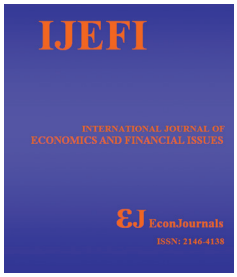

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Fiscal and Monetary Policies Interactions in Nigeria and South Africa: Dynamic Stochastic General Equilibrium Approach

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ABSTRACT

The interaction between fiscal and monetary policies in achieving macroeconomic goals has been a subject of debate, particularly on whether they complement or substitute each other. This issue arises when both policy authorities are independent of each other. This study aims to revisit the interaction of fiscal and monetary policies in Nigeria and South Africa using a dynamic stochastic general equilibrium model (DSGE) and calibration technique. The model consists of 20 equations that illustrate the behaviour of endogenous variables. The parameters are obtained from relevant DSGE literature and economic intuitions about the two economies. The findings reveal that fiscal and monetary policy variables interact in both economies. Inflation responds to fiscal policy shocks such as government spending, revenue and borrowing shocks. Monetary authorities' decisions such as interest rates and inflation also affect fiscal policy variables. However, the performance of monetary and fiscal policy variables is better in South Africa than in Nigeria. The study recommends closer coordination between the monetary and fiscal authorities in both economies to resolve policy design and implementation issues. Government monitoring and assessment units should also be strengthened to track the implementation and delivery of policies decided upon at coordination meetings.

Keywords: Fiscal Policy, Monetary Policy, DSGE
JEL Classifications: C01, E50, H30

1. INTRODUCTION

Fiscal policy and monetary policy are important macroeconomic tools used to achieve macroeconomic objectives (Blanchard, 2000). The dominant objective of fiscal policy is to increase the aggregate output of the economy, while the overriding objective of monetary policy is to regulate and control the interest and inflation rates (Mishkin, 2011). Conventionally, both fiscal and monetary policies were under the control of national governments. Consequently, traditional economic analyses were made with respect to both policies to attain the optimum policy mix of the two in order to achieve the broad macroeconomic goals (Blanchard, 2000). However, more recently, as a result of the transfer of monetary policy control and monetary policy formulation to central banks, there has been a significant and notable structural change in the way in which fiscal and monetary policies interact (Taylor, 2013). There has been a dilemma with regard to whether these two policies are complementary, or are substitutes of each other for achieving macroeconomic goals (Blanchard, 2000). The issue of fiscal and monetary policy interaction and the idea of complementarity or substitutability for each other come up only when both fiscal and monetary policy authorities are independent of each other (Svensson, 2001). Monetarists had earlier suggested inconsequential intervention of government and are opposed to unrestricted policies (Nunes and Portugal, 2009). Their opponents, the Keynesians, support interventions (Daly and Smida, 2015). These submissions by the monetarists and Keynesians have divorced arguments between the two policies (Nunes and Portugal, 2009). Consequently, the empirical discussions on the behaviour of monetary policy were just pertaining to rules and discretionary performance (Woodford, 1998). Fiscal policy was assumed to play an unimportant part, while monetarist models supposed the

presence of Ricardian management, under which the budget of government was prone to repeated deviations (Barro, 1990).

Recent research has shown an increasing adoption of dynamic stochastic general equilibrium models for analyzing the interaction of fiscal and monetary policies. This is because DSGE models offer more room for policy intervention compared to earlier models like the vector autoregression (VAR) model. Central bankers across the world have increasingly used DSGE models for evaluating the dynamic interactions between fiscal and monetary policy variables (Shahid et al., 2016). The use of DSGE models has been especially prevalent in developed countries. In light of this, the current study contributes to the ongoing discussion on fiscal and monetary policy interactions by utilizing a DSGE model to analyze the interaction of fiscal and monetary policies in Nigeria and South Africa.

The following sections of this paper are organized as follows: Section 2 provides a review of the relevant literature, while Section 3 describes the empirical methods used in the study. Section 4 presents the results, and the final section offers concluding remarks.

2. REVIEW OF LITERATURE

Early studies on monetary policy posited that fiscal policy had no significant impact on monetary policy. According to this belief, the role of fiscal policy was to determine the government's budget, while the monetary authority was responsible for regulating the money supply and interest rates. From this assumption, it was concluded that the monetary authority should exercise control over the monetary base to manage inflation, and seigniorage should be determined by the monetary authority. As a result, the monetary authority would determine prices, while the fiscal authority would ensure a balanced government budget. This concept is referred to as monetary dominance (Leeper, 1991; Sargent and Wallace, 1981). With this arrangement, deficits would not lead to future inflation.

Hughes and Weymark (2005) conducted a regression analysis using instrumental variables to explore the interaction between monetary and fiscal policies in the UK and the euro area, and discovered evidence of substitutability of monetary and fiscal policy interaction in the UK, while complementarity was observed in the euro area. Kirsanova et al. (2005) also found and advocated the complementarity between fiscal and monetary policy variables. In addition, Reade and Stehn (2007) employed cointegrated VAR to investigate the interaction of monetary and fiscal policy and its impact on public debt sustainability in the United States from 1960 to 2005. They found that fiscal policy is an important tool for ensuring debt sustainability, which is consistent with the findings of Daly and Smida (2016) and Muscatelli et al. (2004).

According to Bianchi and Ilut (2017), the fluctuations in US inflation can be explained by changes in the balance of power between the fiscal and monetary authorities. When the fiscal authority takes the lead, fiscal imbalances can result in persistent inflation and a loss of control by the monetary authority. The effects of these shocks can last as long as the market expects the fiscal authority to continue dominating. Therefore, if the monetary authority attempts to reduce inflation without support from the fiscal authority, inflation may remain relatively unaffected. However, once the fiscal authority aligns with the central bank's actions, inflation quickly decreases, but the economy enters a recession, and the debt-to-GDP ratio rises. These events are similar to those that occurred in the early 1980s and can be attributed to changes in the policy mix itself.

Cekin (2013) used a Markov switching approach to study inflationary issues in the interaction between monetary and fiscal policies, with a rational expectations model that allows for policy switching. The results suggest that a switch in both monetary and fiscal policies is necessary for the monetary policy to maintain price stability, by preventing deficit shocks from transmitting to inflation.

In a separate study, Choudhri and Malik (2012) employed a small-scale DSGE model to analyse monetary policy in Pakistan. They assumed that monetary policy is passive and found that changes in government expenditure tend to crowd out private investment, while changes in money supply do not significantly cause inflation, but have an important impact on output. These findings are consistent with the empirical results of Coenen and Straub (2004).

Ellison and Tischbirek (2014) used a DSGE model to investigate the impact of long-term government debt purchases on short-term interest rate policy. Their study found that unconventional monetary policy can play a significant role in managing interest rate volatility if the central bank is concerned about it. Punzo and Rossi (2016) employed an NK-DSGE model to analyze the effects of government purchases on monetary and debt financing. They found that the reallocation effect is greater in a money-financed fiscal stimulus than in a debt-financed fiscal stimulus.

Monetary and fiscal policies are not pursued for their own sake, but rather to influence economic outcomes. These policies can have important and sometimes contradictory effects on macroeconomic outcomes. Dungey and Fry (2010) sought to understand the potential outcomes of monetary and fiscal policy actions on the economy. They used an SVAR model to examine the effects of monetary and fiscal policy in Australia. The empirical findings indicate that increases in government expenditure lead to a much larger increase in government revenue, resulting in a decline in the debt-to-GDP ratio.

