimates the following unrestricted error correction models within the ARDL bounds test approach;

$$\Delta PDT_t = \gamma_0 + \sum_{i=1}^{n1} \gamma_{1i}\, \Delta PDT_{t-i} + \sum_{i=1}^{n2} \gamma_{2i}\, \Delta TRV_{t-i} + \sum_{i=1}^{n3} \gamma_{3i}\, \Delta INF_{t-i} + \sum_{i=1}^{n4} \gamma_{4i}\, \Delta RIN_{t-i} + \sum_{i=1}^{n5} \gamma_{5i}\, \Delta POI_{t-i} + \sum_{i=1}^{n6} \gamma_{6i}\, \Delta COR_{t-i} + \gamma_7 PDT_{t-1} + \gamma_8 TRV_{t-1} + \gamma_9 INF_{t-1} + \gamma_{10} RIN_{t-1} + \gamma_{11} POI_{t-1} + \gamma_{12} COR_{t-1} + v_{1t} \quad 4.30$$

$$\Delta TRV_t = \gamma_0 + \sum_{i=1}^{n1} \gamma_{1i}\, \Delta TRV_{t-i} + \sum_{i=1}^{n2} \gamma_{2i}\, \Delta PDT_{t-i} + \sum_{i=1}^{n3} \gamma_{3i}\, \Delta INF_{t-i} + \sum_{i=1}^{n4} \gamma_{4i}\, \Delta RIN + \sum_{i=1}^{n5} \gamma_{5i}\, \Delta POI_{t-i} + \sum_{i=1}^{n6} \gamma_{6i}\, \Delta COR_{t-i} + \gamma_7 TRV_{t-1} + \gamma_8 PDT_{t-1} + \gamma_9 INF_{t-1} + \gamma_{10} RIN_{t-1} + \gamma_{11} POI_{t-1} + \gamma_{12} COR_{t-1} + v_{2t} \quad 4.31$$

$$\Delta INF_t = \gamma_0 + \sum_{i=1}^{n1} \gamma_{1i}\, \Delta INF_{t-i} + \sum_{i=1}^{n2} \gamma_{2i}\, \Delta TRV_{t-i} + \sum_{i=1}^{n3} \gamma_{3i}\, PDT_{t-i} + \sum_{i=1}^{n4} \gamma_{4i}\, RIN_{t-i} + \sum_{i=1}^{n5} \gamma_{5i}\, \Delta POI_{t-i} + \sum_{i=1}^{n6} \gamma_{6i}\, \Delta COR_{t-i} + \gamma_7 INF_{t-1} + \gamma_8 TRV_{t-1} + \gamma_9 PDT_{t-1} + \gamma_{10} RIN_{t-1} + \gamma_{11} POI_{t-1} + \gamma_{12} COR_{t-1} + v_{3t} \quad 4.32$$

$$\Delta RIN_t = \gamma_0 + \sum_{i=1}^{n1} \gamma_{1i}\, \Delta RIN_{t-i} + \sum_{i=1}^{n2} \gamma_{2i}\, \Delta TRV_{t-i} + \sum_{i=1}^{n3} \gamma_{3i}\, PDT_{t-i} + \sum_{i=1}^{n4} \gamma_{4i}\, INF + \sum_{i=1}^{n5} \gamma_{5i}\, \Delta POI_{t-i} + \sum_{i=1}^{n6} \gamma_{6i}\, \Delta COR_{t-i} + \gamma_7 RIN_{t-1} + \gamma_8 TRV_{t-1} + \gamma_9 PDT_{t-1} + \gamma_{10} INF_{t-1} + \gamma_{11} POI_{t-1} + \gamma_{12} COR_{t-1} + v_{4t} \quad 4.33$$

$$\Delta POI_t = \gamma_0 + \sum_{i=1}^{n1} \gamma_{1i}\, \Delta POI_{t-i} + \sum_{i=1}^{n2} \gamma_{2i}\, \Delta TRV_{t-i} + \sum_{i=1}^{n3} \gamma_{3i}\, \Delta INF_{t-i} + \sum_{i=1}^{n4} \gamma_{4i}\, \Delta RIN_{t-i} + \sum_{i=1}^{n5} \gamma_{5i}\, \Delta PDT_{t-i} + \sum_{i=1}^{n6} \gamma_{6i}\, \Delta COR_{t-i} + \gamma_7 POI_{t-1} + \gamma_8 TRV_{t-1} + \gamma_9 INF_{t-1} + \gamma_{10} RIN_{t-1} + \gamma_{11} PDT_{t-1} + \gamma_{12} COR_{t-1} + v_{5t} \quad 4.34$$

$$\Delta COR_t = \gamma_0 + \sum_{i=1}^{n1} \gamma_{1i}\, \Delta COR_{t-i} + \sum_{i=1}^{n2} \gamma_{2i}\, \Delta TRV_{t-i} + \sum_{i=1}^{n3} \gamma_{3i}\, \Delta INF_{t-i} + \sum_{i=1}^{n4} \gamma_{4i}\, \Delta RIN_{t-i} + \sum_{i=1}^{n5} \gamma_{5i}\, \Delta POI_{t-i} + \sum_{i=1}^{n6} \gamma_{6i}\, \Delta PDT_{t-i} + \gamma_7 COR_{t-1} + \gamma_8 TRV_{t-1} + \gamma_9 INF_{t-1} + \gamma_{10} RIN_{t-1} + \gamma_{11} POI_{t-1} + \gamma_{12} PDT_{t-1} + v_{6t} \quad 4.35$$

Where PDT is the public debt, TRV tax revenue, INF inflation, RIN interest rate, POI political instability index, and COR corruption perceptions index. Furthermore, Δ operator denotes difference, γ_{ni} short run coefficients, γ_i long run coefficients and $\sum_{i=1}^{n}$. lags order.

From equation 4.30 to 4.35, tests for cointegration are performed using the F test, to test for the joint significance of the lagged level of the variables under the null hypothesis of "no cointegragtion". Mathematically, the null hypothesis is characterized as follows;

$H_0: \gamma_7 = \gamma_8 = \gamma_9 = \gamma_{10} = \gamma_{11} = \gamma_{12}$

Against the alternative hypothesis(H_a) that;

$H_a: \gamma_7 \neq \gamma_8 \neq \gamma_9 \neq \gamma_{10} \neq \gamma_{11} \neq \gamma_{12}$

The asymptotic distribution of F statistic is not standardized under the null hypothesis and was initially inferred and organized Pesaran and Smith (2001) but modified by Narayan (2005) for smaller samples. Two cases of critical values have been provided; one, which is suitable when all variables are *I(0)* and the other for all variables that are *I(1)*. According to Pesaran and Smith (2001), if testing for the cointegration, if the calculated F statistic exceeds the upper critical limit, an accurate induction on the state of cointegration can be made without knowing whether the variables were *I(0)* or *I(1)*. In this case, the null hypothesis of "no cointegration" is rejected, whether the variables are *I(0)* or *I(1)*.

In a chance that there exists more than one cointegrating vector (multivariate), Khamfula (2004) emphasizes that the Vector Error Correction Model (VECM) framework must be used over the ARDL framework

4.8.1.7 Granger Causality Test

If the variables are cointegrated, there exist either bi-directional or unidirectional causality link between them, as emphasized by Engle and Granger (1987). Hence, the null and alternative hypothesis for the Granger causality test on the two stationary variables (X and Y) are as follows;

H_0= x_t is not the cause of y_t

H_1 = x_t is the cause of y_t

The following equations are used to carry out the Granger Causality test to determine the hypothesis that holds;

$$y_t = a_1 + \sum_{i=1}^{n} \beta i \, x_{t-i} + \sum_{j-1}^{m} \gamma_j y_{t-j} + e_{1t} \quad 4.36$$

$$x_t = a_2 + \sum_{i=1}^{n} \theta i \, x_{t-i} + \sum_{j-1}^{m} \delta \mathrm{j} y_{t-1} + e_{2t} \quad 4.37$$

A time series X is said to Granger-cause Y in the event that it very well may be shown, mostly through a series of t and F-tests on lagged values of X (and with lagged values of Y additionally included), that those X values give statistically significant information about future values of Y (Pesaran and Smith, 2001).

4.8.1.8 Coefficients Stability and Residuals Diagnostic Tests

This section discusses the coefficients stability and residuals diagnostics tests necessary to diagnose the models to be estimated in the following chapter. Coefficients stability tests are discussed first, followed by the residuals diagnostics tests.

4.8.1.8.1 Coefficients Stability Tests

- **Ramsey Regression Error Specification Test**

Ramsey (1969) established a regression error specification test (RESET) to test for misspecification in regression models. RESET test is a famous test, which is routinely utilized to recognize omitted variables and inaccurate functional form in the linear regression model. It utilizes a counterfeit regression, which incorporates the predicted value of the dependent variable and its higher powers among the regressors and tests the statistical significance of these terms.

Hence, this test tests the null hypothesis that 'there is no misspecification' in a regression model. This null hypothesis should not be rejected if the probability value of the F statistic is greater than any level of significance.

- **Cumulative Sum of Recursive Residuals (CUSUM) and CUSUM of square (CUSUMSQ) Tests**

Pesaran and Pesaran (1997) emphasize that once the error correction models have been estimated, parameters' stability must be assessed. Hence, Pesaran and Pesaran (1997) suggest applying the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests to examine the parameter consistency. The error correction model parameters are said to be stable if the estimated CUSUM and CUSUMSQ lines are within the 5% significance bounds (Khamfula, 2004).

4.8.1.8.2 Residuals Diagnostic Tests

Following classical linear regression model (CRLM) assumptions regarding residual terms ($\mu_t's$), the following are the necessary assumptions to be upheld, and the tests to be utilized to ensure the satisfaction of these assumptions.

- **Normality Assumption and Test**

Normality assumption is attributed to a simple linear regression model, where the residuals of the estimated model should be normally distributed. The shape of the distribution for the normal distributed residuals should be bell-shaped (Wagner, 2007). If the residuals are not normally distributed, the estimated coefficient will be biased and inconsistent, hence, making the estimated model not unreliable (Woldridge, 2009). This study makes use of the Jarque-Bera test for normality. Therefore, the following equation presents the test statistic of the Jarque-Bera test for normality;

$$\mathrm{JB} = \frac{\mathrm{N}-\mathrm{K}+1}{6}\left(\mathrm{S}^2 \frac{1}{4}(\mathrm{C}-3)^2\right) \qquad 4.38$$

Where N represents the sample size, K denotes number of regressors, S represents the skewness of the sample's distribution and C denotes the kurtosis of the sample's distribution. The following presents the null hypothesis tested under the normality test;

H0: The residuals are multivariate normally distributed.

- **No Heteroscedasticity Assumption and Test**

Heteroscedasticity refers to an unequal variance on the regression's residuals at time point *t* (Stock and Watson, 2012). The white (1980) heteroscedasiticy test is used in this study. It is important for the variance of the regression's residuals to be constant over time (homoscedasticity) so that the coefficients' estimates for the regression may be unbiased and consistent. If the variance of the residuals changes over time, the coefficients' estimates will unreliable, and the standard hypothesis will be invalid because of the wider confidence interval, thus, committing Type 1 error (the true null hypothesis is bound to be rejected). The following is an assumption for testing.

H0: The residuals are homoscedastic

- **No Serial Correlation Assumption and Langrage Multiplier (LM) Serial Correlation test**

There is serial correlation when there is a correlation among the residuals ordered in time, which is basically the violation of the assumption that there should be no dependence among the residuals in a regression model. If the residuals are constantly dependent among themselves, the coefficients' estimates will be unreliable, and the standard hypothesis testing will also be invalid due to the wider confidence interval (Type 1 error). In most cases, serial correlation arises from incorrect functional forms, automated regressions, data manipulation, data transformation, and nonstationary data (Wooldridge, 2009). The autocorrelation LM test reveals a series of multivariate LM statistics for residuals' serial correlation up to the specified order. Lag-order test statistics are processed by performing auxiliary regressions of residuals (μ), on the original on the right hand regressions and the lagged residuals where the missing principal estimations of μ_{t-h} are replaced by zeros. Hence, the following presents the hull hypothesis tested under the heteroscedasticity;

H0: The residuals are not serially correlated.

4.8.2 Modelling Procedure for NARDL model

Most of the steps for modelling NARDL relationships are the same as those for modelling ARDL relationships. The noteworthy difference here is that NARDL captures the asymmetric (nonlinear) effects of the explanatory variables on the response variable (Mosikari and Eita, 2020). Hence, the steps that are the same as ARDL modelling will not be discussed, as they have already been discussed in the previous section. The following are the steps that are inbuilt in both ARDL and NARDL modelling frameworks; descriptive statistics analysis, informal unit root/stationarity testing, optimal lags selection, and coefficients stability/residuals diagnostic tests. Hence, this section discusses the steps that are only inbuilt in the NARDL modelling framework.

4.8.2.1 Testing for nonlinearity

Narayan (2005) emphasizes that time series must satisfy the condition of "nonlinearity" before nonlinear techniques can be applied on them. It is for this reason that this study makes use of the well-known linearity tests called the Brock, Dechert and Scheinkman (BDS) linearity test by Brock *et al*. (1996), and the White linearity test by White (1989).

4.8.2.1.1 The BDS Linearity Test

The BDS test is a well-known and widely used test in the literature. The ability of the test to recognize the null of linearity when the true model is linear and its high power compared to the nonlinear alternatives are indicated by Barnett *et al*. (1998). To understand how the BDS test works as a model specification test, consider the following data generating process (DGP);

$$Y_t = \vartheta(\rho_{t-1}, \delta, u_t) \quad 4.39$$

Where $\rho_{t-1} = (Y_{t-1}, \dots Y_{t-p})$, Y_t is an observed stationary variable generated by the DGP, δ is an unknown vector of parameters, and the unobserved error term (u_t) follows a normal distribution with zero mean and finite variance, and is not dependent on Y_{t-1} for each time point *t*. Hence, equation 4.36 can be estimated with;

$$Y_t = f(\rho_{t-1}, \delta_T, \hat{u}_t), t = 1, \dots, T \quad 4.40$$

The estimated residual $(\hat{u}_t)$ and δ_T represents the consistent estimator of δ. In any chance that the DGP presented by equation 4.39 is correct, the limit of $\hat{u}_t$ will be equal to u_t and serially independent. That is, $\hat{u}_t$ becomes normally distributed when $\delta_T = \delta$. Hence, failure to pass the BDS test, which tests the null hypothesis of normality assumption, would infer that the fitted model is incorrectly specified.

If the residuals of a parametric model are normally distributed, under the null hypothesis of the BDS test, then its m-history (embedding dimension) correlation integral is equal to the correlation integral for *m* 1-history residuals. Mathematically, for a normally distributed stochastic process;

$$C_{m,T} = [C_1, T(\varepsilon)^m] \quad 4.41$$

The correlation integral for the m-history (m-dimensional vector) can be characterized as;

$$C_{m,T}(\varepsilon) = \frac{2}{T_m(T_m-1)} \sum_{1 \le s < t \le T_m} I_\varepsilon({u_t}^m, {u_s}^m) \quad 4.42$$

Where $T_m = T - m + 1$ and $I_\varepsilon({u_t}^m, {u_s}^m)$ is the closeness indicator function that is equal to 1 if $|{u_t}^m, {u_s}^m| < \varepsilon$, or is equal to zero otherwise. Hence, equation 4.42 measures the fraction of pairs of points $({u_t}^m, {u_s}^m)$ that are within ε distance of each other.

Brock *et al*. (1996) demonstrate that when u_t is normally distributed, then for any fixed m and ε, the term $\left[C_m, T(\varepsilon) - C_{1,T}, T(\varepsilon)^m\right]$ multiplied by $\sqrt{T}$, generates a non-degenerate limiting

distribution with a finite variance. That is, the term $\sqrt{T}\left[C_m, T(\varepsilon) - C_{1,T}, T(\varepsilon)^m\right]$ becomes asymptotically standard normal as *T* approaches infinity with mean zero and variance ${\sigma_m}^2$. Hence, the BDS test statistic can be characterized as;

$$BDS_{m,T}(\varepsilon) = \frac{\sqrt{T} * \left[C_m, T(\varepsilon) - C_{1,T}, T(\varepsilon)^m\right]}{\theta_{m,T}(\varepsilon)} \quad 4.43$$

Where the numerator parenthesis measures the distance between the non-normally distributed and normally distributed components from the u_t process.

The probability value for the BDS test statistic should be less than any level of significance for the null hypothesis to be rejected. The following is the tested null hypothesis;

H_0: Variable is "linear"

4.8.2.1.2 The White Linearity Test

White (1989) proposed a test from the neural network model called the White linearity test. The White test falls under the group of Lagrange Multiplier tests. The White test is basically based on the following demonstration;

Supposing a set $I_t = \{X_{1t}, X_{2t}, \ldots X_{pt}\}$ by W_t. The modelling procedure gets a good approach for$f(W_t)$, so $E[Y_t|I_t] = f(W_t)$. Assuming nonlinear statistical modelling in two phases, namely, linearity testing for Y_t with exogenous variables in the set I_t and if linearity is rejected then other types of approaches such as nonparametric or semi-parametric models are used. Suppose the following nonlinear model;

$$Y_t = \pi(\delta' W_t) + \beta' W_t + \mu_t \quad 4.44$$

Where μ_t follows a white noise process, $W_t = (1, \widetilde{W_t})$, $\widetilde{W_t} = (W_{1t}, \ldots, W_{Pt})'$, $\beta = (\beta_0 + \beta_1, \ldots, \beta_P)$, $\delta = (\delta_0, \hat{\delta}')'$ and $\tilde{\delta} = (\delta_1, \ldots, \delta_P)'$.

For example;

$$\pi(\delta' W_t) = \gamma_0 \rho(\delta' W_t), \text{ with } (\delta' W_t) = \{1 + \exp(-\delta' W_t)\}^{-1} - \frac{1}{2} \quad 4.45$$

Model represented by equation 4.45 can be treated as a hidden layer neural network model in such a way that the model is characterized as;

$$Y_t = \beta' W_t + \sum_{j=1}^{q} \gamma_{0j} \left\{ \rho(Y'_t W_t) - \frac{1}{2} \right\} + \mu_t \quad 4.46$$

With all these demonstrations, hypothesis that $Y_t = \beta' W_t + \mu_t$ is linear, is defined as;

$$H_0: \gamma_{01} = \gamma_{02} =, \dots, = \gamma_{0q} = 0 \quad 4.47$$

$$H_1: \gamma_{01} \neq \gamma_{02} \neq, \dots, \neq \gamma_{0q} \neq 0 \quad 4.48$$

Hence, the hypothesis presented by equation 4.44 is called the linearity hypothesis of neural network test, where the alternative (presented by equation 4.45) is called 'neglected nonlinearity' hypothesis of neural network test.

The probability value for the Chi-squared test statistic should be less than any level of significance for the null hypothesis to be rejected. The following is the tested null hypothesis;

H_0: Variable is "linear"

4.8.2.2 NARDL Model Specification

The empirical model of this study should be presented within the NARDL framework after the variables have been proven (using the BDS and White linearity tests) to be nonlinear in nature. Equation 4.49 presents the NARDL model to determine the asymmetric (nonlinear) effects of tax revenue collection and the other selected independent variables on public debt in South Africa;

$$\begin{aligned}\Delta PDT_t = {} & \beta_0 + \sum_{i=1}^{n1} \beta_{1i} \Delta PDT_{t-i} + \sum_{i=1}^{n2} \beta_{2i} \Delta TRV^{+}{}_{t-i} + \sum_{i=1}^{n3} \beta_{3i} \Delta TRV_{t-i}{}^{-} + \sum_{i=1}^{n4} \beta_{4i} \Delta INF^{+} + \\ & \sum_{i=1}^{n5} \beta_{5i} \Delta INF_{t-i}{}^{-} + \sum_{i=1}^{n6} \beta_{6i} \Delta RIN_{t-i}{}^{+} + \sum_{i=1}^{n7} \beta_{7i} \Delta RIN^{-} + \sum_{i=1}^{n8} \beta_{8i} \Delta POI_{t-i}{}^{+} + \\ & \sum_{i=1}^{n9} \beta_{9i} \Delta POI_{t-i}{}^{-} + \sum_{i=1}^{n10} \beta_{10i} LCOR_{t-i}{}^{+} + \sum_{i=1}^{n11} \beta_{11i} COR_{t-i}{}^{-} + \beta_{12} PDT_{t-1} + \beta_{13} TRV_{t-1}{}^{+} + \\ & \beta_{14} TRV_{t-1}{}^{-} + \beta_{15} INF_{t-1}{}^{+} + \beta_{16} INF_{t-1}{}^{-} + \beta_{17} RIN_{t-1}{}^{+} + \beta_{18} RIN_{t-1}{}^{-} + \beta_{19} POI_{t-1}{}^{+} + \\ & \beta_{20} POI_{t-1}{}^{-} + \beta_{21} COR_{t-1}{}^{+} + \beta_{22} COR_{t-1}{}^{-} + u_t \end{aligned} \quad 4.49$$

Where PDT public debt, TRV tax revenue, INF inflation, RIN interest rate, POI political instability index, and COR corruption perceptions index. Furthermore, Δ operator denotes difference, β_{ni} short run coefficients, β_i long run coefficients, $\sum_{i=1}^{n}$. lags order and $\pm$ measures the short and long run impacts of increase/decrease in the tax revenue collection and the selected macroeconomic variables on public debt.

4.8.2.3 Non-Linear Stationarity Testing

Like in the ARDL framework, the NARDL framework also requires the variables to be stationary at level or first difference. To satisfy this condition within the NARDL framework, this study makes use of nonlinear unit root/stationarity tests such as Bierens (1997) and Breitung (2002) nonlinear unit root tests. Hence, this section briefly discusses the aforementioned nonparametric nonlinear unit root tests.

