Fiscal Policy and Adjustment in a Foreign Exchange Constrained Economy: Evidence from Malawi

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ERSA working paper 778

April 2019

Economic Research Southern Africa (ERSA) is a research programme funded by the National Treasury of South Africa.

Fiscal Policy and Adjustment in a Foreign Exchange Constrained Economy: Evidence from Malawi

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Abstract

Most of the recent literature analysing the adjustments of macroeconomic variables to fiscal policy shocks rely on the inclusion of non-Ricardian households to generate a positive response of consumption to an increase in government spending. This paper examines the dynamic effects of government financing behaviour in a foreign exchange constrained low income economy on key macroeconomic aggregates such as output, consumption, wages and labour supply. Using a dynamic stochastic general equilibrium (DSGE) model with Ricardian households calibrated to Malawian data, we find that consumption, wages and labour supply increase with increased government expenditure. This is contrary to popular arguments that government expenditure is inversely associated with the private consumption of intertemporal optimizing households in DSGE models. We argue that the positive response of consumption to increased government expenditure arises from the inclusion of aid in the government budget since government expenditure in low income economies may rise with increases in aid inflows for a given level of taxes. We also show that a positive shock to aid relaxes the foreign exchange constraint and improves the economy although it induces an appreciation of the real exchange rate.

Keywords: Fiscal policy, Foreign Exchange Constraint, DSGE, Malawi
JEL Classification: E32, F31,F35, H32

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1 Introduction

A large body of empirical literature supports the notion that consumption increases with increased government expenditure (Jooste et al., 2013; Mountford and Uhlig, 2009; Galí et al., 2007; Blanchard and Perotti, 1999) while at the same time others such as Smets and Wouters (2003) and Ramey and Shapiro (1998) show negative effects of government expenditure on consumption. Even though most macroeconomic models seem to predict a positive response of output to a rise in government expenditure, they however disagree on the implied effect of the same on consumption (Galí et al., 2007). For example, the standard real business cycle (RBC) model predicts a negative effect of government spending on consumption, while the IS-LM model predicts a positive effect and therefore amplifies the effects of the expansion of government expenditure on output (ibid). The difference comes in because RBC models feature the Ricardian households whose consumption decisions are based on intertemporal budget constraints. As such, increases in government spending means a reduction in the after tax income thereby generating a negative wealth effect and reduced private consumption[1]. Therefore to successfully generate a positive effect of governemnt expenditure on consumption, RBC and New Keynesian DSGE models include non-Ricardian[2] households. This is always the case especially when modelling LICs consumption responses to increases in government expenditure.

But, there are other features of LICs that are left out when modelling these countries that when incorporated might change the way consumption responds to increases in government expenditure, even if the representative households are Ricardian. For example, firms in LIEs are characterised by heavy importing of intermediate inputs and capital such that the availability and cost of foreign exchange play a crucial role in macroeconomic performance of most LIEs (Senbeta, 2013). This creates high demand of foreign exchange and often the demand for foreign exchange by firms and other consumers fail to match with the supply of foreign exchange available for all importers. In addition, the persistent balance of payments problems of LIEs exarcebate these problems. This inhibit firms to import the required amount of inputs needed for production, but also raises the price of foreign exchange, evidenced by the large difference in official price and the parallel market price of foreign exchange and therefore encourages the growth of the parallel market of foreign exchange. As such,firms are forced to operate below their maximum capacity and making them lose already signed contracts, reduce output and make losses. This makes firms to close production and others relocate to neighbouring countries where macroeconomic conditions are better (Dornbusch and Edwards, 1991). Therefore inelastic import demand, exchange rate misalignment and deteriorating terms of trade worsen balance of

[1]For mechanisms underlying the effects of non-productive government expenditure see Aiyagari et al. (1990), Baxter and King (1993)Christiano and Eichenbaum (1992) and Fatás et al. (2001).

[2]These are also called rule-of-thumb or hand-to-mouth households which are usually credit constrained and cannot smooth their consumption inter-temporally and consume their current labor income.

payment disequilibrium.

Second, LICs favour the macroeconomics of populism [3] (Dornbusch and Edwards, 1991). The effects of this policy has been the culprit of the heavily use of expansive fiscal and credit policies with a focus on distributive purposes in most LICS (Dornbusch and Edwards, 1991). Often, increases in government expenditure are due to foreign aid which is used for state sponsored cash transfer programs currently reaching nearly 50 million people, excluding the social cash transfers by non-governmental organisations (Handa et al., 2018)[4]. Third, literature suggests that there is correlation between prosperity of a country and tax compliance, such that richer countries that belong to the OECD collect about 33% of their GDP in taxes while LIC collect only 12 percent (Morisset and Cunningham, 2015). This is complemented by the share of consumption taxes in total taxes of most LIEs, especially Malawi where it is only 7% (Chiumia and Simwaka, 2012). In addition, the tax base in most LICs is narrow and increases in government expediture may not necessarily mean a decline in after tax income.

Fourth, there is a recent growing literature on LIC household which are able to smooth consumption overtime through informal financial institutions called village savings and loans associations (VSLAs) [5]which is changing the perception of generalising the rural and urban poor people of LICs as having a large percentage of hand-to-mouth agents. As such, we can model these people as Ricardians who smooth their consumption over time, even though their consumption is taxes but not much .

It is against this background that this paper seeks to answer the question: How should fiscal policy be implemented in LIEs with foreign exchange constraints? We contribute to literature by calibrating a small open economy DSGE model to assess the effects of an increase in government expenditure on consumption in LIEs using Malawian data. We assume that the economy is populated by Ricardian households who are rational and smooth their consumption behaviour inter-temporally as in Ngalawa and Viegi (2013). We argue that households in LIEs smooth their consumption by either borrowing or lending

[3]Populism according to Drake (1982) emphasizes among other things has connoted a reformist set of policies tailored to promote development that normally respond to the problems of underdevelopment by expanding state activism to incorporate the workers in a process of accelerated industrialization through ameliorative redistributive measures Dornbusch and Edwards (1991).

[4]Evidence suggests that there are far reaching effects of the programs both on food security and consumption as well as on a range of productive outcomes. After 3 years, household spending is on average 67% larger than the value of the transfer received, implying a sizable multiplier effect which works through increased non-farm activity and agricultural production (Handa et al., 2018; Honorati et al., 2015; Banerjee et al., 2015; Raza et al., 2012).

[5]Also called village banks or Bank Nkhonde (Bank on the Verandah) in Malawi are groupings or social networks of people with various social needs who come together and agree on a set of rules and schedules and start their own bank within their own indegenous environment to cater to their needs.Members get a loan quickly from willing members with individual repayment schedule that matches with their means of repayment and a flexibility that avoids default at 20% interest. ((Handa et al., 2018; Honorati et al., 2015; Banerjee et al., 2015; Raza et al., 2012)., https://www.linkedin.com/pulse/village-banks-our-towns-kumbukani-rashid-1/).

in the informal financial sector and maximise their utility inter-temporally subject to a budget constraint. Second, we incorporate a foreign exchange constraint faced by importing firms of LIEs to examine the distortionary effects of foreign exchange constraints in addition to the fiscal authority's financing behaviour. Specifically, we assess the direction and magnitude of the dynamic responses of output, private consumption, and other key variables to a shock in government spending, consumption tax, labour income tax, import tax, and aid.

The paper is organised as follows: Section 2 presents a discussion of the related literature. Section 3 discusses fiscal policy implementation in Malawi. Section 4 presents a DSGE model with fiscal policy and a foreign exchange constraint. Section 5 discusses model calibration. Section 6 discusses results, and provides a sensitivity analysis. Section 7 concludes the paper.

2 Fiscal Policy in Malawi

The tax structure in Malawi is built on the need to raise revenue fairly, encourage growth and promote equity. The structure has evolved over the years to meet these objectives. From 1970 to 1979, taxes were unchanged, as the country experienced balanced fiscal budgets. However, changes occurred in the 1990s, when import duties declined due to a change in the composition of imports, which changed from consumer goods (which attracted higher taxes), to intermediate and capital goods (which were taxed less) (Chiumia and Simwaka, 2012). Malawi also widened its tax base and reduced its heavy reliance on taxes on trade, which were seen to hinder development. Surtax became the highest revenue collection tool for the government until the year 2010. This was followed by value added tax (VAT), which contributed 37% to revenue and pay as you earn (PAYE) tax, which contributed 24% to revenue between the years 2000 and 2010. These two remain the highest sources of revenue.

In the 1970s, Malawi resorted to foreign borrowing to finance government projects. Rising debt and debt service over the decade, declining foreign exchange earnings induced by low export prices ultimately led to default in the late 1970s. The country's fiscal management and economic condition worsened in the 1980s owing to a series of external shocks, such as increased debt, poor domestic policy, and the disruption of the Nacala Development Corridor due to the Mozambican war (Fagernäs and Schurich, 2004).

Notwithstanding several structural adjustment interventions sponsored by the World Bank and the International Monetary Fund, Malawi's fiscal management remains weak. Up to 40 percent of the government annual budget is donor financed (Chiumia and Simwaka, 2012).Aid has had the additional benefits of easing payment constraints associated with volatile export earnings and contributing significantly to the level of foreign

reserves, although the amount has declined over the recent years. Table 1 shows the performance of selected fiscal indicators for Malawi from 2008 to 2015.

Table 1: Key Fiscal Indicators (as % of GDP)

	2008	2009	2010	2011	2012	2013	2014	2015
Total revenue	29.6	32.1	33.6	32.1	26.6	38.2	32.3	30.3
Domestic Revenue	18.9	20.5	23.4	24.5	22.1	24.0	27.4	26.3
Grants	10.8	11.6	10.3	7.6	4.4	14.2	4.9	4.1
Total Expenditure	32.1	37.8	33.7	34.9	34.9	38.6	40.2	37.8
Recurrent	20.6	30.7	25.7	27.2	26.9	30.1	34.0	30.3
Development	11.5	7.1	7.9	7.8	8.0	8.4	6.2	7.5
Deficit/GDP ratio (after Grants)	-7.8	-8.2	4	-7.5	-6.5	-3.4	-2.6	-3.2

Source: RBM October 2015 and March 2017 Monthly Economic Reviews

3 The Role of Foreign Exchange in Malawi

The role of foreign exchange availability in most Sub-Saharan African countries including Malawi has been emphasized empirically (Senbeta, 2013; Mathisen, 2003; Moran, 1989; Marquez, 1985). Malawi adopted a managed float exchange rate regime in 1994 to resolve the foreign exchange crisis that came with the suspension of balance of payments support from donors and the lagged effects of the 1992 drought (Simwaka and Mkandawire, 2008). Malawi has a seasonal nature of foreign exchange earnings which is directly related to agricultural activities, in addition to the fact that tobacco exports account for 60 percent of total foreign exchange earnings. The Kwacha is likely to appreciate during the tobacco market season (April to August) reflecting an increased supply of foreign exchange and normally depreciates in off season (September to March), reflecting increased demand of foreign exchange on the market as the economy imports farm inputs such as fertlizer (Simwaka and Mkandawire, 2008). This pattern however, tend to vary if the country received a substantial inflow of foreign aid or has received less aid than anticipated.