Chatziantoniou et al. (2014) argue that there is a lack of empirical studies on the interaction between fiscal and monetary policy outcomes and stock market developments. They conducted an SVAR analysis to determine the effects of monetary and fiscal policy shocks on stock market performance in selected European countries. Their empirical findings suggest that both fiscal and monetary policies affect the performance of stock markets.

Davig and Leeper (2009) used Markov-switching to estimate policy rules for the United States and also found evidence of fiscal and monetary policies switching. Dosi et al. (2015) examined the effects of fiscal and monetary policies on income distribution. They concluded that both policies should complement each other to stabilize the economy and that the negative effects of severe

fiscal rules are overstated by passive monetary policy, which could worsen income disparity.

The study conducted by Jin (2013) explored the interactions among debt maturity management, monetary and fiscal policies, using a DSGE model. The empirical findings indicated that debt maturities had no significant impact on the interactions between monetary and fiscal policies. However, the study revealed that longer average maturities of debt amplify the effects of monetary policy shocks on the prices of bonds. Meanwhile, Ojeda-Joya and Guzman (2017) analyzed the impacts of consumption shocks on GDP, utilizing a panel analysis. They found that government consumption shocks were typically accompanied by the tightening of monetary policy. Additionally, the study concluded that consumption shocks have higher multipliers in developing countries.

In their study, Gnocchi and Lambertin (2013) analyzed the interaction between committed monetary and discretionary fiscal policy using Markov-Switching. Their empirical findings suggested that the fiscal authority lacks commitment, leading to a steady-state level of debt determined by time-consistency problems. They believe that fiscal indiscipline contributes to tax rate volatility and inflation. Adam and Billi (2008) conducted a study to reassess the effects of inflation traditionalism on fiscal policy and taxation. Their empirical clarification reaffirms the role of policy timing in affecting inflation.

Hayo and Niehof (2014) developed a DSGE model in an open economy with monetary and fiscal policy in a continuous time framework to analyze the interdependence between the two policies during financial crises. They analyzed the contagious effects on bond markets and real markets under different types of monetary and fiscal policies. They found evidence that the cost of inflation under the modified Taylor rule prevents crises the most; however, there was no evidence supporting either spending or austere fiscal policy. Depending on the inter-connectedness of markets, spending policy can cause a crisis in the bond market instead of preventing the crisis on the stock market. They could not find evidence that financial market crises will affect the monetary and fiscal policy interdependence. Dixit and Lambertini (2001) and Galí and Perotti (2003) demonstrated that financial market crises have an impact on the interdependence between monetary and fiscal policies.

In Gonzalez-Astudillo's (2013) study, Bayesian methods for nonlinear state-space models were utilized to estimate policy rules with time-varying coefficients, endogeneity, and stochastic volatility. The empirical findings indicate that policymaking exhibits significant persistence, with fiscal policy being marginally more persistent than monetary policy. The study also suggests that there are direct interactions between policies, as evidenced by a positive estimated correlation between latent factors. Moreover, the results suggest that monetary policy switches more frequently than fiscal policy and tends to loosen during recessions. Finally, the study finds evidence that taxes have effects on output, but these effects are attenuated compared to a pure fiscal regime.

In 2014, Ehelepola conducted an empirical study using a DSGE model to provide evidence on optimal monetary and fiscal policy rules that maximise welfare in Sri Lanka. The study used a standard Taylor rule-type monetary policy reaction function where the nominal interest rate responds to inflation deviations and output gap. Additionally, a simple fiscal policy reaction function in which tax revenue depends on the level of total government liabilities was employed. To conduct welfare analysis, equilibrium solutions to the model were approximated up to second order accuracy. Ehelepola proposed optimal monetary and fiscal policy rules that are implementable and simple for the Sri Lankan economy.

Philippopoulos et al. (2015) conducted a study on monetary and fiscal feedback policy rules using a new Keynesian model for a non-open economy. Based on their empirical findings, they suggest that monetary authorities should focus on maintaining price stability while fiscal authorities should be prepared to adjust to changes in debt levels. They support the idea that price stability is of utmost importance for monetary authorities.

The 2007/2008 global financial crisis has sparked a debate on the efficacy of monetary and fiscal policy in combating recessions and economic crises. Recent empirical studies suggest that government spending can be effective in mitigating the effects of financial crises. Devereux (2010) examined the role of debt and deficits in an economy with a zero bound on nominal interest rates and found that deficits can induce macroeconomic responses that help alleviate the effects of global financial crises. He argued that spending financed by deficits is more expansionary than tax finance, and during a liquidity trap, reducing taxes is more effective than during normal times. Valdivia (2017) followed the ideas of Hayo and Niehof (2014) on the role of monetary and fiscal policy in combating economic crises and used a DSGE model to investigate the effectiveness of fiscal and monetary policy coordination during the 2007-2010 global crisis. The results showed that fiscal and monetary policy shocks had unfavourable effects on price stability and economic growth during the crisis.

Mwabutwa et al. (2013) conducted a study on the response of monetary policy in Malawi to aid inflows in the short run, using a DSGE model. According to their empirical evidence, monetary policy responds positively to aid inflows. They did not find any evidence of Dutch Disease in Malawi, as they found an association between aid inflows and currency depreciation.

Hohberger and Herz (2012) conducted a study on the macroeconomic responses of current accounts to different shocks. According to their results, inconsistent monetary policies make the economy more vulnerable to shocks and result in exchange rate volatility, which worsens current account conditions. The authors suggest that stability in macroeconomic variables is related to fiscal response to the current account. However, they also found that attempting to stabilize the current account through fiscal policy could cause significant short-run output variations.

Valli and Carvalho (2010) expanded on the works of Coenen et al. (2007) and Christoffel et al. (2010) to explore the implementation of fiscal policy. They proposed a fiscal policy that aims to stabilize the debt level in an open economy. Their empirical findings suggest that the macroeconomic response to output growth worsens

inflation, whereas the response of money growth to the exchange rate shows less worsening of inflation variability.

Sanusi et al. (2021) examined the management and interaction aspects between fiscal and monetary policies in South Africa using a Bayesian vector autoregressive model (BVA) using monthly data on the inflation rate, interest rate, money supply, tax revenue, government spending and government debt for the period 2009-2019 were sourced from the South African Reserve Bank. Their findings show that positive shocks to the money supply prompt monetary authority to raise the economy's interest rate, which increases the bank rate. Inflation does not respond to shock to government spending and could drive inflation in the South African economy from the supply side rather than the demand side. Tax revenue and money supply shocks are significant sources of variation in inflation. These variables account for 7% and 18% variation in government spending. The study concludes that monetary authorities must employ supply-side measures to manage the price level.

3. EMPIRICAL APPROACH

The DSGE model is a useful tool for understanding the interactions between fiscal and monetary policies in an open economy. The model captures the behaviour of three different economic agents, namely households, firms, and the government. By simulating various scenarios and policy responses, the model can provide insights into the likely macroeconomic outcomes in different situations. In the case of Nigeria and South Africa, the DSGE model can help to inform policy decisions and identify potential risks and opportunities for the two economies.