- **Bierens (1997) nonlinear unit root test**

Bierens (1997) proposed a unit root test model from the Dickey-Fuller model augmented with orthogonal Chebishev polynomials;

$$\Delta Y_t = aY_{t-1} + \sum_{t=1}^{P} \beta_i \Delta Y_{t-i} + \sum_{j=0}^{M} \gamma_j P_{j,t} + \mu_t \quad 4.50$$

Where $P_{0,t}$ to $P_{M,t}$ are the Chebisev polynomials, $P_{0,t} = 1$, $P_{1,t}$ represents a linear trend, whereas $P_{2,t}$ to $P_{M,t}$ represents cosine functions. The model presented by equation 4.47 has four tests which are as follows;

$\hat{t}\,(M)$, the t-statistic on the estimated coefficient a, $\hat{A}\,(M) = N\hat{a}/\,1 - \sum_{i=1}^{P} \hat{\beta}_i$, $\hat{F}\,(M)$ joint F test on $\hat{a}$ and coefficients of non-constant Chebishev polynomials, $T(M)$ nonparametric joint test on $\hat{a}$ and the coefficients of nonlinear Chebishev polynomials.

These tests test the null hypothesis that there is a unit root with drift, while the alternative hypothesis is linear or nonlinear deterministic trend stationary. Notably, left hand side rejections for the $\hat{t}\,(M)$, $\hat{A}\,(M)$ and $T(M)$ tests indicate nonlinear trend stationary whereas right hand side rejections prompt ambiguous results for two tests. Cushman (2002) indicates that this ambiguity can be rectified to favour nonlinear trend stationarity only if rejections take place only at nonlinear orders.

Hence, using the model presented by equation 4.51, the following are the Bierens (1997) nonlinear test models for the variables of this study;

$$\Delta PDT_t = aPDT_{t-1} + \sum_{t=1}^{P} \beta_i \Delta PDT_{t-i} + \sum_{j=0}^{M} \gamma_j P_{j,t} + \mu_t \quad 4.51$$

$$\Delta TRV_t = aTRV_{t-1} + \sum_{t=1}^{P} \beta_i \Delta TRV_{t-i} + \sum_{j=0}^{M} \gamma_j P_{j,t} + \mu_t \quad 4.52$$

$$\Delta INF_t = aINF_{t-1} + \sum_{t=1}^{P} \beta_i \Delta INF_{t-i} + \sum_{j=0}^{M} \gamma_j P_{j,t} + \mu_t \quad 4.53$$

$$\Delta RIN_t = aRIN_{t-1} + \sum_{t=1}^{P} \beta_i \Delta RIN + \sum_{j=0}^{M} \gamma_j P_{j,t} + \mu_t \quad 4.54$$

$$\Delta POI_t = aPOI_{t-1} + \sum_{t=1}^{P} \beta_i \Delta POI_{t-i} + \sum_{j=0}^{M} \gamma_j P_{j,t} + \mu_t \quad 4.55$$

$$\Delta COR_t = aCOR_{t-1} + \sum_{t=1}^{P} \beta_i \Delta COR_{t-i} + \sum_{j=0}^{M} \gamma_j P_{j,t} + \mu_t \quad 4.56$$

The null hypothesis that $a = 0$ is rejected if the test *t* statistic is less than -3.97 and -3.64 at 5 and 10 percent level of significance (left side tailed *t* test) respectively.

- **Breitung (2002) nonlinear unit root test**

Breitung (2002) developed a test statistic that does not require the specification of the short run dynamic. Such approach is classified as "model free" or "nonparametric" in light of the fact that the asymptotic properties of the test do not rely upon the short run elements or the annoyance parameters. At that point, the test is robust against a potential misspecification. Following Lindley (2006), Breitung utilizes a meaning of integration that is not limited to a particular time series model.

A time series Z_t is integrated to the order of 1 if;

$$T \to \infty \quad 4.57$$

$$T^{-\frac{1}{2}} Y_{[aT]} \underset{T\to\infty}{\Longrightarrow} \gamma W(b) \quad 4.58$$

Where $\underset{T\to\infty}{\Longrightarrow}$ symbolizes weak convergence with respect to the associated probability measure, γ is a constant greater than zero, $[aT]$ is an integer and $W(b)$ is a Brownian motion defined on C[0,1].

Hence, the following equation presents the Breitung (2002) non-parametric nonlinear unit root test model;

$$\Delta Z_t = \varphi' D_t + \omega Z_{t-1} + u_t \quad 4.59$$

Where φ' is $m * 1$ vector, superscript $'$ denotes transpose, D_t deterministic trends which are specified as $D_t = 1$, when $m = 1$, or $D_t = (1 - t)$ when $m = 2$.

Breitung (2002) proposes the variance ratio statistic to test the null hypothesis that Z_t is non-stationary against the alternative hypothesis that Z_t is stationary. The Q_Z is the variance ratio of the partial sums and the original series, and variance ratio statistic is characterized as;

$$\hat{Q}_Z = \frac{T^{-1} \sum_{t=1}^{T} \hat{U}_t^{\,2}}{\sum_{t=1}^{T} \hat{u}_t^{\,2}} \quad 4.60$$

Where $\widehat{U}_t = \widehat{U}_1 + \cdots + \widehat{U}_t$ and $\hat{u}_t = Z_t - \hat{\pi}' z_t$ are the ordinary least squares (OLS) residuals from the regression of data Z_t on $\hat{\pi}' z_t$.

Just as in the Bierens (1997) nonlinear unit root test, the following are the Breitung (2002) nonlinear unit root test model specifications for the key variables of this thesis as per the model presented by equation 4.59;

$$\Delta PDT_t = \varphi' D_t + \omega PDT_{t-1} + u_t \quad 4.61$$

$$\Delta TRV_t = \varphi' D_t + \omega TRV_{t-1} + u_t \quad 4.62$$

$$\Delta INF_t = \varphi' D_t + \omega INF_{t-1} + u_t \quad 4.63$$

$$\Delta RIN_t = \varphi' D_t + \omega RIN_{t-1} + u_t \quad 4.64$$

$$\Delta POI_t = \varphi' D_t + \omega POI_{t-1} + u_t \quad 4.65$$

$$\Delta COR_t = \varphi' D_t + \omega COR_{t-1} + u_t \quad 4.66$$

The null hypothesis that $\omega = 0$ is rejected if the $\hat{Q}_Z$ test statistic is less than 0.01004 and 0.01435 at 5 and 10 percent level of significance respectively.

4.8.2.4 NARDL Cointegration Bounds testing Approach

Just like the ARDL method, Rezitis (2018) emphasizes that the NARDL method should also be applied when there is only one cointegrating asymmetric vector. That is, all the variables need to be tested endogenously for cointegration using the NARDL bounds test. Hence, the NARDL bounds test tests the following unrestricted error correction models for asymmetric cointegration;

$$\Delta PDT_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1i} \Delta PDT_{t-i} + \sum_{i=1}^{n2} \beta_{2i} \Delta TRV^{+}{}_{t-i} + \sum_{i=1}^{n3} \beta_{3i} \Delta TRV_{t-i}{}^{-} + \sum_{i=1}^{n4} \beta_{4i} \Delta INF^{+} + \sum_{i=1}^{n5} \beta_{5i} \Delta INF_{t-i}{}^{-} + \sum_{i=1}^{n6} \beta_{6i} \Delta RIN_{t-i}{}^{+} + \sum_{i=1}^{n7} \beta_{7i} \Delta RIN^{-} + \sum_{i=1}^{n8} \beta_{8i} \Delta POI_{t-i}{}^{+} + \sum_{i=1}^{n9} \beta_{9i} \Delta POI_{t-i}{}^{-} + \sum_{i=1}^{n10} \beta_{10i} COR_{t-i}{}^{+} + \sum_{i=1}^{n11} \beta_{11i} LCOR_{t-i}{}^{-} + \beta_{12} PDT_{t-1} + \beta_{13} TRV_{t-1}{}^{+} + \beta_{14} TRV_{t-1}{}^{-} + \beta_{15} INF_{t-1}{}^{+} + \beta_{16} INF_{t-1}{}^{-} + \beta_{17} RIN_{t-1}{}^{+} + \beta_{18} RIN_{t-1}{}^{-} + \beta_{19} POI_{t-1}{}^{+} + \beta_{20} POI_{t-1}{}^{-} + \beta_{21} COR_{t-1}{}^{+} + \beta_{22} COR_{t-1}{}^{-} + u_{1t} \quad 4.67$$

$$\Delta TRV_t = \beta_0 + \sum_{i=1}^{n1} \beta_{1i} \Delta TRV_{t-i} + \sum_{i=1}^{n2} \beta_{2i} \Delta PDT^{+}{}_{t-i} + \sum_{i=1}^{n3} \beta_{3i} \Delta PDT_{t-i}{}^{-} + \sum_{i=1}^{n4} \beta_{4i} \Delta INF^{+} + \sum_{i=1}^{n5} \beta_{5i} \Delta INF_{t-i}{}^{-} + \sum_{i=1}^{n6} \beta_{6i} \Delta RIN_{t-i}{}^{+} + \sum_{i=1}^{n7} \beta_{7i} \Delta RIN_{t-i}{}^{-} + \sum_{i=1}^{n8} \beta_{8i} \Delta POI_{t-i}{}^{+} + \sum_{i=1}^{n9} \beta_{9i} \Delta POI_{t-i}{}^{-} + \sum_{i=1}^{n10} \beta_{10i} \Delta COR_{t-i}{}^{+} + \sum_{i=1}^{n11} \beta_{11i} \Delta COR_{t-i}{}^{-} + \beta_{12} TRV_{t-1} + \beta_{13} PDT_{t-1}{}^{+} +$$

$$\beta_{14}PDT_{t-1}^{-} + \beta_{15}INF_{t-1}^{+} + \beta_{16}INF_{t-1}^{-} + \beta_{17}RIN_{t-1}^{+} + \beta_{18}RIN_{t-1}^{-} + \beta_{19}POI_{t-1}^{+} + \beta_{20}POI_{t-1}^{-} + \beta_{21}COR_{t-1}^{+} + \beta_{22}COR_{t-1}^{-} + u_{2t} \quad 4.68$$

$$\Delta INF_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta INF_{t-i} + \sum_{i=1}^{n2}\beta_{2i}\Delta TRV^{+}{}_{t-i} + \sum_{i=1}^{n3}\beta_{3i}\Delta TRV_{t-i}^{-} + \sum_{i=1}^{n4}\beta_{4i}\Delta RIN_{t-i}^{+} + \sum_{i=1}^{n5}\beta_{5i}\Delta RIN_{t-i}^{-} + \sum_{i=1}^{n6}\beta_{6i}\Delta PDT_{t-i}^{+} + \sum_{i=1}^{n7}\beta_{7i}\Delta PDT_{t-i}^{-} + \sum_{i=1}^{n8}\beta_{8i}\Delta POI_{t-i}^{+} + \sum_{i=1}^{n9}\beta_{9i}\Delta POI_{t-i}^{-} + \sum_{i=1}^{n10}\beta_{10i}\Delta COR_{t-i}^{+} + \sum_{i=1}^{n11}\beta_{11i}\Delta COR_{t-i}^{-} + \beta_{12}INF_{t-1} + \beta_{13}TRV_{t-1}^{+} + \beta_{14}TRV_{t-1}^{-} + \beta_{15}RIN_{t-1}^{+} + \beta_{16}RIN_{t-1}^{-} + \beta_{17}PDT_{t-1}^{+} + \beta_{18}PDT_{t-1}^{-} + \beta_{19}POI_{t-1}^{+} + \beta_{20}POI_{t-1}^{-} + \beta_{21}COR_{t-1}^{+} + \beta_{22}COR_{t-1}^{-} + u_{3t} \quad 4.69$$

$$\Delta RIN_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta RIN_{t-i} + \sum_{i=1}^{n2}\beta_{2i}\Delta TRV^{+}{}_{t-i} + \sum_{i=1}^{n3}\beta_{3i}\Delta TRV_{t-i}^{-} + \sum_{i=1}^{n4}\beta_{4i}\Delta INF_{t-i}^{+} + \sum_{i=1}^{n5}\beta_{5i}\Delta INF_{t-i}^{-} + \sum_{i=1}^{n6}\beta_{6i}\Delta PDT_{t-i}^{+} + \sum_{i=1}^{n7}\beta_{7i}\Delta PDT_{t-i}^{-} + \sum_{i=1}^{n8}\beta_{8i}\Delta POI_{t-i}^{+} + \sum_{i=1}^{n9}\beta_{9i}\Delta POI_{t-i}^{-} + \sum_{i=1}^{n10}\beta_{10i}\Delta COR_{t-i}^{+} + \sum_{i=1}^{n11}\beta_{11i}\Delta COR_{t-i}^{-} + \beta_{12}RIN_{t-1} + \beta_{13}TRV_{t-1}^{+} + \beta_{14}TRV_{t-1}^{-} + \beta_{15}INF_{t-1}^{+} + \beta_{16}INF_{t-1}^{-} + \beta_{17}PDT_{t-1}^{+} + \beta_{18}PDT_{t-1}^{-} + \beta_{19}POI_{t-1}^{+} + \beta_{20}POI_{t-1}^{-} + \beta_{21}COR_{t-1}^{+} + \beta_{22}COR_{t-1}^{-} + u_{4t} \quad 4.70$$

$$\Delta POI_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta POI_{t-i} + \sum_{i=1}^{n2}\beta_{2i}\Delta TRV^{+}{}_{t-i} + \sum_{i=1}^{n3}\beta_{3i}\Delta TRV_{t-i}^{-} + \sum_{i=1}^{n4}\beta_{4i}\Delta INF_{t-i}^{+} + \sum_{i=1}^{n5}\beta_{5i}\Delta INF_{t-i}^{-} + \sum_{i=1}^{n6}\beta_{6i}\Delta RIN_{t-i}^{+} + \sum_{i=1}^{n7}\beta_{7i}\Delta RIN_{t-i}^{-} + \sum_{i=1}^{n8}\beta_{8i}\Delta PDT_{t-i}^{+} + \sum_{i=1}^{n9}\beta_{9i}\Delta PDT_{t-i}^{-} + \sum_{i=1}^{10}\beta_{10i}\Delta COR_{t-i}^{+} + \sum_{i=1}^{n11}\beta_{11i}\Delta COR_{t-i}^{-} + \beta_{12}POI_{t-1} + \beta_{13}TRV_{t-1}^{+} + \beta_{14}TRV_{t-1}^{-} + \beta_{15}INF_{t-1}^{+} + \beta_{16}INF_{t-1}^{-} + \beta_{17}RIN_{t-1}^{+} + \beta_{18}RIN_{t-1}^{-} + \beta_{19}PDT_{t-1}^{+} + \beta_{20}PDT_{t-1}^{-} + \beta_{21}COR_{t-1}^{+} + \beta_{22}COR_{t-1}^{-} + u_{5t} \quad 4.71$$

$$\Delta COR_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta COR_{t-i} + \sum_{i=1}^{n2}\beta_{2i}\Delta TRV^{+}{}_{t-i} + \sum_{i=1}^{n3}\beta_{3i}\Delta TRV_{t-i}^{-} + \sum_{i=1}^{n4}\beta_{4i}\Delta INF_{t-i}^{+} + \sum_{i=1}^{n5}\beta_{5i}\Delta INF_{t-i}^{-} + \sum_{i=1}^{n6}\beta_{6i}\Delta RIN_{t-i}^{+} + \sum_{i=1}^{n7}\beta_{7i}\Delta RIN_{t-i}^{-} + \sum_{i=1}^{n8}\beta_{8i}\Delta POI_{t-i}^{+} + \sum_{i=1}^{n9}\beta_{9i}\Delta POI_{t-i}^{-} + \sum_{i=1}^{n10}\beta_{10i}\Delta PDT_{t-i}^{+} + \sum_{i=1}^{n11}\beta_{11i}\Delta PDT_{t-i}^{-} + \beta_{12}COR_{t-1} + \beta_{13}TRV_{t-1}^{+} + \beta_{14}TRV_{t-1}^{-} + \beta_{15}INF_{t-1}^{+} + \beta_{16}INF_{t-1}^{-} + \beta_{17}RIN_{t-1}^{+} + \beta_{18}RIN_{t-1}^{-} + \beta_{19}POI_{t-1}^{+} + \beta_{20}POI_{t-1}^{-} + \beta_{21}PDT_{t-1}^{+} + \beta_{22}PDT_{t-1}^{-} + u_{6t} \quad 4.72$$

Where PDT is public debt, TRV tax revenue, INF inflation, RIN real interest rate, POI political instability index, and COR corruption perceptions index. Furthermore, Δ operator denotes difference, β_{ni} short run coefficients, β_i long run coefficients, $\sum_{i=1}^{n}$. lags order and $\pm$ measures the

short and long run impacts of increase/decrease in the tax revenue collection and associating macroeconomic variables on public debt.

From equation 4.67 to 4.72, tests for asymmetric cointegration are carried out by testing the joint significance of the lagged levels of the variables utilizing the F test where the null hypothesis of "no asymmetric cointegration" is characterized by;

$H_0: \beta_i = 0,$ for $i = 12, \dots, 22$ (No Asymmetric Cointegration), against the alternative (H_a)

$H_a: \beta_i \neq 0$, for $i = 12, \dots, 22$ (Asymmetric Cointegration)

The asymptotic distribution of F statistic is not standardized under the null hypothesis and was initially inferred and organized Pesaran and Smith (2001) but modified by Narayan (2005) for smaller samples. Two cases of critical values have been provided; one, which is suitable when all variables are *I(0)* and the other for all variables that are *I(1)*. According to Pesaran and Smith (2001), if testing for the cointegration, if the calculated F statistic exceeds the upper critical limit, an accurate induction on the state of cointegration can be made without knowing whether the variables were *I(0)* or *I(1)*. In this case, the null hypothesis of "no cointegration" is rejected, whether the variables are *I(0)* or *I(1)*.

4.8.2.5 Testing for long and short run asymmetric effects

It is important to test whether there is the presence of asymmetry in the relationship between variables. The presence of asymmetry simply indicates that the calculated “positive” and “negative” series have unique effects on the dependent variable (Mosikari and Eita, 2020). Hence, the relationships reflecting the hypotheses formulated in chapter one will be tested for asymmetry using the Wald test. Using the principal NARDL model of this study, presented by equation 4.50, the following are the null hypotheses to be tested (starting first with the long run coefficients);

$H_0{}^1: \beta_{13}{}^+ = \beta_{14}{}^-$

$H_0{}^2: \beta_{19}{}^+ = \beta_{20}{}^-$

$H_0{}^3: \beta_{21}{}^+ = \beta_{22}{}^-$

Where the positive and negative long run coefficients (LR) are calculated as;

$$LR_{TRV}{}^{+} = \frac{-\beta_{13}{}^{+}}{\beta_{12}PDT_{t-1}}, LR_{TRV}{}^{-} = \frac{-\beta_{14}{}^{-}}{\beta_{12}PDT_{t-1}} \quad 4.73$$

$$LR_{POI}{}^{+} = \frac{-\beta_{19}{}^{+}}{\beta_{12}PDT_{t-1}}, LR_{POI}{}^{-} = \frac{-\beta_{20}{}^{-}}{\beta_{12}PDT_{t-1}} \quad 4.74$$

$$LR_{COR}{}^{+} = \frac{-\beta_{21}{}^{+}}{\beta_{12}PDT_{t-1}}, LR_{COR}{}^{-} = \frac{-\beta_{22}{}^{-}}{\beta_{12}PDT_{t-1}} \quad 4.75$$

The short-run adjustments to the positive and negative shocks affecting tax revenue collection, inflation, real interest rate, political instability and corruption are captured by the parameters $\beta_{2i}, \beta_{3i}, \beta_{4i}, \beta_{5i}, \beta_{6i}, \beta_{7i}\beta_{8i}, \beta_{9i}, \beta_{10i}$ and β_{11i} respectively. The short-run symmetry can equally be tested by using a Wald test of the null hypothesis that;

$H_0: \beta_i{}^{+} = \beta_i{}^{-}$ for $i = 1, \dots N-1$

Equation 4.50 is reduced to ARDL (linear) if both null hypotheses of short-run and long-run symmetry cannot be rejected. The rejection of either the long run symmetry or the short run symmetry will yield the cointegrating NARDL model with long-run asymmetry presented by equation 4.76 and with short-run asymmetry presented by equation 4.77.

$$\Delta PDT_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta PDT_{t-i} + \sum_{i=1}^{n2}\beta_{2i}\Delta TRV^{+}{}_{t-i} + \sum_{i=1}^{n3}\beta_{3i}\Delta TRV_{t-i}{}^{-} + \sum_{i=1}^{n4}\beta_{4i}\Delta INF^{+} + \sum_{i=1}^{n5}\beta_{5i}\Delta INF_{t-i}{}^{-} + \sum_{i=1}^{n6}\beta_{6i}\Delta RIN_{t-i}{}^{+} + \sum_{i=1}^{n7}\beta_{7i}\Delta RIN^{-} + \sum_{i=1}^{n8}\beta_{8i}\Delta POI_{t-i}{}^{+} + \sum_{i=1}^{n9}\beta_{9i}\Delta POI_{t-i}{}^{-} + \sum_{i=1}^{n10}\beta_{10i}LCOR_{t-i}{}^{+} + \sum_{i=1}^{n11}\beta_{11i}COR_{t-i}{}^{-} + \beta_{12}\,PDT_{t-1} + \beta_{13}TRV_{t-1}{}^{+} + \beta_{14}TRV_{t-1}{}^{-} + \beta_{15}INF_{t-1}{}^{+} + \beta_{16}INF_{t-1}{}^{-} + \beta_{17}RIN_{t-1}{}^{+} + \beta_{18}RIN_{t-1}{}^{-} + \beta_{19}POI_{t-1}{}^{+} + \beta_{20}POI_{t-1}{}^{-} + \beta_{21}COR_{t-1}{}^{+} + \beta_{22}COR_{t-1}{}^{-} + u_{1t} \quad 4.76$$

$$\Delta PDT_t = \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta PDT_{t-i} + \sum_{i=1}^{n2}\beta_{2i}\Delta TRV_{t-i} + \sum_{i=1}^{n3}\beta_{3i}\Delta INF_{t-i} + \sum_{i=1}^{n4}\beta_{4i}\Delta RIN_{t-i} + \sum_{i=1}^{n5}\beta_{5i}\Delta POI_{t-i} + \sum_{i=1}^{n6}\beta_{6i}\Delta COR_{t-i} + \beta_7 PDT_{t-1} + \beta_8 TRV_{t-1}{}^{+} + \beta_9 TRV_{t-1}{}^{-} + \beta_{10}INF_{t-1}{}^{+} + \beta_{11}INF_{t-1}{}^{-} + \beta_{12}RIN_{t-1}{}^{+} + \beta_{13}RIN_{t-1}{}^{-} + \beta_{14}POI_{t-1}{}^{+} + \beta_{15}POI_{t-1}{}^{-} + \beta_{16}COR_{t-1}{}^{+} + \beta_{17}COR_{t-1}{}^{-} + u_t \quad 4.77$$

4.8.2.6 Nonlinear Granger Causality Test

First of all, nonlinear behaviour within the NARDL framework is defined by the positive and negative partial decompositions of the independent variables affecting the dependent variable simultaneously. That is, the standard Granger causality test used for linear relationships, can also be used in a case where nonlinear behaviour is defined in this fashion (Rezitis, 2018). Hence

assuming X and Y (bivariate) to represent the independent and dependent variables respectively, the following null and alternative hypothesis can be observed to trace causality relationship between the nonlinear behaviour of the independent variable and the dependent variable.