The Reserve Bank of Malawi (RBM) has been intervening in the foreign exchange market. The RMB influences the value of the Kwacha by buying foreign exchange in times of excess supply and selling when there is shortage. As a source of its own foreign exchange reserves, the RBM relies on whatever is able to buy from the market, and/or, if there were any donor inflows of funds. Any constraints on the two sources of foreign exchange means inadequate acapacity of the RBM to support the market effectively, thereby affecting the demand and supply balance in the market (Simwaka and Mkandawire, 2008). In times of low donor aid and unfavourable tobacco prices, the country suffers foreign exchange availability problems which affects bith the prices on the market but also the purchasing of inputs necessary for agricultural production and other things.

Foreign exchange constraints often affect the implementation of fiscal policy in Malawi and has for a long time compromised government spending plans by adversely affecting completion times of government projects. Some of these projects were aimed at reducing hunger and ensuring food sustainability in the country. There have been reported cases where the Farm Input Subsidy Program (FISP)[6] was nearly compromised due to shortages of foreign exchange (Chirwa and Dorward, 2014). In a few cases, farmers received farm inputs after the planting season. This was caused by procurement problems that came with late disbursements of funds due to unavailability of foreign exchange which further increased the costs of the program (IRINnews, 2011). At the time of the planned procurement, the country could not raise enough foreign exchange to enable the timely procurement of the inputs.

The US Department of States (2014) publication clearly states that in practice, foreign exchange availability in Malawi is very limited and remittances by foreign investors cannot be made immediately. Although foreign exchange availabilty improved in 2013 after the currency was devalued, the market for foreign exchange has experienced major volatility and as a result, businesses have experienced difficulties in planning forimport bills for their imported raw materials. In addition, due to the periodic availability of foreign exchange, during periods of scarcity, investors experience extended periods withou access to foreign exchange (US Department of State, 2014). This shortage of exchange rate create unfavourable business climate and affects the country's productivity since it smetimes affects the importation of petroleum products leading to fuel scarcity and the scarcity of other basic commodities. This impacts fiscal plans and demonstrates the importance of incorporating foreign exchange constraints when estimating fiscal policy reactions of macroeconomic variables. It also brings to light the question of how should fiscal policy be implemented in an environment with foreign ex change constraints?

The next section describes the model of foreign exchange constrained New Keynesian DSGE framework.

4 Foreign Exchange Constrained DSGE Fiscal Policy Model

The model's structure builds on the standard small open economy New Keynesian models of Monacelli (2005) and Justiniano and Preston (2004) with four sectors in the economy: Households, firms, a monetary authority, and the external sector. The household maximises an inter-temporal utility function separable in consumption and labour with its

[6]FISP is a program which is being implemented by the Government of Malawi to provide subsidised agricultural seeds and fertiliser to farmers.

financial resources coming from labour income and returns from holding bonds.

Firms consist of domestic producers and importers of intermediate goods. Their price setting behaviour follows Calvo (1983) with partial indexation of domestic and imported prices to their respective past inflation values. This allows for additional nominal rigidities to the staggered price setting framework as in Justiniano and Preston (2004). We also assume incomplete pass-through of exchange rate movement and habit formation.

Because of the small open economy properties of the model, we postulate that the relative size of the foreign economy is so large that it is not affected by any developments in the Malawian economy and therefore approximates a closed economy. This work adopts most of its presentation and notation from Senbeta (2013), Galí and Monacelli (2005), Galí (2008), and Peiris and Saxegaard (2007) and extends the Senbeta (2013) model by including foreign aid and export earnings in the evolution of the foreign exchange equation. This is to capture salient features specific to most LIEs that depend heavily on commodity exports and aid as their main sources of foreign financial inflow.

4.1 Consumption Behaviour

We introduce fiscal policy specifications by introducing tax on wage income, and a tax on all imported consumption goods and intermediate inputs. The infinitely lived representative household maximises inter-temporal utility, subject to an inter-temporal budget constraint. The objective function is given as:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{(C_t - hC_{t-1})^{1-\upsilon}}{1-\nu} - \chi \frac{(N_t)^{1+\varphi}}{1+\varphi} \right\} \tag{1}$$

E is the expectation operator and β is the subjective discount factor of the representative household's utility. The household derives utility from the consumption of a composite good C_t, and disutility from labour effort N_t. The parameter ν is the inverse of the elasticity of inter-temporal substitution in consumption, h is the coefficient of habit persistence (where $0 < h < 1$), φ is the inverse of the elasticity of labour supply and χ is the marginal disutility of participating in the labour market.

Consumption is a composite good comprising the home and foreign good and is given by a CES aggregator:

$$C_t = \left[(1-\alpha_1)^{\frac{1}{\rho 1}} C_{H,t}^{\frac{(\rho 1-1)}{\rho 1}} + \alpha_1^{\frac{1}{\rho 1}} C_{F,t}^{\frac{(\rho 1-1)}{\rho 1}} \right]^{\rho_1/(\rho_1-1)} \tag{2}$$

Where $C_{H,t,'}C_{F,t}$ represent consumption of home and foreign goods respectively, ρ_1 measures the elasticity of intra-temporal substitution of consumption between the home and foreign goods. The parameter α_1 measures the proportion of foreign goods in the house-

hold's consumption. The household maximizes utility from consumption of both goods. The overall consumer price index is given by:

$$P_t = \left[(1-\alpha_1)(P_{H,t})^{1-\rho_1} + \alpha_1(P_{F,t})^{1-\rho_1}\right]^{1/(1-\rho_1)} \tag{3}$$

$P_{H,t}$,$P_{F,t}$,P_t are price indices of domestic goods, foreign goods and overall consumer goods respectively. Thus total expenditure becomes:

$$P_t C_t = P_{F,t} C_{F,t} + P_{H,t} C_{H,t} \tag{4}$$

Both the home and foreign goods are composite bundles of differentiated products. Solving the problem of allocation by the household given the overall price index yields the following demand functions:

$$C_{H,t} = (1-\alpha_1)\left(\frac{P_{H,t}}{P_t}\right)^{-\rho_1} C_t \tag{5}$$

$$C_{F,t} = \alpha_1\left(\frac{P_{F,t}}{P_t}\right)^{-\rho_1} C_t \tag{6}$$

The household's income comes from wages and dividends. However, households have imperfect access to the financial market and as such, they hold foreign bonds earning interest rate r^*. Following Justiniano and Preston (2010) and Schmitt-Grohé and Uribe (2003), a debt elastic interest rate premium is introduced to close the model. The debt elastic interest premium takes the form: $\phi_t\ B_t^*$where ϕ_t is a function that is increasing in foreign debt (d_t); $\phi_t = exp\left[-\eta(d_t+\omega_t)\right]$. In this function ϕ_t represents a risk premium shock and foreign debt is defined as $d_t \equiv \frac{\varepsilon_{t-1}B^*_{t-1}}{YP_{t-1}}$[7] as in Justiniano and Preston (2010).

Lifetime utility is maximised subject to:

$$P_t(1+\tau_t^c)C_t + B_t + \varepsilon_t B_t^* \leq (1-\tau_t^w)W_t N_t + D_t + r_{t-1}B_{t-1} + \varepsilon_t r^*_{t-1}B^*_{t-1}\phi_t(d_t) + \varepsilon_t P_t^* A_t \tag{7}$$

Where B_t is government bonds earning interest r_t. Thus the household expenditure consists of expenditure on consumption C_t and purchases of domestic bonds B_t and foreign bonds B_t^*. Income is comprised of dividends D_t, wages W_t, returns from previous holdings of bonds, r_{t-1}, and returns from previous foreign bond holdings r^*_{t-1}; while ε_t is the nominal exchange rate. The variable A_t represents aid and it captures all net foreign transfers both institutional and private. It is important to note here that a large percentage of household income in LIEs is transfers. Personal income tax is τ_t^w and tax on consumption (VAT + excise tax) is τ_t^c.

[7]Is the real outstanding foreign debt expressed in terms of domestic currency as a fraction of steady-state output.

The first order conditions are as follows:

$$(C_t - hC_{t-1})^{-\nu} = \lambda_t P_t(1+\tau_t^c) \tag{8}$$

$$\chi(N_t)^{\varphi} = \lambda_t(1-\tau_t^w)W_t \tag{9}$$

$$\beta E_t \lambda_{t+1} r_t = \lambda_t \tag{10}$$

$$\beta E_t \lambda_{t+1} \varepsilon_{t+1} r_t^* \phi_{t+1} = \lambda_t \varepsilon_t \tag{11}$$

Combining equations (8) and (9) gives the marginal rate of substitution between consumption and labour.

$$\chi(N_t)^{\varphi}(C_t - hC_{t-1})^{\nu} = \frac{(1-\tau_t^w)W_t}{(1+\tau_t^c)P_t} \tag{12}$$

while equations (8) and (10) combined produces the consumption Euler equation:

$$\beta E_t \frac{(C_{t+1} - hC_t)^{-\nu}}{(C_t - hC_{t-1})^{-\nu}} \frac{P_t(1+\tau_t^c)}{P_{t+1}(1+\tau_{t+1}^c)} = \frac{1}{r_t} \tag{13}$$

The combination of equations (10) and (11) yields the uncovered interest parity (UIP) condition:

$\beta E_t \lambda_{t+1} r_t = \beta E_t \lambda_{t+1} \frac{\varepsilon_{t+1}}{\varepsilon_t} r_t^* \phi_{t+1}$

which simplifies to:

$$\frac{r_t}{r_t^* \phi_{t+1}} = E\frac{\varepsilon_{t+1}}{\varepsilon_t} \tag{14}$$

4.2 Firms

4.2.1 Domestic Production

In this model, the firm has to take into account the tax on wage income and the international trade tax when making decisions on how much labour to employ and how many intermediate inputs to import. Domestic production consists of a continuum of identical monopolistic competitive firms that produce domestic goods using capital, labour and imported intermediate inputs.

Importation of intermediate inputs depends solely on the ability of the country to provide foreign exchange. A firm is therefore constrained in its ability to import the required amount of intermediate inputs when it cannot acquire the desired level of foreign exchange. This affects the domestic level of production and output because firms source the

required foreign currency in the parallel (black) market at a higher price. Firms already constrained by foreign exchange availability also have to face import taxes. We assume free mobility of capital and labour in the economy for simplicity, and these inputs are therefore homogeneous.

