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Do fiscal regimes matter for fiscal sustainability in South Africa?

A Markov-switching approach

Gabriel Temesgen Woldu*

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Abstract: This paper empirically examines South Africa's fiscal sustainability through a Markov-switching model which utilizes quarterly datasets for the period from 1960 to 2019. The results show that public debt responds positively, demonstrating a sustainable fiscal policy. Furthermore, considering the regime-specific feedback coefficients of the fiscal policy rule and the durations of fiscal regimes, the study finds that South Africa's fiscal policy satisfies the No-Ponzi game condition. Therefore, from a policy perspective, the South African government should take measures such as pension reforms, reducing operational expenses, reducing subsidies, and funding micro and small enterprises to gain the double dividend on the expenditure side along with revenue-enhancing measures on consumption taxes to achieve stable public finances and lower debt levels.

Keywords: fiscal sustainability, Markov-switching model, South Africa

JEL classification: E62, F34, H62

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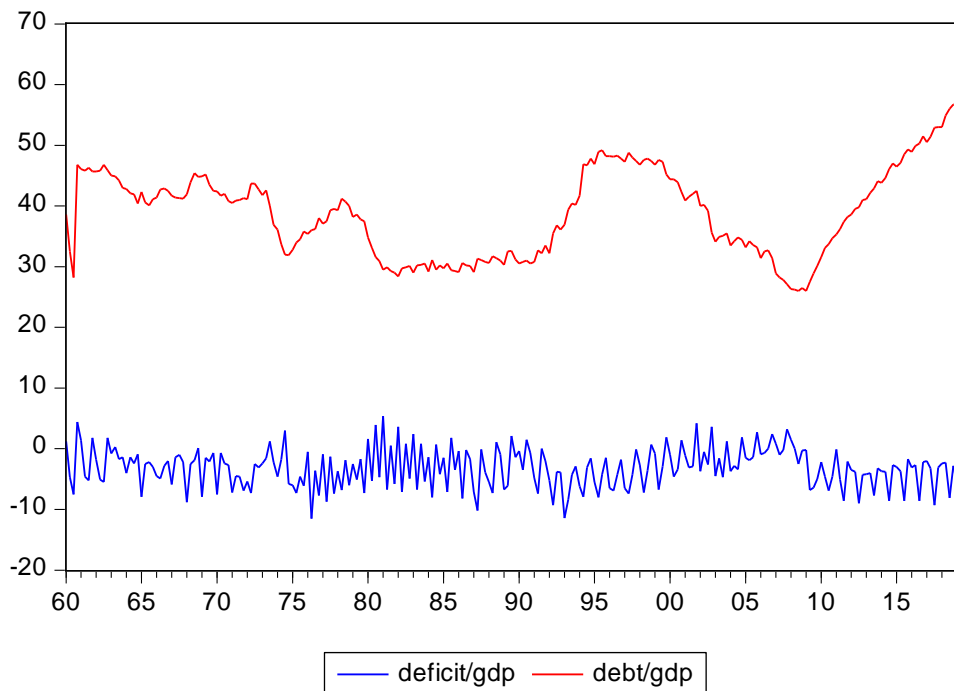
1 Introduction

1.1 Background and justification

Fiscal sustainability typically refers to the sustainability of a government's ability to service its debt; that is, a government's ability to remain solvent without any tax increases, spending cuts, or monetization of the deficit (Blanchard 1990; Blanchard et al. 1990). This study uses the definition of an intertemporal budget constraint (IBC) approach which states that the behaviour of a nation must satisfy intertemporal solvency (Hamilton and Flavin 1986).

Thus, fiscal sustainability which aims to maintain highly sustained economic growth is the key element of an economy. However, in recent years, increasing the size of public debt has become a challenging issue which can dissipate a country's economic growth, particularly when it exceeds a certain threshold (Baharumshah et al. 2017; Mahdavi and Westerlund 2011). As the South Africa Reserve Bank (2020) data revealed, South Africa's public debt increased at an alarming rate after the economic meltdown, representing 61.5 per cent of its gross domestic product (GDP) in the third quarter of 2019, due to the various large-scale expenditure programmes implemented by the government to maintain the momentum of the economy (Kavase and Phiri 2018).

Figure 1: Deficit-to-GDP ratio and debt-to-GDP ratio series 1960:Q1 to 2019:Q3



Source: author's calculations based on data from South African Reserve Bank (2020).

South Africa's fiscal deficit-to-GDP ratio was -1.00 per cent in the first quarter of 2000. It experienced a steep increase after the 2008/09 global financial crisis hit most of the developing countries. This pushed the deficit level up to -6.8 per cent in 2009 and -10.3 per cent in 2018 (South Africa Reserve Bank 2020), which implies that the deficit is summed to the outstanding debt level of the country (Phiri 2019). Data on South Africa's debt-to-GDP ratio and deficit-to-GDP ratio show that the degree of persistence of both series diverged after the global financial crisis (Figure A2). Moreover, the public debt-to-GDP ratio rose sharply, which may have seriously

constrained the country's ability to implement countercyclical policies to increase output and structural reforms.

As Figure 1 shows, South Africa's public debt-to-GDP ratio exhibits a non-linear pattern. This suggests that fiscal sustainability in South Africa may have varied with different fiscal regimes related to the countercyclical policies and structural reforms implemented by the Government of South Africa over past periods. Moreover, Figure A1 shows South Africa's public debt-to-GDP ratio at THE disaggregated level to domestic debt-to GDP ratio and foreign debt-to-GDP ratio.

While many studies have been carried out to examine the fiscal sustainability of South Africa (Battaile et al. 2015; Burger and Marinkov 2012; Burger et al. 2012; Jibao et al. 2012; Kavase and Phiri 2018; Naraidoo and Raputsoane 2015; Siebrits et al. 2014; Tshiswaka-kashalala 2006), they have all focused predominantly on the linearity assumption, and non-linear models have only recently come to the fore. A major limitation of these empirical studies is their contradictory predictions, which makes it difficult to draw precise policy implications from these studies as a collective unit. This study is based on recent developments in the empirical analysis of fiscal studies and time series econometrics methods. In addition, in the data-generating process, it addressed potential breaks in major global and country-level macroeconomic events.

