Dynare Working Papers Series
https://www.dynare.org/wp/

Fiscal Multipliers and Evidence on Effectiveness of Fiscal Policy in Malawi

Thomson Nelson Kumwenda

Working Paper no. 73

February 2022

CEPREMAP
CENTRE POUR LA RECHERCHE ECONOMIQUE ET SES APPLICATIONS
48, boulevard Jourdan — 75014 Paris — France
https://www.cepremap.fr

Fiscal Multipliers and Evidence on Effectiveness of Fiscal Policy in Malawi

A Bayesian DSGE Analysis

Thomson Nelson Kumwenda

February 2022

Fiscal Multipliers and Evidence on Effectiveness of Fiscal Policy in the Malawi

Thomson Nelson Kumwenda
Department of Economics, University of Malawi, Chancellor College
P.O. Box 280, Zomba, Malawi, Africa
tkumwenda@mybucksbanking.mw/tnkumwenda@gmail.com

February 2022

Abstract

This study sheds light on the effects of fiscal policy on the Malawian economy by measuring the value of different Keynesian multipliers and identifying the possible origins of GDP fluctuation. The quantitative method adopted is the Bayesian estimation of a Dynamic and Stochastic General Equilibrium (DSGE) model based on data from the National Statistic Office and Reserve Bank of Malawi over the period 2004Q1-2020Q2. The Keynesian multiplier for government expenditure has been estimated at -0.81 and -1.50 at impact and remains negatively strong in subsequent periods for Output and positive for subsequent period for private investments or aggregate demand; (iii) an decrease in consumption taxes has a positive impact on national production, private investments and negative impact on general consumption, the consumption tax multiplier has been estimated at 1.22 for GDP, 0.69 for private investments and -0.64 for consumption for Ricardians households. (iii) the decrease of employment tax has a negative impact on GDP, private investments and positive impact on consumption for Non Ricardians households. This study shows that overall, the variability of production and private consumption is due in large part to public investment and monetary policy shocks, and this effect is persistent and significant over time. The effects of the public investment shock diminish over time, while those relating to the consumption tax are increases over time.

JEL Classification System: E17, E32, E62
Keywords: DSGE, Bayesian, Ricardian, Non-Ricardian households, multiplier, Fiscal policy.

1.0 Introduction

Fiscal policy is the use of government spending and taxation to influence the economy. Governments across the globe, typically use fiscal policy to promote strong and sustainable growth and reduce poverty. Historically, the prominence of fiscal policy as a policy tool had waned; especially after the rise of market-oriented economics. But of recency the debate of the importance of fiscal policy has again taken center stage after experiences of various market failures such as the stock market crashes, the Great Depression, the global financial crisis and of just now global healthy crises. Across the globe, in all major economies there was a push to scale down the size and function of government in an economy; all major policy institutions had been promoting the notion of free market economics with markets taking on an enhanced role in the allocation of goods and services.

With all the interventions that governments have been putting to prevent economic systems from collapsing and improving general welfare in times of crises; it is then important to study the effectiveness and efficiency of fiscal policy and for this paper, we would dwell our questions on the Malawian Economy. We would seek to answer the following questions: What are the effects of an increase in public spending or a reduction in taxes on output and aggregate demand in the Malawi and the estimated sizes of various fiscal multipliers? Will a fiscal expansion lead to a crowding out effect on household consumption and investment by firms in the Malawi? This paper also as a subsidiary theme aim to investigate the sources of output fluctuations in Malawi from a fiscal perspective. These questions are very important in the case of the Malawi, especially that the role of government is highly debated. Fiscal policy is said to be effective if, following an expansion in government spending or a reduction in taxes, leads to an increase in aggregate demand, i.e. an increase in private consumption and investments by companies. And on the other hand, if it leads to the opposite effect (drop in aggregate demand), it is then said to be inefficient (Baxter & King ,1993; Bouakez & Rebei, 2007; Coenen & Straub,2005; Fatás & Mihov,2001; Galì et al.,2007).

This article seeks to add to the limited evidence from Malawi on the foregoing research questions in fiscal policy administration literature. To the best of our knowledge, the present paper is the first attempt to quantify the impact of fiscal policy on output for Malawi, with specific measurable multipliers. Some of the studies that have investigated matters of fiscal policy in Malawi, have not specifically dwelt on fiscal multipliers and their conclusions have not been conclusive enough on the sizes and signs of multipliers. A lot of studies on fiscal multipliers have either focused on advanced economies, very few studies have been tailored to the cases of a small open emerging economies. Malawi is an interesting example in this regard since in addition for being a small open poor economy it is also facing the challenges of how to diversify and promote growth of its economy and reduce poverty.

2.0 Literature Review

2.1 Theoretical Considerations of Fiscal Policy, Fiscal Multipliers and their Determinants

A good starting point to start the theoretical review on fiscal policy, fiscal multipliers and effectiveness of fiscus is with the Keynesian approach. Keynes argued that it is imperative for government to stabilize business cycles and output; according to Keynes during recessions governments may employ expansionary fiscal policy by lowering taxes and duties, increasing government spending to increase aggregate demand and fuel economic output and on the contrary during times of high inflation, and other symptoms of expansionary fiscal activities, the governments may employ contractionary fiscal policy, by cutting down on government spending and increase in taxes and duties.

The simplest Keynesian model assumes price rigidity and excess capacity, so that output is determined by aggregate demand. In this model, a fiscal expansion has a multiplier effect on aggregate demand and output. The Keynesian multiplier exceeds one, it increases with the responsiveness of consumption to current income, and it is larger for a spending increase than for a tax cut. If a spending increase is matched by a tax increase, the resulting "balanced budget multiplier" is exactly one. Extensions of the simplest Keynesian model allow for additional sources of crowding out through induced changes in interest rates and the exchange rate. This is in additional to direct crowding out which occurs to the extent that the government provides goods and services that substitute for those provided by the private sector, and insofar as part of any increase in domestic demand in an open economy is met from imports. The extent of crowding out affects the size of fiscal multipliers but does not change their sign in the simple Keynesian model. In the standard IS-LM model, private investment depends negatively on interest rates, and therefore a fiscal expansion paid for by increased borrowing that leads to higher interest rates which in turn reduces investment. In the open economy IS-LM (Mundell-Fleming) model, there can also be crowding out through the exchange rate. Higher interest rates attract capital inflows which appreciate the exchange rate, and the resulting deterioration in the external current account offsets the increase in domestic demand deriving from a fiscal expansion.

There have been notable extensions to the original Keynesian views on effectiveness of fiscal policy, size of multipliers and the circumstances under which the original views of Keynes of how fiscal policy would not work. These extensions have come to be referred to as New Keynesian Views on effects of fiscal policy; the notable extensions to the original views of Keynes are discussed below:

Rational expectations. Although some variants of the Keynesian approach recognize the role of expectations (e.g., on consumption in life cycle and permanent income models), they typically rely on adaptive expectations. By comparison, rational expectations tend to bring forward adjustments in variables that would occur more progressively with adaptive expectations. Thus, the longer-term effects of fiscal policy will matter even in the short term, and in this connection the distinction between temporary and permanent policy changes is important. For example, while a temporary fiscal expansion that has no long-term effects will not influence expectations, a permanent fiscal expansion can add to crowding out—possibly to an extent that fiscal multipliers turn negative—because households and firms will expect that an initial increase in interest rates and appreciation of the exchange rate will persist and could become larger (Krugman and Obstfeld, 1997).

Forward looking households will expect the decrease in taxes to have negative impact on output, private investment and consumption especially in a fiscal regime that is financed by monetarized fiscal deficits through issuance of domestic debt, the negative impact comes in because Ricardian Household or investors will expect that there will be increases in interest rates and depreciation of exchange rates. Our study also found similar trend for Malawi; a fiscal expansion that resulted in a 1% decrease in employment tax resulted in decrease in GDP and private investment, and an increase in consumption for Non-Ricardian households, as it makes available resources in households who cannot smoothen their consumption with debt. Also, a 1% decrease in consumption taxes resulted in a decrease in consumption for Ricardian households who expects that lower revenues will result in increased domestic debt and fuel upward adjustments of interest rates. This is mainly the case for Ricardian Households who are forward looking and factors in adjustment of cost of financing the government debt that finances the budget when taxes are reduced in an environment where the revenue base is small or low. The results are in section 5 of this paper.

Ricardian equivalence. The Keynesian approach assumes that consumption is related to current income. If consumers are Ricardian in the sense that they are forward-looking and are fully aware of the government's intertemporal budget constraint, they will anticipate that a tax cut today, financed by issuing government debt, will result in higher taxes being imposed on their infinitely lived families in the future. Permanent income is therefore unaffected, and in the absence of liquidity constraints and with perfect capital markets, consumption will not change (Barro, 1974). Thus, there is Ricardian equivalence between taxes and debt. Perfect Ricardian equivalence implies that a reduction in government saving resulting from a tax cut is fully offset by higher private saving, and aggregate demand is not affected. The fiscal multiplier is zero in this case.

The focus in the Ricardian equivalence literature is on the effects of cuts in lump-sum taxes for a given path of government spending. With proportional or progressive taxes, the way in which the supply-side effects of tax cuts affect permanent income also must be considered. If a fiscal expansion takes the form of increased government spending, the impact on permanent income depends on how this will be paid for in the future. A temporary increase in government spending that will be offset by cuts in future spending will have no impact. However, an increase in government spending financed by higher future taxes will lead to a reduction in permanent income and consumption—and therefore possibly negative fiscal multipliers—although the precise extent of the resulting fall in output will depend on the productivity of government spending.

It is important to note that Ricardian equivalence is based on strong assumptions, which may not be applicable in poor countries. Thus short time horizons, less than perfect foresight, partial liquidity constraints, imperfect capital markets, and a non-altruistic desire to pass some of the current fiscal burden to future generations can reestablish a stronger link between fiscal policy and consumption (Mankiw and Summers, 1984; and Blanchard, 1985). Consequently, the practical significance of Ricardian equivalence is problematic, at least in its perfect form.

It is nevertheless worth asking whether there are circumstances where a Ricardian response is more likely, does the Ricardian equivalence work in developing countries where access to finance is a challenge. For example, if a government is bound by a fiscal rule which requires that a fiscal expansion has to be reversed, then even individuals who do not have very long-time horizons may adjust their saving behavior to at least partially prepare for higher future taxes. Similarly, where it is widely perceived that the current path of government debt is unsustainable, and that future tax increases will soon be required to lower the debt, there could be a seemingly Ricardian offset to a fiscal expansion even in a Keynesian framework (Sutherland, 1997). However, if forward-looking individuals fear that debt will be monetized, or that private savings will be preempted by the government, fiscal policy could be seemingly Keynesian in effect in a Ricardian framework, especially once debt or spending exceeds certain threshold levels (Bertola and Drazen, 1993).

Interest rate premia and credibility. Risk premia on interest rates are an important channel through which debt accumulation may affect the fiscal multiplier. As government debt builds up with fiscal expansion(s), risk premia that reflect the mounting risk of default or increasing inflation risk will reinforce crowding out effects through interest rates (Miller, Skidelsky, and Weller, 1990). Under such circumstances, a temporary fiscal expansion will be more effective than a permanent one, because it poses less risk of undermining debt sustainability. In this context, policy credibility is crucial. If there is little faith in the government's ability to reverse a temporary spending increase or tax cut because it lacks a track record of fiscal prudence, and the expectation is that a fiscal expansion which is announced to be temporary will in fact turn out to be permanent, then interest rates will most likely incorporate risk premia. Sizable risk premia represent perhaps the clearest reason that fiscal multipliers could turn negative, because private spending responds positively to a credible commitment to debt reduction and a lowering of risk premia. This is one of the main explanations for expansionary fiscal contractions given by Giavazzi and Pagano (1990) and Alesina and Perotti (1997).

Uncertainty. For fiscal policy to deliver desirable results, it is paramount that it operates in an environment of macroeconomic certainty. If a fiscal expansion is associated with increased uncertainty, precautionary behavior on the part of households and firms can also reduce fiscal multipliers and possibly turn them negative. In particular, households may accumulate precautionary savings and firms may delay irreversible investments (Caballero and Pyndick, 1996). More generally, in an uncertain environment confidence effects are likely to be important. While the theoretical underpinning of confidence effects that are not related to expectations or credibility is unclear, the general idea is that consumption or investment may depend on households' or firms' attitudes to the general economic environment, and their confidence in this regard is influenced by government policies (e.g., anticipated future deficits have a negative effect on confidence).

In literature, there are two types of determinants of the sizes of fiscal multipliers: (i) structural country characteristics that influence the economy's response to fiscal shocks in "normal times;" and (ii) conjunctural/temporary factors (notably cyclical or policy-related phenomena) that make multipliers deviate from "normal" levels.

Some of the structural characteristics that influence the economy's response to fiscal shocks include:

- **Trade openness**. Countries with a lower propensity to import (i.e., large countries and/ or countries only partially open to trade) tend to have higher fiscal multipliers because the demand leakage through imports is less pronounced (Barrell and others, 2012; Ilzetzki and others, 2013;).
- **Labor market rigidity**. Countries with more rigid labor markets (i.e., with stronger unions, and/or with stronger labor market regulation) have larger fiscal multipliers if such rigidity implies reduced wage flexibility, since rigid wages tend to amplify the response of output to demand shocks (Cole and Ohanian, 2004; Gorodnichenko and others, 2012).
- **The size of automatic stabilizers**. Larger automatic stabilizers reduce fiscal multipliers, since mechanically the automatic response of transfers and taxes offsets part of the initial fiscal shock, thus lowering its effect on GDP (Dolls and others, 2012).
- **The exchange rate regime**. Countries with flexible exchange rate regimes tend to have smaller multipliers, because exchange rate movements can offset the impact of discretionary fiscal policy on the economy (Born and others, 2013; Ilzetzki and others, 2013).
- **The debt levels**. High-debt countries generally have lower multipliers, as fiscal consolidation (resp. stimulus) is likely to have positive (resp. negative) credibility and confidence effects on private demand and the interest rate risk premium (Ilzetzki and others, 2013, Kirchner and others, 2010).
- **Public expenditure management and revenue administration**. Multipliers are expected to be smaller when difficulties to collect taxes and expenditure inefficiencies limit the impact of fiscal policy on output.

Some of the conjunctural (temporary) factors that tend to increase or decrease multipliers from their "normal" level identified in literature are as below:

- **The state of the business cycle**. Fiscal multipliers are generally found to be larger in downturns than in expansions. This is true both for fiscal consolidation and stimulus. A stimulus is less effective in an expansion, because, at full capacity, an increase in public demand crowds out private demand, leaving output unchanged (with higher prices). A consolidation is costlier in terms of output in a downturn, because credit-constrained agents (Non- Ricardian Agents) cannot borrow to maintain (smooth) their consumption. Furthermore, suggests that a downturn has a stronger effect on multipliers than an upturn. In other words, multipliers increase more in a recession than they decrease in an expansion. One reason could be that the supply constraint is asymmetric: while in a upturn the impact of fiscal policy is limited by the inelastic pool of resources (and eventually nullified when the economy reaches maximum productive and full employment capacity), this constraint does not exist when there is a slack in the economy, and the additional resources provided or extracted by the government have more direct traction on output.

- **Degree of monetary accommodation to fiscal shocks**. Expansionary monetary policy and a lowering of interest rates can cushion the impact of fiscal contraction on demand. By contrast, multipliers can potentially be larger, when the use and/or the transmission of monetary policy is impaired—as is the case at the zero interest lower bound (ZLB) (Erceg and Lindé, 2010; Woodford, 2011). Most of the literature focuses on the effect of temporary increases in government purchases and finds that the multiplier at the ZLB exceeds the "normal times" multiplier by a large margin. This effect is conditional on several factors. Erceg and Lindé (2010) show that the size of the shock matters at the ZLB: the larger the discretionary spending increases, the shorter the economy will stay at the ZLB, and therefore the lower the fiscal multiplier. Christiano and others (2011) find that implementation lags reduce the multiplier at the ZLB; for the multiplier to be significantly larger than in "normal times," it is critical that the ZLB is still present when the spending shock hits the economy

2.2 Empirical Literature Review

Empirical literature that has studied the sizes of fiscal multipliers in advanced countries is well established. DSGE simulations and SVAR models, developed since the early 1990s, suggest that first-year multipliers generally lie between **0** and **1** in "normal times." This literature also finds that spending multipliers tend to be larger than revenue multipliers. Based on a survey of 41 such studies, Mineshima and others (2014) show that first-year multipliers amount on average to **0.75** for government spending and **0.25** for government revenues in Advanced Economies. Assuming, in line with recent fiscal adjustment plans in Advanced Economies, that two thirds of the adjustment falls on expenditure measures, this would yield an overall "normal times" multiplier of about 0.6.

The range of estimated short-term multipliers is wide, ranging from **0.1 to 3.1**, but most expenditure multipliers are in the range **0.6 to 1.4**, and most tax multipliers in the range **0.3–0.8**. Moreover, there is some evidence that the divergence of multiplier estimates is diminishing over time. For example, compared to the first study to compare standard simulations across a number of macroeconomic models by Bryant and others (1988) the follow-up studies by Bryant, Hooper, and Mann (1993) and McKibbin (1997) found a narrower range of estimates. Saito (1997) reports fiscal multipliers derived from Japan's Economic Planning Agency macroeconomic model have decreased over time.

Comparing spending multipliers across the G-7 countries, there is some indication that they are larger for Japan than in the United States and Europe. Dalsgaard, André, and Richardson (2001) attribute this to the high short-term sensitivity of investment to output changes in Japan. Among the large European economies, there is a fairly wide range of short term expenditure multipliers, ranging between **0.6 and 1.5** for Germany, for example. Most macro models confirm that short-term multipliers are smaller for tax changes than for spending changes, finds a short-term tax multiplier for the United States of **0.7**, compared to **1.1** for spending. Tax multipliers are significantly smaller than spending multipliers for the United States, Japan, and Germany in the OECD INTERLINK, model (Dalsgaard, André, and Richardson, 2001). Bartolini, Razin, and Symansky (1995).

