Essays on Fiscal and Monetary Policies in Malawi

A Dissertation

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by

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Abstract

This dissertation comprises of two studies on fiscal and monetary policies in Malawi. In these studies, we cover a range of issues concerning the implementation, effectiveness, relevance, and interaction of the policies.

In the first study, designated as ***chapter 3*** of the dissertation, Malawi's fiscal and monetary policy rules are estimated and their effects and influence on key macroeconomic variables analyzed in a New Keynesian DSGE framework. The Bayesian technique is used to estimate the model using data on consumption, investment, inflation, nominal interest rate, government spending, consumption tax revenue, and income tax revenue. It is found that monetary policy in Malawi follows a Taylor type interest rate rule in which interest rates respond strongly to changes in inflation, in accordance with the "Taylor principle", and only mildly to output fluctuations. Fiscal policy too reacts to output fluctuations in a modest fashion. With regards to the main drivers of output fluctuations, it is shown that although fiscal and monetary policy shocks play a significant role, it is actually productivity shocks and to a lesser extent cost-push shocks that are the main determinants of business cycles.

The second study is presented in ***chapter 4*** of the dissertation and in it we analyze the interaction between fiscal and monetary policies in Malawi using a structural VAR framework with sign restrictions. The key question addressed is whether macroeconomic policy environment in Malawi is characterized by fiscal dominance or monetary dominance. The model that we derive is used to identify government spending shocks, government revenue shocks, and monetary policy shocks so as to observe their respective

effects on the conduct of fiscal and monetary policy. The results show that policy making in Malawi leans towards a monetary dominant regime rather than a fiscal dominant one. This is manifested by a counteractive reaction of monetary policy to loose fiscal policy on one hand and a cooperative reaction of fiscal policy to tight monetary policy stance on the other hand. The results also show that spending shocks are not financed by tax revenues which, coupled with the non-cooperative nature of monetary policy, is consistent the high public debt accumulation observed in the data.

The two studies are supplemented by an introductory chapter to the dissertation (***chapter 1***), a summary presentation of some stylized facts about the economy of Malawi that are relevant to our studies (***chapter 2***), and lastly a summary of our main conclusions and recommendations (***chapter 5)***.

I dedicate this work to my dear parents Joseph and Grace

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Whilst I give thanks for the various contributions rendered by the different individuals and institutions mentioned above, I take full responsibilities for the views expressed in this dissertation. Any errors made are mine and mine only.

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CHAPTER I

Introduction

This dissertation explores some of the issues concerning macroeconomic stabilization policies in Malawi. Specifically, it explores four aspects of fiscal and monetary policies namely, implementation, effectiveness, significance to the macro economy, and interaction between the two policies. We recognize that whilst these issues have been intensely studied for other countries particularly in the developed world, in the case of Malawi there are many areas that have been left unexplored. Furthermore, for those areas/themes that have been somewhat explored such as monetary policy effectiveness, we have seen a divergent of results coming from different studies, thus necessitating further research on such themes.

The work carried out in this dissertation is motivated by some observations that we make regarding the state of the Malawi economy and the macroeconomic policy environment that governs it. One such observation concerns the performance of the economy over the years. Looking at growth and inflation trends, it is clear that in the last two decades the Malawi economy has continued to experience high inflation and below target levels of economic growth. In the 20 years between 1997 and 2017, the average annual inflation rate was more than 18 percent while the average growth rate was around 4 percent, well short of the 7.2 percent growth target in the country's economic development strategy and the 6 percent recommended for the country to achieve meaningful poverty reduction. We deem this poor performance on both the inflation and economic growth fronts as either an indictment of the country's macroeconomic policies,

or a reflection of other structural issues that characterize the economy, or both. In this dissertation we investigate which is which.

As already mentioned, there has been several attempts to establish how effective monetary policy is as a macroeconomic stabilization tool capable of addressing the inflation problem and helping the economy attain the desired path of growth. However our surveying of the literature shows a substantial divergence of the findings hence a lack of consensus on this issue. Studies that focused on the impact of monetary policy on prices have found results that ranged from showing a negative impact on prices i.e. monetary policy is effective, to no significant impact, to showing a positive impact, i.e. price puzzle (see Chapter 2). This level of divergence motivates us to reexamine this issue.

Another issue motivating this dissertation is the fact that so far the studies that have looked at the impact of macroeconomic stabilization policies on the real economy such as Chiumia (2015) and Ngalawa et.al (2012), only looked at how policy affects aggregate output and not its individual components. While the impact of fiscal and monetary policies on aggregate output is a very important topic, we find it more informative to also examine how the policies affect specific components of output, particularly how monetary policy affects investment, a crucial relationship in the monetary policy transmission mechanism.

We also note that while there are several studies in Malawi that tackle monetary policy effectiveness, literature on the effectiveness of fiscal policy is virtually non-existent save for one study by Chiumia and Simwaka (2012) who investigated the effectiveness of tax policy on economic growth. This is a big gap in macroeconomic literature which implies that fiscal authorities are not adequately guided by economic

models that are calibrated to or estimated with Malawi data. This dissertation sets out to fill this gap too and it does so by estimating a model for Malawi that incorporates both the taxation and spending side of fiscal policy, in addition to monetary policy and other macroeconomic shocks.

Turning to the issue of the macroeconomic policy environment in Malawi, we also make several observations that raises interesting questions. One such observation is that whereas many researchers seem to assume that there is a problem of fiscal dominance in Malawi (e.g. Chiumia (2013) and Mangani (2012)), when we look at the behavior of the Reserve Bank of Malawi (RBM) especially with regards to its monetary policy stances, one sees that the bank tends to have an aggressive policy towards inflation. This aggressiveness is often highlighted by the Bank itself in its monetary policy reports and is furthermore reflected in the high interest rates that the bank typically allows for when faced with inflationary pressures. This kind of monetary policy environment appears to contradict any notion that monetary policy accommodates fiscal policy at the expense of its own objectives. Therefore a comprehensive empirical study is needed in order to establish the true nature of interaction between fiscal and monetary policies before proceeding with policy based on the assumption of the existence of fiscal dominance.

The above observation also raises an interesting question about the exact policy rules that the RBM follows. Exactly how aggressively do monetary authorities address inflation pressures, and how much focus do they put on output fluctuations. Answering these questions entails estimating the RBM's monetary policy rule and making inferences from it. The same applies to fiscal policy. With fiscal policy one may want to know how much focus the fiscal authorities put on addressing output fluctuations given the

budgetary constraints that they face with regards to undertaking discretionary spending increases and tax cuts. Answering this question similarly requires estimating the fiscal rules governing government spending and tax policy.

Motivated by the issues raised above, we proceed by conducting two related studies that make up the main substance of this dissertation. The first study, which we present as chapter 3, focuses on estimating the policy rules that govern the implementation of fiscal and monetary policies, and analyzing the impact of the rules and their relative importance with regards to price movements and the performance of the real economy. The second study, which constitutes chapter 4 of the dissertation, covers the issue of how fiscal and monetary policy interact with each other and thus answers the question of whether we have fiscal dominance or monetary dominance in Malawi.

We can summarize our findings from these studies as follows. Firstly, on the question of what policy rules are followed by the monetary and fiscal authorities, we find that the RBM does indeed strongly react to inflation pressures and they do so in accordance with the Taylor principle. With regards to their reaction to output fluctuations, we find that they do react but only in a modest fashion. Fiscal policy on the other hand is also found to react to output fluctuations but in an even more modest way compared to monetary policy which already has the additional task of price stabilization. This shows us that that when it comes to macroeconomic stabilization policy in Malawi, it is monetary policy that takes the lead.

This takes us to the second question of how effective and important these rules are with respect to the real economy and prices. Here we find that monetary policy does affect prices in the intended ways although structural factors, chief among them supply

side shocks, combine to dominate the price movements. This explains the observed persistence of high rates inflation despite the central bank's aggressive pursuance of tight monetary policy. With regards to the impact on the real sector, the study also shows that the intended effect of monetary policy is achievable and perhaps more importantly that monetary policy is an important factor in the investment decisions of the private sector.

On the impact of fiscal policy and its importance to business cycles, we establish that while income taxes and consumption taxes affect the economy in ways that conform to theoretical expectations, expansionary spending policy eventually reduces output. In particular, expansionary spending shocks crowd out investment and private consumption which offsets the initial gains in aggregate output. Regarding the relative importance of fiscal policy in influencing business cycles, we find that all fiscal policy rules are of limited importance since output fluctuations are mainly a result of productivity and cost-push shocks.

Last but not least, our investigations reveal that contrary to the beliefs held by many that fiscal policy dominates monetary policy in Malawi, the opposite appears to be true. Our findings rule out fiscal dominance by showing that the RBM strictly adheres to pursuing its inflation objectives and does not go out of its way to loosen monetary policy for the purposes of accommodating fiscal expansions. In fact the results reveal that it is actually fiscal policy that follows the lead of monetary policy which supports the existence of monetary dominance and feeds into our conclusion that in the pursuit of macroeconomic stabilization, monetary policy takes the lead.

CHAPTER II

Stylized Facts about the Malawi Economy

2.1. Structure of the economy

Malawi is one of the poorest countries in the world. According to the Word Bank, in 2017 the country registered a per capita income of US$338.48 which ranked within the world's bottom 5. Despite being a very peaceful country that has never been engaged in any major conflicts, Malawi has not achieved any significant economic development since becoming an independent nation in 1964. As a result, per capita income has only increased slightly from the US$306 that was recorded in 1969 and this has translated into high levels of poverty, with more than 50 percent of the population living below the poverty line of 1US$ a day as of 2015.

Several factors have contributed to the slow economic progress in Malawi. On one level, the country has seen no significant progress in economic transformation from the predominantly agriculture based economy that it is, to a more commercially and manufacturing based one. This is reflected in Table 2.1 below which shows the current sectoral shares of GDP and the sectoral shares of the labor force.[1] Here we see that the agriculture sector continues to be the most dominant in terms of production and labor input and this comes at the expense of manufacturing and other sectors. As of 2017, up to 28 percent of GDP came from agriculture activities while less than 10 percent came from manufacturing. In terms of employment, the agriculture sector still employed more than 64 percent of the labor force as of 2013, while manufacturing employed only 4

[1] Due to the differences in the way some sectors are aggregated by the two sources, some figures are left unreported.

percent. Furthermore, according to the Malawi Growth and Development Strategy III more than 80 percent of the country's exports earnings come from agriculture, with tobacco alone contributing more than 60 percent. These numbers show that even after decades of peaceful independence, the economy has not achieved any significant industrialization that is required to achieve meaningful economic development.

Table 2.1: Sectoral contribution to national output and employment

Sectoral contribution to GDP and employment		
Economic sector	***share of GDP in 2017***	***Labor share in 2013***
Agriculture, forestry and fishing	*28.3*	*64.1*
Wholesale and retail trade	*16.0*	*16.2*
Manufacturing	*9.1*	*4.1*
Construction	*2.8*	*2.6*
Real estate activities	*7.7*	*n.a*
Electricity, gas and water supply	*1.2*	*0.4*
Transportation, storage, and communication	*7.3*	*2.0*
Mining and quarrying	*0.9*	*0.3*
Accommodation and food services	*2.0*	*0.7*
Financial and insurance services	*5.3*	*n.a*
Professional and support services	*0.3*	*0.9*
Public administration and defense	*2.1*	*2.0*
Education	*2.8*	*2.2*
Health and social work activities	*2.8*	*1.4*
Other services	*5.0*	*n.a*

Sources: Malawi Government Annual Economic Report (2018), Malawi Labor Force Survey (2013)

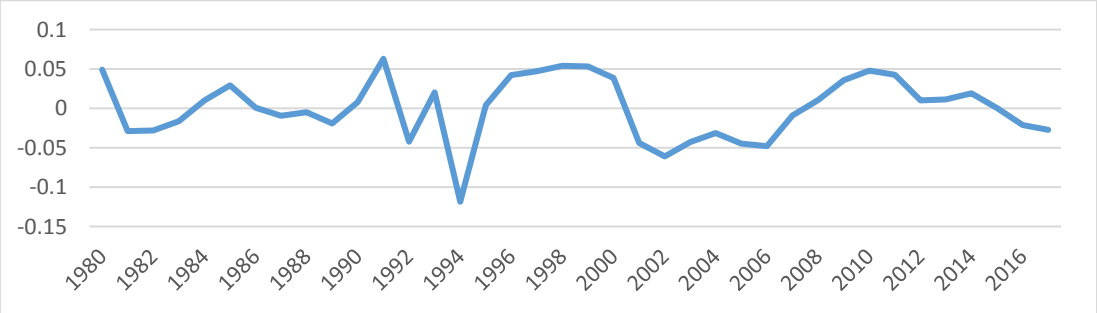
Aside from the lack of progress in the inter-sectoral transformation of the economy, slow intra-sectoral productivity growth has also been a contributing factor to the slow development of the country. This lack of productivity growth has featured in practically all sectors of the economy thus resulting in their stagnations including that of the all-important agriculture sector which to date remains very labor intensive and highly dependent on rainfall despite the country's abundance of water resources.[2]

[2] See Malawi Growth and Development Strategy III.

2.2. Business cycles and price dynamics

Given the heavy reliance of the economy on agriculture, Malawi's business cycles and price movements are strongly dependent on shocks that affect productivity in that sector. As a result, events such as weather shocks, world commodity price shocks, and exchange rate shocks (which affect supply of imported inputs like fertilizers), are some of the main contributing factors to business cycles in Malawi's. Figure 2.1 below shows the graph of detrended real GDP data for the period from 1980 to 2017. The graph captures the country's economic booms of 2009 and 2010, and recessions of 1994, 2001, and 2002. Apart from the 1994 recession whose roots were political, the other cycles were largely a result of performances in the agriculture sector. Specifically, the 2001 and 2002 recessions resulted from a severe drought that hit the country and negatively affected agriculture production in a big way. As for the 2009 and 2010 economic booms, these have largely been attributed to the farm input subsidy program at the time, which made available fertilizers and quality seed to many smallholder farmers.[3] This shows that shocks to productivity, especially in the agriculture sector, are indeed important drivers of business cycles in Malawi.

Figure 2.1: Business cycles in Malawi

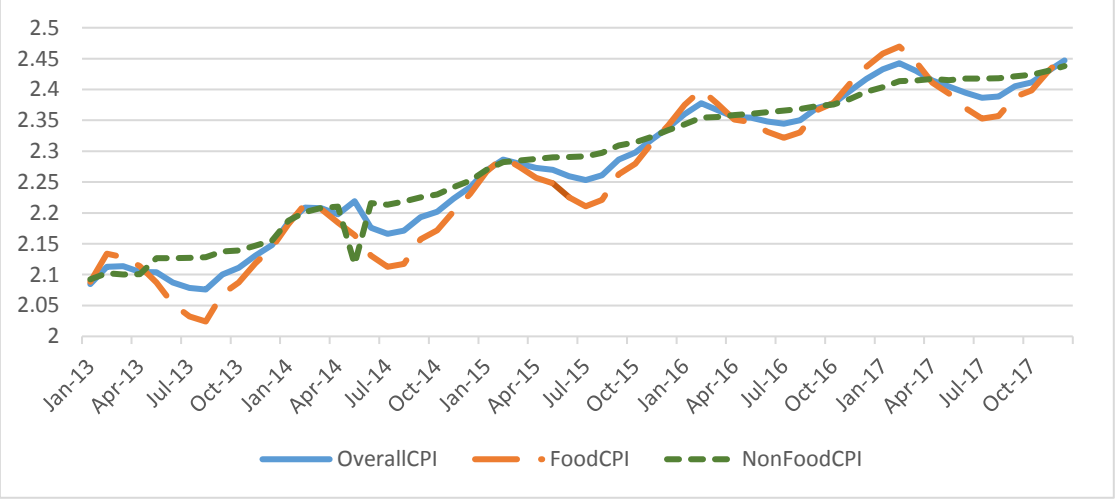


Data source: World Bank

[3] See Reserve Bank of Malawi Annual Economic Report (2009).

With regards to price movements, again agriculture plays a major role. This is reflected in the weights that the consumption basket used for calculating the consumer price index (CPI) places on food items, with maize being the single most important item in the basket. As of 2017, the weight given to food items in the basket was 50.2 percent. This means that the supply and demand of food, particularly agriculture products like maize, contributes significantly to price movements in the country. A visual inspection of price movements is provided in Figure 2.2 which compares monthly observations of food prices, non-food prices, and aggregate prices. Two things stand out from this graph. First, food prices appear to have seasonal variability unlike non-food prices. This is a reflection of the seasonality of the agriculture output produced in Malawi. Secondly, aggregate prices mimic the seasonal patterns of food prices which supports the notion that food production is a very important driver of prices in Malawi.

Figure 2.2: Price dynamics in Malawi



Data source: Reserve Bank of Malawi. All 3 variables are in logarithmic scales

In chapter 3 of this thesis, we will be able to make inferences about what this apparent dominance of agricultural productivity in the determination of prices means for macroeconomic policy. In particular, we will be able to determine whether such

productivity shocks render monetary policy impotent. Ngalawa and Veigi (2012) argue that consumer prices respond weakly to monetary impulses hence suggesting that inflation in Malawi may not be predominated by monetary factors, but rather by structural rigidities in food production. In this thesis we will show that both productivity and monetary policy are very important determinants of prices in Malawi

2.3. Macroeconomic policy

In this section we summarize the macroeconomic policy making process in Malawi. Specifically, we outline the legal framework that guides fiscal and monetary policies, focussing on the legal provisions that are designed to help the authorities adhere to prudent policy stances and the arrangements that allow timely execution of the policies. This discussion is complemented by a brief analysis of the past fiscal and monetary trends.

2.3.1. Legal framework of fiscal policy

The legal framework governing fiscal policy is set in the constitution of the republic of Malawi (1966) and the Public Finance Management (PFM) Act of 2003. All public revenue and expenditure measures are designed and implemented according to the provisions on public finances laid out in these documents. Under the constitution, all government revenue measures such as tax policy are approved by the national assembly and all public funds are consolidated into one account known as the Consolidated Fund. Any amounts paid into or drawn from this account require the approval of the national assembly. Similarly on the expenditure side, only the national assembly has the power to authorize government expenditures and this is done through a legislative act known as the Appropriations Bill, which is drafted and enacted into law on an annual basis.

The constitution and the PFM act further outline provisions for extra expenditures outside the appropriations bill if exceptional circumstances requiring such expenditures arise. These provisions make possible the pursuit of discretionary fiscal policy whenever the government sees the need to help stimulate or stabilize the economy. Section 12 of the PFM act for instance provides conditions under which the Government may depart from the principles of responsible fiscal management whenever an exceptional circumstance arises. In such cases, the government is required to brief parliament of such action at the next session and to also explain the action in the next economic and fiscal update. Therefore, the legal requirements for the pursuit of discretionary fiscal policy in Malawi provides flexibility for implementation of the policy in a timely manner.

Another legal provision that allows for timely execution of discretionary fiscal policy is section 59 of the PFM act which allows the Minister of finance to borrow funds from the central bank by way of overdraft through a government borrowing facility known as the "Ways and Means advances". This facility is designed to help government meet temporary shortfalls in projected revenues required for financing its planned expenditures. However, in order to ensure that responsible fiscal management is maintained and to avoid misuse of the borrowing facility, some prudential measures have been put in place. One such measure is that under this facility the total amount of advances outstanding at any time is not allowed to exceed 20 percent of the projected revenues for that fiscal year. In addition, the Reserve Bank of Malawi Act forbids the central bank from extending further advances under this facility if the government has not settled previous loans, four months after the end of the fiscal year in which the loans were made.

Given the above legislative provisions, a case can be made that the legal framework guiding fiscal policy in Malawi is adequately strong to ensure flexibility in conducting fiscal policy whilst maintaining fiscal discipline. If these laws are fully abided by, many problems associated with imprudent fiscal policies such as the over accumulation of debt and monetization of the same may be avoided.

In practice, the office of the Finance Minister decides on the direction of fiscal policy that is to be pursued.[4] The Minister is aided by the macroeconomic policy unit of the Ministry which serves as the technical department responsible for analyzing macroeconomic developments and recommending policy actions. The unit does so in consultation with other relevant authorities including the central bank, the National Statistical Office, and the department responsible for overall economic development of the country. As such, the process involved in the formulation of fiscal policy is set to encourage consistence with other macroeconomic policies although the political nature of the Finance Minister's office may take the policy in a different direction.

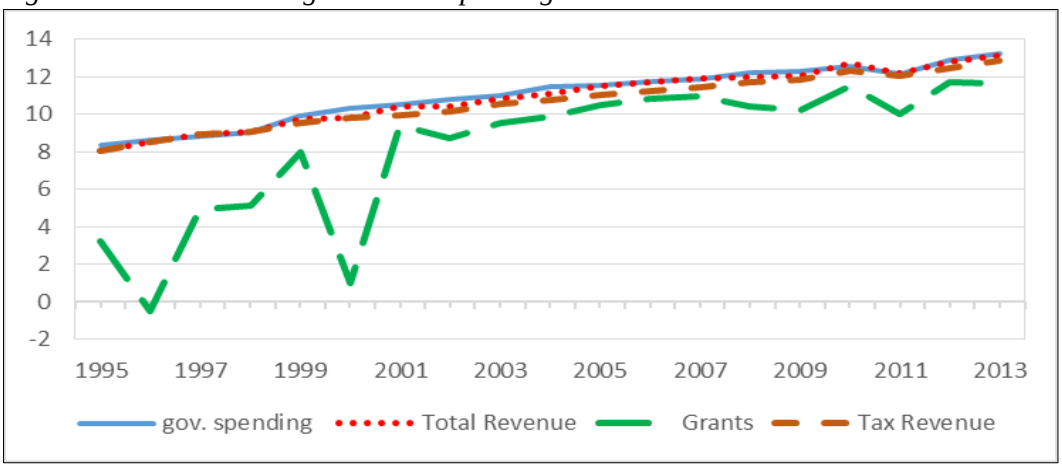
2.3.2. Trends in fiscal policy

Figures 2.3 and 2.4 below provide visual inspections of the trends in the main fiscal variables from 1995 to 2013.[5] Here we see that as both spending and revenues grow overtime, public finances continue to be characterized by persistent fiscal deficits. This has resulted in the government's reliance on foreign aid which has taken a significant role in the financing of the government's budget. This dependence on foreign aid as a source

[4] The Public Finance Management Act of 2003 and Treasury Instructions of 2004 sets out the mandate of the Finance Minister with regards to pursuing macroeconomic stabilization through fiscal policy.
[5] All variables are nominal variables and they are transformed into logs for scaling purposes.

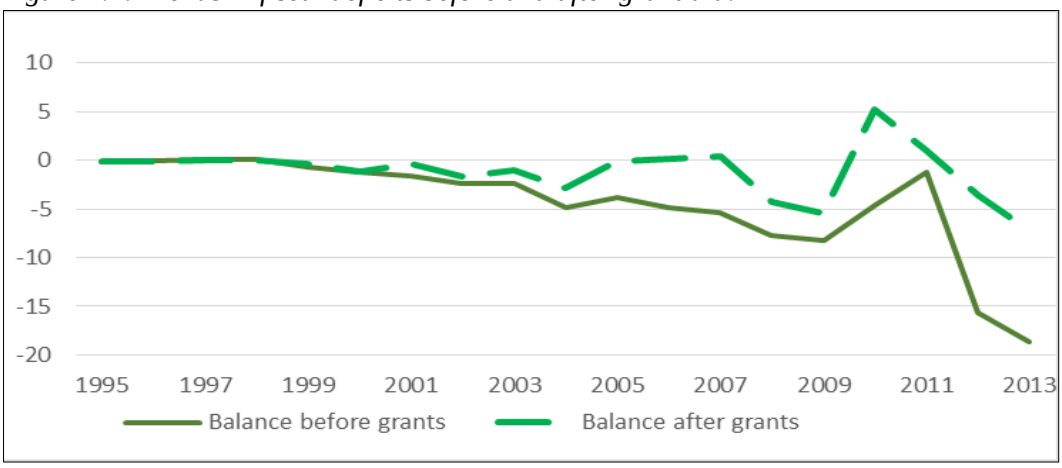
of government revenues is very clearly demonstrated in Figure 2.4 which shows trends in the budget balance before and after receiving aid in the form of grants. As the figure shows, the fiscal balance significantly improves after taking aid into account but nonetheless it tends to falls short of balancing the budget and the trend continues to be that of deficits even after the revenue supplements from foreign aid. In fact from 1995 up to 2014, the government, after receiving grant aid was able to balance the annual budget 6 times only. As for the domestic financing of the budget, only in 1997 and 1998 was the government able to balance the budget with domestically generated revenues alone.