H_0= X^+_{-t} is not the cause of y_t

H_1 = X^+_{-t} is the cause of y_t

Where ± represent positive and negative partial decompositions (nonlinear behaviour) for the time series X.

To make an inference on the hypothesis that holds, consider the following Granger Causality equations;

$$y_t = a_1 + \sum_{i=1}^{n} \beta i X^+_{-t-i} + \sum_{j-1}^{m} \gamma_j y_{t-j} + e_{1t} \quad 4.78$$

$$X^+_{-t} = a_2 + \sum_{i=1}^{n} \theta i \, X^+_{-t-i} + \sum_{j-1}^{m} \delta \mathrm{j} y_{t-1} + e_{2t} \quad 4.79$$

A time series X with positive and negative partial decompositions is said to Granger-cause Y in the event that it very well may be shown, mostly through a series of t and F-tests on lagged values of positive and negative X (and with lagged values of Y additionally included), that those positive and negative X values give statistically significant information about future values of Y (Rezitis, 2018).

4.9 CONCLUSION

This chapter speaks to the methodology to be utilised to study the linear and nonlinear relationships between public debt and tax revenue collection, as well as the selected associating macroeconomic variables in South Africa. This study use annual time series data of 34 observations (1985 to 2019). The ARDL and NARDL techniques are chosen for analysing both short-run and long-run relationships between the variables understudy. The efficiency and legitimacy of the models to be built in this study will be subjected to the discussed residuals diagnostic and coefficients stability tests which are performed in the following chapter.

CHAPTER FIVE

ESTIMATION, PRESENTATION AND INTERPRETATION OF RESULTS

5.1 INTRODUCTION

This chapter estimates and interprets the results within the discussed methodologies in the previous chapter. The researcher starts first by building the efficient Auto-Regressive Distributed Lags (ARDL) model to establish the relationship between the independent variables and the dependent variable of this study. Secondly, the researcher continues from the basis of ARDL model building to build an efficient Nonlinear Auto-Regressive Distributed Lags (NARDL) model to test for possible nonlinear relationships between the independent variables and dependent variable of this study. Lastly, the researcher concludes the chapter by integrating the results of ARDL and NARDL to see which framework explains the relationship between independent variables and dependent variable better, as this will enable the researcher to show the correct economic implications so that better policy implications and recommendations may be provided.

Hence, this chapter is organized as follows; section 5.2 presents the estimation of the relationship between independent variables and dependent variable within an ARDL framework. Section 5.3 presents the estimation of the relationship between independent variables and dependent variable within the NARDL framework. Section 5.4 concludes the chapter by integrating the results of the ARDL and NARDL frameworks.

5.2 ESTIMATION OF THE RELATIONSHIP BETWEEN PUBLIC DEBT AND TAX REVENUE COLLECTION IN SOUTH AFRICA IN AN ARDL FRAMEWORK

This section builds the efficient linear ARDL model to establish the relationship between public debt, tax revenue collection and the selected variables. Hence, the steps discussed in the previous chapter are followed carefully and chronologically to build the model.

5.2.1 Descriptive Statistics Analysis

Exploratory data analysis through descriptive statistics, is a tool used to describe the nature of data. Table 5.1 provides descriptive statistics for all key variables of this study (see Appendix 8.1)

Table 5.1 Descriptive Statistics for the key variables

	PDT	TRV	INF	RIN	POI	COR
Mean	3.226428	3.268900	9.236731	4.682864	2.042072	1.233559
Median	3.230804	3.272226	7.786990	4.037300	2.197225	1.084626
Maximum	3.421000	3.336900	17.22452	12.99292	2.397895	1.791759
Minimum	3.025291	3.183088	3.196540	-2.406257	1.098612	0.693147
Std. Dev.	0.080502	0.045257	4.14390	3.221469	0.327557	0.364582
Skewness	-0.175568	-0.28161	0.731764	0.482180	-1.35825	0.261822
Kurtosis	3.400040	1.898861	2.137412	3.902527	3.704351	1.379874
Jarque B.	0.413187	2.327774	4.208070	2.544129	11.48501	4.227724
P(JB)	0.8134	0.327774	0.121924	0.121924	0.0032	0.1208
Sum	112.9250	114.4115	323.2856	323.2856	71.49252	43.17457
Observations	35	35	35	35	35	35

Source: Author's own calculations using Eviews 10 software

The direction of the skewness coefficient depends on the sign of the skewness coefficient (Wegner, 2007). In the case where the estimated coefficient for skewness is negative, the distribution is skewed to the left. In any case, when the positive skewness coefficient is realized, the distribution is skewed to the right. The variables PDT, TRV and POI have negative skewness coefficients. Hence, the distributions of the latter variables are skewed to the left. INF, RIN and COR have positive skewness coefficient which infers that the distribution of INF, RIN and COR are skewed to the right.

Furthermore, it tends to be seen that PDT, TRV, INF, RIN and COR are normally distributed, though POI is not normally distributed. In any case, this does not present any impediment to building an appropriate ARDL and NARDL model for this study, due to the fact that the assumption of normality is generally fundamental for the residuals from the ARDL and NARDL models to be built and evaluated. Thus, satisfaction of the normality assumption is of great importance on the residuals of the ARDL and NARDL models to be estimated in this study.

5.2.2 Correlation Analysis for Multicollinearity

Correlation alludes to a situation where there is a linear dependency relationship among the variables (Wagner, 2007). Wagner (2007) further indicates that the coefficient for correlation ranges between - 1 and +1. A correlation coefficient of +1 indicates that the variables have a perfect positive linear relationship, while a coefficient of - 1 indicates that the variables have a perfect negative linear relationship. Any correlation coefficient that is close to zero indicates no or little linear relationship.

Similarly, a correlation coefficient in the range of 0.10 and 0.20 indicates a weak linear relationship, 0.30 and 0.50 indicate a moderate linear relationship, 0.60 to 0.70 indicates a satisfactory linear relationship, and 0.80 0.99 indicates strong linear relationship. For a situation where the sign is negative, the relationship is interpreted in the same way. However, the direction of the relationship is in the opposite direction (Gujarati, 2009). Therefore, Table 5.2 provides the pairwise correlation matrix for the variables of this study (see Appendix 8.2).

Table 5.2 Pairwise Correlation Matrix for the Key Variables

	PDT	TRV	INF	RIN	POI	COR
PDT	1					
TRV	-0.2498	1				
INF	0.3837	-0.4906	1			
RIN	-0.4016	0.1684	-0.4246	1		
POI	0.5034	0.5496	-0.4262	0.6102	1	
COR	0.5153	-0.4987	0.2989	-0.4421	-0.6289	1

Source: Author's calculations using Eviews 10 Software

The results for pair-wise correlation presented in Table 5.2 show that tax revenue collection (TRV) and real interest rate are weakly and moderately, and negatively correlated to public debt (PDT) respectively. The results on negative correlation between tax revenue collection and public debt support the hypothesis established by the three gap model which postulates that when the tax revenue collection and other financing resources are not sufficient to foster both current and capital expenditure, borrowing domestically or internationally becomes an alternative financing route. That is, positive shocks in tax revenue collection lead to minimized inclination to borrow.

Moreover, inflation, political instability and corruption are moderately and positively correlated to public debt. The positive correlation on political instability, corruption and public debt supports the hypothesis established by the opportunistic models of political economy which indicate that positive shocks in political instability and corruption within government administration lead to an increase in public debt.

Lastly, as emphasized by Pesaran *et al*. (2001), before preceding to estimate the ARDL model, correlation analysis for the key independent variables should be done to find out if they are highly collinear. Therefore, Pesaran *et al.* (1999) emphasized that the correlation between independent variables should not be more than ±0.80. In any case, the estimated ARDL model can experience the side effects of multicollinearity. Therefore, referring to Table 5.2, the correlation among the independent variables are less than ±0.80. This suggests that the ARDL model to be estimated will not face the problem of multicollinearity.

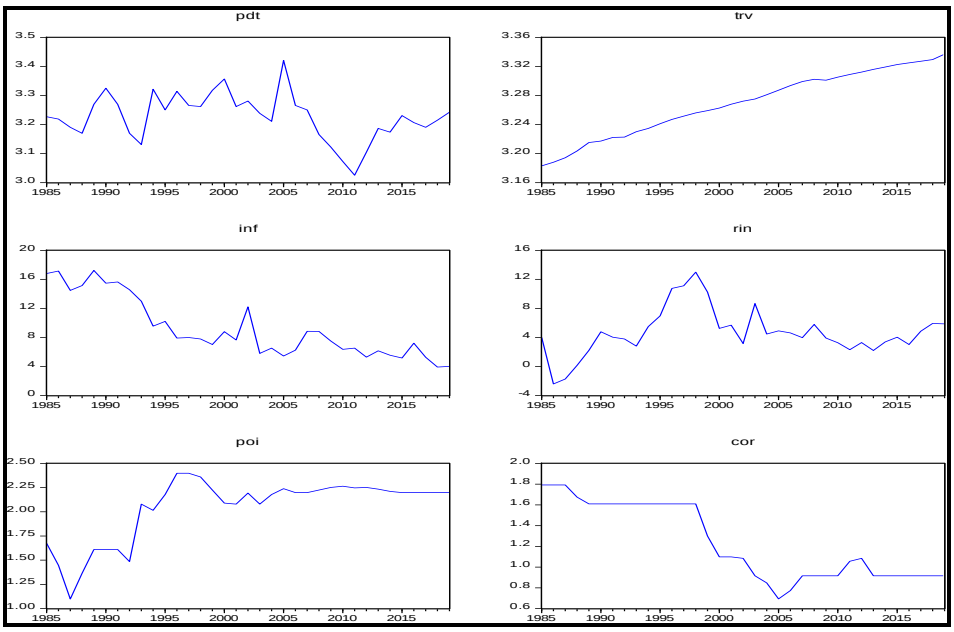
5.2.3 Stationarity Tests for the Key Variables

This section unfolds stationarity tests for the variables used in this study. First, an informal unit root test is carried out on the graphical representation of the variable. Lastly, the formal unit root tests discussed in the previous chapter, are utilized to make inferences on the order of integration of the variables.

5.2.3.1 Informal Unit Root Test

This section examines the trend of the variables' time series to determine the stationarity condition. This is done by analyzing the visual representations of all the variables of this study from 1985 to 2019. Brooks (2008) emphasizes that the time series' trend should reflect a constant mean and variance. In other words, the time series' trend should not change over time (must be constant). Therefore, Figure 5.1 presents a graphical representation of all the variables of this study at level form.

Figure 5.1 Graphical plots for all key variables in level form between 1985 and 2019 in South Africa



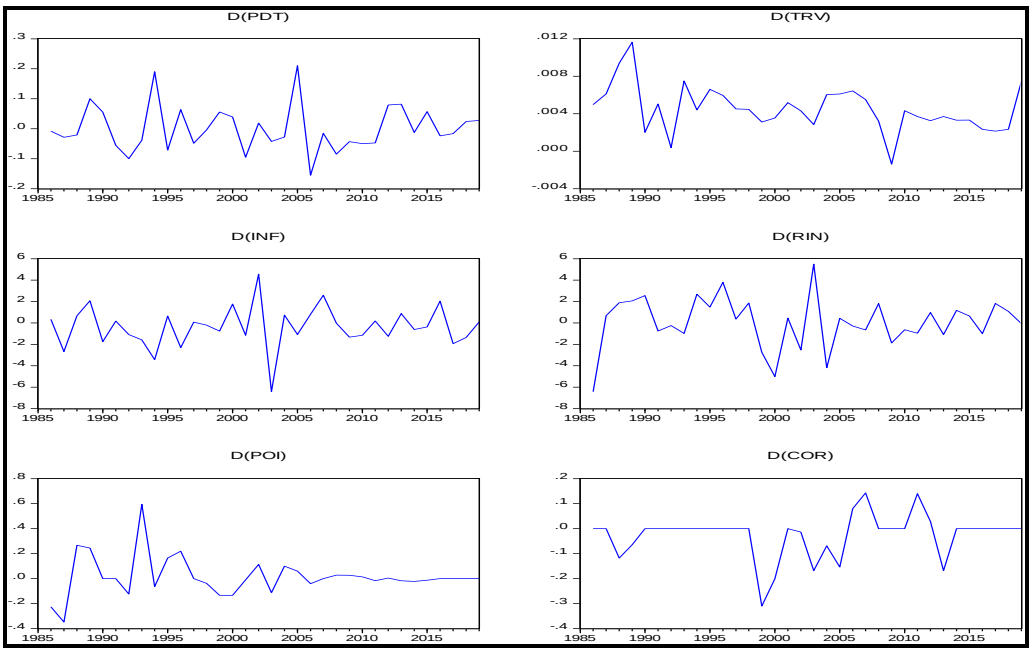
Source: Author's own drawings using Eviews 10 software.

The trend of variables TRV, INF, RIN, POI and COR seems to be changing overtime, except that of PDT. This implies that the mean and variance of the time series for TRV, INF, RIN, POI and COR are not constant, for the period under consideration. Hence, it can be concluded these time series are not stationary at level. Therefore, differencing is needed to ensure constant mean and variance (stationarity). However, the trend of the time series for PDT seems to be constant over time. This means that the mean and the variance of the time series PDT are constant over time at level (stationary).

Notably, the plot presented in Figure 5.1 for all the variables at level does not show any evidence of structural breaks even in 1994 and subsequent years where there was a transition of governments in South Africa. This means that when building the ARDL and NARDL models, it will not be necessary for the researcher to capture pre and post-apartheid events as they are not graphically evident.

Figure 5.2 presents graphical representation of the first differenced key variables that showed non-constant trend at level.

Figure 5.2 Graphical plots for first differenced key variables between 1985 and 2019 in South Africa



Source: Author's own drawings using Eviews 10 software

After differencing key variables TRV, INF, RIN, POI and COR once, their trends seem to be constant across time, this implies that their mean and variance do not change over time. Hence, the variables are stationary. The following section is about testing for the order of integration for the variables of this study.

5.2.3.2 Formal Unit Root Tests

This section presents the results for formal unit root tests carried out in this study to determine the order of integration for the key variables of this study. As discussed in the previous chapter, this study makes use of the Dickey-Fuller GLS and Ng-Perron unit root tests. First, the Dickey-Fuller GLS test is carried out, and interpreted for each key variable of this study. Secondly, the Ng-Perron unit root test is also carried out and interpreted for each key variable of this study.

Thus, Table 5.3 and 5.4 provide the Dickey-Fuller GLS unit root test results for the variables at level and first difference respectively (see Appendix 8.3).

Table 5.3 Dickey-Fuller-GLS unit root test results on the key variables at level

Level				
	With Intercept		**With Intercept and Trend**	
Variable	**Statistic**	**P-Value**	**Statistic**	**P-Value**
PDT	-3.04924	0.0045*	-3.190996	0.0031*
TRV	0.56578	0.5756	-1.43754	0.1600
INF	-0.51186	0.6124	-3.08152	0.0041*
RIN	-2.2510	0.0312**	-2.28203	0.0291**
POI	-1.32627	0.1939	-1.946207	0.0602***
COR	-0.47901	0.6351	-1.917235	0.0645***

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

The results of the Dickey-Fuller GLS unit root test in Table 5.3 show that the null hypothesis, that variables PDT, INF, RIN, POI and LCOR are non-stationary, is rejected under 'intercept and trend' model specification. However, the null hypothesis, that POI and COR are non-stationary, is only rejected at 10 percent level of significance. Rejection of the null hypothesis was realized on the basis that the probability value of the test statistic is less that the desired level of significance. Hence, the order of integration for variables PDT, INF, RIN, POI and COR is 0 under the 'intercept and trend' model specification. Under the 'intercept' model specification, the order of integration for PDT and RIN is 0 when using 1 and 5 percent level of significance.

Table 5.4 Dickey-Fuller-GLS unit root test results on the key variables at 1st difference

1st Difference				
	With Intercept		**With Intercept and Trend**	
Variable	**Statistic**	**P-Value**	**Statistic**	**P-Value**
PDT	N/A	N/A	N/A	N/A
TRV	-4.47309	0.0001*	-5.085395	0.0000*
INF	-8.56296	0.0000*	N/A	N/A

RIN	N/A	N/A	N/A	N/A
POI	-4.72775	0.0000*	N/A	N/A
COR	-4.26792	0.0002*	N/A	N/A

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

The results of the Dickey-Fuller GLS unit root test in Table 5.4 show that the null hypothesis, that variables TRV, INF, POI and COR are non-stationary, is rejected under all model specifications. Rejection of the null hypothesis was realized on the basis that the probability value of the test statistic is less that the desired level of significance. Hence, the order of integration for variables TRV, INF, POI and COR is 1 under the all model specifications.

Similarly, Table 5.5 and 5.6 provide the results for the Ng-Perron unit root test on the key variables of this study at level and 1st difference respectively (see Appendix 3 also).

Table 5.5 Ng-Perron unit root test results on the key variables at level

Level								
	Intercept				**Intercept and Trend**			
Variable	**Mza**	**Mzt**	**MSB**	**MPT**	**Mza**	**Mzt**	**MSB**	**MPT**
PDT	-11.671 **	-2.4140 **	0.20682 **	2.10606 **	-12.2613	-2.46208	0.20080	7.50659
TRV	-0.0133	-0.0071	0.52923	20.4732	-5.09651	-1.47402	0.28922	17.3208
INF	-0.1854	-0.1061	0.5725	22.0328	-11.6106	-2.39948	0.20666	7.89977
RIN	-7.8862	-1.9751	0.2504	3.14645	-8.01316	-2.00025	0.24962	11.3757
POI	-3.0260	-1.1722	0.3874	7.9775	-6.1481	-1.7075	0.2777	14.7836
COR	-0.1612	-0.1188	0.7372	32.2370	-8.7069	-2.0195	0.2319	10.6946

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

The results of the Ng-Perron unit root test at level in Table 5.5 show that the null hypothesis, that LPDT is non-stationary, is rejected under 'intercept' model specification. This is on the basis that the Ng-Perron test statistics are significant at 5 percent level of significance. Thus, it can be concluded that PDT is integrated to the order of 0 under 'intercept' model specification.

Table 5.6 Ng-Perron unit root test results on the key variables at 1st difference

1st Difference								
	Intercept				Intercept and Trend			
Variable	**Mza**	**Mzt**	**MSB**	**MPT**	**Mza**	**Mzt**	**MSB**	**MPT**
PDT	N/A	N/A	N/A	N/A	-15.5363***	-2.78376***	0.17918***	5.88518***
TRV	-15.745*	-2.75671*	0.17509**	1.73768*	-16.3997***	-2.74917***	0.16764***	6.22327***
INF	-13.942*	-2.639*	0.18934*	1.75943*	-13.5326***	-2.59960***	0.19210***	6.74281***
RIN	-15.482*	-1.4649*	0.3269**	1.5229*	-14.8947***	-2.72232***	0.18277***	6.15671***
POI	-15.507*	-2.7784*	0.1792**	1.6029*	-15.863***	-2.8146***	0.1774***	5.7545***
COR	-15.242*	-2.7593*	0.1810**	1.6124*	-15.377***	-2.7722***	0.1803***	5.9293***

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

The results of the Ng-Perron unit root tests in Table 5.6 show that the null hypothesis, that PDT, TRV, INF, RIN, POI, and COR are non-stationary, is rejected at 1, 5 and 10 percent level of significance respectively under both 'intercept' and 'intercept and trend' model specifications. This is on the basis that the Ng-Perron test statistics are significant at 1 and 5 percent level of significance respectively, under 'intercept' and 'intercept and trend' model specifications. Thus, it can be concluded that PDT, TRV, INF, RIN, POI and COR are integrated to the order of 1 under both model specifications.

