



Macroeconomic Dynamics in Low Income Economies

by

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Thesis Presented for the Degree of

DOCTOR OF PHILOSOPHY

in the School of Economics

UNIVERSITY OF CAPE TOWN

February 2016

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Declaration

I declare that this thesis is my original work. Where other people's work is used, acknowledgements have been made. I declare that it has not been previously submitted for the award of a degree at any university.

Bertha Chipo Bangara

Signature

Date

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Dedication

To my father, Fredrick Steiner Bangara

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Acknowledgments

I would like to express my sincere gratitude to my supervisors, Professor J. Paul Dunne and Doctor Amos C. Peters, for their invaluable guidance, critical comments and suggestions. After countless revisions, rewrites and re-edits, I am humbled to acknowledge the time and energy that they dedicated to this work.

I am deeply indebted to the African Economic Research Consortium (AERC) for their generous financial support under the Collaborative PhD Program (CPP). I am also grateful for AERC's financial support at the Joint Facility for Electives (JFE) in 2012, AERC biannual workshops in Arusha and Nairobi, where the proposal and first work in progress of this thesis were presented. I also acknowledge the financial support from the University of Cape Town's School of Economics and the Carnegie Corporation for funding the last years of my study. Without their financial assistance, this work would have remained a work in progress.

I am very grateful to my husband, Norman Griffin Chikadza and my children, Angel-Moshala and Norman-Abel. Your understanding, support, and encouragement during my absence from home made my stay in Cape Town easy. You guys survived it all! The lonely times that you endured because of my absence cannot be recovered, but be assured that it was not in vain. To mum, Beauty, Jane, Fred, Prince, Charity, Catherine and Innocent: I am always grateful for your support and encouragement.

I acknowledge contributions from my fellow researchers at the AERC biannual conferences in Arusha (June 2013) and Nairobi (December 2013), AERC resource persons and UCT's School of Economic's weekly seminars, where the proposal of this work was first presented. I am indebted to my colleagues in the Collaborative PhD Program for creating an environment conducive to success. While I have attempted to mention names, this thesis has benefited from contributions from people too numerous to mention. Their input is greatly appreciated.

And lastly, To the Almighty God for all the wisdom, strength, knowledge and good health. I say you are Jehovah-Tsidkenu! I always tremble at the mention of your name.

Bertha Chipo Bangara (February 2016)

Abstract

This thesis investigates the dynamic effects of two interrelated characteristics of low income economies: Commodity concentration of exports, and foreign exchange constraints on the behaviour of key macroeconomic variables. The literature defines the problem of export fluctuations with reference to commodity concentration of exports, the ability to forecast the fluctuations, and the availability of foreign reserves to meet the effects of fluctuations. When a country's exports are concentrated in a single commodity or a few commodities, price fluctuations may lead to low export earnings and low reserves. This has implications for the macroeconomic environment, since low levels of reserves may not adequately mitigate the effects of price fluctuations. Therefore, we first explore the macroeconomic effects of price fluctuations in low income economies with a high commodity concentration of exports. Specifically, we examine the dynamic response of selected macroeconomic variables to tobacco price shocks in Malawi, using quarterly time series data from 1980 to 2012. Using innovation accounting in a structural vector autoregressive (SVAR) model with short-run restrictions, we find that a positive tobacco price shock increases gross domestic product (GDP), reduces consumer prices, and induces an appreciation of the real exchange rate. These results are also robust to SVAR in differenced data and co-integrating vector autoregressive (CVAR) models. The CVAR confirms the existence of a long run-relationship among the variables, with causality running from tobacco prices to the three variables.

Second, we provide an empirical analysis of the effect of shortage of foreign exchange in an import dependent, low income economy. It has become clear from the existing literature that low income economies tend to suffer from foreign exchange shortages exacerbated by their exports. Because of the concentration of their exports, these countries are susceptible to international price fluctuations which affect the level of foreign exchange. In addition, these countries tend to overvalue and fix their exchange rate, which worsens their terms of trade and leads to low levels of reserves. This causes foreign exchange shortages and leads to excess demand for foreign exchange by importers. We therefore investigate the implications of foreign exchange constraints on the dynamic behaviour of key macroeconomic variables in low income, import dependent economies. To achieve this, we develop a four-sector New Keynesian dynamic stochastic general equilibrium

(DSGE) model with foreign exchange constraints faced by importing firms. Calibrated to the Malawian economy, we demonstrate four important points. First, imports are a vital part of the production process for an economy such as Malawi, and they determine the response and direction of output and consumption. Second, foreign exchange availability is crucial to an import dependent economy. The degree of the foreign exchange constraint determines the degree of variability of the shock, but, does not change the direction of the shock. Third, increasing imports in an effort to increase productivity seems to reduce output and consumption, and induces a depreciation of the exchange rate, which worsens the economy's terms of trade. Fourth, contrary to much of the literature on foreign exchange constraints, the model illustrates that domestic contractionary monetary policy produces the conventional results on output, consumption and other variables.

Third, we employ a DSGE model with Ricardian households to examine the dynamic effects of government financing behaviour in a foreign exchange constrained low income economy, on selected macroeconomic aggregates. Motivated by expanding and largely inconclusive findings in the literature on the relationship between government expenditure and consumption in DSGE models, we include aid as an additional revenue to government, and model fiscal policy with Ricardian households in a foreign exchange constrained environment. Calibrated to the Malawian economy, we find that consumption, wages, and labour supply increase with increased government expenditure. Although contrary to results discussed in the literature, our results could be accurate, since the increase in government expenditure in most low income economies may come from a rise in aid inflows, and not only from an increase in taxes. To the extent that the expected funds materialise, government resorts to borrowing, leading to increased government debt. The model therefore reproduces the stylised atheoretical response of the variables to government expenditure, wages, and import tax shocks without the inclusion of non-Ricardian households in the model. Finally, a positive shock to aid improves the macroeconomic environment of the economy, although it induces an appreciation of the real exchange rate. This is because a positive inflow of aid relaxes the foreign exchange constraint and increases imported inputs, which increases production.