There is very little evidence of negative short-term multipliers from macro-model simulations for advanced countries, though few studies explicitly address the effects of credibility. Three studies that do so, Bayoumi and Laxton (1994), use simulations of MULTIMOD to analyze the effects of debt reduction (through phased cuts in government spending) in Canada, Germany, and Japan, respectively, under different credibility scenarios. These studies conclude that fiscal multipliers are generally positive but small, even when the credibility of fiscal consolidation is low. However, negative multipliers can emerge if fiscal consolidation is highly credible. However, there are specific circumstances that results in fiscal multipliers to be negative, even in advanced economies. The specific instances deal with how fiscal policy administration is funded (the role of financing) and how government spend its resources (type of government spending). Baxter and King (1993) examine how the impact of permanent and temporary spending increases differ if they are financed by an increase in (distortionary) taxes. For a permanent spending change, the tax rate must rise, which reduces incentives to work and invest, reducing the tax base; taxes must therefore increase by more than spending as a share of output. For plausible parameter values, but fixed labor input, they calculate the multiplier to be **-1.1**; with elastic labor supply the multiplier can reach **-2.5**. A temporary spending increase financed by higher taxes also has a negative impact on output, even in the short run, as the higher taxes reduce labor supply and investment. Ludvigson (1996) finds similar results.

Ardagna (2001) compares the output effects of a permanent, unanticipated debt-financed increase in government spending on final goods and employment. The former results in a small but positive impact multiplier, but the latter has a larger and negative effect on output, even in the short run and even when the increase in spending is financed by lump-sum taxes. Higher public employment reduces labor input in the private sector, which offsets the positive effects of lower wealth. However, the sign of the multiplier can be reversed if public employment is assumed to have a positive effect on the productivity of capital and labor in the private sector. In a similar vein, Baxter and King (1993) find that increases in public investment can have positive output effects in the short run if that investment increases the marginal productivity of private capital. With inelastic labor supply the long run multiplier is **1.7**; when productive public investment is combined with elastic labor supply, the long run multiplier increases dramatically, and can exceed **5**.

In contrast with empirical studies in advanced economies; however, little is known about the size of fiscal multipliers in Emerging economies and Low-income countries. From a theoretical point of view, it is not clear whether multipliers should be expected to be higher or lower than in the Emerging and low-income countries. The scarce empirical literature available suggests that multipliers in Emerging economies and Low income countries are smaller than in Advanced economies (Estevão and Samake, 2013; Ilzetzki and others, 2013; Ilzetzki, 2011; and Kraay, 2012). Some studies even conclude that multipliers are negative, particularly in the longer term (IMF, 2008) and when public debt is high (Ghosh and Rahman, 2008).

In terms of fiscal instrument, tax multipliers seem to be broadly similar to expenditure multipliers in Emerging economies. Ilzetzki (2011) finds that, in Emerging economies, spending multipliers range from 0.1 to 0.3, while revenue multipliers lie between 0.2 and 0.4 in the short term. The fact that Emerging economies spending multipliers are, on average, lower than in Advanced economies could be related to several factors, including expenditure inefficiencies, the difficulty to unwind expenditures (with increases more likely to become permanent), or composition effects.

The rest of the work is structured as follows: in addition to this introduction and conclusion, the methodology as well as the interpretations and discussions of the results are respectively started in the second and third sections.

3.0 Modelling Framework

The model presented here is inspired by that of Costa (2016). The model is built for a closed economy reduced to four agents: households, firms, monetary authority and budgetary and fiscal authority. In addition, this model incorporates other characteristics (or frictions) including consumption habits, the costs of adjustment of investments and use of capital. Similar to Coenen & Straub (2005); Galì et al. (2007); Iwata (2009), this model includes two types of households: Ricardian (RMs) who can intervene in financial markets and smooth their consumption over time, and Non-Ricardian (MNRs) who only consume their disposable income.

3.1 Households

There are two types of households in the economy: a fraction $\boldsymbol{\omega_R}$ of RMs who provide work, earn a salary, have access to financial markets and can thus save, buy and resell government securities and acquire securities. capital. The other fraction $\mathbf{1-\omega_R}$ represents the **MNRs** which are excluded from the financial markets, offer work but consume only their disposable or salaried income. Each group is represented by a single representative household.

3.1.1 Ricardian Households

The problem of the **RM** consists in choosing at each period *t* the quantity of goods and services to consume $\boldsymbol{C_{R,t}}$, physical capital $\boldsymbol{K_t}$, the level of use of installed capital $\boldsymbol{U_t}$, the volume of securities $\boldsymbol{B_t}$ and the level of investment $\boldsymbol{I_t^P}$ to maximize its utility.

The intertemporal utility function 2 for this household is given by:

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t\, U\left(C_{R,t}, L_{R,t}\right) \qquad (1)$$

With

$$U\left(C_{R,t}, L_{R,t}\right) = \frac{\left(C_{R,t} - \phi_c C_{R,t-1}\right)^{1-\sigma}}{1-\sigma} - \frac{\left(L_{R,t}\right)^{1+\varphi}}{1+\varphi}$$

Where $\mathbb{E}$_$\boldsymbol{t}$ reflects the mathematical expectation. The latter reflects the value of the expected future utility resulting from consumption and labor taking into account all the information held at time ***t***. $\boldsymbol{\beta^t}$ reflects the individual discount factor; $\boldsymbol{\sigma}$ the inverse of the intertemporal elasticity of substitution (or relative coefficient of risk aversion); $\boldsymbol{\varphi}$ the reciprocal of the elasticity of the labor supply with respect to the real wage and $\boldsymbol{\phi_c}$ measures the extent of consumption habits. These show that current utility derives from current consumption taking into account past consumption (Bouakez & Rebei, 2007; Torres, 2016).

The Ricardian household faces the following budget constraint:

$$P_t(1+\tau_t^c)(C_{R.t} + I_t^P) + P_t K_t^P \Psi(U_t) + \frac{B_{t+1}}{R_t^B} = W_t L_{R,t}\left(1-\tau_t^l\right) + \left(1-\tau_t^k\right) R_t U_t K_t^P + B_t + D_t$$

(2)

The left side represents the agent's expenses and the right side represents the agent's income. In this constraint, $\boldsymbol{C_{R.t}}$ represents the consumption of **MR**; $\boldsymbol{L_{R,t}}$ the number of work; $\boldsymbol{U_{R,t}}$ the level of use of installed capital; $\boldsymbol{I_t^P}$ induced private investment; $\boldsymbol{R_t^P}$ the interest rate on private capital; $\boldsymbol{R_t^B}$ the rate of return on government securities (or treasury bills); $\boldsymbol{P_t}$ the general price level; $\boldsymbol{W_t}$ the hourly wage rate; $\boldsymbol{D_t}$ the dividend received from firms. The parameters $\boldsymbol{\tau_t^c}$, $\boldsymbol{\tau_t^W}$ and $\boldsymbol{\tau_t^K}$ respectively represent the tax on private consumption, the tax on salaried income and the tax on capital held 3. The function $\boldsymbol{\Psi}$ represents the cost linked to the variation in the degree of use of capital installed over time (Smets & Wouters, 2003). This function takes the following form (Fernandez-Villaverde, 2006):

$$\Psi(U_t) = \Psi_1(U_t - 1) + \frac{\Psi_2}{2}(U_t - 1)^2$$

While the function of capital accumulation over time is given by:

$$K_{t+1}^P = (1-\delta)K_t^P + \left[1 - \frac{\chi}{2}\left(\frac{I_t^P}{I_{t-1}^P} - 1\right)^2\right] I_t^P \tag{3}$$

With $\boldsymbol{\delta}$ the rate of depreciation of the capital stock, $\boldsymbol{\Psi_1}$, $\boldsymbol{\Psi_2}$ and $\boldsymbol{\chi}$ are parameters of sensibility. The coefficient of $\boldsymbol{I_t^P}$, represented by $\boldsymbol{f(.)}$, describes the function of the adjustment cost of the investment. Next Smets & Wouters (2003) and Iwata (2009), the rate of use of the capital and the corresponding user cost of installed capital are zero at steady state: $\boldsymbol{U_{ss}} = \boldsymbol{\Psi}$ $\boldsymbol{U_{ss}} = \boldsymbol{0}$. In addition, the function of the adjustment cost of capital satisfies the conditions following $\boldsymbol{f(1)} = \boldsymbol{f^{`}(1)} = \boldsymbol{0}$ meaning that in the equilibrium state (or stationary), the cost of capital is zero but increases with more investment. Knowing that $\boldsymbol{\Lambda_{R,t}}$ and $\boldsymbol{Q_t}$ are the Lagrange multipliers associated respectively with the constraint budget 2 and the capital accumulation equation 3, the first order conditions for maximize the intertemporal utility of the Ricardian household with respect to $\boldsymbol{C_{R.t}}$, $\boldsymbol{K_{t+1}^P}$, $\boldsymbol{U_t}$, $\boldsymbol{I_t^P}$ and $\boldsymbol{B_{t+1}}$ in this order give 4 :

$$\Lambda_{R,t} = \frac{\left(C_{R,t} - \phi_c C_{R,t-1}\right)^{-\sigma}}{P_t(1+\tau_t^c)} - \phi_c\beta\frac{\left(\mathbb{E}_t C_{R,t} - \phi_c C_{R,t-1}\right)^{-\sigma}}{P_t(1+\tau_t^c)} \tag{4}$$

$$Q_t = \beta\mathbb{E}_t\left[(1-\delta)Q_{t+1} + \Lambda_{R,t+1}R_{t+1}U_{t+1}\left(1-\tau_{t+1}^k\right) - \Lambda_{R,t}P_{t+1}\left(\psi_1(U_{t+1}-1) + \frac{\psi_2}{2}(U_{t+1}-1)^2\right)\right] \tag{5}$$

$$\frac{R_t}{P_t} = \left(\frac{1}{1-\tau_t^k}\right)[\psi_1 + \psi_2(U_t - 1)] \tag{6}$$

$$\Lambda_{R,t}P_t - Q_t\left[1 - \frac{\chi}{2}\left(\frac{I_t^P}{I_{t-1}^P} - 1\right)^2 - \chi\left(\frac{I_t^P}{I_{t-1}^P}\right)\left(\frac{I_t^P}{I_{t-1}^P} - 1\right)\right] = \chi\beta\mathbb{E}_t\left[Q_{t+1}\left(\frac{I_t^P}{I_t^P}\right)^2\left(\frac{I_{t+1}^P}{I_t^P}\right) - 1\right] \tag{7}$$

$$R_t^B\beta\mathbb{E}_t\left(\frac{\Lambda_{R,t+1}}{\Lambda_{R,t}}\right) = 1 \tag{8}$$

Under these conditions, $\boldsymbol{Q_t}$ represents Tobin's Q which is a ratio between the market value of a company (market capitalization) and its real assets (Beiton et al., 2001). It allows a decision to be made regarding the investment.

3.1.2 Non-Ricardian Households

The rest of the$\boldsymbol{1 - \omega_R}$ households show the number of MNRs. These offers a workforce to companies but have a simple behavior because they face liquidity constraints that do not allow them to borrow and therefore to stabilize their level of consumption over time. Similar to Coenen & Straub (2005); Djinkpo (2019); Galì et al. (2007); Iwata (2009), these households allocate all of their periodic wage income to consumption. Since they do not have access to financial markets and do not acquire capital, they face the following budget constraint:

$$(1+\tau_t^c)C_{NR,t} = (1-\tau_t^l)W_t L_{R,t} \tag{9}$$

3.1.3 Determination of Wages

Following Galì et al. (2007), it is assumed that the labor market operates in an imperfect structure. In this market, there is a continuum of unions (unions) j which may or may not set the wages $\boldsymbol{W_t}$ of the Ricardian and non-Ricardian employees they represent (with **j ∈ [R; NR]**). On the other hand, the number of working hours $\boldsymbol{L_{j,t}}$ offered by them are determined by the firms. On the one hand, the unions, which cannot fix the wage rate, are forced to adjust it period after period according to the following diagram, taking into account the rigidity of wages 5 (Costa, 2016):

$$W_{j,t} = W_{j,t-1} \tag{10}$$

On the other hand, according to Calvo's rule, other unions are allowed to optimally fix the nominal wage rate of their agents at a period *t* with a probability $\boldsymbol{1-\theta_w}$. They all choose an identical level $\boldsymbol{W_t}$**.** Thus, each union $\boldsymbol{j}$ having received permission to fix the optimal wage rate in period t, maximizes the utility of the household it represents, given by the equation 1, taking into consideration the salary and demand for differentiated labor offered by the household *j* which is written as:

$$L_{j,t} = \left(\frac{W_t}{W_{j,t}}\right)^{\psi_w} L_t \tag{11}$$

Where $\boldsymbol{\psi_w}$ measures the elasticity of substitution between differentiated labor services. The following first order condition follows:

$$W_t^* = \left(\frac{\psi_t}{\psi_t - 1}\right)\mathbb{E}_t \sum_{i=0}^{\infty}(\beta\theta_w)^i \left[\frac{L_{j,t+1}^{\varphi}}{\Lambda_{j,t+1}(1-\tau_{t+i}^l)}\right]_t \tag{12}$$

With $\boldsymbol{\theta_w}$ the probability that the chosen optimal wage level $\boldsymbol{W_t^*}$ remains in effect during the *i* next periods (Iwata, 2009).

Finally, the aggregate real wage level is written:

$$W_t = \left(\frac{\psi_t}{\psi_t - 1}\right)\mathbb{E}_t \sum_{i=0}^{\infty}(\beta\theta_w)^i \left[(1-\theta_w)(W_t^*)^{1-\lambda_w} + \theta_w W_{t-1}^{1-\lambda_w}\right]^{\frac{1}{1-\lambda_w}} \tag{13}$$

3.1.4 Aggregation

The aggregation of each specific variable $\boldsymbol{x_i}$; t for the consumer, where i ∈ [0; 1], is given by (Torres, 2016):

$$x_t = \phi x_{r,t} + (1-\phi)x_{nr,t}$$

Consequently, the aggregate value of consumption (i.e. the sum of the consumption of MR and MNR) and work are written respectively:

$$C_t = \omega_R C_{R.t} + (1-\omega_R) C_{NR.t} \quad (14)$$

$$L_t = \omega_R L_{R.t} + (1-\omega_R) L_{NR.t} \quad (15)$$

3.2 Firms

Two types of firms coexist: those which produce final goods, and which are in perfect competition and a multitude of firms producing intermediate goods in monopolistic competition denoted by j ∈ [0; 1]. The latter sell their intermediate products to the first firms which use them as factors in order to generate the final goods.[7].

3.2.1 Producer of the final good

The final good $\boldsymbol{Y_t}$ is produced by combining a continuum of differentiated intermediate goods (inputs) $\boldsymbol{Y_{j,t}}$ produced by intermediate firms j. The aggregate production function of the final good is given by:

$$Y_t = \left(\int_0^1 Y_{j,t}^{\frac{\psi-1}{\psi}}\right)^{\frac{\psi}{\psi-1}} \quad (16)$$

Where indicates the elasticity of substitution between different inputs or intermediate goods. The producer of the final good sells his product on a perfectly competitive market and maximizes his real profits taking into account (16), and considers as given the prices of inputs Pj; t and the price of the final good Pt. Its input demand function is written:

$$Y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\psi} Y_t \quad (17)$$

3.2.2 Producer of intermediate goods

These producers use their own factors of production (labor and capital) and public goods (road infrastructure, etc.) in order to produce differentiated goods (which are not identical). Their production function is of the Cobb-Douglas type:

$$Y_{j,t} = \left(K_{j,t}^P\right)^{\alpha_1} (L_{j,t})^{\alpha_2} (K_{j,t}^G)^{\alpha_3} \qquad 0 < \alpha_j < 1 \quad (18)$$

Where $K_{j,t}^P$ and $L_{j,t}$ denote respectively the capital and the labor held by the firm *j* and $K_{j,t}^P$ the aggregate public capital. α_1, α_2 and α_3 denote respectively the shares of private capital $K_{j,t}$, labor factor and public capital $K_{j,t}^G$ in the output of firm *j*.

Each firm *j* determines the quantities of capital and labor factors allowing it to minimize the total cost under the constraint of the production function (18). Using the Lagrange function to solve this problem results in demands for the following factors:

$$U_t K_{j,t}^P = \alpha_1 MC_t \frac{Y_{j,t}}{R_t} \quad (19)$$

$$L_{j,t} = \alpha_2 MC_t \frac{Y_{j,t}}{W_t} \quad (20)$$

The marginal cost M Ct of firms is obtained by:

$$MC_t = \frac{1}{(K_{j,t}^G)^{\alpha_3}} \left(\frac{W_t}{\alpha_2}\right)^{\alpha_2} \left(\frac{R_t}{\alpha_1}\right)^{\alpha_1} \tag{21}$$

3.2.3 Determination of the output price

The firms being in monopolistic competition, it is necessary to determine the price of the output thus generated. A part of the firms has the probability of keeping the price of the output unchanged and another has the probability 1 of fixing this price in an optimal way. Based on Calvo's rule, firms that cannot set the output price follow the law:

$$P_{j,t} = P_{j,t-1} \tag{22}$$

For the category of firms that can modify their price, the price is set so as to meet demand 17 ; this leads to the following law:

$$P_t^* = \left(\frac{\psi_t}{\psi_t - 1}\right) \mathbb{E}_t \sum_{i=0}^{\infty} (\beta\theta)^t mc_{t+i}$$

Finally, the general level of the aggregate price of the two firms is:

$$P_t = \left[(1-\theta)(P_t^*)^{1-\psi} + \theta P_{t-1}^{1-\psi}\right]^{\frac{1}{1-\psi}} \tag{24}$$

3.3 Government

The government is represented by a budgetary authority and a monetary authority (central bank).