3.1. Household

The DSGE model consists of households that aim at maximising the expected present discounted value of total utility during her lifetime conditioned by inter-temporal budget constraints:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma_t}}{1-\sigma_c} + x\frac{G_t^{1-\sigma_g}}{1-\sigma_g} - \frac{N_t^{1+\varnothing_n}}{1+\varnothing_n} \right) \quad (1)$$

Where $\beta = 1/(1+\rho)^t$ connotes the household discount factor and $\beta \in (0, 1)$, σ is defined as the inverse of inter-temporal elasticity of substitution in consumption, $\varnothing$ is defined as the inverse of labour supply elasticity concerning real wage and x measures the relative weight on the consumption of public goods; while C_t, G_t and N_t are the aggregate variables in the objective function and they connote private consumption, government spending and labour supplied respectively. The budget constraint function of the household is given as:

$$P_t C_t + P_t G_t + E_t [Q_{t,t+1} D_{t+1}] + T \leq D_t + (1+\gamma_t) W_t N_t \quad (2)$$

Where $Q_{t,t+1} = 1/(1+r_t)$ is the one period ahead stochastic discount factor, r_t connotes the nominal interest rate, T stands for taxes and γ_t is the income tax rate. W_t is the nominal wage rate. D_t represents the nominal portfolio, P_t is the CPI. C_t is the aggregate consumption index that is made up of domestically produced goods ($C_{H,t}$) and imported goods ($C_{F,t}$), and G_t is the consumption of public goods. There is an inherent assumption that both goods are produced by monopolistically competitive firms.

$$C_{H,t} = \left[\int_0^1 C_{H,t}(i)^{\frac{g-1}{\varepsilon}} di \right]^{\frac{g}{\varepsilon-1}} \text{ and } C_{F,t} == \left[\int_0^1 C_{F,t}(i)^{\frac{g-1}{\varepsilon}} di \right]^{\frac{g}{\varepsilon-1}}$$

$$P_t C_t = \int_0^1 \left[P_{H,t}(i).C_{H,t}(i) + P_{F,t}(i).C_{F,t}(i) \right] di$$

The first-order conditions produce a forward-looking open economy IS curve as indicated in Equation (3):

$$\hat{y}_t = E_t(\hat{y}_{t+1}) - E_t(\Delta g_{t+1}) + \alpha(\omega-1)(\rho_{c^*}-1)\hat{c}_t^* - \frac{1}{\sigma_\alpha}(\hat{r}_t - E_t[\pi_{H,t+1}]) \quad (3)$$

σ_α is defined as $\frac{\sigma}{(1-\alpha)+\alpha\omega}$, and $\omega = \sigma\gamma + (1-\alpha)(\sigma\eta - 1)$.

Parameter η denotes the substitution elasticity between domestic goods and foreign goods, α captures the proportion of domestic consumption allotted to foreign goods (degree of openness), while γ reflects the substitution elasticity between the goods produced in different foreign countries. Endogenous variables in the DSGE modelling are defined as follows:

Output $\hat{y}_t = \ln\left(\frac{y_t}{\hat{y}_t}\right) = y_t - \hat{y}$,

Where $\hat{y}_t$ denotes the steady state values of y_t

Government spending $g_t = \ln\left(1 - \frac{G_t}{Y_t}\right)$

Domestic inflation is given as $\pi_{H,t} = \ln\left(\frac{P_{H,t}}{P_{H,t-1}}\right)$

The IS curve for the open economy, which is forward-looking, is given as:

$$\tilde{y}_t = E_t y_{t+1} - E_t \Delta g_{t+1} - \frac{1}{\sigma_\alpha}(r_t - E_t \pi_{H,t+1}) \quad (4)$$

Where $\tilde{y}_t = \hat{y}_t - \hat{y}_t^n$ and $\check{r}_t = \hat{r}_t - \hat{r}_t^n$

$\hat{y}_t^n$ and $\hat{r}_t^n$ connote the natural rate of output and nominal interest rate. They are the equilibrium level of output and interest rate in the absence of nominal rigidities and are described in Equations (5) and (6):

$$\hat{y}_t^n = \frac{(1+\varnothing)}{(\sigma_\alpha+\varnothing)}\hat{a}_t - \frac{(\sigma-\sigma_\alpha)}{(\sigma_\alpha+\varnothing)}\hat{C}_t^* \quad (5)$$

$$\hat{r}_t^n = \sigma_\alpha\left(E_t\left[\hat{y}_{t+1}^n\right] - \hat{y}_t^n\right) + \sigma_\alpha\alpha(\omega-1)(\rho_{\hat{c}}-1)\hat{C}_t^* \quad (6)$$

Where $\hat{a}_t$ is defined as the log of technological progress, A_t.

3.2. Firms

The model assumes a continuum of similar monopolistically firms. The firms produced differentiated products using a linear technology defined as:

$$Y_t(j) = A_t N_t(j) \tag{7}$$

Following the earlier studies on fiscal and monetary policy interactions, such as De Resende (2007), the model assumes that a proportion of 1 – θ of the firm can set a different price in each period, and a proportion of the θ of the firm keeps its price constant. To consider the inflationary persistence, the model incorporates backwards-looking behaviour in the price-setting process:

$$P^b_{H,t} = P^{\bullet}_{H,t-1}\frac{P_{H,t-1}}{P_{H,t-2}} \tag{8}$$

Where $P^{\bullet}_{H,t-1} = \left(P^f_{H,t-1}\right)^{1-\vartheta}\left(P^b_{H,t-1}\right)^{\vartheta}$ defines the total prices chosen in period $t-1$.

Suppose that a fraction of 1 – θ of the firm can set a new price optimally in each production period, the remaining part θ sets their prices past the inflation rate. The rule of thumb price setter takes into account the previous period's inflation rate $\pi_{H,t-1} = \frac{P_{H,t-1}}{P_{H,t-2}}$ as well as the aggregate prices $P^{\bullet}_{H,t-1}$ occurred in time $t-1$, as prices are reset in period t. The presence of backwards-looking firms alongside forward-looking firms makes it possible to obtain equations (9) and (10) in terms of deviation from the steady state.

$$\hat{\pi}_{H,t} = \lambda^b \hat{\pi}_{H,t-1} + \lambda^f E_t\left[\hat{\pi}_{H,t+1}\right] + k\hat{mc} + \varepsilon^{\pi}_t \tag{9}$$

$$\hat{mc}_t = \sigma_{\alpha} + \varnothing\left(\hat{y}_t - \hat{y}^n_t\right) - \sigma_{\alpha}\hat{g}_t + \hat{\tau}_t \tag{10}$$

Where $\lambda^b = \frac{\vartheta}{\theta + \vartheta(1-\theta(1-\beta))}$

$$\lambda^f \frac{\beta\theta}{\theta + \vartheta(1-\theta(1-\beta))}$$

$$k = \frac{(1-\beta\theta)(1-\theta)(1-\vartheta)}{\theta + \vartheta(1-\theta(1-\beta))}$$

$\hat{mc}$ is defined as the marginal cost and $\tau_t = -\ln\left(\frac{1-\gamma_t}{Y_t}\right)$ is the log-linearised tax rate. ε^{π}_t denotes the cost-push.

Equation (4.31) implies that government spending, tax and the output gap directly influence inflation via Equation (4.30).

3.3. Government

Government as an economic agent influences the level of economic activity through monetary policy and fiscal policy. Therefore, the sub-section specifies both monetary and fiscal policy rules.