Firms use capital (K), labour (N) and imported intermediate inputs (M) to produce tradable goods. Empirically, in business cycle frequencies, endogenous variation of capital stock has little relationship to output variations (McCallum and Nelson, 2000; Walsh, 2010). As such, capital is ignored in our model. We assume a linear technology and the firm's production function is given as:

$$Y_{H,t} = A_{H,t} N_{H,t}^{\sigma_1} M_{H,t}^{\sigma_2} \tag{15}$$

where we assume constant returns to scale to the production function such that $\sigma_1, \sigma_2 > 0$ and $\sigma_1 + \sigma_2 = 1$. In addition, $A_{H,t}$ represents total factor productivity and its logarithm follows a first order autoregression process as follows:

$$lnA_{H,t} = \rho_H lnA_{H,t-1} + e_{H,t} \tag{16}$$

Where $0 < \rho_H < 1$. The term $e_{H,t}$ is i.i.d N(0, σ_{eH}). Cost minimisation by the representative firm, given the production level, accounts for the introduced import taxes. This not only increases the importing price of intermediate inputs but also changes the firm's decisions on the amount of inputs and final goods to import and labour to hire. In addition, the introduction of an import tax changes the firm's pricing decisions of the final goods and imported consumption goods. The firm's decision is to minimise labour and import costs as much as possible by solving the following cost minimisation problem:

$$Min_{N_{H,t}, M_t} \left(W N_t + (1 + \tau_t^m) P_{F,t} M_t \right) s.t. Y_{H,t} = A_{H,t} N_{H,t}^{\sigma_1} M_t^{\sigma_2} \tag{17}$$

where τ_t^m is import tax (both VAT and excise taxes levied on imports). This yields input demand functions of labour and imported intermediate inputs as:

$N_t = \left(\frac{\sigma_1}{\sigma_2}\right)^{\frac{\sigma_2}{\sigma_1+\sigma_2}} (1+\tau_t^m)^{\frac{\sigma_2}{\sigma_1+\sigma_2}} P_{F,t}^{\frac{\sigma_2}{\sigma_1+\sigma_2}} W_t^{-\frac{\sigma_2}{\sigma_1+\sigma_2}} Y_{H,t}^{\frac{1}{\sigma_1+\sigma_2}} A_{H,t}^{-\frac{1}{\sigma_1+\sigma_2}}$

$M_t = \left(\frac{\sigma_2}{\sigma_1}\right)^{\frac{\sigma_1}{\sigma_1+\sigma_2}} \left(\frac{1}{1+\tau_t^m}\right)^{\frac{\sigma_1}{\sigma_1+\sigma_2}} P_{F,t}^{\frac{-\sigma_1}{\sigma_1+\sigma_2}} W_t^{\frac{\sigma_1}{\sigma_1+\sigma_2}} Y_{H,t}^{\frac{1}{\sigma_1+\sigma_2}} A_{H,t}^{-\frac{1}{\sigma_1+\sigma_2}}$

Because $\sigma_1 + \sigma_2 = 1$, the inputs demand functions collapse to:

$$N_t = \left(\frac{\sigma_1}{\sigma_2}\right)^{\sigma_2} (1+\tau_t^m)^{\sigma_2} P_{F,t}^{\sigma_2} W_t^{-\sigma_2} Y_{H,t} A_{H,t}^{-1} \tag{18}$$

$$M_t = \left(\frac{\sigma_2}{\sigma_1}\right)^{\sigma_1} (1+\tau_t^m)^{-\sigma_1} P_{F,t}^{-\sigma_1} W_t^{\sigma_1} Y_{H,} A_{H,t}^{-1} \tag{19}$$

Substituting the input demand functions into the objective function, and differentiating with respect to output, we obtain the marginal cost function:

$$MC_{H,t} = \left[\left(\frac{\sigma_2}{\sigma_1}\right)^{\sigma_1} + \left(\frac{\sigma_1}{\sigma_2}\right)^{\sigma_2}\right] \frac{(1+\tau_t^m)^{\sigma_2} P_{F,t}^{\sigma_2} W_t^{\sigma_1} A_{H,t}^{-1}}{P_t} \tag{20}$$

Equation (20) gives us the real marginal cost function in terms of total productivity, output, input prices, import taxes and the share parameters.

4.2.2 Price Setting Behaviour by Importing Firms

Domestic firms follow Calvo (1983) to set their prices, with each firm having the probability $1-\theta$ of being able to change the price of goods that are produced. For those prices that have been changed, we use $P_{H,t}^*$. Therefore, θ_H is used to describe the proportion of goods with a current price, $P_{H,t}$, equal to that of the previous period (i.e.$P_{H,t-1}$) as in Justiniano and Preston (2010). All firms (those that cannot change prices and those that can change their prices) adjust their prices according to an indexation rule ζ_H where $0 \leq \zeta_H \leq 1$ and ζ_H measures the degree of the firm's indexation to a past period's inflation rate. The re-optimising firm's price index evolves according to:

$$P_{H,t}(j) = \left[(1-\theta_H)P_{H,t}^{*(1-\rho_1)} + \theta_H \left(P_{H,t-1}\left(\frac{P_{H,t-1}}{P_{H,t-2}}\right)^{\zeta_H}\right)^{1-\rho_1}\right]^{1/(1-\rho_1)} \tag{21}$$

The firm that sets its price aims to maximise the expected discounted profits which are given by:

$$E_t \sum_{k=t}^{\infty} \theta_H^{k-t} \beta_{t,t+k} C_{H,t+k} \left[P_{H,t}^* \left(\frac{P_{H,t+k-1}}{P_{H,t-1}}\right)^{\zeta_H} - P_{H,t+k} MC_{H,t+k}\right] \tag{22}$$

where β_{t+k} is the usual stochastic discount factor and MC_{t+k} is the real marginal cost function for each firm. The firm's first order condition is the aggregate price index for the traded goods that are produced domestically and is presented as:

$$E_t \textstyle\sum_{k=0}^{\infty} \theta_H^k \beta_{t,t+k} C_{H,t+k} \left[P_{H,t}\left(\frac{P_{H,k-1}}{P_{H,t-1}}\right)^{\zeta_H} - \frac{\rho_1}{\rho_1 - 1} P_{H,t+k} MC_{H,t+k}\right] = 0$$

Solving for the domestic price of the traded goods yields:

$$P_{H,t}^* = \frac{\rho_1}{\rho_1 - 1} \frac{E_t \sum_{k=0}^{\infty} \theta_H^k [\beta_{t,t+k} C_{H,t+k} P_{H,t+k} MC_{H,t+k}]}{E_t \sum_{k=0}^{\infty} \theta_H^k [\beta_{t,t+k} C_{H,t+k} (P_{H,k-1}/P_{H,t-1})^{\zeta_H}]} \tag{23}$$

It should be noted that these firms use foreign currency to import final goods, which are consumed directly by the consumers and are sold to domestic retailers in domestic

currency. In addition, these firms import intermediate goods as factors of production in the economy. This representation is similar to that of Justiniano and Preston (2010) and Christiano et al. (2011), however, a key difference is that firms in Christiano et al. (2011) do not face foreign exchange constraints. In practice, in many LIEs, the central bank is often not able to supply the required amount of foreign exchange to importers, thereby creating an excess demand for foreign currency in the economy.

It is worth remembering that firms in this section charge a mark-up on the original prevailing price to realise their goal of profit maximisation and cover their marginal costs. This is because the foreign exchange for importing the goods can be obtained from entities other than the Central Bank or other formal financial institutions (FFIs) albeit at a higher prices.

4.3 Fiscal Policy

Fiscal policy is prominently featured in this model. We introduce a fiscal authority which follows a period by period budget constraint. The fiscal authority has some policy objectives and follows a simple fiscal policy rule.

4.3.1 Government Budget

The fiscal authority purchases final goods, G_t, issues bonds, B_t, and levies taxes on consumption $(1+\tau_t^c)C_t$, taxes on wage $\tau_t^w W_t N_t$ and $\tau_t^m P_{F,t} M_t$, such that:

$$\tau + B_t + \varepsilon_t P_t^* A_t = r_{t-1} B_{t-1} + P_t G_t \tag{24}$$

where $\tau = \tau_t^w W_t N_t + (1+\tau_t^c)C_t + \tau_t^m P_{F,t} M_t$ and is G_t government purchases or consumption, B_t is government bonds or debt, M_t are imports and A_t is aid. The left hand side of equation (24) is government revenues and the right hand side is government expenditure. The Malawian government generates most of its revenue from taxes, especially personal income tax revenues and import duties because the country is highly dependent on imported goods. Consumption taxes however are small.

Defining deviations of fiscal variables (government expenditure and taxes) from their respective steady state values to be g_t and t_t respectively, we can define $g_t \equiv (G_t - G)/Y$, $T_t = \tau_t^w W_t L_t + \tau_t^m M + (1+\tau_t^c)C_t$ and $t_t \equiv (T_t - T)/Y$ where G, Y and T are the steady state levels of government consumption, output and taxes. We follow Galí et al. (2007) to select the most feasible paths, and to stabilise government debt. As such, a simple log-linear fiscal policy rule is given in the form:

$$t_t = \phi_b b_t + \phi_t g_t \tag{25}$$

where ϕ_b, ϕ_g are elasticities of lump-sum taxes with respect to government debt and government spending respectively. We assume a balanced primary government budget in equilibrium for simplicity, and government purchases[8] are assumed to evolve exogenously according to a first order auto-regressive process:

$$g_t = \rho_g g_{t-1} + \epsilon_{g,t} \tag{26}$$

where $\epsilon_{g,t}$ is government spending shock and ρ_g is a positive coefficient such that $0 < \rho_g < 1$. In addition, $\epsilon_{g,t}$ is i.i.d. with constant variance $\sigma^2_{\epsilon g}$. To simulate the fiscal policy measures, we follow Stork (2011) and decompose taxes as follows:$\tau_t = \bar{\tau}^x + \hat{\tau}^x_t$

where τ_t is the respective tax rate, $\bar{\tau}^x$ is the steady state value of tax rate and $\hat{\tau}^x_t$ is the deviation from the steady state value. We assume that the deviation of each tax rate from the steady state follows an AR(1) process, such that;

$$\hat{\tau}^x_t = \rho_t \hat{\tau}^x_{t-1} + \epsilon_{\tau,t} \tag{27}$$

where ρ_t is the estimated tax parameter and $\epsilon_{\tau,t}$ is a tax shock which is i.i.d. with constant variance $\sigma^2_{\epsilon_\tau}$. The steady state values of taxes are derived from data on Malawi. We do not cover all sources of government taxes in the economy and restrict the model to the main objectives of the paper by assessing only the implications of the two taxes on wages and imports. We therefore assume that the government sources its revenue from taxes on wages and imports which are defined as follows:

$$\tau^w_t = \frac{T^w_t}{W_t N_t} \tag{28}$$

where T^w_t is government revenue from wages. Government revenue from tax on imports, T^m_t and is government revenue from consumption T^c_t are given as:

$$\tau^m_t = \frac{T^m_t}{P_{F,t} M_t} \tag{29}$$

$$\tau^c_t = \frac{T^c_t}{P_t C_t} \tag{30}$$

[8]In deviations from the steady state

4.4 Law of One Price Gap, Exchange Rate and Terms of Trade

The law of one price gap shows the degree to which the law of one price fails to hold; that is, when the ratio of the foreign price to domestic price is not equal to one, even when foreign exchange is taken into consideration (Monacelli, 2005). We define the law of one price gap as:

$$\Psi_t = \frac{\varepsilon_t P_t}{P_{F,t}} \tag{31}$$

where ε_t is the nominal exchange rate, P_t is the domestic price of traded (exported) goods and $P_{F,t}$ is the foreign price. We define the real exchange rate as the ratio of the rest of the world price index in terms of the domestic currency to the domestic price index as:

$$Q_t = \frac{\varepsilon_t P_t^*}{P_t} \tag{32}$$

while terms of trade is defined as $s_t = \frac{P_{F,t}}{P_{H,t}}$ where $P_{H,t}$ is the home produced goods domestic price.

4.5 Monetary Policy

In Malawi, the Reserve Bank of Malawi (RBM) uses an interest rate based monetary policy framework and implements measures to keep excess liquidity at levels that support key rates within a corridor of the policy rate. However, the objective of this paper is to assess the effect of introducing foreign exchange constraints on the behaviour of key macroeconomic variables. Therefore, we defer the modifications of monetary policy rules to subsequent work and use the simple Taylor rule where the RBM adjust interest rates when responding to deviations of inflation, output and exchange rate from their steady state. In log-linearised form it is given as:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)(\phi_{r\pi}\pi_t + \phi_{ry} y_t + \phi_{re}\Delta e_e) + \epsilon_{r,t} \tag{33}$$

where $\phi_{r\pi}, \phi_{ry}, \phi_{re}$ are weights on inflation, output and the nominal exchange rate. The parameter ρ_r is smoothing parameter which indicates the persistence of interest rates. The lagged interest rate is for interest rate smoothing while $\epsilon_{r,t}$ captures the monetary policy shock ($\epsilon_{r,t}$ is i.i.d $(0_{\epsilon r}, \sigma_{\epsilon r})$).

