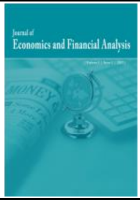
Journal of Economics and Financial Analysis
Type: Double Blind Peer Reviewed Scientific Journal
Printed ISSN: 2521-6627 | Online ISSN: 2521-6619
Publisher: Tripal Publishing House | DOI:10.1991/jefa.v7i1.a57
Received: 13.04.2023 | Accepted: 12.07.2023 | Published: 17.07.2023
Journal homepage: ojs.tripaledu.com/jefa



Examining the Dynamic Nexus of Monetary and Fiscal Policy in South Africa: Evidence from Key Macroeconomic Economic Indicators

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Abstract

This paper examines the dynamic nexus of monetary and fiscal policy in South Africa with evidence from key macroeconomic economic indicators from 2000 quarter 1 to 2022 quarter 3. The Markov-switching dynamic regression is used in the Taylor theoretical framework. The contemplation is what type of monetary and fiscal policy mix in a different state of policy rate or repo rate. There is less attention to the analysis of the impact of fiscal policy macroeconomic variables in a different state of policy rate with the consideration of the lower bound and upper bound rate of inflation. The South Africa Reserve Bank's reaction to fiscal policy macroeconomic variables is significant in different states. Moreover, there is evidence of constant reaction of the South Africa Reserve Bank when inflation is at the lower and upper bound. The increase in the gross domestic product gap and inflation gap results in an increase in the rope rate. The result suggests that the monetary policy provided a supportive policy to fiscal policy macroeconomic variables. However, there is a state that reflects trade-offs in the current monetary and fiscal policy mix reaction. The fiscal policy needs to be adjusted to attain the desired target.

Keywords: *Fiscal Policy; Monetary Policy; Markov-Switching Dynamic Regression (MSDR).*

JEL Classification: *E43, E51, E3.*

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1. Introduction

The dynamics of inflation, repo rate "policy rate" and the overall outcomes of the macroeconomic system are significantly influenced by monetary and fiscal policy Battistini, Callegari et al. (2019), Utama and Fitrady (2022), and Omotosho (2022), among other note this. However, since these policies are frequently implemented separately and independently, their objectives might occasionally conflict (Mankiw, 2019). A fiscal policy that is unsustainable as a result of the fiscal authority's attempt to stabilize production, for instance, may cause the reserve bank to start monetizing debt, endangering the objective of monetary policy's price stability (Cui 2016, Cavalcanti, Vereda et al. 2018). The success of monetary policy also depends on how the fiscal authority responds to monetary shocks because decisions about monetary policy have an impact on how fiscal variables change (Bianchi and Ilut 2017, Al-shawarby and El Mossallamy 2019, Utama and Fitrady 2022). Due to this type of interdependence between policies and their macroeconomic effects, policymakers are frequently interested in describing the policy behaviors of monetary and fiscal authorities. The interplay of monetary and fiscal policy in South Africa with fiscal economic variables has been the subject of a few studies. Moreover, the examination of macroeconomic fiscal policy variables in a different state of repo rate or policy rate has been limited. This seeks to ascertain if the lower of 3% inflation or 6% upper bound inflation is significant and considers fiscal transmission mechanisms for output, government expenditure, government deficit, inflation, government debt and unemployment.

Figure 1 shows the macroeconomic variables. In recent times, inflation has been above the upper bound of 6%. The repo rate or policy rate is shown to have a downward trend. However, in the quarters of 2022, the rate will increase. The rate of the gross domestic product has been below 5%, which is stipulated in the National Development Plan (NDP) of 2013. The level of government expenditure has reflected an upward trend over time. The government debt increased to 72.5%. The Southern African Development Community (SADC) Protocol on Finance and Investment (PFI) of 2006 encourages countries to need to have a government debt share of GDP that is equal to or below 60% (Buthelezi and Nyatanga, 2018). The level of the unemployment rate has been above the target of 24% outlined in the NDP from 2016 to 2020. Moreover, the level of 14% from 2022 onward has not been achieved, as the level of unemployment has been 32.7% in quarter 4 of 2022.

At a policy level, it is critical to comprehend the type of fiscal and monetary policy mix that must be used in various repo rate conditions. The fiscal consolidation *"expansionary austerity"* is characterized by government expenditure cuts and tax increases Alesina, Favero et al. (2019), Cordes (2020) and Karamysheva (2022), among others, argue that such a policy will bring public finances under control. However, Yang, Fidrmuc et al. (2015) Keynesian rationale and the fiscal consolidation self-defeating character of austerity. Monetary policy influences interest rates, and interest rates influence economic growth, employment and inflation. In different stages of a balance sheet recession, monetary policy's efficacy may change. In the early stages of a financial and economic collapse, expansionary monetary policy may be quite helpful in containing uncertainty spikes and tail risks and preventing negative feedback loops (Al-shawarby and El Mossallamy 2019, Liu, Sun et al. 2021, Omotosho 2022).

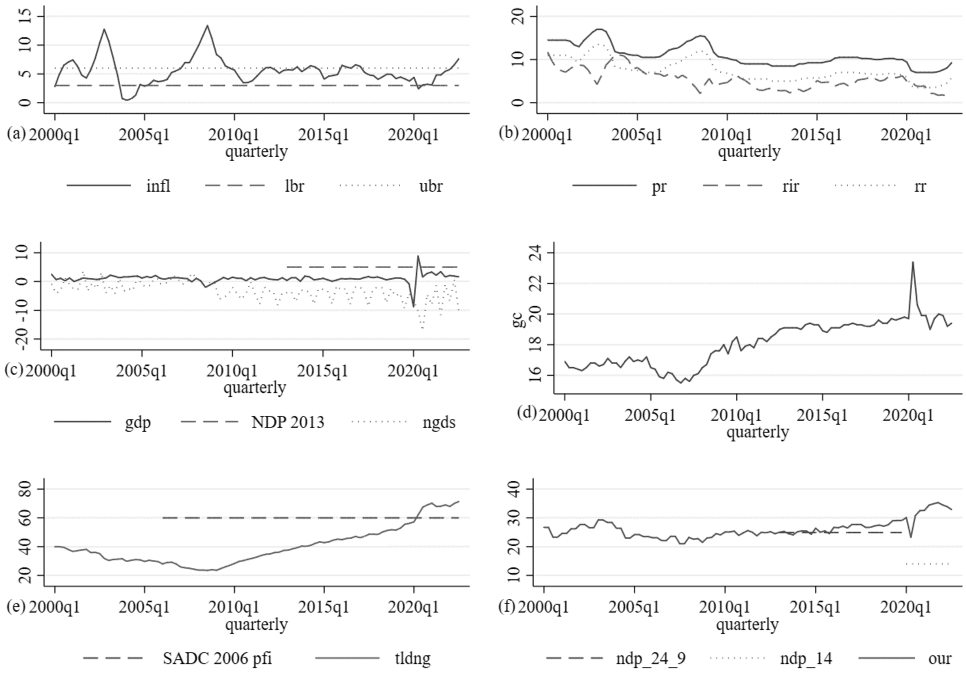

Figure 1: Macroeconomic variable.

Note: The economic variables are INF is inflation rate, LBR is lower bound of 3%, UBR is upper bound of 6%, PR is prime rate, RIR is real interest rate, RR is policy rate (repo rate), GDP is gross domestic product, NGDS is government deficit or surplus as a percentage of GDP, GC is government expenditure as a percentage of GDP, TLDNG is total government debt, OUR is official unemployment rate.

In the context above, the key economic question of this paper is what is the impact of fiscal policy macroeconomic variables on different regimes of the repo rate? What is the impact of the inflation gap on different regimes of the repo rate? What is the impact of the gross domestic product gap on different regimes of the repo rate? The hypotheses of the paper are reduced to the following:

Hypothesis 1

- ✓ H_0:Fiscal policy macroeconomic variables have no impact on different regimes of the repo rate.
- ✓ H_1:Fiscal policy macroeconomic variables have an impact on different regimes of the repo rate.

Hypothesis 2

- ✓ H_0:There is no impact of the inflation gap on different regimes of the repo rate.
- ✓ H_1:There is an impact of the inflation gap on different regimes of the repo rate.

Hypothesis 3

- ✓ H_0:There is no impact of the gross domestic product gap on different regimes of the repo rate.
- ✓ H_1:There is no impact of the gross domestic product gap on different regimes of the repo rate.

Hypothesis 4

- ✓ H_0:There are transition probabilities or repo rates to different regimes.
- ✓ H_1:There are no transition probabilities or repo rates to different regimes.

The rest of the paper has the following. First, section 2 outlines the literature review. Second, section 3 discusses the methodology. Fourth, section 4 discusses the empirical results. Finally, section 5 outlines the conclusion of the paper.