Monetary policy rule:

Following Grith and Uhlig (2007), a simple Taylor-type interest rate rule based on inflation and the output gap is defined as:

$$\hat{r}_t = \rho_r\left(\hat{r}_{t-1} - \hat{r}^n_{t-1}\right) + (1-\rho_r)\left[r_{\pi}\hat{\pi}_{H,t} + r_y\left(\hat{y}_t - \hat{y}^n_t\right)\right] + \hat{r}^n_t + \varepsilon^r_t \tag{11}$$

$\hat{r}^n_t$ stands for the interest rate at a natural level, ρ_r is the interest rate coefficient that is between nil and one. ε^r_t is the interest rate shock that is usually defined as an unsystematic part of monetary policy in the modelling of DSGE. r_{π} and r_y represent the preferences of the central bank between inflation and the output gap. Since the central bank aims at the stability of prices, the parameter r_{π} must be greater than r_y. By implication, the apex bank follows a monetary policy rule that changes the interest rate when there is a deviation of inflation at equilibrium and a departure of output from its natural state. More so, the central bank also considers the previous values of interest rate when resetting the interest rate. The greater the degree of interest rate smoothing, the lower would be the contemporaneous responses of nominal interest rate both inflation and the output gap.

Under fiscal dominance, the apex banks consider the level of borrowing when determining interest rate policy. According to Çebi (2012), the modified version of the Taylor rule could be written as:

$$\hat{r}_t = \rho_r\left(\hat{r}_{t-1} - \hat{r}^n_{t-1}\right) + (1-\rho_r)\left[r_{\pi}\hat{\pi}_{H,t} + r_y\left(\hat{y}_t - \hat{y}^n_t\right) + r_b\left(b_t - b_{t-1}\right)\right] + \hat{r}^n_t + \varepsilon^r_t \tag{12}$$

The parameter r_{π} is defined as proportional weight apportioned to variation in borrowing.

Fiscal policy rules:

The fiscal policy rules consider a backwards-looking version of fiscal policy reaction by taking into account previous responses of fiscal policy to economic activity with the underlying assumption of smoothing of fiscal instruments (Çebi, 2012):

$$\hat{g}_t = \rho_g\hat{g}_{t-1} + (1-\rho_g)\left[g_y\left(\hat{y}_{t-1} - \hat{y}_{t-1}{}^n\right) + g_b\hat{b}_t\right] + \varepsilon^g_t \tag{13}$$

$$\tau_t = \rho_{\tau}\tau_t + (1-\rho_t)\left[\tau_y\left(y_{t-1} - y^n_{t-1}\right) + \tau_b b_t\right] + \varepsilon^{\tau}_t \tag{14}$$

Parameters ρ_g and ρ_{τ} are defined as the degree of fiscal smoothing in Equations (13) and (14). g_y and τ_y show how government spending and tax respond to previous values of the output gap. g_b and τ_b show the responses of unobservable debt stock. ε^g_t and ε^{τ}_t are government spending shocks and tax shocks, respectively, and they are non-systematic elements of discretionary fiscal policy. Conclusively, the government inter-temporal fiscal constraint in the log-linearised form can be expressed as:

$$\hat{b}_{t+1} = \hat{r}_t + \frac{1}{\beta}\left[\hat{b}_t - \hat{\pi}_{H,t} + (1-\beta)\left(\hat{\tau}_t - \hat{y}_t\right) + \frac{\dot{C}}{\bar{B}}\left(\hat{g}_t - \tau_t\right)\right] \tag{15}$$

$b_t = \ln\left(\frac{B_t}{P_{H,t-1}}\right)$ B_t is the nominal stock debt. B^{-} is defined as the steady state debt and $\acute{C}$ is a steady state of consumption.

3.4. Calibration

Once the structural model is solved, the next step in DSGE modelling is to obtain the parameter values, according to Çebi (2012). There are two commonly used methods in the literature to obtain these values. Some studies use econometric techniques, while others use the calibration method (Grith and Uhlig, 2007). The calibration method involves determining parameter values arbitrarily using available data, values from other works, or economic intuitions about the economies being studied (Grith and Uhlig, 2007). This is the method used in most literature. Alternatively, parameters can be estimated. For this study, the calibration technique is used. The model equilibrium consists of 20 equations that demonstrate the behaviour of 20 endogenous variables. The main calibration method used is to obtain parameter values from relevant DSGE literature and economic intuitions about the Nigerian and South African economies.

4. EMPIRICAL RESULTS

To analyze the dynamic responses within the DSGE model, impulse response functions obtained from the Dynare software are evaluated. The study examines the effects of fiscal and monetary policy variables, namely interest rate, inflation rate, government debt, tax revenue, government spending, and output, in response to various modeled shocks in Nigeria and South Africa. This section is divided into two parts, with each part presenting the dynamic responses in each country.

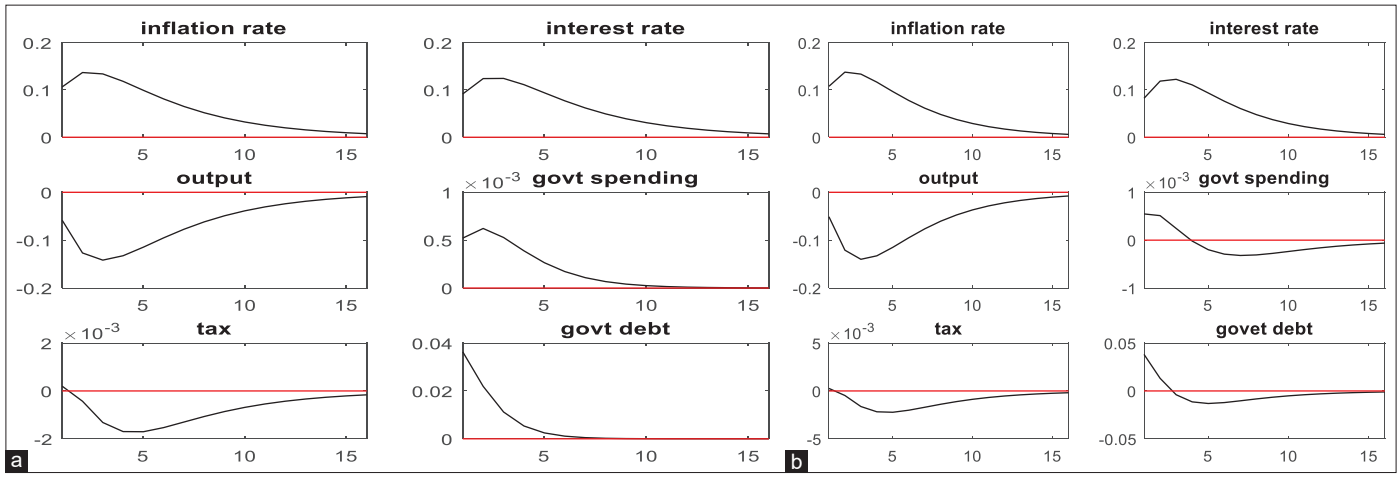
4.1. Inflation Shocks

Figure 1a illustrates the response of different fiscal and monetary policy variables to inflationary shocks in the Nigerian economy. At the onset of an inflationary shock, there is a temporary increase in the inflation rate, interest rate, and government spending. However, these variables gradually return to their steady state levels over time, and the effect of the shock dissipates. This pattern of response is in line with theoretical predictions and existing literature. The initial increase in these variables can be explained by the fact that economic agents were not expecting the shock to occur.