Figure 2.3: Trends in the government spending and revenue variables



Data source: Ministry of Finance. All variables are in logarithmic scale

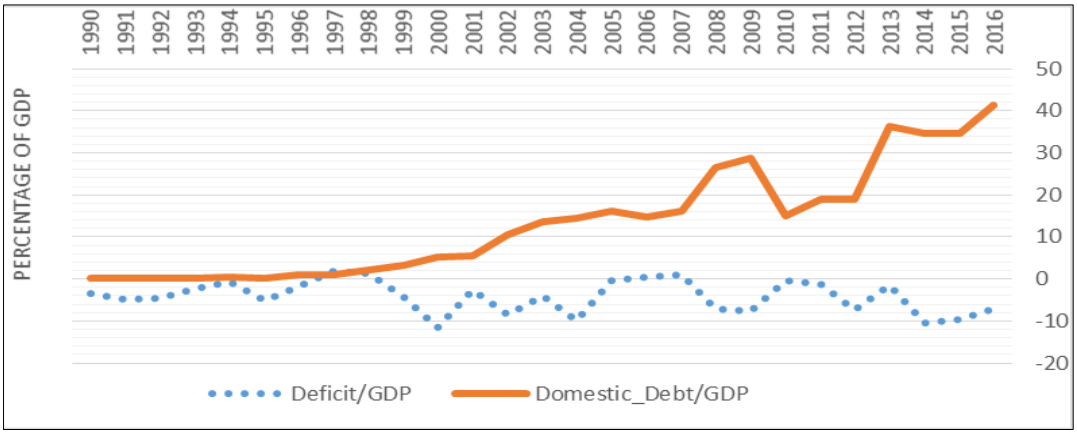
Figure 2.4: Trends in fiscal deficits before and after grant aid.



Data source: Ministry of Finance. All variables are in logarithmic scale

The question then becomes, how does the government fund the deficits that remain after both domestic and foreign revenues have been accounted for? Looking at the trends in public debt helps answer this question given that the government finances a significant part of fiscal policy by issuing debt. In Figure 2.5 below, the time series of domestic public debt is plotted together with that of fiscal deficits. Here we see that overtime, domestic debt as a share of GDP has increased substantially while fiscal deficits as a share GDP has remained roughly constant.[6] This rise is debt reflects the notion that the persistent fiscal deficits are constantly being partly financed by debt thus leading to its accumulation overtime.

Figure 2.5: Fiscal deficits and domestic debt



Data source: Ministry of Finance and Reserve Bank of Malawi

The fiscal trends observed above have several important implications. The first is that due to the government's perennial lack of fiscal space which constrains discretionary spending or tax cuts, fiscal policy becomes less and less of a tool for macroeconomic stabilization and more of administrative process for keeping crucial government institutions operational. This leaves monetary policy as the main player in

[6] Kumbatira, M (2008) provides a comprehensive analysis of Malawi's public debt structure and its sustainability.

macroeconomic stabilization.[7] Another implication is that the deficits and the resultant debt accumulation provide a potential source of fiscal dominance since the government may choose to monetize them as a way of avoiding fiscal solvency problems. However if the central bank is sufficiently independent and adherent to its set monetary policy goals, these trends could be a source of monetary dominance. This follows from the fact that under such conditions, a monetary tightening will have to be followed by a tightening of fiscal policy otherwise fiscal solvency will be highly jeopardized.

2.3.3. Legal framework of monetary policy

The legal framework governing monetary policy in Malawi is provided by the Reserve Bank of Malawi Act of 1989. This act gives the RBM the mandate to perform functions of a central bank including the execution of monetary policy and supervision of financial institutions. The act outlines the goals of monetary policy which are set to include achieving economic growth, low unemployment, stability of prices and sustainable balance of payments position. These goals are to be pursued through the control of money supply and credit availability, interest rates, and exchange rates. However, as many central banks around the world have done in recent times, the RBM has narrowed down its focus of monetary policy to primarily targeting price stability and as a consequence it has moved towards an inflation targeting framework.[8]

Operationally, the RBM targets broad money (M2) by using various instruments provided in the Act. These instruments include the bank rate, the liquidity reserve

[7] We demonstrate in chapters 3 and 4 that monetary policy in Malawi leads fiscal policy with regards to reacting to business cycles and price movements.
[8] Although the RBM Act has not been amended to reflect this narrowing of goals, the bank's monetary policy statements overtly refer to price stability as the main goal of monetary policy.

requirement (LRR), and open market operations (OMO). In addition to these conventional instruments, the RBM Act also gives the bank powers to carry out other more direct market interventions such as prescribing credit ceilings for banks and other financial institutions in order to limit the availability of credit in the market if such conditions are deemed necessary. However in practice, such old-fashioned tools are no longer used as the bank has gravitated towards the market based monetary policy tools.

In practice, the design and implementation of monetary policy is conducted by the Monetary Policy Committee (MPC) at the bank. The committee is chaired by the Governor and comprises of other top officials from the central bank, and representation from the Ministry of Finance, the academia, and the private sector.[9] The committee meets every quarter to deliberate on macroeconomic developments and forecasts and decide on the monetary policy stance to pursue. The composition of the committee is also set to minimize any possible conflicts between the policy stance adopted and fiscal policy. Furthermore, the inclusion of the academia and the private sector also encourages adoption of policy stance that is in line with established economic theory and empirical evidence, and business sentiments.

2.3.4. Trends in monetary policy

Implementation of monetary policy in Malawi has gone through significant changes since the establishment of the RBM in 1964. The bank has had to adopt different monetary policy frameworks as the financial sector evolved and changed in structure. The late 1980s brought about the biggest changes to the monetary policy framework when the

[9] See monetary policy Reserve Bank of Malawi monetary policy reports.

government partnered with the International Monetary Fund (IMF) in implementing the structural adjustment programs (SAPs) which were aimed at transforming the economy from state control to a more market based one. As a result, the financial sector underwent major changes such as the liberalization of interest rates, the elimination of direct credit controls, and the establishment of other non-bank financial institutions, all of which necessitated modifications in the framework of monetary policy. Consequently, new monetary policy instruments such as the reserve requirement ratio were introduced in order to replace the more direct credit controls.

In the end, the structural adjustment programs were fairly successful in their pursuit of a deregulated financial system and as such, more market based monetary policy tools were subsequently introduced. The Treasury bill was introduced in 1992 as a tool for managing liquidity through OMOs and also as an instrument for raising funds for government budgetary purposes. The introduction of the RBM bill would follow in 2000 with the aim of taking over the liquidity management function from the Treasury bill. In addition to the introduction of new policy instruments, other changes were also put into effect including the establishment of the inter-bank market in 1997, and floatation of the Malawi Kwacha (MK) in 1994 which was accompanied by the creation of a foreign exchange market.[10]

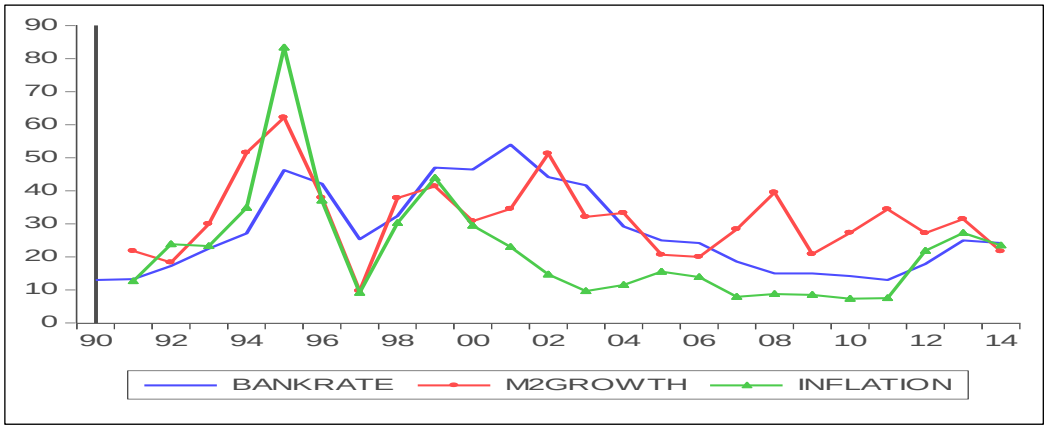
How the structural adjustments actually influenced the conduct and effectiveness of monetary policy is a question beyond the scope of this study. Nevertheless, a visual inspection of the movements of the bank's monetary policy targets (money supply and interest rates) in relation to some of the monetary policy objectives (inflation and

[10] The exchange rate policy since then has varied between a pure float, managed float and a peg.

exchange rates) provides some insights. As Figure 2.7 shows, there has been some co-movement between inflation and exchange rates on one hand and both the bank rate and the growth rate of money on the other hand. The apparent positive correlation between the bank rate and inflation suggests that either the monetary authorities raise the bank rate response to high inflation, or that the price puzzle observed in some VAR based studies is a true market phenomenon.[11] As for the growth rate of money, the positive correlation would suggest that inflation is at least partly a result of increased money supply. Whatever holds true for relationship between these three variables, it is clear that they relate to each other in some way whether directly or indirectly through other variables.

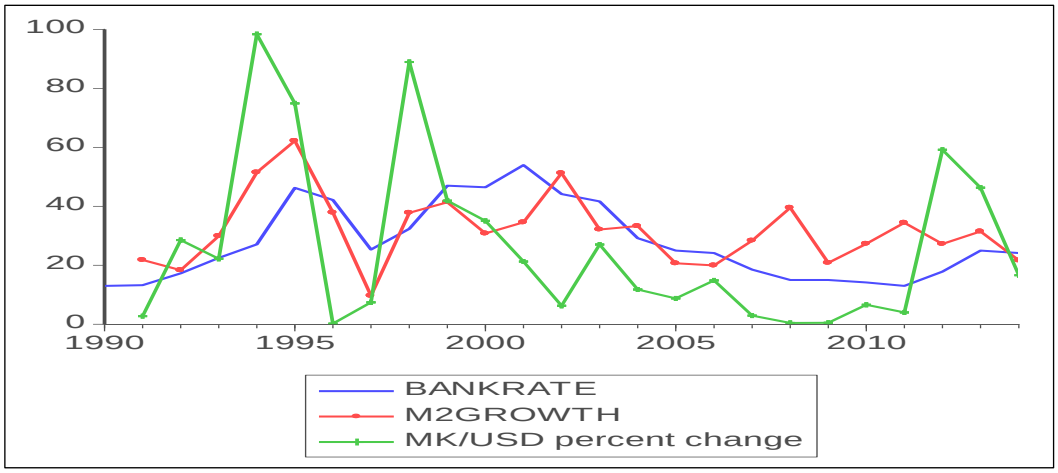
Similar trends are observed in Figure 2.8 where the path of the MK/USD exchange rate is plotted against the bank rate and money growth. Again we see co-movements in all three variables suggesting that either the RBM reacts to exchange rate movements or monetary policy affects the exchange rate or both. The former is supported by the apparent positive correlation between the bank rate and the exchange rate while the latter is supported by the positive correlation between money growth and the exchange rate.

Figure 2.7: Trends in monetary policy variables (bank rate and M2) vs inflation



[11] See Ngalawa (2010) for the price puzzle in the case of Malawi.

Figure 2.8: Trends in monetary policy variables (bank rate and M2) vs exchange rate fluctuations



CHAPTER III

Fiscal and monetary policy rules in Malawi: a New Keynesian DSGE analysis

3.1. Introduction

Traditionally, macroeconomic theory regarded the moderation of business cycles and stabilization of prices as the dual objectives of macroeconomic policy. The work of Taylor (1993) helped solidify this view by proposing the "Taylor rule" in which central banks were recommended to adjust nominal interest rates in response to deviations of inflation and output from the inflation target and potential GDP respectively. In practice however, implementation of policy that simultaneously targets these two objectives can be challenging particularly when macroeconomic shocks result in stagflationary pressures. In such cases, choices have to be made regarding which policy objective to prioritize. Furthermore, fiscal and monetary authorities do not always have the same priorities and at times work in ways that undermine each other thus making it even more difficult to achieve the dual objectives.

Given the above challenges, a substantial amount of research has been dedicated to studying various topics that surround fiscal and monetary policy. Some studies such as Schmitt-Grohe´ and Uribe (2006), Orphanides (2003), and Philippopoulos, et al (2015) have focused on the optimal design of fiscal and monetary policies, others like Eichenbaum and Evans (2005) have investigated the effectiveness of the policies on some key macroeconomic variables, and others have examined the extent to which some recommended policy rules have been adopted in certain countries (Taylor (2012), Clarida, Galì and Gertler (2000)).

In this study, we look at the case of Malawi and examine the fiscal and monetary policy rules that have been adopted by the authorities and how these rules affect the economy. Additionally, the study also explores the relative importance of fiscal shocks, monetary shocks, and other macroeconomic shocks in influencing the real economy and price dynamics. In order to achieve these objectives, 3 main tasks are carried out. First, we estimate feedback rules for the nominal interest rate, government spending, income taxes, and consumption taxes. Secondly, we analyze how shocks to the estimated policy feedback rules affect key macroeconomic variables. And thirdly we examine the relative importance of the policy shocks, productivity shocks, consumer preference shocks, and price mark-up shocks to the dynamics of key macroeconomic variables.

The study takes advantage of recent advances in New Keynesian DSGE (herein after NK-DSGE) modeling which has seen a number of salient features being incorporated in the modelling framework in an effort to improve upon the traditional models. For instance, many NK-DSGE models now incorporate capital accumulation as is done in RBC models, and some also include a variety of structural shocks in order to capture the idea that other shocks besides monetary policy and productivity shocks may be equally important in determining the performance of the economy[12]. The model that we develop here also incorporates the above features thus making it the first of its kind developed for the analysis of the Malawi economy.

In line with the growing popularity of estimating DSGE models in lieu of calibration, our model is also estimated. Specifically, we employ the Bayesian method in order to estimate the main parameters of interest including the coefficients on the

[12] e.g. Ireland, P.N (2004), Smets and Wouters (2003, 2007) incorporate at least 5 shocks in their models.

feedback policy rules. The Bayesian method happens to be an attractive technique for estimating DSGE models given its ability to allow for the a priori imposition of the ranges that parameters may take. This is an improvement on calibration given that data is allowed to dictate the final values of the parameters of interest whilst ensuring that the results maintain conformity to what is theoretically acceptable. More details on the Bayesian approach are provided in section 3.3.2 below.

With regards to our findings, our study shows that monetary policy in Malawi follows a Taylor type interest rate rule whereby nominal interest rates are set respond strongly to inflation but only minimally to output fluctuations. The strength of the response to inflation satisfies the Taylor principle. As for fiscal policy, the reactions of government spending, income tax and consumption tax policies in response to output fluctuations are found to be even milder than in the case of monetary policy.

In terms of the effectiveness of the policies, we find that monetary policy and the tax policy shocks affect output and prices in the conventional ways while expansionary spending shocks initially boost output but crowd out investment and private consumption in the process which eventually leads to a decline in the aggregate output. The study also establishes that although the fiscal and monetary policies affect both output and prices, it is actually productivity shocks and to a lesser extent cost-push (price mark-up) shocks that are the major drivers of business cycles in Malawi.

3.2. Literature review

3.2.1 New Keynesian DSGE Models

The history behind the development of New Keynesian DSGE models has been well documented by many.[13] In this section we try to avoid a regurgitation of this information, and instead focus on providing a brief overview of where NK-DSGE models stand as of today. Specifically we provide a brief review on what new features have been added to the models and what this means for researchers and policy makers.

New Keynesian DSGE models continue to play an important role in the analysis of macroeconomic policy and shocks. In their simplest form, these models comprise of only 3 equations namely: the dynamic IS equation (DIS), the new Keynesian Phillips Curve (NK-PC), and the monetary policy rule. While such model simplicity is desirable, it comes at the cost of realism and the ability of the models to capture certain important features of the economy. As such, many researchers have put a lot of work into the development of these models in a bid to enhance their ability in replicating real life observations.

One of the main issues in NK-DSGE modelling that has continued to put realism at odds with model simplicity is the inclusion of capital accumulation in the models. Common sense dictates that NK-DSGE models should include capital evolution given the role that investment dynamics play in Keynesian economics. However, doing so brings about modelling complications often in the form of absurd results. Traditionally the solution has been to simply ignore the capital accumulation equation all together (e.g

[13] see Gali (2008).

Gali (2008), and Ireland (2004)). However researchers working with bigger models have found ways of incorporating this equation, some by introducing capital adjustment costs (Smets and Wouters (2003, 2007), and Christiano, Eichenbaum, and Evans (2005)), and others maintaining the standard law of motion for capital (Schmitt-Grohe and Uribe (2006), Philippopoulos,Varthalitis, and Vassilatos (2014)). The model that we use in this study follows the latter.

Another important improvement to NK-DSGE modelling has been the inclusion of fiscal policy in the models. Fiscal policy is also an important piece in Keynesian economics given that it is given a significant role for macroeconomic stabilization. Furthermore, incorporating fiscal policy in NK-DSGE models not only makes the models more realistic and more in line with Keynesian economics, but it also opens up doors for researching many other pertinent macroeconomic policy topics within the NK-DSGE framework. For instance, some researchers have now used NK-DSGE models to analyze fiscal and monetary policy interaction, (Furlanetto (2012)), and others to study optimal fiscal and monetary policy rules (Schmitt-Grohe and Uribe (2006), Philippopoulos,Varthalitis, and Vassilatos (2015)).

Other notable developments in the NK-DSGE modelling framework include: the ability to study multiple types of macroeconomic shocks,[14] and the inclusion of other sources of nominal rigidities such as sticky wages and sticky information[15]. All these developments have enhanced the performance and usefulness of NK-DSGE models thus leading many policy makers into adopting them for their macroeconomic analysis and

[14] Smets and Wouters (2003) for instance analyzed up to 10 shocks.
[15] See Mankiw and Reis (2002) for a discussion on sticky information.

policy formulation. Furthermore, the introduction of Bayesian estimation of the models has enhanced their attractiveness by making them much more data guided than is the case with calibration, while simultaneously retaining theoretical guidance more than maximum likelihood (ML) estimation does. We explore this last point more detail next.

3.2.2 Bayesian Estimation

Bayesian estimation of DSGE models continues to gain popularity as the alternative to model calibration and ML estimation. The Bayesian technique is roughly a combination of calibration and ML estimation and as such it possesses the advantages that the two techniques have while at the same time addressing some of the problems with them. This section summarizes some of these advantages most of which have been well documented in the Bayesian estimation literature. But before going into that, a brief discussion on the implementation of the Bayesian method in DSGE modelling is in order.

Let $\boldsymbol{\theta}$ denote a vector of parameters in a model and $\boldsymbol{y^T} \equiv \{\boldsymbol{y_t}\}_{\boldsymbol{t=1}}^{\boldsymbol{T}}$ denote observable data for some of the variables in the model. As the name suggests, the Bayesian estimation method makes use of Bayes theorem of probabilities by linking the likelihood function of the model, $L(\boldsymbol{\theta}|\boldsymbol{y^T})$ (defined as the conditional probability density, $p(\boldsymbol{y^T}|\boldsymbol{\theta})$), with the prior beliefs on the model parameters, $p(\boldsymbol{\theta})$, to produce the estimated parameter distributions (posterior distributions) $p(\boldsymbol{\theta}|\boldsymbol{y^T})$. Specifically, the posterior distribution is given as:

$$p(\boldsymbol{\theta}|\boldsymbol{y^T}) = \frac{p(\boldsymbol{y^T}|\boldsymbol{\theta})\, p(\boldsymbol{\theta})}{\int_{\boldsymbol{\theta}} p(\boldsymbol{y^T}|\boldsymbol{\theta})\, p(\boldsymbol{\theta})\ d\boldsymbol{\theta}}$$

where the denominator $\int_{\boldsymbol{\theta}} p(\boldsymbol{y^T}|\boldsymbol{\theta})\, p(\boldsymbol{\theta})\ d\boldsymbol{\theta}$ is the marginal likelihood, a useful tool for assessing model performance. As mentioned above, compared to other methods this setting provides us with some advantages which include but are not limited to the following.

i. The specification of prior beliefs in the Bayesian approach enables us to restrict our computational search to the parameter spaces that make theoretical sense. This is a very attractive feature in the estimation of DSGE models since DSGE models are highly susceptible to having multiple local maxima and/or flat parameter distributions, in which case the search is likely to end up in the wrong region. This is an advantage that parameter calibration also possesses albeit in a more aggressive manner, but one that ML doesn't.

ii. While ML estimates are easier to obtain in simpler models, in more complex models it is the Bayesian method that delivers estimates without much extra computational complexities. This is because for Bayesian estimation, deriving the posterior distribution only requires the two inputs, $p(\boldsymbol{\theta})$ and $p(\boldsymbol{y^T}|\boldsymbol{\theta})$, no matter how complex the model is. The only challenge that model complexity poses for Bayesian estimation is on calculating the likelihood function, a challenge that is also faced in ML estimation. Nevertheless, algorithms like the Kalman filter and the particle filter have made it fairly easy to estimate $p(\boldsymbol{y^T}|\boldsymbol{\theta})$ numerically thus significantly reducing the computational difficulties associated with estimating complex models using the Bayesian technique.

iii. Although the idea of incorporating prior beliefs in estimations can be criticized for lack of objectivity, the Bayesian method allows for very flexible or non-

informative priors, in which case the estimation of the parameters relies more on the data. As such, one can maintain complete agnosticism on one set of parameters while making use of prior beliefs about another set with a much stronger theoretical and/or empirical backing.

iv. The Bayesian model selection strategy is very compelling as it makes it possible to compare multiple models at the same time. This is not the case with frequentist methods whereby only two models are evaluated at a time.

For these and other reasons, various studies have employed the Bayesian method to estimate and/or evaluate the performance of DSGE models. This has been made possible thanks to the pioneering work of DeJong et al. (2000), Schorfheide (2000), and Otrok (2001). DeJong et al. proposed the use of Bayes theorem in estimating macroeconomic models with the aim of incorporating macroeconomic theory into empirical estimations. As for Schorfheide, his work focused on the usefulness of the Bayesian approach in evaluating the performances of different models, while Otrok's contribution was to apply the Bayesian approach to the estimation of the welfare costs of business cycles.

Adding to the support for the use of the Bayesian approach, Fernández-Villaverde and Rubio-Ramírez (2004) in their application of the Bayesian method to the "Cattle Cycles" model of Rosen et al. (1994) showed that the Bayesian methods not only possessed the asymptotic properties of classical methods, but also outperformed ML estimates with regards to small sample inferences.

Others notable works on the applicability of the Bayesian approach include Smets and Wouters (2003) who estimated a DSGE model for the Euro area in which they

incorporated various features including habit formation, capital adjustment costs, and variable capacity utilization. In this study they showed that the estimated model performed as well as both the standard VAR model and the Bayesian VAR model estimated on the same data. As for the models that they estimated for the US economy in their 2007 paper, they found that their Bayesian DSGE estimation improved on the forecasting performance of the standard VAR model and performed just as good as the Bayesian VAR model.

For a more detailed review of the literature on the formulation and estimation of DSGE models using Bayesian methods, the reader is referred to the works of Fernández-Villaverde (2010), Geweke et al. (2011), and Herbst and Schorfheide (2016).

3.3. The model

In this study, our analysis is based on a NK-DSGE model featuring monopolistic competition among producers and Calvo type price rigidities. The model closely follows that of Philippopoulos et al. (2014) and to a lesser extent that of Schmitt-Grohe´ and Uribe (2006). However we deviate from these two models on two main fronts. Firstly, as has been done in several recent studies (Ireland (2004), and Smets and Wouters (2003, 2007)), we introduce time varying consumer preferences and price mark-ups which allows us to analyze the roles that preference shocks and mark-up (cost-push) shocks play in the economy. Secondly, we introduce exogenous shocks to the fiscal and monetary policy rules thereby increasing the total number of shocks in the model from 1 to 7.[16]

[16] Having 7 shocks instead of 1 means we can use up to 7 data series for estimation and this allows us to estimate the multiple policy rules that we have using all relevant data that is required for a reliable estimation.

The inclusion of consumer preference shocks is meant to capture non-policy induced *demand* shocks. This is necessary given the Keynesian school's treatment of changes in demand as important sources of output fluctuations. Gali (2004) makes the emperical case by comparing the role of technology shocks and demand shocks in the post war US and showing that preference shocks were the main sources of fluctuations in output, inflation, labor supply and other key variables. However, in low income economies such as Malawi where the typical household already consume a significant portion of its available resources, such consumer demand shocks may not be as important as is the case in richer economies such as the US. Nevertheless, incorporating this shock satisfies a key feature of our modelling framework and allows us to test it for our case.

Regarding the cost-push shock, we introduce it in the model in order to capture movements in prices that are *not* related to fluctuations in real output. This shock, originally introduced in NK-DSGE models by Clarida, et.al. (1999) for the same reason, allows us to examine the role of non-business cycle related price changes that are relevant to the economy.