2. Literature Review

The investigation of the fiscal rule to produce countercyclical fiscal policy in South Africa by Du Plessis, Smit et al. (2007). They used the structural vector-autoregression approach from 1994 to 2016 and found that there was evidence of consensus on monetary policy being countercyclical, while fiscal policy was found to be procyclical. Economic variables of fiscal policy, government spending, labor income taxes, and monetary-fiscal stabilization policy were used by Lubik and

Schorfheide (2007) in Australia, Canada, and New Zealand. They provided evidence that monetary policies have a significant impact on macroeconomics. The fiscal and monetary policy interaction of Valli and Carvalho (2010) provides insight through the use of the Taylor rule. The DSGE model utilized showed results that reflected monetary policy and encouraged expansionary fiscal policy. This reflected that monetary policy can be accommodative of fiscal policy. The interaction of fiscal policy variables such as government spending and monetary policy was undertaken by Davig and Leeper (2011). They noted that monetary policy results in positive multipliers of fiscal policy variables. They noted that government consumption often outpaces private consumption, according to both monetary policy and passive fiscal policy. More future taxes have a significant negative wealth effect, whereas an active monetary response raises real interest rates. Agu (2011), documents and monetary policy reaction function with the fiscal macroeconomic variables. However, empirical estimates could also not confirm interest rate smoothing or the relevance of fiscal dominance in the reaction function.

The new Keynesian open economy was used to examine fiscal and monetary policy interactions by Çebi (2012). It was discovered that whereas the monetary authority reacts strongly to the output gap, it only reacts weakly to inflation. There is significant interest rate smoothing. Although fiscal policy has helped to stabilize debt, there is no proof that it has actively closed the output gap. The consideration of the best monetary and fiscal strategies to use in countries that experience deep recessions and financial crises was undertaken by Dosi, Fagiolo et al. (2015). According to their simulation results, an unrestricted policy mix, countercyclical fiscal policy, and monetary policy that focuses on employment are needed to stabilize the economy. Nevertheless, "discipline-guided" fiscal regulations can be counterproductive because they worsen public finances without boosting the economy. Finally, we discover that as the degree of income inequality rises, the consequences of monetary and fiscal policy become more pronounced. On the other hand, Ahmad (2016) noted that the output gap and inflation preferences for the stated monetary policy exhibit significant nonlinearity and imbalance. There were discovered to be two states of the policy rate, and there was proof that the Fed's crisis-related decision making had a significant impact on the observed Taylor rule deviations.

The comprehension of monetary and fiscal interactions with liquidity frictions was undertaken by Cui (2016) with consideration of endogenous asset liquidity. It was found that real government debt at a greater level encourages investment and improves the liquidity of business owners' portfolios. A greater level of taxes that causes distortions and/or a higher real interest rate are two additional costs associated with funding government spending that is increased by the issuing of debt. A government debt supply that is a long-term optimum appears. A severe financial recession can also be avoided with the right balancing of monetary and fiscal policy. Xu and Serletis (2016) expand the existing regime change literature. With the extension, interest rate rules for monetary policy and tax rules for fiscal policy that alternate stochastically between two regimes can be subject to time-varying disturbance variations. The investigation of monetary and fiscal policy mix changes was undertaken by Bianchi and Ilut (2017). They note that the monetary authority had always led or if agents had been confident about this switch. The examination of South African fiscal and monetary policy in an open economy was done by Crowley and Hudgins (2018). They note that restricted fiscal policy is the best option to realize growth, leading to lower interest rates, lower inflation, real exchange depreciation and improved trade balances compared to restricted monetary policy. The six-variable Bayesian VAR of Rezabek and Doucek (2018) strives to understand how monetary and fiscal policies interact. The authors remark that the government's policy initiatives do not complement one another and argue that there is still potential to improve the efficacy of economic measures.

Using a policy-oriented multivariate VECM approach by Wang (2018) was undertaken to access unconventional monetary policy and fiscal policy. The acquisition of treasury securities was discovered to be substantially larger than the size of the monetary stock. During the time of unconventional monetary policy, the combination of monetary and fiscal policy had less of an influence on macroeconomic indicators. These data demonstrate that fiscal and monetary policies have a more synergistic influence on the macroeconomy. Cavalcanti, Vereda et al. (2018) note an increase in the cost of debt financing, thus requiring a fiscal adjustment capable of guaranteeing the sustainability of the debt. Afonso, Alves et al. (2019) examined monetary and fiscal policies. They controlled for institutional variables, inflation was noted to have a significant impact on monetary policy, and governments raise their primary balances when facing increases in government debt. The central bank assumes an active role, especially in cases of higher levels of debt. The dynamic stochastic general equilibrium of Al-shawarby and El Mossallamy (2019) seeks to investigate monetary and fiscal authority. They point out that Egypt's monetary and fiscal policy tools influence production, inflation, and the debt stock, which all affect economic stability. Applying the Taylor rule, they point out that fiscal policy is crucial for stabilizing government debt and output.

Battistini, Callegari et al. (2019) note that monetary policy intervention results in public debt sustainability. Sustainability improves with monetary policy activeness, that is, with the elasticity of the interest rate to changes in inflation and the output gap. The Markov-switching dynamic regression MSDR was utilized by Ayinde, Bankole et al. (2020) to access the behavior of the central bank in a Taylor framework. The results also suggested that political risk factors significantly moderated the behavior of the central bank, especially during the period of the high-interest rate regime. The Taylor rule was applied in South Africa by Iddrisu and Alagidede (2021) to investigate asymmetry in monetary policy. The threshold model demonstrated the SARB's asymmetric reactions below and beyond its threshold inflation rate of 5.2% in terms of policy behavior. Liu, Sun et al. (2021) used structural models to identify monetary and fiscal interactions in emerging economies. They found that the shock of government expenditure resulted in a multiplier of 0.1 to 1.8 increase in the policy rate. Utama and Fitrady (2022), their findings indicate that coordination takes the form of a combination of active and passive fiscal and monetary policies. When the external stress rises, the degree of coordination decreases. Omotosho (2022) findings highlight the need for dynamic tax policies that are less sensitive to receipts from resource rent as a strategy for achieving debt sustainability and overall macroeconomic stability in resource-rich countries. Tavakolian and Taherpoor (2022) used the time-varying parameter VARMA model to access monetary and fiscal policy coordination. The highest level of coordination between the two policymakers occurred in the final years of the second term of the presidency. However, in the third term of the presidency, the level of interaction between the two policymakers increased. Finally, in the last years of this period, the two policymakers moved toward coordination, and this trend continued in the next presidential period, and the least turmoil in this coordination occurred in the last period.

3. Methodology

This paper uses quantitative analysis to investigate the impact of macroeconomic uncertainty on different regimes of economic growth in the presence of fiscal consolidation in South Africa. The economic variables used are reflected in table (1).

The data used are the time series data from 2000 quarter 1 to 2022 quarter 3, sourced from the South African Reserve Banks (SARB), IMF and World Bank. The model adopted in this paper is the Markov-switching dynamic regression model (MSDRM). The MSDRM is used because it provides attractive features of transition over a set of finite regimes (Hansen 1996). This is important because this study seeks to investigate the behavior of the South African reserve bank in different states of policy rate with interaction with macroeconomic variables from the fiscal policy side.

Table 1. Economic Variables Utilized

Variable	Description
Category A	
pr_t	Prime rate
rr_t	Reserve Bank Policy Rate (repo rate)
gdp_t	Gross Domestic Product
Category B	
rr_t^{lbr}	Reserve Bank Policy Rate (repo rate) estimation with inflation gap at a lower bound of 3%
rr_t^{ubr}	Reserve Bank Policy Rate (repo rate) estimation with inflation gap at the upper bound of 6%
rir_t	Real interest rate
inf_t	Inflation rate
inf_t^{lbr}	Inflation gap at the lower bound of 3%
inf_t^{ubr}	Inflation gap at the lower upper bound of 6%
gdp_t^{gap}	Gross domestic product gap
ex_t	SA Exchange to a US Dollar
wui_t	World Uncertainty Index for South Africa
$ngds_t$	Government deficit or surplus as % of GDP
gc_t	Government expenditure (% of GDP)
$tldng_t$	Total government debt
our_t	Official unemployment rate
Category C	
gdp_t^{hp}	GDP trend component from hp filter
gdp_t^{b}	GDP trend component from bw filter
gdp_t^{cf}	GDP trend component from cf filter
gdp_t^{bk}	GDP trend component from bk filter

Note: Category A reflects the economic variable considered, Category B reflects the estimation for reserve bank behavior with fiscal policy macroeconomic variables, and Category C shows the economic variable that filters out the cyclical component.