The phenomenon of shocks to the economy eventually returning to the steady state after initial fluctuations has been observed in various empirical studies, providing support for the DSGE modelling approach. For instance, Çebi (2012) and Galí and Perotti (2003) found that the effects of shocks on the macroeconomic variables tend to become stable over time as agents form expectations and adjust their behaviour accordingly. Regarding the specific inflationary shock analysed in the Nigerian economy, the initial fall in output, government debt, and tax revenue can be attributed to the increased cost of production caused by the inflationary shock. The sharp decline in domestic output may lead to a decrease in government revenues, as tax revenues are closely tied to economic activity. As a result, government debt initially falls due to the decrease in government revenue, but it eventually returns to the steady state. Meanwhile, tax revenue rises after the initial fall and eventually settles at its steady state. Overall, these findings highlight the complex interactions between different macroeconomic variables and the potential impact of shocks on the economy.

Figure 1b demonstrates that the responses of fiscal and monetary policy variables to inflationary shocks in South Africa had some similarities and sharp differences when compared to the Nigerian economy. In the South African economy, a shock to inflation caused a sharp rise in both inflation rate and interest rate. However, just like in Nigeria, inflation eventually began to fall, and the effects of the shock dissipated as the economy returned to its steady state. Similarly, output also fell due to the shock, but unlike in Nigeria, the effects of the fall in output did not last as output began to rise again and the economy converged back to its steady state. It is worth noting that the different responses observed in the two economies could be attributed to several factors, including differences in economic structures, monetary and fiscal policies, and institutional frameworks. Furthermore, the results highlight the importance of understanding the specific characteristics of each economy when designing policies aimed at stabilizing inflation

Figure 1: (a) Orthogonalised inflation shocks. (b) Orthogonalised shocks to inflation



Source: Author's computation

and promoting economic growth. This is consistent with Sanusi et al. (2021).

4.2. Interest Rate Shocks

Figure 2a illustrates how fiscal and monetary policy variables respond to interest rate shocks. The shock causes an initial decline in the inflation rate, interest rate, and tax revenue. The inflation rate and tax revenue experience a brief decline before immediately rising again and converging back to their steady state, while the interest rate continues to fall until the effects of the shock dissipate. On the other hand, the shock leads to an initial increase in output, government debt, and government spending. However, the effects of the shock gradually diminish over time, and the variables eventually return to their steady state levels. The observed increase in government debt is consistent with theoretical expectations, as a shock to the interest rate typically prompts the government to increase debt in order to boost aggregate output, which in turn leads to increased government spending and output. These empirical results align with a number of existing studies, such as Muscatelli and Tirelli (2005) and Sims (1994), but differ from those of Shahid et al. (2016).

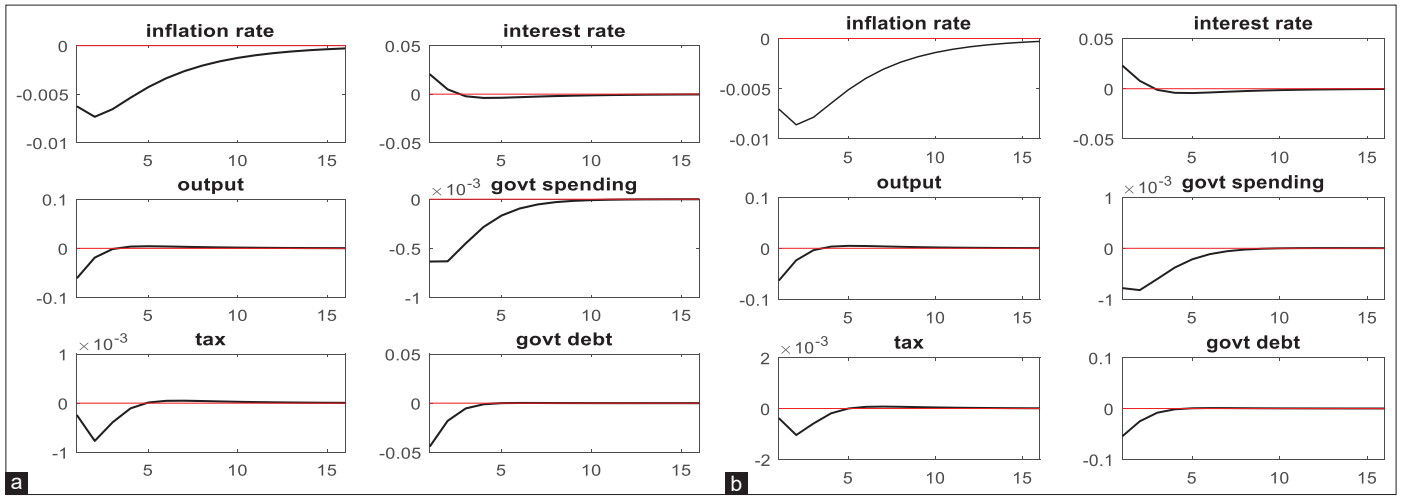
Figure 2b illustrates the responses of fiscal and monetary policy variables to interest rate shocks in the South African economy. The shock initially causes a brief decline in the inflation rate, followed by a rapid recovery as it converges back to its steady state. The responses of the interest rate to its own shocks and tax revenue to interest shocks are similar to those observed in the Nigerian economy. They initially deviate from the steady state with a rise, then quickly begin to increase again, and eventually settle at the steady state. Similarly, the shock to the interest rate in South Africa leads to an initial deviation from the steady state in output, government debt, and government spending, followed by a quick return to the steady state. The rise in government debt after the deviation from the steady state, caused by the interest rate shock, can be attributed to the increase in the aggregate output in the economy, which leads to a rise in government spending and output. Overall, the response of fiscal and monetary policy variables to interest rate shocks is similar in South Africa and Nigeria. Prior empirical studies, such as Muscatelli et al. (2005) and Sims (1994), also support the notion that fiscal and monetary policy variables behave similarly. The findings are howver at variance with Valli and Carvalho (2010) Coenen et al. (2007) and Christoffel et al. (2010).

4.3. Government Spending Shocks

Figure 3a shows that shocks to government spending in Nigeria lead to an immediate fall in inflation rate, which is followed by a positive impact as people form expectations about the shocks. This supports the claim that inflation in Nigeria is not predominantly a monetary phenomenon. The shocks to government spending have an expected positive impact on the output level, but the effect diminishes as output converges back to the steady state. The initial increase in the output level could be attributed to the sudden surge in aggregate spending, which stimulates economic activity and consequently increases the output level. These findings are consistent with previous studies, including Çebi (2012) and Shahid et al. (2016). The effects of shocks to government spending on government debt are positive throughout, until the economy converges at the steady state. The rise in government debt can be attributed to the fact that the change in government spending is a shock and not planned, and the government is likely to finance the majority of the spending shocks through debt. Tax revenue is observed to fall immediately, but it begins to increase as the economy moves towards the steady state. The response of government spending to its own shocks also aligns with virtually all previous studies, where government spending initially rises and later stabilizes, tending to converge back to its steady state.

Figure 3b illustrates the impact of shocks in government spending on fiscal and monetary policy variables in the South African economy. The graph reveals that the response of domestic output is stronger and more sustained than in Nigeria. Moreover, the long-term effect of government spending shocks on domestic output is greater in South Africa than in Nigeria. One possible reason for this is the higher incidence of corruption and inefficiencies in the Nigerian economy, whereas better infrastructure in South Africa may have played a role. Additionally, the impact of government spending shocks on the economy's own spending is greater in South Africa than in Nigeria.