List of Acronyms

AD	Aggregate Demand
AERC	African Economic Research Consortium
AS	Aggregate Supply
CABS	Common Approach to Budgetary Support
CPI	Consumer Price Index
CVAR	Cointegrating Vector Autoregression
DSGE	Dynamic Stochastic General Equilibrium
FAO	Food and Agriculture Organisation
FCTC	Framework Convention on Tobacco Control
FEVD	Forecast Error Variance Decomposition
FISP	Farm Input Subsidy Program
GDP	Gross Domestic Product
GNI	Gross National Income
HIE	High Income Economies
HIPC	Highly Indebted Poor Countries
IMF	International Monetary Fund
IFS	Informal Financial Sector
IRF	Impulse Response Function
LIE	Low Income Economies
MCC	Millenium Challenge Corporation
MK	Malawi Kwacha
MDRI	Multilateral Debt Relief Initiative
NSO	National Statistical Office of Malawi
OPEC	Organisation of the Petroleum Exporting Countries
PAYE	Pay As You Earn
PRGF	Poverty Reduction Growth Facility
PRSG	Poverty Reduction Support Grants
RBC	Real Business Cycle
RBM	Reserve Bank of Malawi
SADC	Southern African Development Community

SAPS	Structural Adjustment Programs
SSA	Sub-Saharan Africa
SVAR	Structural Vector Autoregression
UIP	Uncovered Interest Parity
USD	United States Dollar
VAT	Value Added Tax
VAR	Vector Autoregression
WDI	World Development Indicators
WHO	World Health Organisation

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Chapter 1

Introduction

A major concern for Low Income Economies (LIEs)¹ is their concentration of commodity exports. This has been linked to the vulnerability of most developing economies because of fluctuations in export prices. The literature defines price fluctuations with reference to three key aspects of an economy. These are commodity concentration of exports, the ability to forecast the fluctuations that often lead to low or high prices, and the availability of foreign reserves to meet the effects of fluctuations (Katrak 1973). Low prices of exports that are concentrated in a single or a few commodities may lead to low export earnings and low reserves. Katrak (1973) argues that if fluctuations are properly forecasted, reserves may be used to mitigate their effects. Unfortunately, LIEs are well known for having a high concentration of commodity exports, poor forecasters of price fluctuations, and low levels of foreign reserves. Fluctuations in the international price of commodities also affect the level of foreign exchange reserves in these countries, which often leads to foreign exchange shortages (Diao et al. 2002, Dehn 2000a, Katrak 1973).

Extensive empirical literature links the shortage of foreign exchange in LIEs to concentration of commodity exports (Mohaddes et al. 2012, Senbeta 2011a, Moran 1989). When exports are highly concentrated, fluctuations in the main export commodity leads to low export earnings, and low foreign reserves. This problem is intensified by the fixed exchange rate regimes practiced in these countries. Most often, this leads to overvaluation of their currencies and worsen their terms of trade conditions. (Moran 1989) argues that large imports comprising intermediate inputs and capital goods intensifies the shortage

¹The World Bank classifies country's economies as low, middle or high-income using the World Bank Atlas method. This measure classifies low-income economies as those with a GNI per capita of \$1,045 or less in 2013. Middle-income economies are those with a GNI per capita of more than \$1,045 but less than \$12,746 while high-income economies are those with a GNI per capita of \$12,746 or more (2014 classifications). Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of \$4,125. Low and middle-income economies are sometimes referred to as developing economies. For convenience, these countries are grouped into low income economies (which includes lower middle income economies), and high income economies (which includes upper-middle income economies).

of foreign exchange because these countries fail to generate sufficient amounts of foreign exchange. These characteristics of LIEs have implications for the macroeconomic environment, since low levels of reserves may affect the level of imported inputs and may not adequately mitigate the effects of price fluctuations. This thesis investigates the implications of foreign exchange constraints on the dynamic behaviour of key macroeconomic variables in LIEs with a high concentration of commodity exports using Malawi as a case study. Specifically, the thesis tries to answer three broad questions. First, what are the macroeconomic impacts of commodity price shocks on output, consumer prices and exchange rate in LIEs? Second, what are the dynamic effects of foreign exchange constraints on key macroeconomic variables in low income economies? Third, how does fiscal policy and macroeconomic adjustment occur in a foreign exchange constrained economy? In order to investigate this, it is important to understand the differences between LIEs and high income economies (HIEs).

Low income economies (LIEs) are different from high income economies (HIEs), and the challenges that they face are different. LIEs are characterised by high foreign exchange constraints, concentrated commodity exports, undeveloped capital markets, high government debts (both domestic and foreign) and fiscal deficits (Ngalawa and Viegli 2011, Ubok-Udom 1982). Exports are concentrated on a single, or a few, mostly unprocessed, commodities which generate a large proportion of export earnings annually. Therefore shocks that affect the production and marketing of these key commodities, such as a major reduction in the international price, can destabilise the economy by reducing the inflow of foreign exchange. Moreover, LIEs tend to practise fixed exchange rate regimes and their governments constantly intervene in the foreign exchange market to stabilise their currencies (Simwaka and Mkandawire 2008, Simwaka 2004, Doroodian and Caporale 2001). This can lead to a shortage of foreign exchange, low debt-servicing capacity, and low levels of import cover, which cause a slowdown in economic growth (Agénor and Montiel 2008b, Ubok-Udom 1982).

HIEs, on the other hand, have low levels of debt, floating exchange rates, a wide export base, good access to financial markets, and are unlikely to suffer from foreign exchange problems (Bolnick 1991). Certainly, to study LIEs using models developed for HIEs without proper modification is inappropriate, and produces undesired results which obscure the problems in LIEs. For this reason, most recent macroeconomic analyses of LIEs have considered including specific features of these economies to differentiate them strongly from HIEs to generate meaningful results (Senbeta 2011a,b, Agénor and Montiel 2008b, Stiglitz et al. 2006).

Most studies on macroeconomic adjustment in LIEs are carried out using cross-country

datasets, that often control for heterogeneity and therefore fail to capture specific features that could produce different results (Stiglitz and Charlton 2006, Deaton and Miller 1996). The recent literature on macroeconomic fluctuations in LIEs reveal that low income economies respond differently from HIEs to similar shocks (Fernandez 2014, Mohaddes et al. 2012, Conforti et al. 2010, Diao et al. 2002). Cross-country studies that control for heterogeneity tend to overlook some “within” and “between” country characteristics. These may only be able to influence the results of analysis by carrying out case studies. For example, countries that have a high proportion of a single commodity in their export basket seem to be hit worse by setbacks than those with a diversified export basket (Conforti et al. 2010). This thesis uses Malawi as a case study to assess the dynamic responses of macroeconomic variables in a foreign exchange constrained LIE, taking into account the institutional make-up of these economies.

There are several reasons why Malawi is an interesting case for this analysis. Malawi is one of the smallest countries in Sub-Saharan Africa (SSA), with a predominantly agricultural economy (FAO 2003b,a). The country exports tobacco, tea, cotton, and sugar. Tobacco is the major export crop, earning 20 times more than tea. Tobacco alone generates over 60% of foreign exchange earnings annually and contributes about 40% to GDP, making Malawi the largest producer of tobacco in Africa (Tobacco Atlas 2014, SPAA 2012, FAO 2003b). Evidence suggests that Malawi’s reliance on tobacco has increased over the years. This is because of the implementation of the country’s Export Strategy in 1980, which intensified the growth of tobacco as the main export crop through estate farming. The Export Strategy of 1980 made the economy vulnerable to tobacco price shocks by reducing the cultivation of all other commodities in the country (Chirwa 2011, Harrigan 2003, FAO 2003b, Davies 2003). This made tobacco a difficult crop to replace, and fluctuations in tobacco prices have been detrimental to the economy because low prices seem to be synonymous with low foreign exchange reserves (Jomo 2010, Otanez et al. 2009).