In acknowledging the fact that more attention is given to the trend of the time series, the results under 'intercept and trend' model specification are used to make final inferences on the determination of the order of integration for the key variables of this study. Hence, with aid of the results presented on Dickey Fuller GLS and Ng-Perron unit root tests, this study generally

concludes that the maximum order of integration for the variables PDT, TRV, INF, RIN, POI and COR is 1.

5.2.4 Optimal Lag Length Selection

Brooks (2008) emphasizes that selecting optimal lags is important when building VAR/VECM and ARDL models. Table 5.7 provides the values for Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannah Quinn Criterion (HQIC) at lags 0,1 and 2 respectively (see Appendix 8.4).

Table 5.7 Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SIC	HQIC
0	-9.414278	NA	9.98e-08	-0.218545	-0.0008199	-0.142253
1	177.0906	**296.2136***	**1.48e-11***	**-7.946503***	**-6.060999***	**-7.303492***

Notes: * represents the lag length selected by the information criterion
Source: Author's own calculations using Eviews 10 Software

Table 5.7 indicates that lag 1 is selected by all information criteria. Therefore, the optimal lag is 1. Thus, the ARDL model to be estimated is ARDL (1, 1, 1, 1, 1) if the lags would be permitted to be fixed across all the variables.

5.2.5 ARDL Bound Test to Cointegration Analysis

The unit root tests proved that the key variables of this study are integrated to the order of 0 and 1. This is the satisfaction of the main assumption of the ARDL/NARDL framework, which states that the variables should be stationary only at level and/or first difference (Mosikari and Eita, 2020). As discussed in the previous chapter, all the key variables of this study should be tested endogenously for cointegration. The reason for this is to ensure only one cointegrating vector, since ARDL/NARDL method is only deemed to be suitable for cointegration analysis if there is only one cointegrating vector. Table 5.8 provides the results for the ARDL bound test, where each key variable is treated as an endogenous variable (see Appendix 8.5).

Table 5.8 ARDL Bound Test Results

Model	Calculated F-Statistic	Conclusion
$pdt = f(trv, inf, rin, poi, cor)$	4.381984 *	Cointegration

$trv = f(pdt, inf, rin, poi, cor)$	1.689497	No Cointegration
$inf = f(pdt, trv, rin, poi, cor)$	2.003445	No Cointegration
$rin = f(pdt, trv, inf, poi, cor)$	1.444819	No Cointegration
$poi = f(pdt, trv, inf, rin, cor)$	1.100706	No Cointegration
$cor = f(pdt, trv, inf, rin, poi)$	1.291271	No Cointegration

Notes: α sig. level: Critical F statistic at *I(0)* and *I(1)*

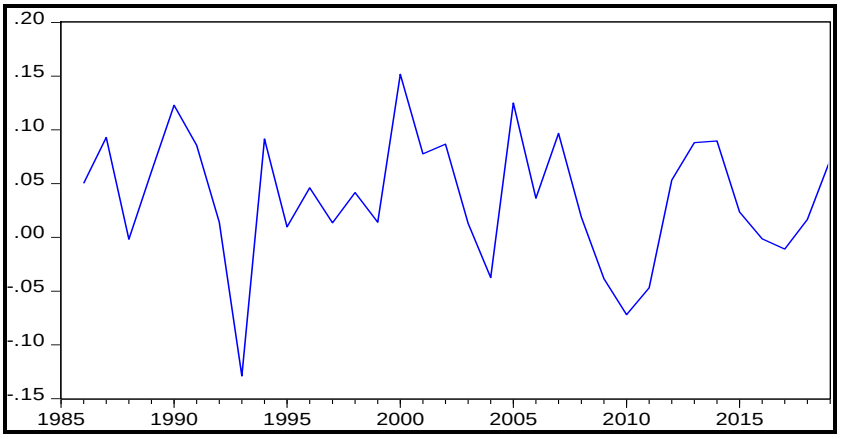
1%:	3.29	4.37
5%:	2.56	3.49
10%:	2.20	3.09

*/**/*** represents statistical significance at 1%, 5% and 10% respectively

Source: Author's own calculations using Eviews 10 Software

Table 5.8 shows that there is only one cointegrating model/vector (the first model) which also happens to be the model of interest in this study, based on the hypotheses and objectives formulated in chapter one. The decision on the presence of cointegrating relationship is based on the fact that the calculated F statistic is greater than the critical F statistic at the upper limit/bound (*I (1)),* at all levels of significance. The remaining models/vectors do not show any presence of cointegrating relationship since their calculated F statistics are lower than the critical F statistic at the lower limit/bound *(I (0)),* at all levels of significance. Hence, Figure 5.3 presents the cointegration graph.

Figure 5.3 Cointegration Graph



Source: Author's own drawings using Eviews 10 software

To confirm the results on cointegrating vector, the cointegration graph shows that the shocks of the dependent variable (PDT) from equilibrium are stationary for the period under consideration

(1985 to 2019). Hence, the following section presents long and short run coefficients for the model ARDL (1,1,1,1,1).

5.2.6 ARDL Long and Short Run Model Estimates

Continuing from the previous section, the model desired in this study showed the presence of cointegration between the dependent variable and independent variables of this study. As determined by the lag length selection criteria, the optimal lag for dependent and independent variables is 1 respectively. Hence, Table 5.9 presents the ARDL long run relationship estimates for the model ARDL (1,1,1,1,1) under the 'restricted constant' model specification (see Appendix 8.6).

Table 5.9 Long Run Estimates for ARDL (1,1,1,1,1) Model

Dependent Variable: PDT

Regressor	**Coefficient**	**Standard Error**	**t-Statistic**	**Probability V.**
C	8.288449	5.853804	1.415908	0.1708
TRV (-1)	-0.602405	0.104858	-5.744959	0.0000*
INF (-1)	0.273250	0.119026	2.295717	0.0421**
RIN (-1)	0.340620	0.095436	3.569093	0.0012*
POI (-1)	0.109767	0.101247	5.408947	0.0000*
COR (-1)	0.313336	5.853804	3.094768	0.0023**
Coefficient of Determination (R Squared) and F Statistic (Joint Significance)				
R Squared	0.658234			
P(F Statistic)	0.000631*			

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

In the long run, the results presented in Table 5.9 show that 1 percent increase in tax revenue collection significantly leads to 0.6024 percent decrease in public debt, holding all other factors constant. This finding supports the hypotheses hypothesized by the three-gap (fiscal gap) model and the debt service in the tax competition model of fiscal policy. In brief, these models hypothesize that economies with less tax revenue collection (especially developing economies) may incur higher levels of debt. Gupta (2007) got the same results on the case study of developing

economies using POLS. Hence, the economic implication raised here is that South Africa would decrease its inclination to borrow only if it could improve its tax revenue.

Furthermore, the results in Table 5.9 show that 1 percent increase in inflation and the real interest rate significantly leads to 0.2733 and 0.3406 increase in public debt, holding all other factors constant. Swammy (2015) obtained the same results in the case study of 46 developing economies using the POLS method. Oulubi and Hammamis (2020) also got the same results in 4 panels of countries. The economic implication here is that an increase in domestic inflation and the real interest rate increases the public debt in South Africa.

Furthermore, a unit increase in political instability and corruption index significantly leads to 0.1098 and 0.3133 percent increase in public debt respectively. All established relationships are statistically significant at 1, 5 and 10 percent level of significance respectively. These results support the hypotheses hypothesized by the fiscal illusion theory and political economy models. In brief, these hypotheses infer that severe political instability delays emergency policy reforms necessary to respond to contrasting economy and structural or institutional harmful failure, and corrupt activities lead to increasing unproductive public expenditures, inefficient tax revenue collection and debt accumulation.

Using the POLS method, similar results were obtained by Crivelli *et al*. (2016), Palil and Mustupha (2011) and Rimmer (2010). However, using the same method, Ellis and Schansburg (2004) found that political instability and corruption were not largely significant in explaining the public debt in 52 developing economies. The economic implication here is that political instability and corruption in South Africa are positively associated to the South African public debt.

Lastly, the coefficient of determination (R Squared) is 65.82 percent. This implies that 65.82 percent of deviation in the public debt is explained by the deviations on tax revenue collection, inflation, real interest rate, political instability and corruption. This model is reasonably fitted since the 65.87 (coefficient of determination) percent is greater than 50 percent, and the predictor variables are jointly significant since the F statistic is significant at 1, 5 and 10 percent level of significance.

Similarly, Table 5.10 presents the ARDL short run relationship estimates for the model ARDL (1,1,1,1,1) under the ‘restricted constant’ model specification (see Appendix 8.7).

Table 5.10 Short Run Estimates for ARDL (1,1,1,1,1) Model

Dependent Variable: D (PDT)

Regressor	Coefficient	Standard Error	t-Statistic	Probability V.
D(TRV)	-4.573618	2.409526	-1.898140	0.0709***
D(INF)	0.361366	0.106846	3.3822120	0.0023*
D(RIN)	0.012917	0.005581	2.314590	0.0304**
D(POI)	0.067408	0.072784	0.926129	0.3644
D(COR)	0.373525	0.116964	3.193505	0.0042*
ECT	-0.718997	0.156078	-4.606660	0.0001*

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

In the short run, there is a negative and significant relationship between tax revenue collection and public debt. Hence, a 1 percent increase in tax revenue collection leads to 4.5736 percent decrease in public debt respectively. The findings on the short run relationship between tax revenue collection and public debt support the hypotheses hypothesized by the three-gap (fiscal gap) model and the debt service in the tax competition model of fiscal policy, just like in the long run. Alawneh (2017) obtained the same results in the case study of Jordan using multiple linear regression. Hence, the economic implication raised here is that South Africa would decrease its inclination to borrow by 4.5736 percent only if it would improve its tax revenue by 1 percent in the short term.

Furthermore, Table 5.9 shows that a 1 percent increase inflation and the real interest rate significantly leads to a 0.3613 and 0.0129 percent increase in public debt respectively, holding all other factors constant. Swammy (2015) obtained the same results in the case study of 46 developing economies using the POLS method. The economic implication here is that an increase in inflation causes the public debt to rise in South Africa.

Furthermore, political instability and corruption have positive relationship to public debt. Hence, a unit increase in political instability and corruption index leads to 0.0674 and 0.3735 percent increase in public debt respectively. However, only the relationship of corruption and public debt is statistically significant, whereas that of political instability and public debt is statistically insignificant. These results support the hypotheses hypothesized by the fiscal illusion theory and political economy models, which infer that severe political instability (in the short or long run)

delays emergency policy reforms necessary to respond to contrasting economy and structural or institutional harmful failure. Furthermore, the fiscal illusion theory also infers that corrupt activities lead to increasing unproductive public expenditures, inefficient tax revenue collection and debt accumulation. Monte and Pennacchio (2020) as well as Cooray *et al*. (2017) got the same results, though they found both political instability and corruption to be significantly related to public debt. The economic implication here is that the political instability and corruption in South Africa increases the public debt by 0.0674 and 0.3735 percent respectively in the short term, though the political instability short term effect on public debt is statistically insignificant.

The error correction term is -0.7190 and it is statistically significant. This implies that 71.90 percent of disequilibrium in the model is corrected in the period (year), hence the model adjusts very quickly towards an equilibrium steady state. This is satisfactory, as 71.90 percent is greater than 50 percent.

5.2.7 Granger Causality Test

According to Engle and Granger (1987), if there exists a cointegrating relationship between the dependent and independent variables, then the direction of cointegration is either from the dependent variable to the independent variables, or from the independent variables to the dependent variable. Furthermore, Engle and Granger (1987) developed a 'pairwise' test called the Granger Causality test, which can be used to determine the direction of cointegration. This study applied this test to check the direction of the established cointegration. Notably, since the information criteria chose lag 1 for both dependent variable and independent variables (ARDL (1,1,1,1,1)) as an optimal lag, the Granger Causality test is also undertaken at lag 1. Thus, Table 5.11 provides the results for Granger Causality pairwise test (see Appendix 8.8).

Table 5.11 Pairwise Granger Causality Test Results

Null Hypothesis	Obs	F Statistic	Probability Value	Conclusion
TRV is not the cause of PDT	34	3.85092	0.0304**	There is causality
PDT is not the cause of TRV	34	0.04865	0.8269	There is no causality
INF is not the cause of PDT	34	4.43682	0.0223**	There is causality
PDT is not the cause of INF	34	3.87983	0.0324**	There is causality

RIN is not the cause of PDT	34	1.01316	0.3219	There is no causality
PDT is the cause of RIN	34	0.42060	0.5214	There is no causality
POI is not the cause of PDT	34	0.11951	0.7319	There is no Causality
PDT is not the cause of POI	34	0.66095	0.4224	There is no causality
COR is not the cause of PDT	34	4.45381	0.0217**	There is causality
PDT is not the cause of COR	34	0.04551	0.8325	There is no causality

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

Using 5 percent level of significance, Table 5.11 indicates that changes in tax revenue collection, inflation and corruption affect the changes in the South African public debt. Furthermore, changes in the South African public debt affect changes in inflation. Hence, the direction of the long run relationship is from tax revenue collection to public debt, inflation to public debt, corruption to public debt, and from public debt to inflation.

The results on long run causality between tax revenue and public debt support the hypothesis established by the three gap model, which postulates that when the tax revenue collection and other financing resources are not sufficient to foster both current and capital expenditure, borrowing domestically or internationally becomes an alternative financing route. That is, positive shocks in tax revenue collection lead to minimized inclination on borrowing, and negative shocks in tax revenue collection lead to an increased inclination on borrowing. Aregbeshola (2014) also obtained the same views on the Granger causality between tax revenue collection and public debt. The economic implication here is that changes in the South African tax revenue collection effect changes in the South African public debt.

In terms of the long run causality between corruption and public debt, these results confirm the hypothesis established by the opportunistic models of political economy which established that positive shocks in corruption within government administration lead to an increase in public debt, and negative shocks in corruption within the government administration lead to a minimized inclination for public borrowing, since tax revenue collection would not be compromised as the major source of government financing resource (*ceteris paribus*), especially in developing economies. Monte and Pennacchio (2020) as well as Cooray *et al*. (2017) obtained the same Granger causality test results between political instability, corruption and public debt. The

economic implication here is that an increase and a decrease in corrupt activities within the government administrations as well political instability lead to an increase and a decrease in the South African public debt.

5.2.8 ARDL Coefficients Stability and Residuals Diagnostics Tests

The estimated ARDL model can only be relied upon if the coefficients stability and residuals diagnostic tests are passed. Passing these tests, implies that the estimated parameters would be efficient and unbiased, and the model would be fitted reasonably well (Shin *et al*., 2014).

5.2.8.1 ARDL Coefficients Stability Diagnostics Tests

First, the Ramsey Reset Specification test is carried out to test if the specified ARDL model is correctly specified. Second, the actual and fitted values, and residuals plots are presented to judge the goodness of fit for the estimated ARDL model. Lastly, CUSUM and CUSUM of Squared diagrams are plotted to judge the consistency of the estimated ARDL long and short run parameters. Table 5.12 provides the results for the Ramsey Reset Specification test (see Appendix 8.9), followed by Figures 5.4, 5.5 and 5.6, which present the actual and fitted values, and residuals plot, CUSUM and CUSUM of Squares diagrams respectively.

- **ARDL (1,1,1,1,1) Ramsey Reset Specification Test**

Table 5.12 Ramsey Reset Specification Test Results for ARDL (1,1,1,1,1)

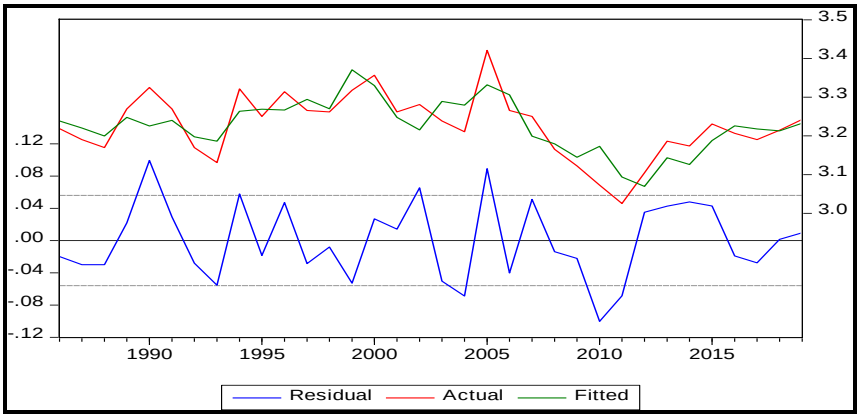
Test	**Null Hypothesis**	**Prob (F statistic)**	**Conclusion**
Ramsey Reset Specification	There is no misspecification	0.7174	The model is correctly specified

Source: Author's own calculations using Eviews 10 Software

The probability value for the test statistic (F statistic) is greater than 1, 5 and 10 percent. This implies that the primary model of this study is correctly specified. Hence, there is no specification biasness.

- **Actual and Fitted Values, and Residuals Plot for ARDL (1,1,1,1,1)**

Figure 5.4 Actual and Fitted Values, and Residuals Plot

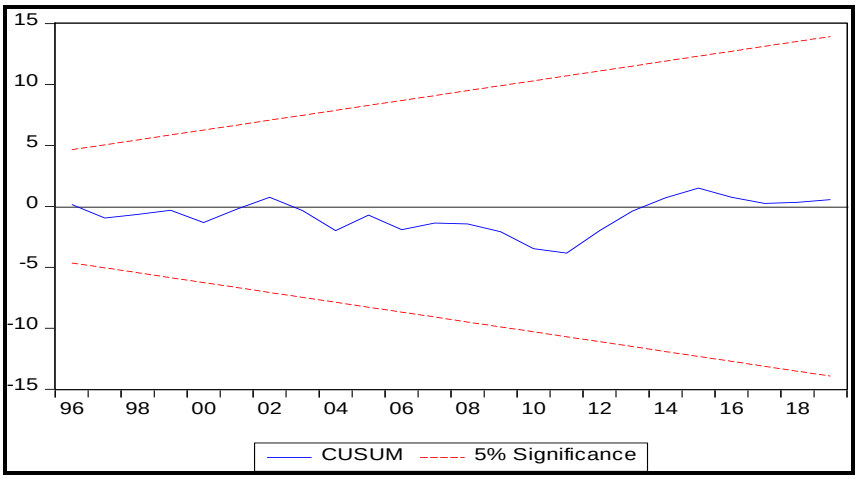


Source: Author's own drawings using Eviews 10 software

To judge the goodness of fit on the estimated model, Figure 5.4 shows less substantial deviations between the actual and fitted values. This implies that the model fits the data reasonably well. Furthermore, the residuals plot seems to be stationary for the period under study, which indicates that the residuals series follows the white noise process. Given all these, the estimated ARDL model seems to be adequate.

- **ARDL (1,1,1,1,1) CUSUM Stability Test**

Figure 5.5 CUSUM Plot Diagram

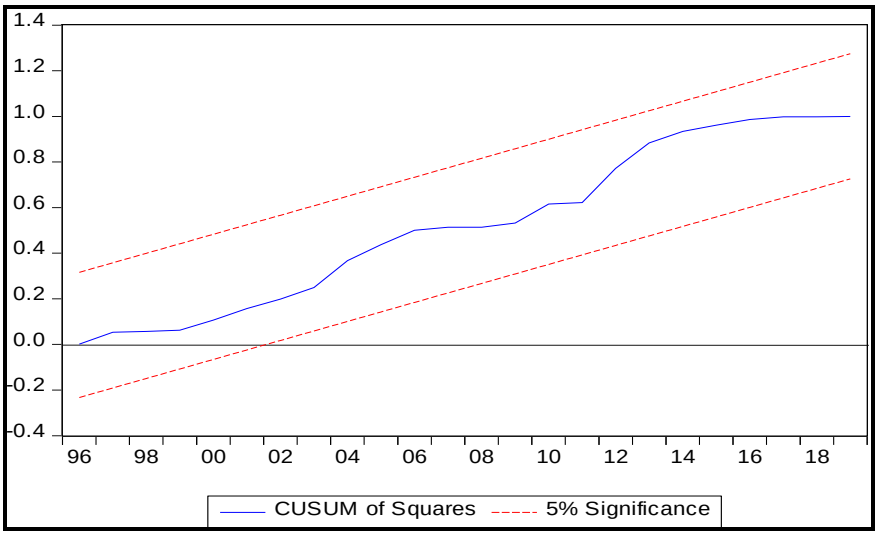


Source: Author's own drawings using Eviews 10 software

The estimated CUSUM line lies within the 5 percent significance bound, as shown in Figure 5.5. This implies that estimated long and short run coefficients are consistent at 5 percent level of significance.

- **ARDL (1,1,1,1,1) CUSUM of Squares Stability Test**

Figure 5.6 CUSUM of Squares Plot Diagram



Source: Author's own drawings using Eviews 10 software

Similarly, the estimated CUSUM of Squares line lies within the 5 percent significance bound, as shown in Figure 5.6. This implies that estimated long and short run coefficients are consistent at 5 percent level of significance.

5.2.8.2 ARDL Residuals Diagnostics Tests

Lastly, the residuals of the estimated ARDL model must subjected to a few diagnostics tests, as fully discussed in the previous chapter. Hence, Table 5.13 presents the results for normality, serial correlation and heteroscedasticity test (see Appendix 8.10).

Table 5.13 ARDL (1,1,1,1,1) Residuals Diagnostic Tests Results

Test	Null Hypothesis	Prob.	Conclusion
Normality (Jarque-Bera)	The residuals are normally distributed	0.7107	The residuals are normally distributed

Serial Correlation (Langrage Multiplier)	The residuals are not serial correlated	0.7902	The residuals are not serially correlated
Heteroscedasticity (Breusch-Pagan-Godfrey)	The residuals are not heteroscedastic	0.1853	The residuals are homoscedastic

Source: Author's own calculations using Eviews 10 Software

Under all residuals diagnostic tests, the null hypotheses fail to be rejected at 1 %, 5% and 10% significance level which implies that the residuals do not suffer from serial correlation and heteroscedasticity, and the residuals are normally distributed.