While only a few studies have been conducted globally on regime-switching fiscal policy rules and these studies identify periods when governments have not stabilized public debt, there is little understanding in the case of South Africa of whether the regime-switching feature of fiscal policy has had a negative effect on the long-run sustainability of the country's public debt. There is therefore a need to fill the knowledge gap in the recent literature by assessing the long-run fiscal sustainability of South Africa using the time-varying features of fiscal policy. This paper addresses a regime-switching fiscal policy rule using the government's IBC as a necessary and sufficient condition to be held in the fiscal policy rules.

As fiscal policy rules vary over time because of 'structural breaks' or 'regime changes', this has motivated researchers to follow a regime-switching approach in empirical studies. Thus, to provide plausible explanations for South Africa's fiscal sustainability, this study employs the Markov-switching fiscal policy rule by introducing a regime-switching model which stochastically switches between sustainable and unsustainable regimes.

1.2 Objective of the study

The overall objective of the study is to examine, using quarterly data, the fiscal sustainability of South Africa under different fiscal deficit regimes.

1.3 Research questions

- 1) Does South Africa's long-run fiscal sustainability depend on regime-specific fiscal policy rules?
- 2) How long can a fiscal policy be unstable for without impacting its long-run sustainability?

1.4 Organization of the paper

The remainder of this paper is organized as follows. The next section focuses on the literature review. Section 3 describes the methodology and data used to examine fiscal sustainability in South Africa. Section 4 presents the results and discussion. Finally, Section 5 sets out concluding remarks and policy options going forward.

2 Literature review

2.1 Theoretical and empirical review

Fiscal sustainability is defined as the stability of public finances under which a steady state of equilibrium is achieved in a given policy regime. Sustainability is a forward-looking concept and refers to the ability of a government to maintain solvency. Fiscal policies play a major role in enhancing the stabilization process of an economy, especially in responding to country-specific shocks.

It is pertinent to note that the fiscal sustainability literature has evolved substantially since Domar (1944) developed the framework which states that the growth rate of income must exceed the interest rate as a necessary condition for sustainability. Following Domar, Buiter (1985) defined sustainable policy as a policy capable of keeping the ratio of public sector net worth to output at its current level. In the same vein, Blanchard (1990) set two criteria for sustainability to be met: first, the debt-to-GNP ratio needs to gradually converge back to its initial level; second, the present discounted value of the primary deficit-to-GNP ratio must be equal to the negative present debt-to-GNP ratio. Hamilton and Flavin (1986) subsequently argued that the net present value of the government budget must be balanced. From a theoretical point of view, fiscal sustainability takes as an initial point the fact that a government must satisfy both an IBC and, in every period, a static budget constraint which refers to solvency: that is, is the government capable of servicing its debt obligations without explicitly jeopardizing them (Burnside 2005)? Conversely, if the alternative policies used cannot constrain the rising debt indefinitely, then the combination of the fiscal and/or monetary policy is referred to as unsustainable (Burnside 2005).

According to Quintos (1995), a dynamically efficient economy balances its budget over time by setting the current market value of debt equal to the discounted sum of the expected future surpluses. Conversely, if the value of debt expands over time at a faster rate than the growth rate of the economy, then the intertemporal budget balance indicates an unsustainable fiscal policy (Quintos 1995).

There are two approaches to measuring fiscal sustainability in the empirical literature: the indicator of fiscal sustainability approach and the intertemporal budget constraint (IBC) approach. The first was developed by Buiter (1985), who argued that sustainable fiscal policy should maintain the ratio of public sector net worth to output at its current level. The main problem with Buiter's model is that it is difficult to obtain accurate information about the true size of government net worth. Blanchard (1990) then proposed a solution to this problem by measuring the sustainability of the macro economy via the fiscal sustainability indicator. The model was further developed by Burnside (2003), Chouraqi et al. (1990), Croce and Juan-Ramon (2003), and Gramlich (1990). Many scholars prefer this model because it is simple to apply for different countries and times; it can also be understood, evaluated, and compared. Blanchard et al. (1990: 8) defined the indicator as the gap between the sustainable tax rate and the current tax rate over a given horizon: '...the sustainable tax rate is in turn defined as the tax rate which, if constant, would achieve an unchanged debt-to-GNP ratio over the relevant horizon, given forecasts of spending and transfers'.

The fiscal sustainability indicator is constructed with short-term, medium-term, and long-term horizon gaps. The short-term gap is mainly used to measure a one-year gap. However, it has a weakness of myopia and does not show expected future changes in public spending. Public spending or transfers are expected to change in the future either because of the cyclical movement in GDP or because there is a recession, during which public spending will definitely increase.

Second, due to the change in the demographic structure of a country, public spending and transfers move in the same direction (Blanchard et al. 1990).

The medium-term gap is estimated based on projecting public spending and transfers for the upcoming five years to account for cyclical movements. The other forward-looking indicator is the long-term gap, which uses 40-year projections to assess the implications of changes in public spending or transfers for population ageing.

According to the primary gap approach, if the real interest rate exceeds the growth rate, the equilibrium point is unsustainable. Conversely, if the dynamic term is negative, the equilibrium point is stable (Blanchard 1990).

The use of fiscal sustainability indicators is a forward-looking approach which assesses the sustainability rule for the medium and long term relative to a chosen base year (Pattnaik et al. 2003). The main drawback of the Buiter (1985) and Blanchard (1990) sustainability indicators are that they are based on a constant ratio of either net worth or debt to GDP. However, for countries that are heavily indebted or have a large negative net worth, sustainable fiscal policies may necessitate a reduction in the debt-to-GDP ratio or an increase in net worth to output. On the contrary, fiscal policies may still be sustainable for countries that have little debt or have significant net worth, even if they lead to an increase in debt or lower net worth (Chalk and Hemming 2000). As the IMF (2003) indicates, an assessment of fiscal sustainability should consider various factors such as country-specific circumstances, economic policy track record, and policy options.

The second research approach focuses on the IBC (Hamilton and Flavin 1986), which states that the sustainability of a policy is tested on the stationarity of the discounted debt. This approach answers questions such as: when should the government run a primary deficit or surplus to maintain fiscal sustainability? The IBC illustrates an empirical framework based on unit root tests, assuming a constant real interest rate.

Wilcox (1989) extended Hamilton and Flavin's research and asserted that deficit sustainability must impose exogenous structural breaks in the deficit process: that is, there must be cointegration between revenue and expenditure, including the interest rate. Indeed, a sustainable fiscal policy is one that would achieve the forecast trajectory of the discounted value of the debt to zero, that is, when the growth rate of the economy exceeds the growth rate of debt.