Malawi is largely an importing economy and experiences frequent volatility in its exchange rate. Fluctuations in the exchange rate, coupled with seasonal demand and supply bottlenecks, are common in Malawi. This affects the level of foreign exchange reserves and has made planning for both the private and public sectors difficult. An example is the detrimental aftermath of a massive withdrawal of foreign aid between 2009 and 2015. This was an attempt to force the incumbent president to devalue the Kwacha and correct the macroeconomic mismanagement that prevailed during his rule. Another example is the 10% and 49% devaluation of the currency in May and September 2012, followed by the floatation of the Kwacha in the same year to stop its overvaluation (IMF 2012). In addition, the massive plunder of public resources from 2012 to 2015, called the “Cash-gate Scandal,” left the government coffers empty and foreign exchange reserves depleted

because the money was stolen in different foreign currencies. The population suffered because the government at this time could not even supply basic medicine and food to government hospitals (News and 2014 2014, BBC 2013). Furthermore, the reliance on natural rainfall for the growth of tobacco often leads to poor crop quality when the rains are scarce or heavy. The results are low prices of tobacco on the auction floor, low levels of foreign exchange, shortages of staple foods, and skyrocketing maize prices, which lead to inflationary pressures on almost all goods (IMF 2012). The natural price delivery mechanism brought a level of certainty in terms of foreign exchange supply. However, this was short-lived as the country still has a low supply of foreign reserves at 1.3 months of import cover. The withdrawal of aid and budgetary support in the 2014/15 fiscal year and declining export prices contributed to the scarcity of foreign exchange. In addition, monetary policy is conducted in an environment characterised by fiscal dominance, excessive dependence on donor aid, and the lack of central bank independence. These are coupled with a political and institutional set-up that makes the implementation of monetary policies difficult (Mangani 2011, Simwaka and Mkandawire 2008). This has worsened the macroeconomic environment of the country. Despite evidence of such pricing and supply uncertainties, little research has been devoted to determining the implications of a shortage of foreign exchange in the country. There has also been very little investigation of the nexus between fluctuations in the price of commodity exports and macroeconomic variables in Malawi. This thesis attempts to fill this gap.

Chapter Two examines the macroeconomic impact of commodity price shocks on output, consumer prices, and exchange rates in LIEs, using export prices of tobacco in Malawi as a case study. One of the key stylised facts of LIEs is concentrated exports comprising either a single commodity or very few commodities. Recent studies on LIEs show that the erratic nature of international commodity prices coincide with fluctuations in the performance of the domestic economy (Bulír and Hamann 2008, Bolnick 1991). Clearly, commodity prices have implications for macroeconomic variables and the growth of LIEs, such that the over-dependence of mono-crop economies such as Malawi on selected export crops puts the economy at risk. Given the nature of their exports, such countries are prone to instabilities in international commodity prices (Addison and Ghoshray 2013, Diao et al. 2002). Despite growing concerns, little attention has been paid to the dynamic effects of tobacco price shocks on macroeconomic variables in LIEs. Studies that exist are based on cross-country datasets, with no studies that we are aware of that have assessed the effects of tobacco prices on the Malawian economy, despite the importance of crops in this economy.

Chapter Two contributes to the literature by filling this gap. Employing a structural vector auto-regressive model (SVAR), with short run restrictions on quarterly data, we differenti-

ate the aggregate demand and aggregate supply (AD-AS) shocks as having temporary and permanent effects on output respectively following [Blanchard and Quah \(1988\)](#), [Sorensen and Whitta-Jacobsen \(2010\)](#) and [Cover et al. \(2002\)](#). We model tobacco price shocks as aggregate supply shocks having a permanent effect on the economy. Using this approach, we quantify the dynamic effects of tobacco price fluctuations to assess the effect, the direction, and the magnitude of tobacco price shocks on output, consumer prices, and the real exchange rate. We expect a positive relationship between tobacco prices and GDP, and a negative relationship between consumer prices, the real exchange rate, and tobacco prices. This is consistent with earlier studies on commodity price shocks in developing economies and those on the effect of productivity shocks on aggregate supply ([Diao et al. 2002](#), [Deaton 1999](#), [Blanchard and Quah 1988](#)).

Although recent research on SVARs supports the estimation of SVAR in levels (see for example, [Ngalawa and Viegli 2011](#), [Bernanke and Mihov 1997, 1998b](#)), other research advocates for estimating SVARs in first difference, or accounting for the long-run relationships among the variables by estimating a cointegrating vector auto-regressive model. Therefore, to check for consistency of the results, we estimate a SVAR on the differenced data and a cointegrating VAR that account for long-run relationships among the variables. From the conclusions reached by [Ngalawa and Viegli \(2011\)](#) and [Bernanke and Mihov \(1997\)](#), we expect the results from the different models to be the same.

While SVARs are simple and provide a good interpretation of structural shocks, dynamic stochastic general equilibrium (DSGE) models seem to perform better in macroeconomic forecasting. DSGE models are derived from microeconomic foundations of constrained decision making. They are structural, and perform better following the estimation of deep parameters, making it possible to avoid the Lucas Critique². DSGE models emphasize agents' inter-temporal choices, where agents dynamically maximise their objectives subject to a budget constraint. The model captures the interactions between policy actions and the behaviour of economic agents, while giving a detailed specification of the stochastic shocks that cause economic fluctuations ([Sbordone et al. 2010](#)). DSGE models provide an allowance to trace more clearly the transmission mechanism of the shocks in the economy (*ibid*). Therefore the remaining chapters make use of the DSGE model because of its attractive microeconomic features.

Chapter Three explores the effects of foreign exchange constraints on the dynamic responses of selected macroeconomic variables in low income economies, using a DSGE model calibrated to a LIE. Specifically we examine the dynamics of macroeconomic vari-

²Where models with parameters that do not vary with policy interventions are matched when assessing the effects of a policy change.

ables in a foreign exchange constrained economy where firms face foreign exchange shortages in the importation of intermediate inputs. LIEs face foreign exchange problems which are exacerbated by the implementation of fixed and managed float exchange rate regimes. In such circumstances, a large amount of foreign reserves are used to defend the currency. These countries rely heavily on foreign aid, a single export commodity, and foreign financial inflows, such as remittances. The unpredictable nature of export earnings, aid, and remittances contribute to variability in foreign exchange prices and in the level of foreign reserves. Often low export prices, low levels of remittances and aid, lead to low foreign reserves and foreign exchange constraints (Bulír and Hamann 2008). The concentration of exports in a single commodity or just a few commodities means that shocks that affect the production and pricing of these commodities affect foreign exchange earnings and reduce foreign exchange reserves (ibid). Despite the problems of foreign exchange, LIEs are further characterised by high levels of imports of intermediate inputs and consumption goods because production in some sectors of the economy depends solely on imported inputs. Therefore the availability of foreign exchange influences the level of production and growth in LIEs (Stiglitz and Charlton 2006, Lensink 1995, Moran 1989).