3.3.1 Budgetary Authority

The role of this authority comes down to financing government spending, in particular public consumption spending G_t , the payment of the public debt B_t) and public investment expenditure I_t^G). These expenditures are financed for the most part with the help of taxes and levies (collected on household consumption, private investment, professional income and physical capital) or either by public debt (internal debt or treasury bills, B_t). The government's budget constraint is given by:

The change function of the stock of public capital (public goods) is written:

$$\tau_t^c P_t (C_t + I_t^P) + \tau_t^l W_t L_t + \tau_t^k (R_t - \delta) K_t^P + \frac{B_{t+1}}{R_t^B} - B_t = P_t G_t + P_t I_t^G \tag{25}$$

With δ_g the rate of depreciation of the public capital stock.

$$K_{t+1}^G = (1 - \delta_g) K_t^G + I_t^G \tag{26}$$

With δ_g the rate of depreciation of the public capital stock. It was also said that the State resorts to PB in order to act on the economic situation. This action can either go through tax revenue or through budgetary expenditure (Beiton et al., 2001). Therefore, the budgetary authority conducts the PB using two groups of instruments (or shocks): those relating to public expenditure (I_t^G and G_t) and those relating to fiscal measures (τ_t^c; τ_t^k; τ_t^l). Fiscal shocks are reduced to the increase in current expenditure G_t and public investments I_t^G. Following Iwata (2009) and Djinkpo (2019), all instruments are affected by a change in the debt-to-GDP ratio of the previous period. In other words, a variation in the level of indebtedness has a direct influence on the level of taxation of the current period and the level of expenditure to be engaged in the same period. Thus, all the shocks follow a log-linearized AR (1) with error term $\varepsilon_t^x \sim N(0, \sigma_x^2)$:

$$\hat{X}_t = \gamma_x \hat{X}_{t-1} + (1-\gamma_x)\phi_x\left(\hat{B}_t - \hat{Y}_{t-1} - \hat{P}_{t-1}\right) + \varepsilon_t^x \quad (27)$$

With $X \in [\tau_t^c;\ \tau_t^k;\ \tau_t^l, G_t, I_t^G]$ The coefficient γ_x of each shock is interpreted as being the persistence of the shock considered over time. The factor $(1-\gamma_x)\phi_x$ in each equation reflects the speed of repayment of the public debt (Iwata, 2009).

3.3.2 Monetary Authority

The monetary authority for its general aims is price stability. It does this by using monetary policy (PM) by fixing nominal interest rates. This authority adopts a behavior guided by the following Taylor rule, linearized around its stationary state (Costa, 2016; Iwata, 2009):

$$\hat{R}_t^B = \gamma_R \hat{R}_{t-1}^B + (1-\gamma_R)\left(\gamma_\pi \hat{\pi}_t + \gamma_y \hat{Y}_t\right) + \hat{\varepsilon}_t^m \quad (28)$$

In this equation, γ_π and γ_y reflect basic interest rate sensitivities in relation to output and the rate of inflation; while γ_R emerges the smoothing parameter over time.

3.4 Model Equilibrium Conditions

The labor market is in equilibrium when the demand for labor by intermediary firms is equal to the labor services offered by households $L_t = \int_0^1 L_{j,t}\, dj$. Similarly, the capital market is in equilibrium if the demand for capital factor by intermediary firms is equivalent to the supply of capital from Ricardian consumers $K_t^R = \int_0^1 K_{j,t}\, dj$. The markets for final goods and services are also in equilibrium when the output of the firms supplying the final goods corresponds to the demand of households and the government. This last condition of equilibrium results in the equation:

$$Y_t = C_t + I_t + G_t + I_t^G \quad (29)$$

The model linearized around its stationary state is summarized in appendix 3.

4.0 Estimation method, data and Calibration

The purpose of this subsection is to briefly describe the Bayesian technique used to estimate some parameters of the model (point 1), to explain the process of generating important data for the estimate (point 2) and to present the a priori values. which were given to the parameters of the model (point 3).

4.1 Bayesian Estimate

To determine the values of the parameters of a DSGE model, two possibilities are offered to the researcher: either proceed by calibration (use the values of the parameters taken from other macroeconomic or microeconomic studies which have estimated them) or either proceed by estimation of these parameters using an appropriate methodology (Torres, 2016). The first option is the simplest but the main disadvantage which emerges is the great risk according to which the simulated model cannot meet the real characteristics of the studied economy. In addition, it is very likely that the theoretical moments 10 (generated by the model) and the empirical moments (generated by the observed data) differ widely. To reflect the real facts of the Malawi economy, this study used a Bayesian estimate for several reasons.

First, the Bayesian estimation allows the researcher to resort to the use of a priori (or known) information coming from existing microeconomic studies or from studies which have resorted to a very sophisticated calibration (in particular by reducing the difference between empirical and theoretical moments). The use of known information on parameters offers the advantage of remaining closely related to previous work. Second, the use of prior distributions makes the nonlinear optimization algorithm more stable especially when the size of the data sample is small, as is the case here (Coenen & Straub, 2005; Smets & Wouters, 2003). Thirdly, this technique makes it possible to characterize completely the uncertainty in the estimation of structural parameters (not relating to the five shocks) (Umba, 2017). Finally, it is good to note that the DSGE models pose a problem of singularity. This means that within the model there are linear relationships (perfect multicollinearity) between the variables. This singularity is due to the fact that the model generates predictions on a large number of observable endogenous variables with respect to exogenous shocks used. The Bayesian method applies even in the case where the variance-covariance matrix of the endogenous variables is singular whereas this constitutes a problem in the case where the maximum likelihood method is used (Smets & Wouters, 2003).

Bayesian modelers recognizes that "all models are false", rather than assuming they are working with the correct model. This perspective contrasts with the classical methods that search for a single model with the highest posterior probability given the evidence.

To formulate the principle of Bayesian statistic below; we will start with a simple case when one is concerned with the interaction of two random variables, X and Y. let $p(\cdot)$ denote either a probability mass function or density, depending on whether the variables are discrete or continuous. The rule of conditional probability will be:

$$\mathrm{p}(X \mid \mathrm{Y}) = \frac{\mathrm{p}\,(\mathrm{X},\mathrm{Y})}{\mathrm{p}(\mathrm{Y})}$$

And can be used to derive the so-called Bayes' Theorem:

$$p(X \mid \mathrm{Y}) = \frac{p(\mathrm{Y} \mid \mathrm{X})p(X)}{p(\mathrm{Y})}$$

In a typical statistical problem, we usually have a data vector y, which is assumed to be a sample from a probability model with an unknown parameter vector θ. We represent this model using the likelihood function $L(\theta;\ y)\ =\ f(y,\ \theta)\ = \prod_{i=1}^{n} f(y_i \mid \theta)$, where $f(y_i \mid \theta)$ denotes the probability density function of y_i given θ. We want to infer some properties of θ based on the data y. In Bayesian statistics, model parameters θ is a random vector. We assume that θ has a probability distribution $p(\theta) = \pi(\theta)$, which is referred to as a **prior distribution**. Because both y and θ are random, we can apply Bayes Theorem to derive the **posterior distribution** of $\boldsymbol{\theta}$ given data **y**.

$$p(\theta \mid \mathrm{y}) = \frac{p(\mathrm{y} \mid \theta)p(\theta)}{p(\mathrm{y})} = \frac{f(\mathrm{y};\theta)\pi(\theta)}{m(\mathrm{y})}$$

Where $m(\mathrm{y}) = p(y)$, known as the marginal distribution of y, is defined by

$$m(\mathrm{y}) = \int f(\mathrm{y};\theta)\pi(\theta)d\theta$$

Since the marginal distribution $m(\mathrm{y})$ does not depend on the parameter of interest θ, we therefore, reduce our posterior distribution equation to:

$$p(\theta \mid \mathrm{y}) \propto L(\mathrm{y};\theta)\pi(\theta)$$

This equation is fundamental in Bayesian analysis and states that the posterior distribution of a model parameters is proportional to their likelihood and probability distribution. The above equation is often computationally in a more convenient log-scale form as per below:

$$In\{p(\theta \mid \mathrm{y})\} = l(\mathrm{y};\theta) + In\{\pi(\theta)\} - \mathrm{c}$$

Where $l(\cdot;\cdot)$ denote the log likelihood of the model. Depending on the analytical procedure involving the log-posterior $In\{p(\theta \mid \mathrm{y})\}$, the actual value of the constant $c = In\{m(y)\}$ may or may not be relevant. For valid statistical analysis, however it is always assumed that c is finite. The likelihood function can be computed via the state-space representation of the model together with the measurement equation linking the observed data and the state vector. The model state-space representation will be:

$$S_{t+1} = \Gamma_1 S_t + \Gamma_2 w_{t+1}$$

$$Y_t = \Lambda S_t + \mu_t$$

Where $S_t = \{x_t, y_t\}$ x_t and y_t is the equilibriums described by the matrices of the deep parameters, Y_t is the vector of observed variables, μ_t is the measurement error, matrices Γ_1 and Γ_2 are functions of the model's deep parameters and Λ defines the relationship between observed and state variables.

The likelihood function will be computed under the assumption of normally distributed disturbances by combining the state-space representation implied by the solution of the linear rational expectations model and the Kalman filter. Posterior draws will be obtained using MCMC methods. After obtaining an approximation of the mode of the posterior, we will rely on a RWMH algorithm to generate posterior draws, as discussed in Schorfheide (2014). Point estimates of θ will be obtained from the generated values by using various location measures such as mean or median. Similarly, measures of uncertainty will follow from computation of the percentiles of the draws.

4.2 Data Used

Contrary to what is known, the estimation of a DSGE model does not require the possession of data on all the endogenous variables of the model. In principle, the number of observed variables should at most equal the number of shocks that are included in the model (Smets Wouters, 2003). If this condition is not met, a singularity problem results (Pfeifer, 2020). Since this study only incorporates six shocks (τ_c, τ_k, τ_l, G_t and I_t^G), it follows that only six variables can be considered. But these variables are not chosen at random; in fact, a choice must be made on (i) those which make it possible to measure the parameters in which the researcher is interested; (ii) those which have been properly measured, etc. (Pfeifer, 2020). For these reasons and given the fact that this study is more interested in the parameters relative to shocks, the following variables were used: internal public debt B, tax receipts from the tax on salaried income c and tax revenue from the consumption tax τ_l.

GDP has been used to generate some important steady state ratios (see next subsection). Household final consumption C, public expenditure G and private investment IP (measured in terms of gross fixed capital formation) were used to generate public investment and some steady-state ratios, notably $\phi_{B_{ss}}$ and $\phi_{I^G_{ss}}$. The data are all expressed in quarterly frequency ranging from 2004Q1 to 2020Q2 by re-running the Eviews 9 software.

The econometric estimations of the study were done in MATLAB 2015 using Dynare 4.6.4 version.

Data on gross fixed capital formation (private investment), final household consumption, public expenditure and GDP (real and nominal), tax revenues are obtained from the National Statistics Office. While the data on Public Debt was obtained from the Reserve Bank of Malawi. Public investment was generated using the following formula, resulting from the equilibrium of the model: $I^G = Y - C - I^P - G$

The data have been deflated to subtract the effects of inflation using the GDP deflator. The latter was calculated by taking the ratio of nominal GDP to real GDP. All nominal data was transformed into real data by dividing each variable by the deflator. The logarithm was introduced for each variable because the model was also (log-) linearized around its deterministic stationary state. Finally, the stationarity study was carried out in order to avoid spurious regressions (Gujarati & Porter, 2009). The Augmented Dickey-Fuller and Phillips-Perron tests were used to do this. All the variables are stationary at level, with the exception of the variables relating to tax revenues (c and l), to private consumption C and to internal debt B. They have been made stationary in first difference.

4.3 Calibration

Bayesian estimation requires fixing the a priori mean values of the model parameters. The model includes two groups of parameters: those which are structural and those relating to the six shocks considered. All the parameters have not been estimated due to the specific needs of the estimated model. It is necessary to specify the measurement of certain values. As indicated in appendix 3, the parameters $\phi_{B_{ss}}$ and $\phi_{I^G_{ss}}$ have been calibrated so that the empirical moments can correspond to the theoretical moments. Thus, they were determined by taking the ratios of the means of the variables; i.e. $\phi_{B_{ss}} = \frac{B}{Y} = 0.1430$ and $\phi_{I^G_{ss}} = \frac{I^G}{Y} = 0.2010$. In addition, in the stationary state, $\chi = \psi_2 = 1$. In addition, it was assumed that in the steady state the tax on private consumption τ^C_{ss} or VAT is equivalent to 16.5%, professional income tax τ^l_{ss} is on average 25% (Malawi Revenue Authority) and the capital tax τ^k_{ss} is taken from Malawi Revenue Authority and is set at 30%.

The proportion of RMs in the Malawi represents 20% and the rest (80%) shows the number of MNRs, which best reflects the characteristics of the population of the Malawi, made up mainly of a poor rural population and a small population of the working class. The rest of the parameters relating to shocks, in particular shock persistence γ_j with $j \epsilon [I^G, G, \tau_c, \tau_k, \tau_l, Y, \pi, R]$ and the coefficients of debt-to-GDP ratios, ϕ_j with $j \epsilon [I^G, G, \tau_c, \tau_k, \tau_l, Y, \pi, R]$ have been calibrated either according to Costa (2016); Djinkpo (2019); Iwata (2009). For the rest of the parameters, see the following table:

5.0 Results

This section presents the results obtained. Long before this presentation, some comments on the estimated parameters are presented first. Then, the efficiency of the PB is analyzed from the simulations carried out on the model thus estimated. Finally, in addition, cyclical fluctuations in GDP are analyzed using two tools: the decomposition of the variance of the error and the decomposition of the historical variance, that is, that which is based on the quarterly data used.

Table 1 - Calibrated parameters and sources

Parameter name	Symbol	Value	Source
Individual discount factor	β	0.99	Mwabutwa et al; Gali
Intertemporal substitution elasticity	σ	1.3	Costa (2016)
Disutility of work	ϕ	3	Costa (2016)
Proportion of RM	ϕ_R	0.2	See text
Consumption tax	τ_{ss}^{c}	0.17	Malawi Revenue Authority
Employee income tax	τ_{ss}^{l}	0.25	Malawi Revenue Authority
Tax on capital held	τ_{ss}^{k}	0.30	Malawi Revenue Authority
Share of private capital in production	α_1	0.329	IMF Country Reports
Share of public capital in production	α_3	0.07	IMF Country Reports
Labor share in production	α_2	0.66	IMF Country Reports
Elasticity of substitution between inter-goods intermediaries	ψ	10	Author
Elasticity of substitution between dif-ferentiated	ψ_w	20	Costa (2016)
Calvo probability for prices	θ	0.65	Author
Calvo probability for wages	θ_w	0.45	Author
Private capital depreciation rate	δ	0.25	Literature
Depreciation rate of public capital	δ_G	0.035	Djinkpo (2019)

5.1 Estimated Parameters

To assess the goodness of the Bayesian estimators of a DSGE model, several tools can be used and generated at the end of the estimation. Among them, it is worth noting the univariate diagnosis of Monte Carlo Markov chains (MCMC), the diagnosis of multivariate convergence, the Blanchard-Kahn conditions, the pairings between the prior and posterior distributions, etc.

The prior and posterior distributions in Appendix 1, Figures 4-5, show two important facts. On the one hand, most of the a priori distributions (gray color) match the posterior distributions (black color) adequately. This reflects the idea that the data used for the estimations contain enough information that meets the author's beliefs on the prior distributions of the parameters (Pfeifer, 2020). On the other hand, overall, the estimated parameters are significantly different from zero. This is true for all parameters including standard deviations of shocks except the coefficient of debt-to-GDP ratios in fiscal shocks (τ_l, τ_c, and τ_k) whose a priori averages have been set to zero.

With regard to the univariate diagnosis of the convergence of MCMC chains, it should be noted the analysis was performed with 10,000 simulations of the Metropolis-Hastings (MH) algorithm. The acceptance ratios in the two chains averaged 24%, (chain 1 was 24.44% and chain 2 was 24.84%), which is quite satisfactory. If the results are conclusive, the two chains relating to each parameter should evolve at a constant pace and converge towards a common value. Figures 5 and 6 (appendix 2) clearly show that this requirement is met in the case of this study.

Finally, figure 7 (appendix 2) suggests that the calibrated values of the parameters provide non-explosive solutions to the model and that the Blanchard-Kahn conditions are satisfied because the estimated mode is at the maximum of the posterior likelihood for all the models settings.

Table 2:Prior and Posteriors of the Estimated Parameters

parameters		prior	prior mean	post mean	90% HPD Interval		pstdev
alpha2	α_2	beta	0.66	0.6556	0.5761	0.7392	0.05
alpha3	α_3	beta	0.07	0.0705	0.0532	0.086	0.01
beta	β	beta	0.99	0.9902	0.9876	0.9933	0.002
deltaG	δ_G	beta	0.035	0.0351	0.0321	0.0384	0.002
theta	θ	invg	0.65	0.6493	0.6134	0.6795	0.02
thetaW	θ_w	invg	0.45	0.4463	0.4151	0.4759	0.02
sigma	σ	gamm	1.3	1.3029	1.2714	1.3375	0.02
phi	ϕ	gamm	1.5	1.5525	0.8596	2.2456	0.5
psi	ψ	gamm	10	9.8439	6.964	12.6554	2
psiW	ψ_w	gamm	20	20.0811	16.993	23.5546	2
phic	ϕ_c	beta	0.9	0.8864	0.7764	0.9857	0.05
omegaR	ω_R	beta	0.3	0.3004	0.2823	0.3161	0.01
gammaG	γ_G	beta	0.5	0.5012	0.4854	0.5178	0.01
gammaIG	γ_{IG}	beta	0.1	0.0941	0.0789	0.1082	0.01
gammatau_c	γ_{τ_c}	beta	0.507	0.3656	0.2379	0.4984	0.1
gammatau_l	γ_{τ_l}	beta	0.568	0.3976	0.2626	0.532	0.1
gammatau_k	γ_{τ_k}	beta	0.6	0.6036	0.4414	0.7718	0.1
phiG	ϕ_G	norm	0.2	0.1819	0.0232	0.3482	0.1
phiIG	ϕ_{IG}	norm	0.3	0.3817	0.2079	0.5648	0.1
phitau_c	ϕ_{τ_c}	norm	0.01	-0.0224	-0.086	0.0492	0.05
phitau_l	ϕ_{τ_l}	norm	0.01	-0.0211	-0.0847	0.0475	0.05
phitau_k	ϕ_{τ_k}	norm	0.01	0.0098	-0.0622	0.0991	0.05
gammaR	γ_R	beta	0.8	0.8095	0.738	0.8904	0.05
gammaY	γ_Y	norm	0.5	0.5072	0.4341	0.5807	0.05
gammaPI	γ_π	norm	1.5	1.5037	1.4172	1.5781	0.05
Standard deviation of shocks							
e_m	e_m	invg	0.1	0.0532	0.0247	0.0868	2
e_G	e_G	invg	0.3	0.2013	0.08	0.3276	2
e_IG	e_{IG}	invg	0.3	0.2926	0.236	0.345	2
e_tau_c	e_{τ_c}	invg	0.1	0.021	0.0179	0.0241	2
e_tau_l	e_{τ_l}	invg	0.1	0.0206	0.0171	0.0233	2
e_tau_k	e_{τ_k}	invg	0.4	0.2616	0.11	0.4217	2

The parameters were estimated only for the sake of studying the impulse response functions or reactions of the main endogenous variables to fiscal policy shocks. Their interpretations add nothing to the questions raised in this study, especially since it is a tedious exercise. However, a few parameters require special attention.