Figure 2: (a) Orthogonalised interest rate shocks. (b) Orthogonalised shocks to interest rate



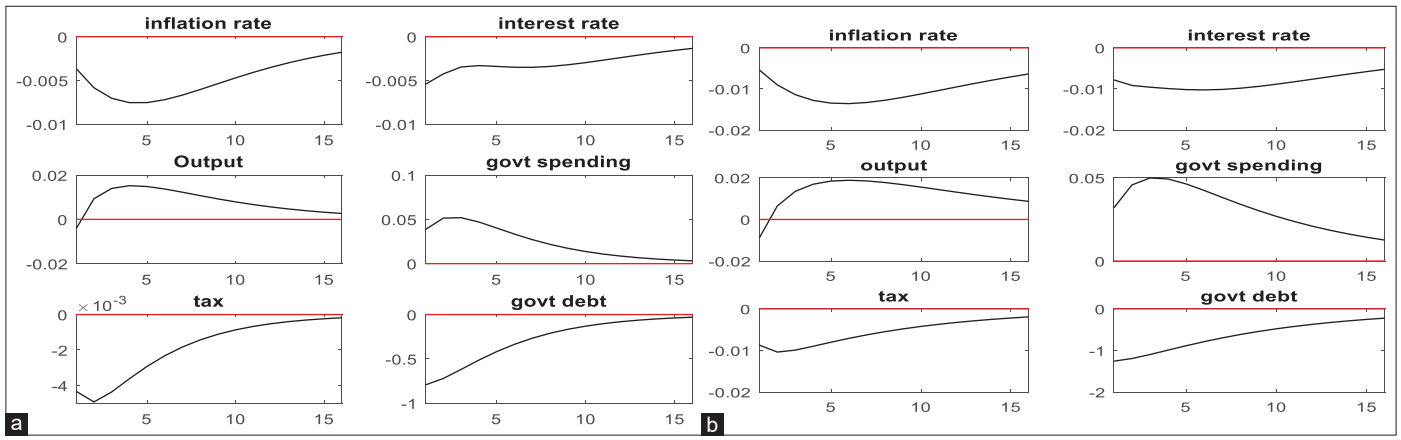
Source: Author's computation

However, Figure 3b reveals that in the South African economy, inflation falls more gradually than in Nigeria before eventually converging to its steady state. As people adjust their expectations to the inflationary shocks, the shocks begin to increase and approach the steady state. Additionally, the effects of shocks to government spending on government debt can be observed to cause a sudden deviation from the steady state and subsequently rise. This effect remains positive throughout the convergence towards the steady state. It can also be argued that the increase in government debt may be due to the fact that debt is primarily utilized to finance the shocks in spending. The response of tax revenue to shocks in government spending is similar to that observed in Nigeria. In other words, the tax response to sudden shocks in government spending in South Africa is comparable to the case of Nigeria. This empirical position is supported bt Hohberger and Herz (2012) and Mwabutwa et al. (2013) among others.

4.4. Tax Shocks

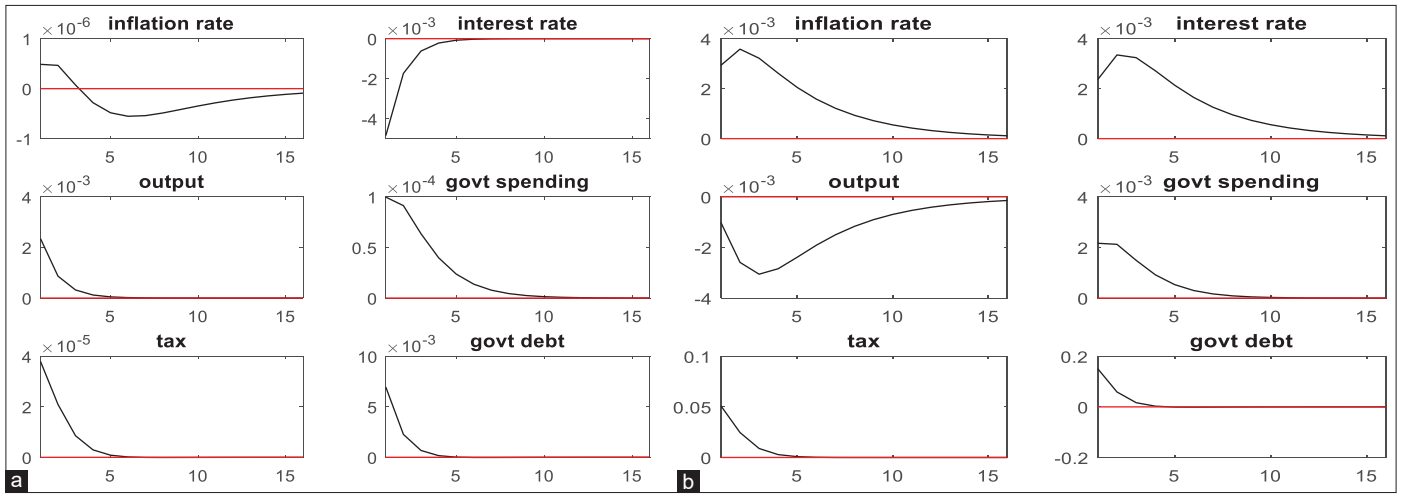
In Figure 4a, the response of fiscal and monetary policy variables to tax shocks in the Nigerian economy is shown. The graph indicates that tax shocks lead to a slight decrease in inflation, which eventually stabilizes and begins to rise toward the steady state. The effect of tax shocks on interest rates is positive, as interest rates increase continuously until the economy reaches the steady state. The positive response of interest rates to tax shocks can be attributed to some imperfections in Nigeria's financial system, such as information asymmetry between borrowers and lenders, and the absence of organized financial markets where buyers and lenders can freely interact. However, tax shocks do not produce the expected macroeconomic outcomes on output and government spending in Nigeria. Usually, tax is an automatic stabilizer in the economy, which reduces the amount by which output responds to changes in any of its autonomous components. If tax is used effectively, it would boost the output level through increased government spending on production. However, the graph indicates a negative impact on output level, while government spending responds negatively as well. One possible explanation for this is that tax is not being well and judiciously used. The graph also shows that government debt falls due to the shocks in tax revenue. The increase in government revenue from tax causes a significant reduction in the proportion of spending financed by debt. The effects of tax shocks on government debt also diminish as the economy converges back to its steady state. This is consistent with findings of Mwabutwa et al. (2013), Valdivia (2017) and Sanusi et al. (2021).