Other authors, such as Hakkio and Rush (1991), Haug (1991), Smith and Zin (1991), and Trehan and Walsh (1988, 1991), developed an alternative framework to test the IBC by using the concept that revenues and expenditures must be cointegrated. If revenues and expenditures inclusive of interest payments are stationary at first difference, then the sustainability condition for deficit sustainability is fulfilled.

The empirical literature which uses IBC follows different approaches, such as the primary gap, the stationarity of the debt ratio, the stationarity of the first differential of the debt ratio, the cointegration of the revenue and the expenditure sides, the fiscal reaction function, and the Markov-switching regression. This study adopts the Markov-switching regression model.

Following the seminal paper by Hamilton and Flavin (1986) on modelling regime changes or sudden shifts, the Markov-switching method gained widespread acceptance, for instance in the empirical works of Akram and Rath (2019), Baharumshah et al. (2017), Doğan and Bilgili (2014), Raybaudi et al. (2004), and Wagner and Elder (2005). The Markov-switching model is preferred in economic and financial time series modelling because of its many advantages:

First, one can resort to the usual asymptotic critical values for residual-based tests, as the finite-sample distributions of the standardized residuals appear to be well approximated by the usual asymptotic distributions. Secondly, [...] a Markov switching approach is [...] more flexible, as it allows for an unspecified number of breaks, of unknown location. Moreover, information on the timing of the breaks is a natural by-product of estimation. Thirdly, one can also assume changes in the variance of the long-run relationship. Furthermore, testing for cointegration arises naturally from the estimation step, since only standard cointegration testing procedures are used. Specifying long-run relationships in this way encompasses a number of empirically plausible and economically relevant models, including the case of a single permanent regime change. [...] [Fourth,] one can interpret changes in the cointegration vector as shifts in fiscal regimes. (Gabriel and Sangduan 2011: 2–3)

2.2 Empirical literature review

There are two strands of empirical literature which describe global fiscal sustainability. The first strand supports the existence of fiscal sustainability in the series (Akram and Rath 2019; Arestis et al. 2004; Arghyrou and Luintel 2007; Baharumshah et al. 2016; Bajo-Rubio et al. 2004, 2006; Bravo and Silvestre 2002; Ehrhart and Llorca 2008; Escario et al. 2012; Greiner et al. 2006; Hatemi-J 2002; Makrydakis et al. 1999; Payne and Mohammadi 2006; Paniagua et al. 2017; Payne et al. 2008; Sarno 2001; Westerlund and Prohl 2008, to name a few), while empirical studies (Adedeji and Thornton 2010; Bajo-Rubio et al. 2008; Phiri 2019) support the evidence of weak fiscal sustainability.

The second strand of literature finds an insignificant relationship and fiscal unsustainability in the series (Baglioni and Chierubini 1993; Caporale 1995; Chen 2014; Greiner and Semmler 1999; Hakkio and Rush 1991; Hyung and Morita 2015; Kia 2008; MacDonald 1992; Makrydakis et al. 1999; Olekalns and Cashin 2000; Smith and Zin 1991; Wilcox 1989).

In their study of fiscal regime changes and the sustainability of fiscal imbalance in South Africa, Jibao et al. (2012) tested the asymmetry relationship between revenue and expenditure by applying a non-linear model smooth transition error-correction model. The study used quarterly data from 1960:Q1 to 2008:Q4 to analyse the data and noted that fiscal policy was found to be sustainable. However, the assumption that adjustment towards equilibrium is always present does not hold for South Africa.

Using various methods (ordinary least squares (OLS), threshold autoregressive (TAR), state-space modelling, and a vector error-correction model (VECM), Burger et al. (2012) estimated South Africa's fiscal reaction function based on annual data from 1946 to 2008. They found that South Africa had a sustainable fiscal policy.

Phiri (2019) investigated the asymmetries in the revenue–expenditure nexus by taking quarterly data from 1960:Q1 to 2016:Q2 for South Africa. The author applied a momentum threshold autoregressive (MTAR) model supplemented with a threshold error-correction (TEC) component to examine the cointegration between the revenue–expenditure nexus and found a weak sustainable budget in South Africa with bidirectional causality between revenues and expenditures.

Kavase and Phiri (2018) analysed fiscal budget sustainability in nine South African provinces over the period from 2000 to 2016 by utilizing a non-linear autoregressive distributive lag (N-ARDL) model to investigate the expenditure–revenue relationship. The study recommended budget reductions for the Eastern Cape, Northern Cape, Free-Sate, and KwaZulu-Natal provinces, and

minimizing public expenditures to provinces such as the Western Cape, North West, Gauteng, Mpumalanga, and Limpopo to attain long-term fiscal sustainability.

Ganyaupfu (2014) analysed South Africa's fiscal sustainability for the sample period 1990:Q1 to 2013:Q4. The findings showed that the government had behaved in a fiscally sustainable manner during the sample period. Ganyaupfu and Robinson (2019) re-examined fiscal policy sustainability in South Africa, employing a fiscal reaction function based on a VECM for the period from 1960:Q1 to 2016:Q2. Their findings revealed strong evidence of a positive relationship between primary balance and public debt which supported the country's fiscal sustainability stance.

Employing a structural VAR model, Siebrits et al. (2014) analysed fiscal sustainability in South Africa using annual data covering the period from 1984 to 2010. The results showed that South Africa had a dramatic increase in public debt followed by periods of substantial reduction in the debt burden. This was reflected in periods of increasing deficit levels followed by periods of decreasing deficit levels to return the fiscal policy to its sustainable levels, thereby preventing major domestic economic crises and external interventions.

Baharumshah et al. (2016) examined the cointegration between revenue and expenditure in South Africa based on annual data from 1960 to 2013. They adopted TAR and MTAR cointegration and error-correction models to examine the nexus between revenue and expenditure. Their findings confirmed that there was long-term cointegration, which suggested the existence of fiscal sustainability in the country.

Naraidoo and Raputsoane (2015) explored fiscal prudence in South Africa using annual time series data from 1865 to 2010. Their results revealed that there was fiscal sustainability in South Africa above the 56 per cent threshold level of the debt-to-GDP ratio.

Burger and Marinkov (2012) investigated the fiscal reaction function in South Africa using the Markov-switching model based on historical quarterly data for the period from 1972:Q1 to 2010:Q4. Their findings confirmed fiscal sustainability in South Africa and proposed a band for the debt-to-GDP ratio. Lastly, the study identified medium-term automatic stabilizers for maintaining fiscal sustainability.