The estimated ARDL model passed all the coefficients stability and residuals diagnostic tests. This means that the estimated coefficients are efficient and robust. Furthermore, the residuals of the estimated ARDL model behave reasonably well. That is, the inferences established in the results of the estimated ARDL model can be confidently relied on.

5.3 ESTIMATION OF THE RELATIONSHIP BETWEEN PUBLIC DEBT AND TAX REVENUE COLLECTION IN SOUTH AFRICA IN A NARDL FRAMEWORK

This section develops the NARDL model to explain how the asymmetric effects of the tax revenue collection and the selected independent variables affect public debt in South Africa between 1985 and 2019.

Firstly, the BDS and the White linearity tests are carried out to test for the presence of nonlinearity on the key variables of this study. Secondly, the nonlinear unit root tests discussed in the previous chapter are carried out on the key variables of this study to determine the order of integration in the presence of nonlinearity. Thirdly, the optimal lags for the key variables are selected (the same lags length as in the ARDL model is used). Fourthly, the NARDL bound test is carried out to test for asymmetric cointegration. Fifthly, asymmetric long and short run coefficients are presented and interpreted. Lastly, Granger causality test for the nonlinear components of the independent variables (to be estimated) against the dependent variable, and the residuals as well as coefficients stability diagnostics tests are carried out and interpreted.

5.3.1 Linearity Test on the Key Variables

This study makes use of the BDS and White linearity tests to test for nonlinearity on each key variable of this study. This reason for this is simply on the basis that nonlinear methods are only applicable when the data on the variables is nonlinear in nature (Narayan, 2005). Table 5.14 provides the results for the BDS linearity test on the key variables of this study (see Appendix 8.11).

Table 5.14 BDS Linearity Test Results

VARIABLE	DIMENSION	BDS Test Statistic	Probability
PDT	2	3.791811	0.0000*
	3	4.428618	0.0000*
	4	9.272657	0.0000*
	5	10.06084	0.0000*
	6	11.49231	0.0000*
TRV	2	26.92558	0.0000*
	3	28.42770	0.0000*
	4	30.36190	0.0000*
	5	33.41762	0.0000*
	6	37.85300	0.0000*
INF	2	13.79082	0.0000*
	3	15.29529	0.0000*
	4	16.56932	0.0000*
	5	17.95688	0.0000*
	6	19.89931	0.0000*
RIN	2	4.744140	0.0000*
	3	5.455676	0.0000*
	4	5.418163	0.0000*
	5	5.457279	0.0000*
	6	5.446089	0.0000*
POI	3	30.00475	0.0000*
	4	34.23478	0.0000*
	5	39.62548	0.0000*
	6	46.73166	0.0000*
	6	15.24244	0.0000*
COR	2	27.94255	0.0000*
	3	30.00475	0.0000*
	4	34.23478	0.0000*
	5	39.62548	0.0000*
	6	46.73166	0.0000*

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

The results for the BDS linearity test indicate that the null hypothesis of linearity on all the key variables of this study is rejected at 1, 5 and 10 level of significance, as shown in Table 5.14. To get more information on the linearity and nonlinearity on the key variables of this study, the White linearity test is also carried out in this study. Thus, Table 5.15 provides the results for the White linearity test on the key variables of this study (see Appendix 8.11 also).

Table 5.15 White Linearity Test Results

Variable	Test Statistic (χ^2)	DF	Probability
PDT	2.3479	2	0.3091
TRV	0.3735	2	0.8296
INF	4.2841	2	0.1174
RIN	6.3780	2	0.0243**
POI	5.3780	2	0.0599***
COR	5.5199	2	0.0633***

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using R Package Software

The results in Table 5.15 shows that the hypothesis of linearity is not rejected on the key variables such as PDT, TRV and INF. However, the test presents different results on the variables RIN, POI and COR, at 5 and 10 percent level of significance respectively.

To explore further on the nature of all the key variables, Table 5.16 presents the summary for the BDS and White linearity test results.

Table 5.16 Summary for BDS and White Linearity test results

Linearity Test	Variables					
	PDT	TRV	INF	RIN	POI	COR
BDS	N	N	N	N	N	N
White	L	L	L	N	N	N

Notes: N and L denotes Nonlinear and Linear respectively
Source: Author's own illustration using the BDS and White linearity tests results

An illustration presented in Table 5.16 indicates that the BDS linearity test results declare all key variables of this study to be having nonlinearity characteristics, whereas the White linearity test results declare public debt (PDT), tax revenue collection (TRV) and inflation (INF) to be having linearity characteristics, and real interest rate (RIN), political instability (POI) as well as corruption (COR) to be having nonlinearity characteristics. In this regard, this study concludes that PDT, TRV and INF have both linearity and nonlinearity characteristics, whereas RIN, POI and COR have strictly nonlinearity characteristics.

Furthermore, the summary presented in Table 5.16 is important in such a way that it gives hints on the type of methodology that should be used to analyze the relationship between the dependent variable and the respective independent variables. Briefly, the linearity tests results summarized in Table 5.16 imply that the relationship between public debt, tax revenue collection and foreign direct investment can be captured by either a linear or nonlinear method (ARDL or NARDL). This is on the basis that PDT, TRV and INF have both linear and nonlinear characteristics. On the other hand, the relationship between PDT, RIN, POI and COR can only be captured by nonlinear method (NARDL). This is on the basis that RIN, POI and COR have only nonlinear characteristics, though PDT has both linear and nonlinear characteristics.

However, to make the final decision on which method should be used to analyze the relationship between the dependent variable and the respective independent variables, a NARDL procedure called 'testing for asymmetric (nonlinear) effects on both long and short run relationships' will be carried out. As discussed in the previous chapter, if the long or short run relationship shows the presence of asymmetry (nonlinearity), then the NARDL method should be used to analyze the relationships. Otherwise, if there is absence of asymmetry (linearity), then the ARDL (linear) method should be used to analyze the relationships, no matter the results of linearity tests.

5.3.2 Nonlinear Unit Root Tests

As discussed in the previous chapter, this study makes use of the Bierens (1997) and Breitung (2002) nonlinear unit root tests. First, the Bierens (1997) nonlinear unit root test is carried out, and interpreted for each key variable of this study. Secondly, the Breitung (2002) nonlinear unit root test is also carried out and interpreted each key variable of this study. Hence Table 5.17 presents the results for Bierens (1997) nonlinear unit root test at level on each key variable (see Appendix 8.12).

Table 5.17 Bierens (1997) Nonlinear Unit Root Test Results at Level

Level				
With Nonlinear Trend				
Variable	**Optimal lags selected by the AIC**	**Estimate for the "a" coefficient**	**T-Statistic**	**Conclusion**
PDT	0	-0.57543	-3.677***	Nonlinear Stationary Process
TRV	0	-0.14837	-1.977	Nonlinear Non Stationary Process
INF	1	-0.25417	-2.325	Nonlinear Non Stationary Process
RIN	1	-0.10551	-0.548	Nonlinear Non Stationary Process
POI	0	-0.24677	-2.204	Nonlinear Non Stationary Process
COR	0	-0.09833	-0.933	Nonlinear Non Stationary Process

Notes: Critical values for the t statistic at 5 and 10 percent level of significance are -3.97 and -3.64 respectively
/* represents statistical significance at 5% and 10% respectively
Source: Author's own calculations using EasyReg Software

Table 5.17 shows that only PDT is nonlinearly stationary at lag 0 (selected by the AIC) in its level form, at 10 percent level of significance. This is on the basis that the null hypothesis that PDT is a nonlinear non-stationary process is rejected at 10 percent level of significance, since the test statistic of -3.677 is less than the critical statistic of -3.64.For the remaining variables, the null hypothesis that these variables are not nonlinearly stationary in their level form at the selected lags, is not rejected since their respective test statistics are greater than the critical statistic at both 5 and 10 percent level of significance. Hence, they need to be tested for nonlinearly stationarity in test for the variables TRV, INF, RIN, POI and COR at first difference.

Table 5.18 Bierens (1997) Nonlinear Unit Root Test Results at 1st Difference

1st Difference				
With Nonlinear Trend				
Variable	**Optimal lag(s) selected by the AIC**	**Estimate for the "a" coefficient**	**T-Statistic**	**Conclusion**
TRV	0	-1.00420	-5.014**	Nonlinear Stationary Process
INF	1	-1.00365	-3.989**	Nonlinear Stationary Process
RIN	1	-1.00521	-4.527	Nonlinear Stationary Process
POI	1	-1.35338	-5.863**	Nonlinear Stationary Process
COR	0	-0.76529	-4.266**	Nonlinear Stationary Process

Notes: Critical values for the t statistic at 5 and 10 percent level of significance are -3.97 and -3.64 respectively.
/* represents statistical significance at 5% and 10% respectively
Source: Author's own calculations using EasyReg Software

Table 5.18 shows that variables TRV, INF, RIN, POI and COR are now nonlinearly stationary at lag 0 and 1(selected by the AIC) in their first difference form, at both 5 and 10 percent levels of significance respectively. This is on the basis that the null hypothesis that variables TRV, INF, RIN and COR are the nonlinear non-stationary processes, is rejected at 5 and 10 percent level of significance, since their respective test statistics are less than critical statistics at both 5 and 10 level of significance. Therefore, the Bierens (1997) nonlinear unit root test declares the order of integration for PDT as 0, and for TRV, INF, RIN POI and COR as 1 respectively.

Similarly, Table 5.19 presents the results for the Breitung (2002) nonlinear unit root test results for all the key variables of this study in level form.

Table 5.19 Breitung (2002) Nonlinear Unit Root Test Results at Level

Level		
With Nonlinear Trend		
Variable	**Test Statistic**	**Conclusion**
PDT	0.01627	Nonlinear Non Stationary Process
TRV	0.09889	Nonlinear Non Stationary Process
INF	0.02226	Nonlinear Non Stationary Process
RIN	0.01258	Nonlinear Non Stationary Process
POI	0.05487	Nonlinear Non Stationary Process
COR	0.08434	Nonlinear Non Stationary Process

Notes: Critical values for the test statistic at 5 and 10 percent level of significance are 0.01004 and 0.01435 respectively.
/* represents statistical significance at 5% and 10% respectively
Source: Author's own calculations using EasyReg Software

Table 5.19 shows that all key variables of this study are not nonlinearly stationary, at 5 and 10 percent level of significance. This is on the basis that the null hypothesis that these variables are nonlinearly non-stationary processes, is not rejected at 5 and 10 percent level of significance, since the variables' test statistics are greater than the critical statistics at both 5 and 10 percent level of significance. Hence, all the key variables of this study need to be tested for nonlinear stationarity at their first differences.

Table 5.20 Breitung (2002) Nonlinear Unit Root Test Results at 1st Difference

1st Difference		
With Nonlinear Trend		
Variable	**Test Statistic**	**Conclusion**
PDT	0.001030**	Nonlinear Stationary Process
TRV	0.001270**	Nonlinear Stationary Process
INF	0.001243**	Nonlinear Stationary Process
RIN	0.005530**	Nonlinear Stationary Process
POI	0.002550**	Nonlinear Stationary Process
COR	0.005347**	Nonlinear Stationary Process

Notes: Critical values for the test statistic at 5 and 10 percent level of significance are 0.01004 and 0.01435 respectively.
/* represents statistical significance at 5% and 10% respectively
Source: Author's own calculations using EasyReg Software

Table 5.20 shows that PDT, TRV, INF, RIN, POI and COR are now nonlinearly stationary, at 5 and 10 percent level of significance. This is on the basis that the null hypothesis that these variables are nonlinear non-stationary processes, is rejected at 5 and 10 percent level of significance, since the variables' test statistics are less than the critical statistics at both 5 and 10 percent level of significance. Hence, Breitung (2002) nonlinear unit root test declares the order of integration for all key variables of this study to be 1.

Bierens (1997) and Breitung (2002) nonlinear unit root test results show that the maximum order of integration of the key variables of this study is 1, in the presence of nonlinear behavior. This is the satisfaction of the main assumption behind ARDL and NARDL methodologies, which require the variables to be integrated to the order of 0, 1 or the combination of 0 and 1.

5.3.3 Optimal Lag Length Selection

As discussed in the previous chapter, most of the characteristics and/or estimation procedures of ARDL method are also applicable in NARDL method. Optimal lag length selection estimation procedure is applicable to both ARDL and NARDL. On the basis that the NARDL model is built on the ARDL, Shin *et al*. (2014) demonstrated that the same lag length selected on the ARDL model ought to be also used as an optimal lag length for the NARDL model.

Hence, it is for this reason the lag 1 is used as an optimal lag for the NARDL model, as it has been used as an optimal lag length for an ARDL model estimated in the previous section. Hence, the NARDL to be estimated is NARDL (1, 1, 1, 1, 1, 1, 1, 1, 1) if the lags would be permitted to be fixed across all the positive and negative partial decompositions of the independent variables, and the dependent variable.

5.3.4 NARDL Bound Test to Asymmetric Cointegration Analysis

Like in the ARDL model, all the key variables of this study are tested endogenously for asymmetric cointegration. The reason for this is to ensure only one asymmetric cointegrating vector, since the NARDL method is only deemed to be suitable for asymmetric cointegration analysis if there is

only one asymmetric cointegrating vector. Thus, Table 5.21 provides the results for the NARDL bound test where each key variable is treated as an endogenous variable (see Appendix 8.13).

Table 5.21 NARDL Bound Test Results

Model	**Calculated F-Stat.**	**Conclusion**
$pdt = f(trv_{-}^{+}, inf_{-}^{+}, rin_{-}^{+}, poi_{-}^{+} cor_{-}^{+})$	12.57142*	Asymmetric Cointegration
$trv = f(pdt_{-}^{+}, inf_{-}^{+}, rin_{-}^{+}, poi_{-}^{+}, lcor_{-}^{+})$	2.487677	No Asymmetric Cointegration
$inf = f(pdt_{-}^{+}, trv_{-}^{+}, rin_{-}^{+}, poi_{-}^{+}, cor_{-}^{+})$	1.872430	No Asymmetric Cointegration
$rin = f(pdt_{-}^{+}, trv_{-}^{+}, inf_{-}^{+}, poi_{-}^{+}, cor_{-}^{+})$	1.382482	No Asymmetric Cointegration
$poi = f(pdt_{-}^{+}, trv_{-}^{+}, inf_{-}^{+}, rin_{-}^{+}, cor_{-}^{+})$	2.534349	No Asymmetric Cointegration
$cor = f(pdt_{-}^{+}, trv_{-}^{+}, inf_{-}^{+}, rin_{-}^{+}, poi_{-}^{+})$	0.188348	No Asymmetric Cointegration

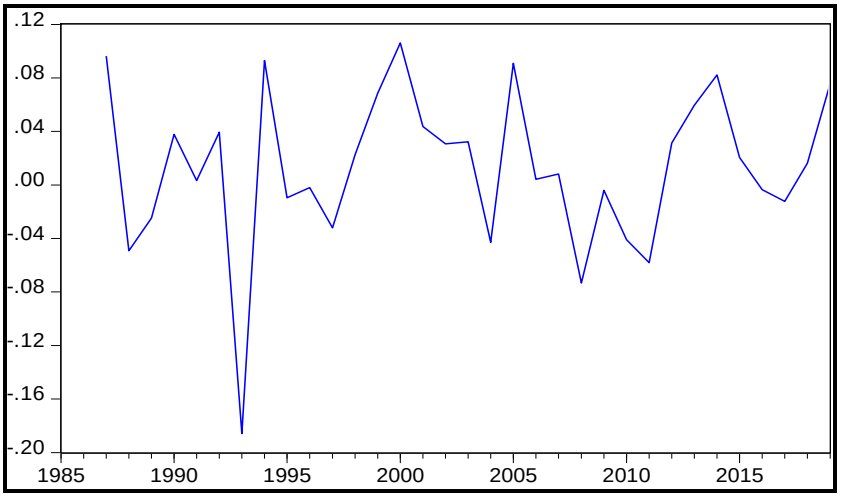
Notes: α sig. level: Critical F statistic at *I(0)* and *I(1)*

1%:	2.62	3.77
5%:	2.11	3.15
10%:	1.85	2.85

± represents partial positive and negative decompositions of the independent variables
*/**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

Table 5.21 shows that there are is one asymmetric cointegrating vector, which is the principal model of this study. The decision on the presence of the asymmetric cointegrating vector as discussed in the previous chapter is based on the fact that the calculated F statistic of 12.57142 is greater than the critical F statistic at the upper limit/bound (*I* (1)), at 1 and 5 percent level of significance respectively. Hence, Figure 5.7 presents the cointegration graph for the selected asymmetric cointegrating vector.

Figure 5.7 Asymmetric Cointegration Graph



Source: Author's own drawings using Eviews 10 software

To confirm the results on asymmetric cointegrating vector, the asymmetric cointegration graph shows that the shocks of the dependent variable (LPDT) from equilibrium are stationary between 1985 and 2019, as shown in Figure 5.7.

5.3.5 NARDL Long and Short Run Model Estimates

As shown in the previous section, the principal model of this study showed the presence of asymmetric cointegration between the dependent variable and the partial decompositions (positive and negative shocks) of the independent variables of this study, at 1, 5 and 10 percent level of significance respectively. As determined by the lag length selection criteria, the optimal lag for dependent and independent variables (regressors) is 1 respectively. Hence, Table 5.22 presents the NARDL asymmetric long run relationship estimates for the model NARDL (1, 1, 1, 1, 1, 1, 1, 1, 1) under the 'restricted constant' model specification (see Appendix 8.14).

Table 5.22 Long Run Estimates for NARDL (1,1,1,1,1,1,1,1,1) Model

Dependent Variable: PDT

Regressors	Coefficient	Standard Error	t-Statistic	Probability V.
C	3.881766	0.109178	35.55431	0.0000*
PDT(-1)	-0.654586	0.072228	-9.062773	0.0000*
TRV POS (-1)	0.089471	0.017932	4.989438	0.0040*
TRV NEG (-1)	0.90332	0.183484	4.923154	0.0032**

INF POS (-1)	-0.065158	0.011194	-5.820926	0.0001*
INF NEG (-1)	-0.035211	0.009091	-3.873231	0.0026**
RIN POS (-1)	-0.032033	0.012535	-2.555448	0.0267**
RIN NEG(-1)	-0.004613	0.015872	-0.290662	0.7767
POI POS (-1)	-0.120460	0.061625	-1.954716	0.0765***
POI NEG (-1)	1.678838	0.328785	5.086308	0.0004*
COR POS (-1)	-0.678838	0.246902	-2.749423	0.0189**
COR NEG (-1)	-0.731232	0.175654	-4.162916	0.0016***
Coefficient of Determination (R Squared) and F Statistic (Joint Significance)				
R Squared	0.8296			
P(F Statistic)	0.0034*			

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
POS/NEG denotes independent variables' positive and negative decompositions respectively
Source: Author's own calculations using Eviews 10 Software

As discussed in the previous chapter, in section 4.8.2.5; the long run coefficients of the variables are calculated differently from the one of the standard ARDL model. They are calculated by the dividing the negative of the estimated coefficients for the variables (presented in Table 5.22) by the coefficient of the error correction term (PDT (-1)).

Table 5.22 indicates that the coefficient for an increase in tax revenue collection is 0.089471 and is statistically significant. Furthermore, a decrease in tax revenue collection has the coefficient of 0.90332 and is statistically significant. Therefore, in the long run, a 1 percent increase in tax revenue collection will result to 0.1367 percent increase in public debt. However, a 1 percent decrease in tax revenue collection will result to 1.3799 percent decrease in public debt in South Africa. Salar *et al*. (2013) obtained the same results in the sense that their study found tax revenue collection to be having a significant long run positive and negative effect on public debt in the case study of Namibia, using the OLS method.

The results also indicate that the coefficient for an increase inflation is -0.065158 and is statistically significant, and the coefficient for a decrease in inflation is -0.035211 and is statistically significant. Therefore, in the long run, a 1 percent increase in inflation will result to -0.0995 percent

increase in public debt (insignificant). However, a 1 percent decrease in inflation results to -0.0538 decrease in public debt in South Africa. Notably, the decrease effect is greater than an increase effect. Hence decrease in inflation decreases the public debt more than it increases the public debt.

The coefficient for an increase in the real interest rate is -0.032033 and is statistically significant, and the coefficient for a decrease in the real interest rate is -0.004613 and is statistically insignificant. Therefore, in the long run, a 1 percent increase in the real interest rate will result to -0.04894 percent increase in public debt. However, a 1 percent decrease real interest rate results to -0.0074 decrease in public debt in South Africa (insignificant). The decrease effect is greater than the increase effect. This implies that the real interest rate decreases the public debt more than it increases the public debt.

An increase coefficient for political instability and corruption are -0.120460 and -0.678838 respectively, and both coefficients are statistically significant. Furthermore, the decrease coefficients for political instability and corruption are 1.678838 and -0.731232, and these coefficients are statistically significant. Therefore, in the long run, a unit increase in political instability and corruption index results to -0.1840 and -1.0370 percent increase in public debt respectively. However, a unit decrease in political instability and corruption index will result to 2.5647 and -1.1171 decrease in public debt respectively in South Africa. Similar results were obtained by Crivelli *et al*. (2016), Palil and Mustupha (2011) and Rimmer (2010) respectively. However, using POLS Ellis and Schansburg (2004) found that political instability and corruption were not largely significant in explaining the public debt in 52 developing economies. The economic implication here is that an increase and a decrease in political instability and corruption in South Africa leads to an increase and a decrease in the South African public debt. Similarly, Table 5.23 presents the NARDL short run relationship estimates for the model NARDL (1,1,1,1,1,1,1,1,1) under the 'restricted constant' model specification (see Appendix 8.15).