3.1. Theoretical Framework

This paper follows the framework of Taylor (1993), which defined the monetary rule that can proxy the repo rate in the South African Reserve Bank. This framework is expressed in Equation (1).

$$r_t = p_t + 0.5y_t + 0.5(p_t - 2) + 2 \quad (1)$$

where r_t is the reserve bank policy rate, p_t is the rate of inflation completed in the prior four quarters and y_t is the proportion deviation of real GDP from the target. This suggests that if inflation climbs over the 2% objective or if real GDP increases above the trend of GDP, the policy interest rate will rise. However, in the context of South Africa, this would be different in the threshold range between 3% to 6% for inflation and 5% according to the target of national development. Nevertheless, Taylor (1998) improved the model that was developed by Taylor (1993), and he noted that there is a need to add economic variables of π^* , which is the reserve bank's target inflation, and r_t^f estimate of the equilibrium real rate of interest. The modified model is expressed in Equation (2).

$$r_t = \pi_t + gy_t + h(\pi_t - \pi^*) + r_t^f \quad (2)$$

where π_t is the inflation rate. The modification of Taylor (1998) comes under much criticism with the argument that it fails to consider the economic variable of the exchange rate, which is critical in monetary policy. This led to the proposal of the augmented Taylor rule, which is an outline in the work of (Taylor, 1999) reflected in Equation (3).

$$i_t = f\pi_t + gy_t + h_0e_i + h_1e_{i-1} \quad (3)$$

where i_t is the short-term nominal interest rate and e_i is the real exchange rate. No intercept in this equation implies that the targeted inflation rate is zero, and interest rates and exchange rates are measured relative to their long-run values Taylor (2001). In the present paper, the linear Taylor rule that is used is as reflected in Equations (4 to 5).

$$rr_t^{lbr} = rir_t + inf_{t-1} + [0.5 * (inf_t - lbr_t)] + \left[0.5 * \left(gdp_t - gdp_t^{hp}\right)\right] \quad (5)$$

$$rr_t^{ubr} = rir_t + inf_{t-1} + [0.5 * (inf_t - ubr_t)] + \left[0.5 * \left(gdp_t - gdp_t^{hp}\right)\right] \quad (6)$$

To account for the out gap, the paper makes the following definition, as reflected in Equations (7 to 9).

$$inf_t^{lbr} = [0.5 * (inf_t - lbr_t)] \quad (7)$$

$$inf_t^{ubr} = [0.5 * (inf_t - ubr_t)] \quad (8)$$

$$gdp_t^{gap} = \left[0.5 * \left(gdp_t - gdp_t^{hp}\right)\right] \quad (9)$$

Given the definition in Equations (8 to 9) and Equations (5 to 6), the paper then includes other economic variables of interest outlined by Taylor (1998). The paper then includes other economic variables of interest outlined by Taylor (1998) and (Taylor 1999), which are reflected in Equations (10 to 11).

$$rr_t^{lbr} = rir_t + inf_{t-1} + inf_t^{lbr} + gdp_t^{gap} \tag{10}$$

$$rr_t^{ubr} = rir_t + inf_{t-1} + inf_t^{ubr} + gdp_t^{gap} \tag{11}$$

The reduced form variable of the lower bound and upper bound is reflected in Equations (12 to 14).

$$rr_t^{lu\_br} = \begin{cases} rr_t^{lbr} \\ rr_t^{ubr} \end{cases} \tag{12}$$

$$inf_t^{gap\_br} = \begin{cases} inf_t^{lbr} \\ inf_t^{ubr} \end{cases} \tag{13}$$

Given the reduced form, the estimation equation is reflected in Equation (14).

$$rr_t^{lu\_br} = rir_t + inf_{t-1} + inf_t^{gap\_br} + gdp_t^{gap} + ex_t + wui_t + \sum_{k=1}^{4} \Gamma_t \tag{14}$$

where wui_t is the world uncertainty index for South Africa and $\sum_{k=1}^{4} \Gamma_t$ are the 4 economic variables $ngds_t$ government deficit or surplus as a percentage of GDP gc_t is government expenditure percentage of GDP $tldng_t$ is total government debt our_t and official unemployment rate.

3.2. Model specification MSDR model

The Markov-switching dynamic regression is used for series that are believed to transition over a finite set of unobserved regimes, allowing the process to evolve differently in each state. The transitions occur according to a Markov process, from one state to another, and the duration between changes in the state is random (Hansen, 1996; Hansen, 2000). If given an economic data series denoted by $rr_t^{lu\_br}$, where $t = 1,2,\ldots,T$, is characterized by two regimes, such economic data series can be presented in Equations (15) and (16).

$$State\ 1: \quad rr_t^{lu\_br} = \psi_{st} + \varphi_{t-1}^{lu\_br} + \epsilon_s \tag{15}$$

$$State\ 2: \quad rr_t^{lu\_br} = \psi_{st} + \beta \sum_{k=1}^{4} X_{k,t} + Z_t \lambda_s + \epsilon_s \tag{16}$$

Equation (15) is a Markov switching autoregression model, and Equation (16) is a Markov switching dynamic regression model. Due to the dynamics of the explanatory variables, the former have constant transition probabilities, and the latter have time-varying transition probabilities, making them susceptible to changes in the shape of the transition probabilities from one state to another. Equation (16) λ_s is the state-dependent coefficient for the control variables, and a state-invariant coefficient is denoted by β, but the other variables controlling interest rates are considered to be control variables, combined with independent identically distributed random variables ϵ_s that follow a zero-mean normal distribution. The different paraments of states are reflected in Equations (17 to 19).

$$\epsilon_t \sim N\left(0, \delta_{s_t}^2\right) \tag{17}$$

$$\delta_{s_t}^2 = \sum_{s=1}^{k} \delta_s^2 , \sum_{s=1}^{k-1} \delta_s^2 > 0 \tag{18}$$

$$\psi_{s_t} = \sum_{s=1}^{k} \psi_s \tag{19}$$

where ψ_1 and ψ_2 are the intercept terms in state 1 and state 2, respectively, and $\epsilon_t$is a white noise error with variance $\delta_{s_t}^2$. The two-regime model shifts in the intercept term (Hamilton, 1989; Hamilton, 1990). If the timing of switches is known, the above model can be expressed as in equation (20).

$$rr_t^{lu\_br} = \psi_{st}\psi_1 + (1 - \psi_{st})\psi_2 + \epsilon_t \tag{20}$$

The subscript ψ_{s_t} is 1 if the process is in state 1 and 0 otherwise. Markov-switching regression models allow the parameters to vary over the unobserved regimes. The MSDR model with a state-dependent intercept term is reflected in question (21).

$$rr_t^{lu\_br} = \psi_{st}\psi_2 + \epsilon_t \tag{21}$$

where $\psi_{\psi_{s_t}}$ is the parameter of interest; $\psi_{\psi_{s_t}} = \mu$ when $\psi_{s_t} = 1$, and $\psi_{\psi_{s_t}2} = \mu_2$ when $\psi_{s_t} = 2$. The probabilities of being in each state can be estimated with transition probabilities. One-step transition probabilities are given by $p_{\psi_{s_t}}, \psi_{s_t} + 1$, so for a two-state process, p_{11} denotes the probability of staying in state 1 in the next period given that the process is in state 1 in the current period. Likewise,

p_{22} denotes the probability of staying in state 2 (Hansen, 1996; Hansen, 2000). The probability that ψ_{s_t} is equal to $j =\in (1, \ldots k)$ depends on the most recent realization, $\psi_{s_{t-1}}$, and is given by Equation (22).

$$P_r\left(\psi_{s_t} = j \middle| \psi_{s_{t-1}} = i\right) = P_{ij} \tag{22}$$

The transition probabilities k*k from one state to another can be presented in matrix (23).

$$P = \begin{pmatrix} p_{11} & p_{12} & \cdots & p_{k1} \\ p_{21} & p_{22} & \cdots & p_{k2} \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ p_{k1} & p_{k2} & \cdots & p_{kk} \end{pmatrix} \tag{23}$$

which governs the evolution of the Markov chain. All elements of Pare are nonnegative, and the column sums to 1. To avoid some numerical complications caused by $\sum_{j=1}^{k} p_{ij} = 1$, the probability distribution follows a logistic form with the estimations of p_{ij} being normalized by p_{ik}, which is given by Equation (24).

$$p_{ij} = \frac{exp\left(-q_{ij}\right)}{1 + exp\left(-q_{ij}\right) + exp(-q_{i2}) + \ldots + exp\left(-q_{i,k-1}\right)} \tag{24}$$

Normalizing p_{ik} is given by Equation (25).

$$p_{ik} = \frac{1}{1 + exp(-q_{i1}) + exp(-q_{i2}) + \ldots + exp\left(-q_{i,k-1}\right)} \tag{25}$$

Equation (1) describes the behavior of the state-dependent parameter ψ. Equation (18) is the fixed probability of the Markov regime changing distribution. To obtain a time-varying distribution where the probabilities of regime changes are endogenized by introducing the economic variables as their determinants, the transition matrix in equation (23) is thus altered with matrix (26).

$$P = \begin{pmatrix} p_{11}\eta_{t-1} & p_{12}\eta_{t-1} & \cdots & p_{k1}\eta_{t-1} \\ p_{21}\eta_{t-1} & p_{22}\eta_{t-1} & \cdots & p_{k2}\eta_{t-1} \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ p_{k1}\eta_{t-1} & p_{k2}\eta_{t-1} & \cdots & p_{kk}\eta_{t-1} \end{pmatrix} \tag{26}$$

where $\eta_{t-1}$is a set of information variables that includes the composite variable. Therefore, the argument of the transition probabilities now includes the information shown in Equation (27).