The results of these empirical studies on fiscal sustainability in South Africa, as listed in Table 1, vary depending on the study period and methodology applied. A plethora of studies in the literature used a linear approach (Burger et al. 2012; Ganyaupfu 2014; Ganyaupfu and Robinson 2019; Ghartey 2010; Jibao et al. 2012; Kavase and Phiri 2018; Lusinyan and Thornton 2007; Narayan and Nayaran 2006; Ndahiriwe and Gupta 2010; Nyamongo et al. 2007; Siebrits et al. 2014). Other studies (Baharumshah et al. 2016; Burger and Marinkov 2012; Naraidoo and Raputsoane 2015; Phiri 2019) used non-linear techniques and found sustainable fiscal policy, while the empirical works of Cronje (1995), Roux (1993), and Schoeman (1994) investigated the fiscal sustainability of South Africa and found unsustainable fiscal policy. Reviewing the past and recent literature reveals a wide range of mixed results and no consensus. Thus, there is a need to fill the gap in the recent literature by testing the fiscal sustainability in different regimes in the context of South Africa.

Table 1: List of studies on South Africa

Studies	Countries and samples covered	Methodology	Sustainability
Jibao et al. (2012)	South Africa (Quarterly: 1960:Q1 to 2008:Q4)	Smooth transition error-correction model	Sustainable
Burger et al. (2012)	South Africa (annual: 1946 to 2008)	Fiscal reaction functions (OLS, VAR, TAR, GMM, State-space modelling and VECM)	Sustainable
Phiri (2019)	South Africa (quarterly: 1960:Q1 and 2016:Q2)	MTAR model supplemented with a TEC component	Weak sustainable
Kavase and Phiri (2018)	Nine South African provinces (annual: 2000 to 2016)	Non-linear autoregressive distributive lag (N-ARDL) model	Mixed
Ganyaupfu and Robinson (2019)	South Africa (Quarterly: 1997:Q4 to 2016:Q2)	Fiscal reaction function based on VECM model	Sustainable
Ganyaupfu (2014)	South Africa (Quarterly: 1990:Q1 to 2013:Q4)	Fiscal reaction function based on VECM model	Sustainable
Fincke and Greiner (2010)	Low-and middle-income developing countries in Africa and Latin America (annual: 1970 to 2005)	Stationarity and cointegration tests	Mixed
Siebrits et al. (2014)	South Africa (annual: 1984 to 2010)	Structural VAR model	Sustainable
Baharumshah et al. (2016)	South Africa (annual: 1960 to 2013)	Threshold autoregressive (TAR), momentum threshold autoregressive (MTAR) cointegration and error-correction model	Sustainable
Naraidoo and Raputsoane (2015)	South Africa (annual: 1865 to 2010)	Non-linear logistic smooth transition autoregressive (LSTAR) model	Sustainable
Burger and Marinkov (2012)	South Africa (quarterly: 1972:Q1-2010:Q4)	Markov-switching estimations for fiscal reaction function	Sustainable

Source: author's construction based on South Africa studies.

3 Methodology and data

This study examines the fiscal sustainability of South Africa by splitting the fiscal policy rule whose parameters stochastically switch between sustainable and unsustainable regimes, using a Markov-switching VECM. The model was selected because it better allows for shifts in the mean of deficit series and accounts for variance of the budget deficit. The paper answers two research questions related to long-run fiscal sustainability depending on regime-specific feedback coefficients of the Markov-switching fiscal policy rule and the expected durations of fiscal regimes.

3.1 Intertemporal budget constraint (IBC) approach

This study adopts the IBC approach to examine the debt sustainability of the South African government (Akram and Rath 2019; Baharumshah et al. 2017; Byrne et al. 2011; Quintos 1995). The sustainability of public debt is, in essence, an intertemporal issue in which every short-term deficit can be sustainable as long as the surplus is adequately matched. Structural breaks can cause the level or slope (or both) of the series to change permanently, but the inherent nature of the series remains constant. As a remedy, this study adopts a non-linear estimation technique because classical linear models do not allow parameters to be adjusted for structural changes. In addition,

failing to allow regime shifts or structural changes leads to the persistence of variances in a series being overestimated (Akram and Rath 2019; Baharumshah et al. 2017).

Building on Wilcox's (1989) framework and on the literature on Markov-switching fiscal policy rules, this study therefore employs the Markov-switching technique to justify the changes related to the deficit-to-GDP ratio, public debt features, and global events. The main assumption behind the Markov-switching technique is that the fiscal policy rule stochastically switches between sustainable and unsustainable regimes. Unsustainable regimes are defined as those with periods of persistently expanding public debt:

...A Markov-switching framework allows for different fiscal regimes, where one regime may allow discounted debt to expand and the other causes it to collapse. Global sustainability is implied if the unconditional mean of the process for discounted debt is zero. A fiscal policy process can be globally sustainable, even if a particular regime allows discounted debt to expand.... (Davig 2005: 8)

The present value of the IBC can be formulated as:

$$Debt_t - Debt_{t-1} = G_t - R_t + (r_t)Debt_{t-1} \quad (1)$$

where G_t refers to the government primary expenditure, R_t refers to the government revenue, r_t refers to the interest rate, and $Debt_t$ stands for debt over time $t=1, \dots, T$.

After rearranging and applying for substitution, equation (1) can be rewritten as:

$$Debt_t = \varphi_t(R_{t+1} - G_{t+1} + Debt_{t+1}) \quad (2)$$

Where $\varphi_t = (1 + r_{t+1})^{-1}$

The IBC can be further reduced as:

$$Debt_t = \sum_{i=1}^{\infty} \varphi^i G_t (R_{t+i} - G_{t+i}) \quad (3)$$

This holds true as long as the transitivity condition of $\lim_{n \rightarrow \infty} \varphi_t G_t (Debt_{t+n})$ is satisfied. Moreover, a non-Ponzi scheme is considered for the public debt sustainability. Indeed, many researchers (Baharumshah et al. 2017; Chen 2014; Hamilton 2010) have explored the property of the fiscal indicators over a long period of time, although the integrated property of the debt ratio is highly debatable. The use of a unit root test and cointegration tests are incapable of rejecting sustainability, despite any cointegrated variables meeting the transitivity condition (Bohn 2007).