In summary, the model comprises of four sectors namely: households, firms, the government, and the central bank. The households own the firms and they invest capital and labor hours into them. The firms in turn use the capital and labor to produce goods which are then consumed in the form of private consumption, investment, and public goods. The government provides the public goods and finances them by taxing consumption goods, and incomes earned by the households. The government also uses its public spending and taxation authority for the purposes of macroeconomic stabilization by way of discretionary fiscal policy. Lastly, the central bank conducts monetary policy

by controlling the nominal interest rate in response to inflation and business cycles. The details on how each sector operates are as follows.

3.3.1. Households

Our model economy is inhabited by an infinitely lived representative household whose objective is to maximizes expected lifetime utility denoted as

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t(c_t, m_t, n_t)$$

where E_t is the conditional expectations operator given information available to the household at time t, $\beta \in (0,1)$ denotes the household's discount factor, and U_t denotes the household's period utility function whose arguments consist of a consumption bundle c_t, labor hours n_t, and real money balances m_t. Here c_t assumed to be a Dixit–Stiglitz composite good that is produced by a final good producing firm by aggregating a variety of goods $j \in [0,1]$ that the household consumes. Specifically it is defined as

$$c_t = \left[\int_0^1 \left(c_t(j)\right)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}$$

where $c_t(j)$ denotes a differentiated consumption good j, and $\epsilon > 1$ denotes the elasticity of substitution across the varieties of the goods.

With regards to the functional form of U_t, we assume a constant relative risk aversion (CRRA) utility function which is increasing in consumption and real money balances and decreasing in the amount work hours. Specifically, U_t is assumed to take the following form.

$$U_t(c_t, m_t, n_t) = \begin{cases} \dfrac{e^{a_t}\, c_t^{1-\sigma}}{1-\sigma} - \lambda_n \dfrac{n_t^{1+\eta}}{1+\eta} + \lambda_m \dfrac{m_t^{1-\mu}}{1-\mu} & \sigma, \mu \neq 1 \\ e^{a_t}\, ln(c_t) - \lambda_n \dfrac{n_t^{1+\eta}}{1+\eta} + \lambda_m\, ln(m_t) & \sigma, \mu = 1 \end{cases}$$

where σ is the CRRA parameter, η is the inverse Frisch elasticity of labor supply, μ is a parameter measuring the elasticity for real money balances, λ_n and λ_m are the respective preference parameters for work hours and real money balances, and a_t measures changes in the household's consumption preferences. We further assume that a_t follows a stationary first order autoregressive process

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \qquad \varepsilon_t^a \sim N(0, \sigma_a^2) \tag{1.1}$$

Since household owns the firms, it allocates part of its income for investment i_t and hence accumulate capital k_t for use in the firm's production process. Therefore, for a given capital depreciation rate $\delta \in (0,1)$, the amount of capital owned by the household is assumed to evolve according to the standard law of motion for capital

$$k_t = i_t + (1-\delta)k_{t-1} \tag{1.2}$$

As the household allocates its resources to maximize utility, it is bound by a budget constraint that restricts its expenditures to its disposable income and does not allow borrowing of additional resources. This budget constraint is given by

$$\begin{aligned} \left(1-\tau_t^y\right)(w_t n_t + r_t^k k_{t-1} + d_t) + \Pi_t^{-1}(R_{t-1} b_t + m_{t-1}) \\ = (1+\tau_t^c)c_t + i_t + b_{t+1} + m_t \end{aligned} \tag{1.3}$$

where τ_t^y and τ_t^c represent the tax rates for household incomes and consumption respectively, r_t^k is the rental rate of capital, w_t is the hourly wage rate, d_t is dividend

payments from the firms, b_t is the amount of government bonds held at the beginning of period t paying R_t in gross nominal return, and $\Pi_t \equiv P_t/P_{t-1}$ is the gross inflation rate. Here all variables apart from the tax rates are expressed in real terms by dividing their nominal counterparts with the price index, P_t.

The solution to the household problem satisfies the first order conditions (FOCs) in equations (1.4) - (1.7) below in addition to the budget constraint (1.3) above. These equations comprise of the consumption Euler equation (1.4), and the optimality conditions for labor hours (1.5), real money balances (1.6) and for bond holdings (1.7).[17]

$$\frac{a_t\, c_t^{-\sigma}}{1+\tau_t^c} = \beta E_t\left[\frac{a_{t+1}\; c_{i,t+1}^{-\sigma}}{1+\tau_{t+1}^c}\left\{\left(1-\tau_{t+1}^y\right)r_{t+1}+1-\delta\right\}\right] \tag{1.4}$$

$$\lambda_n n_t^{\eta} c_t^{\sigma} = a_t\left(\frac{1-\tau_t^y}{1+\tau_t^c}\right)w_t \tag{1.5}$$

$$\frac{a_t\, c_t^{-\sigma}}{1+\tau_t^c} - \lambda_m m_t^{-\mu} = \beta E\left[\frac{a_{t+1}\; c_{t+1}^{-\sigma}}{1+\tau_{t+1}^c}\,\frac{1}{\Pi_{t+1}}\right] \tag{1.6}$$

$$\frac{a_t\, c_t^{-\sigma}}{1+\tau_t^c} = \beta E\left[\frac{a_{t+1}\; c_{t+1}^{-\sigma}}{1+\tau_{t+1}^c}\,\frac{R_{t+1}}{\Pi_{t+1}}\right] \tag{1.7}$$

3.3.2. Firms

In this economy there are two types of firms. The first type consists of a continuum of monopolistic firms $j \in [0,1]$ that produce differentiated intermediate goods $y_t(j)$. The second type of firms operate in a perfectly competitive market and use $y_t(j)$ as inputs to produce the final composite good y_t.

3.3.2.1. Final good producing firm

[17] Note that the household does not borrow funds hence no borrowing constraint is specified in the FOCS.

The final good producing firm uses the differentiated goods $y_t(j)$ as the only inputs for producing the composite final good y_t which is demanded in the form of c_t, i_t, and g_t. As such, y_t is produced by the same Dixit-Stiglitz aggregator function for c_t given in the previous section. Therefore we have

$$y_t = \left(\int_0^1 \{y_{j,t}\}^{\frac{\epsilon-1}{\epsilon}} \partial j \right)^{\frac{\epsilon}{\epsilon-1}}$$

Given this production technology, the firm's problem is to choose a combination of $y_t(j)$ that minimizes its total production costs

$$\int_0^1 P_t(j)\, y_t(j)\, \partial j$$

where $P_t(j)$ denotes the price for input $y_t(j)$. The first-order condition from this problem yields the optimal levels of $y_t(j)$ as functions of their respective prices $P_t(j)$, the aggregate price P_t and aggregate demand y_t. Specifically, the final good firm chooses the amount of good *j* to be used as inputs according to

$$y_t(\mathrm{j}) = \left(\frac{P_t(j)}{P_t} \right)^{-\epsilon} y_t$$

where $$P_t = \left(\int_0^1 \{P_t(j)\}^{1-\epsilon}\, \partial j \right)^{\frac{1}{1-\epsilon}}$$

Furthermore, in equilibrium the level of y_t produced must satisfy all demand from the household and the government. Therefore, given the levels of c_t, i_t, and g_t demanded, the goods market equilibrium satisfies

$$y_t = c_t + i_t + g_t \qquad (1.8)$$

3.3.2.2. Intermediate good producing firms

Unlike the final good firms, the firms producing the intermediate good possess some monopolistic power. This allows each firm *j* to set its price $P_t(j)$ at a markup above the marginal cost MC_t and hence generate some positive profit $d_t(j)$. However when setting the price, the intermediate good firm faces some inflexibilities in the form of Calvo price stickiness. Specifically, every period the firm faces a probability $\theta \in (0,1)$ that it fails to reset its price. Given this setting, the firm faces a two stage problem, one involving how to choose factor inputs, and the other involving how to set the price for its output.

Factor input choice

In the first stage, the firm chooses the level of capital $k_{t-1}(j)$ and labor hours $n_t(j)$ that minimize production costs $(w_t n_t(j) + r_t k_{t-1}(j))$ subject to its production technology. This production technology is assumed to be of a Cobb-Douglas form and is given by

$$y_t(j) = e^{z_t}\{\, k_{t-1}(j)\}^{\alpha} \{n_t(j)\}^{1-\alpha} \tag{1.9}$$

$$z_t = \rho_z z_{t-1} + \varepsilon_t^z + \rho_{zz}\varepsilon_{t-1}^z \tag{1.10}$$

where z_t is total factor productivity (TFP) that follows an ARMA(1) process with a persistence parameter $\rho_z \in [0,1)$, and a shock component $\varepsilon_t^z \sim N(0, \sigma_z^2)$ whose persistence is measured by $\rho_{zz} \in [0,1)$. The moving average component is added to capture the apparent persistent nature of productivity issues in Malawi including prolonged electricity power problems and weather shocks. Lastly $\alpha \in [0,1]$ is the capital share of income. The first order conditions for this problem are the labor and capital demand conditions

$$w_t = (1-\alpha)\, e^{z_t} \left(\frac{k_{t-1}(j)}{n_t(j)}\right)^{\alpha} \tag{1.11}$$

$$r_t = \alpha\, e^{z_t} \left(\frac{k_{t-1}(j)}{n_t(j)}\right)^{\alpha-1} \tag{1.12}$$

Given these input prices the nominal cost function $\mathrm{C}_t(y_t(j))$ becomes

$$\mathrm{C}_t(y_t(j)) = MC_t y_{j,t}$$

where $MC_t \equiv e^{z_t} \left(\frac{r_t}{\alpha}\right)^{\alpha} \left(\frac{w_t}{1-\alpha}\right)^{1-\alpha}$ is the nominal marginal cost common to all firms j.

Pricing decision

Having chosen the optimal levels of $k_{t-1}(j)$ and $n_t(j)$, the firm that is able to adjust its price sets the new price $P_t^*(j)$ which maximizes profits expected in the next *s* periods that this price is expected to be maintained. Thus $P_t^*(j)$ is chosen by solving

$$\max_{P_t^*(j)} \; E_t \sum_{s=0}^{\infty} \theta^s \, \Omega_{t,t+s} \, \left\{P_t^*(j)\, y_{t+s}(j) - e^{\psi_{t+s}}\, \mathrm{C}_{t+s}(y_{t+s}(j))\right\}$$

subject to the demand for $y_{t+s}(j)$ from the final goods firm. Here, $\Omega_{t,t+s} \equiv \beta^s \left(\frac{c_{t+s}}{c_t}\right)^{-\sigma} \left(\frac{P_{t+s}}{P_t}\right)^{-1} \left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)$ is the firm's discount factor of period $t+s$ as at period t, and ψ_t is a time varying price markup (or "cost-push") that is common to all intermediate goods producers and follows a stationary AR(1) process

$$\psi_t = \rho_\psi \psi_{t-1} + \varepsilon_t^{\psi} \qquad\qquad \varepsilon_{\psi,t} \sim N(0, \sigma_\psi^2) \tag{1.13}$$

The solution to this problem satisfies the first order condition

$$E_t \sum_{s=0}^{\infty} \theta^s \, \Omega_{t,t+s} \; \Xi_{t+s}^{-\epsilon} \, y_{t+s} \left\{\Xi_t - \Lambda\, e^{\psi_{t+s}}\, mc_{t+s}\, \Pi_{t,t+s}\right\} = 0 \tag{1.14}$$

where $\Xi_{t+s} \equiv P_t^*(j)\,/P_{t+s}$, $\Lambda \equiv \epsilon/(\epsilon-1)$ is the desired price markup over marginal cost,[18] $mc_{t+s} \equiv MC_{t+s}/P_{t+s}$ denotes the real marginal cost in period $t+s$, and $\Pi_{t,t+s} \equiv P_{t+s}/P_t$ is gross inflation between periods t and $t+s$.

Price dynamics

As demonstrated in Gali (2008), this setting implies that aggregate prices will evolve according to the process

$$\Pi_t^{1-\epsilon} = \theta \; + (1-\theta)\,(\Xi_t\,\Pi_t)^{1-\epsilon} \tag{1.15}$$

3.3.3. The Government

The government is responsible for the provision of public goods, g_t, which it funds by imposing taxes on consumption goods and household incomes. The government also issues interest bearing bonds b_t and has access to a stock of money m_t. As such, the government's budget constraint is as expressed in equation (1.16) below.

$$\begin{aligned} b_{t+1} + m_t + \tau_t^c c_t + \tau_t^y\left(w_t n_t + r_t^k k_{t-1} + d_t\right) \\ = g_t + \Pi_t^{-1}\left(R_{t-1} b_t + m_{i,t-1}\right) \end{aligned} \tag{1.16}$$

Furthermore, in addition to providing public services, the government also conducts discretionary fiscal policy in response to output fluctuations. It does so by targeting g_t, τ_t^c, and τ_t^y using policy rules (1.17) – (1.19) below.

$$\tilde{g}_t = \rho_g \tilde{g}_{t-1} - \gamma_y^g \tilde{y}_t + \varepsilon_t^g \tag{1.17}$$

$$\tilde{\tau}_t^c = \rho_\tau^c \tilde{\tau}_{t-1}^c + \gamma_y^c \tilde{y}_t + \varepsilon_t^{\tau c} \tag{1.18}$$

$$\tilde{\tau}_t^y = \rho_\tau^y \tilde{\tau}_{t-1}^y + \gamma_y^y \tilde{y}_t + \varepsilon_t^{\tau y} \tag{1.19}$$

[18] See Gali (2008).

where $\tilde{g}_t$, $\tilde{\tau}_t^c$, and $\tilde{\tau}_t^y$ indicate log deviations of g_t, τ_t^c, and τ_t^y from their respective steady state values, parameters ρ_g, ρ_τ^c, and ρ_τ^y are the smoothing parameters for g_t, τ_t^c, and τ_t^y respectively, parameters γ_y^g, γ_y^c, and γ_y^y are the policy feedback coefficients with respect to output fluctuations, and ε_t^g, $\varepsilon_t^{\tau c}$, and $\varepsilon_t^{\tau y}$ are the exogenous shocks to the corresponding policies, each having a zero mean and the respective standard deviations, σ_g, $\sigma_{\tau c}$, and , $\sigma_{\tau y}$.

3.3.4 Central Bank

Lastly, the central bank is responsible for maintaining stability of prices and output through monetary policy. It does so by targeting nominal interest rates in reaction to deviations of the inflation rate and output growth from their desired values. Specifically, the bank employs a Taylor type monetary policy rule given by

$$\tilde{r}_t = \phi_\pi \tilde{\pi}_t + \phi_y \tilde{y}_t + ln(u_t) \tag{1.20}$$

$$log(u_t) = \rho_u \, log(u_{t-1}) + \varepsilon_t^R$$

where $\tilde{r}_t \equiv ln\frac{R_t}{R}$ is the log deviation of nominal interest rates from the steady state value, $\tilde{\pi}_t \equiv ln\frac{\Pi_t}{\Pi}$ is the log deviation of the gross inflation rate from its steady state value, and $\tilde{y}_t \equiv y_t - y$ is output deviation from the steady state value. The parameters ϕ_π and ϕ_y measure the responsiveness of interest rate to changes in inflation and output respectively, $-1 < \rho_u < 1$ is the parameter measuring the persistence of monetary policy shocks and $\varepsilon_t^R \sim N(0, \sigma_\varepsilon^2)$ is the monetary policy shock.

3.3.5 Model equilibrium

Model equilibrium requires that all factor input prices and the price of goods adjust in such a way that all markets clear and all agents and entities in the model

maximize their respective objectives. In our model this is achieved when equations 1.1 through 1.20 above are all satisfied. These equations determine the short-run paths of the 20 endogenous variables in our model given the state of the stochastic shocks.[19]

3.4. Estimation

DSGE models are typically characterized by high dimensional non-linearities and stochasticity that result in computational difficulties. As such, transforming the model to a more tractable version becomes necessary for estimation. This is typically done by log-linearizing the model around its steady state which significantly lowers the computational burden in solving the model. For our case, a first order log-linear approximation of the model is done with the help of the MATLAB based Dynare 4.5.6 software which uses perturbation methods to compute the approximate decision rules and transition equations of a model. The model is then estimated using data and prior distributions given below.

3.4.1. Data description

We estimate the model using quarterly data on 7 variables comprising of private consumption, private investment, consumer prices, government spending, nominal interest rates, consumption tax revenue, and income tax revenue. Our sample period is 2008:Q3 to 2017:Q2. However, data for private consumption and private investment are available at annual frequency only and therefore we get their quarterly estimates by means of interpolation. Specifically, we employ the Chow-Lin method of interpolation in which we use imports and private debt as indicator variables for private consumption and private investment respectively.

[19] Endogenous variables in the model comprise of $y_t, c_t, i_t, k_t, n_t,\ z_t, a_t, \psi_t, r_t, w_t, \Pi_t, \Xi_t, mc_t, m_t, b_t, d_t, R_t, g_t, \tau_t^c$, and τ_t^{in}.

The data is sourced from 4 databases namely, the IMF's International Financial Statistics (IFS), the World Bank's World Development Indicators (WDIs), the Reserve Bank of Malawi (RBM) statistics, and the National Statistical Office of Malawi (NSO) statistical reports. Table 3.1 below summarizes sourcing and description of the data.

Table 3.1: Data description and sources

Variable	**Description**	**Source**
consumption, c_t	final private consumption expenditure.[20]	IFS, NSO
investment, i_t	gross fixed capital formation by the private sector.[21]	WDI, RBM
govt. spending, g_t	total government expenditures	IFS
prices, P_t	consumer price index (CPI)	IFS
interest rate R_t	3 month treasury bill rate	IFS
consumption tax revenue	taxes on goods and services	NSO
income tax revenue	taxes on incomes and profits	NSO

These 7 variables whose data we use in the estimations are selected based on two reasons. First and most importantly, we choose variables that aid identification of the shocks that we estimate. Specifically, consumption data helps in the estimation of consumer preference shocks, investment (which together with consumption and government spending make up total output in the model) aids the identification of productivity shocks, prices help identify cost-push shocks, and interest rate, government spending, consumption tax revenue, and income tax revenue help in the respective identification monetary policy shocks, government spending shocks, income tax shock, and consumption tax shock.

[20] Annual private consumption data is obtained from IFS while the annual and quarterly imports data used for interpolation is obtained from NSO statistical reports.
[21] Annual private investment data is obtained from WDIs while the annual and quarterly private debt data used for interpolation are obtained from RBM statistics.

The other reason for selecting these variables for our estimations is availability of the data. This particularly applies to our choice of consumption tax revenues and income tax revenues which are used due to the unavailability of data on consumption tax rates and income tax rates. To get around this problem, first we introduce in the model new variables corresponding to consumption tax revenue and income tax revenue. We then specify equations that capture the respective relationships between each of these new variables and their corresponding tax rates. In this way we are able to estimate our tax rules based on actual tax data.[22]

3.4.2 Choice of priors

All parameters in this the model except for σ (the CRRA parameter), η (inverse of Frisch labor supply elasticity), and δ (the depreciation rate of capital) are estimated and thus require that prior distributions be provided. We obtain these priors from related literature and from sample moments of available data. Fairly loose priors are used in order to accommodate the possibility that the true parameters for the Malawi economy may significantly deviate from the values that are commonly presented in DSGE literature which tends to focus on more advanced economies. The prior distributions for all parameters and their sources are summarized in Table 3.2 below.

[22] While the estimates based on this data may be subject to "observation error" bias, we proceed nonetheless and simply caution the reader about this potential bias.

Table 3.2: Prior distributions for parameters

Parameter		**Prior**			**Source**
		density	***mean***	***std dev***	
discount factor:	β	beta	0.96	0.03	average treasury bill rate
labor preference parameter:	λ_n	gamma	1	0.25	common value in utility functions
money preference parameter	λ_m	gamma	1	0.25	
CRRA parameter :	σ	fixed	1	0	special case of CRRA
Inverse of Frisch labor supply elasticity :	η	fixed	1	0	unitary Frisch elasticity of labor supply
inverse elasticity of substitution for real money balances :	μ	gamma	2.38	0.25	set to match estimated interest-rate semi elasticity of money demand in Malawi
capital share of income :	α	beta	0.3	0.01	common in related literature
capital depreciation rate :	δ	fixed	0.025	0	common in DSGE literature
price elasticity of demand :	ϵ	gamma	6	1	Gali (2008)
Calvo pricing parameter	θ	beta	0.5	0.1	author
persistence of consumption preferences :	ρ_a	beta	0.5	0.125	set at the midpoint of the prior density
persistence of price markups	ρ_ψ	beta	0.5	0.125	
persistence of productivity :	ρ_z	beta	0.5	0.125	
productivity shock persistence:	ρ_{zz}	beta	0.3	0.1	author
Parameters for policy rules					
Taylor rule inflation coefficient:	ϕ_π	gamma	0.5	0.25	Taylor's recommendation
Taylor rule output coefficient :	ϕ_y	gamma	0.5	0.25	Taylor's recommendation
persistence of monetary policy shock	ρ_u	normal	0	0.1	set as in the basic Taylor rule
govt. spending response to output :	γ_y^g	gamma	0.1	0.05	set within ranges in related literature
consumption tax response to output :	γ_y^c	gamma	0.1	0.05	
income tax response to output:	γ_y^y	gamma	0.1	0.05	
govt. spending smoothing :	ρ_g	beta	0.5	0.125	set at the midpoint of the prior density
consumption tax smoothing :	ρ_τ^c	beta	0.5	0.125	
income tax smoothing :	ρ_τ^y	beta	0.5	0.125	
Shocks (standard deviations)					
$\sigma_z, \sigma_a, \sigma_\psi, \sigma_R, \sigma_g, \sigma_{\tau,c}, \sigma_{\tau,in}$		inverse-gamma	0.1	5	harmonized uninformative priors for all shocks

3.4.3 Estimation Results

As already stated, our 3 main tasks in this study comprise of: 1) estimating the policy feedback rules for the nominal interest rate, government spending, income taxes, and consumption taxes, 2) analyzing the effects of policy rules on key macroeconomic variables, and 3) analyzing the relative importance of the policy shocks vis-a-vis shocks to productivity, consumer preference, and price mark-ups, in the determination of prices and business cycles in Malawi. This section provides our findings with regards to these tasks by making inferences from the posterior estimates of the model parameters, the estimated impulse response functions, and the estimated variance decompositions of key variables. However before making such inferences, we make sure that our estimated model is stable and our parameter estimates have converged to their final values. For this we make use of the parameter trace plots presented in appendix 3.2. These trace plots show how well our model converges after 400,000 iterations from which 100,000 are discarded as *burn in*.[23]

3.4.3.1. Fiscal and monetary policy rules

The posterior distributions for the model parameters are presented in Table 4.3 below. The table shows the parameters' posterior means and their respective 90% highest posterior densities (HPDs) which we use as our credible intervals. From the posterior means of the policy parameters, we can write our estimates of the fiscal policy and monetary policy feedback rules specified in sections 3.3.3 and 3.3.4 as follows.

[23] We use Chris Sim's "csminwel" Metropolis-Hastings based optimization routine to maximize the log-likelihood of the model. This algorithm has the advantage of overcoming non-differentiability in the log-likelihood function and achieving converge quickly given that it is a local maximizer. However due to its dependence on the initial values entered, robustness checks are required to ensure that the algorithm is not stuck in a local extremum. For this we depend on our use of high prior variances and we also run the code multiple times.

Taylor rule	$\tilde{r}_t = 1.16\,\tilde{\pi}_t + 0.14\,\tilde{y}_t$
spending rule:	$\tilde{g}_t = 0.18\,\tilde{g}_{t-1} + 0.05\,\tilde{y}_t$
consumption tax rule :	$\tilde{\tau}_t^c = 0.49\,\tilde{\tau}_{t-1}^c + 0.07\,\tilde{y}_t$
income tax rule	$\tilde{\tau}_t^y = 0.40\,\tilde{\tau}_{t-1}^y + 0.07\,\tilde{y}_t$

Monetary policy rules

The estimated Taylor rule shows that monetary policy in Malawi reacts to both inflation and output. With regards to inflation, the central bank operates within the Taylor principle by raising interest rates by 1.16 percentage points for every 1 percentage point increase in inflation. As for output fluctuations, the Bank has a moderate reaction than Taylor's recommendation of $\phi_y = 0.5$. Specifically, our estimates show that a 1 percentage point decrease in output induces an interest rate cut of about 0.14 percentage points. This shows that whilst monetary policy still maintained the dual policy objectives of price stability and output stability, its main focus is on the former. Lastly we find that monetary policy shocks are typically non-persistent and they are quickly reversed by the bank. This is manifested by the negative ρ_u that is generated in our estimations.

Fiscal policy rules

All three fiscal policy rules that we estimate also show very modest reactions to output fluctuations. The fiscal authorities react to a 1 percentage decline in output by increasing government spending by $\gamma_y^g = 0.05$ percent and cutting the consumption and income tax rates by 0.07 percentage points for both. All three reactions here are milder compared to the reaction of monetary policy seen above. This suggests that for

macroeconomic stabilization policy in Malawi, monetary policy takes a leading role over fiscal policy even when it comes to the moderation of output fluctuations.