Table 5.23 Short Run Estimates for NARDL (1,1,1,1,1,1,1,1,1) Model

Dependent Variable: D (PDT)

Regressors	**Coefficient**	**Standard Error**	**t-Statistic**	**Probability V.**
D(TRV) POS	3.861055	1.389451	2.760951	0.0185**
D(TRV) NEG	0.235258	0.077075	3.052323	0.0011*

D(INF) POS	-0.020289	0.004981	-4.073094	0.0018*
D(INF) NEG	-0.043756	0.005310	-8.240614	0.0000*
D(RIN) POS	-0.001940	0.005040	-0.384597	0.7079
D(RIN) NEG	-0.021302	0.004825	-4.414879	0.0010*
D(POI) POS	-0.235442	0.040118	-5.868684	0.0001*
D(POI) NEG	1.816768	0.111311	16.32156	0.0000*
D(COR) POS	-0.977075	0.117046	-8.347815	0.0000*
D(COR) NEG	-0.669172	0.064226	-10.41909	0.0000*
ECT	-0.654586	0.072228	-9.062773	0.0000*

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
POS/NEG denotes independent variables' positive and negative decompositions respectively
Source: Author's own calculations using Eviews 10 Software

In the short run, an increase in tax revenue collection has a significant short term positive effect on public debt. That is, in the short term, a 1 percent increase in tax revenue collection will significantly result to 3.8621 percent increase in public debt. Furthermore, a decrease in tax revenue collection has a significant short term positive effect on public debt. That is, a 1 percent decrease in tax revenue collection will significantly result to 0.2353 percent decrease in public debt.

The results support the three gap model which shortly postulates that when the tax revenue collection and other financing resources are not sufficient to support both current and capital expenditure, borrowing domestically or internationally becomes an alternative financing route. That is, positive shocks in tax revenue collection lead to minimized inclination for borrowing, and negative shocks in tax revenue collection lead to an increased inclination for borrowing. Salar *et al*. (2013) obtained the same results in the sense that their study found tax revenue collection to be having a significant short run positive and negative effect (as in the long run) on public debt in the case study of Namibia, using the OLS method. The economic implication here is that if South Africa increases and decreases its tax revenue collection by 1 percent, in the short term, then the South African public debt increases and decreases by 3.8621 and 0.2353 percent respectively.

Short term increase coefficients for inflation and the real interest rate are -0.020289 and -0.001940 respectively, and only an increase coefficient for inflation is statistically insignificant.

Furthermore, the decrease coefficients for inflation and real interest rate are -0.043756 and-0.0213, and these coefficients are statistically significant. Therefore, in the short term, a 1 percent increase in inflation and the real interest rate will result to -0.0203 and -0.0019 percent increase in public debt respectively. However, a 1 percent decrease in inflation and the real interest rate will result to a -0.043756 and a -0.0213 decrease in public debt respectively in South Africa.

Short term increase coefficients for political instability and corruption are -0.2354 and -0.9777 respectively, and both coefficients are statistically insignificant. Furthermore, the decrease coefficients for political instability and corruption are 1.816768 and -0.669172, and these coefficients are statistically significant. Therefore, in the short term, a unit increase in political instability and corruption index result to -0.2354 and -0.9777 percent increase in public debt respectively. However, a unit decrease in political instability and corruption index result to 1.8167 and a -0.6692 decrease in public debt respectively in South Africa. These results support the hypotheses hypothesized by the fiscal illusion theory and political economy models. Briefly, these hypotheses infer that an increase in political instability delays emergency policy reforms necessary to respond to contrasting economy and structural or institutional harmful failure, and an increase in corrupt activities lead to increasing unproductive public expenditures, inefficient tax revenue collection and debt accumulation. Similar results were obtained by Crivelli *et al*. (2016), Palil and Mustupha (2011) and Rimmer (2010). However, using the POLS method, Ellis and Schansburg (2004) found that political instability and corruption were not largely significant in explaining the public debt in 52 developing economies. The economic implication here is that political instability and corruption in South Africa are positively associated to the South African public debt.

The error correction term is -0.6546 and it is statistically significant. This implies that 65.46 percent of disequilibrium in the model is corrected in the next period (year), hence the model adjusts substantially toward an equilibrium steady state. This is satisfactory, as 65.46 percent is greater than 50 percent.

5.3.6 NARDL Long and Short Run Asymmetric Effects

This section is about testing the presence of asymmetry in the estimated long and short run relationships. That is, the calculated partial positive and negative decompositions on the dependent variable need to be tested for asymmetry. In simpler terms, asymmetry infers that the calculated partial positive and negative decompositions have unique effects on the dependent variable

(Mosikari and Eita, 2020). Thus, Table 5.24 provides the results of the Wald test for asymmetric effects in both the long and short run respectively (see Appendix 8.16).

Table 5.24 Long and Short Run Asymmetric Effects Results

Asymmetric Null Hypothesis	Long Run		Short Run	
	t Statistic	**P(t Statistic)**	**t Statistic**	**P(t Statistic)**
$TRV^+ = TRV^-$	-0.289705	0.7760	-0.519157	0.6082
$INF^+ = INF^-$	-0.295922	0.7713	0.420047	0.6780
$RIN^+ = RIN^-$	-2.859722	0.0155**	-0.776178	0.4540
$POI^+ = POI^-$	5.453846	0.0001*	-1.082513	0.2894
$COR^+ = COR^-$	-12.93787	0.0001*	-0.136518	0.8925

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
Source: Author's own calculations using Eviews 10 Software

As fully discussed in the previous chapter, if the Wald test results do not show any evidence on the presence of asymmetric effects on either long or short run, then established relationships are best captured within the ARDL framework. Otherwise, if the Wald test results show any evidence of asymmetric effects on either long or short run, then the established relationships are best captured within the NARDL framework.

Table 5.24 shows that only the long run relationship between real interest rate, political instability, corruption and public debt show evidence of an asymmetric effect. That is, in the long run, the relationship between tax revenue collection, inflation and public debt is best captured within the ARDL framework, whereas the relationship between real interest rate, political instability, corruption and public debt is best captured within the NARDL framework.

In the short run, the results presented in Table 5.24 show that there is no evidence of asymmetric effects on the relationship between tax revenue collection, inflation, real interest rate, political instability, corruption and public debt. That is, all the short run relationships established in this study are best captured within the ARDL framework.

5.3.7 Asymmetric Granger Causality Test

This section presents the nonlinear Granger Causality test results, since a nonlinear (asymmetric) cointegrating relationship exists between the dependent variable and the partial positive and

negative decompositions of some independent variables, as shown in the long run asymmetric effect test results. Hence, the partial positive and negative decompositions of all the independent variables are tested for causality against the dependent variable of this study. Table 5.25 provides the results for the Granger causality test on the partial positive and negative decompositions (nonlinear effects) of the independent variables against the dependent variable (see Appendix 8.17).

Table 5.25 Pairwise Asymmetric Granger Causality Test Results

Null Hypothesis	Obs	F-Statistic	Probability Value	Conclusion
TRV POS is not the cause of PDT	33	0.87805	0.3562	There is no causality
PDT is not the cause of TRV POS	33	0.13903	0.7119	There is no causality
TRV NEG is not the cause of PDT	33	2.03251	0.1643	There is no causality
PDT is not the cause of TRV NEG	33	1.98429	0.1692	There is no causality
INF POS is not the cause of PDT	33	0.03508	0.8527	There is no causality
RIN POS is the cause of PDT	33	0.69196	0.4121	There is no causality
PDT is the cause of RIN POS	33	4.08165	0.0200**	There is causality
RIN NEG is the cause of PDT	33	1.61380	0.2137	There is no causality
PDT is the cause of RIN NEG	33	0.27687	0.6026	There is no causality
PDT is not the cause of INF POS	33	0.48301	0.4924	There is no causality
INF NEG is not the cause of PDT	33	1.98480	0.1692	There is no causality
PDT is not the cause of INF NEG	33	0.88059	0.3555	There is no causality
POI POS is not the cause of PDT	33	5.52504	0.0097*	There is causality
PDT is not the cause of POI POS	33	1.61380	0.4121	There is no causality
POI NEG is not the cause of PDT	33	3.60369	0.0410**	There is causality
PDT is not the cause of POI NEG	33	0.01322	0.9092	There is no causality
COR POS is not the cause of PDT	33	4.21503	0.0042*	There is causality
PDT is not the cause of COR POS	33	0.09585	0.7590	There is no causality
COR NEG is not the cause of PDT	33	3.00652	0.0400**	There is causality
PDT is not the cause of COR NEG	33	6.9E-05	0.9934	There is no causality

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
POS/NEG denotes independent variables' positive and negative decompositions respectively

Source: Author's own calculations using Eviews 10 Software

Using 1 and 5 percent level of significance, Table 5.25 indicates that an increase in the real interest rate affects the South African public debt. Hence, the direction of asymmetric long run relationship is from positive shock of the real interest rate to public debt. Furthermore, an increase and the decrease in political instability and corruption affect the South African public debt. Hence, the direction of asymmetric long run relationship is also from the positive and negative shock of the political instability and corruption to public debt. These results confirm the findings of the long run asymmetric effects test, which established the cointegrating asymmetric (nonlinear) relationship between the real interest rate, political instability, corruption and public debt.

On the basis that this study established a symmetric long run relationship between tax revenue collection, inflation and public debt, and an asymmetric long run relationship between the real interest rate political instability, corruption and public debt, the Granger causality test is also carried out to see if asymmetric effects of the interest rate, political instability and corruption affect symmetric effects of tax revenue collection and inflation. The reason for this exercise is to help the researcher to provide possible better policy recommendations in the next chapter. Hence, Table 5.26 presents the results for the Granger causality test between asymmetric components (positive and negative partial decompositions) of the real interest rate, corruption and political instability, and the symmetric tax revenue collection and inflation (See Appendix 8.18).

Table 5.26 Granger Causality Test Results on the Symmetric and Asymmetric Independent Variables

Null Hypothesis	Obs	F-Statistic	Probability Value	Conclusion
TRV is not the cause of POI POS	33	0.01829	0.8933	There is no causality
POI POS is not the cause of TRV	33	0.33482	0.5672	There is no causality
INF is not the cause of POI POS	33	1.49502	0.2310	There is no causality
POI POS is not the cause of INF	33	0.87623	0.3421	There is causality
POI NEG is not the cause of TRV	33	3.96631	0.0556***	There is causality
TRV is not the cause of POI NEG	33	4.78172	0.0367**	There is causality
POI NEG is not the cause of INF	33	0.87623	0.3421	There is no causality

INF is not the cause of POI NEG	33	0.50933	0.4809	There is no causality
TRV is not the cause of COR POS	33	0.00837	0.9277	There is no causality
COR POS is not the cause of TRV	33	4.43996	0.0437**	There is causality
LINF is not the cause of COR POS	33	2.31439	0.1387	There is no causality
COR POS is not the cause of INF	33	4.70429	0.0381**	There is causality
RIN POS is not the cause of INF	33	7.11088	0.0122**	There is no causality
RIN NEG is not the cause of INF	33	1.52619	0.2263	There is no causality
COR NEG is not the cause of INF	33	1.68535	0.2041	There is no causality
INF is not the cause of LCOR NEG	33	0.42784	0.5180	There is no causality

Notes: */**/*** represents statistical significance at 1%, 5% and 10% respectively
POS/NEG denotes independent variables' positive and negative decompositions respectively
Source: Author's own calculations using Eviews 10 Software

Table 5.26 shows that an increase in corruption affect changes in tax revenue collection, and the decrease in political instability also affect tax revenue collection; and vice versa (bi-directional). Tax revenue collection is also affected by the decrease in political instability and vice versa (bi-directional). Furthermore, changes in inflation are affected by an increase in the real interest rate and corruption respectively.

Briefly, the results on the long run causality between tax revenue collection and an increase in political instability as well as an increase in corruption support the hypothesis established by the opportunistic models of political economy, which emphasizes that positive shocks in political instability may encourage some politicians to serve their own interests (corruption) due to future political or economic power uncertainty caused by political and/or structural instability.

Furthermore, the results for long run causality between an increase in corruption and tax revenue collection support the above mentioned models (fully discussed in chapter three) in the sense that governments do not normally collect efficient tax revenue in government administrations that are known to be too corrupt. Consequently, governments find themselves having no option but to borrow to patch the gap between the generated tax and/or general government revenue and the budgeted expenditure. Hence, this explains the significant long run causality relationship between an increase in political instability and public debt, and the significant long run causality

relationship between an increase in corruption and public debt (see Table 5.25). Aregbeshola (2014), Cooray *et al*. (2017) as well as Monte and Pennacchio (2020) obtained the same results.

5.3.8 NARDL Coefficients Stability and Residuals Diagnostics Tests

Coefficients stability and residuals diagnostics tests for NARDL model are quite similar to that of ARDL model. The reason for this is because the NARDL model is quite similar to the ARDL model as it is built on the ARDL model, with a noteworthy distinction that NARDL captures the nonlinear effect (partial positive and negative decompositions) of the independent variables on the dependent variable (Shin *et al*., 2014). Hence, the same coefficients stability and residuals diagnostics tests applied to the estimated ARDL model are also applied to diagnose the NARDL model estimated in section 5.3.5.

5.3.8.1 NARDL Coefficients Stability Diagnostics Tests

First, the Ramsey Reset Specification test is carried out to test if the specified NARDL model is correctly specified. Second, the actual and fitted values, and residuals plots are presented to judge the goodness of fit for the estimated NARDL model. Lastly, CUSUM and CUSUM of Squared diagrams are plotted to judge the consistency of the estimated NARDL long and short run parameters. Table 5.27 provides the results for the Ramsey Reset Specification test (see Appendix 8.19), followed by Figures 5.8, 5.9 and 5.10, which present the actual and fitted values, and residuals plot, CUSUM and CUSUM of Squares diagrams respectively.

- **NARDL (1,1,1,1,1,1,1,1,1) Ramsey Reset Specification Test**

Table 5.27 Ramsey Reset Specification Test Results for NARDL (1,1,1,1,1,1,1,1,1) Model

Test	**Null Hypothesis**	**Prob (F statistic)**	**Conclusion**
Ramsey Reset Specification	There is no misspecification	0.7394	The model is correctly specified

Source: Author's own calculations using Eviews 10 Software

The probability value for the test statistic (F statistic) is greater than 1, 5 and 10 percent. This implies that the primary NARDL model of this study is correctly specified. Hence, there is no specification biasness.

- **Actual and Fitted Values, and Residuals Plot for NARDL (1,1,1,1,1,1,1,1,1)**

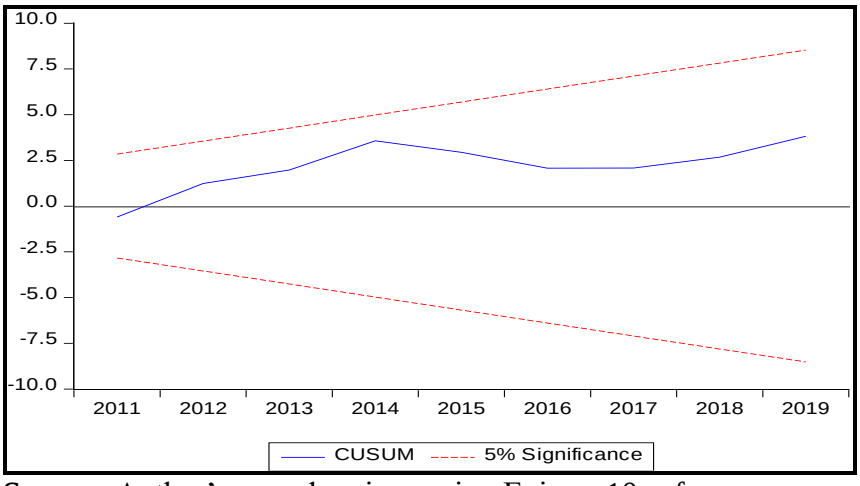
Figure 5.8 Actual and Fitted Values, and Residuals Plot

Source: Author's own drawings using Eviews 10 software

To judge the goodness of fit on the estimated NARDL model, Figure 5.8 shows less substantial deviations between the actual and fitted values. This implies that the model fits the data reasonably well, since the error magnitude is not that great. Furthermore, the residuals plot seems to be stationary for the period under study, which indicates that the residuals series follows the white noise process. Given all these, the estimated NARDL model seems to be adequate.

- **NARDL (1,1,1,1,1,1,1,1,1) CUSUM Stability Test**

Figure 5.9 CUSUM Plot Diagram

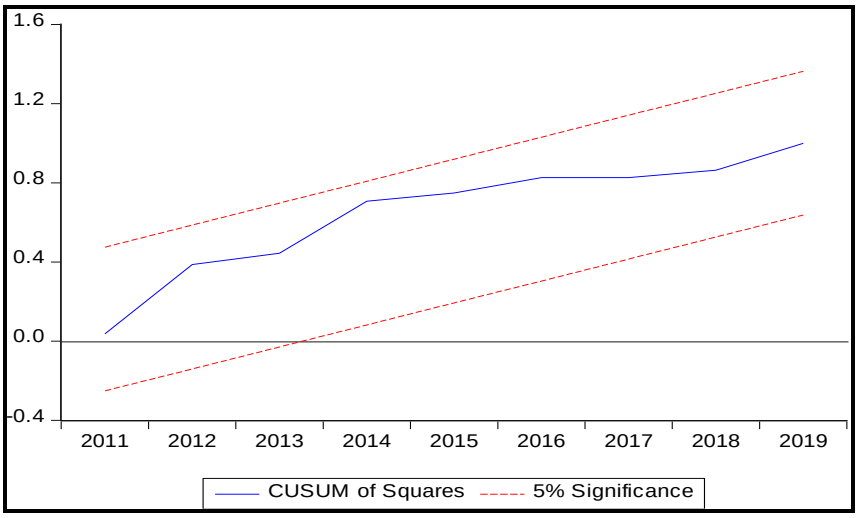


Source: Author's own drawings using Eviews 10 software

The estimated CUSUM line lies within the 5 percent significance bound, as shown in Figure 5.9. This implies that estimated long and short run coefficients are consistent at 5 percent level of significance.

- **NARDL (1,1,1,1,1,1,1,1,1) CUSUM of Squares Stability Test**

Figure 5.10 CUSUM of Squares Plot Diagram



Source: Author's own drawings using Eviews 10 software

Similarly, the estimated CUSUM of Squares line lies within the 5 percent significance bound, as shown in Figure 5.10. This implies that estimated long and short run coefficients are consistent at 5 percent level of significance.

5.3.8.2 NARDL (1,1,1,1,1,1,1,1,1) Residuals Diagnostics Tests

Lastly, the residuals of the estimated NARDL model must also be subjected to the same residuals diagnostics tests applied to the estimated ARDL model. Hence, Table 5.28 presents the results for normality, serial correlation and heteroscedasticity test (see Appendix 8.20).

Table 5.28 NARDL (1,1,1,1,1,1,1,1,1) Residuals Diagnostic Tests Results

Test	Null Hypothesis	Prob. Val.	Conclusion
Normality (Jarque-Bera)	The residuals are normally distributed	0.7280	The residuals are normally distributed
Serial Correlation (Lang. Multiplier)	There is no serial correlation	0.5808	The residuals are not serially correlated

Heteroscedasticity (Breusch-Pagan-Godfrey)	There is no heteroscedasticity	0.2879	The residuals are homoscedastic

Source: Author's own calculations using Eviews 10 Software

Under all residuals diagnostic tests, the null hypotheses fail to be rejected at 1 %, 5% and 10% significance level which implies that the residuals for the estimated NARDL model do not suffer from serial correlation and heteroscedasticity, and the residuals are normally distributed.

Having passed all the coefficients stability and residuals diagnostic tests, the coefficients for the estimated NARDL model are efficient and robust. Furthermore, the residuals of the estimated NARDL model behave reasonably well. That is, the inferences established in the results of the estimated NARDL model can be confidently relied on.

5.4 INTEGRATION OF ARDL AND NARDL FRAMEWORK RESULTS

The purpose of this chapter has been to estimate, present and interpret the results that would be helpful in answering the research questions raised by this study, and testing the hypotheses formulated in chapter one. The Wald test results on testing the relationships established by this study for asymmetric (nonlinear) effects revealed interesting outcomes in both the short and long run.

In the long run, the relationship between real interest rate, political instability, corruption and public debt is best captured in the NARDL framework, whereas the relationship between tax revenue collection, inflation and public debt is best captured in the ARDL framework. This implies that the established long run relationship between the real interest rate, political instability, corruption and public debt is nonlinear in nature whereas the established long run relationship between tax revenue collection, inflation and public debt is linear in nature.

In the short run, the Wald test results revealed that all the established relationships are best captured in the ARDL framework. That is, the short run relationship between tax revenue collection, inflation, real interest rate, political instability, corruption and public debt is actually linear in nature.

The policy implications and recommendations to be discussed in the next chapter will be guided by these revelations. That is, in the long run, the results of ARDL framework (linear) on the

relationship between tax revenue collection, inflation and public debt will be used to show policy implications so that relevant policy recommendations may be proposed. However, on the relationship between the real interest rate, political instability, corruption and public debt, the results of NARDL framework (nonlinear) will be used. In the short run, the results of ARDL framework (linear) on all the established relationships will be used to show policy implications to enable relevant policy recommendations to be proposed.