Equation (1) can be rearranged by considering the transversality condition as:

$$\frac{(R-G)_t}{GDP_t} = (i - g) \frac{Debt_{t-1}}{GDP_{t-1}} \quad (4)$$

The budget balance response function (equation 4) can be rewritten as:

$$\frac{(R-G)_t}{GDP_t} = \beta_1 + \beta_2 \frac{Debt_{t-1}}{GDP_{t-1}} \quad (5)$$

If the sign of β_2 (coefficient) is positive, then there is a budget balance improvement on the part of the government. There is evidence of fiscal sustainability if an increase in the debt level helps

the government to increase its primary surplus, which tends to mean reversion to the primary surplus-to-GDP ratio (cited in Akram and Rath 2019).

According to Aldama and Creel (2017), the main limitation of constant parameter linear or non-linear fiscal policy rules in the presence of regime-switching properties of fiscal policy rule estimates is that they are potentially biased in favour of an unsustainable fiscal regime (Aldama and Creel 2017). As the work of Akram and Rath (2019) showed, the Markov-switching model is applied to test fiscal sustainability (Hamilton 2010) as debts do not follow a linear path. This model has advantages in that it considers regime shifts of parameters; allows various behaviours in different regimes; takes account of residual changes; and considers the persistence of extreme observations and time series inconsistency (Akram and Rath 2019).

As fiscal policy rules vary over time because of ‘structural breaks’ or ‘regime changes’, this has motivated researchers to follow a regime-switching approach in empirical studies. Thus, to provide plausible explanations for South Africa’s fiscal sustainability, this study employs the Markov-switching fiscal policy rule by introducing a regime-switching model which stochastically switches between sustainable and unsustainable regimes.

In this paper, the (Wilcox 1989) deficit sustainability approach was adopted to assess the sustainability of the fiscal policy rules in South Africa, that is, the ‘structural breaks’ or ‘regime changes’ in the deficit process. To address this, I adopted the Markov-switching technique to examine the non-linear evidence between the deficit-to-GDP ratio and the debt-to-GDP ratio in the South African fiscal stance. The MS-VECM is preferred because, first, it allows us to distinguish distinct shifts in regimes in both the drift term and the long-run equilibrium. Second, the model differentiates regimes and the frequency of switches from regime to regime. Third, it helps us to know whether the regime switches captured are related mainly to events pertaining to the deficit and debt stances.

The model can be written as follows:

$$\Delta \frac{(R-G)_t}{GDP_t} = \alpha_1(S_t) + \sum_{i=1}^q \alpha_{2i}(S_t) \Delta \left(\frac{R-G}{GDP} \right)_{t-i} + \sum_{i=1}^q \alpha_{3i}(S_t) \Delta \left(\frac{Debt}{GDP} \right)_{t-i} + \beta D_t + \delta(S_t) ECT_{t-1} + \mu_t \quad (6)$$

where Δ is the difference operator, ECT_{t-1} refers to an error-correction condition which has a natural economic interpretation, S_t refers to the random variable of the regime with $\mu_t \sim N[0, \sigma^2(S_t)]$. S_t follows a Markov chain defined by transition probabilities among the N states or regimes. α , β , and σ are the parameters to be estimated. D stands for the dummy variable (Akram and Rath 2019).

3.2 Data source

This paper uses quarterly data covering the 1960:Q1 to 2019:Q3 sample period for the estimations. The data for public debt-to-GDP ratio, domestic debt-to-GDP ratio, foreign debt-to-GDP ratio, and real GDP per capita were sourced from the South African Reserve Bank (2020).

4 Empirical results

4.1 Descriptive statistics

As shown in Table 2, the average value of South Africa's total debt-to-GDP ratio is 38.97 per cent, internal debt-to-GDP ratio is 36.2 per cent, and external debt-to-GDP ratio is 2.77 per cent. Of the total 38.97 per cent of public debt-to-GDP ratio, the domestic debt-to-GDP ratio accounts for 36.2 per cent, which indicates the country's major source of government borrowing. South Africa's deficit-to-GDP ratio is about 3.23 per cent below zero. Moreover, as the table shows, a sizeable fraction of South Africa's public debt is dominated by its internal debt stock. The data also shows a high level of volatility in the total public debt-to-GDP ratio and domestic (internal) debt-to-GDP ratio as compared to the budget balance-to-GDP ratio and external (foreign) debt-to-GDP ratio over the period 1960:Q1 to 2019:Q3. The South African government's total debt-to-GDP ratio has been rising very rapidly since the global financial crisis. As shown in the Appendix, the historical data reveal that public debt increased during times of economic recession and slowed down during the post-crisis periods, although it expanded after the global economic and financial crisis. The Appendix shows that the divergence between the deficit (government revenue minus government expenditure (R-E)) (R-E)-to-GDP ratio and total public debt-to-GDP ratio rose after the economic meltdown, while the (R-E)-to-GDP ratio adjusted quickly, and the total public debt-to-GDP ratio exhibited a high degree of persistence due to the fact that the deficit is summed to the outstanding debt levels.

Table 2: Descriptive statistics

	(R-E)-GDP ratio	Debt-GDP ratio	Domestic Debt-GDP ratio	Foreign Debt-GDP ratio
Mean	-3.229707	38.96987	36.20377	2.766109
Median	-3.100000	39.80000	36.30000	2.300000
Maximum	5.400000	61.50000	54.40000	8.200000
Minimum	-11.50000	26.00000	21.90000	0.500000
Std. Dev.	3.273268	7.414324	7.152829	1.592308
Observations	239	239	239	239

Source: author's calculations based on data from South African Reserve Bank (2020).

Table 3 presents the unit root test of the variables. The stationarity test was conducted using the Augmented Dickey Fuller Test (ADF) unit root test for stationarity. Based on the ADF test, there is a unit root presence in the debt-to-GDP ratio, domestic debt-to-GDP ratio, and foreign debt-to-GDP ratio, while the budget balance-to-GDP ratio exhibits stationary at level.

Table 3: ADF unit root test

Variables	Debt-GDP ratio	(R-E)-GDP ratio	Domestic debt ratio	Foreign debt ratio
Level (C&T)		-3.72(0.02)**		
1st difference (C&T)	-3.52(0.039)**		-3.54(0.038)**	-13.61(0.00)***

Note: p-values are given in parentheses. ** and *** are 5% and 1% level of significance. C&T refer to constant and trend respectively.

Source: author's calculations based on data from South African Reserve Bank (2020).