According to the estimates made here, Malawian households exhibit very pronounced consumption habits. Indeed, the estimated value of the parameter $\boldsymbol{\phi_c}$ of 0.8864 implies that a change in income will tend to lead to a very slow variation in consumption over time (Torres, 2016). This value differs from that of Iwata (2009) (in Japan), Smets & Wou-ters (2003) and of Coenen & Straub (2005) (in the European Union) who have found a value around 0.4. It gets closer to that of Burriel et al. (2010) (0.847) for the Spanish economy.

Another parameter that attracts attention is $\boldsymbol{\omega_R}$, ie the number of RM. Its estimated value of 0.3004 suggests that for the Malawian economy, the number of RMs stands at **30.04%**. This result confirms the thesis that in the Malawi the percentage of households that can maintain a constant level of consumption over time (by saving or borrowing) is very low, while the number of MNR is very high (**70%**). The explanation behind this fact is that most households do not have access to financial markets to take on debt to bring their future consumption back to the present (consumption smoothing). This highlights the exclusive nature of the financial markets in the Malawi. This result is far from those of Coenen & Straub (2005) and Iwata (2009) who find a low proportion of these MNRs (respectively **37%** and **25%**) within the economies of the European Union and Japan.

Regarding the shocks, it should be noted that the fiscal consumption and re-entry shocks are not very persistent over time because of all the shocks, they don't have very high persistence parameter values ($\gamma_{\tau_c}$and γ_{τ_l} are equal to 0.3656, 0.3976 respectively). In other words, fiscal shocks are not more likely to influence fluctuations in macroeconomic variables over time, and more particularly output. The main reason is likely because of the significant number of MNRs in Malawi which is being estimated at more than 70%.

In addition, the coefficients of the debt-to-GDP ratio of shocks (ϕ_G, ϕ_{IG}, and ϕ_{τ_k}) are all positive but to different degrees with exception to (ϕ_{τ_c}, ϕ_{τ_l}) which are negative. This result suggests that tax rates and the level of current and investment spending respond negatively to an increase in the economy's debt level. These reactions vary according to the type of shock: they vary between **-0.33** and **1.22** in the case of fiscal shocks and between **-0.81** and **1.04** in the case of expenditure shocks. The resulting information is that an increase in internal indebtedness considerably increases current public expenditure and investment, but the tax rates negatively. This empirically demonstrates that the government of Malawi finances most of its expenditure by borrowing and not by a consistent mobilization of tax revenues. As a result, the structure of the Fiscal Policy's financing method in the Malawi is based on indebtedness.

However, revenue mobilization is the most effective means of financing the economy's expenditure (Spiegel, 2007). This weakness in being able to mobilize sufficient fiscal resources can be explained in a number of ways: (i) income tax only represents a small percentage of total revenue; (ii) the multiple exemptions and (iii) the large informal sector (MNRs) which until now has escaped the control of the State (Spiegel, 2007).

5.2 Study of Efficiency of Fiscal Policy in Malawi

This section presents the main results of the study. It should be remembered that the main objective here is to analyze the effects of an increase in public expenditure and / or a reduction in taxes and duties on private consumption, private investment and production. To answer this question, five shocks (excluding that relating to monetary policy) were simulated. Subsection 1 presents the effects of an increase in current expenditure and public investment, and subsection 2 highlights those of a reduction in taxes. The analysis of the multiplier takes place in subsection 3. The simulations were carried out over a period of 40 periods, each period representing one quarter.

5.2.1 Current Expenditure and Public Investment

Figures 1 give the impulse response functions of the main variables of interest. The graph in figure 1 below shows the baseline results effects of current expenditure shock whilst the graph in figure 1.1 shows the effects of a capital expenditure shock. The x-axis represents the time expressed in quarters, while the y-axis gives the deviations in percentage of the variables having suffered the shock. The red line indicates the steady state or the initial equilibrium level before the shock.

Figure 1 - Impulse response functions from expenditure shocks – Baseline Results

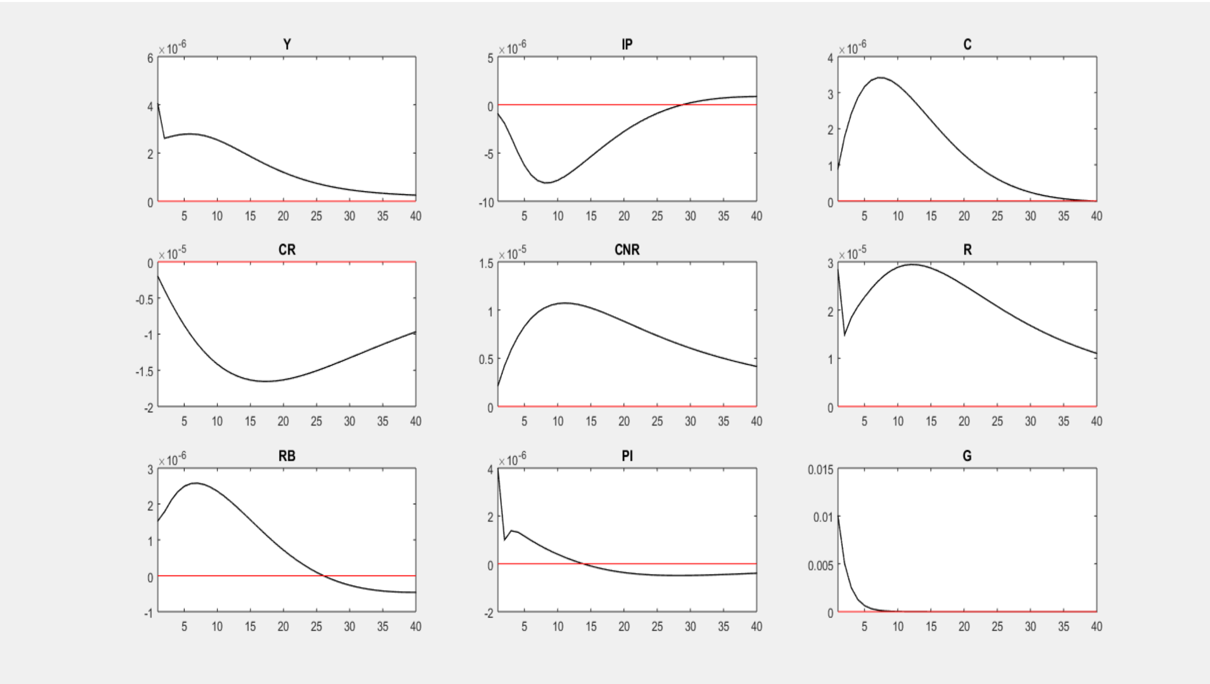
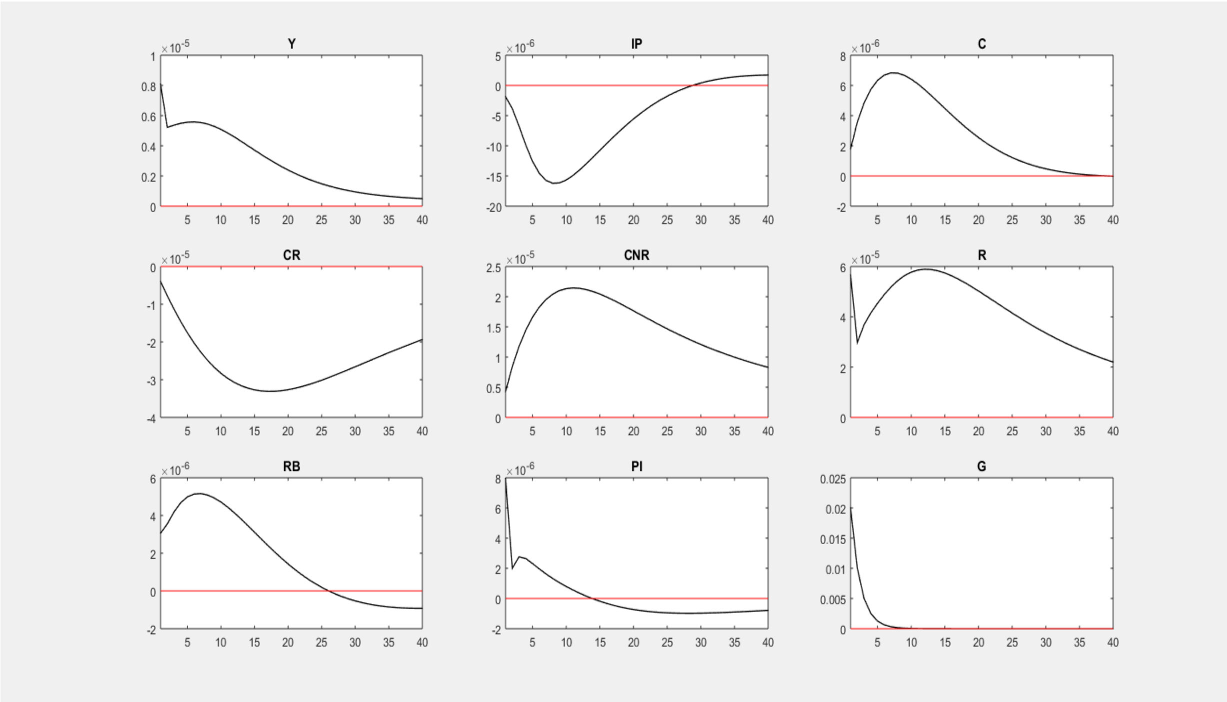


Figure 1.1 - Impulse response functions from expenditure shocks – 1% Increase in G



As can be seen perfectly, a 1% increase in current expenditure (mainly made up of wages in the Malawi) reduces national production to impact and private investment. However, it increases the level of overall household consumption and consumption of RMs. This result is different from what the theory predicts: indeed, the expected results would be that an increase in spending either increases or decreases production and aggregate demand. What emerges from the results suggests a mixed result. One of the ways of explaining this fact results from the following reasoning. When the government votes for a higher budget for future periods (increases spending), firms anticipate increased demand for public goods and services and invest more. The budgetary authorities get into debt through the creation of treasury bills or bilaterally with private organizations. However, given the high level of recurrent expenditures and corruption in the economy, capital is diverted to areas that do not contribute to Output growth; which has a negative impact on the GDP and the increases the nominal interest rate of government securities. All these supports the theory of Neo-Keynesian rational expectations effects on operations of fiscal policy.

Figure 1.2 - Impulse response functions from public expenditure shocks – Baseline Results IG IRF

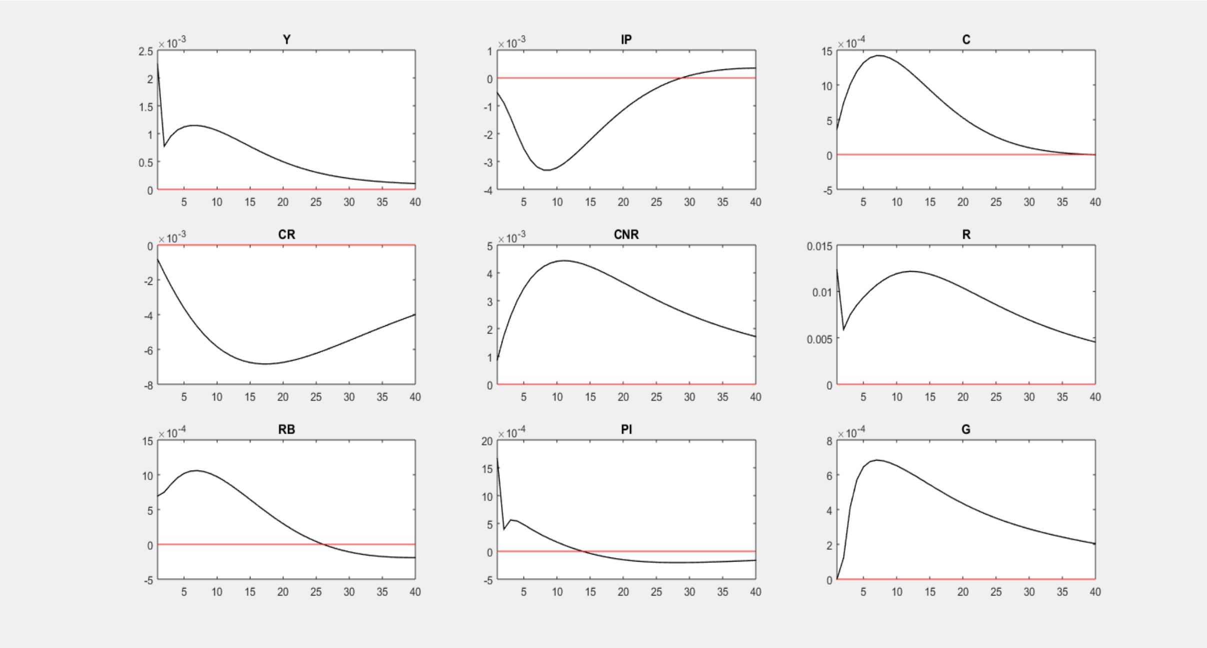
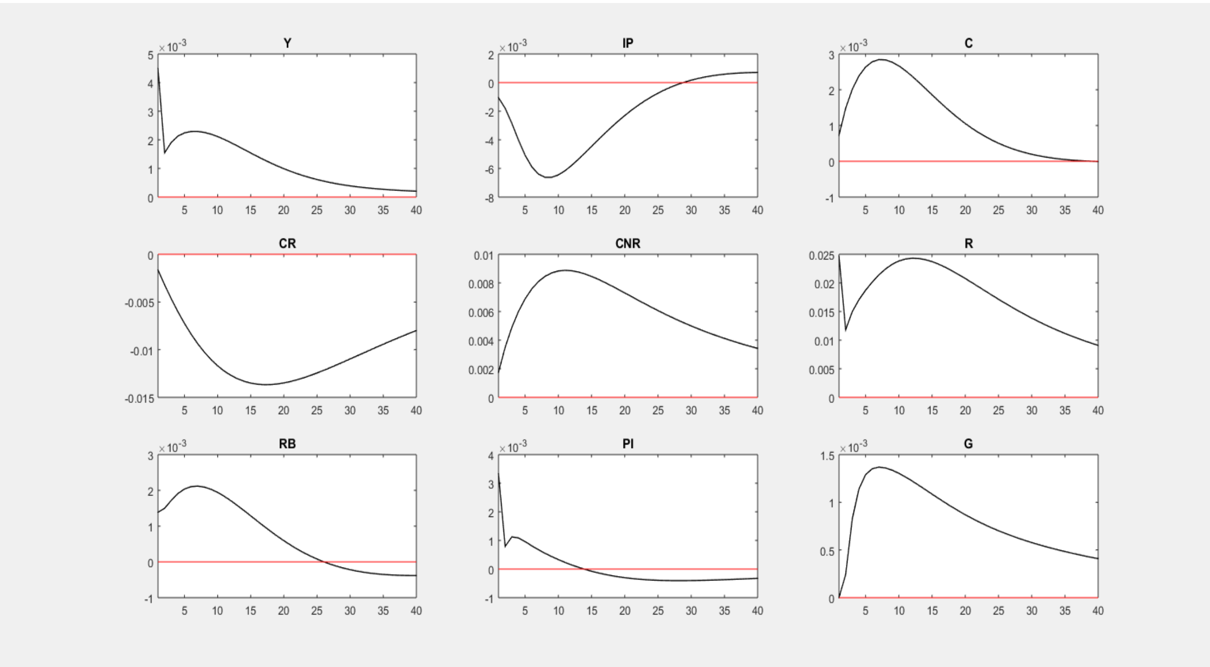


Figure 1.3 - Impulse response functions from public expenditure shocks – 1% Increase in IG



Following an increase in public investment (construction of agricultural feeder roads, etc.), national production and private final consumption increase on impact. However, this shock causes companies to reduce the level of investment and decline in overall level of consumption. Indeed, as has been said above, the government of the Malawi finances its investment expenditure by borrowing. In other words, because the reasoning is carried out within a closed economy, the State creates securities or treasury bonds to finance its policy. This causes an increase in the nominal interest rate of securities and private capital in the financial markets and leads companies to lower their level of investment. The crowding out of private investment meets the theoretical predictions of neoclassical analysis. Mountford & Uhlig, 2009).

The drop in the consumption level of RMs is best understood using the principle of Ricardian equivalence: these households actually anticipate a drop in their future consumption and therefore decide to significantly reduce their consumption in order to cope with the taxation future. On the other hand, as has been predicted, MNRs significantly increase their level of consumption. Being the most numerous within the economy (more than 70%), they will have an effect on aggregate private consumption and thus on the national wealth produced. After twenty quarters, companies notice the effective market demand and increase their level of private investment.