5.5 CONCLUSION

This chapter has been about fulfilling the objectives formulated in chapter one, using the proposed methodologies discussed in the previous chapter. The estimated ARDL (symmetric) and NARDL (asymmetric) models revealed interesting results. On the main objective of this study, this chapter established that tax revenue collection has a negative (symmetric) and significant effect on public debt in South Africa (in both the long and short run).

On the specific objective of testing the effect of political instability and corruption on public debt, this chapter established that political instability and corruption have an asymmetric and significant long run effect on public debt in South Africa.

The asymmetric effect of both political instability and corruption on public debt means that these factors affected public debt both positively and negatively at the same time (simultaneous double effects), as shown in the estimated results. Furthermore, the symmetric effect of tax revenue collection on public debt means that this factor affected public debt negatively (single effect), as also revealed by the estimated results.

Furthermore, the Granger causality test results indicates that long run changes in public debt are affected by the long run symmetric changes in tax revenue collection and inflation respectively. Granger causality test results also show that changes in the South African public debt are affected by both an increase and a decrease (asymmetric) in political instability and corruption.

Additionally, the symmetric independent variables (tax revenue collection and inflation) and the asymmetric independent variables (real interest rate, political instability and corruption) were tested for Granger causality. The results indicate that an increase in corruption affect changes in tax revenue collection, and the decrease in political instability also affect tax revenue collection; and vice versa (bi-directional). Tax revenue collection is also affected by the decrease in political

instability and vice versa (bi-directional). Furthermore, changes in inflation are affected by an increase in the real interest rate and corruption respectively.

On the specific objective of testing for the possible asymmetric effect of tax revenue collection, political instability, corruption on public debt, the results of the Wald test on the long and short run asymmetric effects show that only political instability and corruption have long run asymmetric (nonlinear) effects on the public debt, whereas tax revenue collection and have long run symmetric (linear) effects on the public debt. In the short run, the Wald test results indicate that tax revenue collection, political instability and corruption have symmetric effects on the public debt in South Africa, for the period of 1985 to 2019.

Lastly, statistical and economic inferences made from the estimated ARDL and NARDL models estimated in this chapter can be declared valid, efficient and reliable, since all coefficients stability and residual diagnostic tests are passed by these models.

CHAPTER SIX
SUMMARY, CONCLUSIONS, POLICY RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

6.1 INTRODUCTION

This chapter provides a summary, conclusions and synthesis of empirical evidence, policy recommendations and the limitations of the study. This chapter also suggests an area for further research. Hence, this chapter is structured as follows; section 6.2 presents the summary of the key findings. Section 6.3 presents the conclusions of the study and the synthesis of the empirical evidence. Section 6.4 presents policy implications and recommendations emanating from the key findings of the study. Lastly, Section 6.5 concludes the chapter by presenting the limitations of the study and the suggestions for further research.

6.2 A SUMMARY OF THE KEY FINDINGS

This study used yearly time series data. The first step, which is to determine the order of integration on all key variables, was followed. Hence, informal and formal unit root tests were carried out. The visual plot (informal) at level revealed that only the series for public debt shows a constant trend over time, whereas the visual plots for all other remaining variables show a changing (non-constant) trend over time.

Using the formal unit root tests, Dickey-Fuller GLS and Ng-Perron unit root tests (for ARDL framework) support the results obtained by the informal unit root test (visual plot) on the public debt variable, though there has been some inconsistency on the level form results of political instability and corruption as far as the Dickey Fuller GLS test results are concerned. Inconsistency is realized in the sense that the Dickey-Fuller GLS unit root declared political instability and corruption to be stationary (constant trend) at level (using 10 percent level of significance), which is not what is being concluded by the informal unit root test results at level. Furthermore, to account for the NARDL framework, only the Bierens (1997) nonlinear unit root test results (level) supported the results obtained by the informal unit root test, when the Breitung (2002) nonlinear unit root test results declared all key variables to be not nonlinearly stationary at level.

The visual plots in first difference reveal that the series for tax revenue collection, inflation, real interest rate, political instability and corruption show a constant trend over time. Dickey-Fuller GLS and Ng-Perron unit root test results (at first difference) support the results obtained by the

informal unit root test (visual plot). Similarly, to account for the NARDL framework, the afore-mentioned series are nonlinearly stationary after first difference, according to Bierens (1997) and Breitung (2002) nonlinear unit root test results.

Hence, the maximum order of integration for the key variables of this study is 1, for both ARDL and NARDL frameworks. This is the satisfaction of the main assumption behind ARDL and NARDL frameworks which requires the variables to be integrated to the order of 0, 1 or the combination of 0 and 1.

Both ARDL and NARDL required an optimal lag order to be selected. Depending on the sample size of 35 observations (1985 to 2019), the maximum lag order was selected to be 1. All information criterion selected lag 1 as the optimal lag for both ARDL and NARDL frameworks, that is, model ARDL (1,1,1,1,1) and NARDL (1,1,1,1,1,1,1,1,1) were estimated using the bound test approach. Hence, for both ARDL and NARDL frameworks, the bound test results established only one cointegrating vector at 1 percent level of significance. The established one cointegrating vector happened to be the principal model of this study.

Following the specific objective of testing for possible nonlinear (asymmetric) relationship between the predictor variables and the response variable, this study made use of the Wald test to test for the asymmetric effects. In the long run, the Wald test results only established the nonlinear relationship between real interest rate, political instability, corruption and public debt. That is, in the long run, the relationship between the real interest rate, political instability, corruption and public debt is best explained within the NARDL framework, whereas the relationship between tax revenue collection, inflation and public debt is best explained within the ARDL framework. In the short run, the Wald test results could not find any evidence of asymmetric effects on the relationship between predictor variables and the response variable. That is, all the established short run relationships of this study are best explained within the ARDL framework.

In the long run, a 1 percent increase in the real interest rate; and a unit increase in the political instability and corruption index result to -0.04894, -0.1840 and 2.5647 percent increase in public debt respectively. However, a 1 percent decrease in the real interest rate; and a unit decrease in the political instability and corruption index result to -0.0074, -1.0370 and -1. 1171 percent decrease in public debt respectively (asymmetric relationships). Similarly, a 1 percent increase in tax revenue collection and inflation results to 0.6024 and 0.2733 percent decrease in public debt

respectively in South Africa (symmetric relationships). These long run relationships are statistically significant at 1, 5 and 10 percent level of significance, except for the long run relationship between the decrease of the real interest rate and the public debt.

In the short run, a 1 percent increase in tax revenue collection leads to a 4.5736 percent decrease in public debt. Furthermore, a 1 percent increase in inflation, real interest rate, political instability and corruption leads to 0.3613, 0.01297, 0.0674 and 0.3735 percent increase in public debt respectively in South Africa (symmetric relationships). Only the short run relationship between political instability and public debt is statistically insignificant, when the remaining short run relationships are statistically significant at 1, 5 and 10 percent level of significance.

The results on the established short and long relationships of this study are quite similar to those of Gupta (2007), Salar *et al*. (2013), Crivelli *et al*. (2016), Palil and Mustupha (2011) and Rimmer (2010) and Swammy (2015). However, Ellis and Schansburg (2004) obtained different results on the long run relationship between political instability, corruption and public debt. Hence, they found out that political instability and corruption were not largely significant in explaining the public debt in 52 developing economies.

In testing for the direction of cointegration, the Granger causality test results indicates that changes in public debt are affected by changes in tax revenue collection, positive shock of the real interest rate, positive and negative shocks of political instability and corruption. Furthermore, Granger causality test results further indicate that changes in the public debt are affected by changes in inflation and tax revenue collection. Granger causality test results also indicate that changes in tax revenue collection are affected by a decrease in political instability, and an increase in political instability. Lastly, changes in inflation and tax revenue collection are affected by an increase in political instability and corruption respectively.

The estimated ARDL and NARDL models were subjected to coefficients and residuals diagnostic tests. Under the coefficients diagnostic tests, the results for the Ramsey regression specification error test indicate that the estimated ARDL and NARDL models were correctly specified. Furthermore, the estimated CUSUM and CUSUM of squares lines lie within the 5 percent significance bound for both estimated ARDL and NARDL model. This implies that estimated ARDL/NARDL long and short run coefficients are consistent at 5 percent level of significance.

Under the residuals diagnostic tests, the results for the Jarque-Bera test for normality, Langrage Multiplier serial correlation test and Breusch-Pagan-Godfrey heteroscedasticity test indicated that the residuals are normally distributed, and there is no serial correlation and heteroscedasticity.

6.3 CONCLUSIONS AND SYNTHESIS OF THE EMIPIRAL EVIDENCE

This section presents the conclusions emanating from the results obtained in the previous chapter, and synthesis of the empirical evidence in terms approaches used in this study. Hence, section 6.3.1 presents the conclusions of the study whereas section 6.3.2 presents the synthesis of empirical evidence.

6.3.1 Conclusions of the study

The results presented in the previous section do present a notable scenario of the current situation as far as South African public finances are concerned. In both the long and short run, if South Africa desires to reduce its public debt, then it must improve its tax revenue collection, more especially as tax revenue collection is the main source of government revenue. To add on to this, Granger causality test results established that changes in tax revenue collection significantly affect changes in public debt.

However, as established by the problem statement in chapter one, South Africa has a challenge of raising sufficient tax revenue just like any other developing economy. Nevertheless, South Africa's inefficiency to raise notable tax/government revenue is attributed to institutional factors such as corruption and political instability, as established by the results presented in the previous section. To support this, Granger causality test results further indicated that changes in tax revenue collection are affected by the decrease in political instability, and an increase in corruption respectively. Due to inefficiency in raising enough tax/government revenue, South Africa finds itself having to finance both current and capital expenditure through extensive borrowing. This kind of borrowing affects a country's credit worthiness in financial markets, thus leading to poor investor' confidence.

The null hypothesis that 'there is no significant between tax revenue collection, political instability, corruption and public debt is rejected in both long and short run. This is due to the fact that this study establishes a significant linear relationship between tax revenue collection and public debt; and a significant nonlinear relationship between corruption and public debt in South Africa

Lastly, this study also rejects the null hypothesis of 'no long run asymmetric effects' between political instability, corruption and public debt in the long run. Hence, this study establishes the long run asymmetric (nonlinear) relationship between political instability, corruption and public debt in South Africa, since the long run test statistics for the Wald test are statistically significant. Furthermore, the Wald test results do not reject the null hypothesis of no asymmetric long run relationship between tax revenue collection and public debt in the long run, since the long run test statistics for the Wald test are statistically insignificant. Thus establishing the long run linear relationship between tax revenue collection and public debt in South Africa.

In the short run, the Wald test results do not reject the null hypothesis of 'no short run asymmetric effects' between tax revenue collection, political instability, corruption and public debt, since the short run test statistics for the Wald test are statistically insignificant. Hence, this study establishes the short run linear relationship between tax revenue collection, political instability, corruption and public debt in South Africa.

6.3.2 Synthesis of the empirical evidence

This study contributed to the body of knowledge by exploring the empirical effect of tax revenue collection, political instability and corruption on public debt in South Africa. The selected empirical studies in the case of South Africa showed no evidence of the exploration of the empirical effect of tax revenue collection, political instability and corruption on public debt. In this regard, the results obtained in this study could only be compared to the selected empirical studies done in other developing economies and some developed economies.

All of these empirical studies applied linear methods, that is, researchers assumed symmetric relationships among government financing, institutional, structural and economic variables. It is not really wrong to assume symmetric relationships but in some cases linear models are not correctly specified. Also, various significant factors such as political instability, corruption and tax policy reforms, which are mostly more severe in developing economies, assist the case for possible asymmetric (nonlinear) relationships among the time series of economic, financing, structural and institutional variables.

Therefore, comparing the findings of this study with the work of other researchers, the researcher makes a submission that given the volatile economic environments in the current era, researchers must sometimes (in some cases) use methods that establish asymmetric relationships, as those

methods provide better economic and statistical inferences that reflect the modern economic environments, and account for volatile economic characteristics and/or phenomena that cannot be captured by linear methods.

6.4 POLICY IMPLICATIONS AND RECOMMENDATIONS

The policy implications raised by this study are; tax revenue collection is negatively and significantly related to public debt, whereas political instability and corruption are both positively and negatively related to public debt in both the short and long run. Also, the positive and negative effects of political instability and corruption on public debt are significant in both the short and long run. However, on the policy implication raised on the established relationship between tax revenue collection and public debt, South Africa still has a challenge of raising enough government/tax revenue, as emphasized in the problem statement. Thus, the researcher recommends that government ought to re-channel its expenditure programmes by identifying sectors that are more productive (productive expenditures), and invest in them as government would be able to recoup the resources, and consequently generate more income which would possibly be in taxes and/or net received receipts.

Moreover, the problem statement emphasizes that the bailouts of state owned enterprises (SOEs) accounts for a large portion of the South African public debt. Thus, government tends to rely more on tax revenue collection (over-reliance), since these SOEs are no longer generating income for the government. Furthermore, the problem statement states that this is due to the maladministration and corruption that have been going on in the administration of these enterprises. To this effect, the researcher recommends that proper leadership and corporate governance styles as well ethical standards should be re-practiced in the South African SOEs and general government administrations. This would restore efficiency and competitiveness of South African SOEs and general government administrations.

The researcher further recommends an elimination of political patronage coupled with clear and strict ethical standards that show clear and harsh consequences for the perpetrators found to be involved in any opposite conduct, as this would promote accountability. Obviously, this will improve productivity in government administrations and SOEs, thus increasing profits, as that is the primary purpose for the existence of the SOEs. An improvement in the profits generated on

the SOEs will reduce government's over-reliance on tax revenue to cover both public current and capital expenditure.

Lastly, corruption in South Africa has abruptly upset government policies in such a way that the political atmosphere in South African is drastically unstable. This is supported by the Granger causality test results, which indicate that long run positive and negative shocks of corruption affect positive and negative shocks of political instability. Hence, policy-makers have a short horizon (uncertainty) when making policy decisions. This practice has manifested itself in such a way that it has deeply affected the credibility of the South African government as it promotes abuse of power by the official authority/politicians to benefit underserving political loyalists of the ruling party. Uprooting corruption would reduce political instability and/or uncertainty as the right qualifying people would certainly bring about the desired results and/or performance, thus increasing productivity and restoring public confidence in the government administrations and SOEs. That is, the conflicts between the ruling party and opposition parties will not be severe, thus stabilizing the political atmosphere a little bit if not much.

6.5 LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

The NARDL methodology used to account for the nonlinear relationship between tax revenue collection and public debt, could not establish the long run nonlinear relationship among the afore-mentioned variables, although it managed to establish long run nonlinear relationship between political instability, corruption and public debt.

However, this limitation does not nullify the statistical and economic inferences established by the methodology used to account for linearity assumption (ARDL) on the long run relationship between tax revenue collection and public debt, as the theoretical and empirical literature support these inferences. Furthermore, these inferences back up the problem statement.

Hence, from the technical side; the researcher suggests that the relationship between tax revenue collection and public debt may be researched by future studies using different predictive nonlinear methodologies such as Vector Smooth Transition Regression (VSTR). This methodology, compared to the NARDL methodology, has the advantage of treating each explanatory variable as a transition variable. That is, the VSTR methodology would describe situations in which the dynamic behaviour of the variables can be modelled through defining a limited number of linear regimes or transitions that the modelling process can accommodate. Otherwise, from the general

side, future studies may look at how the South African government can improve its tax revenue collection, and public debt service measures.

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8. APPENDICES

Appendix 8.0: Data

YEAR	PDT	TRV	INF	RIN	POI	COR
1985	3.2268	3.1831	16.8152	4.0105	1.6740	1.7918
1986	3.2189	3.1881	17.1523	-2.4063	1.4469	1.7918
1987	3.1905	3.1942	14.4790	-1.7287	1.0986	1.7918
1988	3.1697	3.2036	15.1493	0.1598	1.3652	1.6740
1989	3.2696	3.2152	17.2245	2.2255	1.6094	1.6094
1990	3.3250	3.2172	15.4771	4.7827	1.6094	1.6094
1991	3.2696	3.2223	15.6519	4.0298	1.6094	1.6094
1992	3.1697	3.2226	14.5678	3.7865	1.4854	1.6094
1993	3.1311	3.2301	12.9816	2.8118	2.0794	1.6094
1994	3.3214	3.2345	9.5611	5.4967	2.0149	1.6094
1995	3.2504	3.2411	10.2135	6.9704	2.1785	1.6094
1996	3.3142	3.2471	7.9057	10.7642	2.3979	1.6094
1997	3.2658	3.2516	7.9873	11.1242	2.3979	1.6094
1998	3.2619	3.2561	7.7870	12.9929	2.3593	1.6094
1999	3.3178	3.2592	7.0282	10.2514	2.2246	1.2993
2000	3.3569	3.2627	8.7963	5.2425	2.0898	1.0986
2001	3.2619	3.2679	7.6419	5.6939	2.0794	1.0986
2002	3.2809	3.2722	12.2053	3.1591	2.1926	1.0846
2003	3.2387	3.2751	5.7936	8.6629	2.0794	0.9163
2004	3.2108	3.2811	6.5270	4.4727	2.1785	0.8473
2005	3.4210	3.2872	5.4491	4.9084	2.2380	0.6931
2006	3.2658	3.2937	6.2552	4.6223	2.1972	0.7732
2007	3.2504	3.2992	8.8494	3.9663	2.1972	0.9163
2008	3.1655	3.3024	8.8315	5.7828	2.2246	0.9163
2009	3.1224	3.3010	7.5045	3.9104	2.2513	0.9163
2010	3.0727	3.3053	6.3510	3.2743	2.2644	0.9163
2011	3.0253	3.3090	6.5322	2.3165	2.2469	1.0561
2012	3.1046	3.3123	5.2828	3.2933	2.2513	1.0846
2013	3.1864	3.3160	6.1553	2.2088	2.2336	0.9163
2014	3.1739	3.3193	5.5470	3.3900	2.2110	0.9163
2015	3.2308	3.3226	5.1706	4.0373	2.1972	0.9163
2016	3.2068	3.3250	7.2063	3.0334	2.1972	0.9163
2017	3.1905	3.3271	5.2675	4.8520	2.1972	0.9163
2018	3.2149	3.3294	3.9165	5.9344	2.1972	0.9163
2019	3.2426	3.3369	4.0212	5.8678	2.1972	0.9163

Appendix 8.1: Descriptive Statistics for the Key Variables

	PDT	TRV	INF	RIN	POI	COR
Mean	3.226428	3.268900	9.236731	4.682864	2.042072	1.233559
Median	3.230804	3.272226	7.786990	4.037300	2.197225	1.084626
Maximum	3.421000	3.336900	17.22452	12.99292	2.397895	1.791759
Minimum	3.025291	3.183088	3.916540	-2.406257	1.098612	0.693147
Std. Dev.	0.080502	0.045257	4.143903	3.221469	0.327557	0.364582
Skewness	-0.175568	-0.281614	0.731764	0.482180	-1.358246	0.261822
Kurtosis	3.400040	1.898861	2.137412	3.902527	3.704351	1.379874
Jarque-Bera	0.413187	2.230861	4.208707	2.544129	11.48501	4.227724
Probability	0.813350	0.327774	0.121924	0.280252	0.003207	0.120771
Sum	112.9250	114.4115	323.2856	163.9003	71.47252	43.17457
Sum Sq. Dev.	0.220338	0.069637	583.8457	352.8473	3.647977	4.519284
Observations	35	35	35	35	35	35

Appendix 8.2: Correlation Matrix for the Key Variables

Covariance Analysis: Ordinary
Date: 02/06/21 Time: 16:06
Sample: 1985 2019
Included observations: 35

Correlation	PDT	TRV	INF	RIN	POI	COR
PDT	1.000000					
TRV	-0.249779	1.000000				
INF	0.383719	-0.490566	1.000000			
RIN	-0.401596	0.168837	-0.424644	1.000000		
POI	0.503398	0.549624	-0.426211	0.610203	1.000000	
COR	0.515302	-0.498671	0.298955	-0.442060	-0.628895	1.000000

Appendix 8.3: Optimal Lags Selection for the Key Variables

VAR Lag Order Selection Criteria
Endogenous variables: PDT TRV INF RIN POI COR
Exogenous variables: C
Date: 02/06/21 Time: 19:38
Sample: 1985 2019
Included observations: 34

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-9.414278	NA	9.98e-08	0.906722	1.176080	0.998581
1	177.0906	296.2136*	1.48e-11*	-7.946503*	-6.060999*	-7.303492*

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

Appendix 8.4: ARDL Bounds Test Results

1. PDT=F (TRV, INF, RIN, POI, COR)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.381984	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

2. TRV=F (PDT, INF, RIN, POI, COR)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.689497	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

3. INF=F (PDT, TRV, RIN, POI, COR)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	2.003445	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

4. RIN=F (PDT, TRV, INF, POI, COR)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.444819	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

5. POI=F (PDT, TRV, INF, RIN, COR)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.100706	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

6. COR=F (PDT, TRV, INF, RIN, POI)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.291271	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Appendix 8.5: ARDL (1,1,1,1,1) Long Run Estimates

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TRV	-0.602405	0.104858	-5.744959	0.0000
INF	0.273250	0.119026	2.295717	0.0421
RIN	0.340620	0.095436	3.569093	0.0012
POI	0.109767	0.020293	5.408947	0.0000
COR	-0.313336	0.101247	-3.094768	0.0023
C	8.288449	5.853804	1.415908	0.1708

Appendix 8.6: ARDL (1,1,1,1,1) Short Run Estimates

ARDL Error Correction Regression
Dependent Variable: D(PDT)
Selected Model: ARDL(1, 1, 1, 1, 1, 1)
Case 2: Restricted Constant and No Trend
Date: 02/06/21 Time: 18:01
Sample: 1985 2019
Included observations: 34

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TRV)	-4.573618	2.409526	-1.898140	0.0709
D(INF)	0.361366	0.106846	3.382120	0.0023
D(RIN)	0.012917	0.005581	2.314590	0.0304
D(POI)	-0.067408	0.072784	-0.926129	0.3644
D(COR)	0.373525	0.116964	3.193505	0.0042
CointEq(-1)*	-0.718997	0.156078	-4.606660	0.0001

R-squared	0.524915	Mean dependent var	0.000463
Adjusted R-squared	0.440078	S.D. dependent var	0.076678
S.E. of regression	0.057377	Akaike info criterion	-2.719568
Sum squared resid	0.092179	Schwarz criterion	-2.450211
Log likelihood	52.23266	Hannan-Quinn criter.	-2.627710
Durbin-Watson stat	1.926038		

* p-value incompatible with t-Bounds distribution.