The South African economy has been characterized by numerous global shocks that may have had various effects on the country's economy (Phiri 2019). Therefore, it is likely that macro data on

these variables would potentially be characterized by structural breaks during the sample period. To correct for possible structural breaks, I employ the structural break tests of Bai and Perron (2003), which account for a potential endogenous structural break in the dataset. The results presented in Table 4 reveal that there is one structural break identified in 1999:Q4 and 2009:Q2 for intercept only.

Table 4: Results of structural breaks unit root test

Breaks	F-statistic	Scaled F-statistic	Weighted F-statistic	Critical Value	Structural break
1 *	15.85063	15.85063	15.85063	8.58	2009Q2
2 *	27.57200	27.57200	32.76562	7.22	1999Q4, 2009Q2
3 *	21.19011	21.19011	30.50523	5.96	1991Q1, 1999Q4, 2009Q2
4 *	16.22596	16.22596	27.89955	4.99	1980Q1, 1991Q1, 1999Q4, 2009Q2
5 *	14.27310	14.27310	31.32050	3.91	1971Q1, 1980Q1, 1991Q1, 1999Q4, 2009Q2

Source: author's calculations based on data from South African Reserve Bank (2020).

Using the approach in Brock et al. (1987), I conducted a test for non-linearity on the residuals of the variables. The BDS primarily confirms the presence of non-linearity in the residuals of the variables. The BDS non-linear independence test confirms non-linearity for all the series (Table 5). It is important that this test is done before conducting a test for fiscal sustainability, whether it is linear or not.

Table 5: BDS Non-linear independence test

Dimension	(R-E)-GDP ratio	Debt-GDP ratio	Domestic Debt-GDP	Foreign Debt-GDP ratio
2	-0.011082** (0.003742)	0.167633*** (0.003251)	0.170045*** (0.002849)	0.168355*** (0.003977)
3	-0.015812* (0.005875)	0.280531*** (0.005136)	0.285131*** (0.004526)	0.284876*** (0.006276)
4	-0.019018* (0.006909)	0.355959*** (0.006076)	0.364060*** (0.005384)	0.360860*** (0.007417)
5	0.014326** (0.007111)	0.407650*** (0.006290)	0.417385*** (0.005604)	0.411830*** (0.007672)
6	0.029146*** (0.006770)	0.440061*** (0.006024)	0.451203*** (0.005396)	0.443344*** (0.007341)

Note: standard errors are given in parentheses. ***, **, and * refer to 1%, 5% and 10% level of significance respectively.

Source: author's calculations based on data from South African Reserve Bank (2020).

4.2 Fiscal sustainability

Table 6 presents the estimates of the transition matrix for the Markov two-state models. The durations of the transition of both regimes appear to be considerably different with expected durations of 14.2 and 9.8 quarters respectively for sustainable and unsustainable regimes. As shown in the table, there is a 0.93 probability of moving from a stable regime, while there is a 0.89 probability of moving from an unstable regime. Thus, the probability of moving from a stable regime to an unstable one is higher than the probability of moving from an unstable regime to a stable one. This confirms that South Africa's deficit spending to stimulate economic growth does not necessarily impede economic growth, provided that it is accompanied with probity of fiscal policy which ensures debt burdens are at sustainable levels. Furthermore, the results indicate that

the regime-switching fiscal policy rule found in South Africa satisfies the No-Ponzi game. From the viewpoint of policy makers, it is pertinent to know that South African fiscal policy satisfies the IBC's solvency condition with short-run fiscal imbalances. It is advisable for policy makers in South Africa to mitigate the crisis periods, which could create a burden on the fiscal imbalances and mounting debt problems in the future.

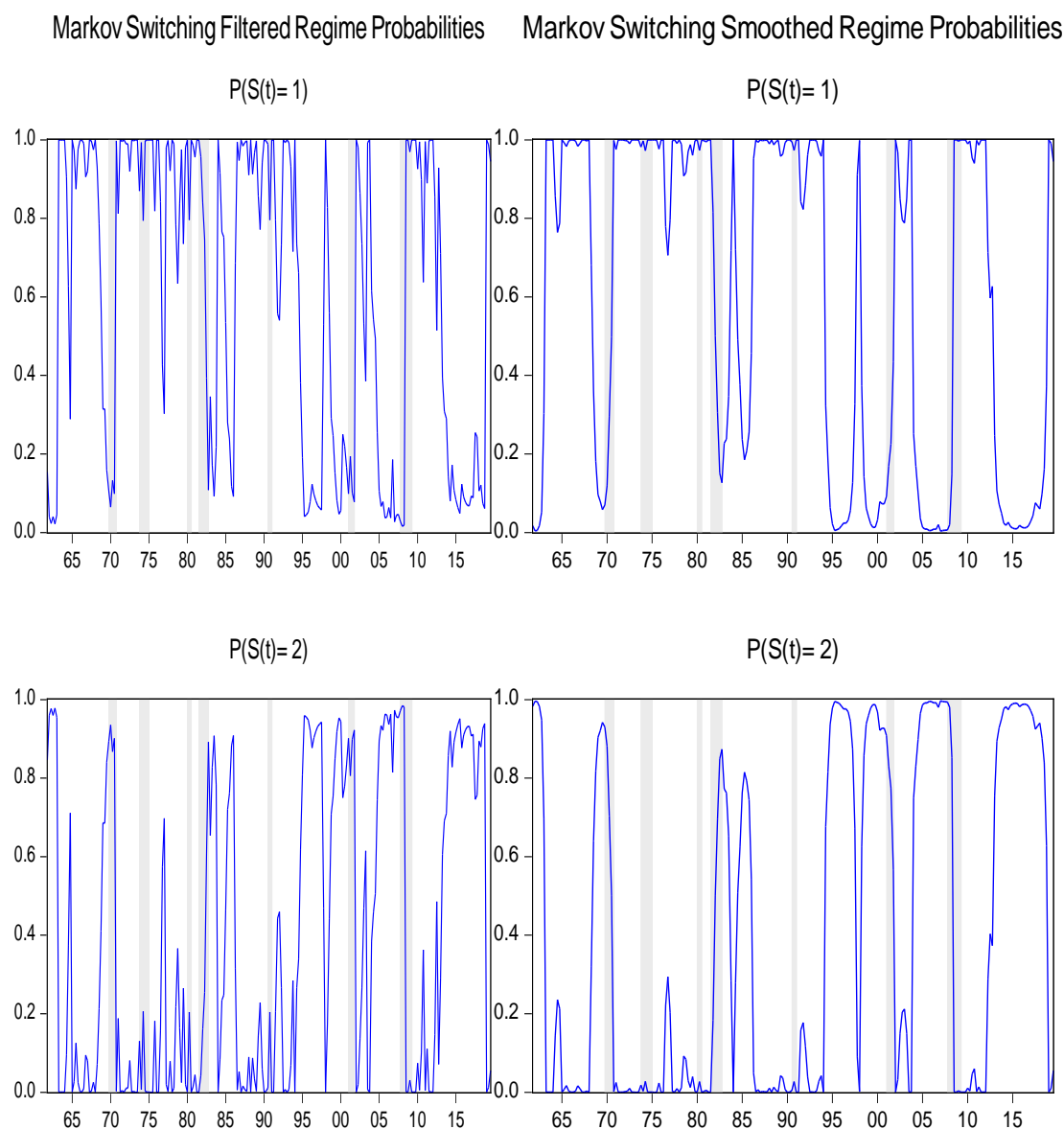
Table 6: Transition matrix and regime properties