Figure 3: (a) Orthogonalised government spending shocks. (b) Orthogonalised shocks to government spending



Source: Author's computation

Figure 4: (a) Orthogonalised shocks to tax. (b) Orthogonalised tax shocks



Source: Author's computation

Figure 5: (a) Orthogonalised technological shocks. (b) Orthogonalised technological shocks

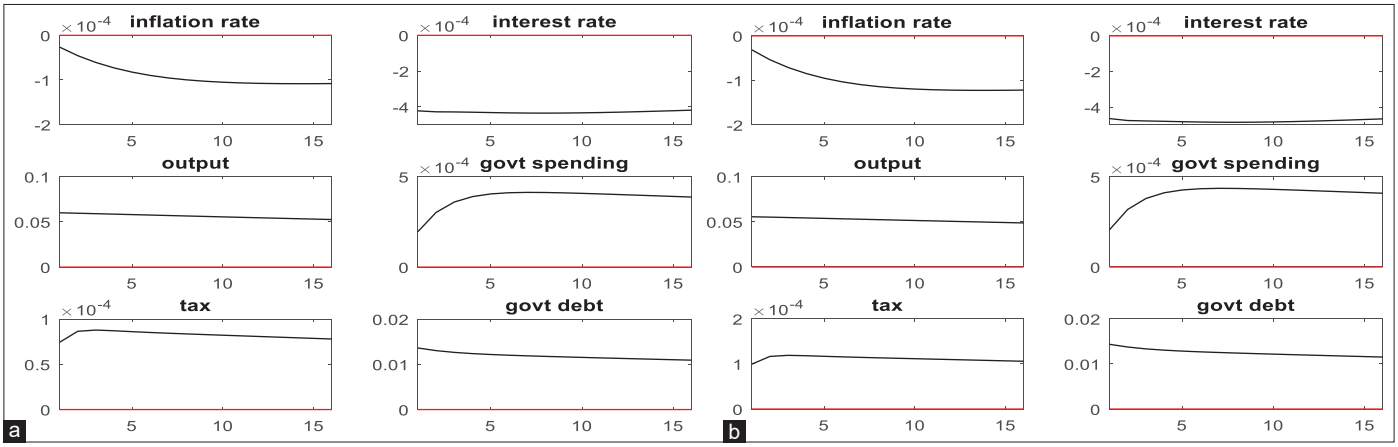


Figure 4b illustrates how different fiscal and monetary variables respond to tax shocks. The shock to tax affects both interest rate and inflation rate in a similar way, causing them to increase sharply before falling back towards their steady state levels. The observed fall in interest rate following tax shocks is in contrast to Nigeria, where interest rates continued to rise until they reached their steady state. This difference could be attributed to the more organized financial market in South Africa. Our findings support the position of Hayo and Niehof (2014).

It is noteworthy that government debt responded as expected to the tax shocks, as it fell sharply. This indicates that as the government experiences a sudden increase in tax revenue, the proportion of spending financed by debt significantly decreased. The effects of the shocks on government spending were relatively stable, and began to dissipate as government spending fell and returned to its steady state.

4.5. Technological Shocks

In the context of DSGE analysis of fiscal and monetary policies interactions, technological shocks are a crucial factor to consider, and Figure 5a presents the role of such shocks on fiscal and monetary policy variables. The empirical results demonstrate that shocks to technology, also known as total factor productivity, have a permanent positive impact on domestic output, resulting in a shift in the economy's steady state. Additionally, a technological shock appears to have a reducing effect on the inflation rate and interest rate. However, the shock leaves a permanent rising effect on government debt, as the steady state appears to shift upward. This implies that the bulk of the cost used in financing the technology might be through government debt.

The shocks to technology cause both government spending and tax to increase, and the effects are relatively stable. According to Figure 5a, the increase in government spending may be associated with an increase in other components of government expenditure, such as education and research, which are necessary to stimulate technological breakthroughs. As technology becomes more advanced, the means of collecting taxes become easier, and various methods by which people avoid taxes become blocked. The result of this is increased revenue from tax, and all fiscal and monetary policy variables respond appropriately to shocks in technology. These findings are consistent with standard economic theory, which suggests that technology plays a crucial role in fiscal and monetary policy interactions. Furthermore, these findings are consistent with previous studies, such as Shahid et al. (2016) and Grith and Uhlig (2007).

Figure 5b illustrates the response of fiscal and monetary policy variables to technological shocks in the South African economy. According to the empirical evidence, shocks to technology, also known as total factor productivity, have a permanent positive impact on domestic output, resulting in a change in the economy's steady state. This impact is similar to that of Nigeria and is consistent with several other studies, including Grith and Uhlig (2007) and Smets and Wouters (2003a). Similarly to Nigeria, technological shocks in South Africa have a reducing impact on both inflation and interest rates. However, the impact on interest rates is higher in South Africa, possibly due to the country's more organized and efficient financial system. Technological shocks also lead to a permanent increase in government debt.

Investing in technology and research can be expensive, and emerging economies such as South Africa have had to take on more debt to finance these endeavors. As noted in the previous section, technological shocks cause both government spending and tax revenue to rise. This is expected given that the costs of technology and its maintenance are high. Additionally, advancements in technology can make it easier to collect and analyze data, which can lead to more accurate assessment of tax burdens and ultimately result in increased tax revenue. Our submission is consistent with Gonzalez-Astudillo's (2013).

5. CONCLUSION

This study utilized a dynamic stochastic general equilibrium model to examine the interactions between fiscal and monetary policies in Nigeria and South Africa. The model consists of 20 equations that illustrate the behavior of 20 endogenous variables. The calibration technique was used to obtain the values of parameters, drawing from previous DSGE works and economic intuition specific to the Nigerian and South African economies. Results from the study show that fiscal and monetary policy variables respond to shocks from each other in both economies. Inflation is affected by

fiscal policy shocks such as government spending, revenue, and borrowing, while monetary decisions also impact fiscal policy variables. However, the interaction between monetary and fiscal policies is stronger in South Africa compared to Nigeria.

In order to achieve more effective coordination between monetary and fiscal policies, it is recommended that the two economies increase communication and cooperation between their respective authorities to collaboratively address policy design and implementation issues. Both the fiscal and monetary authorities have a responsibility to establish guidelines and procedures that are binding on both sides. The government should also strengthen monitoring and evaluation units in all relevant policy institutions to monitor the implementation and execution of policies and track deliverables agreed upon in policy coordination meetings. Furthermore, both countries are encouraged to strengthen their medium-term forecasting and estimation frameworks, as well as align their budgets with sectoral policies.

REFERENCES

Adam, K., Billi, R. M. (2008), Monetary conservatism and fiscal policy. Journal of Monetary Economics, 55(8), 1376-1388.

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

Barro, R. J. (1990). Government spending in a simple model of endogeneous growth. Journal of political economy, 98(5, Part 2), S103-S125.

Blanchard, O. (2000), Bubbles, liquidity traps and monetary policy. Comments on Jinushi et al and on Bernanke. Japan's Financial Crisis and its Parallels to US Experience, Institute for International Economics Special Report, 13.

Çebi, C. (2012), The interaction between monetary and fiscal policies in turkey: An estimated new Keynesian DSGE model. Economic Modelling, 29(4), 1258-1267.

Cekin, S.E. (2013), Monetary and Fiscal Policy Interactions in Turkey: A Markov Switching Approach. p1-56. Available from: http://www.stlouisfed.org.

Chatziantoniou, I., Duffy, D., Filis, G. (2014), Stock Market Response to Monetary and Fiscal Policy Shocks: Multi-Country Evidence. p1-35. Available from: http://www.bournemouth.ac.uk.

Choudhri, E., Malik, H. (2012), Monetary Policy in Pakistan: Confronting Fiscal Dominance and Imperfect Credibility. Pakistan: Carleton University and State Bank of Pakistan, p1-34.

Christoffel, K., Jaccard, I., Kilponen, J. (2010), Bond Risk Premium, Fiscal Rules and Monetary Policy: An Estimated DGSE Approach. European Central Bank.