Lastly, the fiscal rules show that, as expected, tax rates are more persistent than government spending which is found to have lower inertia ($\rho_g \approx 0.14$) compared to those of consumption tax ($\rho_\tau^c \approx 0.49$) and income tax ($\rho_\tau^y \approx 0.40$).

Table 3.3: Parameter estimates

Parameter		Prior			Posterior	
		density	*mean*	*std. dev*	*mean*	*90% HPD interval*
discount factor:	β	beta	0.96	0.03	0.9712	[0.9590 , 0.9825]
labor preference parameter:	λ_n	gamma	1	0.25	0. 6207	[0.2462 , 0.9893]
money preference parameter :	λ_m	gamma	1	0.25	1.0008	[0.2391 , 1.7333]
parameter related to elasticity for money demand :	μ	gamma	2.38	0.5	2.3836	[1.9653 , 2.7942]
capital share of income :	α	beta	0.3	0.01	0.3155	[0.2991 , 0.3320]
Calvo pricing parameter :	θ	beta	0.5	0.1	0.3657	[0.2373 , 0.4933]
price elasticity of demand :	ϵ	gamma	6	1	6.9057	[5.2985, 8.5378]
persistence of consumer preferences :	ρ_a	beta	0.5	0.125	0.3512	[0.1654, 0.5265]
persistence of price markups :	ρ_ψ	beta	0.5	0.125	0.5215	[0.3364 , 0.7029]
persistence of productivity:	ρ_z	beta	0.5	0.125	0.8406	[0.7788 , 0.9054]
productivity shock persistence	ρ_{zz}	beta	0.3	0.1	0.3960	[0.2416 , 0.5475]
Parameters for policy rules						
Taylor rule inflation coefficient :	ϕ_π	gamma	1.5	0.25	1.1551	[1.0040 , 1.3058]
Taylor rule coefficient on output:	ϕ_y	gamma	0.5	0.25	0.1434	[0.0530 , 0.2298]
persistence of monetary policy shock	ρ_u	normal	0	0.1	-0.1867	[-0.2665, -0.1099]
govt. spending smoothing :	ρ_g	beta	0.5	0.25	0.1780	[0.0074 , 0.3396]
spending's response to output :	γ_y^g	gamma	0.1	0.025	0.0485	[0.0113 , 0.0852]
consumption tax smoothing :	ρ_τ^c	beta	0.5	0.25	0.4911	[0.2963 , 0.6921]
cons. tax's output response :	γ_y^c	gamma	0.1	0.05	0.0708	[0.0239 , 0.1163]
income tax smoothing :	ρ_τ^y	beta	0.5	0.25	0.3997	[0.2306 , 0.5701]
income tax's output response:	γ_y^y	gamma	0.1	0.05	0.0747	[0.0195 , 0.1269]

Shocks (standard deviations)						
productivity :	σ_z	inv. gamma	0.1	5	0.0319	[0.0202 , 0.0434]
preference :	σ_a	inv. gamma	0.1	5	0.0368	[0.0291 , 0.0446]
cost-push :	σ_ψ	inv. gamma	0.1	5	0.1251	[0.0889 , 0.1612]
monetary policy :	σ_R	inv. gamma	0.1	5	0.0570	[0.0442 , 0.0691]
govt. spending :	σ_g	inv. gamma	0.1	5	0.0266	[0.0189 , 0.0344]
consumption tax :	$\sigma_{\tau c}$	inv. gamma	0.1	5	0.0150	[0.0122 , 0.0175]
income tax:	$\sigma_{\tau y}$	inv. gamma	0.1	5	0.0234	[0.0188 , 0.0280]

3.4.3.2. Macroeconomic impact of fiscal and monetary policy

Having estimated the fiscal and monetary policy rules, next we analyze the impact of these policies on a number of key macroeconomic variables. We do so by examining the responses of selected variables to our estimated monetary policy and fiscal policy shocks. For our purposes, we focus on the impulse responses of output, consumption, investment, and inflation for a given monetary or fiscal policy shock of 1 standard deviation in magnitude. These impulse responses are presented in Figures 4.1 to 4.4. Also, in Table 3.4 below we present the model's implied steady state values which serve as the reference points for our impulse responses.[24]

Table 3.4: Model implied steady state values

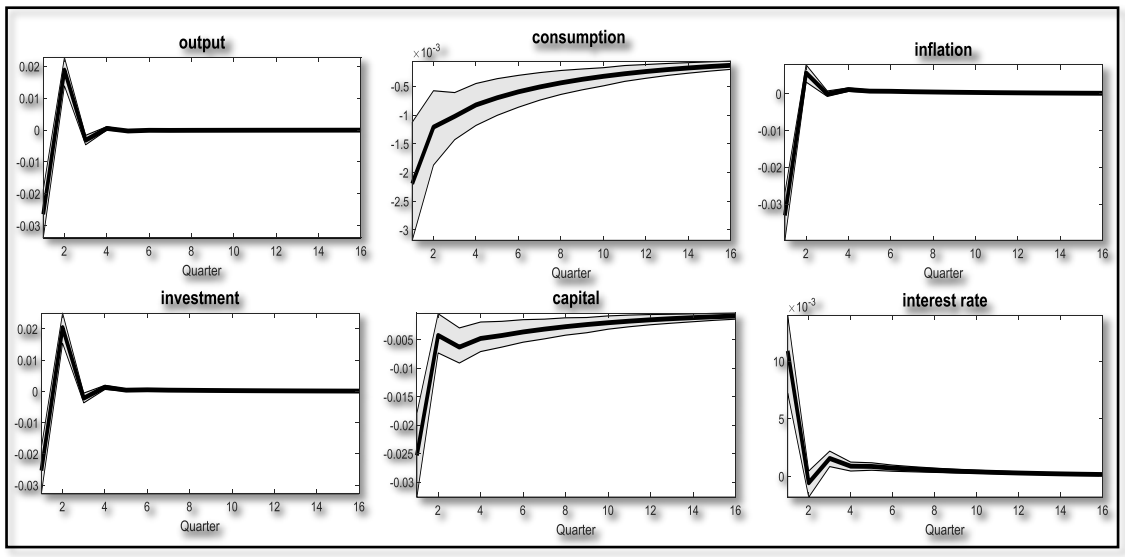
Variable	*Steady state value*	*Variable*	*Steady state value*
output, y_t	1.0489	nominal interest rate, R_t	1.0405
consumption, c_t	0.7795	government spending, g_t	0.1195
investment, i_t	0.0701	income tax rate, τ_t^c	0.19
gross inflation, Π_t	1	consumption tax rate, τ_t^y	0.16

[24] For the tax rates and government spending share of total output, their steady state values are set to their data averages. For the rest of the variables, theirs are derived analytically as functions of the model parameters by assuming time invariance for all variables.

The impact of monetary policy

The impulse responses to a monetary policy shock are shown in Figure 3.1. Looking at the responses of output, investment, and consumption, we see that monetary policy is not neutral but rather it affects both nominal and real variables. Specifically we see that a 1 standard deviation (5.7 basis point) increase in the nominal interest rate induces an immediate 2.1 basis point decline in output as both investment and consumption also decline by 1.3 and 0.2 basis points respectively. The declines of consumption and investment result from a rise in real interest rates which ultimately makes savings more attractive while simultaneously making debt financed investment and consumption less so. However it should be noted that in the next period investment and consumption increase as the policy reverses.

Figure 3.1: Impulse responses to a monetary policy shock



Note: Thick lines are the mean responses and the shaded areas are 90th percentile confidence bands.

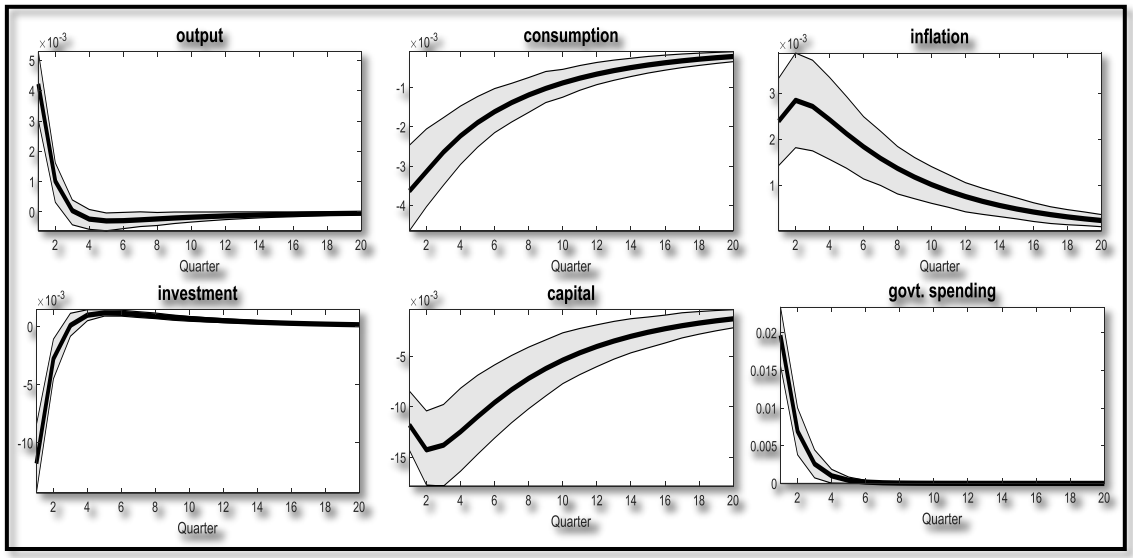
The shock to interest rates also leads to a reduction in inflation of about 3 basis points. In contrast to some VAR based studies done on Malawi that found the so called "price puzzle", this result satisfies the theoretical predictions regarding the impact of

monetary policy on prices.[25] Therefore, our model indicates that monetary policy is indeed an effective tool for managing inflation in Malawi at least in the short run.

The impact of fiscal policy

The effects of government spending shocks, consumption taxes and income taxes are respectively shown in Figures 3.2 - 3.4 below. As Figure 3.2 shows, a positive government spending shock of 1 standard deviation (2.7 basis points) immediately raises output and prices by 0.4 and 0.25 basis points respectively. The initial increase in output occurs in spite of the crowding out of both investment and consumption by up to 1.2 and 0.35 basis points respectively. Nevertheless, aggregate output eventually declines by the fifth quarter before returning to its initial position.

Figure 3.2: Impulse responses to government spending shock



Note: Thick lines are the mean responses and the shaded areas are 90th percentile confidence bands.

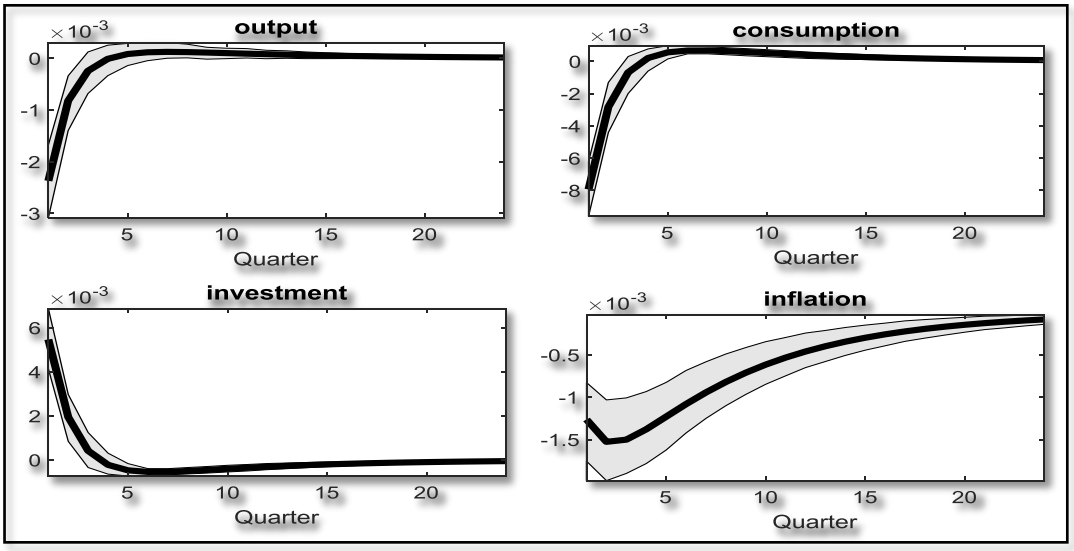
Here it is important to note that whilst government's ability to crowd out private investment is theoretically and empirically well established, the crowding out effect on

[25] see Ngalawa (2010) and Mangani (2012) both of whom found price puzzles in their models.

private consumption is still in debate. One proposed explanation is the existence forward looking agents who anticipate future tax increases given the increased government spending, and therefore increase their savings now for consumption smoothing purposes. Furthermore the resultant rise in interest rates (which we observe in our model) provides extra incentive to save while the aforementioned rise in consumer prices forces households to cut consumption as their budget constraint tightens.

With regards to consumption taxes, the effects of a positive shock of 1.5 basis points include a 0.8 basis point reduction in consumption which results into reductions in output and inflation of about 0.25 and 1.25 basis points respectively. The reduction in consumption reflects both the income effect and the distortionary nature of consumption taxes as households reallocate resources from consumption to savings. In our model the latter is reflected in the 0.52 basis point increase in investment.

Figure 3.3: Impulse responses to a consumption tax shock

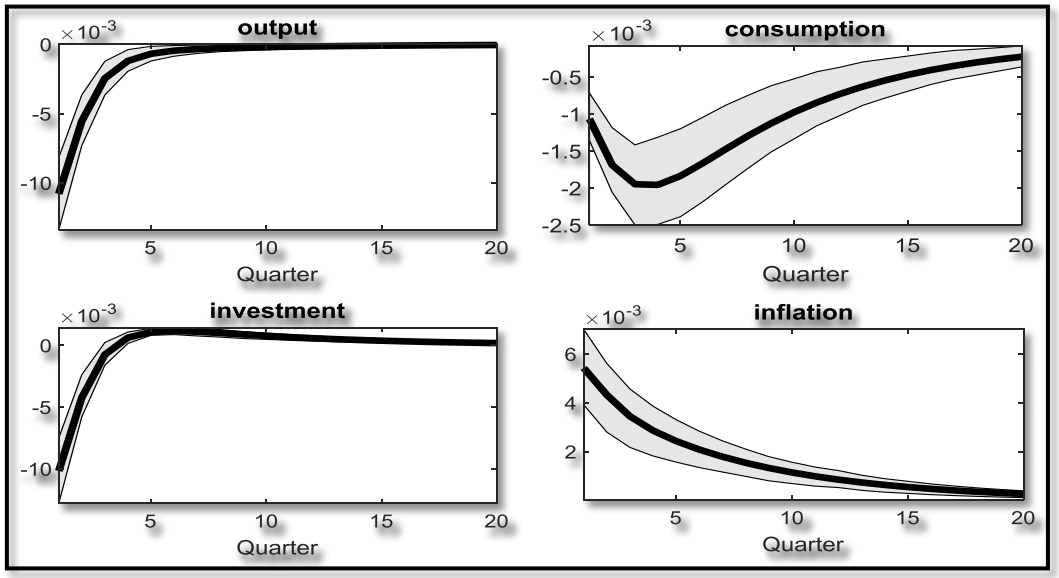


Note: Thick lines are the mean responses and the shaded areas are 90th percentile confidence band

In the case of income taxes, a positive shock to the tax rate of 2.34 basis points also leads to decreases of about 0.2 and 1 basis point for consumption and output

respectively. But unlike in the case of consumption tax shocks, here investment goes down (by about 1 basis point) and the inflation rate increases (by about 0.55 basis points). The decline in investment is due to both the income effect of paying more taxes and a substitution effect since the taxation of dividends and capital rent creates a disincentive to invest. As for the price increase, this indicates a tendency of the owners of capital to shift their tax burden to consumers.

Figure 3.4: Impulse responses to an income tax shock



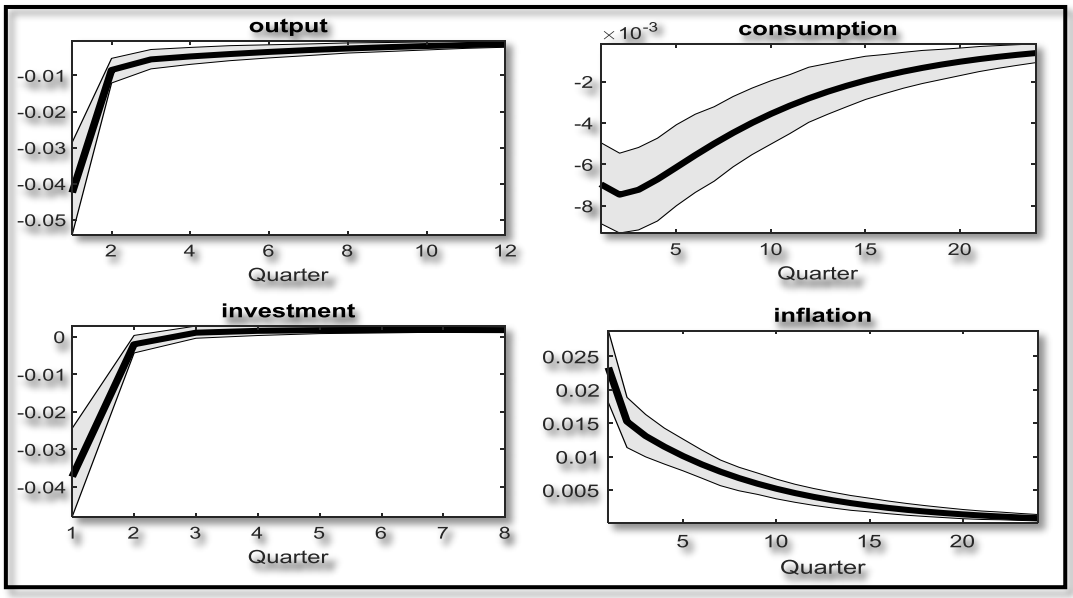
Note: Thick lines are the mean responses and the shaded areas are 90th percentile confidence band.

The impact of non-policy shocks

Besides fiscal and monetary policy shocks, the demand and supply shocks that we estimate also have significant impacts on the macroeconomic variables in the model. The question of how big a role each of them play is answered in the next section when we analyze variance decompositions. For now we focus on the macroeconomic dynamics induced by each of these shocks. In this regard, from Figure 3.5 below we find that in the case of a negative productivity shock of 1 standard deviation (3.19 basis points) in size,

output immediately declines by up to 4 basis points, and prices jump up 2.4 basis points.[26] Consumption also declines by 0.8 basis points which is a smaller drop than that of output thus reflecting the tendency by households to smooth consumption. This is further reflected in the response of investment which also drops 3.5 basis points as households attempt to stabilize consumption.

Figure 3.5: Impulse responses to a negative productivity shock



Note: Thick lines are the mean responses and the shaded areas are 90th percentile confidence bands.

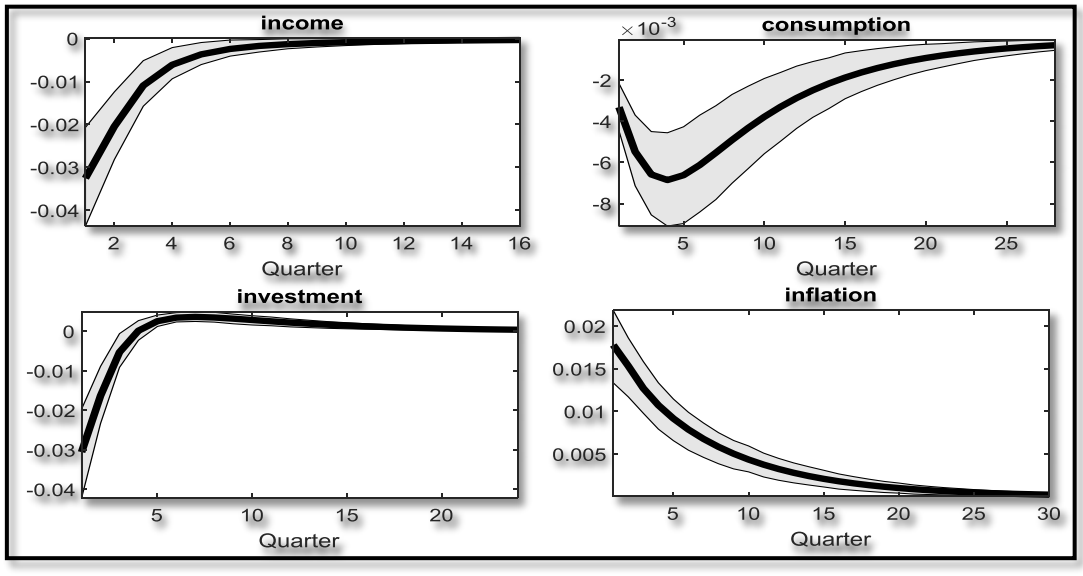
Turning to the other supply side shock – a cost-push shock, we see from Figure 3.6 that a positive (12.5 basis point) shock induces reactions from output, consumption, investment, and prices that are similar to those induced by productivity shocks, but notably by smaller magnitudes. Specifically the declines in output, consumption and investment reach 3, 0.6, and 3 basis points respectively. With regards to the impact on prices, the increase is also smaller than that of productivity shocks, peaking at just over

[26] Malawi has been increasingly exposed to electric power outages, and negative weather shocks thus making the analysis of the impact of *negative* productivity shocks rather interesting. Nevertheless, the converse of our findings should hold true for positive shocks since the IRFs are symmetric.

1.7 basis point increase in the inflation rate. All this is points to a dominance of productivity shocks over cost-push shocks when it comes to triggering business cycles, a point that is expounded in the next section.

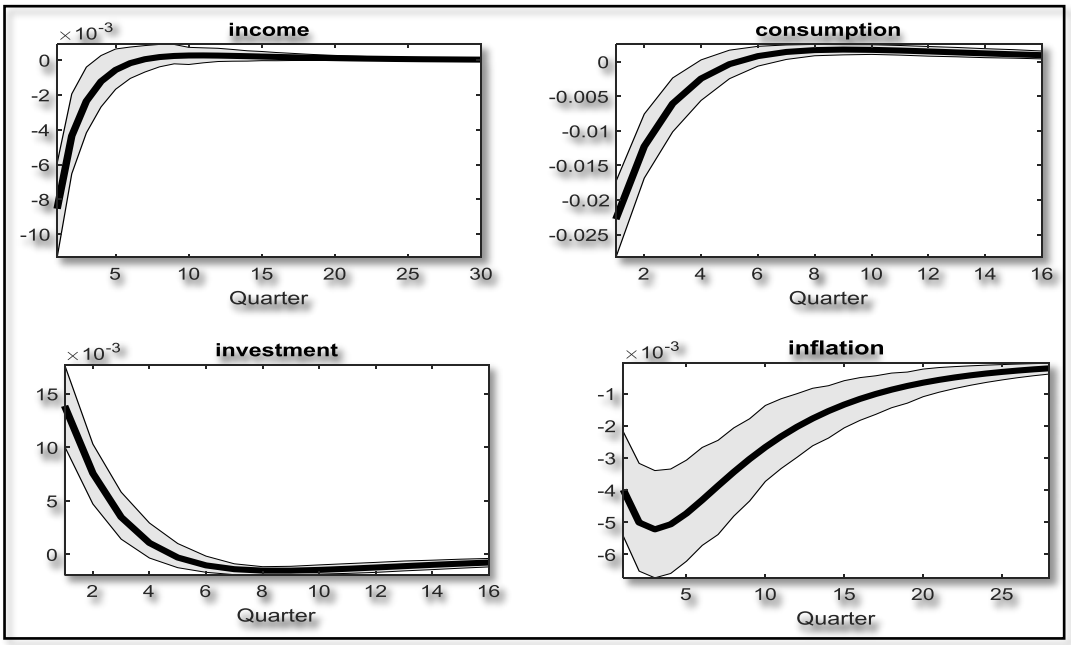
Lastly, we look at the impact of consumer preference shocks whose impulse responses are plotted in Figure 3.7 below. As the figure shows, a negative preference shock of induces downward movements in output, and consumption, reaching up to 0.8 and 2 basis points respectively. Investment on the other hand increases by up to 1.4 basis points. These magnitudes are also smaller than those observed for productivity shocks. The reaction of prices on the other hand differs from the two supply shocks above. Here, as one would expect from a negative demand shock, prices decrease rather than increase. Specifically, the shock results in a 0.5 basis point drop in inflation which is also a smaller magnitude than that observed in the case of a productivity shock.

Figure 3.6: Impulse responses to a cost-push shock



Note: Thick lines are the mean responses and the shaded areas are 90th percentile confidence bands.