$$p_{ik} = \frac{1}{1 + exp(-\eta_{t-1}\Omega_0) + exp(-\eta_{t-1}\Omega_0)+\ldots+exp(-\eta_{t-1}\Omega_0)} \quad (27)$$

where Ω_0 denotes the vector coefficients of information variables. To estimate the regime-switching model, a complete data likelihood function is imperative. The Markov-switching dynamic regression is reflected in equation (28).

$$rr_t^{lu\_br} = \begin{cases} \beta_{11} + \beta_{21} rir_t + \beta_{31} inf_{t-1} + \beta_{41} inf_t^{gap\_br} + \beta_{51} gdp_t^{gap} + \beta_{61} ex_t \\ +\beta_{71} wui_t + \beta_{k,1} \sum_{k=1}^{4} \Gamma_t + e_{1,t} \\ \beta_{12} + \beta_{22} rir_t + \beta_{32} inf_{t-1} + \beta_{42} inf_t^{gap\_br} + \beta_{52} gdp_t^{gap} + \beta_{62} ex_t \\ +\beta_{72} wui_t + \beta_{k,1} \sum_{k=1}^{4} \Gamma_t + e_{2,t} \end{cases} \quad (28)$$

Equation 28 is the theoretical framework outlined in Equations (10 to 14) extended to the Markov-switching dynamic regression.

3.2. Stylized Data

As mentioned, the paper employs two filters in an effort to isolate the time series data to obtain the out gap, which is achieved by Equation (29).

$$y_t = \tau_t - c_t \quad (29)$$

where y_t is the time series of interest series in this paper $y_t = [\ gdp_t\ ]$. c_t is the stationary automatic or cyclical component driven by stochastic cycles, and τ_t is the structural or trend component, which will assist in obtaining the gross domestic product gap. The time series is explained by Equation (26) and extended to Equation (30).

$$y_t^* = \sum_{j=0}^{\infty} \alpha_j y_{t-j} = \alpha(L) y_t, f_{y^*}(\omega) = |\ \alpha\left(e^{i\omega}\right)|^2 f_y(\omega) \quad (30)$$

where α_j is the filter of an infinitely long time series y_t that is smoothed without any unwanted stochastic frequency. Under filtering, the smoothed series is defined by the spectral density $f_{y^*}(\omega) = 0$, in which ω denotes the frequency of the independent stochastic cyclic that contributes to the variance and autocovariance of y_t. The gain of the filter $\alpha\left(e^{i\omega}\right)$ mines what is filtered out of the series. The filter adopted in this paper is the HP filter, which is reflected in equation (31).

$$y_{t,HP}^{*} = \lim_{\tau_t}\left[\sum_{t=1}^{T}(y_t - \tau_t)^2 + \lambda\sum_{t=2}^{T-1}\{(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})\}^2\right] \quad (31)$$

Minimize the sum of the squared deviation of the series $y_{t,HP}^{*}$ from the trending subject to the smoothing parameter λ typical 1600 for the quarterly data. This paper uses the annual data it 400[i]. The HP filter has the limitation of being biased in its ending point (Hodrick and Prescott,1997). This problem is solved in this paper by extending data using the forecasted values in each economy. To note the consistency in the estimation, the paper adopted the Christiano and Fitzgerald (2003) filter reflected in equation (32).

$$y_{t,CF}^{*} = \sum_{j=1}^{T-t-1} b_j y_t + j + \tilde{b}_{T-t} y_T + \sum_{j=1}^{t-2} b_j y_{t-j} + j + \tilde{b}_{t-t} y_1 \quad (32)$$

Equation (32) reflects that there is a minimization of the mean square error between the filtered series and the series filtered by the ideal bad-pass filter. The cyclical component is given by $y_{t,CF}^{*}$, and b_0, b_1,…, b_j, reflecting the weight from the ideal band-pass filter (Christiano and Fitzgerald 2003), as reflected in equation (33).

The results of the above-stylized framework are shown in Table 1. The paper will use the HP-filter data in graph a, given that there is less data loss.

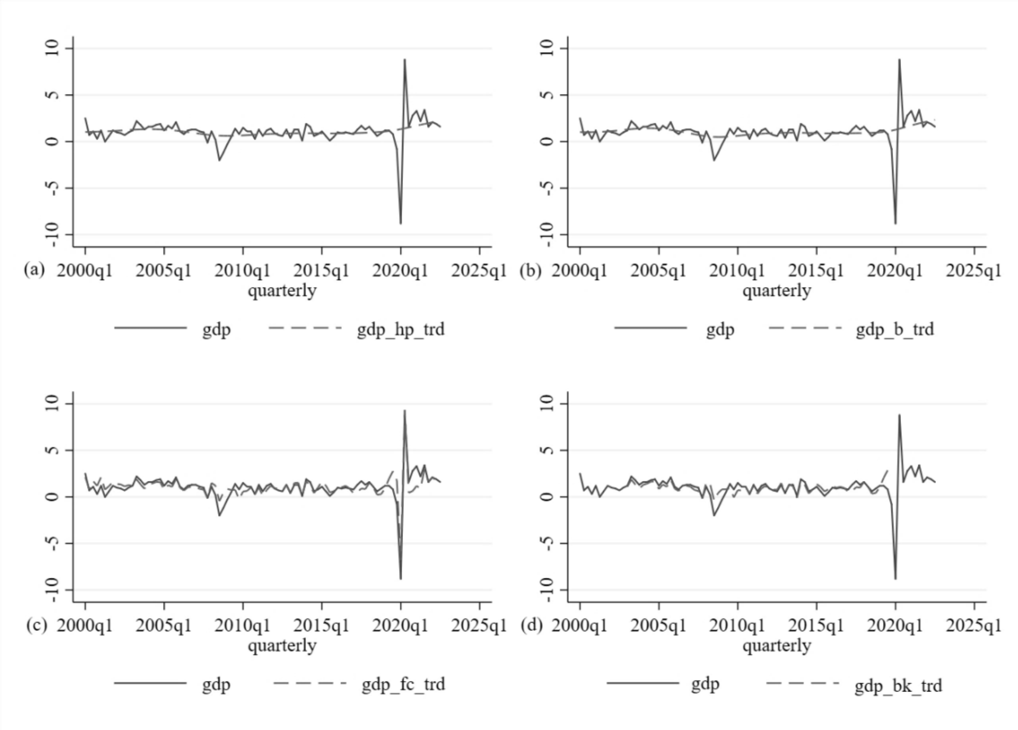

Figure 2. Stylized data using filter framework.

Note: The economic variables are gdp is a gross domestic product, gdp_hp_trd is the GDP trend component from the hp filter, gdp_b_trd is the GDP trend component from the bw filter, gdp_fc_trd is the GDP cyclical component from the cf filter and gdp_bk_trd is the GDP trend component from the cf filter.

4. Results

Table 2 shows the descriptive statistics and economic variables considered in the paper. The rr is the reserve bank policy rate, which is the repo rate and is found to have a mean of 7.73% throughout 2000 quarter 1 to 2023 quarter 3. This suggests that over the period, the prince rate could have a mean of 11.23% with an additional 3.5%. The shift in rr is the reserve bank policy rate, which is the repo rate expected to be 2.56%, as reflected in the standard deviation, and the range is expected to be between 3.5% and 13.5%, as reflected by the minimum and maximum values. The rir real interest rate and inf inflation rate are found to have a mean of 5.39% and 5.53%, respectively. With inflation posing concern of being on the bound, however, what makes for stability is that it is with the policy tart of 3% to 6%. The inf_t^{lbr} inflation gap at the lower bound of 3% and the inf_t^{ubr}

inflation gap at the lower upper bound of 6% are shown to have a mean rate of 1.26 and a negative rate of 0.23. This also confirms the mean average that is within the range of 3% to 6%. When inflation is at the upper bound on average, inflation turns out to be below 6% over the period, and the same is true when inflation is at the lower target.

Table 2. Distributive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	Shapiro-Wilk
rr	91	7.43	2.56	3.50	13.5	0.012	0.43	0.934
rir	91	5.39	2.33	1.48	11.7	0.014	0.67	0.964
inf	91	5.53	2.35	0.43	13.4	0.001	0.07	0.929
inf_t^{lbr}	91	1.26	1.17	-1.28	5.20	0.001	0.07	0.929
inf_t^{ubr}	91	-0.23	1.17	-2.78	3.70	0.001	0.07	0.929
gdp	91	1.07	1.54	-8.8	8.80	0.000	0.00	0.627
gdp_t^{gap}	91	0.80	0.73	-5.03	3.70	0.000	0.00	0.548
ex	91	10.25	3.47	5.63	17.9	0.032	0.00	0.895
wui	91	0.48	0.39	0.00	1.82	0.000	0.08	0.901
$ngds$	91	-3.18	3.48	-17.1	3.70	0.001	0.07	0.951
gc	91	18.10	1.48	15.5	23.4	0.317	0.67	0.928
$tldng$	91	40.12	13.05	23.5	71.4	0.001	0.69	0.901
our	91	26.13	3.17	21.0	35.3	0.000	0.05	0.908

Note: H_0: there is a normal distribution, H_1: there is no normal distribution.