Coenen, G., Lombardo, G., Smets, F., Straub, R. (2007), International transmission and monetary policy cooperation. In: International Dimensions of Monetary Policy. Chicago: University of Chicago Press. p157-192.

Coenen, G., Straub, R. (2004), Non-Ricardian Households and Fiscal Policy in an Estimated DSGE Model of the Euro Area. European Central Bank International Monetary Fund, 25, 1-37.

Daly, H., Smida M. (2016), Monetary and Fiscal Policy Interaction in the Greece: A Cointegration Approach. International Review of Business Research Papers, 12(1), 1-16.

Davig, T., Leeper, E. (2009), Monetary-Fiscal Policy Interactions and Fiscal Stimulus. Federal Reserve Bank of Kansas City Working Paper. p9-12.

De Resende, C. (2007), Cross-country estimates of the degree of fiscal dominance and central bank independence. Working Papers of Bank of Canada, 7(36), 1-36.

Devereux, M.B. (2010), Fiscal deficits, debt, and monetary policy in a liquidity trap. Globalization and Monetary Policy Institute Working Paper 44, 1-40.

Dixit, A., & Lambertini, L. (2001). Monetary–fiscal policy interactions and commitment versus discretion in a monetary union. European Economic Review, 45(4-6), 977-987.

Dosi, G., Fagioloy, G., Napoletanoz, M., Roventinix, A., Treibich, T. (2015), Fiscal and Monetary Policies in Complex Evolving Economies. Journal of Economic Dynamics and Control, 52, 166-189.

Dungey, M., Fry, R. (2010), Fiscal and monetary policy in Australia: An SVAR Model. CFAP Working Paper, 15, 1-30.

Ehelepola, K. (2014), Optimal Monetary and Fiscal Policy Analysis for Sri Lanka: A DSGE Approach. Central Bank of Sri Lanka, International Research Conference. p1-44.

Ellison, M., Tischbirek, A. (2014), Unconventional government debt purchases as a supplement to conventional monetary policy. Journal of Economic Dynamics and Control, 43, 199-217.

Galí, J., Perotti, R. (2003), Fiscal policy and monetary integration in Europe. Economic Policy, 18(37), 533-572.

Gnocchi, S., Lambertiniz, L. (2013), Monetary and Fiscal Policy Interactions with Debt Dynamics. p1-30. Available from: http://www.epfl.ch.

Gonzalez-Astudillo, M. (2013), Monetary-fiscal policy interactions: Interdependent policy rule coefficients. MPRA Working Paper, 50040, 1-51.

Grith, M., Uhlig, H. (2007), Master Thesis: Monetary and Fiscal Policy in a Two Country Model with Sticky Prices. Available from: https: wiwi.hu-berlin.de.

Hayo, B, Niehof, B. (2014), Monetary and fiscal policy in times of crises: A new Keynesian perspective in continuous time. University of Hamburg Joint Discussion Paper Series in Economics, l55, 1-33.

Hohberger, S., Herz, B. (2012), Fiscal policy, monetary regimes and current account dynamics. Discussions Papier, 12, 1-41.

Hughes, A., Weymark, D.N. (2005), Independence before conservatism: Transparency, politics and central bank design. German Economic Review, 6(1), 1-21.

Jin, H. (2013), Debt Maturity Management, Monetary and Fiscal Policy Interactions. p1-26. Available from: http: www.indiana.edu.

Kirsanova, T., Stehn, S., Vines, D. (2005), The interactions between fiscal policy and monetary policy. Oxford Review of Economic Policy, 21(4), 532-564.

Leeper, E. M. (1991). Equilibria under 'active'and 'passive'monetary and fiscal policies. Journal of monetary Economics, 27(1), 129-147.

Mishkin, F.S. (2011), Monetary Policy Strategy: Lessons from the Crisis (No. w16755). Cambridge: National Bureau of Economic Research.

Muscatelli, V., Tirrelli, P., Trecroci, C. (2004), Fiscal and monetary policy interactions in a new Keynesian model with liquidity constraints. Centre for Dynamic Macroeconomic Analysis, 10, 1-39.

Muscatelli, V.A., Tirelli, P. (2005), Analyzing the interaction of monetary and fiscal policy: Does fiscal policy play a valuable role in stabilisation? CESifo Economic Studies, 51(4), 549-585.

Mwabutwa, C., Bittencourt, M., Viegi, N. (2013), Monetary Policy Response to Foreign Aid in an Estimated DSGE Model of Malawi. ERSA Working Paper 350, 1-39.

Nunes, A.F.N., Portugal, M. S. (2009), Active and Passive Fiscal and Monetary Policies: An Analysis for Brazil after the Inflation Targeting Regime. In: Proceedings of the 37th Brazilian Economics Meeting.

Ojeda-Joya, J. N., & Guzman, O. E. (2019). The size of fiscal multipliers and the stance of monetary policy in developing economies.

Contemporary Economic Policy, 37(4), 621-640.
Philippopoulos, A., Varthalitis, P., Vassilatos, V. (2015), Optimal fiscal and monetary policy action in a closed economy. Economic Modelling, 48, 175-188.
Punzo, C., Rossi, L. (2016), Money-financed versus debt financed fiscal stimulus with borrowing constraints. DEM Working Paper Series, 131, 12-16.
Reade, J., Stehn, J. (2007), Estimating the Interactions between Monetary and Fiscal Policy using the Co-integrated VAR Methodology. Mimeo, Department of Economics, University of Oxford. Available from: http://www.econ.ox.ac.uk/students/james.reade/MonetaryFiscalInteractions.pdf.
Sargent, T. J., & Wallace, N. (1981). Some unpleasant monetarist arithmetic. Federal reserve bank of minneapolis quarterly review, 5(3), 1-17.
Sanusi, K.A., Eita, J.H, Meyer, D. F. (2021), Management of fiscal and monetary policies interdependence in South African economy: A Bayesian VAR approach. Journal of Contemporary Management, 18(2), 86-113.
Shahid, M., Qayyum, A., Waseem Malik, S. (2016), Fiscal and Monetary Policy Interactions in Pakistan Using a Dynamic Stochastic General Equilibrium Framework. Available from: https://mpra.ub.uni-muenchen.de/72595/.
Sims, C.A. (1994), A simple model for study of the price level and the interaction of monetary and fiscal policy. Economic Theory, 4(3), 381-399.
Smets, F., Wouters, R. (2003a), An estimated Dynamic Stochastic General Equilibrium Model of the Euro Area. Journal of the European Economic Association, 1(5), 1123-1175.
Svensson, L. E. (2001). Price stability as a target for monetary policy: defining and maintaining price stability. In The monetary transmission process: recent developments and lessons for Europe (pp. 60-111). London: Palgrave Macmillan UK.
Taylor, J. B. (2013). International monetary policy coordination: past, present and future. https://web.stanford.edu/~johntayl/Onlinepaperscombinedbyyear/2013/BIS_paper_June_2013.pdf
Valdivia, P. (2017). Literature, crisis, and Spanish rural space in the context of the 2008 financial recession. Romance Quarterly, 64(4), 163-171.
Valli, M., Carvalho, F.A. (2010), Fiscal and Monetary Policy Interaction: A Simulation-Based Analysis of a Two-Country New Keynesian DSGE Model with Heterogeneous Households. Banko Central Do Brazil Working Paper. p1-115.
Woodford, M. (1998), Control of the public debt: A requirement for price stability? IEA Conference, 118, 117-154.