Figure 3.7: Impulse responses to a negative consumer preference shock



Note: Thick lines are the mean responses and the shaded areas are 90th percentile confidence bands.

3.4.3.3. What drives business cycles and prices?

The analysis of impulse responses above points to productivity shocks as being the most important driver of business cycles and prices among the non-policy shocks. This appears to be the case given the relatively bigger effect that this shock has on output, consumption, investment, and prices. In this section we look at how the shocks identified in the model compare to one another in terms of their respective contributions to the fluctuations of output and prices. Table 3.5 below, which shows variance decompositions of output, consumption, investment and prices helps us answer this question.

As we observed in the analysis of the impulse response functions above, the variance decompositions too indicate that output and prices are largely driven by changes in productivity although for the investment component of output, cost push shocks and monetary policy shocks are more important. Productivity shocks alone account for 42 percent of changes in consumption, 19.1 percent of changes in investment and 41 percent

of fluctuations of total output. With regards to price movements, productivity shocks account for up to 50 percent of the changes in inflation with monetary policy also playing a significant role.

Table 3.5: Variance decomposition of selected variables

Type of shock	***Percentage of variability due to shock***			
	output	*consumption*	*investment*	*inflation*
productivity	**41.42**	**41.96**	19.38	**50.89**
preference	0.66	37.62	9.57	1.97
cost-push	33.46	11.76	**36.29**	11.48
monetary policy	21.24	0.37	25.83	33.84
govt. spending	0.13	1.26	4.20	1.97
consumption tax	0.10	5.89	1.52	0.28
income tax	3.00	1.14	3.20	1.19

Another shock playing a sizable role in business cycles is cost-push shock whose contributions to fluctuations in output, consumption and investment turn out to be around 33.5 percent, 11.8 percent, and 36.3 percent respectively. Put together, the numbers above show that productivity and cost-push shocks together account for up to 74 percent of output fluctuations which suggests that GDP is mainly influenced by supply shocks rather than the policy shocks or consumer demand shocks. Nevertheless, one should not downplay the importance of policy in influencing the real economy, particularly monetary policy. This is because monetary policy is shown to be an important driver of investment for which it contributes up to 25.83 percent of its variability which translates into a contribution of 21 percent of all fluctuations in total output. In other words, the Keynesian monetary policy transmission mechanism appears to be functional in Malawi.

3.5. Conclusions

In summary, this chapter has examined Malawi's fiscal and monetary policies in a closed economy New-Keynesian DSGE model with multiple shocks. The model that is developed has been estimated by the Bayesian estimation method using flexible priors and quarterly data on seven macroeconomic variables that include consumption, investment, government spending, consumer prices, nominal interest rate, consumption tax revenue, and income tax revenue.

The main contributions of the study are threefold. Firstly, policy feedback rules for both monetary and fiscal policy have been estimated and with that, how fiscal and monetary authorities in Malawi react to macroeconomic instability has been established. Secondly, evidence on the effects of the fiscal and monetary policy in Malawi on key macroeconomic variables including consumption and investment has been established. And thirdly, the comparative importance of the different fiscal policies, monetary policy, and other demand and supply shocks, in the determination of business cycles and price movements has also been established.

The study finds that both monetary and fiscal policies react to output fluctuations rather mildly, with fiscal policy being meeker than monetary policy. However monetary policy is found to react strongly to inflation and it does so by adjusting interest rates in accordance with the Taylor principle. With regards to effectiveness of the policy feedback rules, the study establishes that monetary policy and both tax policies affect business cycles in the expected (conventional) ways, while expansionary spending policy eventually reduces aggregate output on account of the crowding out effect that it has on investment and private consumption.

The study also establishes that although the fiscal and monetary policy rules can be used with success to influence the movements of output and prices, it is actually productivity shocks that have the biggest impact and influence on both variables. We also establish that cost-push shocks and monetary policy play significant roles in the movements of output and prices. These findings point to the reason why Malawi still faces high inflation despite having tight monetary policy given that the effect of monetary policy on prices is undercut by the more pronounced influence of productivity shocks and that of cost-push shocks.

Given these results, one obvious message to macroeconomic policy makers in Malawi is to recognize that supply shocks, especially productivity shocks, play a very important role in the stability economy and therefore affect the extent to which fiscal and monetary policy can achieve their objectives. With this in mind, our recommendation is for the government to increase its efforts on improving and maintaining a high the level of productivity in the economy and also to firmly react to supply shocks as they occur. The former can be achieved by promoting the adoption of new productivity enhancing technologies, and by investing in technology improving research and development. One specific case that is applicable here the issue of severe electric power outages that the country has been facing constantly. Given the importance of reliable electricity supply to production process, the power outages serve as negative productivity shocks. The efforts undertaken by Malawi government so far in the form of projects designed to increase power generation have unfortunately been stalling.[27] Therefore, completing and getting

[27] see Malawi-Mozambique power interconnection project, and the Khammwamba Thermal Power Station.

these projects fully operational would be in line with our recommendation for enhancing the effectiveness of fiscal and monetary policies.

Another recommendation given the results of our study is for the monetary authorities to maintain their strong monetary policy stance with regards to inflation since this is shown to be an effective way towards maintaining price stability. However caution has to be exercised with regards to how such a strong monetary policy stance affects investment. Overreliance on monetary policy in pursuing price stability could hinder the growth of the economy in the long run by limiting private investment. Instead, price stability would optimally be achieved by addressing structural issues facing the economy such as the low levels of productivity and the constant disruptions of the same that we mentioned above.

Similarly, fiscal authorities need to be cautious of the crowding out effect that government spending has on private investment and consumption. Like with monetary policy, this has the potential of significantly hindering economic growth in the long run. In this regard, we recommend coordination between the fiscal authorities and monetary authorities when deciding the modalities for financing government spending shocks as this can help ensure that the cost of credit and the amount available for the private sector is not significantly affected by expansions in government spending. Thus this would help minimize the crowding out of private investment and consumption.

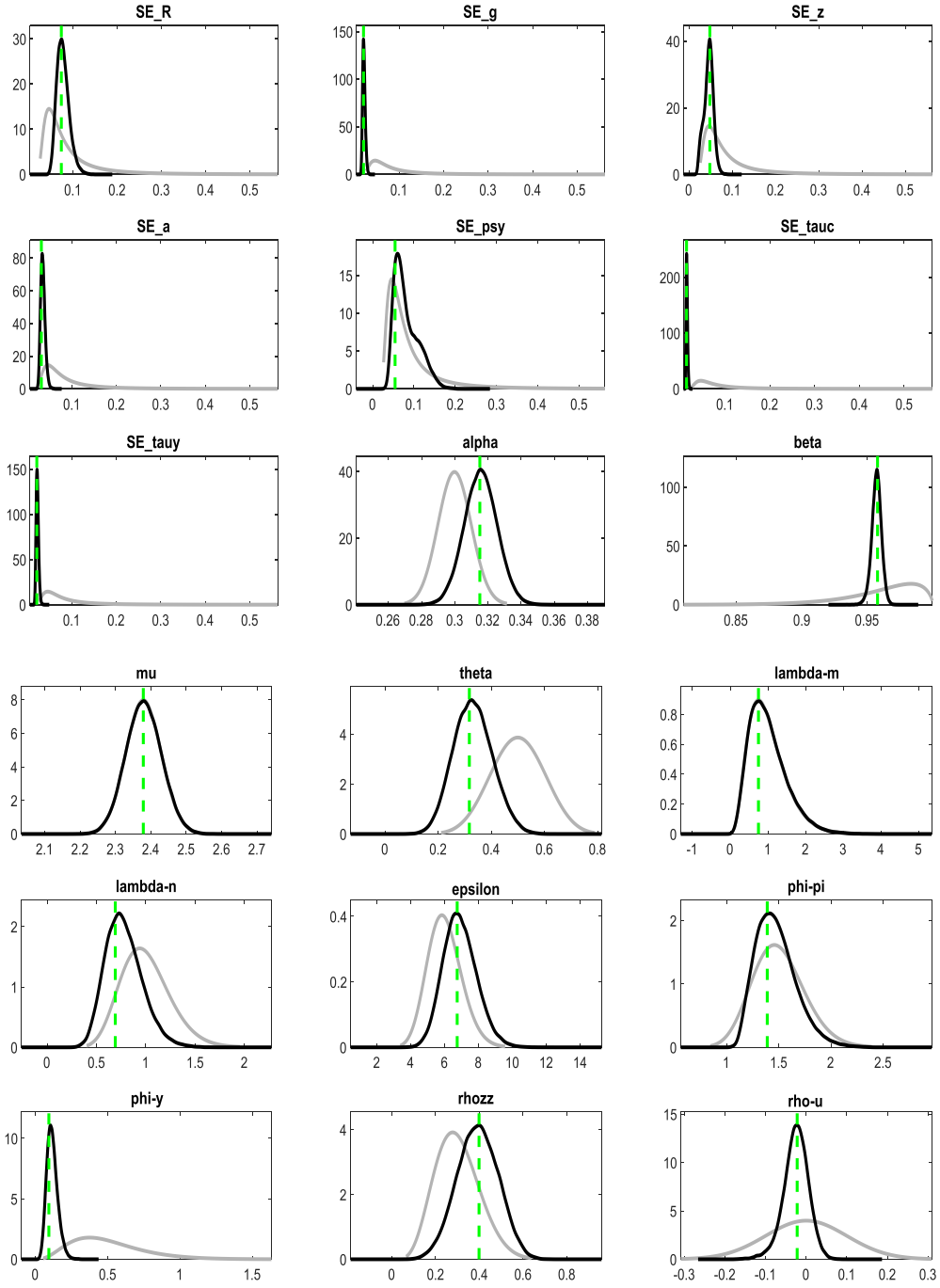
As is with most studies based on simplified macroeconomic models, ours too faces some limitations that the reader needs to be aware of. One important limitation comes from our use of a closed economy model. Although Malawi is not a heavily trade dependent economy, we recognize that the external sector may be quite important for the

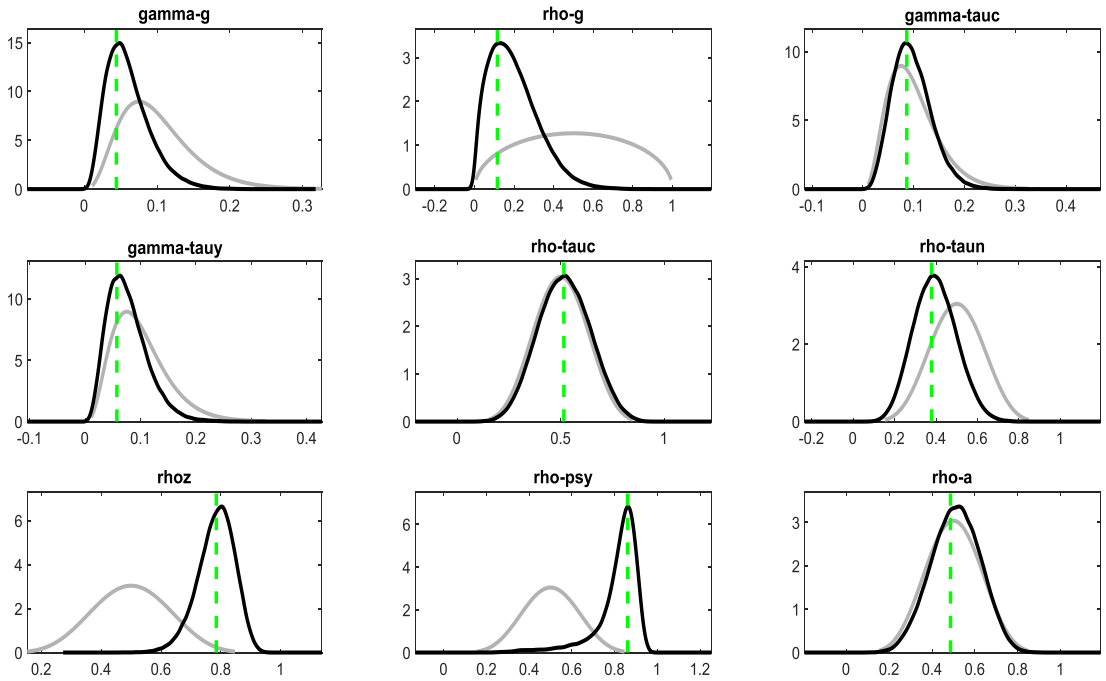
issues addressed in this study. For instance, as Ngalawa (2011) and Mangani (2012) show in their VAR models, exchange rate movements appear to be very important in influencing inflation dynamics in Malawi. Therefore the fact that our model does not allow us to explore the role that the exchange rate plays price stability is a notable limitation of the study that is worth further exploration.

A second limitation of the study has to do with the size of our sample data set used in the estimation of the model. Our sample size of 38 observations per variable is smaller than what would be ideal but this is necessitated by the availability of data. Nevertheless, this issue is partly addressed by the fact that the study employs the Bayesian estimation method which supplements potential deficiencies in the data with prior information about the parameters in the model.

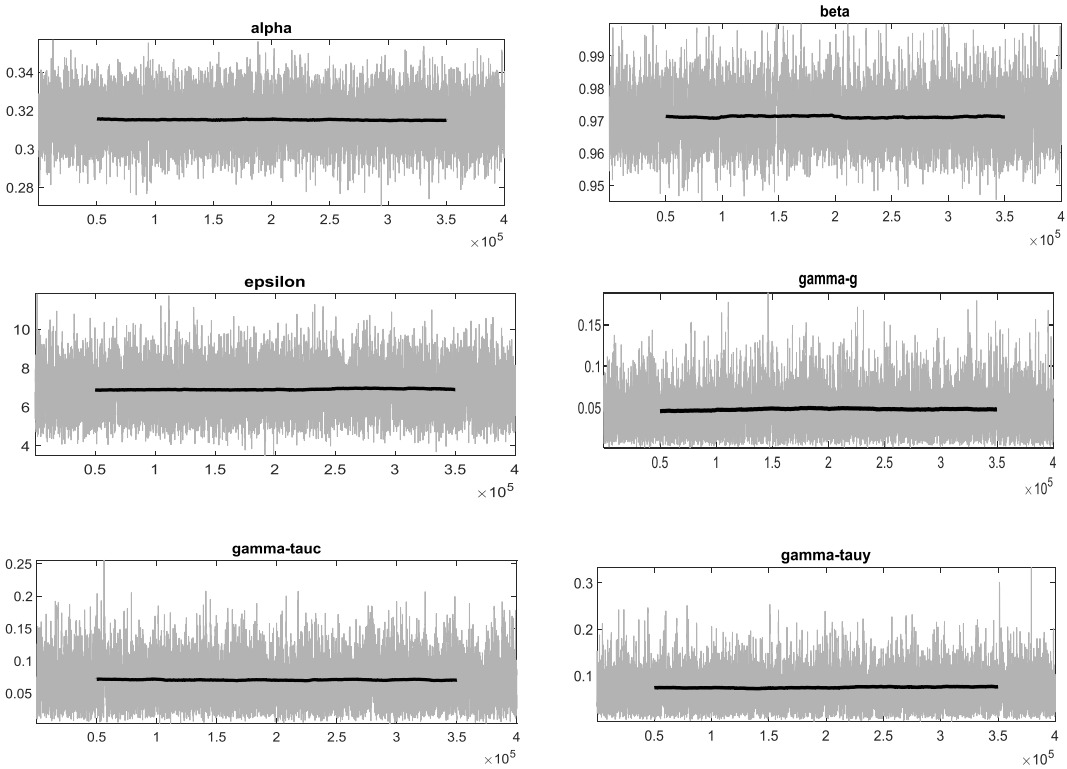
Appendices

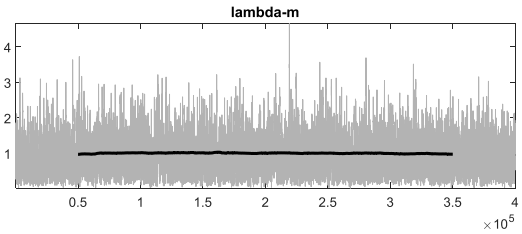
Appendix 3.1: Prior and posterior distributions





Appendix 3.2: Parameter trace plots

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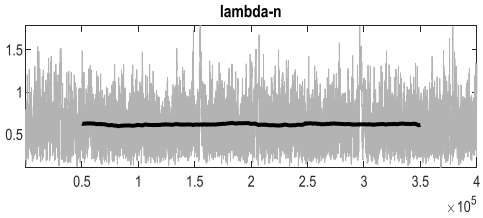
×10^5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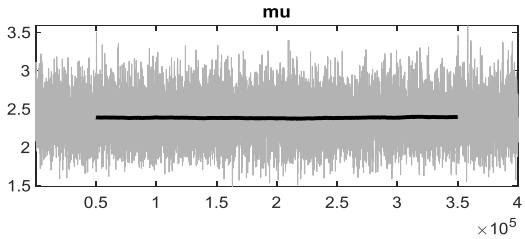
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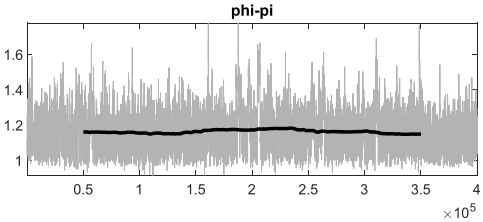
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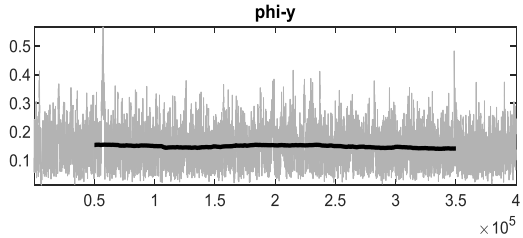
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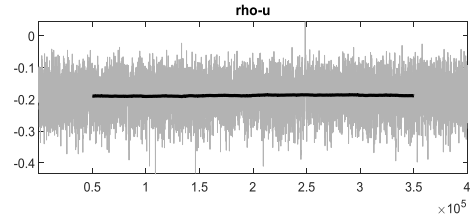
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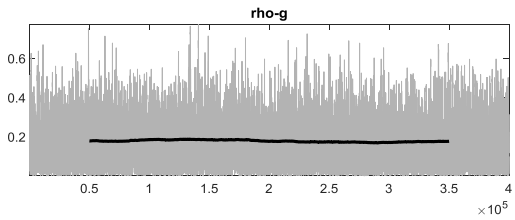
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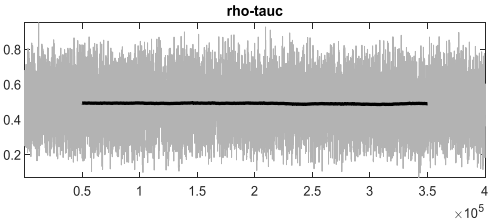
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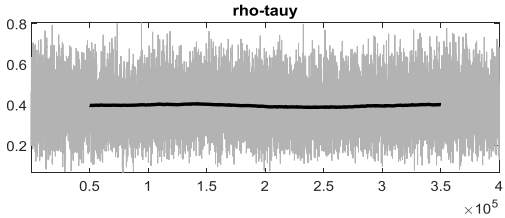
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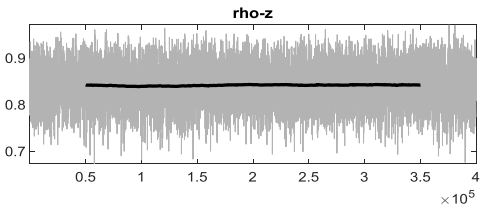
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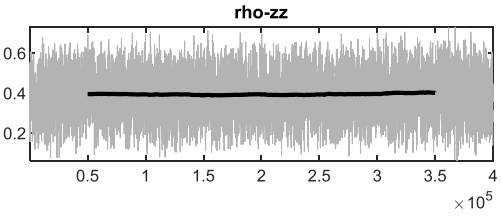
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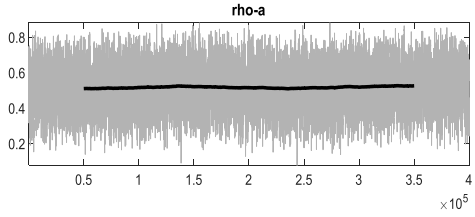
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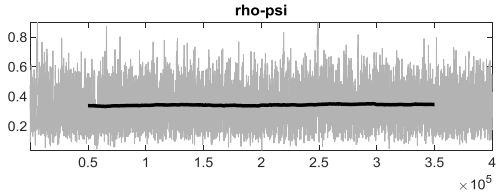
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CHAPTER IV

Fiscal and monetary policy interaction in Malawi

4.1. Introduction

In this chapter, we explore the interaction between fiscal and monetary policy in Malawi in order to establish how the two affect each other and whether the macroeconomic policy environment in the country is characterized by of fiscal dominance or monetary dominance. In particular, we examine how the Reserve Bank of Malawi's monetary policy variables (the bank rate and reserve money) respond to structural shocks to the government's fiscal policy variables (government spending and revenues) and vice versa. We conduct the analysis by employing a structural vector autoregression (SVAR) with sign restrictions, an approach that has not been explored so far in the analysis of macroeconomic data for Malawi.[28] As such, our primary contributions are twofold. Firstly, we provide evidence on the form of interaction between fiscal and monetary policies in Malawi, and secondly we use the sign restrictions approach to analyze macro policy in Malawi. The motivation behind the study is as follows.

It is generally accepted that central bank independence, and synergy of fiscal and monetary policies are crucial for effective macroeconomic policy. A central bank's ability to execute monetary policy without undue influence from fiscal authorities enables it to adhere its set monetary policy rules that dictate the monetary policy stance deemed appropriate for attaining desired macroeconomic objectives such as price stabilization and business cycle moderation. It is therefore not surprising that a lot of evidence points to a

[28] To the author's best of the knowledge, no study preceding this one has used SVAR with sign restrictions to analyze macroeconomic policy in Malawi.

positive relationship between macroeconomic performance of a country on one hand, and the level of independence of the central bank or it's adherence to monetary policy rules on the other.[29]

In the case of Malawi, how fiscal and monetary policies interact with one another is of particular interest given that the country's limited capacity for public revenue generation from its small tax base regularly results in substantial budget deficits as recurrent expenditures alone tend to exhaust virtually all domestically generated revenues.[30] This setting implies that if the Reserve Bank of Malawi (RBM) does not exercise full independence from the central government or if it does not strictly adhere to its own monetary policy rules, the risk of fiscal policy dominating monetary policy is high as long as the central bank takes into consideration the financing needs of the government when implementing monetary policy. However if monetary authorities remain committed to their policy objectives and are only minimally influenced by the government's fiscal needs, then fiscal policy would largely be influenced by monetary policy since the former would have to operate within the conditions set forth by the latter.

In general, policy environment that is reflective of fiscal or monetary dominance can take on many forms. With fiscal dominance for instance, monetary authorities may react to debt financed fiscal expansion by artificially holding interest rates low in order to create favorable borrowing conditions for the government. Another way would be for monetary authorities to ignore inflation targets so that accumulated public debt is inflated

[29] See Alesina, A. and L. Summers (1993), and Taylor J.B. (2013). Taylor shows that in the case of the US, adherence to monetary policy rules generated good monetary policy outcomes although formal central bank independence alone did not.

[30] See next section. Figures 1 and 2 provides a visual inspection of budgetary trends in Malawi.

away. But probably the most obvious and yet quite common form of fiscal dominance is seigniorage financing of government expenditures.[31] As for monetary dominance, one case arises when tight monetary policy raises concerns about fiscal solvency thereby prompting fiscal authorities to resort to fiscal tightening in order to satisfy the government's inter-temporal budget constraint. Heavily indebted economies with inflation targeting central banks or those pursuing exchange rate pegs for example are more susceptible to this kind of monetary dominance.[32]

At this point, it is important however to emphasize that in many countries fiscal and monetary policies do not operate in such parasitic relationships. Coordination between the two is a common feature in many economies and is encouraged by most economists. The response of United States of America to the 2008 global economic crisis serves as a good example of fiscal and monetary policy coordination. The US responded to the crisis by on one hand employing loose fiscal policy measures through the economic stimulus act of 2008 and the America Recovery and Reinvestment Act of 2009, both of which comprised of massive spending programs and tax rebates, while simultaneously employing an aggressively loose monetary policy through the quantitative easing programs. Some analysts have pointed to this coordination as the reason why the US presumably did not slide into an even greater recession and appeared to have recovered from the crisis faster and more robustly than other advanced economies such as in the euro area.

[31] Sabate et al (2005) examines this kind of fiscal dominance in the case of Spain.
[32] Tanner, E. & Ramos, E.M. (2003) investigate whether Brazil had undergone this kind of monetary dominance during some periods in the past.