Polterovich and Popov (2003) state that an increase in the level of foreign exchange in a developing economy enhances the confidence of foreign investors. This is because investors are able to repatriate their profits, apart from the usual objectives of holding reserves, where foreign reserves act as a security to the domestic economy. In addition, foreign reserves enhance productivity because domestic producers and consumers are able to access foreign produced goods (ibid). However, low foreign reserves force firms to reduce their import demands, and lead them to source the foreign currency at a high price in parallel (black) markets. This raises a firm's operational costs, but also affects the pricing decisions of the final goods (Senbeta 2013, 2011a).

Although LIEs have experienced shortages of foreign exchange for a long time, studies that analyse the dynamics of macroeconomic variables in response to exogenous shocks in these countries do not include the problem of shortage of foreign exchange. Those that incorporate the foreign exchange unavailability problem are cross country studies (Moran 1989). The only studies that include the problem of foreign exchange in a DSGE model are those of Senbeta (2013) and Senbeta (2011a). Calibrated to Ethiopia, Senbeta (2013) concludes that the model with foreign exchange constraints produced greater variability than the standard dynamic stochastic general equilibrium (DSGE) model. In addition, Standard New Keynesian dynamic stochastic general equilibrium (DSGE) models assume implicitly that firms use capital and intermediate inputs that are domestically produced. However, most firms in LIEs import intermediate inputs and capital that is determined by the availability of foreign exchange. Therefore, these models fail to account for the

problems of a shortage of foreign exchange that these firms face. This chapter contributes to the literature by developing a four-sector DSGE model with a foreign exchange constraint problem. We calibrate the model on a low income economy using quarterly data on Malawi. This chapter provides a case study of a low income economy SSA country that has experienced an extreme foreign exchange unavailability problem for over a decade. The country relies on a single export crop for export earnings and depends heavily on foreign financial inflows to finance about half of its national government budget. Therefore, in the Malawi study we analyse the dynamics of shocks to a foreign exchange constrained economy when firms face foreign exchange constraints in their importation of intermediate inputs.

We focus on six experiments which are identified by a positive foreign monetary policy shock, a positive domestic monetary policy shock, positive import shock, positive aid shock, positive terms of trade shock and positive productivity shock. We assess the dynamic effects of foreign exchange constraints on output, consumption, marginal cost, imports, imported inflation, domestic inflation, CPI inflation, and real and nominal exchange rates. We include these variables in the model because these determine the macroeconomic responses of most low income economies. A shock that affects the importation of intermediate inputs tends to affect the dynamics of employment, output, inflation, and private consumption. We expect an appreciation of the exchange rate to worsen the domestic economy's terms of trade because exports and imports will fall. The fall in imports might lead to a fall in production, which may cause output and consumption to fall, despite marginal costs and imported inflation falling in the process. We also expect a positive aid shock to ease the foreign exchange constraint by supplementing the low foreign reserves that are in the economy. The easing of the foreign exchange constraint will generate a positive response of the variables to an increase in aid. Therefore, because aid increases government expenditure, output and consumption may also increase. These results are expected because they are in line with results from studies on low income economies by (Senbeta 2013, 2011a).

Chapter Four uses a DSGE model with foreign exchange constraints to examine the dynamic effects of government financing behaviour in a LIE. The effects of the spending and financing behaviour of the government continue to be of interest. Governments in LIEs are characterised by high government debts created to fund their increasing expenditures, and the implementation of tax structures that burden both investors and local households (Nation-Malawi 2011). There are many studies that have assessed the implementation of different fiscal policies and the dynamic responses of variables in LIEs using DSGE models (Jooste et al. 2013). However, recent studies in real business cycle (RBC) estimations focus on reversing the strong negative response of private consumption to government

expenditure which was first estimated by [Smets and Wouters \(2003\)](#). This is because the empirical literature postulates a positive effect of government expenditure on private consumption ([Galí et al. 2007](#), [Fatás et al. 2001](#)). Recent studies on fiscal policy using DSGE models have relied on the inclusion of non-Ricardian households to generate a positive effect of consumption to an increase in government expenditure. Most of the literature on DSGE models with Ricardian households³ conclude that private consumption responds negatively to increases in government expenditure ([Galí et al. 2007](#)). This is because any changes in government spending leads to a decrease in labour income through an increase in tax on income, which affects the households negatively. For example, in Malawi the tax structure was termed “retrogressive” as households ended up paying more tax on goods and services while corporations paid more taxes to government ([Chiumia and Simwaka 2012](#)).

Despite the [Smets and Wouters \(2003\)](#) outcome being identified as the result of the assumption of inter-temporal consumption of households in RBC models, many studies on fiscal policy have included the assumption of non-Ricardian households in their estimations ([Jooste et al. 2013](#), [Galí et al. 2007](#)). These studies have, however, left out key stylised factors that characterise LIEs, which may generate different results. [Agénor and Montiel \(2008b\)](#), [Lensink \(1995\)](#), [Moran \(1989\)](#), [Porter and Ranney \(1982\)](#) confirm that shortage of foreign exchange is a recurrent problem in LIEs. We cannot, therefore, continue to assume that governments in these countries are not affected by foreign exchange shortages. This chapter contributes to the literature by examining macroeconomic effects of fiscal policy in a DSGE model of a foreign exchange constrained LIE. We employ a DSGE model with Ricardian households to examine only the effects of fiscal policy and macroeconomic adjustment in LIES, using Malawi as a case study. We include Ricardian households only because we assume that low income economies have rational consumers. These households smooth their consumption across a determined period with little or no government benefits to assist in their inter-temporal consumption behaviour. [Ngalawa and Viegi \(2013\)](#) argues that households in LIEs smooth their consumption by either borrowing or lending in the informal financial sector (IFS). Therefore we can argue that although these households are formally credit constrained (thus cannot borrow from the formal financial markets), they are still rational, and maximise their utility inter-temporally, subject to budget constraints. In addition, we modify the government budget constraint to include aid as an additional source of income for government, apart from income from tax on imports and tax on labour income. We include aid in the government budget because much of the literature argues that one of the key stylised facts of low income economies is their reliance on foreign financial inflows to stabilise the domestic

³Ricardian households are rational consumers that maximise inter-temporal utility subject to an inter-temporal budget constraint.

economy.

We focus on four experiments; labour income tax shock, import tax shock, government expenditure shock, and aid shock. Calibrated to the Malawian economy, we expect the model to reproduce the stylised responses of the variables to government policies under analysis. Consumption, wages, and labour supply are expected to fall with an increase in labour income tax and import tax, while inflation should increase. This result is expected because taxes are meant to reduce income from labour and the amount of imported intermediate inputs and consumption goods by firms. Therefore a rational consumer will reduce consumption following an increase in tax on income and a profit maximising firm will reduce production following an import tax, which will eventually lead to a fall in output. Contrary to popular arguments that government expenditure is inversely related to private consumption in DSGE model estimations (due to the effect of tax on labour income), consumption in our model might respond positively to increased government expenditure. This may be surprising due to the foreign exchange problems currently in the model. However, this result might not be surprising for LIEs because the increase in government expenditure could come from a rise in aid inflows and not from taxes only. To the extent that the expected funds that government is yet to receive materialise, the government might resort to borrowing domestically or internationally to supplement the planned budget, and increase expenditure. Therefore, in the absence of expected inflows of aid, government borrowing might increase which may also raise the level of government debt.