In a country plagued with foreign exchange problems, reseve accumulation by the Reserve Bank takes an added significance. In Malawi, foreign exchange is earned primarily from export earnings and foreign aid. Foreign reserves are modeled in log-linear form as follows:

$$\rho_{res} res_t = \rho_{res} res_{t-1} + \rho_{debt}(r_{t-1} + \varepsilon_t + b_{t-1} + \phi_t) + \rho_a(\varepsilon_t + a_t) + \rho_{ex}(p_t + c^*_{H,t}) - \rho_m(\varepsilon_t + p_{F,t} + y_{F,t}) \tag{34}$$

where ρ_{res}, ρ_{debt}, ρ_a, ρ_{ex}, ρ_m are ratios of reserves to GDP, debt to GDP, aid to GDP, exports to GDP and imports to GDP respectively while the variables res_t, ε_t, a_t, p_t, $c^*_{H,t}$ and $y_{F,t}$ are the usual total foreign reserves in this period, the nominal exchange rate, aid, domestic prices, exported consumption (exports), foreign price level of imports and foreign output (imported output). Reserves at the end of the current period are a function of reserves at the end of the last period, returns on last year's foreign bonds, this year's aid inflows and export earnings less import payments during this period. If $\rho_{res} res_t \leq$ demand for foreign exchange in a particular period, then a foreign exvhange contraint exists.

4.6 The External Sector

The external sector is exogenous. Foreign interest rate r^*_t, foreign inflation π^*_t, foreign output or income y^*_t are determined by a vector of auto-regressive processes of order one,

$$y^*_t = \rho_{y^*} y^*_{t-1} + \epsilon_{y^*,t} \tag{35}$$

$$\pi^*_t = \rho_{\pi^*} \pi^*_{t-1} + \epsilon_{\pi^*,t} \tag{36}$$

$$r^*_t = \rho_{r^*} r^*_{t-1} + \epsilon_{r^*,t} \tag{37}$$

where $0 < \rho_{y^*}, \rho_{\pi^*}, \rho_{r^*} < 1$, and y^*_t, π^*_t, r^*_t are foreign output, inflation and interest rate respectively in log-deviation from the steady state. All disturbance terms are distributed normally as follows: $\epsilon_{i,t} \sim N\ (0, \sigma^2_i)$.

4.7 Market Equilibrium

Equilibrium is achieved when all agents optimise and when the markets clear, such that:

$$Y_t = Y_{H,t} = C_{H,t} + C^*_{H,t} \tag{38}$$

and the log-linearised foreign consumption (exports) is given as:

$$c_{H,t} = -\rho_1(p_{H,t} - p_t) + c_t)$$

but using the fact that $p_t - p_{H,t} = \alpha_1 s_t$, then $C_{H,t} = \rho_1 \left(\frac{P_{H,t}}{\varepsilon_t P_t^*}\right)^{-\rho_1} C_t^*$, thus $C_{H,t} = \alpha_1 \left(\frac{P_{H,t}}{\varepsilon_t P_t^*}\right)^{-\rho_1} C_t^*$ which can be simplified to $c_{H,t}^* = \rho_1 \alpha_1 s_t + \rho_1 q_t + c_t^*$.

5 Calibration

To identify the long-run dynamic properties of the model, the system is log-linearised. The model solution for the system of linear equations presented in the previous section and the detailed representations in the appendix[9].

We calibrate the parameters following DeJong and Dave (2007). Most of the parameters were adopted from the literature and selected on the basis that they are consistent with LIE characteristics. Following Mwabutwa et al. (2013), the consumer discount factor β is approximated at 0.99, which is also supported by Alpanda et al. (2010), Peiris and Saxegaard (2009) and Adam et al. (2009).

According to the literature the common value for inter-temporal elasticity of substitution for low income Sub-Saharan African countries is 0.34 ($\nu = 2.96$) as estimated by Ogaki and Park (1997). This was adopted by Berg et al. (2012) and Senbeta (2013) while the elasticity of labour supply φ is assumed to be 2, supported by Berg et al. (2010) and Mwabutwa et al. (2013). In addition, evidence from many countries indicates that time spent working does not significantly vary in low income countries. Therefore, we assign the share of labour in the production of home produced goods and the share of intermediate inputs in the production of home produced goods σ_1, σ_2, to be 0.74 and 0.26 respectively following Mwabutwa et al. (2013). We also adopt the constant returns to scale description of imported intermediate inputs and labour shares from Senbeta (2013). Some parameter values are calibrated by using quarterly data to approximate steady state values. For example, χ_r, the ratio of imports to foreign exchange reserves is approximated at 1 because the data show that the Reserve Bank of Malawi has averaged been 1.3 months of import cover for several years.

In addition, consumption to GDP ratio χ_g is assumed to be 0.8, total imports to GDP ratio χ_f is approximated at 0.4750, the ratio of imported consumption goods in total imports χ_c is 0.8 and the ratio of aid to imports χ_a is 0.12 following Mwabutwa et al. (2013), Ngalawa and Viegi (2013) and various IMF Country Reports. Table 2 provides the additional parameters used in the model and their values, while a full table of the parameters used in the model is provided in the appendix.

The data used for the calculation of the remaining variables specific to fiscal policy in Malawi is sourced from World Bank's World Development Indicators (WDI) database,

[9]The complete system of log-linearised equations is provided in the Appendix.

IMF's International Financial Statistics (IFS) and the Reserve Bank of Malawi's Economic Reviews and Financial Statements. DYNARE is used to simulate the model and generate impulse response functions for the variables of interest: output, private consumption, firm's marginal cost, imports, CPI inflation, household labour income, labour supply, and government debt.

Table 2: Calibration of the Model Parameters

Parameter	Value	Description
ρ_{τ^w}	0.30	Speed of convergence of wage tax
ρ_{τ^m}	0.40	Speed of convergence of import tax
ρ_{res}	0.08	Reserves to GDP ratio
ρ_d	0.49	Debt to GDP ratio
ρ_a	0.12	Aid to GDP ratio
ρ_x	0.29	Exports to GDP ratio
ρ_m	0.48	Imports to GDP ratio
ρ_g	0.82	Speed of convergence for government policy
ρ_{gg}	0.24	Ratio of government expenditure to GDP
$\rho_{\tau^w g}$	0.23	Ratio of Wage tax revenue to GDP
$\rho_{\tau^c g}$	0.07	Ratio of consumption tax revenue to GDP
$\rho_{\tau^m g}$	0.34	Ratio of import tax revenue to GDP

6 Simulations, Results and Inferences

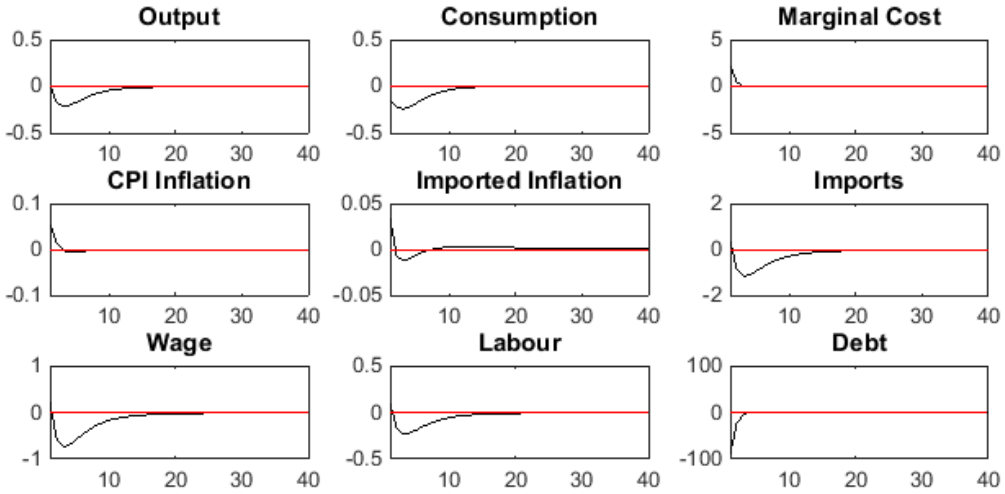
The main focus of this article is to analyse the adjustment of key macroeconomic variables to fiscal policy shocks in a foreign exchange constrained economy. Specifically, we examine the impact of wage tax shocks ϵ_t^w, import excise tax shocks ϵ_t^m, government expenditure shocks ϵ_t^g and a shock to aid ϵ_t^a on the economy. We assess the effects of these shocks on output, consumption, marginal costs, CPI inflation, imported inflation, imports, wages, labour supply, and government debt. Given the importance of aid in Malawi and its interaction with fiscal policy, we also examine aid shocks. As stated before, 40% of Malawi's annual government budget is donor funded, and thus aid constitutes a significant proportion of foreign financial flows to Malawi. As such, aid has serious implications for the implementation of fiscal policy and adjustment in the economy.

6.1 Labour Income Tax Shock

Figure 1 shows the responses of output, consumption, marginal costs, CPI inflation, imported inflation, wage, labour supply, and government debt to a positive innovation in labour income tax.

The IRF shows that an increase in the labour income tax rate has a small contractionary effect on output, consumption, and labour supply, as labour income decreases with the effect of the tax. Output and consumption fall by about 0.2 percentage points, as house-

Figure 1: Impulse Responses to Labour Income Tax Shock



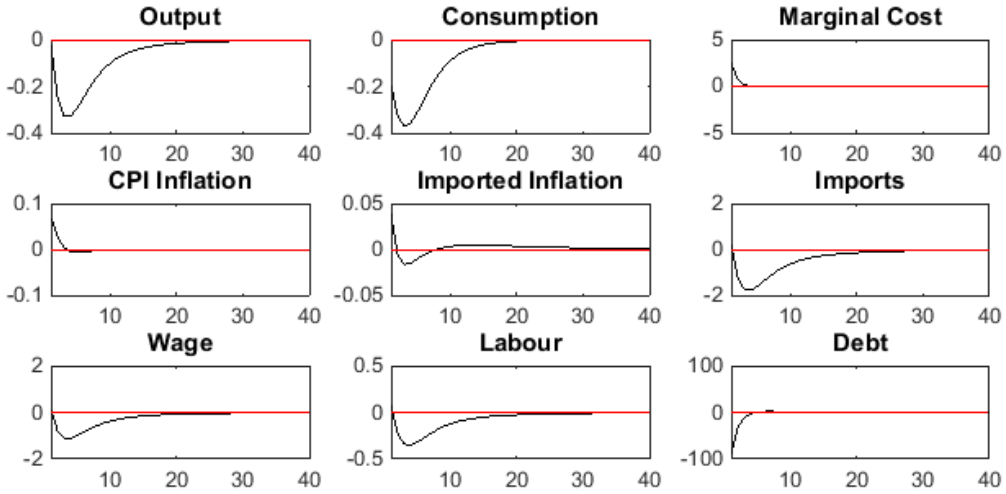
holds reduce their supply of labour due to the reduction in wages, which also affects the production function. The reduction in labour supply and wages is less than one percentage point.