The euro area on the other hand is often criticized for having a monetary union without a common fiscal policy, an arrangement that renders coordination between monetary policy pursued at the European Central Bank (ECB), and the multiple country specific fiscal policies practically impossible. Not surprisingly, many of the critics have attributed the apparent slower recovery of the euro area to the fiscal-monetary policy coordination challenges. Orphanides, A. (2017) for instance does a comparative analysis of the fiscal and monetary policies of the euro area and the US and their effects economic outcomes and he finds that both fiscal and monetary policy in the euro area had been overly tight as a result of the institutional framework of fiscal policy and the rigidities that still hamper the ECB's implementation of monetary policy.

Whatever position one takes regarding the appropriate framework of macroeconomic policy, it is clear that fiscal and monetary policy coordination is crucial to attaining macroeconomic policy objectives. At the very least, fiscal and monetary authorities should not be working to undermine each other by necessitating significant compromises from the other party with regards to pursuing that party's own policy objectives. It is therefore important for macro-policy makers to empirically establish how the two policies interact with each other so that appropriate steps can be undertaken to enhance effective macroeconomic policy implementation.

4.2. Literature review

4.2.1. Theoretical Literature

This section examines some of the main theoretical propositions that are relevant to the topic of fiscal and monetary policy interaction. First we do a quick review of the

Quantity Theory of Money (QTM) and the Fiscal Theory of Price Level (FTPL). Although the main focus of these theories is not on how fiscal and monetary policies interact, they do provide insights on their respective individual roles with regards to their impacts on macroeconomic policy objectives. Secondly, we examine the theory proposed by Sargent, T.J and Wallace, N. (1981) in which the interaction between fiscal policy and monetary policy is explicitly modeled in order to see how monetary policy is affected by fiscal policy.

4.2.1.1. Quantity Theory of Money vs the Fiscal Theory of Price Level

In macroeconomic literature, inflation dynamics have largely been considered a monetary phenomenon. Therefore the monetarist view of price level determination, in which the quantity theory of money is at the core, has maintained traction over a long period of time. In its most basic form, the QTM is represented by the Fisher's equation of exchange which is specified as follows.

$$M_t V = P_t Y_t$$

where M_t is the period t supply of nominal money balances in the economy, V is the velocity of money which is assumed to be constant, P_t is the period t price level, and Y_t is the period t real output. The Fisher equation says that the value of total transactions in the economy must equal to total expenditures. The basic QTM goes on to assume low volatility of real output such that Y_t is considered constant at least in the short run thereby making the price level directly proportional to money supply by the equation

$$P_t = M_t V / Y$$

This setting implies that inflation is entirely determined by the supply of nominal money balances and therefore prices will adjust immediately with changes in money supply.

Unsurprisingly, the simplistic nature of the QTM has earned it a lot of criticism particularly with regards to the assumption of a constant money velocity, and also with regards to the implication that money is neutral. Furthermore, it is generally accepted that variables such interest rates and fiscal variables have significant influence on the price level, but these are completely overlooked by the QTM.

In sharp contrast to the QTM, the Fiscal Theory of Price Level (FTPL) whose main proponents include Leeper, E. (1991), Woodford, M. (1994), and Sims, C. (1994) focuses on fiscal factors as the primary determinants of prices. In the FTPL framework, public debt and primary fiscal surpluses rather than money supply determine the price level in the long run. This theory can be summarized as follows.

Let B_t stand for nominal government debt, T_t for nominal tax revenue, G_t for nominal government expenditures, and β for the discount factor. In this theory, the price level is determined by the government's solvency equation,

$$\frac{B_t}{P_t} = \sum_{t=0}^{\infty} \beta^t \, (T_t - G_t)$$

which says that at any given time t, government debt in real terms must be equal to the present value of current and future primary surpluses. Under a Ricardian fiscal regime, when real debt B_t/P_t rises, governments must adjust primary surpluses $T_t - G_t$ in order to ensure long run fiscal solvency. However, FTPL recognizes that in reality governments are mostly non-Ricardian in which case it is the price level P_t that has to adjust to changes

in government debt or changes in primary fiscal surpluses. As such, in this framework prices are determined by fiscal policy.

Both FTPL and QTM represent rather extreme views given their respective treatment of fiscal or monetary policy as the sole determinants of inflation, without exploring how the two policies might affect each other. One can make the argument that at any given point in time, both fiscal and monetary policy have some explanatory power on price movements and as such both theories are valid to some degree. If that is the case, then clearly monetary policy and fiscal policy would affect each other if either one of them was concerned with price movements. In that case, any theory attempting to explain price movements must unify the two views and incorporate the interaction between the two policies. Sargent, T. and Wallace, N. (1981) set out to do just that.

4.2.1.2. The Sargent and Wallace Model

In their seminal paper "Some Unpleasant Monetarist Arithmetic", Thomas Sargent and Neil Wallace provided new insights on how long run inflation could be affected by the relationship between fiscal and monetary policy. In their model, seigniorage is factored into their government inter-temporal budget constraint specified as

$$D_t = \frac{(M_t - M_{t-1})}{P_t} + [B_t - B_{t-1}(1 + R_{t-1})]$$

which says that fiscal deficit D_t is financed by adjustments in the monetary base M_t, and the issuing of government bonds B_t that pay R_t in real interest rate.

In the model, fiscal solvency beyond some horizon T is only achieved when the path of M_t satisfies the condition that the stock of real government debt, $b_T \equiv B_t/P_t$ be

held constant at the level attained in period T. This is a restriction on fiscal policy which is consistent with there being a limit on the amount of real debt that the government can accumulate and sustain. This has interesting implications on inflation namely that, the inflation rate in periods beyond T depends on the level of period T real government debt b_T, and that b_T negatively depends on the growth rate of money, m. That is to say, tight monetary policy (low m) leads to high long run debt b_T, which in turn leads to higher long run inflation.[33] The model shows that in order to maintain b_T at a level consistent with solvency in the periods $t > T$, seigniorage will inevitably have to be used to finance fiscal deficits. In short, tight monetary policy cannot be sustained overtime due to accumulated government debt thus ensuring fiscal dominance in the economy.[34]

4.2.2. Empirical literature

Studies concerning the interaction of fiscal and monetary policy have been conducted by several authors. Some of the studies, mostly based on DSGE models, have focused on the optimal mix between the two policies, others, mostly employing VAR models, have looked at how the two policies shape each other. In this section, we review some of these studies with a focus on the latter category since the issues that they cover and the methodologies used are more aligned with our own study here.

Arora (2017) used a VAR with sign and magnitude restrictions to analyze how India's tax policy, government spending policy, and monetary policy affect each other and other macroeconomic variables. The study found evidence of fiscal dominance which

[33] See Sargent and Wallace (1981) page 4 for a detailed explanation.
[34] Another implication from the model is that the policy conflict between fiscal and monetary policy can be easily resolved by simply adjusting the power dynamics such that the monetary authorities make the first move by deciding θ and then fiscal authorities formulate fiscal policy within the parameter set forth by the monetary authorities.

manifested by an expansionary reaction of the two fiscal policies in response to a monetary policy tightening.

Sabate et.al (2005) focusses on identifying how fiscal policy affects monetary policy in the case of Spain. In this paper, they use a two variable VAR with only fiscal deficit and base money growth. They too find evidence of fiscal dominance that takes the form of seigniorage financing of fiscal deficits. They further conclude that it was this need for seigniorage financing of deficits that was responsible for Spain's renouncement of the gold standard.

Obenyeluaku and Viegi (2009) investigated fiscal and monetary dominance focusing on southern African countries. In this study, identification of the policy regime is achieved by examining the relationship between public liabilities and primary fiscal surplus. Specifically, they test how primary surpluses respond to temporary shocks in public liabilities in those countries. They concluded that Lesotho, Botswana, Malawi, Zambia and Zimbabwe have fiscal dominant regimes while South Africa, Swaziland, Mauritius, Seychelles and Tanzania have monetary dominant ones.

Similarly, Zoli (2005) also investigated fiscal and monetary dominance in several emerging economies by examining the relationship between current public liabilities and future primary fiscal surplus. The study also tested whether fiscal balances were integrated into the monetary policy functions of these countries. The study concluded that fiscal dominance existed in Argentina and Brazil in the 1990s and 2000s, while for Colombia, Mexico, Thailand and Poland the results were ambiguous.

The above cases all focus on a specific type of fiscal dominance, one in which monetary policy is constrained by concerns of fiscal solvency. However, a case has been

made for a different kind of fiscal dominance, one whereby high public debt makes tight monetary policy undesirable since raising interest rates increases the risk of sovereign debt default which in turn depreciates the exchange rate and causes inflation. Blanchard (2004) looked at this type of fiscal dominance in the case of Brazil and found that the level and the composition of public debt in Brazil as of the year 2002, and an increase in risk aversion in world financial markets, resulted in perverse effects of interest rate hikes on the exchange rate and inflation. Due to perceived increase in sovereign default risk, tight monetary policy led to capital flight and exchange rate depreciation which in turn resulted in higher inflation instead of lower inflation as intended. The aforementioned Zoli (2005) also looks at this kind of fiscal dominance for Brazil and found quite similar results to Blanchard's. Specifically, Zoli concluded that fiscal events had significantly influenced sovereign spreads and exchange rates in a way that pushed the economy into an equilibrium in which interest rate hikes were likely to be associated with a depreciation, rather than an appreciation of the exchange rate.

4.3. Methodology

Our analysis is based on a structural VAR model employing sign restrictions to identify fiscal and monetary policy shocks and analyze how they affect macroeconomic policy. The sign restrictions approach has recently gained popularity for among other reasons, the fact that it allows for more structure to be imposed into the VAR model so that crucial prior expectations are not violated.[35] The approach also allows one to identify only the subset of shocks that are of relevance to the subject matter at hand without having to focus on identifying the other shocks in the model.

[35] see Fry, R and Pagan. A (2011) for summary of papers that employ the sign restrictions methodology.

4.3.1. How SVAR with sign restrictions work

In this section we look at how the method of "SVAR with sign restrictions" works. We focus on how it achieves the identification of structural shocks from a given reduced form VAR model. For illustration, we use following n-variable reduced form VAR.

$$X_{\mathrm{t}} = \beta_0 C + \sum_{j=1}^{j=p} \beta_j X_{t-j} + e_t \ , \qquad t = 1, \dots, T. \tag{4.1}$$

where X_{t} is an $n \times 1$ vector of endogenous variables, C contains deterministic terms such as constants and trends, β_0 and β_j s are parameter matrices for C and X_{t-j} respectively, and e_t is the $n \times 1$ vector of zero mean normally distributed forecast errors which are likely correlated. Furthermore, denote Σ as the $n \times n$ variance-covariance matrix of the forecast errors such that:

$$\Sigma = E[e_t{}' e_t]$$

The goal in the SVAR framework is to discern the relationship between e_t and some vector of uncorrelated errors, $u_t \sim N(0, I)$. One way of achieving this is through the recursive SVAR approach where the variables in X_{t} are ordered based on their level endogeneity and then Σ and e_t are used to extract to $u_t$using the linear relationship:

$$e_t = \mathrm{A} u_t \tag{4.2}$$

where A is set to be the Cholesky factor of Σ. Thus in this framework, $u_t = A^{-1} e_t$ is the identified vector of structural shocks with zero mean and zero covariances.

However the u_t derived by the recursive approach is only one of the many candidate structural shocks of equation (4.1). But in order to restrict the behavior of

impulse responses, the sign restrictions approach seeks to generate many other candidate shocks, $\eta_{k,t}$, so that only those that conform to the imposed sign restrictions are retained or given higher weights during simulations. Using the "pure sign restrictions" approach of Uhlig (2005), this can be achieved by further transforming u_t using

$$\eta_{k,t} = Q_k u_t \tag{4.3}$$

where Q_k are set to be some n × n orthonormal matrices that are randomly generated from a uniform prior. In this case, given that

$$E\left[\eta_{k,t}\,\eta'_{k,t}\right] = E[Q_k u_t u'_t Q'_k] = Q_k E[u_t u'_t] Q'_k = Q_k Q'_k = I_n\,,$$

then it follows that all $\eta_{k,t}$ contain uncorrelated elements and therefore are candidate impulses for the VAR model in (4.1). Once these impulses have been derived, identification of shocks becomes a matter of satisfying the relevant sign restrictions.

With the sign restrictions approach however, one must keep in mind two important issues when making statistical inference. The first is that two different shocks may look similar with respect to the identifying variables on which sign restrictions are imposed. If that happens to be the case, then one runs the risk of misidentifying the shocks and therefore making wrong inferences about how variables relate to one another. Fry, R. et al (2011) calls this the *multiple shocks problem*. It is therefore imperative when implementing this approach to provide enough restrictions necessary for distinguishing one shock from another because failure to do so may result in misidentification.

The second issue is that of non-exact model identification which results from the use of multiple Q_k. This "multiple models problem" adds another source of uncertainty on top of that coming from the estimation of the VAR parameters, ($\beta_0\,, \beta_j\,, \Sigma$) thereby

making statistical inference more challenging. The pure-sign-restrictions approach addresses this issue by employing a Bayesian technique that assigns equal prior probabilities to all $\eta_{k,t}$ satisfying the sign restrictions and zero prior probabilities to those that do not. In this approach, Uhlig uses a Normal-Wishart prior and draws $\theta \equiv (\beta_0, \beta_j, \Sigma)$ from the resultant Normal-Wishart posterior distribution while selecting Q_k from a uniform distribution. This way, one can simply use the median and some quantiles of the generated impulse responses to summarize the models and make statistical inferences.[36] [37] We use this same approach in this study.

4.3.2. Identification of fiscal and monetary shocks

For our purposes, we identify and analyze 3 shocks namely: government spending shocks, government revenue shocks and monetary policy shocks. We do so by using the "pure sign restrictions" strategy explained above. The specification of the VAR system that we use, the data, and the sign restrictions imposed are outlined next.

4.3.2.1. VAR specification

The shocks under examination are identified using a Bayesian VAR model that corresponds to setting equation 4.1 such that X_t is an 8×1 vector of macroeconomic variables that include: government spending, government revenue, the bank rate, reserve money (monetary base), private credit, exchange rate, the Consumer Price Index (CPI), and industrial production index (IPI). All the variables in our VAR model, apart from the

[36] Fry R. et al (2011) make the point that, still more these percentiles should not be considered as providing point estimates and confidence intervals but rather just a glimpse of the possible range of impulse responses across possible models.

[37] Another approach is using median target which standardizes the impulse vectors and selects the model whose impulse responses are closest to the median response.

bank rate, are transformed into logs and the VAR model is fitted in levels (of the logs) as opposed to the stationary differences of the variables.[38] This follows arguments from Sims, C.A (1980) and Sims, C.A et al. (1990) where the idea of taking differences of the data it is argued against from the perspective that transforming data to its stationary differences entails loss of important information.

We include $p = 6$ lags in the system although the lag selection tools recommend fewer lags (1 lag in the case of the Bayesian Information Creterion (BIC)). The inclusion of up to 6 lags is based on the prior beliefs that policy makers base their decisions on data observed over a longer period of time rather than on the observations of the previous month alone. With regards to the choice of the deterministic components in the VAR, C is set to include a constant only. This choice is based on model stability tests and likelihood tests comparing 3 specifications of C. The results of these tests are summarized in Table 4.1 below. As the table shows, setting C to 0 results in a model that is not stable as the highest root of the characteristic equation lies outside the unit circle. On the other hand, setting C to contain a constant or a constant and a linear trend passes the model stability test. Therefore, our choice of C comes down to either a constant only or a constant and linear trend. For this decision, we look at the Bayesian Information Criterion (BIC) and there we choose the model with a constant only.

Table 4.1: VAR model specification criteria

Model	with no deterministic component	with intercept only	with intercept and trend
BIC	-4.187768	**-4.279801**	-4.245500
Log likelihood	1537.390	1569.980	1587.788
Highest root	1.001438	0.997980	0.972835

[38] All eight variables are tested for stationarity using the augmented Dicky-Fuller test and the results show that all the variables are integrated of order one, *I(1)*.

For the estimation of the parameters in our VAR, a diffuse normal-Wishart prior is used in which we set the first hyper-parameter μ_1 equal to 1 to reflect the persistence in our data, and set the second hyper-parameter λ_1 to infinity to maintain as much objectivity as possible.[39] The structural shocks which we use in our sign restrictions algorithm described in section 4.3.1, are computed from the posterior residual covariance matrices which are derived analytically (thanks to our use of a conjugate prior) as opposed to by simulations with MCMC algorithms. We use EViews 9 software for the computations.

4.3.2.2. Data

The data used in this study is of monthly frequency from 1995/04 to 2015/03, a total of 240 observations. This data is sourced from the Reserve Bank of Malawi (RBM), the Ministry of Finance (MoF) in Malawi, and International Financial Statistics (IFS) of the IMF. A total of 8 variables are used in the analysis and these variables are sourced as follows.

The two fiscal variables, government spending and revenue, are both sourced from MoF and are respectively defined as total government expenditures and total domestic revenue collected by the government.[40] For the monetary policy variables, the RBM bank rate and reserve money are used as measures the central bank's policy rate and money supply respectively.[41] Both these variables are sourced from the RBM statistical database. For private credit we use the RBM's data on credit extended by financial institutions to the private sector. The US dollar (USD) to Malawi kwacha (MWK) exchange rate is used

[39] Here, μ_1 is the hyper-parameter for the persistence of the variables' own first lags, and λ_1 is the hyper-parameter that controls the overall tightness of the prior distribution. The other hyper-parameters λ_3 and λ_4 are both set to zero.
[40] Cubic spline interpolation is used to estimate 1 missing value (1996:03) of government revenue data.
[41] The RBM's bank rate is interest rate that the RBM charges commercial banks for short term loans. Its movements work as a signal to the banks regarding changes in monetary policy stance.

for the exchange rate variable and it is also sourced from the RBM. For the CPI and IPI, both taken from the IFS.[42]

4.3.2.3. Identifying restrictions

The sign restrictions that are used in the identification of the shocks are summarized in Table 4.2 below. For each shock, the restrictions are imposed over a $K = 6$ month period starting from the impact month (month $k = 1$) through month number 6. We use $K = 6$ in order to rule out minor temporary movements in the variables that could be mistaken for the actual policy shocks. Stricter restrictions of 12 months are also employed in order to check if the results are sensitive to *K.*

Table 4.2: Sign restrictions for identifying fiscal and monetary shocks

	gov. spend.	gov. rev.	bank rate	reserve money	pvt. credit	exch. rate	CPI	IPI
Fiscal policy shocks								
spending shock	+	?	?	?	?	?	+	?
revenue shock	?	-	?	?	?	?	?	?
monetary policy shocks								
interest rate	?	?	+	?	-	?	-	?
money supply	?	?	?	-	-	?	-	?

Note: "+" / "-" means the variable reacts positively/negatively, for k = 1,…,6. "?" means the variable is unrestricted.

Fiscal policy shocks

The sign restrictions imposed on government spending shocks and government revenue shocks as presented in Table 4.2 correspond to the following assumptions:

[42] Cubic spline interpolation is used to estimate 8 missing values in industrial production index data (2004:09 to 2004:12 and 2011:01 to 2011:04).

Assumption 1: an expansionary government spending shock is one in which reactions of government spending and prices are not negative at horizons $k = 1, \ldots, 6$.

Assumption 2: an expansionary government revenue shock is one in which the reaction of domestic revenue is not positive at the horizons $k = 1, \ldots, 6$.

Assumption 1 is straight forward with respect to the government spending variable given that we are considering an expansionary shock. As for the restrictions on prices, we use the aggregate demand-aggregate supply (AG-AS) macroeconomic model as justification. This model has a generally supported the prediction that an increase in government spending *ceteris paribus*, implies higher aggregate demand and thus a positive adjustment of prices. *Assumption 2* it is also straight forward as it simply says that an expansionary revenue shock is characterized by reduction in government revenues.

For both types of fiscal shocks, the analysis is agnostic with respect to the reaction of the bank rate and reserve money, the two monetary policy variables whose reactions are of primary focus in this study. In fact, no hypothesis on the reaction of these variables is proposed since their respective reactions largely depend on institutional factors rather than economic theory. In other words, how they react is entirely an empirical issue.

Lastly, when we identify government spending shocks, we leave government revenues unrestricted and similarly when we identify revenue shocks, government spending is left unrestricted. This is done in order to observe the "pure" reactions of the two fiscal variables in response to a shock to the other. How these two react to each other provides some additional information on whether we have fiscal or monetary dominance.

Monetary policy shocks

With regards to the monetary policy shocks, we focus on both interest rate shocks, and a money supply shocks and examine how each of these two affect fiscal policy and vice versa. For this reason, we proceed by providing two different definitions of monetary policy, one corresponding to a targeting of interest rates and the other corresponding to a targeting of money supply. The sign restrictions that we impose for the two types of monetary policy shocks are summarized in Table 4.2 and these correspond to the following assumptions.

Assumption 3: a contractionary policy rate shock is one in which the reaction of the bank rate is not negative, and that of private credit and prices is not positive for periods $k = 1, \dots, 6$.

Assumption 4: a contractionary money supply shock is one in which reactions of reserve money, private credit, and prices are not positive for periods $k = 1, \dots, 6$.

Assumption 3 is guided by a very strong consensus among economists on the expected behavior of a policy rate shock. The restriction on private credit stems from the credit demand function whereby less credit is expected to be demanded if its price (interest rate) goes up. As such it is reasonable to expect that at the very least, borrowers will not borrow more as a result of interest rates going up. One could also look at this argument from the supply side and note that lenders would have incentive to supply more credit if the return from it (interest rate) goes up. In this case one could identify the shock using supply side variables such as non-borrowed reserves as done by Uhlig (2005). With regards to the restriction on prices, the goal is to address the "price puzzle" that is often observed in monetary VAR models including those using Malawi data such as Ngalawa

(2011). Under the Keynesian interest rate channel, we expect that monetary tightening through an interest rate hike will not lead to an increase in prices given that liquidity is negatively affected. As Uhlig (2005) states, the expected relationship between interest rates and prices is one of the least debatable issues in economics.

For *Assumption 4*, the negative restriction on prices with respect to money supply shocks is a prediction of the quantity theory of money which says that money supply shrinkage (growth) is disinflationary (inflationary). The restriction on private credit is a recognition that when altering money supply, central Banks target the liquidity of commercial banks in order to influence their lending behavior and facilitate or slow down the money creation process. As such a contractionary money supply is expected to lower the level of private credit extended by commercial banks due to the decreased liquidity of commercial banks. Lastly, in order to see the pure reaction of the fiscal variables to the monetary shocks, we leave government spending and revenues unrestricted.

4.3.3. Criteria for identifying fiscal or monetary dominance

As discussed in section 4.1, there are many ways in which fiscal and monetary policies affect each other. As such, different definitions of fiscal and monetary dominance tend to be used depending on the type of interaction that one is looking at. Therefore, having identified the shocks, our next step is to specify the criteria that we use to classify policy regimes. In other words, we need a precise decision rule on what behavior of policy variables given the identified shocks constitutes fiscal dominance and what constitutes monetary dominance. This criteria is presented in Figures 6 and 7 below.

Two conditions are used as decision rules for identifying a policy regime. The first is a necessary condition for ruling in or ruling out a particular regime. Under this

condition, the dominance of a policy is *ruled out* if a shock to that policy *does* induce a counteractive reaction from other policy. Otherwise, it is ruled in. Thus in our analysis, if loose fiscal policy induces contractionary monetary policy, then fiscal dominance is ruled out since monetary policy is active.[43] Similarly if contractionary monetary policy induces loose fiscal policy, then we can rule out monetary dominance since fiscal policy is active.