The chapter expects a positive aid shock in a foreign exchange constrained economy to ease the foreign exchange constraints. In principal, an increase in aid inflow in a foreign exchange constrained economy eases the foreign exchange pressure caused by the excess demand for foreign exchange by importers, and in turn, relaxes the foreign exchange constraint. This should, therefore, improve the macroeconomic conditions of the domestic economy by increasing government expenditure and reducing taxes. This effect is meant to increase output and private consumption, although an appreciation is expected, as is the case with positive inflows of aid ([Adam et al. 2009b,a](#)). On the other hand, an increase in aid might worsen the macroeconomic condition of the economy if the effect of the appreciation outweighs the benefits of aid. Other studies found that a positive inflow of aid leads to a depreciation of the exchange rate, which worsens or improves the economy depending on the responses of the macroeconomic variables ([Adenauer and Vagassky 1998](#)). Therefore, we may argue first, that the proportion of labour employed by the government may influence the response of private consumption to increases in government expenditure in DSGE models. This is because if government employs a large proportion of people, increases in government consumption may mean increases in labour

income, as government may supplement expenditure with foreign aid. Second, LIEs may produce the opposite of the result in high income economies when certain features specific to LIEs are included in the model. The changes in private consumption can therefore be attributed solely to the way increased government expenditure is financed. Third, the effects of aid depend to a large extent on how the economy responds to the inflow of aid.

The next chapter examines the macroeconomic effects of commodity price shocks in a LIE using Malawi as a case study. The chapter analyses the effects of tobacco price fluctuations on selected macroeconomic variables in Malawi.

University of Cape Town

Chapter 2

Macroeconomic Effects of Commodity Price Shocks in a Low Income Economy: The Case of Tobacco in Malawi

2.1 Introduction

There has been considerable debate over the implications of developing countries' dependence on commodity exports for growth, including concerns about the implications of commodity price changes on macroeconomic variables in these countries (Diao et al. 2002). Despite this, little attention has been paid to the effects of commodity price shocks and their dynamics in developing economies. This is regrettable, given that low income economies (LIEs) may be prone to instability in international commodity prices due to the nature of their exports (Addison and Ghoshray 2013). It is important to understand the implications of over-dependence on commodity exports, especially in mono-crop export countries which defines most low income Sub-Saharan African (SSA) economies. These implications can provide insights into whether the effects of commodity price shocks can be used as an early signal for potential instability in the macro-economy that might need immediate intervention. For example, the oil price shocks of 1973-74 and 1979-80 were visible events that preceded the turmoil in various markets in both developed and developing economies, as both shocks were followed by worldwide recessions. The coincidental timing of the shocks and macroeconomic disturbances were too close to ignore a possible causal link (Jones and Leiby 1996). Moreover, the 1986 OPEC members' disagreements

and the Iraqi invasion of Kuwait led to a collapse in the price of oil and an economic recession, which was preceded by a 9% reduction in world oil production due to uncertainty in the oil markets. These events led to an increased academic interest in oil shocks in developed economies.

Most of the existing literature on commodity price shocks focuses on the effects of commodity prices when explaining business cycles of high income economies, with a few studies focusing on developing economies (Iwayemi and Fowowe 2011, Kilian and Park 2009, Hamilton 2009, 2005, Kilian 2005). Those studies that focus on developing economies are based on cross country datasets, with only a small portion focusing on case studies of small open economies. This has been the case, despite the fact that cross country studies fail to address problems of heterogeneity within and between countries. Factors that affect the macroeconomic variables differ between developed and developing countries and also differ among developing countries (Stiglitz and Charlton 2006, Deaton and Miller 1996). For instance, developing economies are different from developed economies in many ways and among the key features of this is the dependence of developing economies on the export of a single commodity or very few commodities, or on mostly agricultural commodities. This indicates that their export earnings and domestic economies are susceptible to fluctuations in international prices. Stiglitz et al. 2006 and Katrak (1973) argue that fluctuation of international prices has more serious economic implications for developing economies than for developed economies (Stiglitz et al. 2006, Katrak 1973). In addition, the recent literature states that responses of developed economies to a shock in commodity prices differ from the responses of developing economies. They maintain this is partly because the policies that operate in most low income economies are not effective in stabilising the economy in the way they are in developed countries¹ (Lin and Ye 2009, Stiglitz et al. 2006, Masson et al. 1998, 1997).

To incorporate the characteristics of these economics in macroeconomic models and to forecast properly the effects of commodity price fluctuations, there is a need for case studies on low income economies. This is because most recent studies on the effects of commodity price fluctuations and macroeconomic adjustments find that the response of economic variables to shocks to commodity prices depends on several factors. These include: The nature of the shock, the structure of the economy, the effectiveness of the domestic policy-making process, and the ease in handling price fluctuations (Deaton and Miller 1996, Kose and Riezman 2001). Most importantly, the percentage of the commodity

¹For example, Ngalawa and Viegı (2013) in their analysis of the interaction between formal and informal financial sectors in LIEs, argue that, while inflation targeting is an alternative in HICs, it is an unlikely option for the majority of low income countries. (Masson et al. 1998, 1997) point out that the preconditions for adopting an inflation targeting framework are not yet present in LIEs. Only a few LIEs have so far adopted inflation targeting as a monetary policy strategy, as revealed by a recent study on developing countries by Lin and Ye (2009) in which only one out of 13 countries is a LIE.

in the country's GDP, and the percentage component of the commodity in the total export earnings determines the effect of the price shock on the economy (ibid). This suggests that to understand the dynamics and the determinants of commodity price shocks in LIEs, it is also important to understand how to forecast commodity price shocks and know how these shocks propagate in the economy.

This chapter contributes to the literature by providing a case study of a developing economy and LIE, namely Malawi, concerned with the macroeconomic impact of price shocks to its major export crop. As discussed in the previous chapter, Malawi possesses most of the LIE stylised characteristics. These include an agricultural economy, a single-export-crop commodity (tobacco) in total exports, and weak industrial and financial sectors (FAO 2003b). Specifically, we investigate the interaction of tobacco price shocks with selected macroeconomic variables by determining the effects of fluctuations in tobacco prices on the economy. We further determine the channels through which tobacco price shocks are transmitted to other macroeconomic variables. This entails the identification of selected policy options that channel the effects of tobacco price shocks in the economy.