Furthermore, a positive change in labour income tax decreases the imported inputs and consumption goods, as total imports decline on impact. This is likely because the reduction in wages induces a shift in consumption from imported goods to domestically produced goods. This effect however raises imported inflation on impact, which falls as consumers adjust their consumption to domestically produced goods. This raises marginal costs and domestic CPI inflation in the economy. This result is in line with earlier empirical studies on fiscal policy and the effects of tax on wages and labour supply. Indeed a cut in wage tax has an opposite effects. It increases labour supply, wages, consumption, and output (Yasuharu, 2009). This result is in consistent with the stylised effects of distortionary labour income taxes on an economy.

6.2 Import Tax Shock

The effect of an increase in import excise tax is shown in Figure 2. Increasing import tax makes imported goods and services more expensive, causing firms to decrease total imports, ultimately making production more costly. This is because if factors of production are not being utilised efficiently, the firms marginal costs rise. The results show that the demand for private consumption falls by 0.03 percentage points. This is more than the impact decline in output of 0.01 percentage points. This fall in consumption and output yields lower labour demand and an increase in unemployment in the economy, while private sector wages fall slightly. The result is in line with the empirical literature

Figure 2: Impulse Responses to an Import Tax Shock



on the effect of trade tax, since import tax is a distortion to imports and has the same effect as the effect of the VAT rate, raising the price of imported goods. For example, Stähler and Thomas (2012) reach the same conclusions when they estimate the effects of the VAT rate using a medium scale DSGE model for Spain. They reached this conclusion by estimating a permanent change in the VAT rate, and not a temporary change, which led to slightly different results.

Malawi is a country that imports almost everything and as it is expected that such a tax increase would lead to a decline in private consumption, as the imported goods became more expensive. In addition, firms reduce their imports as a result of a positive shock to import tax. This is an additional cost to firms which have to take this effect into consideration, notwithstanding foreign exchange constraints prevailing in the economy. This double effect on firms raises the costs of imported intermediate inputs, which also raises the marginal costs of the firm, as shown in Figure 2. Because the country imports a large number of goods, imported inflation rises with the tax on imports, which raises the domestic inflation even further (since imported inflation constitutes a large part of domestic inflation). This leads to a decline in output, and a subsequent decline in private consumption. Overall, the effects of increases in import taxation are similar to the effects of a tax on labour income although slightly different in the magnitudes of changes in consumption. Regardless, the fall in output resulting from both taxes is small.

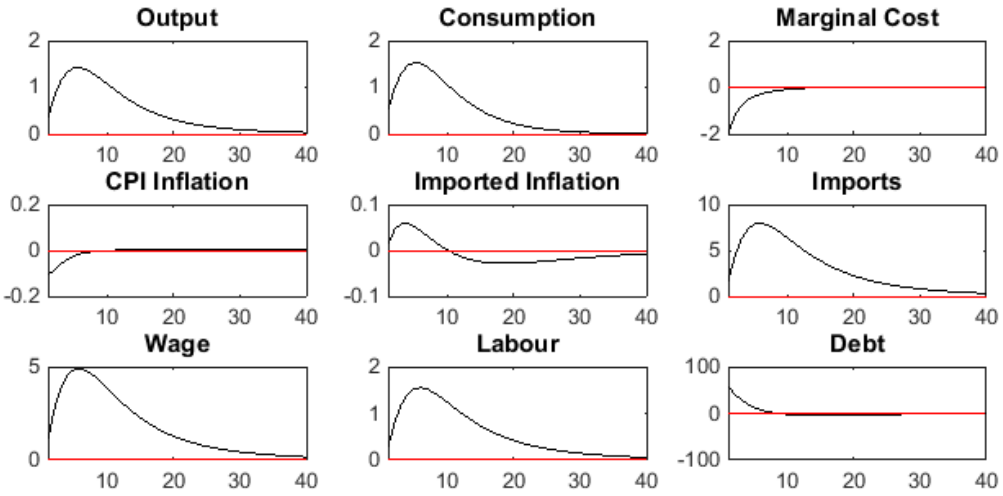
6.3 Government Expenditure Shock

Figure 3 presents the impulse responses of the variables after a positive shock to government expenditure. The effect of a rise in government expenditure seems to defy the

constraining effect of limited foreign exchange. Increasing government expenditure raises output and private consumption immediately by 0.8 percentage points, they then subsequently rise further before gradually declining to their steady state levels. In this case, there is an immediate and rather large increase in production, and, thus GDP. In this case, optimising households increase consumption because, government expenditure is not directly associated with increased taxation, but rather increases with foreign financial inflows such as aid. Governments in LIEs facing foreign exchange problems usually have limited access to international financial markets and therefore tend to finance their expenditure by borrowing domestically, which increases domestic government debt levels.

In theory, private demand would decrease if agents believe increased government expenditure will be financed through higher taxes. In the context of a somewhat anomalomous fiscal policy, these outcomes are much more uncertain. Aid among other things acts as a wedge between revenues and expenditure. Notwithstanding the rise in aggregate demand, the results show that marginal costs decline. The reduction in marginal costs reduces the operating costs of firms despite foreign exchange problems which reduce access to intermediate inputs. Firms maintain their labour force, and so employment remains stable while wages rise.

Figure 3: Impulse Responses to a Government Expenditure Shock



A one percentage point increase in government expenditure increases output by less than one percentage point on impact, but rises above one percentage point soon after the impact. This result is consistent with most of the literature on government expenditure multipliers (see Blanchard and Perotti, 1999). Inflation falls (Figure 3) although the literature postulates an increase in inflation under such circumstances, and imported inflation seems to rise with the increase in imports. As a result, consumption rises by almost the same proportion as output. Moreover, in an open economy setting, if you

increase government spending, often time consumption rises but via the current account, because as output rises, people will import more. Thus this spending leaks through the current account and reduces the impact that government expenditure has on output. If however they are foreign exchange constrained, the ability of consumers or firms to import more is reduced, and thus consumption will rise as they spend more on domestic goods and not foreign produced goods.

A foreign exchange constrained economy therefore delivers a successful *non-Ricardian consumption effect* with Ricardian households, when responding to a positive government shock. This model differs from other DSGE models of Ricardian agents because it takes into account the large scale domestic and foreign borrowing of governments in LIEs. If inflation is manageable, private consumption can increase, despite the economy experiencing foreign exchange problems. In LIEs such as Malawi, increases in government spending can through the provision of subsidised inputs by government to the farming sector, increase local production and reduce domestic inflation. This means available foreign exchange can be used for importation of necessary intermediate inputs by firms, other than food, which might increase their productivity and aggregate output. In this model both output and consumption increase, despite the potential negative effect of future taxes on consumption.

6.4 Aid Shock

Figure 4: Impulse Responses to an Aid Shock (when fully spent)

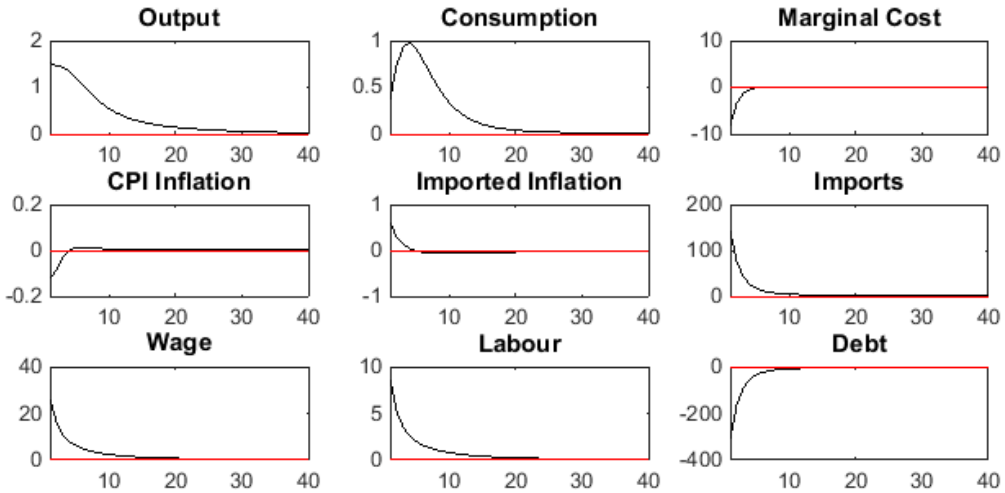


Figure 4 shows that the effect of a one percentage point increase in aid leads to an increase in output and consumption and decreases government debt. This is applicable when aid is fully spent and is used to increase the amount of imported intermediate

inputs, which expands output. Government may decide to fully spend incoming aid or decide to sterilise it. When aid is fully spent, an increase in aid induces an appreciation of the real exchange rate on impact. In an open economy, the appreciation of the exchange rate decreases competitiveness and exports decline, resulting in lower foreign exchange earnings. This outcome can worsen the foreign exchange shortages in the economy and further affect the volume of imported intermediate inputs and consumption. However, should the appreciation be small in magnitude, its likely adverse impact will be small and output and consumption will still rise as funds are disbursed.

A positive flow of aid to a foreign exchange constrained economy eases the foreign exchange pressures caused by excess demand for foreign exchange by importers. The model demonstrates that an increase in aid inflow results in the relaxation of the foreign exchange constraint and induces an appreciation of the real exchange rate on impact. Despite the worsening terms of trade in the domestic economy, the positive inflow of aid increases imported inputs, which increases production of firms. In response to positive production by firms, labour income and employment rise, thereby raising overall output. Increased labour income rises results in an increase in private consumption and output.

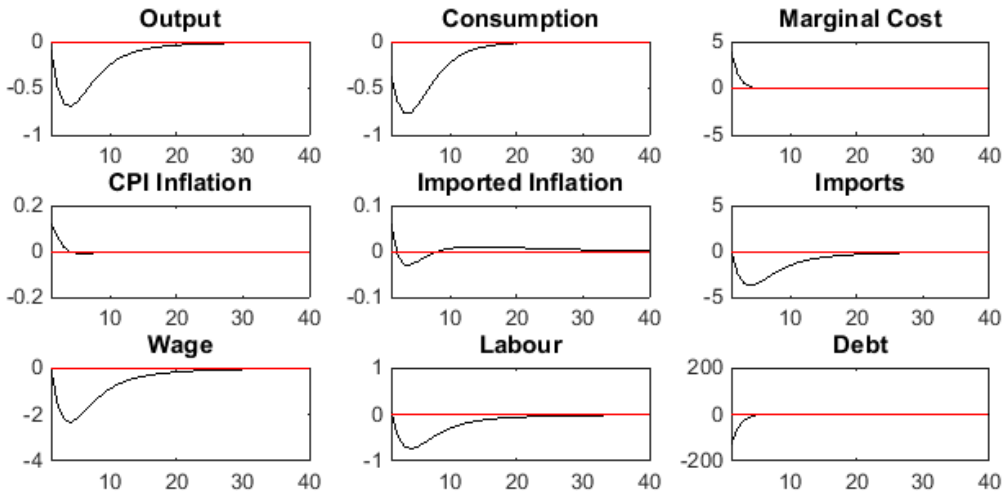
Furthermore, a positive aid shock reduces government debt. This is because aid supplements government revenue and reduces the government borrowing requirements. Positive aid inflows therefore lead to a decline in government debt.

An increase in aid (when aid is fully spent) to the government results in an improvement in the economy, despite an appreciation of the exchange rate. Although aid increases public expenditure, it also leads to a reduction in debt. This result is similar to findings in the literature on the effects of aid on debt, which show that a positive inflow of aid leads to a fall in debt in the economy, as it substitutes for domestic borrowing (Fagernäs and Schurich, 2004). Fagernäs and Schurich (2004) show that net domestic borrowing in Malawi has decreased following aid surges in recent years. In this case, government resorts to domestic borrowing when the anticipated amount of aid inflow does not materialise, raising domestic debts. However, in this case, domestic debt falls, showing that the increase in government expenditure is financed mostly through aid inflows and not through taxation.