Figure 4.1: Regime identification given fiscal shocks

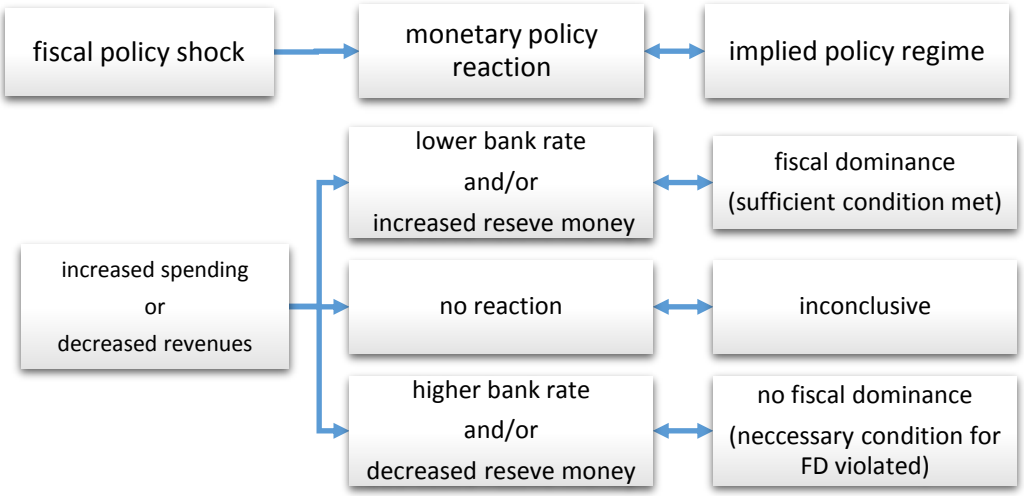
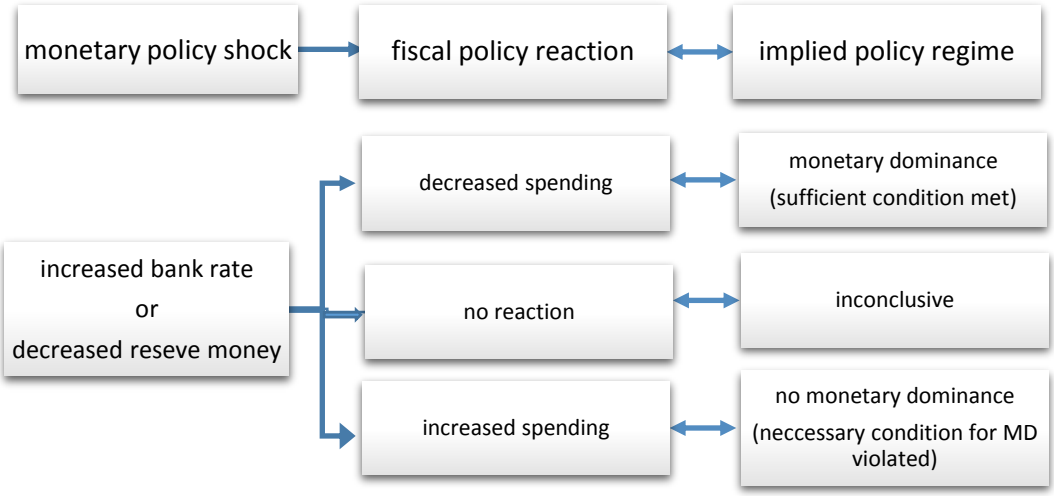


Figure 4.2: Regime identification given monetary shocks



[43] we use Eric Leeper's definitions of active and passive policies. "An active authority pays no attention to the state of government debt and is free to set its policy as it sees fit. A passive authority on the other hand responds to debt shocks and is therefor constrained by the active authority's actions.

The second condition that we use is a sufficient condition for deciding in favor of a particular regime over the other. Under this condition, the dominance of a policy is accepted if shocks to that policy are accommodated by cooperative adjustments in the dominated policy. For instance, it is sufficient to rule in favor fiscal dominance if expansionary fiscal shocks trigger monetary easing. Similarly, we can rule in favor of monetary dominance if a contractionary monetary policy shock triggers fiscal contraction. However, we take caution with regards to how we interpret the reactions of government revenue in response to monetary policy. This is because when a monetary contraction is followed by a decline revenue, it may imply two things. Either government has adopted loose fiscal policy, or tax remittances have simply decreased. The latter does not necessarily signal a loosening of fiscal policy, but rather it may also reflect the tight economic conditions created by the monetary contraction. In this analysis therefore, the reaction of revenues to a monetary shock does not help us distinguish one regime from the other, and for this reason we focus on the reaction of government spending.

4.4. Findings

Our inferences are based on the analysis of impulse responses and forecast error variance decompositions (FEVDs) of the policy variables. The impulse responses help us decide on the type of policy regime that we have since they show us how policies react to one another. The FEVDs on the other hand help us discern how much influence the policies have on each other. Our principle conclusion is that macroeconomic policy making in Malawi is characterized by monetary dominance and not fiscal dominance. This section provides the analysis leading to this conclusion.

4.4.1. Impact of fiscal policy on monetary policy

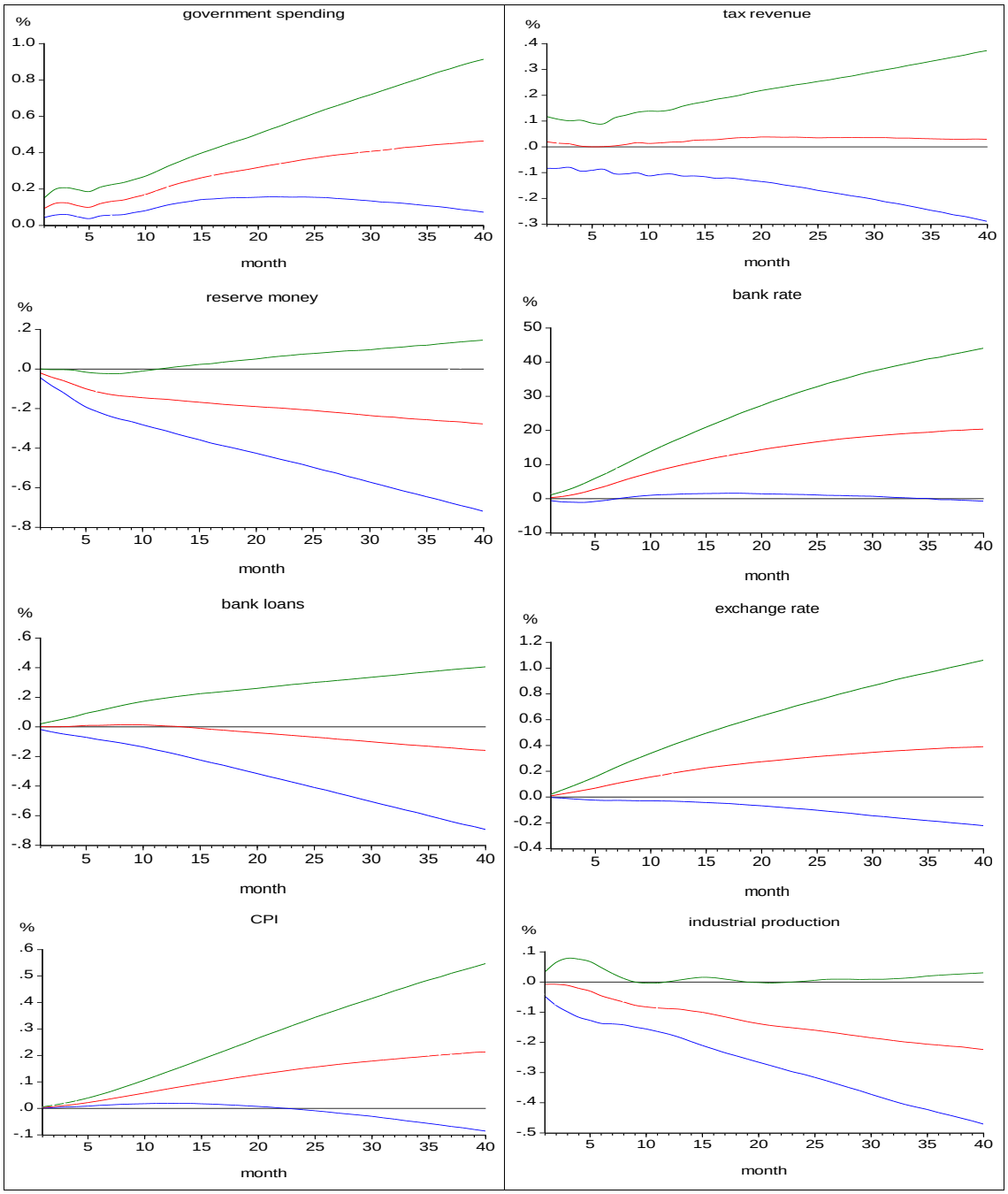
4.4.1.1. Government spending shocks

The impulse responses to a government spending shock are presented in Figure 8. But before analyzing the reaction of the monetary policy, we to examine the general behavior of the identified shocks and see if they resemble theoretical ones. Here we see that although the responses of government spending and prices are restricted to respond positively for the first 6 months after the shock, the former remain positive for the entire 40 months that we observe, increasing by up to 0.4 percent while the latter remains positive for at least 23 months, increasing by up to 0.1 percent. This implies that government spending shocks in our model are quite persistent. Other notable features of the shock are that the domestic currency appears to depreciate by about 0.3 percent although this result is only significant when we set K=12 (see appendix 1). The depreciation of the currency signals that when it comes to the Malawi Kwacha exchange rate movements, the price channel is more important than the interest rate channel. In other words, the rise in prices that comes with increased government spending dominate the exchange rate dynamics by causing a depreciation of the currency that offsets any appreciation pressures coming from any ensuing rise in the interest rate.

The spending shock also leads to a decline in industrial output of at least 0.15 percent which suggests that the expansionary spending policy crowds out investment in the industrial sector. This result supports our own Bayesian DSGE based findings (see chapter 3) where a crowding out effect of government spending on private investment is established. Furthermore, Uhlig (2009) also found similar result using US data where he showed that government spending shocks reduce investment although surprisingly not

via interest rates. In our case however, we do observe a rise in the policy rate which provides more support to the "crowding out effect" proposition.

Figure 4.3: Impulse responses to a government spending shock.



Note: *The middle line is the median and the bottom and top lines are the 16th and 84th percentiles respectively. The shock is one standard deviation in size.*

With the above observations put together, one can see that the identified shock does indeed resemble a theoretical government spending shock as all variables in the model react to the shock in ways that are expected.

Moving to our main question of how monetary policy reacts to spending shocks, we look at the impulse responses of the bank rate and reserve money. Here we find that following the shock, both these variables react in a manner that is indicative of a monetary policy tightening. Specifically, the bank rate steadily rises by up to 20 basis points by the 40^{th} month after the shock, while reserve money declines by about 0.15 percent within 11 months after the shock. This kind of reaction suggests that monetary authorities do not work to accommodate government spending whether through reducing interest rates or through providing seigniorage funds as would be the case in a fiscal dominance regime. On the contrary, they counteract expansionary spending policy in an attempt to subdue inflation pressures resulting from the shock[44] and also perhaps to reflect the upward pressure on interest rates that follows from increased government borrowing. In short, this result shows that while monetary policy is indeed influenced by fiscal policy, it is not in a manner that is inconsistent with its own policy objectives.

With these observations, one important question that arises concerns how these expenditure shocks are financed given that monetary policy is non-accommodative. Fiscal prudence requires that the increased public spending be accompanied by increased public revenues through higher taxes. However looking at the response of government revenues in our model, we find no significant reaction to the spending shock. This indicates that fiscal policy expansion in Malawi is mainly financed through debt rather

[44] see chapter 3 on how monetary policy in Malawi reacts to inflation.

than increased revenues or seigniorage, a conclusion that is consistent with the observed upward trend in public debt observed in section 2.3.2.

How much of the changes in monetary policy is attributable to spending shocks?

In addition to observing the dynamic responses of variables, it is also informative to isolate how much of the variation in the policy variables we can attribute to a particular shock. This is done using the FEVD analysis which we summarize in Table 4.3 and graph in more detail in appendix 2. The table shows 40 month average and peak contribution of the government spending shocks to the variances of the variables in our model.

Table 4.3: Contribution of government spending shocks to variations in variables

Variable	***Percentage of variation attributed to government spending shocks***		
	mean contribution	*peak contribution*	*peak horizon*
government spending	15.29	19.07	22
government revenue	5.57	6.42	1
reserve money	7.80	9.57	9
bank rate	12.08	13.42	21
private loans	5.53	5.93	1
exchange rate	7.58	8.09	2
CPI	7.70	9.04	9
industrial production	10.73	12.30	24

Here, it is estimated that in the 40 month period after a government spending shocks, its mean monthly contribution to the variation in the monetary policy variables is about 12 percent for the bank rate and 7.8 percent for reserve money. The contribution to the variance of the bank rate peaks at 13.4 percent at 21 months after the shock while for reserve money it peaks at 9.57 percent at 9 months after the shock. This means that at least up to 13 percent of adjustments in monetary policy is attributable to government spending shocks.

For government revenues, mean contribution of the shock is less than 6 percent and only peaks at 6.4 percent, a result that is consistent with the earlier observation that fiscal authorities do not significantly resort to raising revenues in order to finance spending increases. Lastly, unsurprisingly more than 19 percent of the variation in government spending is as a result of own shocks.

4.4.1.2. Government revenue shocks

Dynamic responses to government revenue shocks

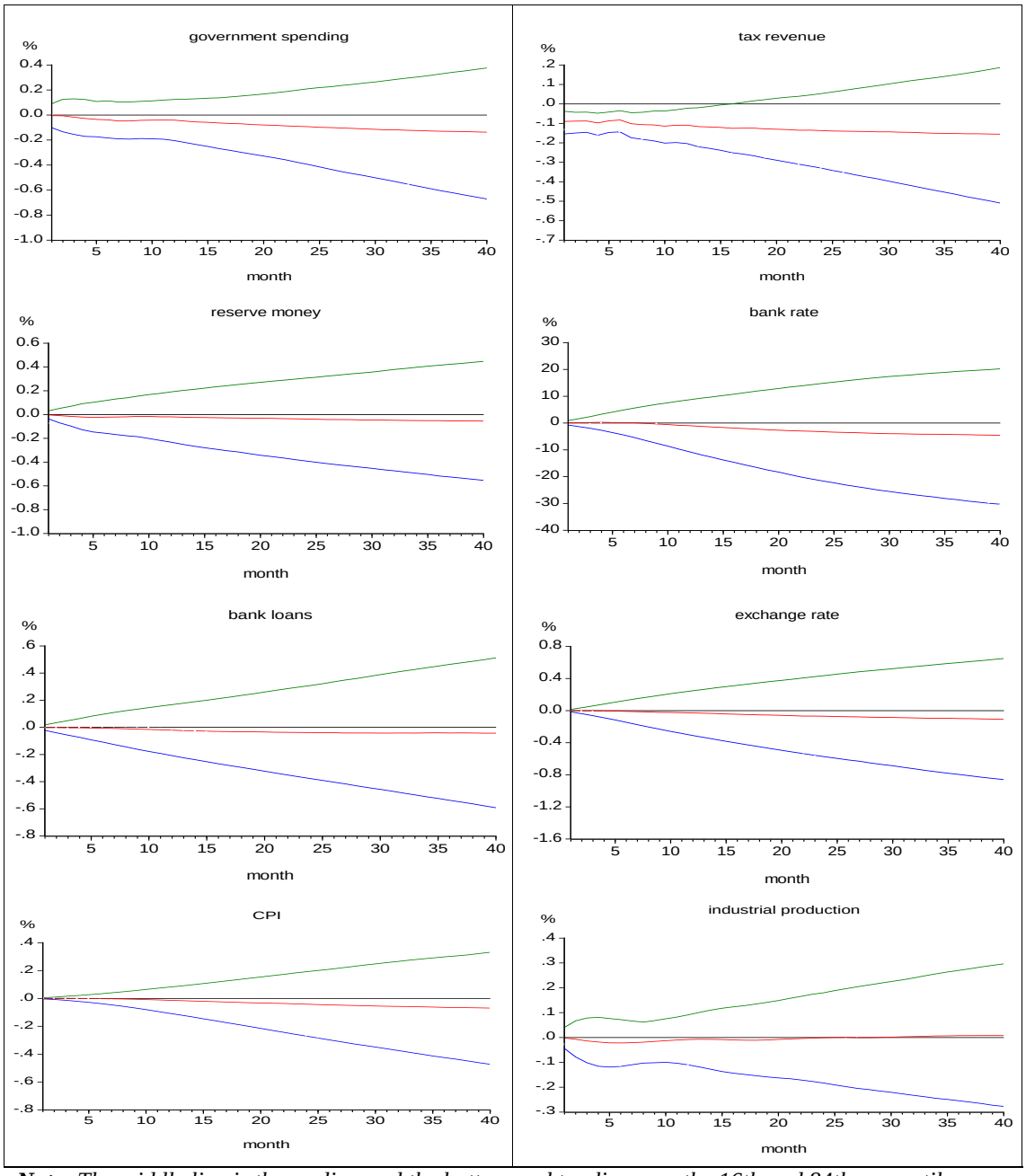
The impulse responses to shock revenue cuts are shown in Figure 4.4 below. In a nutshell, these responses provide no evidence of any significant policy reaction to revenue shocks, be it from monetary policy or from the spending side of fiscal policy. Monetary authorities, who seem to take strong action in response to spending policy appear to be inactive when it comes to revenue policy. One explanation is that monetary authorities find revenue policy to be inconsequential to their operational objectives. Indeed looking at the impulse responses of their target variables such as prices and the exchange rate, we see that both these variables and even industrial output exhibit no significant reaction of any kind. As such, a non-response from the monetary authorities does make sense given that the goals of monetary policy are not affected by the revenue shock.

How much of the changes in monetary policy is attributable to revenue shocks?

The contribution of revenue shocks to the variances of the variables in our model is presented Table 4.4 below. Consistent with the impulse responses to this shock, the forecast error variance decompositions also indicate that revenue shocks do not contain much information regarding the variations in both monetary policy and spending policy. For both reserve money and the bank rate, about only 6.5 percent of their respective

variances are attributable to revenue shocks. Furthermore, the influence of this shock these variables peaks at only 6.75 percent for reserve money, and at 6.67 for the bank rate.

Figure 4.4: Impulse responses to a negative government revenue shock.



Note: *The middle line is the median and the bottom and top lines are the 16th and 84th percentiles respectively. The shock is one standard deviation in size.*

With regards to government spending, only up to 7 percent of its variation is a result of revenue shocks, which again shows that spending decisions are not as closely tied to revenues as they would be in a more fiscally prudent environment.

Table 4.4: Contribution of government revenue shocks to variations in variables

Variable	***Percentage of variation attributed to government revenue shocks***		
	mean contribution	*peak contribution*	*peak horizon*
government spending	6.7	7.2	7
government revenue	9.7	11.6	8
reserve money	6.5	6.8	13
bank rate	6.5	6.7	40
private loans	5.9	6.5	2
exchange rate	6.9	6.98	4
cpi	6.5	6.6	33
industrial production	7.3	8.1	12

Of the four policy variables, unsurprisingly government revenue is the one with the most variance attributed to own shocks, peaking at 11.6 percent after 8 months. The variances of all the other variables in the model are only modestly affected. Specifically, the shock contributes to less than 7 percent of the respective variances of private credit, exchange rate, and CPI and contributes only up to 8 percent for industrial output.

4.5.2. Impact of monetary policy on fiscal policy

4.5.2.1. Policy rate shocks

Dynamic responses to monetary policy

The impulse responses to a monetary policy shock as defined in assumption 3 are plotted in Figure 4.5. From this figure, one can see some of the features that we expect from a monetary policy shock. One such feature is that while the bank rate rises, money

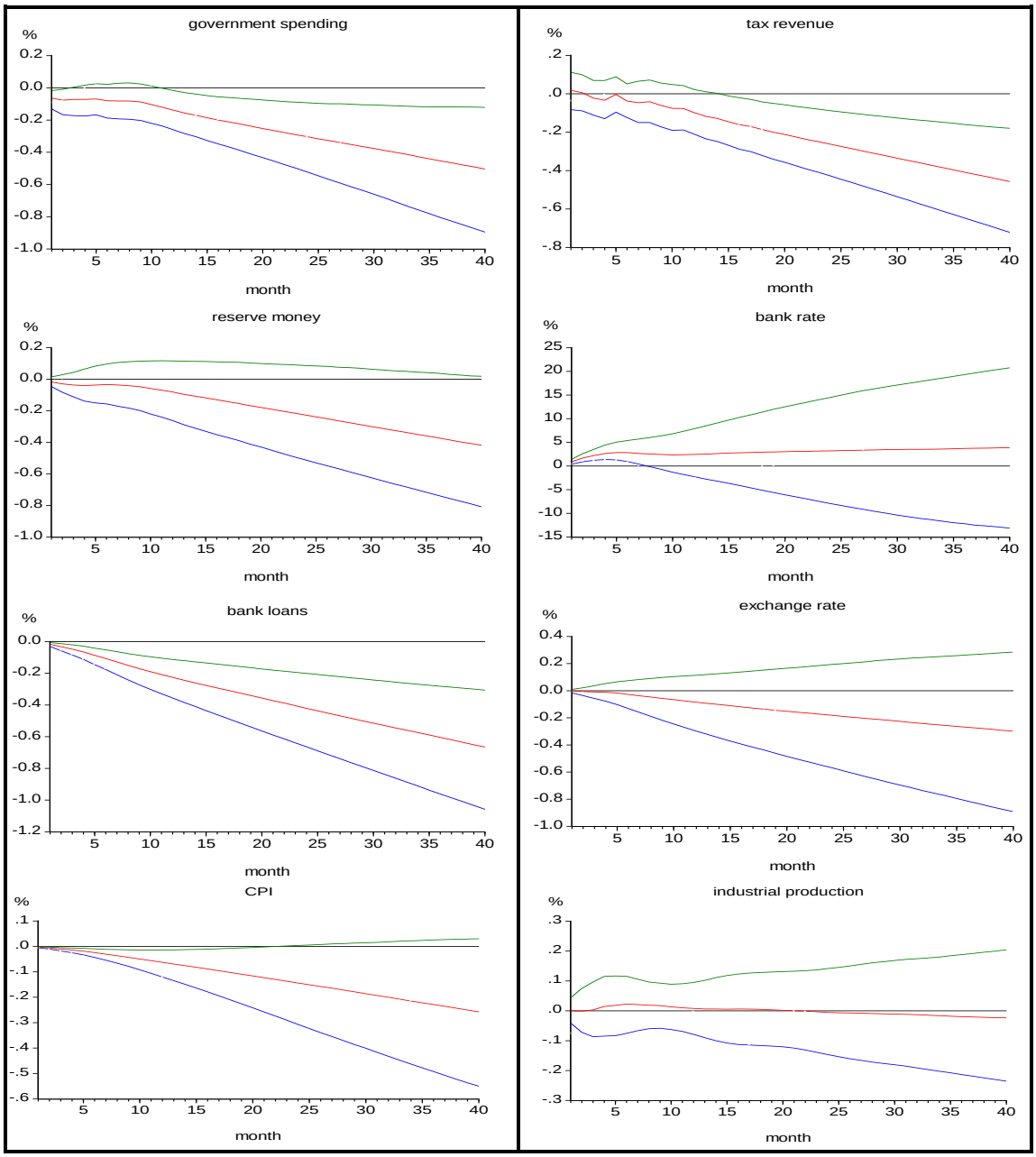
supply (as measured by reserve money) declines. Specifically our model shows that in a typical monetary policy shock, the bank rate rises on impact and remains raised for at least 7 months with the size of the increase estimated at around 30 basis points. The monetary base on the other hand gradually declines by up to 0.4 percent by the fortieth month following the shock. Other features of the shock include a decrease in prices of up to 0.1 percent and a persistent decrease in private credit of up to 0.6 percent. Interestingly, although private credit drops significantly following the shock, the impact on industrial output is not pronounced. As for the impact on the exchange rate, it is also inconclusive although the point estimate indicates a downward movement (appreciation) which is what would be expected from an interest rate increase.

Turning to our main question, namely how monetary policy effects fiscal policy, we see that both government spending and revenues react negatively to a monetary tightening. Specifically, government spending declines on impact and continues to do so and reaching a total decrease of about 0.5 percent. Revenues on the other hand decrease by about 0.4 percent. The decline in spending may indicate two things. One is cooperation by fiscal authorities to monetary policy, and the other is reduction in debt financed spending as a result of the tight monetary conditions. Either way, this reaction displays fiscal conformity to the tight monetary policy stance, a scenario which is consistent with a monetary dominant regime (refer to our criteria in section 4.3). As for the decline in revenues, not much can be inferred from this as already explained in section 4.3.

Put together, these results support those from the analysis of government spending shocks in the sense that with both shocks, it is fiscal policy that reacts within the conditions set forth by monetary policy while monetary policy appears to act in strict

adherence to monetary policy objectives. Therefore, the presence of fiscal dominance is once again rejected while the case for monetary dominance is strengthened.

Figure 4.5: Impulse responses to a contractionary monetary policy shock as defined in assumption 3.



Note: *The middle line is the median and the bottom and top lines are the 16th and 84th percentiles respectively.*

How much of the variation in fiscal policy is attributable to monetary policy shocks?

In Table 4.5, the percentages of forecast error variance that is attributed to monetary policy shocks are presented for all the variables in the model. Here we see that monetary policy accounts for a significant portion of variation in fiscal policy. Up to a fifth of the variance in government revenue can be attributed to this shock while for the variance in government spending, monetary policy accounts for up to 13 percent. This shows that fiscal policy is indeed significantly informed by changes in monetary policy.