5.2.2 Reduction of Taxes

The graphs of impulse responses to fiscal shocks are given in Figures 1.4 to 1.9 below. The graphs show the effects of a reduction in consumption tax, employment tax and capital taxes respectively. A reduction in consumption tax is highly effective because it increases both the level of production, private investment and reduces the level of final consumption by companies. By assumption of Ricardian equivalence, RMs reduce their level of consumption.

In summary, the responses of the variables to budget and fiscal shocks are conclusive and allow us to confirm that the Fiscal Policy in the Malawi is efficient since it increases the level of production, private investment and final household consumption. However, this efficiency strongly depends on the component of the BP considered. On the one hand, the budgetary aspect shows that an increase in public expenditure in general has positive effects on the economy only if a large proportion of this expenditure is allocated to public investment. On the other hand, the tax aspect indicates that a tax cut has major effects on production, household consumption and business investment.

Figure 1.4 - Impulse response functions from baseline consumption tax shocks

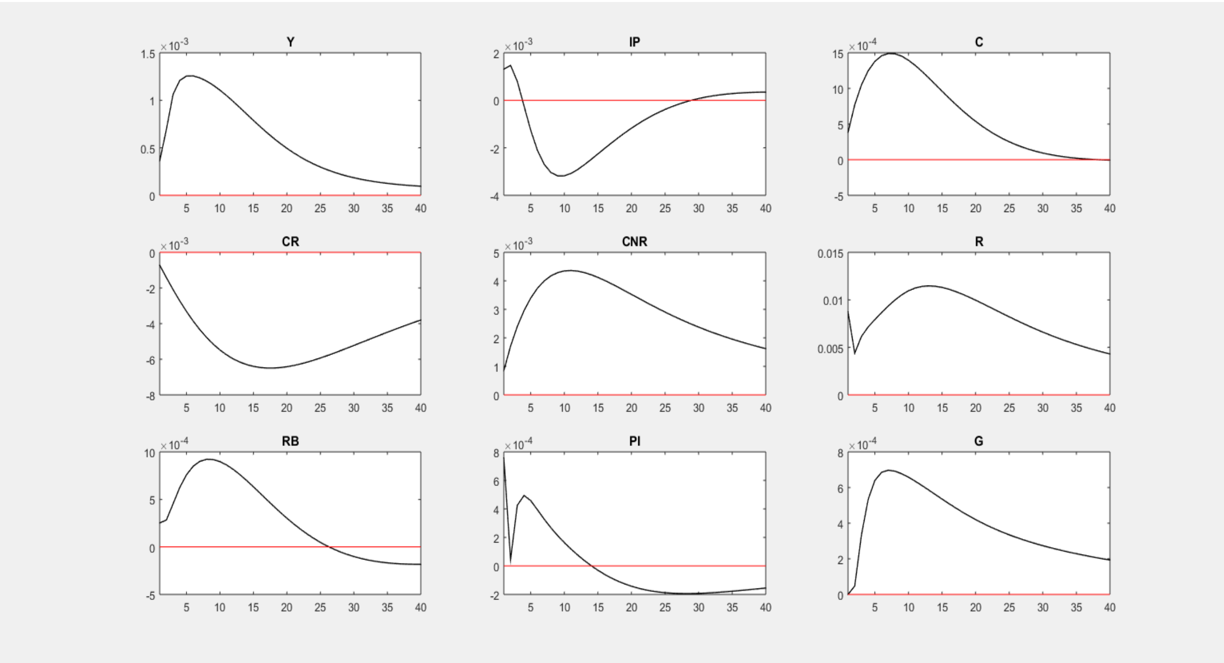


Figure 1.5 - Impulse response functions from 1% reduction in consumption tax

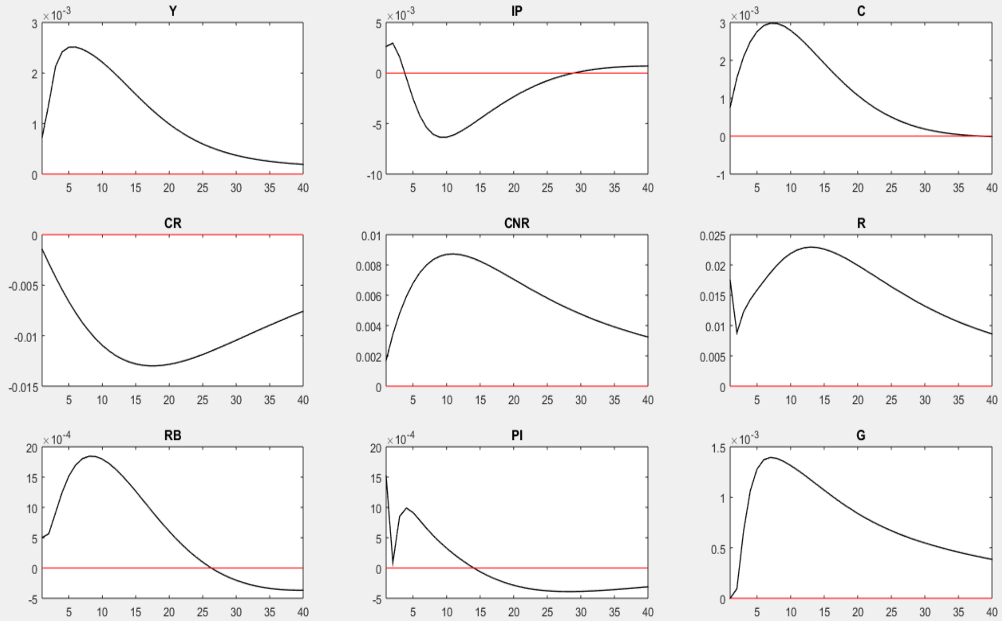


Figure 1.6 - Impulse response functions from baseline employment tax shocks –

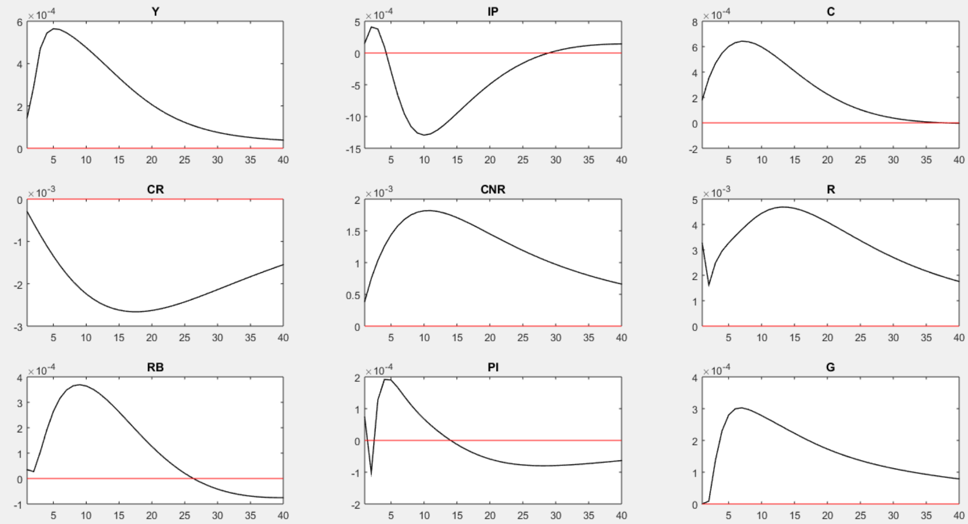


Figure 1.7 - Impulse response functions from a 1% reduction in employment tax

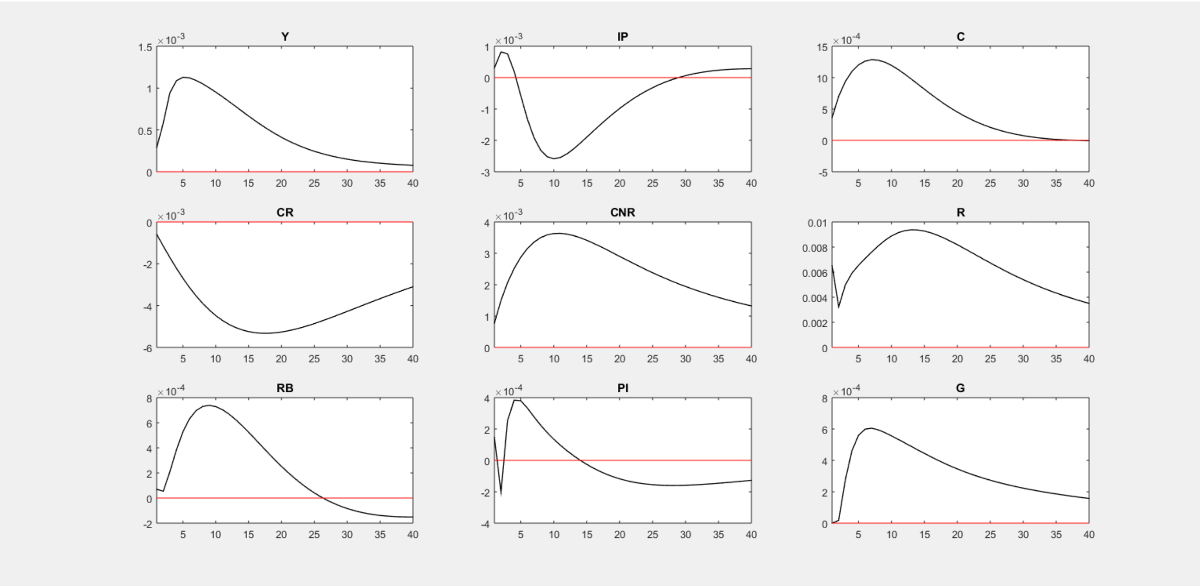


Figure 1.8 - Impulse response functions from baseline capital tax shocks

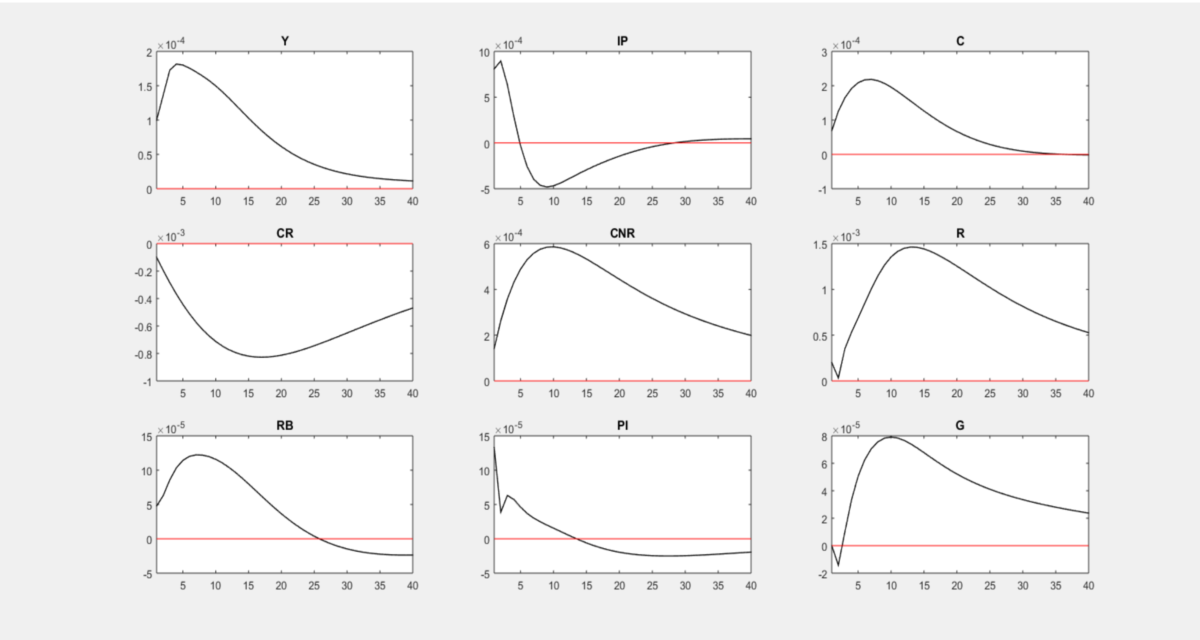
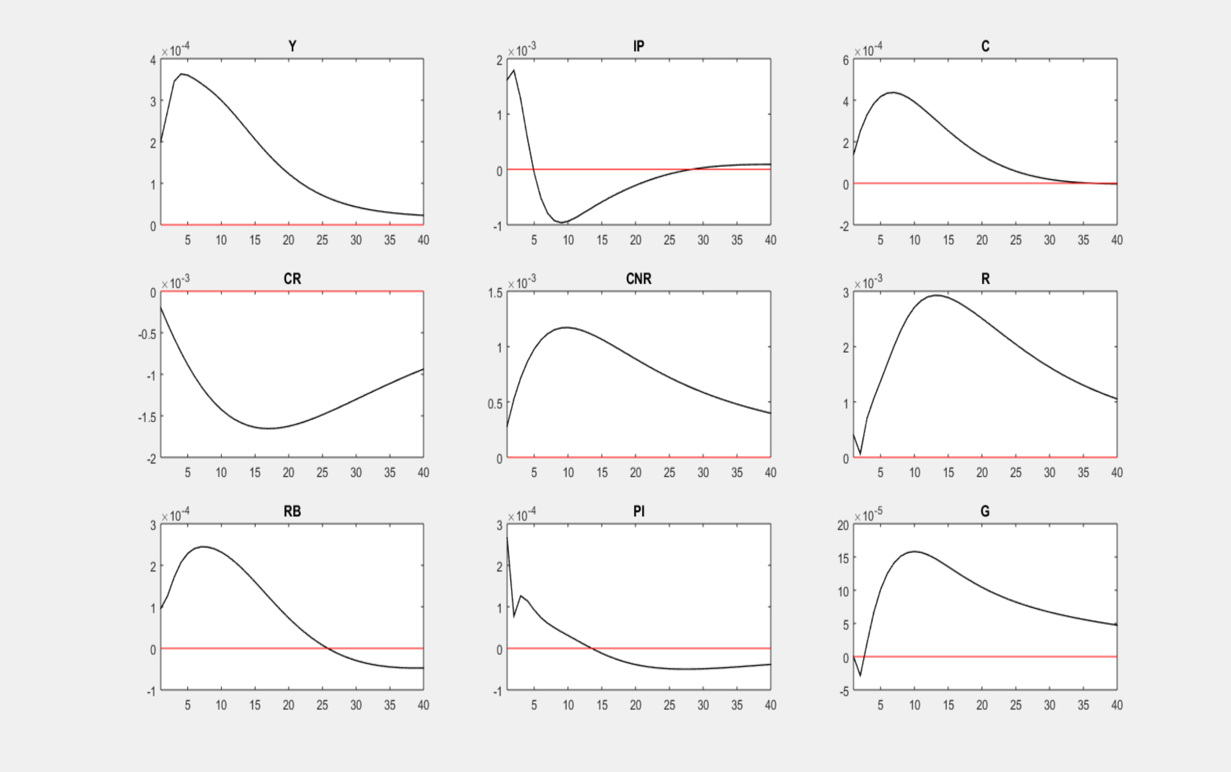


Figure 1.9 - Impulse response functions from 1% reduction in capital tax



These results are consistent with those found in the literature, except for the effect of the shock of current spending on private investment. In fact, studies of advanced economies show that an increase in public expenditure in general increases production and aggregate demand (Bouakez & Rebei, 2007; Galì et al., 2007; Iwata, 2009; Mountford & Uhlig, 2009, among others). However, as said in addition, this efficiency is explained differently according to the authors. For Galì et al. (2007); Iwata (2009) and Coenen & Straub (2005), this stimulus effect (or crowding-in effect) depends on the number of RMs within the economy because the impact of fiscal policy passes through them in order to affect production. In other words, when the government increases spending or cuts taxes, MNRs, thinking in the short term, take the opportunity to consume more and thus create a strong demand for companies if they are in the majority (over 60%) within the economy (Galì et al., 2007). Thus, the effect of the fiscal policy depends on their proportion. However, this is low in several advanced economies: 37% in the European Union (Coenen & Straub, 2005), 25% in Japan (Iwata, 2009), 12% in the United Kingdom (Bhattarai & Trzeciakiewicz, 2016). According to Coenen & Straub (2005), this weakness explains why fiscal policy is not efficient within the European Union.

As part of this study, it was shown that the proportion of MNR exceeds **60%**, which explains the effectiveness of fiscal policy in the Malawi and thus confirms the hypothesis initially set. The results found here are partially similar to those of Diwambuena & Boketsu (2019) and largely different from those of Barhangana (2006) and Tavulyandanda (2015). For Diwambuena Boketsu (2019), a budget shock increases private consumption and production but crowds out private investment. The results found here suggest rather that it is the expenditure component of public investment which increases GDP and final consumption, but (weakly) crowds out investment by firms due to the rise in the interest rate on private capital.

On the other hand, current spending reduces GDP and household consumption without discouraging private investment.