Transition matrix	Stable regime	Unstable regime
Stable regime	0.929364	0.101722
Unstable regime	0.070659	0.898278
Regime properties		
Duration	14.15241	9.829628

Source: author's calculations based on data from South African Reserve Bank (2020).

Figure 1 presents an estimation of filtered and smoothed probabilities for stable and unstable regimes. It gives a graphical presentation of the transition matrix and regime properties. As Akram and Rath (2019) stated, filtered and smoothed probabilities are computed by an expectation maximization algorithm to get the filtered and smoothed probabilities in the case of a stable (low-deficit) regime and an unstable (high-deficit) regime. The shaded area shows the crisis periods and the switch from a stable regime to an unstable one during the economic downturns. This may be because of various events, such as the Convention for a Democratic South Africa (CODESA) negotiations, ANC military resistance, Rand depreciation or currency crises, or global financial crises. From the viewpoint of policy makers, it is pertinent to know that there was a sharp increase in the debt-to-GDP ratio in the country. To address this, the government of the country is taking various policy measures, such as curbing expenditure, reforms of the South African Revenue Service (SARS) aimed at better revenue collection, adopting a prudent fiscal stance, efficient coordination of fiscal and monetary policy, a range of institutional reforms, and a debt management strategy, which justifies the switching process in the regression (National Treasury Republic of South Africa 2020).

Figure 1: Filtered and smoothed probabilities for stable and unstable regimes



Source: author's calculations based on data from South African Reserve Bank (2020).

The results in Table 7 show the results of the regime of the Markov-switching VECM. The equilibrium error-correction term is found to be negative and significant for low-deficit and insignificant for high-deficit regimes, indicating long-run fiscal sustainability.

In the low- and high-deficit regimes, the coefficient on the debt-to-GDP ratio is positive, suggesting that an increase in the debt-to-GDP ratio leads to an increase in the budget balance-to-GDP ratio and exerts a tendency toward mean reversion, which shows the fiscal probity of the government. Any increase in debt is reflected in an increase in the government balance: that is, evidence of the sustainability of the implemented fiscal policy path reflecting the sustainability of the fiscal policy in the low-deficit regime.

Moreover, based on Bai and Perron's (2003) structural break test, two endogenously determined structural breaks were identified: 1999:Q4 and 2009:Q2. As the results indicate, the 1999:Q4 structural break has a positive effect on the budget balance, while the 2009:Q2 break has a negative

effect. The 1999:Q4 break in the data series was because of the Asian crisis, while the 2009:Q2 break was due to the global financial crisis.

Table 7: Regime-switching vector error-correction regression

	Stable regime	Unstable regime
Constant	-0.199224 (0.226564)	0.290314* (0.158485)
Δ DEBT(-1)	-0.129459 (0.230175)	0.328602** (0.138830)
Δ DEBT(-2)	-0.340985 (0.230899)	0.175507 (0.114035)
Δ DEBT(-3)	-0.131307 (0.233274)	-0.118014 (0.124632)
Δ DEBT(-4)	0.290948*** (0.030506)	-0.175324*** (0.030053)
Δ DEBT(-5)	0.181511 (0.276534)	-0.199584*** (0.038427)
Δ DEBT(-6)	0.256675 (0.233774)	-0.044819 (0.058390)
Δ DEFICIT(-1)	0.809786* (0.454560)	-1.018163*** (0.291304)
Δ DEFICIT(-2)	0.580481 (0.352978)	-0.709781** (0.292217)
Δ DEFICIT(-3)	0.202940 (0.279524)	-0.703691*** (0.206599)
Δ DEFICIT(-4)	0.988556*** (0.284080)	0.205245 (0.204936)
Δ DEFICIT(-5)	-0.457229** (0.206335)	0.259800* (0.136321)
Δ DEFICIT(-6)	-0.185273 (0.127217)	0.023232 (0.123473)
ECM(-1)	-0.731562** (0.294587)	0.159172 (0.219102)
Error variance	0.790767*** (0.071846)	-0.323799*** (0.086314)
DUMMY (2009:Q2)	-3.988079*** (0.844107)	
DUMMY (1999:Q4)	1.250048*** (0.287757)	
Diagnostic checking		
Mean dependent var	-0.021983	S.D. dependent var 4.637191
S.E. of regression	2.007987	Sum squared resid 806.4025
Durbin-Watson stat	1.992916	Log likelihood -443.9318
Akaike info criterion	4.120102	Schwarz criterion 4.625227
Hannan-Quinn criter.	4.323814	

Note: *, **, and *** show level of significance at the 10%, 5%, and 1% levels, respectively. The values in parentheses are the standard errors.

Source: author's calculations based on data from South African Reserve Bank (2020).

The results also revealed that the fiscal policy effectiveness of the country is evaluated by the level of debt, and South Africa's level of debt can hamper the health of the economy at higher public debt levels. Higher rates of the public debt-to-GDP ratio might hinder the ability of the country to conduct countercyclical policies and thus increase output volatility and reduce economic growth.

5 Conclusion and policy implications

Using MS-VECM econometric techniques, this paper highlighted three main problems related to regime-specific fiscal sustainability which provide guidance for policy options. The empirical results reveal that South Africa's fiscal deficit path is sustainable with short-run imbalances which might affect the country's fiscal sustainability in the long run. Our results confirm that high levels of debt can impede fiscal sustainability. Thus, it is imperative for policy makers in South Africa to understand the regime-specific fiscal sustainability of the country in order to formulate sound macroeconomic policies for future fiscal policy and growth prospects. This study has the following important policy implications.