The gdp gross domestic product and gdp_gap the gross domestic product gap are found to have mean rates of 1.07% and 0.8%, respectively. The gross domestic product is far from the National Development Plan, which outlines a rate of 5%. wui is the world uncertainty index for South Africa and has a mean rate of 0.45%. The mean for ex SA exchange to a US Dollar is 10.25. The economic variables proxy the fiscal policy side of things in the economy is $ngds$ government deficit or surplus as % of GDP with a mean rate of negative 3.18%. The gc government expenditure is found to have an average rate of 18.10%, while the $tldng$ total government debt has a mean rate of 40.12%. The our official unemployment rate has a mean rate of 26.13%, which is higher than the 14% outlined in the National Development Plan of 2013. The economic variables that are considered in the paper are all positively skewed. The kurtosis reflects an atheoretical measure of the normal distribution with the economic variables that have the highest value being the $tldng$ total government debt will have a value of

0.69. This value suggests that the $tldng$ total government debt is leptokurtic, that is, it was highly peaked with a very thin tail. The Shapiro–Wilk probability p values are higher than 0.05%; as such, we fail to reject that there is no normal distribution among economic variables.

The test statistics for the unit-root and stationarity tests detailed in Table 3 suggest that some of the variables are unit-root as well as nonstationary at levels while some other variables are nonunit-root as well as stationary at levels. The use of the augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests confirm the unit root across all economic variables considered except wui and $ngds$.

Table 3. Conventional unit root and stationary tests

	Dickey-Fuller Test Stat.	Phillips-Perron Test Stat	5% Critical Value	Structural break	
				Break	P value
Δrr	-5.136	-5.136	-2.90	2009q3	0.00
Δrir	-6.817	-6.817	-2.65	2008q1	0.00
Δinf	-5.294	-5.294	-2.70	2009q1	0.00
Δinf^{lbr}	-5.294	-5.294	-2.80	2003q4	0.00
Δinf^{ubr}	-5.294	-5.294	-2.89	2003q4	0.00
Δgdp	-4.680	-4.680	-2.89	2019q2	0.00
Δgdp^{gap}	-7.628	-7.628	-2.90	2018q3	0.00
Δex	-6.543	-6.543	-2.59	2014q4	0.00
wui	-3.718	-3.718	-2.99	2011q4	0.00
$ngds$	-5.680	-5.680	-2.69	2009q2	0.00
Δgc	-9.423	-9.423	-2.89	2010q1	0.00
$\Delta tldng$	-4.950	-4.950	-2.90	2015q4	0.00
Δour	-4.950	-4.950	-2.90	2019q2	0.00

Note: Unit-root and Stationarity tests includes constant intercept term but without deterministic trends. Lags are included with automatic and based on Schwarz info criteria. The *, **, ***, imply that the series is stationary at 1%, 5% and 10%, respectively. ADF and PP represent Augmented Dickey-Fuller and Phillips-Perron.

As detailed in Table 3, it is evident that the variables have different break periods. Deterministic models would not be acceptable for this study if these variables were combined with various stationarity levels and break times in the same model. In a modeling framework such as this, this further validates the usage of Markov switching models that can capture several break-point phases inside the structure of this paper. The variable of interest of the policy rate has a structural break in 2008 quarter 3. This reflects the significance of the final crises. The fiscal economic variables of $ngds$, gc, $tldng$ and our have structural breaks in 2009 quarter 2, 2010 quarter 1, 2015 quarter 4 and 2019 quarter 2 for the respective variables. These structural breaks are also reflected in Figure 3 per economic variable.

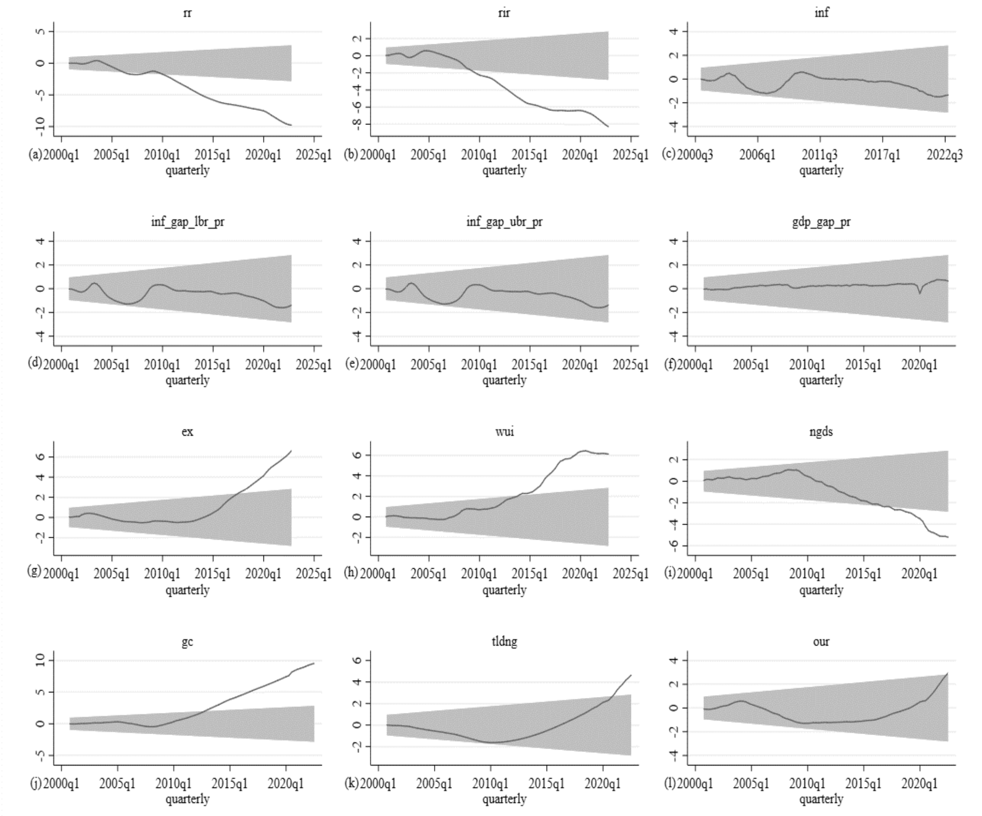

Figure 3. Structural break.

Note: the economic variables are rr is policy rate (repo rate) rir is real interest rate inf_{t-1} is lag inflation rate $inf_t^{lbr} = 0.5(inf - lbr)$ is inflation gap of lower bound from the Taylor Rule function inf is inflation lbr is lower bound of 3% $inf_t^{ubr} = 0.5(inf - ubr)$ is inflation gap of upper lower bound from the Taylor Rule function ubr is upper bound of 6%, wui is world uncertainty index for South Africa, $ngds$ is government deficit or surplus as % of GDP, gc is government expenditure (% of GDP), $tldng$ is total government debt and our official unemployment rate.

We have also carried correlation test between input variable. The result are given at Table 1A at appendix. According to the results, input variables that found to have positive correlation with rr include rir, inf, inf^{lbr}, inf^{ubr} and $ngds$. On the other hand, the variables that are found to have a negative relation with rr are gdp , gdp^{gap} , ex , wui , gc , $tldng$ and our . Figure 4 reflects the implementation of Equations (5 to 6). The repo rate has been below the Taylor Rule function policy rate.

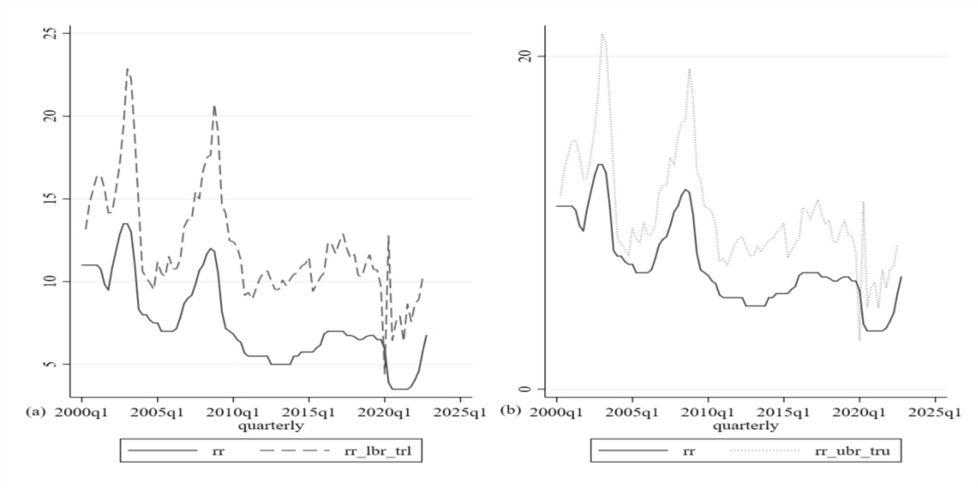

Figure 4. Taylor Rule function.