Figure 5 reports the impulse responses to an aid shock when aid is not fully spent.

We reduce the ratio of the aid to GDP ratio from 0.12 to 0.01. We assume that not all aid is spent by the government directly, a certain proportion of aid enters into the economy through other channels such as non governmental organisations which sometimes delay in spending.

Figure 5: Impulse Responses to an Aid Shock (when not fully spent)



Although this leads to a reduction in government debt, other variables fail to respond in the same way. In this case, aid is insufficient to ease foreign exchange constraints. Since the economy is a predominantly importing economy, a decline in imports leads to low production by firms higher prices rise as firms try to recoup their costs (which is characterised by a rise in marginal costs in figure 5). This is shown by a rise in the CPI inflation on impact. At the same time, output and private consumption decline because this effect leads to a decline in the demand for factors of production and subsequent decline in aggregate demand. In an economy such as Malawi's therefore, sterilising aid has negative consequences. It fails to ease foreign exchange shortages in the country, and leads to a fall in importation of intermediate inputs, lowers productivity and ultimately the level of output.

6.5 Sensitivity Analysis

We carry out two types of sensitivity analysis to determine how the results we obtained might change given alternative calibration values. In this way we can determine how robust our results are to alternative specification/calibrations of the model. First, we adjust the key policy parameters of tax on labour income $\rho_{\tau_g^w}$ to 0.33 and tax on imports $\rho_{\tau^m g}$ to 0.44 respectively which increases the tax burden on households while raising government revenue.

The figures reporting the results of the alternative parameter specification are presented in an electronic appendix. The IRFs of a shock to labour income tax are similar to those in the original models. Changing the degree of the shock only changes the magnitude of the

fluctuations. The speed of convergence appears to be faster with the new parameter values. The IRFs of output, consumption, wage, labour supply, CPI inflation, and imported inflation die in the 10th period. In the original model the IRFs converge in the 30th period. The remaining variables converge before the 5th period with the decline in output and consumption being lower in the sensitivity analysis model relative to the original specification. The IRFs of variables from an import shock are similar to those of the previous model again differing slightly in magnitude and speed of convergence.

Second, we relax the foreign exchange constraint in order to assess the response of variables when the constraint is not binding. Figures 6 to 9 provide the results.

Figure 6: Labour Income Tax Shock

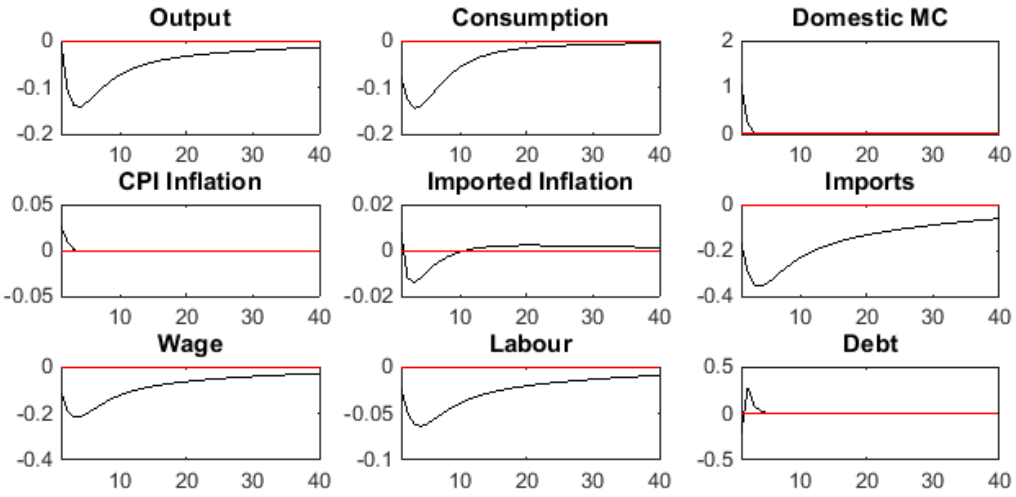
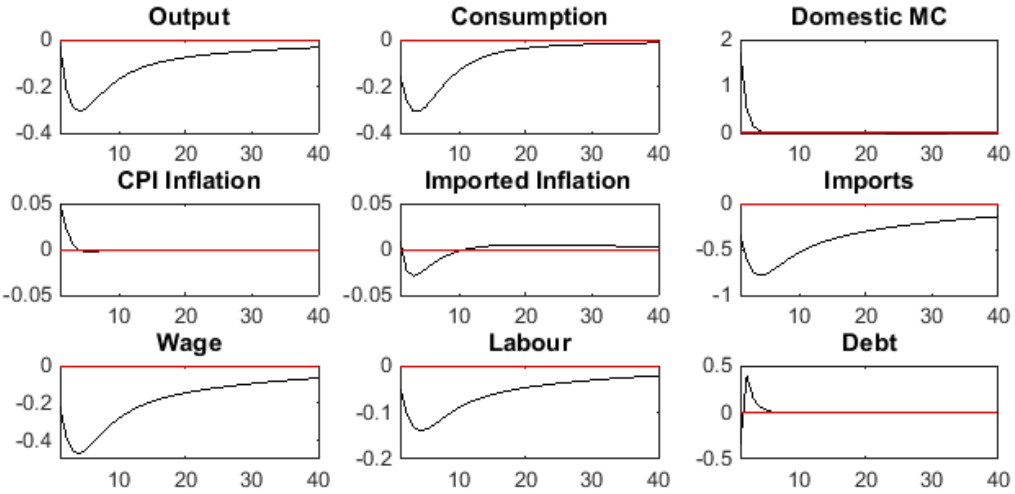


Figure 6 shows that in the absence of scarcity in foreign exchange, a positive labour income tax shock reduces output, consumption, wages, and employment level on impact. The result and the mechanism is the same as in figure 1. The only difference is that the effect of the shock is limited when the constraint is not binding. Output falls by less than 0.1% while consumption falls by 1% which is less than the approximately 0.2% decline in output when the economy faces foreign exchange scarcity.

The same trend is observed in Figure 7 with a positive import tax shock. The difference is in the magnitude of the decline in the variables and not the direction of the shocks.

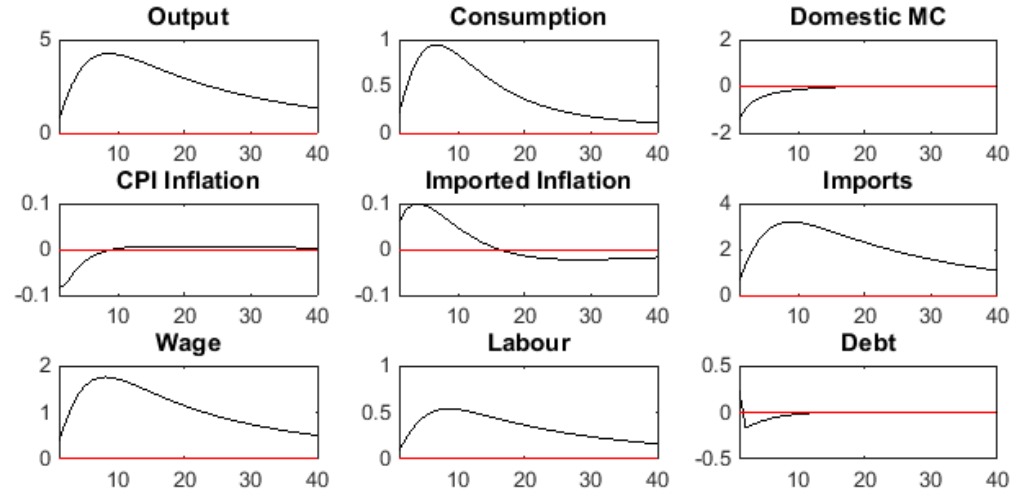
Figure 8 shows the effect of a positive government expenditure shock when the constraint is not binding. There is a huge improvement in the output response when foreign exchange is available. Output increases by 1% while consumption increases by only about 0.4% at impact. The increases reach their peaks at 4% and 1% respectively. The limited consumption response can be explained by the increase in imported inflation, which is generally passed on to consumers. The same effect is also observed in figure 9 following a

Figure 7: Import Tax Shock



positive aid shock.

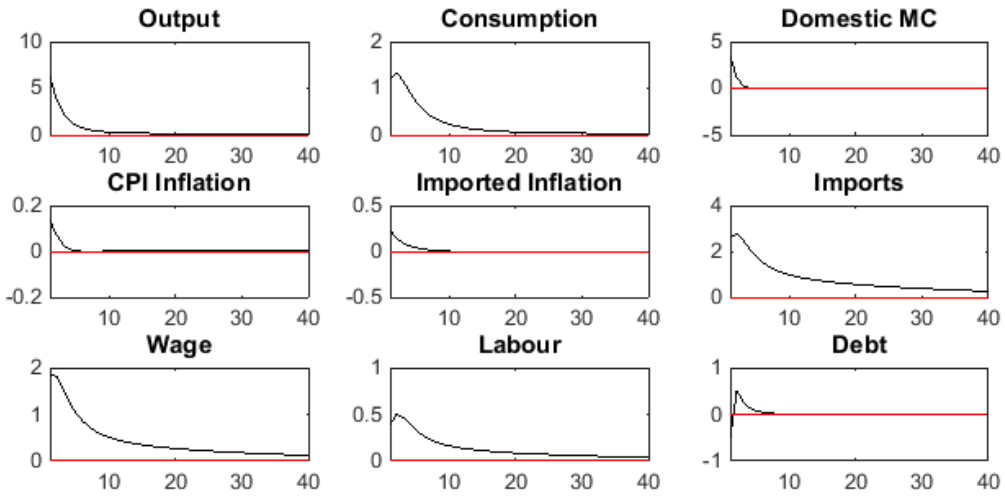
Figure 8: Government Expenditure Shock



A positive aid shock increases output, consumption, wages, and employment. At the same time, debt increases at impact but falls immediately after the impact. Imported inflation also rises as imports rise, following a positive aid surge in the economy without foreign exchange problems.

Figure 9 shows that despite the rise in imported inflation, CPI inflation falls. The fall in CPI inflation can be attributed to the increased availability of food and other consumables.

Figure 9: Aid Shock (when fully spent)



7 Conclusion

In this article, we contribute to the literature in two ways: First, we study fiscal policy and adjustment in a low income economy using a calibrated structural model of a small economy with a foreign exchange constraint and aid. The interaction of these key features of low income economies are seldom studied. Second, we assess the effects of an increase in government expenditure on consumption and other key macroeconomic variables. We assumed that the economy is populated with rational Ricardian households who are formally credit constrained but are able to use informal financial institutions to maximise their intertemporal utility, a feature present in most LIEs.

Among several findings, a key result we obtain is that an increase in government expenditure in developed countries where tax systems are fully operational leads to a reduction in consumption simply because almost all of the increase in government purchases is funded with revenue from increases in various taxes in the domestic economy. Second, foreign exchange constraints have a usual effect of contracting the economy as firms fail to honour contracts and fail to purchase the required imported intermediate inputs.