The remainder of the chapter is organised as follows: Section 2.2 discusses the importance of tobacco crops and their production and marketing in Malawi, and reviews the related literature on the future of tobacco production in Malawi. Section 2.3.1 reviews the empirical literature on commodity price shocks, followed by a discussion of the chosen theoretical model in section 2.3.2. The estimation, identification and data issues are presented in section 2.4, with section 2.5 providing the estimation, inferences and model results, and finally section 2.6 presenting the conclusion.

2.2 Tobacco Production in Malawi

The commercial cultivation of tobacco in Malawi dates back to the 1890s, and by the 1920s, the crop had assumed a significant position in the economy (FAO 2003b). The expansion and contractions of tobacco production remained a major aspect of the colonial economy. In 1964, soon after Malawi's independence, the Malawian President established the Agricultural Development and Marketing Corporation (ADMARC) to prioritize the development of estate growing of Burley leaf tobacco when production was shifting globally from the developed to the developing countries (ibid). Tobacco then took on a more central role in the country's political economy. Large segments of the nation's political leadership and economic elite invested in the crop, which had been backed by supportive policies, regulations, and public resources already put in place by the colonial govern-

ment. Average annual output in 1961-1963 totalled 15 000 tonnes, but increased rapidly by about 90 per cent by the early 1970s and reached more than 110 000 tonnes in the 1990s as importers sought substitutes for the high cost Zimbabwe leaf which had suffered from sanctions in the 1960s by the United Nations (FAO 2003b,a). In the 1970s, the international tobacco manufacturing companies identified Malawi as a possible ally in the fight against tobacco control, and this decision shaped the economy of Malawi forever. This is because it prompted the government to enact the Special Crops Act in 1972 and limit the production of tobacco, sugarcane and tea to estate production (Harashima 2008).

A series of exogenous shocks such as the 35% collapse in the terms of trade, drought of 1979-1980, and the Mozambican civil war exposed the fundamental weaknesses of the Malawian economy, which made the government's export strategy based on estate farming no longer viable (Otanez et al. 2009). The strategy concentrated on intensifying the growth of tobacco as the country's main export base, making it vulnerable to shocks (Harrigan 2003). This led to an import dependent economy, as smallholder farmers were largely marginalized. Food shortages and foreign exchange shortages followed. Prices remained unresponsive to smallholder farming activities despite numerous efforts aimed at increasing individual price elasticities, and the production of tobacco replaced food crop farming. With the rapid expansion of the industry in the 1970s and 1980s, tobacco became the country's primary source of wealth, political patronage, (non-governmental) employment, and foreign exchange earnings. During the colonial period, through to the late 1970s, participation in the lucrative cultivation of tobacco was restricted to an elite cadre of growers who owned or leased estates (FAO 2003b).

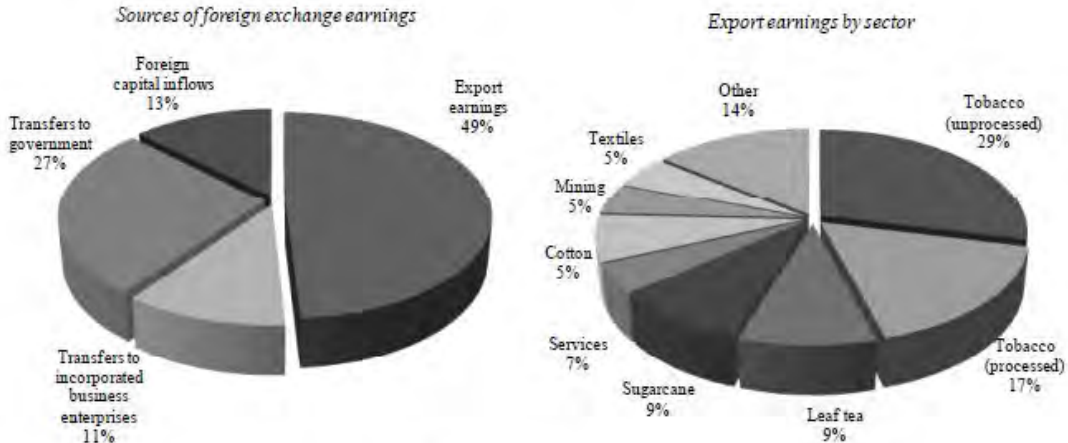
The removal of a fertilizer subsidy program during the Structural Adjustment Programs (SAPs) of the 1980s hastened the displacement of maize as a local crop, as it was costly to produce and had low returns. The Special Crops Act (1964) maintained earlier restrictions on smallholder farmers, preventing them, with few exceptions, from the cultivation of the higher value burley and flue-cured varieties of tobacco and the system of production controls remained firmly in place through the 1970s and 1980s (Tobacco Atlas 2014). This, together with a system of production quotas served as a primary means of allocating opportunities and distributing income and wealth in the country. Although the quotas were supposedly designed to control the overall size of the tobacco crop to approximate the committed demand of major international buyers, they also served as a primary means of allocating opportunities and distributing income and wealth in the country (FAO 2003b,a). This made tobacco difficult to replace as a crop and therefore importance of tobacco in Malawi cannot be over-emphasized in the current economic conditions.

Tobacco production is a major source of income for Malawi. The country was the 12th

largest producer and the 7th largest global exporter of the leaf in 2005 (Jomo 2010, Otanez et al. 2009). The world economy showed an interest in the low-grade, high-nicotine Malawi tobacco to replace the declines in tobacco production in the West because of new tobacco control regulations (Otanez et al. 2009). Tobacco still remains the country's main cash crop (which earns up to 76% of foreign exchange, employs up to 86% of the country's labour force, contributes around 40% to Gross Domestic Product (GDP), and 23% to government taxes) and the main foreign exchange earner for Malawi (FAO 2003b). In the 2014 tobacco selling season (which begins in March), tobacco sales earned about \$237 million from 113 million kilograms by July, registering a 3% decline from 2013 because of an increase in production compared to the number of buyers of the leaf (Tobacco Atlas 2014). Since tobacco is the main foreign exchange earner for Malawi, shocks to its prices have an affect on the macroeconomic policies of the country.

The expansion and contraction of tobacco production have been a major aspect of the Malawian economy since its inception in the 1890s (Chirwa 2011). Between 1961 and 1963 the crop assumed a significant position in the economy, as 15,000 tonnes were produced annually. The annual growth of tobacco production increased and by 1990 production of tobacco was 110,000 tonnes annually (FAO 2003b). Tobacco is Malawi's largest industry and currently accounts for nearly 70% of the nation's export earnings. The tobacco industry is the largest employer in Malawi after the government (Chirwa 2011, Otanez et al. 2009, Davies 2003). Strong government support for the tobacco industry includes subsidies and tax breaks, and has led to the domination of tobacco crops in Malawi's export market (Davies 2003). Figure 2.1 provides sources of foreign exchange earnings in Malawi and shows tobacco's contribution to the economy.

Figure 2.1: Sources of Foreign Exchange and Export Earnings by Sector



Source: Malawi 2004 social accounting matrix (Benin et al. 2008).