From a policy perspective, long-term fiscal sustainability can be strengthened through spending cuts in parallel with revenue-enhancing measures. On the expenditure side, to avoid economic distortions and ensure stable public finance, measures, such as pension reforms, reducing operational expenses, reducing subsidies, and funding micro and small enterprises to gain the double dividend, should be taken. Furthermore, maintaining explicit fiscal rules and trimming the size of the public sector are essential to reduce the debt level and for fiscal sustainability. On the revenue side, the South African government should focus on consumption taxes (excise duties on alcohol and tobacco, environmental taxes, VAT, excise tax, etc.) rather than on income taxes to reduce short-run imbalances in public finances and achieve lower debt levels. The government should also focus on reform of SARS to create a prudent fiscal stance and an efficient tax policy.

To achieve long-run fiscal sustainability, the South African government should undertake substantial fiscal consolidation measures to reduce the debt-to-GDP ratio to prudent levels. As the existing public debt surpasses the threshold, it will have a crowding-out effect and impede economic growth by creating instability in the macroeconomic system.

The South African government should be cautious about the timing of the implementation of consolidation efforts while tightening up the budget deficit, as this might worsen the economic distortions by reducing aggregate demand.

To stabilize the public debt-to-GDP ratio, the South African government with the ratings agencies, COSATU (Congress Of South African Trade Union), FEDUSA (Federation of Union of South Africa), NACTU (National Council of Trade Unions), and private businesses should organize a platform on key reforms that would support the economy and reduce the burden on the public finances.

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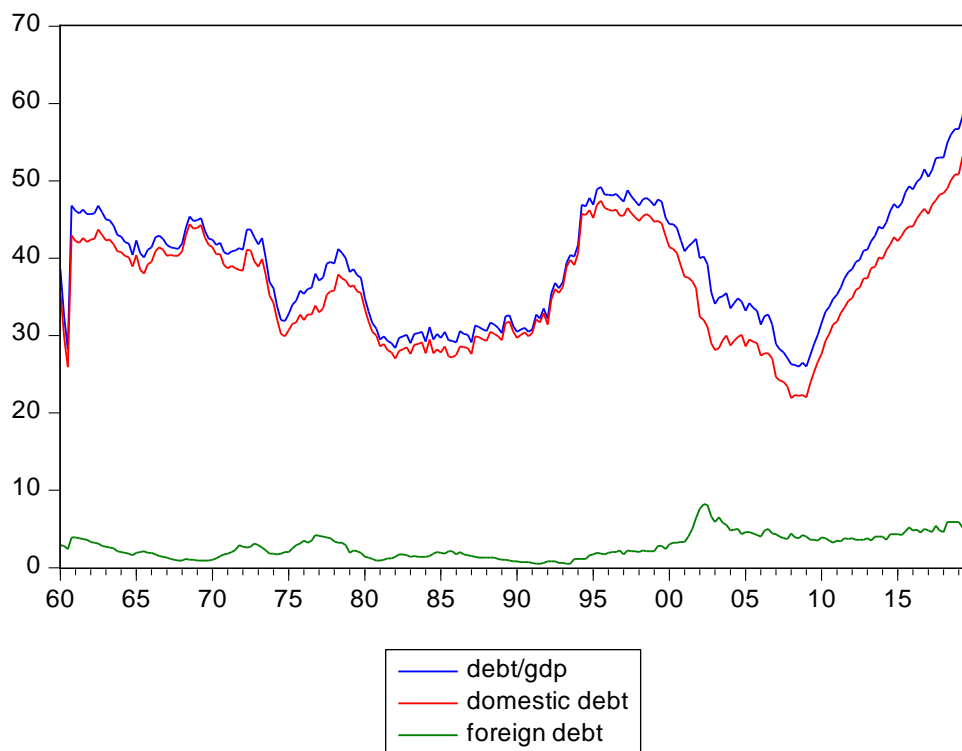
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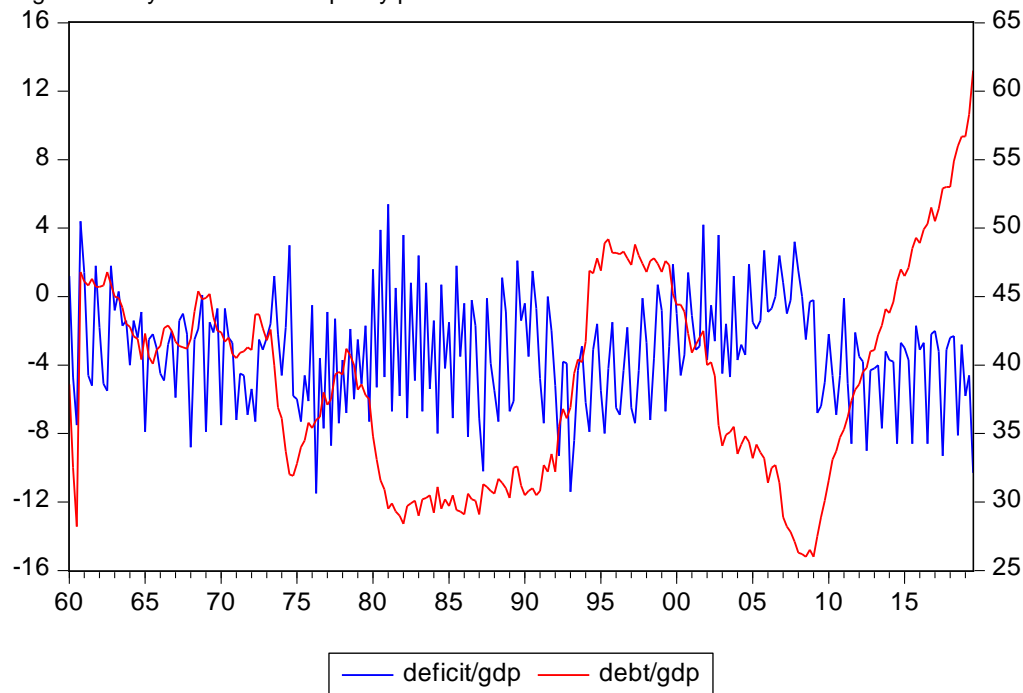
Appendix

Figure A1: Public debt, domestic debt, and foreign debt as percentage of GDP



Source: author's calculations based on data from South African Reserve Bank (2020).

Figure A2: Dynamics of fiscal policy persistence



Source: author's calculations based on data from South African Reserve Bank (2020).