However, in most of LICs the case is different. An increase in government expenditure results in successive increases in both output and consumption. The increase in government expenditure does not lead to a fall in consumption because the tax burden is not much. In addition, even the consumption taxes only amount to not more than 7% of total taxe revenue. However, an increase in consumption tax reduces consumption for only a single period but afterwards, consumption peaks up again. As such, in most aid dependent countries, the effect of rising expected tax burden does not dampen private consumption. This result differs from findings by Fatás et al. (2001).

In this paper, we also find that a positive inflow of aid in a foreign exchange constrained economy eases the foreign exchange pressure caused by excess demand for foreign exchange by importers. This improves the macroeconomic conditions of the domestic economy by increasing government expenditure and reducing taxes. The model demonstrates that an increase in aid inflow induces an appreciation of the real exchange rate on impact. Despite the worsening terms of trade of the domestic economy, imported inputs increase and therefore labour, wages, and output all increase.

These results shed some light on how certain characteristics common in LIEs can impact fiscal policy. In Malawi, aid surges are associated with real appreciation. The appreciation does not worsen the economy, but rather increases the provision of factors of production, and therefore increases growth. Since the monetary authorities react to aid inflows, this also has implications for the conduct of monetary policy. We conclude that the availability and cost of foreign exchange in our model affects the cost of production for firms operating in countries facing foreign exchange constraints. Foreign exchange constraints increase the magnitude of most of the exogenous shocks to the economy. Since intermediate inputs and exports are very important to low income small open economies, any shock that affects the exchange rate has serious implications for the economy. The results cannot be generalised to all LIEs as macroeconomic conditions tend to differ from country to country and international relations dtermines the amount of aid each country may receive, which also differs among countries.

References

Adam, C., O'Connell, S., Buffie, E., and Pattillo, C. (2009). Monetary policy rules for managing aid surges in Africa. *Review of Development Economics*, 13(3):464–490.

Aiyagari, S. R., Christiano, L. J., and Eichenbaum, M. (1990). The output, employment, and interest rate effects of government consumption. Technical report, National Bureau of Economic Research.

Alpanda, S., Kotzé, K., and Woglom, G. (2010). The role of the exchange rate in a New Keynesian DSGE model for the South African economy. *South African Journal of Economics*, 78(2):170–191.

Banerjee, A., Duflo, E., Goldberg, N., Karlan, D., Osei, R., Parienté, W., Shapiro, J., Thuysbaert, B., and Udry, C. (2015). A multifaceted program causes lasting progress for the very poor: Evidence from six countries. *Science*, 348(6236):1260799.

Baxter, M. and King, R. G. (1993). Fiscal policy in general equilibrium. *The American Economic Review*, pages 315–334.

Berg, A., Mirzoev, T., Portillo, R., and Zanna, L. (2010). The Short Run Macroeconomics of Aid Inflows: Understanding the Interaction of Fiscal and Reserve Policy. Technical report, nIMF Working Paper 10/65.

Berg, M. A., Portillo, R., Buffie, M. E. F., Pattillo, M. C. A., and Zanna, L.-F. (2012). *Public investment, growth, and debt sustainability: Putting together the pieces*. Number 12-144. International Monetary Fund.

Blanchard, O. and Perotti, R. (1999). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. Technical report, National bureau of economic research.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of monetary Economics*, 12(3):383–398.

Chirwa, E. and Dorward, A. (2014). The Implementation of the 2012/13 Farm Input Subsidy Programme. *FISP Policy Brief*, 2.

Chiumia, A. and Simwaka, K. (2012). Tax policy developments, donor inflows and economic growth in Malawi. *Journal of Economics and International Finance*, 4(7):159–172.

Christiano, L. J. and Eichenbaum, M. (1992). Current real-business-cycle theories and aggregate labor-market fluctuations. *The American Economic Review*, pages 430–450.

Christiano, L. J., Trabandt, M., and Walentin, K. (2011). Introducing financial frictions and unemployment into a small open economy model. *Journal of Economic Dynamics and Control*, 35(12):1999–2041.

DeJong, D. and Dave, C. (2007). Structural macroeconomics.

Dornbusch, R. and Edwards, S. (1991). The macroeconomics of populism. In *The macroeconomics of populism in Latin America*, pages 7–13. University of Chicago Press.

Fagernäs, S. and Schurich, C. (2004). The fiscal effects of aid in Malawi. *London: Overseas Development Institute (ODI), Economics and Statistics Analysis Unit, Working Paper*, 7.

Fatás, A., Mihov, I., et al. (2001). The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence. Technical report, CEPR Discussion Papers.

Galí, J. (2008). Monetary Policy. *Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework*.

Galí, J., López-Salido, J. D., and Vallés, J. (2007). Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, 5(1):227–270.

Galí, J. and Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *Review of Economic Studies*, 72(3):707–734.

Handa, S., Natali, L., Seidenfeld, D., Tembo, G., Davis, B., Team, Z. C. T. E. S., et al. (2018). Can unconditional cash transfers raise long-term living standards? evidence from zambia. *Journal of Development Economics*, 133:42–65.

Honorati, M., Gentilini, U., and Yemtsov, R. G. (2015). The state of social safety nets 2015. *Washington, DC: World Bank Group*.

IRINnews (2011). Malawi: Farm subsidy programme shrinks. Electronic Newspaper.

Jooste, C., Liu, G. D., and Naraidoo, R. (2013). Analysing the effects of fiscal policy shocks in the South African economy. *Economic Modelling*, 32:215–224.

Justiniano, A. and Preston, B. (2004). Small open economy DSGE models: Specification, estimation and model fit. *Manuscript, Columbia University*, 1(2):3.

Justiniano, A. and Preston, B. (2010). Can structural small open-economy models account for the influence of foreign disturbances? *Journal of International Economics*, 81(1):61–74.

Marquez, J. (1985). Foreign exchange constraints and growth possibilities in the LDCs. *journal of Development Economics*, 19(1):39–57.

Mathisen, J. (2003). Estimation of the equilibrium real exchange rate for Malawi. *IMF Working Paper No. 03/104*.

McCallum, B. and Nelson, E. (2000). Monetary policy for an open economy: an alternative framework with optimizing agents and sticky prices. *Oxford Review of Economic Policy*, 16(4):74–91.

Monacelli, T. (2005). Monetary Policy in a low pass-through environment. *Journal of Money, Credit and Banking*, 37(2):19.

Moran, C. (1989). Imports under a foreign exchange constraint. *The World Bank Economic Review*, 3(2):279–295.

Morisset, J. and Cunningham, V. (2015). Why isnot anyone paying taxes in low-income countries?

Mountford, A. and Uhlig, H. (2009). What are the effects of fiscal policy shocks? *Journal of applied econometrics*, 24(6):960–992.

Mwabutwa, C., Bittencourt, M., and Viegi, N. (2013). Monetary Policy Response to Foreign Aid in an Estimated DSGE Model of Malawi. Technical report, Economic Research Southern Africa.

Ngalawa, H. and Viegi, N. (2013). Interaction of Formal and Informal Financial Markets in Quasi-Emerging Market Economies. *Economic Modelling*, 31:614–624.

of State, D. (2014). Department of state: 2014 investment climate statement.

Ogaki, M. and Park, J. Y. (1997). A cointegration approach to estimating preference parameters. *Journal of Econometrics*, 82(1):107–134.

Peiris, S. and Saxegaard, M. (2007). An estimated DSGE model for monetary policy analysis in low-income countries. *IMF Working Paper No. 07/282*.

Peiris, S. and Saxegaard, M. (2009). An Estimated Dynamic Stochastic General Equilibrium Model for Monetary Policy Analysis in Mozambique. *IMF Staff Papers*, 57(1):256–280.

Ramey, V. A. and Shapiro, M. D. (1998). Costly capital reallocation and the effects of government spending. In *Carnegie-Rochester Conference Series on Public Policy*, volume 48, pages 145–194. Elsevier.

Raza, W. A., Das, N. C., and Misha, F. A. (2012). Can ultra-poverty be sustainably improved? evidence from brac in bangladesh. *Journal of Development Effectiveness*, 4(2):257–276.

Schmitt-Grohé, S. and Uribe, M. (2003). Closing small open economy models. *Journal of international Economics*, 61(1):163–185.

Senbeta, S. R. (2013). Foreign exchange constraints and macroeconomic dynamics in a small open economy. Technical report, University of Antwerp, Faculty of Applied Economics.

Simwaka, K. and Mkandawire, L. (2008). The efficacy of foreign exchange market intervention in Malawi. Technical report, University Library of Munich, Germany.

Smets, F. and Wouters, R. (2003). An estimated dynamic stochastic general equilibrium model of the euro area. *Journal of the European Economic Association*, 1(5):1123–1175.

Stähler, N. and Thomas, C. (2012). Fimod-A DSGE model for fiscal policy simulations. *Economic Modelling*, 29(2):239–261.

Stork, Z. (2011). A DSGE model of the Czech economy: a Ministry of Finance approach. *Minstry of Finance Papers*, 1:43.

Walsh, C. E. (2010). *Monetary theory and policy*. MIT press.

Yasuharu, I. (2009). Fiscal Policy in an Estimated DSGE Model of the Japanese Economy: Do Non-Ricardian Households Explain All? Technical report, Economic and Social Research Institute, Cabinet Office.

Appendix

Sensitivity Analysis Results

Impulse response functions of the variables when the tax burdens have been increased.