As shown in Figure 2.1, tobacco exports account for approximately 50% of the country's

foreign exchange earnings in 2004, a figure which increased to over 65% by 2010. This means tobacco contributes about 50% in the export basket and 40 % of GDP, followed by tea, sugar, and cotton, which, when combined, contribute about 20% of the nation's exports (Davies 2003). The rest of foreign exchange earnings are provided by other export commodities, foreign capital inflows, and transfers to government and business enterprises. While some of the world's tobacco growers earn about 2% from tobacco exports, Malawi earns the highest share of export earnings from tobacco. Malawi has also dedicated a large portion of its land (4%) to tobacco production. Tobacco, nicknamed 'green gold' in the country, is the most profitable crop, with 20 times more value than tea (Geist et al. 2008). Specifically, Malawi produces the largest share of Burley tobacco, a high-grade tobacco with a high nicotine content which is considered to have a superior flavour to other tobacco types. Malawi's Burley tobacco constitutes nearly 20% of the total world's Burley tobacco and comprises 70% of total tobacco exports for Malawi, with the remaining 30% coming from Flue-Cured and Virginia types of tobacco (FAO 2003b).

Table 2.1: Global Tobacco Export Earnings (million US\$)

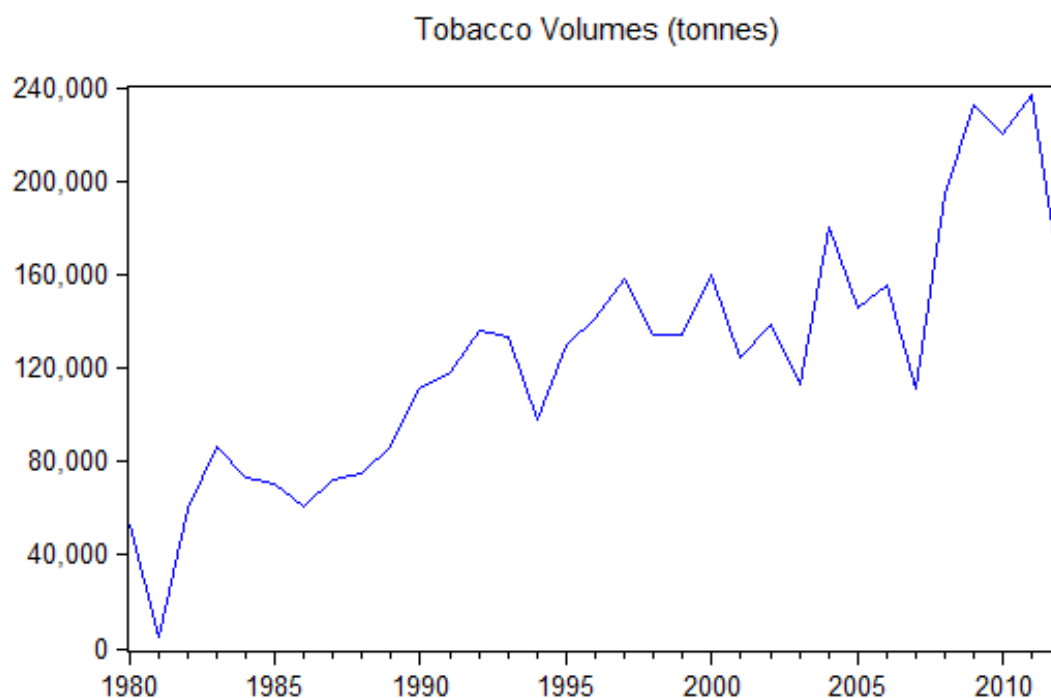
Country	Total Export Earnings	Tobacco Earnings	As % of Total Earnings
Argentina	12,235	143	1.2
Brazil	35,965	804	2.2
Malawi	383	293	76.5
Zimbabwe	1,235	450	36.4
Turkey	14,715	309	2.1
India	19,795	163	0.8
Indonesia	33,815	81	0.4
Thailand	32,473	142	0.4
China	84,940	141	0.17

Source: <http://www1.american.edu/ted/maltobac.htm>

Table 2.1 shows that export earnings from tobacco leaf in Malawi are second only to those of Brazil, despite the country being small. The tobacco industry is supposed to increase economic growth and promote development in Malawi. This led the government to introduce laws that restricted growth of tobacco to estate farming by early 1970s. These laws led to tobacco crops registering a 90% increase in the early 1970s with 29,000 tonnes of total tobacco the 1970s and more than 110,000 tonnes in the 1990s (FAO 2003b).

The international market price of tobacco declined by 50% in the past 10 years in real terms, due mostly to campaigns against tobacco in industrialised nations which are the main markets for tobacco leaf produced in Malawi (Jaffe 2003). The drop in demand has caused a decline in market prices of tobacco, thereby lowering export earnings and affecting the ability of the country to earn foreign currency (see Figure 2.2).

Figure 2.2: Trends in Tobacco Volumes in Malawi (1980-2012)