5.2.3 Expenditure and Tax Multipliers

In order to quantitatively assess the impact of Fiscal Policy, this work uses the Keynesian multiplier. It is an indicator measuring the increase in output in response to a change in one of the components of the Fiscal Policy given by $\Delta F_t \epsilon [G_t, IG_t, \tau_t^c, \tau_t^l, and\ \tau_t^k]$ resulting from k periods ahead: $\Delta Y_{t+k}/\Delta F_t$ (Zubairy, 2010). These multipliers come from the IRFs shown above:

Table 3: Expenditure and tax multipliers

Multipliers	*Q1*	*Q10*	*Q20*	*Q30*	*Q40*	*AVG's*
Government expenditure multiplier						
GDP	-0.80	-0.84	-0.81	-0.86	-0.75	-0.81
Private Investment	-1.50	0.94	1.00	0.14	1.00	0.32
Consumption	1.00	1.19	0.47	0.13	0.00	0.56
Government public investments multiplier						
GDP	1.09	1.05	1.40	0.67	1.00	1.04
Private Investment	-1.00	-1.13	-1.00	0.67	1.00	-0.29
Consumption	-0.83	-0.81	-0.80	-0.80	0.00	-0.65

1% Decrease

Multipliers	*Q1*	*Q10*	*Q20*	*Q30*	*Q40*	*AVG's*
Consumption tax multiplier						
GDP	1.67	1.09	1.40	1.20	0.75	1.22
Private Investment	0.74	-1.33	-1.30	4.00	1.33	0.69
Consumption	-0.83	-0.81	-0.80	-0.75	0.00	-0.64
Employment tax multiplier						
GDP	-0.84	-0.80	-0.80	-0.60	0.00	-0.61
Private Investment	-0.75	0.82	-0.80	-0.71	-0.40	-0.37
Consumption	1.40	1.17	1.50	0.50	0.00	0.91
Capital tax multiplier						
GDP	1.00	0.94	1.40	1.00	0.50	0.97
Private Investment	0.78	-0.80	-0.70	0.00	-0.92	-0.33
Consumption	1.50	1.00	1.43	1.00	0.00	0.99

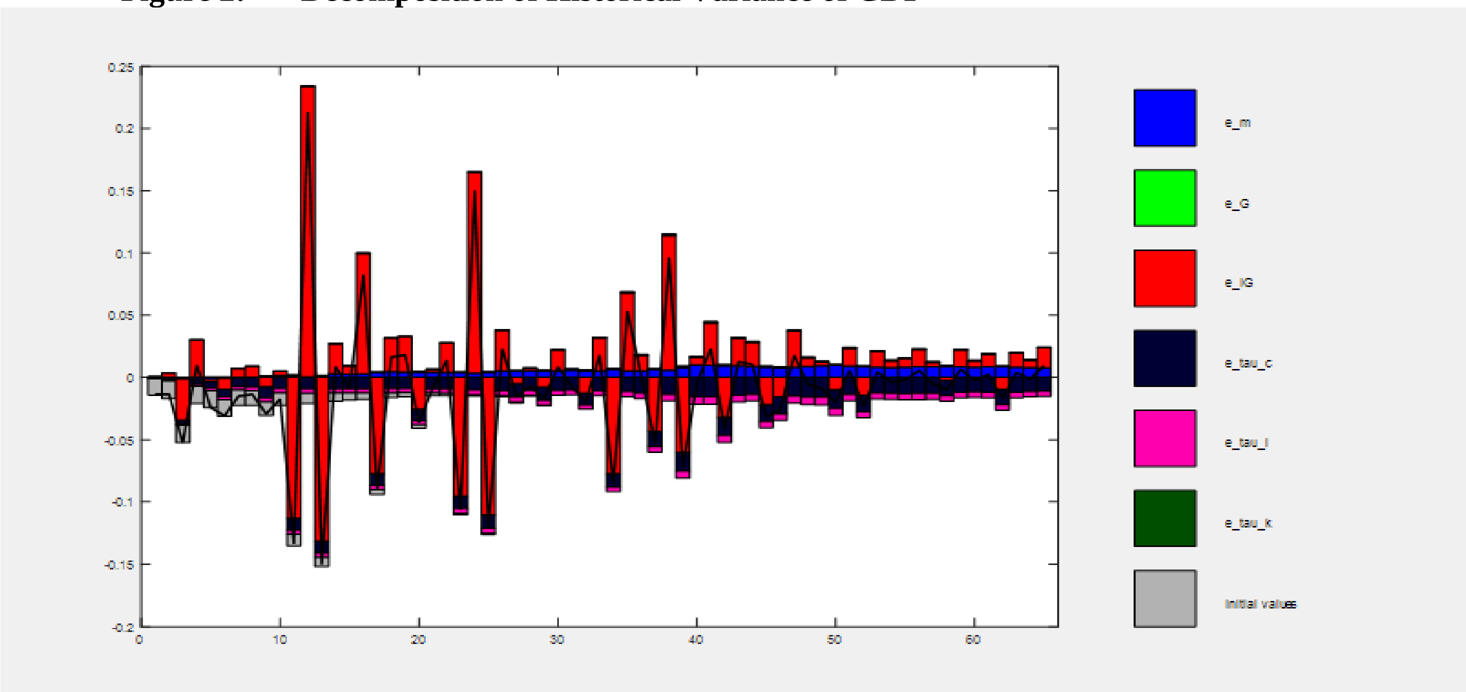
Source Author

On impact, a 1% increase in current expenditure reduces national production by 0.80 while a 1% increase in public investment increases it considerably by 1.09. This result suggests that investment spending must represent a significant share of public spending for two reasons. On the one hand, they can serve in the stabilization of economic activity in the short term and thus make the fiscal policy counter-cyclical. On the other hand, their effects increase after each quarter and multiply the GDP on average by 1.04, while current expenditure reduces it even more. In terms of fiscal shocks, a reduction in the consumption tax and the tax on capital multiplies output by 1.22 and 0.97 respectively. Nevertheless, these results are consistent with those found in the literature. In fact, in advanced countries, the multiplier varies between 0 and 1 in normal times and can exceed 1 in abnormal times when economies experience a severe recession. Moreover, in advanced countries, the expenditure multipliers vary between 0.1 -1.4 are often higher than the fiscal multipliers which ranges between **0.3-0.8**. For developing countries, on the other hand, these multipliers are lower than those for advanced countries, varying in the short term between **0.1-0.3** for expenditure multipliers and **0.2-0.4** for tax multipliers (Batini et al., 2014). The results found suggest that the public expenditure multiplier is on average (after three years) of **1.04** if a significant proportion of this expenditure is allocated to public investments. On the other hand, if current expenditure dominates, then this multiplier is located at **0.32**. These results confirm the conclusions of previous studies in developing countries, in particular that of (Batini et al., 2014), the expenditure multiplier in the Malawi varies between **-0.81** and **1.04**. As for the fiscal multiplier, this study finds that it is fixed at 0.31 on average. These conclusions are within the acceptable limit according to previous studies (Batini et al., 2014; Diwambuena & Boketsu, 2019; Djinkpo, 2019; Iwata, 2009), Estevão and Samake, 2013; Ilzetzki and others, 2013; Ilzetzki, 2011; and Kraay, 2012). Some studies even conclude that multipliers are negative, particularly in the longer term (IMF, 2008) and when public debt is high (Ghosh and Rahman, 2008).

5.3 Fluctuations in the Business Cycle

This section shows the source of fluctuations in production using the decomposition of historical variance (point 3.3.1) and the decomposition of the variance of forecast errors (point 3.3.2). This last tool comes in addition because it studies these determinants in the short, medium and long term. It also helps identify the main shocks that cause fluctuations in private consumption and investment.

Figure 2: Decomposition of Historical Variance of GDP



Analysis of the historical decomposition (figure 2) of production reveals that since the first quarter of 2004, the cyclical (periodic) variation in GDP is mainly explained by the public investment shock. This shock is followed by those of the tax on final consumption and the tax on salaried income. The large spike shows that between 2008Q1 and 2010Q1, a period marked by the economic and financial crisis, a reduction in these two rates, on their own, was able to generate a fiscal multiplier exceeding 0.5. Monetary policy comes fourth in explaining variations in GDP.

While the fiscal shocks explain in part the developments in productivity shocks in a minority way. This study ignored productivity shock because innovations are insignificant or at low levels in developing countries compared to developing countries. In this vein, the Malawi consumes more imported technologies from advanced countries, as is the case for developing countries in general, but generates little. Thus, this component was explicitly ignored within the model to retain only likely shocks to the Malawi economy. The resulting general information can be formulated as follows: the government must focus more on increasing public investment and reducing taxes in times of crisis, or especially economic recession,

5.3.1 Decomposition of the Variance of Forecasted Errors

Like the previous exercise, the decomposition of the variance of forecast errors is an instrument for highlighting the shocks determining fluctuations in production but in the future. To do this, this study of the variability of the output is spread over a horizon of 32. The need to have recourse to this tool stems from the concern to be able to confirm or deny if really the shocks of public investment expenditure and fiscal (on consumption and wage income) also explain the variability of production in the short (1 year), medium (2 years) and long term (8 years). Table 4 below gives a summary:

Table 4: Decomposition of the variance of forecast errors (in %)

Period	Shock	Y	IP	C
1	Monetary Policy	14.85	99.51	56.75
	Public Investment Expenditure	82.52	0.05	18.21
	Consumption Tax	2.13	0.31	19.86
	Employee Income Tax	0.34	0	4.54
4	Monetary Policy	26.83	99.49	46.06
	Public Investment Expenditure	48.48	0.26	23.15
	Consumption Tax	20.19	0.17	25.14
	Employee Income Tax	3.93	0.01	5.02
8	Monetary Policy	21.7	97.8	38.92
	Public Investment Expenditure	41.55	1.26	26.23
	Consumption Tax	30.16	0.79	28.72
	Employee Income Tax	5.91	0.09	5.47
16	Monetary Policy	27.53	94.37	36.33
	Public Investment Expenditure	35.75	2.81	27.48
	Consumption Tax	30.33	2.36	29.98
	Employee Income Tax	5.76	0.36	5.58
32	Monetary Policy	31.39	93.77	36.83
	Public Investment Expenditure	33.59	3.08	27.36
	Consumption Tax	29	2.64	29.7
	Employee Income Tax	5.44	0.41	5.5

This table shows that overall, the variability of production and private consumption is due in large part to public investment and monetary policy shocks, and this effect is persistent and significant over time. . The effects of the public investment shock diminish over time, while those relating to the consumption tax are increasing. As said above, the productivity shock was not considered, it was replaced by the monetary shock. In addition, the Consumption tax shock comes third to explain the variability of production and general consumption behaviour. The shock to wage income contributes to smaller variations in household consumption, mainly due to on average lower salaried MNRs. In short, in the short term, the contribution of public investment shocks and the consumption tax shock is estimated at nearly 82% in the short run, to 30% in the long run. As a result, these two shocks significantly explain the variations in GDP in the simulated periods. Although monetary policy shock to the fluctuations of all the aggregates, it explains more those of general consumption with increasing effects over time (from 14% to 31%) and private investments.

6.0 Conclusion and Recommendations

The general aim of this work was to answer the question: what the effects of an increase of expenditure and / or decreases in taxes on production, consumption, and private investment. More precisely, the idea was to assess the effectiveness of the fiscal policy in the presence of heterogeneous households made up of Ricardians and non Ricardians. The subsidiary objectives were to quantitatively assess this impact through the multiplier and study the main shocks that have contributed to GDP fluctuations in the Malawi.

The results show that (i) the increase in government expenditure has a negative effect on national production, household consumption, and the private sector. The Keynesian multiplier for government expenditure has been estimated at -0.81 and -1.50 at impact and remains negatively strong in subsequent periods for Output and positive for subsequent period for private investments or aggregate demand; (iii) an increase in consumption taxes has a positive impact on national production, private investments and negative impact on general consumption, the consumption tax multiplier has been estimated at 1.22 for GDP, -0.64 for consumption and 0.69 for private investments. (iii) the increase of employment tax also is negative on GDP, Consumption and private investments.

These results show that in the Malawi, a fiscal policy financed by debt stimulates significantly economic activity as a whole. As for cyclical variations in GDP, the decomposition of the historical variance reveals that the great part of these fluctuations, observed since the first quarter of 2004, results from public investment shocks, and the tax on consumption. In addition, over 40 simulated quarters, the decomposition of the variance show that the two previous shocks contribute significantly and persistently changes in GDP and consumption. While monetary policy explains significantly variations in private investment.

The recommendations made here are that the government should (i) increase the share of capital expenditures as these have a significant and persistent effect on economic activity; (ii) in a period of recession, a fiscal policy of reducing taxes and levies must be undertaken in order to promote household consumption and, in turn, private investment. This could significantly reduce the unemployment rate in times of crisis. (iii) The government must also ensure that its fiscal policy is financed by tax revenues collected during periods of overheating and fight against corruption, embezzlement and exemptions.

7.0 Limitations of Study

It should be noted that this study was unable to integrate the banking system, exchange rates and trade with the rest of the world. Subsequent research could integrate these aspects in order to bring out the Keynesian multiplier in open economy.

A Appendices

A.1 A priori and a posteriori distributions of the parameters; univariate diagnostics of MCMC chains and check plots mode