Figure A.1: Sensitivity Analysis of Wage Tax Shock

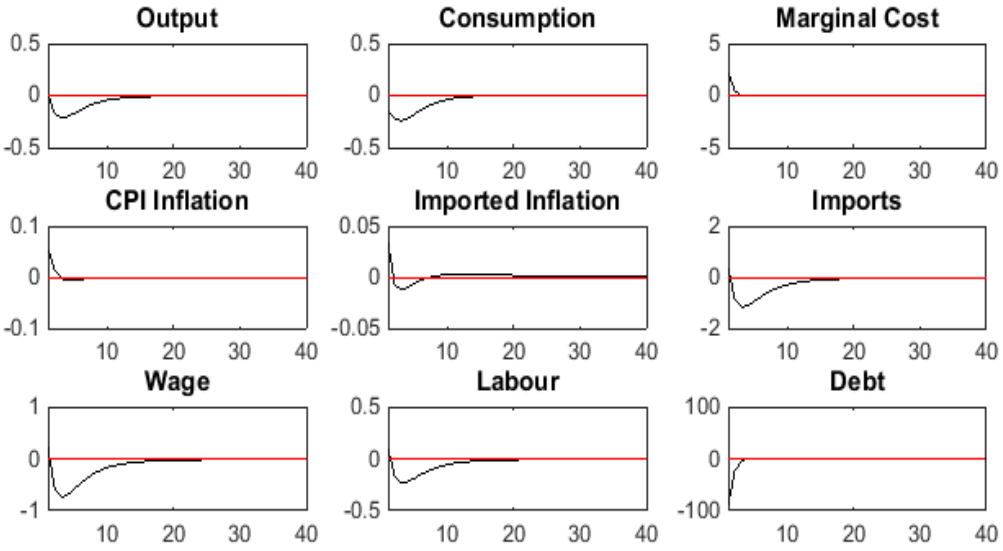


Figure A.2: Sensitivity Analysis of Import Tax Shock

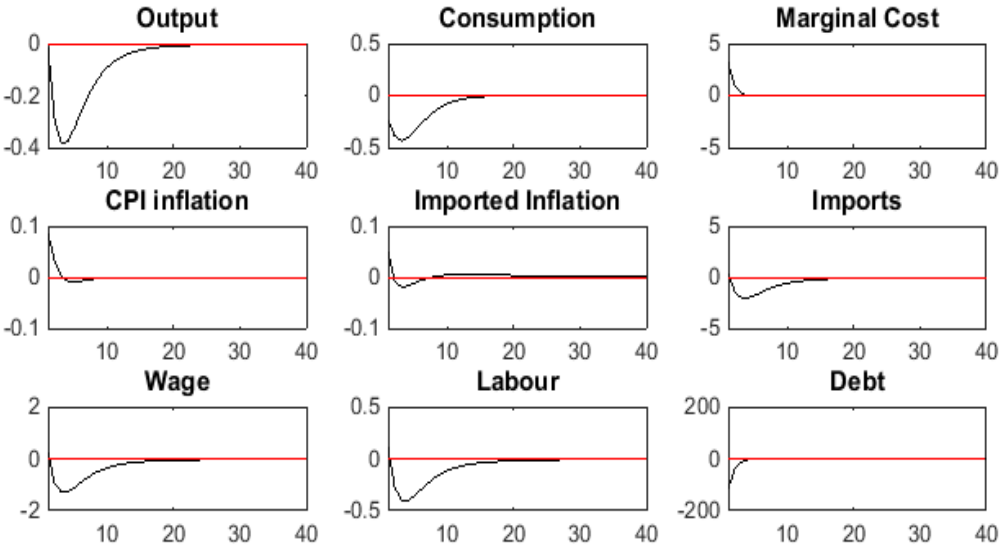
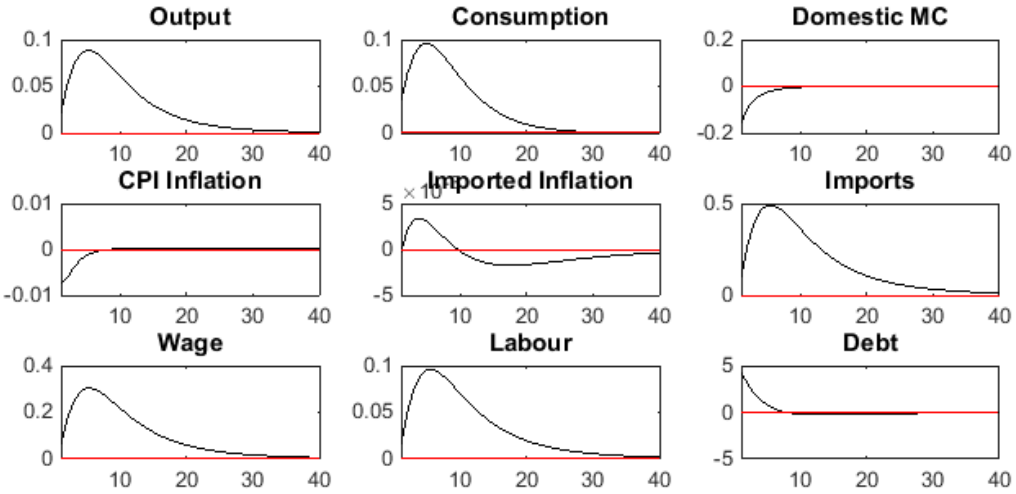


Figure A.3: Sensitivity Analysis of Government Expenditure Shock



Estimated Linearised Model

Household's Euler condition yields a partially forward looking IS curve in consumption as:

$$c_t = \frac{1}{1+h}E_t c_{t+1} + \frac{h}{1+h}c_{t-1} - \frac{(1-h)}{\nu(1+h)}(r_t - E_t\pi_{t+1}) \tag{C.1}$$

where $r_t - E_t\pi_{t+1}$ is the ex-ante real interest rate.

The Optimal holdings of domestic and foreign assets:

$$r_t - E_t\pi_{t+1} = r_t^* - E_t\pi_{t+1}^* + E_t\Delta q_{t+1} - \eta d_t - \varepsilon_{rps,t} \tag{C.2}$$

The marginal rate of substitution becomes

$$\varphi l_t + \frac{\nu}{1-h}c_t - \frac{h\nu}{1-h}c_{t-1} = w_t - \tau_t^w w_t - p_t + \tau_t^c) \tag{C.3}$$

Wage equation is given as:

$$w_t - p_t = \varphi l_t + \frac{\nu}{1-h}c_t - \frac{h\nu}{1-h}c_{t-1} + \tau_t^w w_t + p_t\tau_t^c \tag{C.4}$$

Labour equation becomes:

$$l_t = \frac{1}{1+\sigma_2\varphi}\left[\sigma_2(1-\alpha_1)s_t - \frac{\sigma_2\nu}{(1-h)}c_t + \frac{\sigma_2 h\nu}{(1-h)}c_{t-1} + y_{H,t} - a_{H,t} - \tau_t^w w_t\right] \tag{C.5}$$

The goods market clearing condition is given as:

$$y_{H,t} = (1-\alpha_1)\chi_g(\rho_1\alpha_1 s_t + c_t) + (\alpha_1\chi_g + (\chi_m - \chi_a)\chi_f)(\rho_1\alpha_1 s_t + \rho_1 q_t + c_t^*) \tag{C.6}$$

The terms of trade is defined as s_t, such that:

$$s_t = p_{F,t} - p_{H,t} \tag{C.7}$$

The real exchange rate is given as q_t , then:

$$q_t = e_t + p_t^* - p_t \tag{C.8}$$

Time-differencing the terms of trade gives:

$$s_t = s_{t-1} + \pi_{F,t} - \pi_{H,t} + \epsilon_{tot} \tag{C.9}$$

where $\pi_{F,t}$ is foreign inflation rate, $\pi_{H,t}$ is the domestic inflation rate and ϵ_{tot} is the terms of trade shock; and $\epsilon_{tot} \sim i.i.d.N(0, \sigma_d^2)$.

Imports are given as:

$$m_t = \varphi l_t + \frac{\sigma_1 v}{(1-h)}c_t - \frac{\sigma_1 hv}{(1-h)}c_{t-1} - a_{H,t} + y_{H,t} - \sigma_1(1-\alpha_1)s_t - \sigma_1(\tau_t^w m_t + \tau_t^m m_t) + \epsilon_m \tag{C.10}$$

The deviation of imported goods prices from the law-of-one-price is therefore defined as ψ_t , where:

$$\psi_t = e_t + p_t^* - p_{F,t}. \tag{C.11}$$

The partially forward looking New Keynesian Phillips curve for domestic price inflation:

$$\pi_{H,t} - \varsigma_H \pi_{H,t-1} = \beta E_t(\pi_{H,t+1} - \varsigma_H \pi_{H,t}) + \kappa_H mc_{H,t} \tag{C.12}$$

The marginal cost is given as: $mc_{H,t} = \sigma_1 (1 + \tau_t^m) + \sigma_1 w_t + \sigma_2 p_{F,t} - p_t - a_{H,t}$

Substituting for $w_t = p_t + \varphi l_t + \frac{\nu}{1-h} c_t - \frac{hv}{1-h} c_{t-1} - \tau_t^w w_t$ gives the marginal cost as:

$$mc_{H,t} = \sigma_2 (1 + \tau_t^m) - \sigma_1 (1 - \tau_t^w) + \sigma_1 \left(\varphi l_t + \frac{v}{(1-h)} c_t - \frac{hv}{(1-h)} c_{t-1} \right) + \sigma_2 (1 - \alpha_1) s_t - a_{H,t} \tag{C.13}$$

The Government Budget is given as:

$$\rho_{\tau_{tg}^w}(\tau_t^w + w_t + n_t) + \rho_{\tau_{tg}^c}(\tau_t^c + p_t + c_t)\rho_{\tau_{tg}^m}(\tau_t^m + p_{F,t} + m_t) + \rho_{b^g}(b_t - (r_{t-1} + b_{t-1})\beta^{-1} - 1) + \rho_{a_t}(q + a) = \rho_{gg} g_t \tag{C.14}$$

Table C.1: Parameter Values and Description

Parameter	Value	Description and Sources
ρ_{τ^w}	0.3	Speed of convergence of wage tax (Malawi Data)
ρ_{τ^m}	0.4	Speed of convergence of Import tax (Malawi Data)
ρ_{res}	0.08	Reserves to GDP ratio (Calibrated)
ρ_d	0.49	Debt to GDP ratio (Mwabutwa et al., 2013)
ρ_a	0.12	Aid to GDP ratio (Malawi Data)
ρ_x	0.29	Exports to GDP ratio (Mwabutwa et al., 2013)
ρ_m	0.48	Imports to GDP ratio (Mwabutwa et al., 2013)
ρ_g	0.82	Speed of convergence for government policy (Calibrated)
ρ_{gg}	0.24	Ratio of government expenditure to GDP (Mwabutwa et al., 2013)
$\rho_{\tau^w g}$	0.23	Ratio of wage tax revenue to GDP (Calibrated)
$\rho_{\tau^m g}$	0.34	Ratio of import tax revenue to GDP (Calibrated)
χ_a	0.12	Ratio of net aid to imports (Ngalawa and Viegi, 2013)
χ_r	1	Ratio of imports to foreign reserves (World Bank Econ. Indicators)
χ_c	0.3	Ratio of imported consumption goods in total imports (NSO)
χ_g	0.8	Consumption to GDP ratio (Mwabutwa et al., 2013)
χ_f	0.48	Total imports to GDP ratio (IMF country reports)
χ_m	0.7	Ratio of imported intermediate inputs in total imports (Senbeta, 2013)
β	0.99	Household discount factor (Gali and Monacelli, 2005)
ν	0.34	Intertemporal elasticity of substitution in consumption (Berg et al. 2007)
φ	2	Elasticity of labour (Berg et. al., 2010)
χ	0.24	Marginal disutility of working (Senbeta, 2013)
ρ^1	0.83	Elasticity of substitution between imported and home goods (Malawi Data)
θ_f	0.56	Elasticity of substitution between varieties of imported goods (Malawi Data)
α_1	0.5	Share of imported goods in consumption (Senbeta, 2013)
h	0.25	Coefficient of habit persistence (Senbeta, 2013)
χ_{risk}	0.92	Risk premium parameter (Alpanda, Kotze and Woglom, 2010)
σ_1	0.74	Share of labour in production of home goods (Mwabutwa et al., 2013)
σ_2	0.26	Share of intermediate inputs in production of home goods (Senbeta, 2013)
ς_F	0.5	Weight attached to past inflation for importing firms (Senbeta, 2013)
ς_H	0.5	Weight attached to past inflation by domestic producers (Senbeta, 2013)
θ_F	0.5	Fraction of importing firms that index their prices (Senbeta, 2013)
θ_H	0.5	Fraction of domestic producers that index prices (Senbeta, 2013)
ρ_H	0.66	Persistence of total productivity shock (Senbeta, 2013)
ρ_r	0.73	Persistence of interest rate (Ortiz and Sturz, 2007)
ϕ_π	1.6	Inflation stabilization (Alpanda, Kotze and Woglom, 2010)
ϕ_y	0.057	Output stabilization (Senbeta, 2013)
ϕ_e	0.18	Exchange rate stabilization (Senbeta, 2013)
ρ_a	0.12	Persistence of aid shock (IMF Country Report)
ρ_{y^*}	0.54	Persistence of foreign income shock (Alpanda, Kotze and Woglom, 2010)
ρ_{π^*}	1.2771	Persistence of foreign inflation shock (Alpanda, Kotze and Woglom, 2010)
ρ_{r^*}	0.8	Persistence of foreign interest rate shock (Alpanda, Kotze and Woglom, 2010)