Note: The variables are rr policy rate (repo rate), rr_lbr_tru is the estimation of the policy rate (repo rate) in the Taylor rule framework with the target of the lower bound rate of 3% and rr_ubr_tru is the estimation of the policy rate (repo rate) in the Taylor rule framework with the target of the upper bound rate of 3%

Table (4) reflects estimates of the standard and extended Taylor's rule for South Africa in a Markov chain, dynamic regression model in the time series data from 2000 quarter 1 to 2022 quarter 3. Table (4) estimations 1 and 4 reflect state 1 and 2 mean of the rr reserve bank policy rate which is the repo rate which is found to have a mean rate of 6.064% and 11.00%, respectively and with a statistically significant 1% p value. This result suggests that during the period of 2000 quarter 1 to 2022 quarter 3, the ir prime rate would have been 9.564% to 14.5%. Estimations 2 and 5 show the inf^{lbr} inflation gap at a lower bound of 3% and the inf^{ubr} inflation gap at the lower upper bound of 6% when there is no inclusion of the wui world uncertainty index for South Africa. It is found in stat 1 that a 1% increase in the inf^{lbr} inflation gap at a lower bound of 3% and the inf^{ubr} inflation gap at the lower upper bound of 6% result in a 0.297% increase and 1.303% increase in the reserve bank policy pate, which is the repo rate in states 1 and 2, respectively, and which is statistically significant at the 5% and 1% p values.

Table 4. Estimates of the standard and extended Taylor's rule for South Africa

Variable	State 1			State 2		
	(1)	(2)	(3)	(4)	(5)	(6)
	rr	rr	rr	rr	rr	rr
rir	-	0.773*** (19.32)	0.758*** (20.54)	-	0.555*** (4.95)	1.107*** (12.54)
inf_{t-1}	-	0.667*** (21.80)	0.643*** (21.97)	-	0.745*** (8.47)	1.290*** (13.04)
inf^{lbr}	-	0.297* (2.14)	0.464*** (3.49)	-	1.303*** (5.26)	0.189 (0.49)
inf^{ubr}	-	0.297* (2.14)	0.464*** (3.49)	-	1.303*** (5.26)	0.189 (0.49)
gdp^{gap}	-	0.107* (2.09)	0.495*** (4.25)	-	0.0618 (0.19)	0.108 (1.58)
ex	-	-0.022 (-1.11)	0.0205 (0.73)	-	0.341*** (4.30)	0.0589 (1.09)
wui	-	-	-0.164 (-0.79)	-	-	-1.358** (-3.04)
Const.	6.064*** (37.01)	-0.546 (-1.26)	-0.647 (-1.53)	11.00*** (38.24)	-1.400 (-1.08)	-5.038*** (-3.73)
N	91	89	89	91	89	89

Note: t-statistics are given in paranthesis. * p < 0.05, ** p < 0.01, *** p < 0.001.

However, in state 2, the result is found to be insignificant. Estimations 2 and 5 show the gdp^{gap} gross domestic product gap when there is no inclusion of the wui world uncertainty index for South Africa. It is found that when gdp^{gap} the gross domestic product gap increases by 1%, this results in a 0.107% increase in the reserve bank policy pate, which is the repo rate in state 1, which is statistically significant at the 5% p value. However, in state 2, the result is found to be insignificant. Estimations 3 and 6 show the gdp^{gap} gross domestic product gap when there is an inclusion of the wui world uncertainty index for South Africa. It is found that when gdp^{gap}, the gross domestic product gap increases by 1%, which results in a 0.495% increase in the reserve bank policy pate, which is the repo rate in state 1 that is statistically significant at the 1% p value. However, in state 2, the result is found to be insignificant. With or without political risk, output gaps for the economy are significantly positively related to the rate of interest under a high-interest rate regime but negative under a low rate of interest, albeit insignificantly. This is intuitive in that when the actual output level exceeds its potential level for the economy, then the interest rate increases further to control for inflationary pressure that could be occasioned by excess production in the domestic economy. This result is similar to that of Ayinde et al. (2020).

Estimations 2 and 5 show the ex SA exchange to a US dollar when there is no inclusion of the wui world uncertainty index for South Africa. It is found that when ex SA exchange to a US dollar increases by 1%, this results in a 0.341% increase in the reserve bank policy rate, which is the repo rate in state 2, which is statistically significant at the 1% p value. However, in state 1, the result is found to be insignificant. Estimations 3 and 6 show the ex SA exchange to a US dollar when there is no inclusion of the wui world uncertainty index for South Africa. The results in states 1 and 2 are found to be insignificant. Estimations 3 and 6 show the ex SA exchange to a US dollar when there is the inclusion of the wui world uncertainty index for South Africa. It is found that when the wui world uncertainty index for South Africa increases by 1%, this results in a 1.358% fall in the reserve bank policy rate, which is the repo rate in state 2, which is statistically significant at the 5% p value. The result in state 1 is found to be insignificant.

Table 5 shows the estimates of the standard and extended Taylor's rule with a fiscal macroeconomic variable for South Africa. Estimations 2 and 7 show the $ngds$ government deficit or surplus as a percentage of GDP when it increases by 1%, which results in a 0.0786% increase in the reserve bank policy rate, which is the repo rate in state 1, which is statistically significant at the 5% p value. However, in state 2, the result is found to be insignificant. Estimations 3 and 8 show the gc government expenditure (% of GDP). It is found that when it increases by 1%, this results in a 0.657% and 1.175% fall in the reserve bank policy rate, which is the repo rate in state 1, which is statistically significant at the 5% p value. However, in state 2, the result is found to be insignificant. These results are similar to those of Liu et al. (2021), but the magnitude is small. This increase in the interest rate suggests that most of the government expenditure is financed by debt. Estimations 4 and 9 show that when $tldng$ total government debt increases by 1%, it results in a 0.0972% fall in the reserve bank policy rate, which is the repo rate in state 2, which is statistically significant at the 5% p value. However, in state 1, the result is found to be insignificant. These results are contrary to the view of the classical school of thought that government debt has a crowding-out effect on investment, which is characterized by an increase in the interest rate (Mankiw, 2019). The use of government debt needs to be discouraged because it is currently above the rate of 60%, which was found by (Buthelezi and Nyatanga, 2018) to harm economic growth and other macroeconomic variables. Estimations 4 and 9 show that when the our official unemployment rate increases by 1%, it results in a 0.0700% fall in the reserve bank policy rate, which is the repo rate in state 1, which is statistically significant at a 5% p value. However, in state 2, the result is found to be insignificant.

Table 5. Estimates of the standard and extended Taylor's rule with a fiscal macroeconomic variable

Var.	State 1					State 1				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
rir	-	0.740*** (19.49)	0.509*** (10.62)	0.756*** (18.20)	0.769*** (20.04)	-	0.166 (1.39)	0.505*** (3.97)	0.820*** (9.28)	1.074*** (9.20)
inf_{t-1}	-	0.634*** (19.08)	0.660*** (25.03)	0.615*** (15.54)	0.654*** (22.37)	-	0.361*** (3.97)	0.826*** (9.51)	0.791*** (10.71)	1.229*** (9.31)
inf^{lbr}	-	0.237 (1.70)	0.174 (1.47)	0.327* (2.45)	0.423** (3.15)	-	1.280*** (5.54)	0.265 (1.40)	1.778*** (8.88)	0.381 (0.86)
inf^{ubr}	-	0.147** (3.02)	0.003 (0.05)	0.112* (2.04)	0.053 (0.94)	-	-0.068 (-0.21)	0.046 (0.39)	0.140 (0.73)	0.485* (1.96)
gdp^{gap}	-	-0.004 (-0.18)	0.160*** (4.43)	0.054 (0.97)	0.036 (1.00)	-	0.275** (3.09)	0.052 (1.27)	0.367*** (4.31)	0.022 (0.22)
ex	-	0.052 (0.32)	0.160 (0.87)	0.039 (0.20)	-0.097 (-0.44)	-	-0.834 (-1.34)	-2.089*** (-3.88)	-1.121* (-2.06)	-1.345** (-2.67)
$ngds$	-	0.078*** (3.86)	-	-	-	-	0.054 (0.99)	-	-	-
gc	-	-	-0.657*** (-8.08)	-	-	-	-	-1.175*** (-4.59)	-	-
$tldng$	-	-	-	-0.031 (-1.90)	-	-	-	-	-0.097*** (-5.42)	-
our	-	-	-	-	-0.070* (-2.19)	-	-	-	-	0.036 (0.41)
$cons.$	6.064*** (37.01)	-0.121 (-0.29)	10.97*** (7.74)	0.237 (0.43)	0.837 (1.07)	11.00*** (38.24)	4.729 (2.59)	22.00*** (3.96)	-0.418 (-0.29)	-5.044* (-2.12)
N	91	89	89	89	89	91	89	89	89	89

Note: Dependent variable is rr. The t-statistics are given in paranthesis. * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 6 shows the transition probabilities of the two states for the rr reserve bank policy pate, which is the repo rate. There is a 95.65% chance that rr reserve bank policy pate, which is the repo rate that will move from state one and return to state one. However, there is an 88.44% chance that rr reserve bank policy pate, which is the repo rate that will move from state two and return to state two.