Appendix 8.7: Granger Causality Test Results

Pairwise Granger Causality Tests
Date: 02/06/21 Time: 19:40
Sample: 1985 2019
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
TRV does not Granger Cause PDT	34	3.85092	0.0304
PDT does not Granger Cause TRV		0.04865	0.8269
INF does not Granger Cause PDT	34	4.43682	0.0223
PDT does not Granger Cause INF		3.87983	0.0324
RIN does not Granger Cause PDT	34	1.01316	0.3219
PDT does not Granger Cause RIN		0.42060	0.5214
POI does not Granger Cause PDT	34	0.11951	0.7319
PDT does not Granger Cause POI		0.66095	0.4224
COR does not Granger Cause PDT	34	4.45381	0.0217
PDT does not Granger Cause COR		0.04551	0.8325

Appendix 8.8: Stability Test Results

Ramsey Reset Specification Test

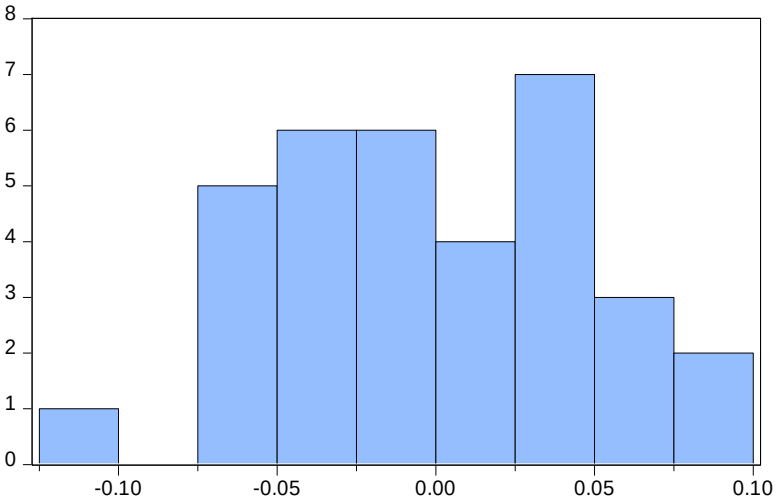
	Value	df	Probability
t-statistic	0.366481	23	0.7174
F-statistic	0.134308	(1, 23)	0.7174

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000437	1	0.000437
Restricted SSR	0.075304	24	0.003138
Unrestricted SSR	0.074867	23	0.003255

Appendix 8.9: Residual Diagnostic Tests Results

Normality Test



Series: Residuals
Sample 1986 2019
Observations 34

Mean	-1.83e-15
Median	-0.010991
Maximum	0.099298
Minimum	-0.100289
Std. Dev.	0.047770
Skewness	0.126169
Kurtosis	2.353163
Jarque-Bera	0.682935
Probability	0.710726

Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.154503	Prob. F(2,22)	0.8578
Obs*R-squared	0.470939	Prob. Chi-Square(2)	0.7902

Heteroscedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.555287	Prob. F(9,24)	0.1855
Obs*R-squared	12.52495	Prob. Chi-Square(9)	0.1853
Scaled explained SS	4.222415	Prob. Chi-Square(9)	0.8962

Appendix 8.10: Linearity Test Results

BDS Linearity Test Results

PDT

BDS Test for PDT
Date: 02/08/21 Time: 22:34
Sample: 1985 2019
Included observations: 35

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.050384	0.013288	3.791811	0.0001
3	0.052357	0.021558	2.428618	0.0152
4	0.033365	0.026217	1.272657	0.2031
5	0.029616	0.027917	1.060839	0.2888
6	0.041067	0.027519	1.492309	0.1356

Raw epsilon	0.113795		
Pairs within epsilon	869.0000	V-Statistic	0.709388
Triples within epsilon	23237.00	V-Statistic	0.541971

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	298.0000	0.531194	389.0000	0.693405	0.480810
3	195.0000	0.369318	360.0000	0.681818	0.316961
4	121.0000	0.243952	336.0000	0.677419	0.210586
5	76.00000	0.163441	311.0000	0.668817	0.133825
6	53.00000	0.121839	286.0000	0.657471	0.080772

TRV

BDS Test for TRV
Date: 02/08/21 Time: 22:35
Sample: 1985 2019
Included observations: 35

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.202996	0.007539	26.92558	0.0000
3	0.343417	0.012080	28.42770	0.0000
4	0.440296	0.014502	30.36190	0.0000
5	0.509287	0.015240	33.41762	0.0000
6	0.561133	0.014824	37.85300	0.0000

Raw epsilon	0.070494		
Pairs within epsilon	861.0000	V-Statistic	0.702857
Triples within epsilon	22123.00	V-Statistic	0.515988

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	392.0000	0.698752	395.0000	0.704100	0.495757
3	372.0000	0.704545	376.0000	0.712121	0.361129
4	353.0000	0.711694	358.0000	0.721774	0.271397
5	334.0000	0.718280	340.0000	0.731183	0.208992
6	317.0000	0.728736	323.0000	0.742529	0.167602

INF

BDS Test for INF
Date: 02/08/21 Time: 22:37
Sample: 1985 2019
Included observations: 35

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.156650	0.011359	13.79082	0.0000
3	0.282850	0.018493	15.29529	0.0000
4	0.373834	0.022562	16.56932	0.0000
5	0.432786	0.024101	17.95688	0.0000
6	0.474233	0.023832	19.89931	0.0000

Raw epsilon	6.946836		
Pairs within epsilon	873.0000	V-Statistic	0.712653
Triples within epsilon	23195.00	V-Statistic	0.540991

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	366.0000	0.652406	395.0000	0.704100	0.495757
3	334.0000	0.632576	372.0000	0.704545	0.349725
4	307.0000	0.618952	349.0000	0.703629	0.245118
5	280.0000	0.602151	326.0000	0.701075	0.169365
6	259.0000	0.595402	306.0000	0.703448	0.121169

RIN

BDS Test for RIN
Date: 02/08/21 Time: 22:39
Sample: 1985 2019
Included observations: 35

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.090690	0.019116	4.744140	0.0000
3	0.170151	0.031188	5.455676	0.0000
4	0.206752	0.038159	5.418163	0.0000
5	0.223164	0.040893	5.457279	0.0000
6	0.220967	0.040574	5.446089	0.0000

Raw epsilon	4.838201		
Pairs within epsilon	871.0000	V-Statistic	0.711020
Triples within epsilon	24065.00	V-Statistic	0.561283

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	322.0000	0.573975	390.0000	0.695187	0.483285
3	260.0000	0.492424	362.0000	0.685606	0.322273
4	207.0000	0.417339	336.0000	0.677419	0.210586
5	166.0000	0.356989	311.0000	0.668817	0.133825
6	132.0000	0.303448	287.0000	0.659770	0.082481

POI

BDS Test for POI
Date: 02/08/21 Time: 22:40
Sample: 1985 2019
Included observations: 35

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.157594	0.015491	10.17319	0.0000
3	0.292888	0.024937	11.74493	0.0000
4	0.384651	0.030096	12.78064	0.0000
5	0.442519	0.031809	13.91166	0.0000
6	0.474400	0.031124	15.24244	0.0000

Raw epsilon	0.560686		
Pairs within epsilon	861.0000	V-Statistic	0.702857
Triples within epsilon	23117.00	V-Statistic	0.539172

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	354.0000	0.631016	386.0000	0.688057	0.473422
3	322.0000	0.609848	360.0000	0.681818	0.316961
4	294.0000	0.592742	335.0000	0.675403	0.208091
5	268.0000	0.576344	311.0000	0.668817	0.133825
6	243.0000	0.558621	288.0000	0.662069	0.084221

COR

BDS Test for COR
Date: 02/08/21 Time: 22:42
Sample: 1985 2019
Included observations: 35

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.192672	0.007462	25.82087	0.0000
3	0.298703	0.010938	27.30917	0.0000
4	0.367212	0.012013	30.56821	0.0000
5	0.400579	0.011551	34.67915	0.0000
6	0.413481	0.010280	40.22000	0.0000

Raw epsilon	0.693147		
Pairs within epsilon	787.0000	V-Statistic	0.642449
Triples within epsilon	18629.00	V-Statistic	0.434496

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	334.0000	0.595365	356.0000	0.634581	0.402693
3	295.0000	0.558712	337.0000	0.638258	0.260009
4	267.0000	0.538306	319.0000	0.643145	0.171094
5	240.0000	0.516129	302.0000	0.649462	0.115550
6	215.0000	0.494253	286.0000	0.657471	0.080772

White Neural Network Linearity Test Results

✔ pdt

```
        White Neural Network Test

data:  pdttseries
X-squared = 2.3479, df = 2, p-value = 0.3091
```

✔ trv

```
White Neural Network Test

data:  trvtseries
X-squared = 0.37354, df = 2, p-value = 0.8296
```

✔ inf

```
White Neural Network Test

data:  inftseries
X-squared = 4.2841, df = 2, p-value = 0.1174
```

✔ rin

```
White Neural Network Test

data:  rintseries
X-squared = 6.378, df = 2, p-value = 0.0243
```

✔ poi

```
        White Neural Network Test

data:  poitseries
X-squared = 5.378, df = 2, p-value = 0.0599
```

✔ cor

```
        White Neural Network Test

data:  cortseries
X-squared = 5.5199, df = 2, p-value = 0.0633
```

Appendix 8.11: NARDL Bound Test Results

1. $\boldsymbol{pdt = f(trv^{+}_{-}, inf^{+}_{-}, rin^{+}_{-}, poi^{+}_{-}, cor^{+}_{-})}$

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	12.57142	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

2. $trv = f(pdt^{+}_{-}, inf^{+}_{-}, rin^{+}_{-} poi^{+}_{-}, cor^{+}_{-})$

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	2.487677	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

3. $inf = f(pdt^{+}_{-}, trv^{+}_{-}, rin^{+}_{-} poi^{+}_{-}, cor^{+}_{-})$

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.872430	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

4. $rin = f(pdt^{+}_{-}, trv^{+}_{-}, inf^{+}_{-} poi^{+}_{-}, cor^{+}_{-})$

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.382482	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

5. $poi = f(pdt^{+}_{-}, trv^{+}_{-}, inf^{+}_{-}, rin^{+}_{-}, cor^{+}_{-})$

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	2.534349	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

6. $cor = f(pdt^{+}_{-}, trv^{+}_{-}, inf^{+}_{-}, rin^{+}_{-}, poi^{+}_{-})$

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	0.188348	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

Appendix 8.12: NARDL Long Run Estimates

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TRV_POS	0.089471	0.017932	4.989438	0.0040
TRV_NEG	-0.903320	0.183434	4.923154	0.0032
INF_POS	-0.065158	0.011194	-5.820926	0.0001
INF_NEG	-0.035211	0.009091	-3.873231	0.0026
RIN_POS	-0.032033	0.012535	-2.555448	0.0267
RIN_NEG	-0.004613	0.015872	-0.290662	0.7767
POI_POS	-0.120460	0.061625	-1.954716	0.0765
POI_NEG	1.678838	0.328785	5.086308	0.0004
COR_POS	-0.678838	0.246902	-2.749423	0.0189
COR_NEG	-0.731232	0.175654	-4.162916	0.0016
C	3.881766	0.109178	35.55431	0.0000

Appendix 8.13: NARDL Short Run Estimates

ARDL Error Correction Regression
Dependent Variable: D(PDT)
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1)
Case 2: Restricted Constant and No Trend
Date: 02/09/21 Time: 11:13
Sample: 1985 2019
Included observations: 33

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TRV_POS)	3.861055	1.398451	2.760951	0.0185
D(TRV_NEG)	0.235258	0.077075	3.052323	0.0011
D(INF_POS)	-0.020289	0.004981	-4.073094	0.0018
D(INF_NEG)	-0.043756	0.005310	-8.240614	0.0000
D(RIN_POS)	-0.001940	0.005044	-0.384597	0.7079
D(RIN_NEG)	-0.021302	0.004825	-4.414879	0.0010
D(POI_POS)	-0.235442	0.040118	-5.868684	0.0001
D(POI_NEG)	1.816768	0.111311	16.32156	0.0000
D(COR_POS)	-0.977075	0.117046	-8.347815	0.0000
D(COR_NEG)	-0.669172	0.064226	-10.41909	0.0000
CointEq(-1)*	-0.654586	0.072228	-9.062773	0.0000

R-squared	0.948043	Mean dependent var	0.000719
Adjusted R-squared	0.924426	S.D. dependent var	0.077852
S.E. of regression	0.021402	Akaike info criterion	-4.589437
Sum squared resid	0.010077	Schwarz criterion	-4.090601
Log likelihood	86.72571	Hannan-Quinn criter.	-4.421594
Durbin-Watson stat	2.668938		

Appendix 8.14: Long and Short Run Asymmetric Effects Test Results

Long Run

1. $TRV^{+} = TRV^{-}$

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
t-statistic	-0.298614	15	0.7760
F-statistic	0.083929	(1, 15)	0.7760
Chi-square	0.083929	1	0.7720

Null Hypothesis: C(3)=C(5)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3) - C(5)	-4.796717	16.063258

2. $INF^{+} = INF^{-}$

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
t-statistic	-0.783096	15	0.7713
F-statistic	0.087570	(1, 15)	0.7713
Chi-square	0.087570	1	0.7673

Null Hypothesis: C(7)=C(9)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(7) - C(9)	-0.003632	0.004638

3. $RIN^{+} = RIN^{-}$

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
t-statistic	-2.859722	15	0.0155
F-statistic	8.178011	(1, 15)	0.0155
Chi-square	8.178011	1	0.0042

Null Hypothesis: C(11)=C(13)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(11) - C(13)	-0.053762	0.018800

4. $POI^{+} = POI^{-}$

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
t-statistic	-2.254365	15	0.0431
F-statistic	2.269824	(1, 15)	0.0400
Chi-square	2.269824	1	0.0343

Null Hypothesis: C(11)=C(13)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(11) - C(13)	-0.721656	0.320115

5. $\boldsymbol{COR^{+} = COR^{-}}$

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
t-statistic	2.831426	15	0.0244
F-statistic	2.467007	(1, 15)	0.0204
Chi-square	2.467007	1	0.0200

Null Hypothesis: C(15)=C(17)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(15) - C(17)	0.552533	0.195143

Short Run

1. $\boldsymbol{D(TRV^{+}) = D(TRV^{-})}$

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	0.206918	25	0.6082
F-statistic	0.269524	(1, 25)	0.6082
Chi-square	0.269524	1	0.6037

Null Hypothesis: C(1)=C(2)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1) - C(2)	1.505431	7.275500

2. $D(INF^{+}) = D(INF^{-})$

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	0.105486	25	0.6780
F-statistic	0.176440	(1, 25)	0.6780
Chi-square	0.176440	1	0.6745

Null Hypothesis: C(3)=C(4)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3) - C(4)	0.011107	0.105294

3. $D(RIN^{+}) = D(RIN^{-})$

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	-0.776178	25	0.4540
F-statistic	0.602452	(1, 25)	0.4540
Chi-square	0.602452	1	0.4376

Null Hypothesis: C(1)=C(2)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5) - C(6)	-4.115641	5.302446

4. $D(POI^{+}) = D(POI^{-})$

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	-0.749305	25	0.2894
F-statistic	0.171835	(1, 25)	0.2894
Chi-square	0.171835	1	0.2790

Null Hypothesis: C(5)=C(6)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5) - C(6)	-0.961572	1.283286

5. $D(COR^{+}) = D(COR^{-})$

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	0.661349	25	0.8925
F-statistic	0.018637	(1, 25)	0.8925
Chi-square	0.018637	1	0.8914

Null Hypothesis: C(7)=C(8)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(7) - C(8)	0.314830	0.476042

Appendix 8.15: Nonlinear Granger Causality Test Results

Pairwise Granger Causality Tests
Date: 02/07/21 Time: 07:50
Sample: 1985 2019
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
RIN_POS does not Granger Cause PDT	33	0.69196	0.4121
PDT does not Granger Cause RIN_POS		4.08165	0.0200
RIN_NEG does not Granger Cause PDT	33	1.61380	0.2137
PDT does not Granger Cause RIN_NEG		0.27687	0.6026
POI_POS does not Granger Cause PDT	33	5.52504	0.0097
PDT does not Granger Cause POI_POS		1.10121	0.3024
POI_NEG does not Granger Cause PDT	33	3.60369	0.0410
PDT does not Granger Cause POI_NEG		0.01322	0.9092
COR_POS does not Granger Cause PDT	33	4.21503	0.0042
PDT does not Granger Cause COR_POS		0.09585	0.7590
COR_NEG does not Granger Cause PDT	33	3.00652	0.0400
PDT does not Granger Cause COR_NEG		6.9E-05	0.9934

Appendix 8.16: Symmetric and Asymmetric Independent Variables Granger Causality Test Results

Pairwise Granger Causality Tests			
Date: 02/07/21 Time: 08:42			
Sample: 1985 2019			
Lags: 1			
Null Hypothesis:	Obs	F-Statistic	Prob.
INF does not Granger Cause TRV	34	0.69372	0.2546
TRV does not Granger Cause INF		0.98496	0.1428
RIN_POS does not Granger Cause TRV	33	0.58267	0.4512
TRV does not Granger Cause RIN_POS		0.35100	0.8773
RIN_NEG does not Granger Cause TRV	33	0.04137	0.9124
TRV does not Granger Cause RIN_NEG		0.39961	0.5445
POI_POS does not Granger Cause TRV	33	0.33482	0.5672
TRV does not Granger Cause POI_POS		0.01829	0.8933
POI_NEG does not Granger Cause TRV	33	3.96631	0.0556
TRV does not Granger Cause POI_NEG		4.78172	0.0367
COR_POS does not Granger Cause TRV	33	4.43996	0.0437
TRV does not Granger Cause COR_POS		0.00837	0.9277
COR_NEG does not Granger Cause TRV	33	1.63313	0.2111
TRV does not Granger Cause COR_NEG		1.63750	0.2105
RIN_POS does not Granger Cause INF	33	7.11088	0.0122
INF does not Granger Cause RIN_POS		1.52619	0.2263
RIN_NEG does not Granger Cause INF	33	0.39448	0.1553
INF does not Granger Cause RIN_NEG		0.38172	0.2568
POI_POS does not Granger Cause INF	33	0.87623	0.3421
INF does not Granger Cause POI_POS		1.49502	0.2310
POI_NEG does not Granger Cause INF	33	2.73795	0.1084
INF does not Granger Cause POI_NEG		0.50933	0.4809
COR_POS does not Granger Cause INF	33	1.35300	0.2539
INF does not Granger Cause COR_POS		2.92934	0.0973
COR_NEG does not Granger Cause INF	33	1.68535	0.2041
INF does not Granger Cause COR_NEG		0.42784	0.5180

Appendix 8.17: NARDL Ramsey Reset Specification Test Results

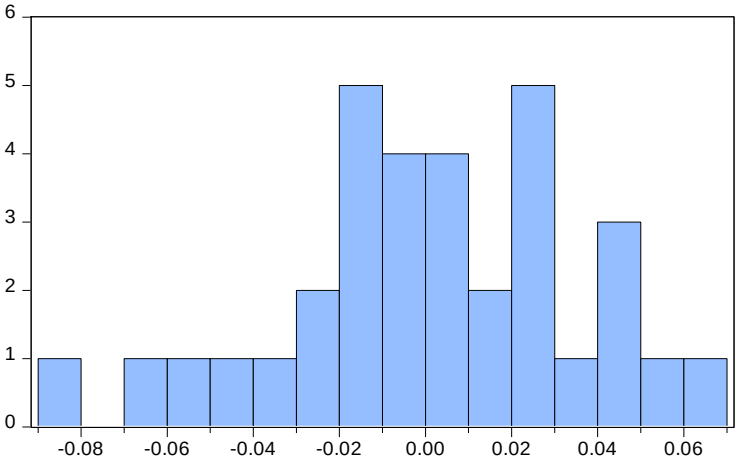
	Value	df	Probability
t-statistic	0.339301	14	0.7394
F-statistic	0.115125	(1, 14)	0.7394

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000306	1	0.000306
Restricted SSR	0.037528	15	0.002502
Unrestricted SSR	0.037222	14	0.002659

Appendix 8.18: NARDL Residuals Diagnostics Tests Results

Normality Test Results



Series: Residuals
Sample 1987 2019
Observations 33

Mean	-8.75e-16
Median	0.000000
Maximum	0.066012
Minimum	-0.081490
Std. Dev.	0.034245
Skewness	-0.326096
Kurtosis	2.809075
Jarque-Bera	0.634985
Probability	0.727972

Heteroscedasticity Test Results

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.313132	Prob. F(17,15)	0.3007
Obs*R-squared	19.73749	Prob. Chi-Square(17)	0.2879
Scaled explained SS	3.688698	Prob. Chi-Square(17)	0.9997

Serial Correlation Test Results

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.130585	Prob. F(1,14)	0.7232
Obs*R-squared	0.304962	Prob. Chi-Square(1)	0.5808