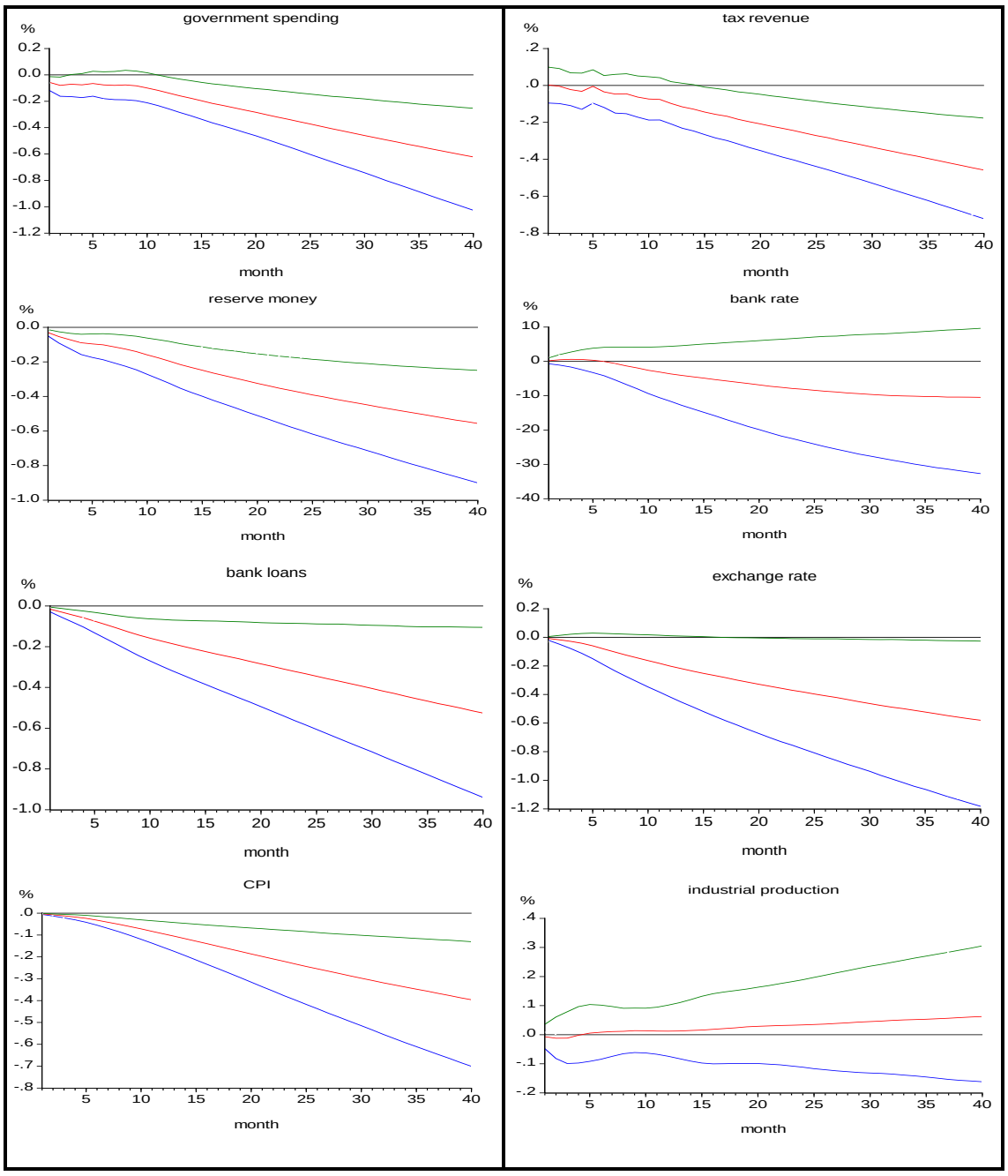
Table 4.5: Contribution of monetary policy shocks to variations in variables

Variable	***Percentage of variation attributed to a Monetary policy shock***		
	mean contribution	*peak contribution*	*peak horizon*
government spending	9.5	13.2	40
government revenue	12.7	20.9	40
reserve money	7.6	9.99	40
bank rate	4.1	14.9	2
private loans	17.5	20.9	40
exchange rate	4.3	4.7	1
CPI	6.7	7.1	3
industrial production	5.7	6.9	9

4.5.2.2. Money supply shocks

Using the second definition for a monetary policy shocks does not change the results and our conclusions made above regarding the impact of monetary policy on fiscal policy. This can be seen in the impulse responses plotted in Figure 4.6 below where declines in government spending and revenues are still observed and hence confirming the existence of monetary dominance. Additionally, in this case the appreciation of the exchange rate due to monetary policy tightening is found to be statistically significant thus confirming that tight monetary policy appreciates the domestic currency.

Figure 4.6: Impulse responses to contractionary monetary policy shocks as defined in assumption 4.



Note: *The middle line is the median and the bottom and top lines are the 16th and 84th percentiles.*

4.6. Conclusions

In this paper we have investigated the ways in which fiscal policy and monetary policy interact with each other in Malawi in order to establish whether macroeconomic

policy making environment can be characterized as that of fiscal dominance or monetary dominance. A structural VAR with sign restrictions was employed in order to identify government spending shocks, revenue shocks, and monetary policy shocks so as to observe their dynamic effects on the fiscal and monetary policy variables.

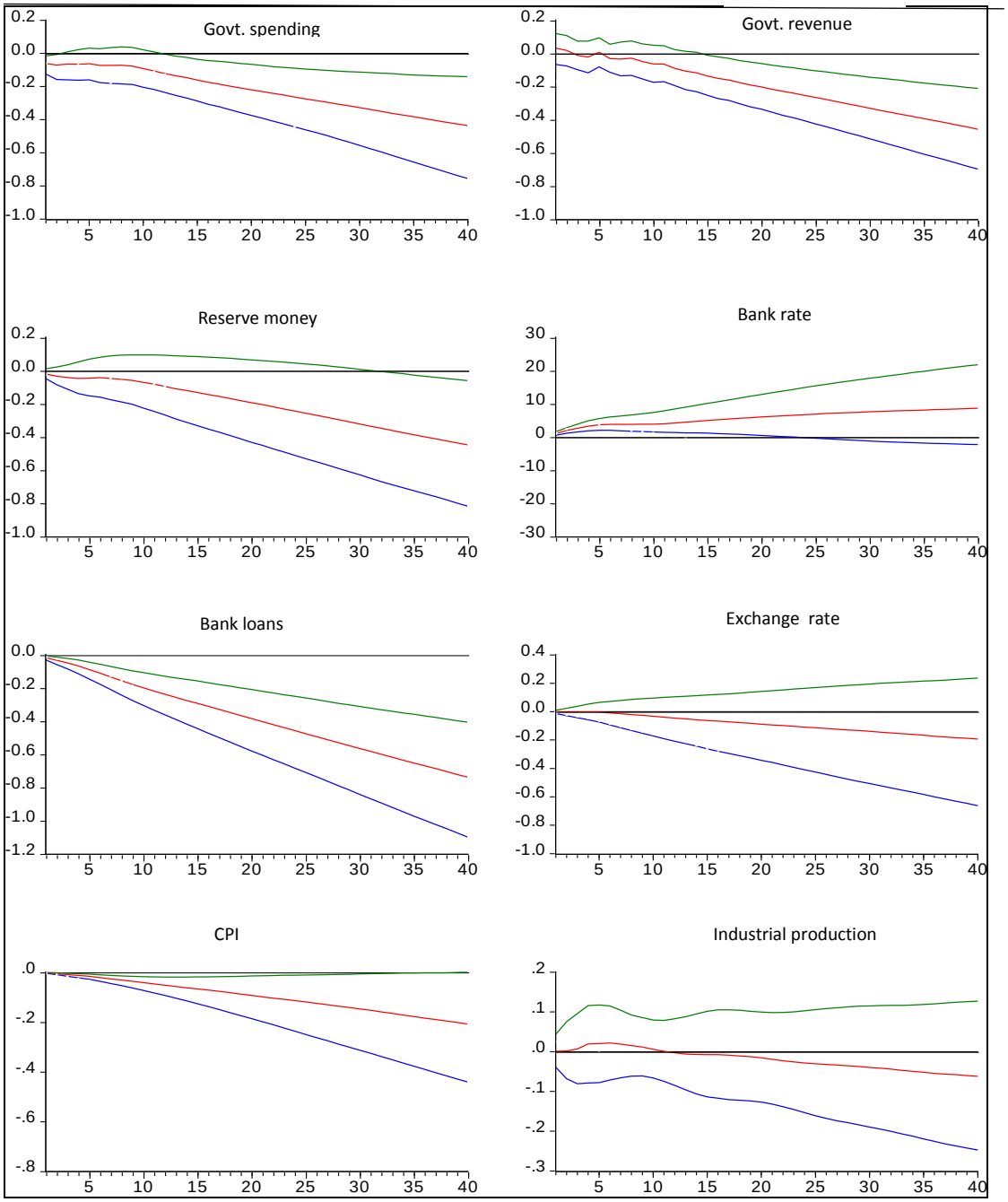
Our principle conclusion is that policy making in Malawi is characterized by monetary dominance, not fiscal dominance. In this regard, we have established that while the two policies affect each other, the manner in which they do differs. Monetary policy responds to fiscal policy in a manner that is indicative of strict adherence to its own policy goals or rules. Specifically, loose fiscal policy via government expenditure is countered by tight monetary policy through higher interest rates and lower money supply. Fiscal policy on the other hand reacts to monetary policy in a manner that shows adherence with the monetary stance. It does so by responding to contractionary monetary policy with expenditure cuts. The analysis also shows that government revenues do not respond to spending shocks which, coupled with the absence of seigniorage and the observed rise in interest rates, indicates that fiscal shocks are generally financed by public debt.

These findings paint the macroeconomic policy making process in Malawi as quite encouraging especially on the part of monetary policy. The central bank's tendency to counter increased spending with tight monetary policy indicates that it exercises a degree of independence from fiscal authorities by exercising restraint to accommodate loose fiscal policy at the expense of monetary policy objectives. This independence is an important attribute in the conduct of monetary policy. On the fiscal side however, the non-response of government revenues to spending shocks is a cause for concern as it entails an unsustainable path of public debt that may eventually result in fiscal dominance.

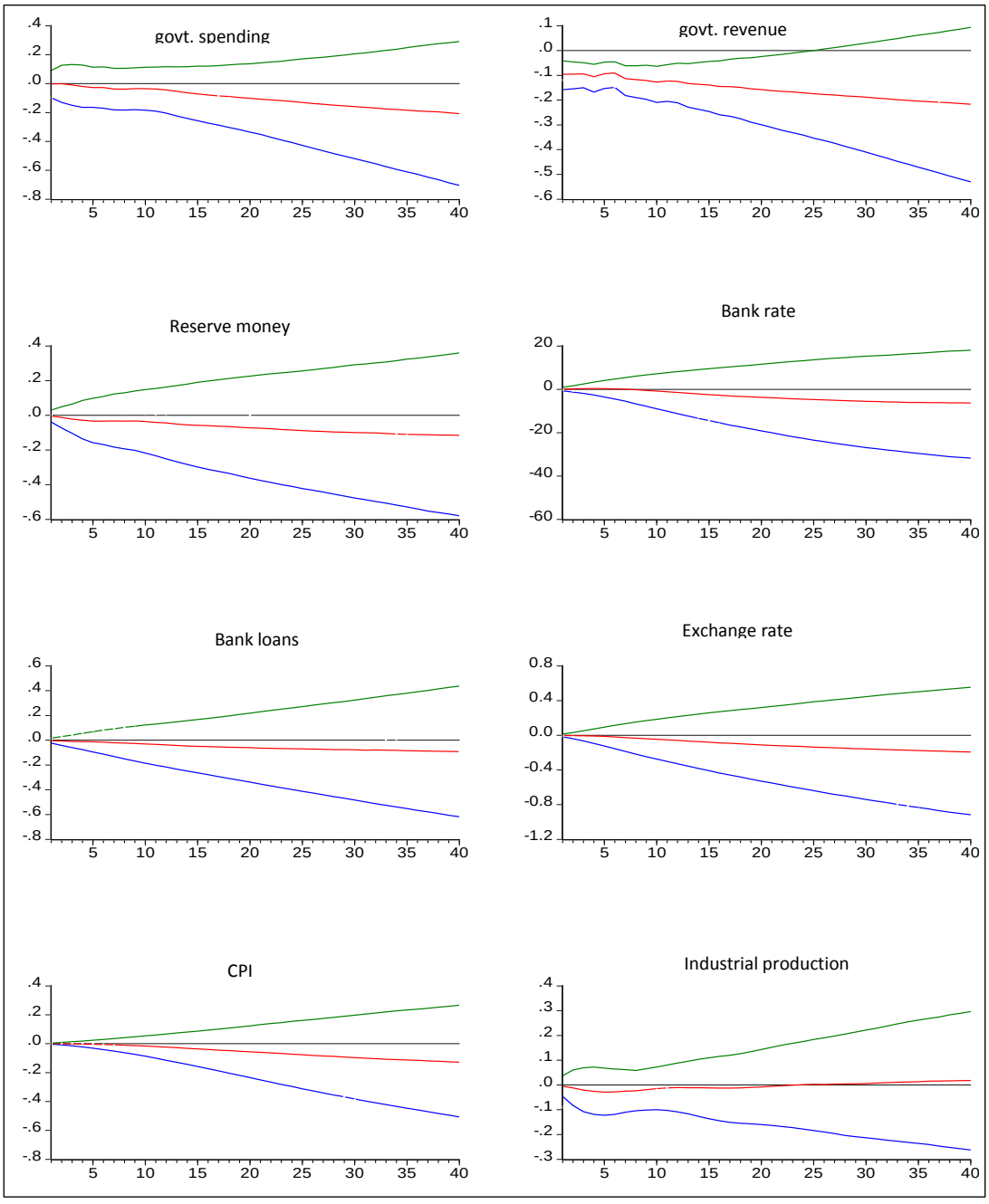
Appendices

Appendix 4.1: *impulse responses identified using K=12*

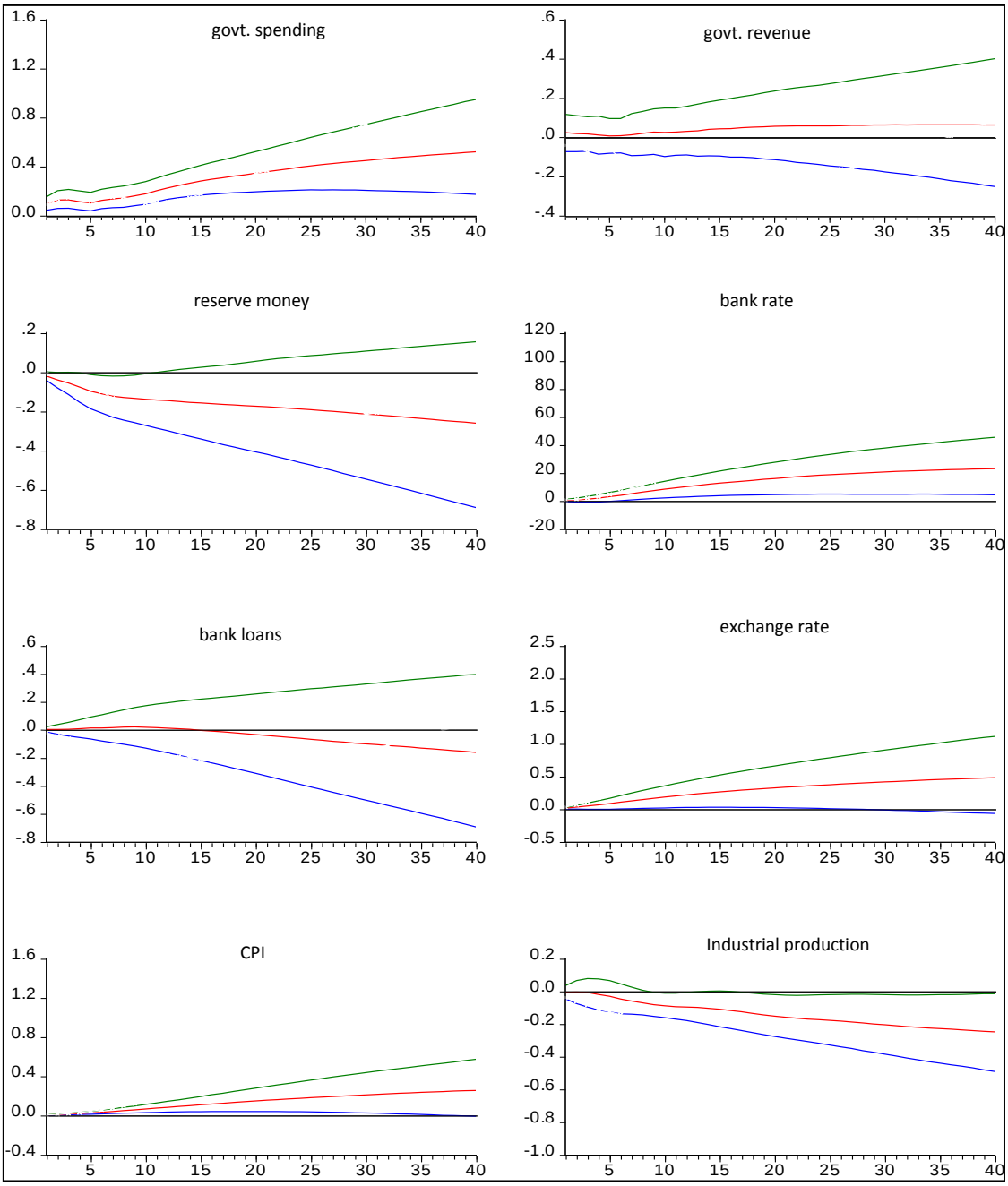
Impulse response to a monetary policy shock



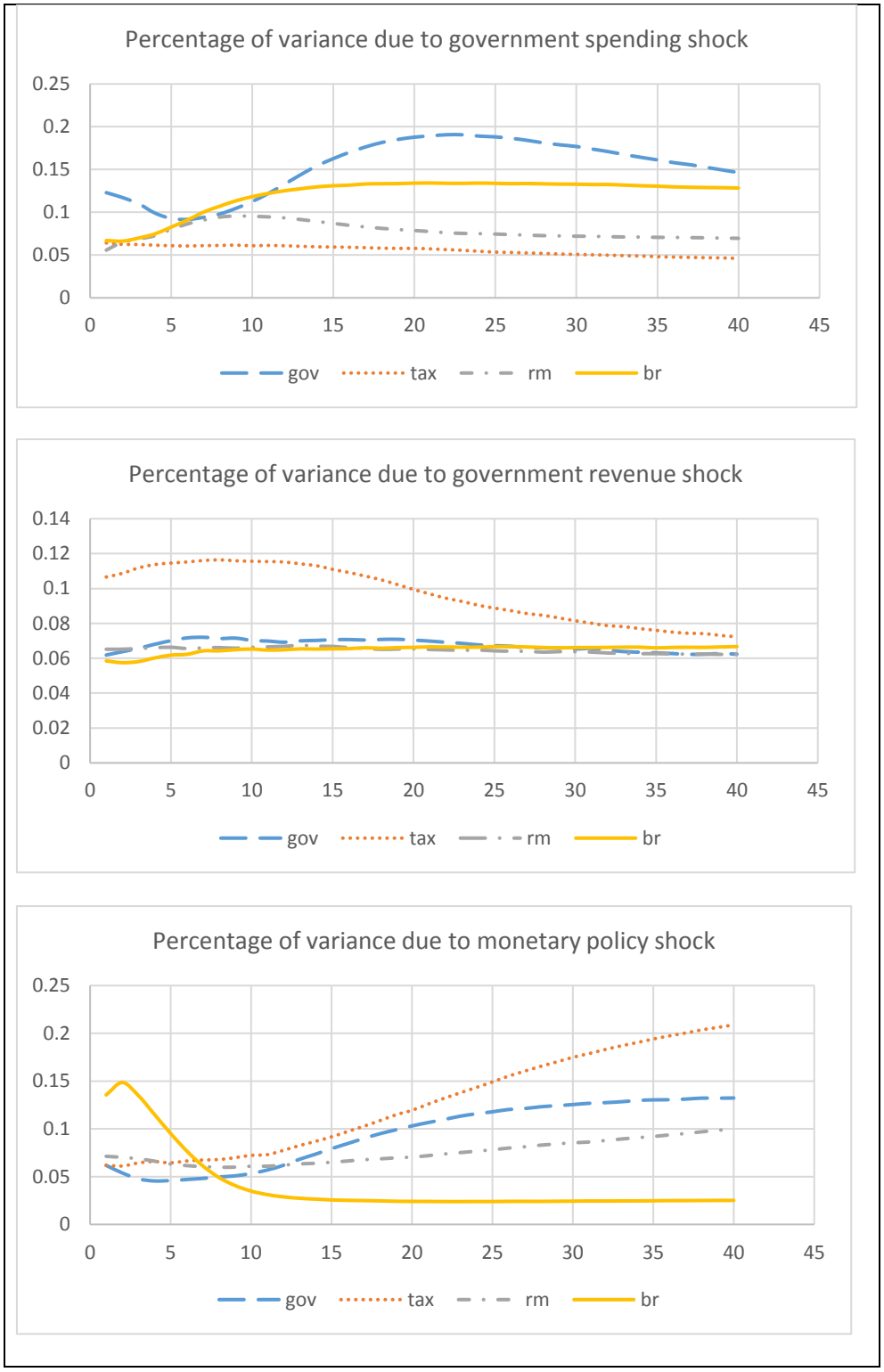
Impulse responses to a government revenue shock



Government spending shock



Appendix 4.2: *Forecast variance error decompositions overtime*



CHAPTER V

Conclusions and Policy Recommendations

In this dissertation, we have examined four major issues concerning macroeconomic stabilization policies in Malawi. The first issue that is examined is the implementation of fiscal and monetary policies whereby our main contribution was to estimate the fiscal and monetary policy rules that are employed by fiscal authorities and the central bank. From the results of our estimation, we have shown that monetary policy reacts strongly to inflation by observing the Taylor principle while its reaction to output fluctuations is modest. Fiscal policy on the other hand is also demonstrated to react to business cycles although in an even more moderate fashion than monetary policy. These observations lead us to conclude that monetary policy takes the lead when it comes to macroeconomic stabilization policy in Malawi.

The second issue that is examined is the impact of fiscal and monetary policies on key macroeconomic variables including total output, consumption, investment, and prices. Here our main contribution has been to provide new evidence on the impact of these policies on prices and the real economy including filling the gap in literature regarding the impact of the policies on private consumption and investment. Our results have shown that both fiscal policy and monetary policy affect the real economy and prices in the conventional ways with the exceptions that expansionary government spending crowds out both investment and private consumption which in turn eventually lowers output.

The third issue that we examine is the importance of the macroeconomic stabilization policies to the macro economy vis a vis other structural demand and supply

shocks. Here our contribution has been to provide a comparison between policy on one hand, and demand and supply shocks on the other, with regards to what is the most important driver of fluctuations in prices and real output. Our results have led us to conclude that it is the non-policy factors particularly the supply shocks in the form of productivity and cost-push shocks that affect the real economy the most. However we show that when it comes to price dynamics and investment, monetary policy also counts in a significant way.

The last issue that we examined is on how fiscal and monetary policy interact with each other. On this issue our main contribution was to establish whether the conduct of macroeconomic stabilization policy in Malawi is characterized by fiscal dominance or monetary dominance. Our conclusion here is that the macroeconomic policy environment in Malawi cannot be characterized as that of fiscal dominance. Rather, the behavior of both the fiscal authorities and the central bank points to a regime of monetary dominance. This conclusion is based on our observation that the central bank does not compromise on its objective of price stability in order to accommodate fiscal expansions while fiscal authorities on the other hand do adjust fiscal policy in cooperation with the prevailing monetary policy stance.

Given these findings we make a number of recommendations to policy makers. The first is that monetary authorities should maintain their strong stance against inflation since monetary policy does have a significant impact. However, given that other factors, particularly productivity shocks, have equally high influence on prices, caution should be taken regarding the limitations that monetary policy has in achieving this objective without severely hampering investment and long run economic growth.

Secondly, in light of the important role that productivity shocks play in the determination of business cycles and prices, the government must increase its efforts on improving and maintaining a high the level of productivity in the economy. In this regard, addressing issues such as power outages and improving mitigation measures for weather shocks would enhance the effectiveness of macroeconomic stabilization policies and ensure that overly aggressive monetary policy is not required for achieving price stability.

Thirdly, since government spending has a crowding out effect on private investment and consumption, like monetary policy it has the potential of significantly hindering economic growth in the long run. In this regard, we recommend that fiscal authorities and monetary authorities strengthen their coordination when deciding how to finance fiscal expansion. Specifically, the two authorities need to identify financing modalities that do not have a considerably negative effect on the cost of credit and the amount of it available for the private sector.

Lastly, we encourage fiscal authorities to keep in mind the fact that monetary authorities do not compromise on their main objective of stable prices for the purposes of accommodating loose fiscal policy. This has important implications on public debt sustainability given that debt monetization or having it inflated away are not options that are available to them. Therefore, the fiscal authorities need to put more effort on balancing the budget by being more prudent with expenditures and more diligent on tax collection.

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