Figure 3 - A-A priori and a posteriori distributions

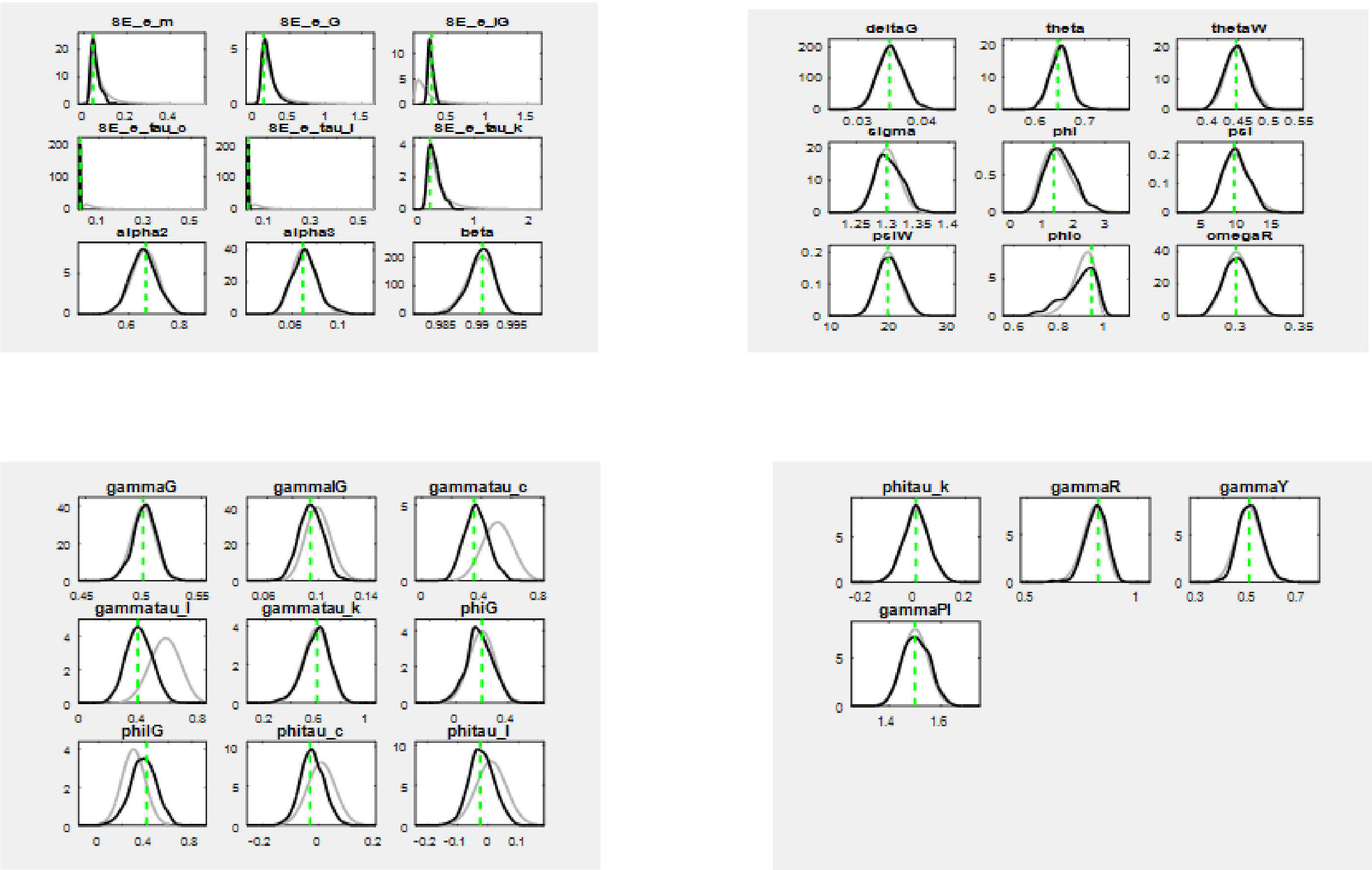


Figure 4 - b-A priori distributions

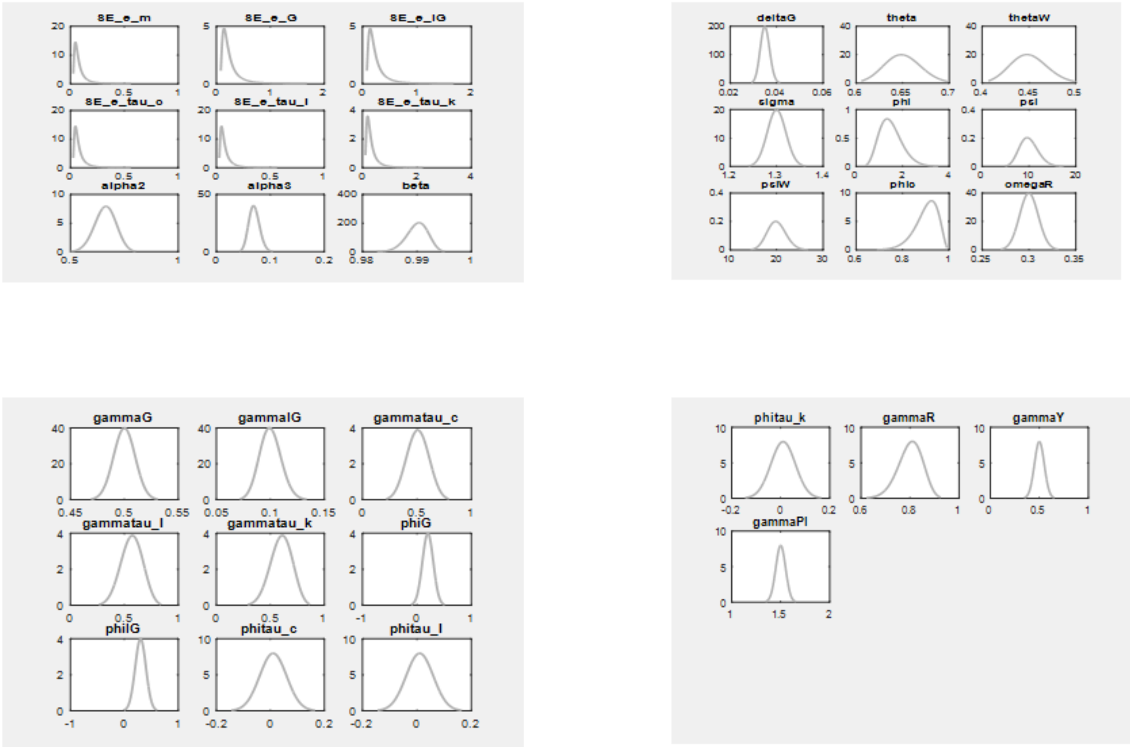


Figure 5 - a-Univariate diagnosis of MCMC chains

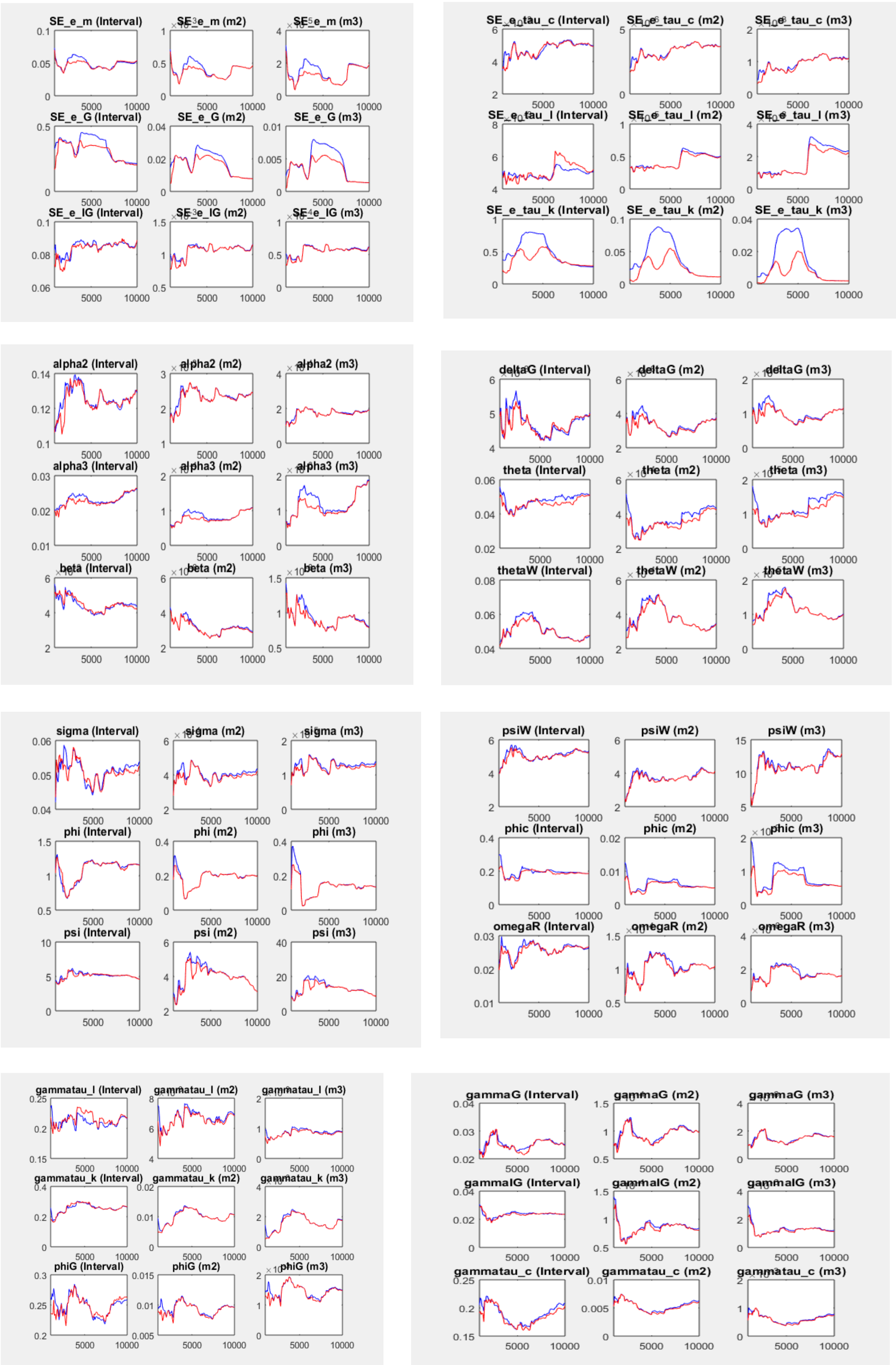


Figure 6 - a-Univariate diagnosis of MCMC chains

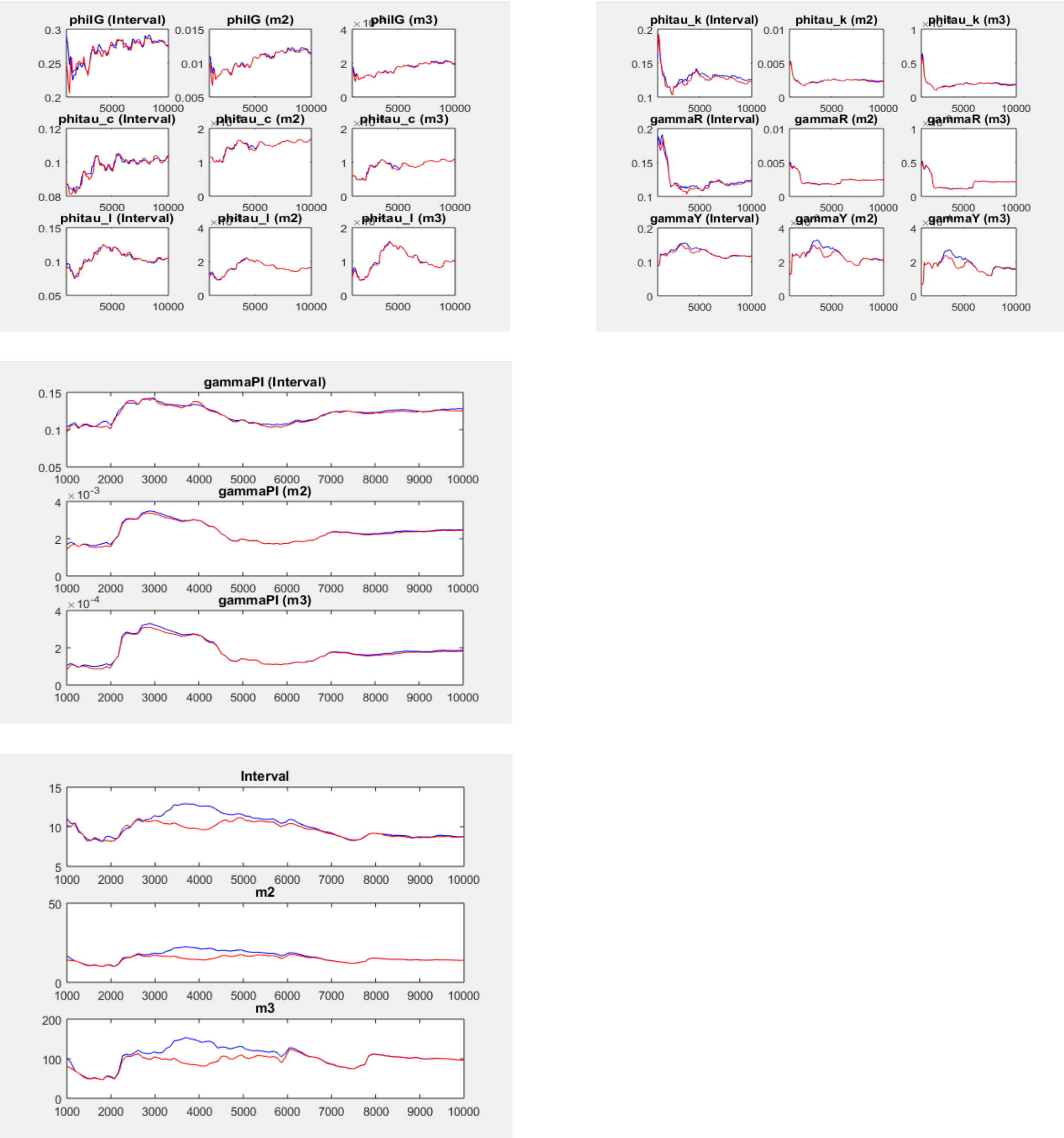
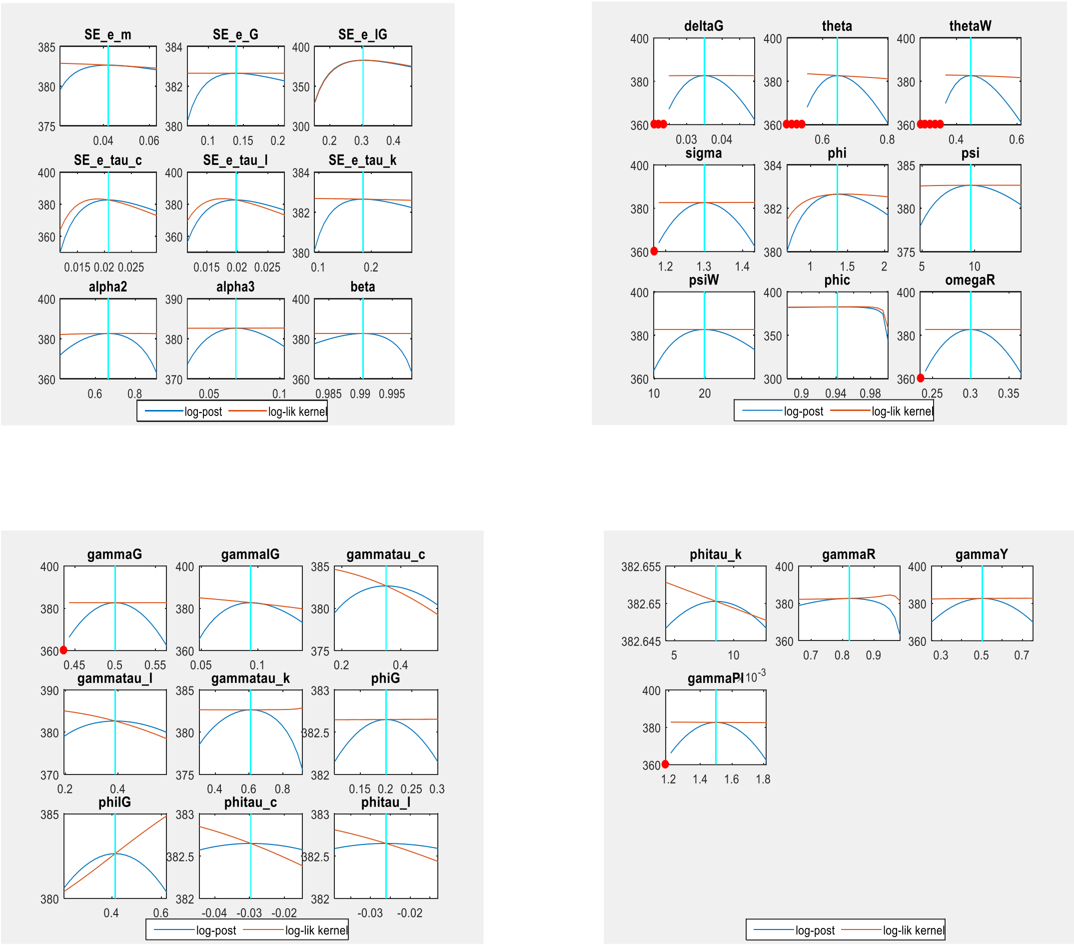


Figure 7 - Check plot mode (Blanchard-Kahn conditions)



A.3 Log-linear form of model

The letters "$\hat{X}$" denote the deviations of the variables from their stationary states; while the letters "X_{SS}" represent the steady-state variables. Some important assumptions have been considered for linearization:

$C_{R,ss} = C_{NR,ss} = C_{ss};\ L_{r,ss} = L_{nr,ss} = L_{ss};\ K^G_t = 0.2;$

$IssG = \phi IssGYss;\ Bss = \phi BssYss;\ Uss = Qss = Pss = \pi ss = \chi = \psi 2 = 1$

And

$\psi 2 = (1 + \tau^{ss}_{ss})\left[\frac{1}{\beta} - 1 + \delta\right]$ (Costa, 2016; Iwata, 2009; Smets & Wouters, 2003).

The linear form of the model is given by the following table:

Table 6: Log-linearized form of the model

(1) $$\widehat{\Lambda}_{R,t} = \left[\frac{\sigma}{(1-\phi_c)(1-\phi_c)}\right]\left[\phi_c\beta\left(\mathbb{E}_t\hat{C}_{R,t+1} - \phi_c\hat{C}_{R,t}\right) - \left(\hat{C}_{R,t} - \phi_c\hat{C}_{R,t}\right)\right] - \hat{P}_t - \left(\frac{\tau^c_{ss}}{1+\tau^c_{ss}}\right)\hat{\tau}^c_t$$

(2) $$\widehat{\pi}_{w,t} = \beta\mathbb{E}_t\hat{\pi}_{R,t+1} + \left[\frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w}\right]\left[\varphi L_{R,t} - \Lambda_{R,t} + \left(\frac{\tau^l_{ss}}{1+\tau^l_{ss}}\right)\hat{\tau}^l_t\right]$$

(3) $$\hat{\pi}_{w,t} = \widehat{W}_t - \widehat{W}_{t-1}$$

(4) $$\widehat{Q}_t = \beta\mathbb{E}_t\left[(1-\delta)Q_{ss}\hat{Q}_{t+1} + \Lambda_{Rss}R_{ss}\left(1-\tau^k_{ss}\right)\left(\widehat{\Lambda}_{R,t+1} + \hat{R}_{t+1} + \hat{U}_{t+1} - \frac{\tau^k_{ss}}{1-\tau^k_{ss}}\tau^k_{t+1}\right) - \Lambda_{R,ss}\right]$$

(5) $$\left(1-\tau^k_{ss}\right)\left(\frac{R_{ss}}{P_{ss}}\right)\left(R_t - P_t - \left(\frac{\tau^c_{ss}}{1-\tau^k_{ss})}\right))\tau^k_{t}{}_{ss}\right) = \psi_2 U_{ss}U_t$$

(6) $$(1-\tau^c_{ss})\lambda_{ss}P_{ss}(\lambda_t + P_t + \left(\frac{\tau^c_{ss}}{1-\tau^k_{ss})}\right)\tau^c_t) - Q_{ss}Q_t + \chi_t Q_{ss}(IP_t - IP_{t-1}) = \chi_t\beta_t Q_{ss}(IP_{t+1} - IP_t)$$

(7) $$\widehat{K}^P_{t+1} = (1-\delta)\widehat{K}^P_t + \delta\hat{I}^P_t$$

(8) $$\widehat{\Lambda}_{t+1} = \widehat{\Lambda}_{R,t} - \widehat{R}^B_t$$

(9) $$\widehat{\Lambda}_{MNR,t} + \hat{P}_t + \left(\frac{\tau^c_{ss}}{1+\tau^c_{ss}}\right)\hat{\tau}^c_t = \left[\frac{\sigma}{(1-\phi_c)(1-\phi_c\beta)}\right]\left[\phi_c\beta\left(\mathbb{E}_t\hat{C}_{MNR,t+1} - \phi_c\hat{C}_{MNR,t}\right) - (\hat{C}_{MNR,t} - \phi_c\hat{C}MN_{R,t})\right]$$

(10) $$\widehat{\pi}_{w,t} = \beta\mathbb{E}_t\hat{\pi}_{R,t+1} + \left[\frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w}\right]\left[\phi L_{MNR,t} - \widehat{\Lambda}_{MNR,t} + \left(\frac{\tau^l_{ss}}{1+\tau^l_{ss}}\right)\hat{\tau}^l_t\right]$$

(11) $P_{ss}CR_{ss}\big((P_t + CR_t)(1+\tau_{ss}^c) + \tau_{ss}^c\tau_t^c\big) = W_{ss}LR_{ss}(W_t + LR_t)\big(1-\tau_{ss}^l\big) - \tau_{ss}^l\tau_t^l)$

$P_{ss}C_{MNRss}\big[\big(\hat{P}_t + \hat{C}_{MNR,t}\big)(1+\tau_{ss}^c) + \tau_{ss}^c\tau_t^c\big] + P_{SS}I_{SS}^P\big[\big(\hat{P}_t + \hat{I}_t^P\big)(1+\tau_{ss}^c) + \tau_{ss}^c\tau_t^c\big] + \frac{B_{ss}}{R_{ss}^B}(\widehat{W}_t - \hat{R}_t^B)$=$W_{ss}L_{MNR,ss}\big[\big(\widehat{W}_t + \hat{L}_{MNR,t}\big)\big(1-\tau_{ss}^l\big) - \tau_{ss}^l\hat{\tau}_t^l\big] + R_{SS}K_{SS}^P\big[\big(\hat{R}_t + \widehat{K}_t^P\big)\big(1 - \tau_{ss}^k\big) - \tau_{ss}^k\hat{\tau}_t^l\big] + B_{ss}B\hat{B}_t$

(12) $\hat{C}_t = \phi C_{R,ss}\hat{C}_{R,t} + (1-\phi)C_{NR,ss}\hat{C}_{NR,t}$

(13) $\hat{L}_t = \phi L_{R,ss}\hat{L}_{R,t} + (1-\phi)L_{NR,ss}\hat{L}_{NR,t}$

(14) $\hat{Y}_{j,t} = \alpha_1\big(\widehat{U}_t + \widehat{K}_t^P\big) + \alpha_2\hat{L}_t + \alpha_3 K_t^G$

(15) $\widehat{K}_t^P = \widehat{U}_t + \hat{L}_t - \hat{R}_t + \widehat{W}_t$

(16) $\widehat{mc}_t = \alpha\hat{R}_t + (1-\alpha)\widehat{W}_t - \alpha_g\widehat{K}_t^G$