Table 6. Transition Probabilities

p_{11}	0.9565372	p_{12}	0.0434628
p_{21}	0.0434628	p_{22}	0.8844827
Number of obs = 89			

Table 7 reflects the expected duration to be spent in each state. It is found that rr reserve bank policy pate which is the repo rate will be in state 1 for 23 quarters and spend 8 quarters in state 2.

Table 7. Expected Duration

States	Expected Duration
State 1	23.00821
State 2	8.656714
Number of obs = 89	

Figure 5 shows the filter transition probability from state 1 to state 2 as well as the rr reserve bank policy rate, which is the repo rate. Figure 5, graph a, shows the state 1 filter rr reserve bank policy rate, which is the repo rate, which is characterized by a repo rate of 6.06%, suggesting a 9.56% prime rate in this state. There are 2 times that the economy operated in state 1 during the period of 2004 quarter 4 to 2006 quarter 4. The economy then returns to state 1 during the period of 2009 quarter 4 to 2023 quarter 3. South Africa successfully led through the global financial crisis of 2008 thanks in large part to the SARB, and 650 basis points were taken off the buyback rate between November 2008 and November 2010. The bank intensified its attention on financial stability goals as a result of this crisis[1].

On the other hand, Figure 5, graph a, shows the state 2 filter rr reserve bank policy rate, which is the repo rate, which is characterized by an 11.06% repo rate, suggesting a 14.56% prime rate in this state. There are 2 times that the economy operated in state 2 during the period of 2000 quarter 1 to 2003 quarter 4. The economy then returns to state 1 during the period of 2007 quarter 3 to 2009

[1] SARB, 2022. "History of South Africa Reserve Bank from 1921 To 2023."

quarter 1. State 2 was hit by 2 macroeconomic events, which included the recession of 2016 and COVID-19. During this time, the SARB was acting in the COVID-19 epidemic that caused financial turmoil on a worldwide scale in 2020. The SARB once again played a significant role in South Africa's reaction to the crisis by reducing the buyback rate by 225 basis points in the first four months of the year. To ensure the financial system's ongoing efficient operation, it also imposed liquidity measures[2].

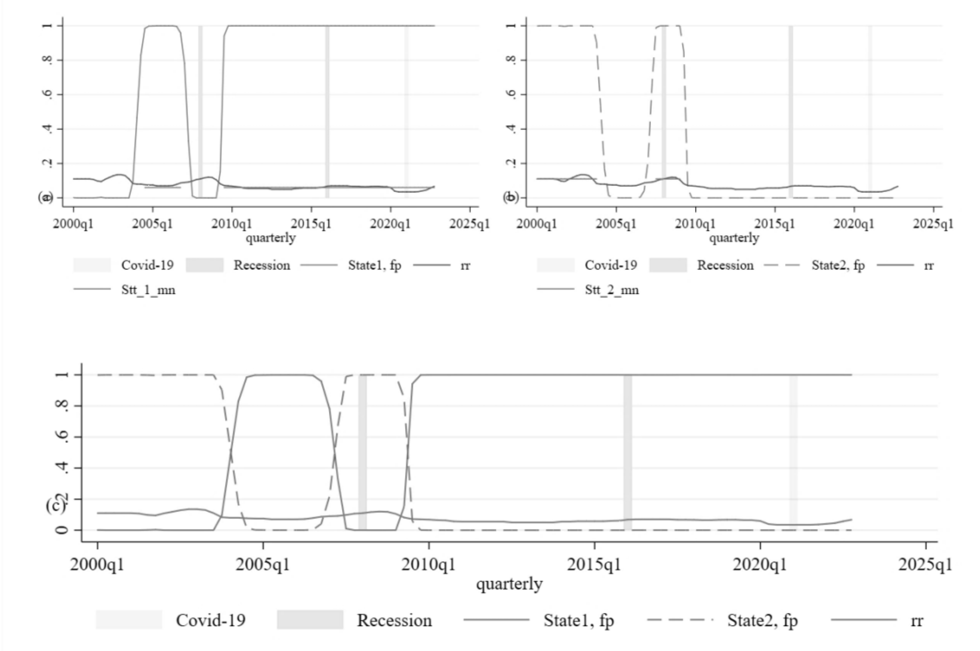

Figure 5. Transition state probability.

Note: The variables are rr is the policy rate (repo rate), state1, fp state 1 filter policy rate and state2, fp state 2 filter policy rate.

5. Conclusion

The interaction between monetary and fiscal policies plays an important role in stabilizing an economy. The implementation of a sound fiscal policy provides room for an active monetary policy. The contemplation of what type of monetary and fiscal policy mix in a different state of policy rate or repo rate. There is less

[2] SARB, 2022. "History of South Africa Reserve Bank from 1921 to 2023."

attention to the analysis of the impact of fiscal policy macroeconomic variables in a different state of policy rate with the consideration of the lower bound and upper bound rate of inflation. This paper examines the dynamic nexus of monetary and fiscal policy in South Africa with evidence from key macroeconomic economic indicators from 2000 quarter 1 to 2022 quarter 3. Markov-switching dynamic regression is used in the Taylor theoretical framework. Broadly speaking, the economy typically displays two *"regimes"* (or more technically, two *"states"*) of the repo rate. The results highlight the importance of scrutinizing the prevailing monetary-fiscal policy regime in understanding macroeconomic dynamics, particularly in emerging economies, which have been largely understudied. The South Africa Reserve Bank's reaction to fiscal policy macroeconomic variables is significant in different states. Moreover, there is evidence of a constant reaction of the South Africa Reserve Bank when inflation is at the lower and upper bounds. The increase in the gross domestic product gap and inflation gap results in an increase in the rope rate. The result suggests that the monetary policy provided a supportive policy to fiscal policy macroeconomic variables. However, there is a state where trade-offs in the current policy of monetary and fiscal mix reaction. The fiscal policy needs to be adjusted to attain the desired target.

References

Afonso, A., Alves, J., & Balhote, R. (2019) Interactions between monetary and fiscal policies. *Journal of Applied Economics*, 22(1), 132-151, DOI: 10.1080/15140326.2019.1583309

Agu, C. (2011). An econometric analysis of the monetary policy reaction function in Nigeria, AERC.

Ahmad, S. (2016). A multiple threshold analysis of the Fed's balancing act during the Great Moderation. Economic Modeling, 55, 343-358.

Al-shawarby, S., and El Mossallamy, M. (2019). Monetary-fiscal policies interactions and optimal rules in Egypt. *Review of Economics and Political Science*, 4(2), 138-157.

Alesina, A., Favero, C., and Giavazzi, F. (2019). Effects of Austerity: Expenditure- and Tax-Based Approaches. *Journal of Economic Perspectives*, 33(2), 141-62. DOI: 10.1257/jep.33.2.141

Ayinde, T.O., Bankole, A.S., and Adeniyi, O. (2020). Modelling central bank behaviour in Nigeria:A Markov-switching approach. *Central Bank Review*, 20(4), 213-221. https://doi.org/10.1016/j.cbrev.2020.11.001.

Battistini, N., and Callegari, G., and Zavalloni, L. (2019). Dynamic Fiscal Limits and Monetary-Fiscal Policy Interactions. ECB Working Paper No. 2268. http://dx.doi.org/10.2139/ssrn.3374165

Bianchi, F., and Ilut, C. (2017). Monetary/fiscal policy mix and agents' beliefs. *Review of economic Dynamics*, 26, 113-139.

Buthelezi, E.M., and Nyatanga, P. (2018). Government Debt and Economic Growth: Evidence from ECOWAS and SADC. *African Journal of Business & Economic Research*, 13(3).

Cavalcanti, M.A.F.H., Vereda, L., Doctors, R.B., Lima, F.C., & Maynard, L. (2018). The macroeconomic effects of monetary policy shocks under fiscal rules constrained by public debt sustainability. *Economic Modelling*, 71, 184-201. https://doi.org/10.1016/j.econmod.2017.12.010.

Çebi, C. (2012). The interaction between monetary and fiscal policies in Turkey: An estimated New Keynesian DSGE model. *Economic Modeling*, 29(4), 1258-1267.

Christiano, L., and Fitzgerald, T. (2003). The Bandpass Filter. *International Economic Review*, 44(2), 435-465.

Cordes, A.C. (2020). Fiscal Consolidation Following a Sovereign Default. Hertie School of Governance.

Crowley, P.M., and Hudgins, D. (2018). Evaluating South African fiscal and monetary policy trade-offs using a wavelet-based model. *South African Journal of Economics*, 86(4), 401-427.