(17) $\hat{\pi}_t = \beta\mathbb{E}_t\hat{\pi}_{R,t+1} + \left[\frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w}\right]\left[\widehat{MC}_t - \hat{P}_t\right]$

(18) $\pi_w = \hat{P}_t - \hat{P}_{t-1}$

(19) $\frac{B_{ss}}{R_{ss}^B{}_t}\big(\hat{B}_{t+1} - \hat{R}_t^B\big) - B_{ss}\hat{B}_t + T_{ss}\hat{T}_t = P_{ss}\hat{G}_t\big(\hat{G}_t + \hat{P}_t\big) + P_{ss}\hat{I}_t^G(\hat{P}_t + \hat{I}_t^G)$

(20) $T_{ss}T_t = \tau_{ss}^c P_{ss}(C_{ss}(C_t + P_t + \tau_t^c) + I_{P_{ss}}(I_p + P_t + \tau_t^c)) + \tau_{l_{ss}}W_{ss}L_{ss}(W_t + L_t + \tau_t^l) + \tau_{k_{ss}}KP_{ss}(R_{ss}(R_t + KP_{t-1}) + \tau_t^k) - \delta(KP_{t-1} + \tau_t^k)$

(21) $KG_{t+1} = \big(1-\delta_t^g\big)KG_t + \delta_t^g IG_t$

(22) $G_{t+1} = \gamma_t^g G_{t-1} + \big(1-\gamma_t^g\big)\phi_t^g(B_{t-1} - Y_{t-1} - P_{t-1}) + \varepsilon_t^g$

(23) $IG_{t+1} = \gamma_t^{IG} IG_{t-1} + (1-\gamma_t^{IG})\phi_t^{IG}(B_{t-1} - Y_{t-1} - P_{t-1}) + \varepsilon_t^{IG}$

(24) $\tau_t^c = \gamma_{\tau_c}\tau_{t-1}^c + (1-\gamma_{\tau_c})\big(1-\gamma_R\big)(\phi_{\tau_c}B_{t-1} - Y_{t-1} - P_{t-1} - e_{\tau_c}$

(25) $\tau_t^l = \gamma_{\tau_l}\tau_{t-1}^l + (1-\gamma_{\tau_l})\big(1-\gamma_R\big)(\phi_{\tau_l}B_{t-1} - Y_{t-1} - P_{t-1} - e_{\tau_l}$

(26) $\tau_t^k = \gamma_{\tau_k}\tau_{t-1}^k + (1-\gamma_{\tau_k})\big(1-\gamma_R\big)(\phi_{\tau_k}B_{t-1} - Y_{t-1} - P_{t-1} - e_{\tau_k}$

(27) $$\hat{R}_t^B = \gamma_R \hat{R}_{t-1}^B + (1-\gamma_R)\left(\gamma_\pi \hat{\pi}_t + \gamma_y \hat{Y}_t\right) + \hat{\varepsilon}_t^m$$

(28) $$Y_{ss}\tilde{Y}_t = C_{ss}\tilde{C}_t + I_{ss}^P \tilde{I}_t^P + I_{ss}^G \tilde{I}_t^G + G_{ss}\tilde{G}_t$$

(29) $$\tilde{A}_t = \rho_A \tilde{A}_{t-1} + \epsilon_t$$

References

Acemoglu, D. (2009). Introduction to modern economic growth. Princeton University Press.

Adjemian, S., Bastani, H., Juillard, M., Karamé, F., Maih, J., Mihoubi, F., et al. (2011). Dynare: Reference Manual Version 4 (Dynare Working Papers No 1). CEPREMAP.

Afonso, A., & Sousa, RM (2009). The Macroeconomic E ff ects of Fiscal Policy in Portugal: a Bayesian SVAR Analysis (Working Papers Nº9). School of Economics and Management.

Alesina, A., Campante, F., & Tabellini, G. (2008). Why is Fiscal Policy often Procyclical. Journal of the European Economic Association, 6 (5), 1006-1036.

Alesina, Alberto, and Roberto Perotti, 1997, "Fiscal Adjustments in OECD Countries: Composition and Macroeconomic Effects," *IMF Working Paper 96/70* (Washington: International Monetary Fund).

Angullo-Rodriguez, H., Castillo-Duran, MA, Garza-Rodriguez, J., Gonzalez-Hernandez, MG, & Puente-Ortiz, R. (2011). The Effectiveness of Fiscal Policy in Mexico. The Empirircal Economics Letters, 10 (6).

Ardagna, Silvia, 2001, "Fiscal Policy Composition, Public Debt, and Economic Activity" *Public Choice*, Vol. 109, pp. 301–325.

Arestis, P. (2012). Fiscal Policy: a Strong Macroeconomic Role. Review of Keynesian Economics, Inaugural Issue, 93–108.

Barhangana, FA (2006). E ffi ciency of Budgetary Policy in the Congo. (Bachelor thesis, Unpublished, UCB)

Barro, Robert J., 1974, "Are Government Bonds Net Wealth?" *Journal of Political Economy*, Vol. 82 (November–December), pp. 1095–1117.

Batini, N., Eyraud, L., & Weber, A. (2014). A Simple Method to Compute Fiscal Multipliers (Vol. 14; IMF Working Paper No 93). International Monetary Fund.

Barrell, R., D. Holland and I. Hurst (2012), "Fiscal multipliers and prospects for consolidation:, OECD Journal: Economic studies 2012 (1):71-102.

Bartolini, Leonardo, Assaf Razin, and Steven Symansky, 1995, "G-7 Fiscal Restructuring in the 1990s: Macroeconomic Effects," *Economic Policy*, No. 20 (April), pp. 111–46.

Baxter, M., & King, RG (1993). Fiscal Policy in General Equilibrium. The American Economic Review, 83 (3), 315–334.

Bayoumi, Tamim, and Douglas Laxton, 1994, "Government Deficits, Debt, and the Business Cycle," in *Deficit Reduction—What Pain, What Gain?*, ed. by William B.P. Robson and William M. Scarth (Toronto: C.D. Howe Institute).

BCC. (2018). 2018 Annual Report of the Central Bank of Congo (Technical Report). Central Bank of Congo.

Beiton, A., Cazorla, A., Dollo, C., & Drai, A.-M. (2001). Dictionary of Economic Sciences. Armand Colin.

Bertola, Giuseppe, and Allan Drazen, 1993, “Trigger Points and Budget Cuts: Explaining the Effects of Fiscal Austerity,” *American Economic Review,* Vol. 83 (March), pp. 11–26.

Bhattarai, K., & Trzeciakiewicz, D. (2016). Macroeconomics Impacts of Fiscal Policy Shocks in the UK: A DSGE Analysis. Economic Modeling, 61.

Bouakez, H., & Rebei, N. (2007). Fiscal Policy in General Equilibrium. The Canadian Journal of Economics / Revue canadienne d'Economie, 40 (3), 954–979.

Born B,. Juessen F,. and Muller G,. “Exchange rate regimes and fiscal multipliers”, Journal of Economic Dynamics and Control, Volume 37, Issue 2, 2013, pages 446-465.

Bryant Ralph C., Dale W. Henderson, Gerald Holtham, Peter Hooper, and Steven Symansky, eds., 1988, *Empirical Macroeconomics for Interdependent Economies* (Washington: Brookings Institution).

Bryant, Ralph C., Peter Hooper, and Catherine L. Mann, eds., 1993, *Evaluating policy Regimes: New Research in Empirical Macroeconomics* (Washington: Brookings Institution).

Burriel, P., Fernández-Villaverde, J., & Rubio-Ramirez, J. (2010). MEDEA: A DSGE model for the Spanish economy. Series, 1 (1-2).

Caballero, Ricardo J., and Robert S. Pyndick, 1996, “Uncertainty, Investment, and Industry Evolution,” *International Economic Review,* Vol. 37 (August), pp. 641–62.

Coenen, G., & Straub, R. (2005). Non-Ricardian Households and Fiscal Policy in an Estimated DSGE Model of the Euro Area. Computing in Economics and Finance, 102.

Cole H., and Ohanian L., “New Deals Policies and the Persistence of the Great Depression: A General Equilibrium Analysis”, Journal of Political Economy 112(4): 779-816

Costa, CJ (2016). Understanding DSGE. Vernon Press. (Series in Economic Methodology)

Christiano, L., Eichenbaum M,. and Rebelo S,. “When Is the Government Spending Multiplier Large?” Journal of Political Economy Vol.119, No.1, February 2011, pages 78-121.

Dalsgaard, Thomas, Christophe André, and Pete Richardson, 2001, “Standard Shocks in the OECD Interlink Model,” *OECD Working Paper 306* (Paris: Organization for Economic Cooperation and Development).

De Castro, F. (2013). The Macroeconomic E ﬀ ects of Fiscal Policy in Spain (Working Paper Series No 311). Bank of Spain.

Diab, W., Atlam, B., & Nimer, N. (2016). A Critical Literature Survey of the Macroecnomic E ﬀ ects of Policy in Light of Recent empirical evidence. In (p. 781-790). 18th Internationzl Scientific Conference on Economic and Social Development. (Building Resilient Society)

Diwambuena, MJ, & Boketsu, BJ-P. (2019). Budget Policy and Macre-economic Performances in the Democratic Republic of Congo. Revue Congo Challenge, 1 (2), 202–227.

Dj'andima, MJ-MF (2007). Tax Code. Presses Universitaires du Congo.

Djinkpo, M. (2019). A DSGE model for Fiscal Policy Analysis in The Gambia (Technical Report). West African Monetary Agency / Department of Research and Statistics.

Dolls, Mathias & Fuest, Clemens & Peichl, Andreas, 2012. "Automatic stabilizers and economic crisis: US vs Europe", Journal of Public Economics, Eisevier, vol. 96(3), pages 279-294.

Drygalla, A., Holtemöller, O., & Kiesel, K. (2018). The E ff ects of Fiscal Policy in an Estimated DSGE Model – The Case of the German Stimulus Packages during the Great Recession. Macroeconomics Dynamics, 1–31.

Erceg C,. and Linde J,. "Is there a Fiscal Free Lunch in a Liquidity Trap?", Board of Governors of the Federal Reserve System, International Finance Discussion Papers, No 1003, July 2010.

Estevão, M and I. Samake, 2013, "The Economic Effects of Fiscal Consolidation with Debt Feedback," IMF Working Paper 13/136 (Washington: International Monetary Fund).

Fatás, A., & Mihov, I. (2001). Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence (Working Paper). INSEAD.

Fernández-Villaverde, J. (2006). A Baseline DSGE Model (Technical report). NBER and Banc of Atlanta.

Galì, J., Lòpez-Salido, J., & Vallés, J. (2007). Understanding the E ff ects of Government Spending on Consumption. Journal of the European Economic Association, 5 (1), 227–270.

Ghosh A., Chamon M., Crowe J., and Ostry C., "Coping with the Crisis: Policy Options for Emerging Market Countries", IMF Staff Position Note SPN/09/08.

Ghosh, A., and L. Rahman, 2008, "The Impact of Fiscal Adjustment on Economic Activity" (Washington: International Monetary Fund, unpublished).

Giordano, R., Momigliano, S., Neri, S., & Perotti, R. (2007). The e ff ects of fiscal policy in Italy: Evidence from a VAR model. European Journal of Political Economy, 23, 707–733.

Giavazzi, Francesco, and Marco Pagano, 1990, "Can Severe Fiscal Contractions be Expansionary? Tales of Two Small European Countries" in *NBER Macroeconomics Annual 1990*, ed. by Olivier J. Blanchard and Stanley Fischer (Cambridge, Massachusetts: MIT Press).

Gujarati, DN, & Porter, DC (2009). Basic Econometrics (5th ed.). Mc-Graw-Hill Irwin.

Herbst, EP, & Schorfheide, F. (2016). Bayesian Estimation of DSGE Models. Princeton University Press.

INS. (2014). Results of the 2012 Employment, Informal Sector and Household Consumption Survey: Survey 1-2-3 (Global Report). National Institute of Statistics and Ministry of Planning and Monitoring of the Implementation of the Revolution of Modernity.

Ilzetzki E , Mendoza E, Vegh C, "How Big (Small) are Fiscal Multpliers?" IMF Working Paper WP/11/52.

Iwata, Y. (2009). Fiscal Policy in an Estimated DSGE Model of the Japanese Economy: Do Non-Ricardian Households Explain All? (Technical report). Economic and Social Research Institute / Cabinet O ffi ce / Government of Japan.

Kabuya, K., Ntagoma, J.-B., & Tsasa, J.-P. (2019a). Review of Macroeconomic Dynamics in the MALAWI (I): Growth Accounting. Congo Challenge Review, 1 (1), 1–25.

Kabuya, K., Ntagoma, J.-B., & Tsasa, J.-P. (2019b). Review of the Macroeconomic Dynamics in the DRC (II): Accounting of the economic cycle. Congo Challenge Review, 1 (1), 26–48.

Kaminsky, G., Reinhart, C., & Végh, C. (2004). When it rains, it for: Procyclical capital flows and macroeconomic policies. National Bureau of Economics Research (NBER) Macroe- economics Annual, 19, 11-82.

Kirchner M, Cimadomo J, Hauptmeier S, "Transmission of Government Spending Shocks in the Euro Area, Time Variation and Driving Forces". Working Paper series No1219/July 2010.

Koop, G. (2003). Bayesian Econometrics. John Wiley and Sons.

Kraay, A., 2012, "How large is the Government Spending Multiplier? Evidence from World Bank Lending," Quarterly Journal of Economics, Vol. 127, No. 2, pp. 829–87.

Krugman, Paul R., and Maurice Obstfeld, 1997, *International Economics: Theory and Policy*, 4 th ed. (Reading, Massachusetts: Addison-Wesley).

Kuttner, KN, & Posen, AS (2002). Fiscal Policy Effectiveness in Japan. Journal of the Japanese and International Economies, 16, 536–558.

Ludvigson, Sydney, 1996, "The Macroeconomic Effects of Government Debt in a Stochastic Growth Model," *Journal of Monetary Economics*, Vol. 38 (March), pp. 25–45.

Mankiw, GN (2000). The Savers-Spenders theory of the fiscal policy. American Economic Review, 90 (2), 120–125.

Mankiw, Gregory N., and Lawrence H. Summers, 1984, "Do Long-Term Interest Rates Overreact to Short-Term Interest Rates?" *NBER Working Paper No. 1345* (Cambridge, Massachusetts: National Bureau of Economic Research).

Mankiw, Gregory N., 1985, "Small Menu Costs and Large Business Cycles: A Macro- economic Model of Monopoly," *Quarterly Journal of Economics*, Vol. 100, pp. 529–37.

McKibbin, Warwick J., 1997, "Empirical Evidence on International Economic Policy Coordination," in *Handbook of Macroeconomic Policy in Open Economies*, ed. by Michele

Fratianni, Dominick Salvatore, and Jurgen von Hagen (Westport, Connecticut, and London: Freenwood Press).

Gorodnichenko Y., and Auerbach A., “Measuring the Output Responses to Fiscal Policy”, American Economic Journal: Economic Policy Vol.4, No.2, May 2012.

Miller, Marcus, Robert Skidelsky, and Paul Weiler, 1990, “Fear of Deficit Financing—Is it Rational?” in *Public Debt Management: Theory and History*, ed. by Rudiger Dornbusch and Mario Draghi (Cambridge and New York: Cambridge University Press), pp. 293–310.

Mineshima, A., M. Poplawski-Ribeiro, and A. Weber, 2014, “Fiscal Multipliers,” in Post-Crisis Fiscal Policy, ed. by C. Cottarelli, P. Gerson, and A. Senhadji (Cambridge: MIT Press, forthcoming).

Mountford, A., & Uhlig, H. (2009). What are the E ff ects of Fiscal Policy Shocks. Journal of Applied Econometrics, 24, 960–992.

Ntagoma, J.-BK, Tsasa, J.-PV, & Mavingu, MN (2015). Inclusiveness and the Labor Market in the DRC: Approach by the non-Ricardian DSGE model. Revue Congolaise de Politique Economique, 1 (2), 139–186.

Perotti, R. (2004). Estimating the e ff ects of fiscal policy in OECD countries (Working Paper No 276). IGIER / Innocenzo Gasparani Institute for Economic Research / Bocconi University.

Pfeifer, J. (2020). An Introduction to Graphs in Dynare (Technical Report). Universitat der Bundeswehr Munchen.

Saito, Jim, 1997, “The Japanese Business Cycle after 1991: How is it Different, and Why?” *Journal of Asian Economics*, Vol. 8, pp. 263–93.

Smets, F., & Wouters, R. (2003). An Estimated Dynamic Stochastic General equilibrium Model of the Euro Area. Journal of the European Economic Association, 1 (5), 1123–1175.

Spiegel, S. (2007). Macroeconomic Policy and Growth Policy: National Development Strategies, Orientation Notes. United Nations, Department of Economic and Social A airs (DESA / UNDESA).

Sutherland, Alan, 1997, “Fiscal Crises and Aggregate Demand: Can High Public Debt Reverse the Effects of Fiscal Policy?” *Journal of Public Economics*, Vol. 65 (August), pp. 147–62.

Tavulyandanda, NA (2015). Budgetary Policy in the MALAWI: Instruments, Means and E ffi ciency. (Bachelor thesis, Unpublished, Catholic University of Graben)

Torres, JL (2016). Introduction to Dynamic Macroeconomic General Equilibrium Models (Second ed.). Vernon Press. (Series in Economic Methodology)

Umba, GB (2017). Bayesian estimate of a DSGE model for a small open economy: Case of the Congo (Technical report). Central Bank of Congo.

Woodford, M. (2011): “Simple Analytics of the Government Expenditure Multiplier,”, American Economic Journal: Macroeconomics, 3, 1-35.

Zubairy, S. (2010). On Fiscal Multipliers: Estimates from a Medium Scale DSGE Model (Technical Report No 30). Bank of Canada.