Cui, W. (2016). Monetary–fiscal interactions with endogenous liquidity frictions. *European Economic Review*, 87, 1-25.

Davig, T. and Leeper, E.M. (2011). Monetary–fiscal policy interactions and fiscal stimulus. *European Economic Review*, 55(2), 211-227.

Dosi, G., Fagiolo, G., Napoletano, M. Roventini, A., & Treibich, T. (2015). Fiscal and monetary policies in complex evolving economies. *Journal of Economic Dynamics and Control*, 52(C), 166-189

Du Plessis, S., Smit, B., & Sturzenegger, F. (2007). The Cyclicality Of Monetary And Fiscal Policy In South Africa Since 1994. *South African Journal of Economics, Economic Society of South Africa*, 75(3), 391-411. DOI: 10.1111/j.1813-6982.2007.00128.x

Hamilton, J.D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the econometric society*, 357-384.

Hamilton, J.D. (1990). Analysis of time series subject to changes in regime. *Journal of econometrics*, 45(1-2), 39-70.

Hansen, B.E. (1996). Inference when a nuisance parameter is not identified under the null hypothesis. *Econometrica: Journal of the econometric society*, 413-430.

Hansen, B.E. (2000). Sample splitting and threshold estimation. *Econometrica*, 68(3), 575-603.

Hodrick, R.J., & Prescott, E.C. (1987). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*, 29(1), 1-16

Iddrisu, A.A., and Alagidede, I.P. (2021). Is the monetary policy behavior of the South African Reserve Bank nonlinear? *Global Business and Economics Review*, 24(2), 193-209.

Karamysheva, M. (2022). How do fiscal adjustments work? An empirical investigation. *Journal of Economic Dynamics and Control*, 137(C). DOI: 10.1016/j.jedc.2022.104347

Liu, D., Sun, W., & Chang, L. (2021). Monetary–fiscal policy regime and macroeconomic dynamics in China. *Economic Modelling*, 95(C), 121-135. DOI: 10.1016/j.econmod.2020.12.007

Lubik, T.A., and Schorfheide, F. (2007). Do central banks respond to exchange rate movements? A structural investigation. *Journal of Monetary economics*, 54(4), 1069-1087.

Mankiw, N.G. (2019). *Brief Principles of Macroeconomics*. Boston: Cengage Learning.

Omotosho, B.S. (2022). Monetary and fiscal policy interactions in resource-rich emerging economies. *Macroeconomics and Finance in Emerging Market Economies*, 1-22.

Rezabek, P., and Doucek, P. (2018). Monetary and fiscal policy interactions in the Czech Republic. *Systems*, 6(2), 25.

Tavakolian, H., and Taherpoor, J. (2022). Fiscal and Monetary Policy Interaction in Iran: A TVP-VARMA Model. Iranian Economic Review, 26(3), 637-665.

Taylor, J.B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester conference series on public policy*, 39, 195-214, https://doi.org/10.1016/0167-2231(93)90009-L.

Taylor, J.B. (1998). Monetary policy and the long boom. Federal Reserve Bank of St. Louis Review, 3-12.

Taylor, J.B. (1999). The robustness and efficiency of monetary policy rules as guidelines for interest rate setting by the European Central Bank. *Journal of Monetary economics*, 43(3), 655-679.

Taylor, J.B. (2001). The role of the exchange rate in monetary-policy rules. *American Economic Review*, 91(2), 263-267.

Utama, C., and Fitrady, A. (2022). Fiscal and Monetary Policy Interactions in Indonesia during Periods of Economic Turmoil in the US: 2001Q1-2014Q4. *Bulletin of Monetary Economics and Banking*, 25(1), 97-116.

Valli, M., and Carvalho, F.A. (2010). Fiscal and monetary policy interaction: a simulation-based analysis of a two-country new Keynesian DSGE Model with Heterogeneous Households. Bank of Italy Occasional Paper.

Wang, L. (2018). Monetary-fiscal policy interactions under asset purchase programs: Some comparative evidence. *Economic Modeling*, 73, 208-221.

Xu, L., and Serletis, A. (2016). Monetary and fiscal policy switching with time-varying volatilities. *Economics Letters*, 145, 202-205.

Yang, W., Fidrmuc, J., & Ghosh, S. (2015). Macroeconomic effects of fiscal adjustment: A tale of two approaches. *Journal of International Money and Finance*, 57, 31-60, https://doi.org/10.1016/j.jimonfin.2015.05.003.

Appendices

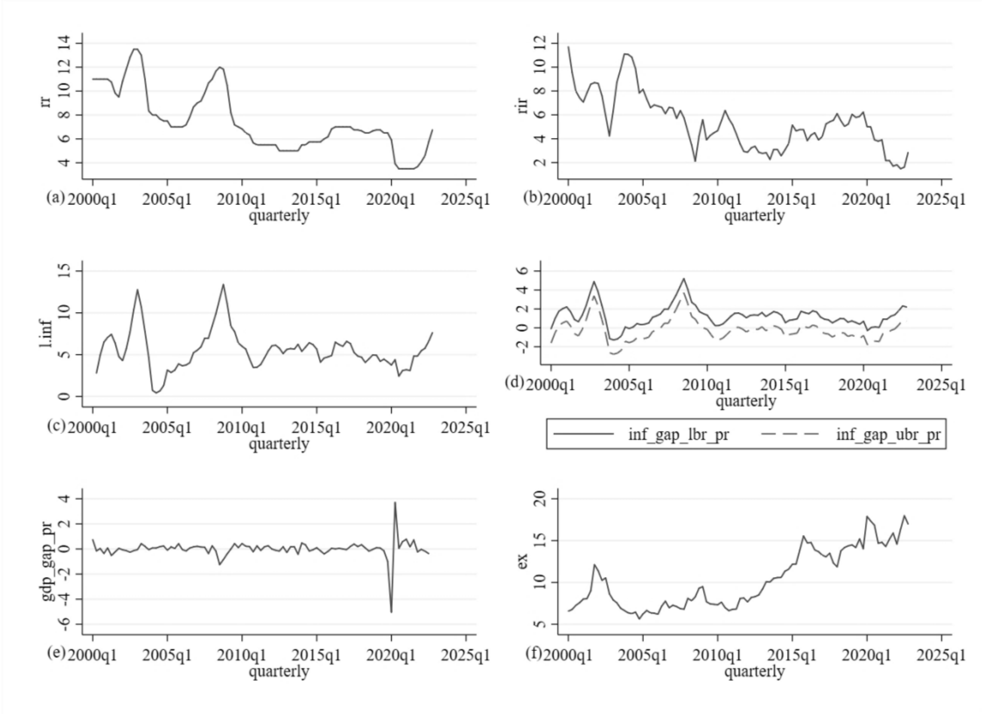

Figure 1.A. Economic variables that are considered in the model.

Note: The variables are rr is the policy rate (repo rate), rir is the real interest rate, $l.inf$ is the lag inflation rate, $inf\_gap\_lbr\_pr = 0.5(inf - lbr)$ is the inflation gap of the lower bound from the Taylor Rule function, inf is inflation, lbr is the lower bound of 3%, $inf\_gap\_ubr\_pr = 0.5(inf - ubr)$ is the inflation gap of the upper lower bound from the Taylor Rule function, ubr is the upper bound of 6%, and ex is the SA Exchange to a US Dollar.

Table 1.A. Correlation among economic variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
rr	1.00												
rir	0.54	1.00											
inf	0.55	-0.40	1.00										
inf^{lbr}	0.55	-0.40	1.00	1.00									
inf^{ubr}	0.55	-0.40	1.00	1.00	1.00								
gdp	-0.21	0.04	-0.27	-0.27	-0.27	1.00							
gdp^{gap}	-0.15	0.05	-0.21	-0.21	-0.21	0.97	1.00						
ex	-0.47	-0.47	-0.05	-0.05	-0.05	0.02	-0.08	1.00					
wui	-0.29	-0.37	0.04	0.04	0.04	-0.07	-0.02	0.49	1.00				
$ngds$	0.50	0.32	0.22	0.22	0.22	-0.12	-0.07	-0.48	-0.23	1.00			
gc	-0.71	-0.58	-0.20	-0.20	-0.20	0.18	0.13	0.80	0.52	-0.64	1.00		
$tldng$	-0.59	-0.39	-0.26	-0.26	-0.26	0.20	0.04	0.88	0.31	-0.51	0.76	1.00	
our	-0.36	-0.23	-0.17	-0.17	-0.17	0.12	-0.07	0.66	0.10	-0.39	0.50	0.82	1.00

Note: The variables are associated with $rr\_ubr_t = 1$, $rr\_ubr_t = 2$, $rir_t = 3$, $inf_t = 4$, $inf\_gap\_lbr_t = 5$, $inf\_gap\_ubr_t = 6$, $gdp\_gap_t = 7$, $ex_t = 8$, $wui_t = 9$, $ngds_t = 10$, $gc_t = 11$, $tldng_t = 12$, and$our_t = 13$.