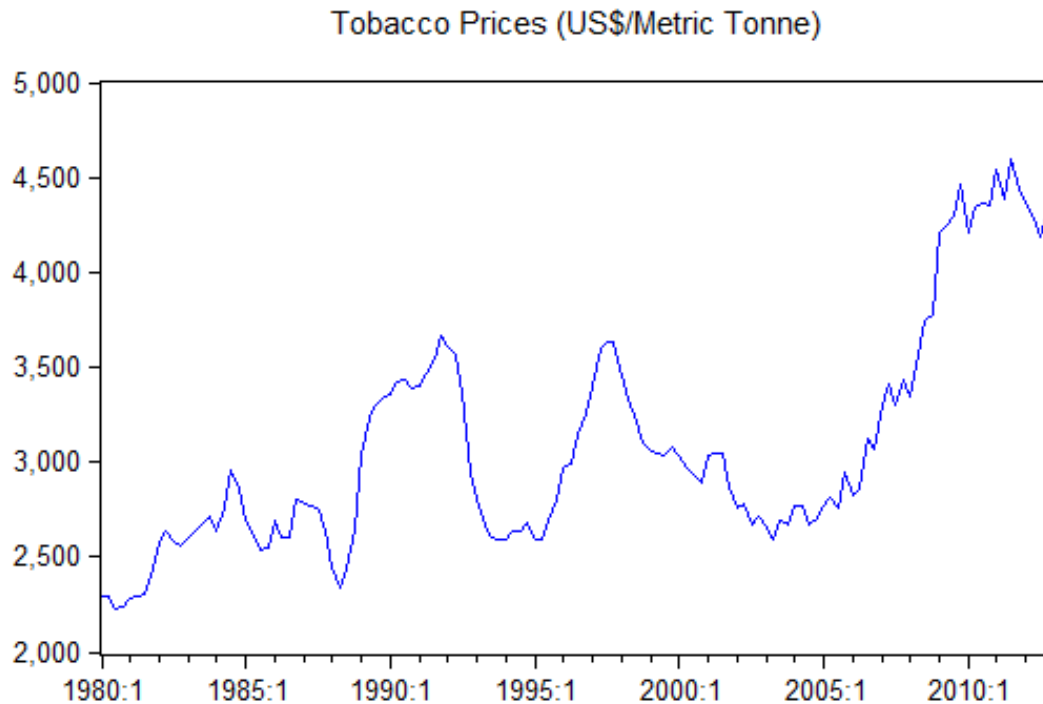


Despite the importance of the tobacco crop in Malawi, the country's role in the international tobacco market as a whole is limited, due to the small size of the country (Jaffe 2003). The country faces a dilemma because, while tobacco prices are declining, Malawi relies heavily on tobacco export earnings. This has made the economy more vulnerable to external shocks. Tobacco price fluctuations have always put the country at a disadvantage. This is because fluctuations in tobacco prices mean fluctuations in the inflow of export earnings, and also fluctuations in foreign currency, and other important macroeconomic variables. The reason for this is because almost all of the tobacco that is produced in Malawi is exported. Unlike in China, where almost all of the tobacco produced is consumed domestically, the domestic market does not provide a market for the tobacco produced in Malawi (Tobacco Atlas 2014).

The tobacco industry in Malawi has been described as the 'tinted gold', the 'sinking ship' or the 'dying industry', or an industry that is 'standing on one leg' because declining international tobacco prices are worsening the macroeconomic environment of the country (Jaffe 2003). Tobacco prices suffered a 25% decline between 1991 and 1995, a 20% decline between 1997 and 2004, a 22% decline between 2009 and 2010 and a 37% decline between 2010 and 2011² (IMF 2012). With the constant decline in tobacco prices, it is surprising that the Malawian government still sees tobacco as the most lucrative industry and also

²See the IMF presentation of 2011 on Malawi's macroeconomic environment

Figure 2.3: Volatility in Tobacco Prices (1980-2012)



the most effective means of earning foreign currency need to pay its loans and promote development. The government views the production of tobacco as the only vehicle for rural development and continues to encourage the production of tobacco as a cash crop for export.

2.3 Literature Review

2.3.1 Theoretical Framework

It is important to properly identify the model to determine the channels through which a shock propagates in the economy. The literature defines disturbances that have a permanent effect on output as 'supply' disturbances, while those that have a temporary effect are termed 'demand' effects. For example, [Blanchard and Quah \(1988\)](#) argues that supply disturbances increase steadily, causing the slow return of variables to their original value over time, while demand disturbances have a hump-shaped-mirror image effect on output. This theory has been adopted empirically by [Kilian \(2014\)](#), [Shah and Yuanyuan \(2012\)](#), [Rapaport \(2010\)](#), [Kilian and Park \(2009\)](#), [Elwood \(2001\)](#), and [Tatom \(1987\)](#) among others. While on the same, [Fernandez \(2014\)](#) uses the aggregate demand (AD)

and aggregate supply (AS) model, with price shocks categorized by demand and supply-side factors, and summarises the demand side factors as increasing wealth in developing economies, bio-fuel production, and financialisation of commodities which result in market speculations and macroeconomic cycles.

However, an important study by [Ball and Mankiw \(1992\)](#), proposes the theory of supply shocks, or shifts in the short-run Phillips curve based on short-run relative price changes and frictions in nominal price adjustment. Thus, large shocks entail costly price adjustments that firms have to make but not small shocks. This indicates that large shocks have a disproportionate effect on price levels and aggregate inflation depends on the distribution of relative-price changes. Since it is more controversial to define determinants of changes of inflation in the short-run (rather than in the long run, which is the growth in money supply), this study walks in the footsteps of many 1970s economists who emphasized the role of “supply” or “price” shocks (see [Ball and Mankiw 1992](#)).

Supply shocks are defined as the changes in certain relative prices. Theoretically though, it is not obvious why, for example, the famous supply shocks of the 1970s (which were increases in the relative prices of food and energy in the US) are inflationary. [Friedman \(1975\)](#) argue that this situation should not be inflationary. However, [Friedman \(1975\)](#) assumes that nominal prices are perfectly flexible, when in fact, they are not. As such, the economy responds to shifts in relative prices that, in the absence of frictions, would otherwise leave the price level unchanged. It is in this regard that we define consumer prices as aggregate supply shocks which are not long-term, but often lead to costly price adjustments by firms in the economy and have a disproportionate effect on price levels and aggregate inflation (see for example [Ball and Mankiw 1992](#)). When tobacco prices are lower than expected, the level of foreign exchange generated is low, leading to low foreign exchange reserves and high prices of foreign exchange. This leads to firms importing few inputs for production, resulting in low investment and low overall productivity for the economy. The scarcity of basic goods fails to match the aggregate demand, and therefore inflation rises.

We thus use the AD-AS framework to identify tobacco price shocks. We assume further that tobacco price shocks are short term in the economy and we model commodity prices as productivity shocks to the aggregate supply. We assume that the aggregate supply function may shift in response to a shock to the prices of the commodity, in instances when the shock is allowed to affect the aggregate supply directly. It is through this mechanism that commodity price shocks affect output using a Structural VAR model. A

structural specification of the model is defined as³:

$$AD(y, cp, \varepsilon) \tag{2.1}$$

$$AS(y, cp, \theta) \tag{2.2}$$

where AD is the aggregate demand function and AS is the aggregate supply function. The variables y is the real GDP, cp is consumer prices, θ is productivity and ε is real exchange rate.

Equation (1) states that aggregate demand is a function of output, consumer prices, and the real exchange rate. Notice that productivity here is only allowed to affect aggregate supply. This implies that when $\theta > 0$; a higher level of productivity may imply higher aggregate supply and therefore a shift on the aggregate supply function to the right and a downward move along the aggregate demand function⁴.

We assume that a positive productivity shock shifts the aggregate supply function outwards, increasing output in the process. Consumer prices react to a positive productivity shock by declining. A positive productivity shock that increases output increases the level of money supply in the economy, which raises interest rates and therefore appreciates the real exchange rate.

This leads to the hypothesis that a higher international price for tobacco should be associated with higher output, low consumer prices, and a higher price of domestic currency relative to a foreign currency (a real appreciation of the exchange rate). In the same way, lower international prices for tobacco should be associated with lower output, high consumer prices, and a depreciation of the exchange rate. The productivity shock is thus referred to as the international tobacco price shock, propagating through the economy using the aggregate supply function. A negative tobacco price shock will generate the opposite of the above positive shock, so output will decline, raising the domestic inflation rate and depreciating the real exchange rate.

We follow [Kilian \(2014\)](#), [Shah and Yuanyuan \(2012\)](#), [Rapaport \(2010\)](#), [Kilian and Park \(2009\)](#), [Elwood \(2001\)](#), and [Tatom \(1987\)](#) and identify a tobacco price shock as a shock to the aggregate supply function. We also follow [Kim and Roubini \(2000\)](#) and [Sims and](#)

³Our purpose is not to develop a perfect structural model but to investigate how tobacco price shocks affect output, consumer prices, and real exchange rate and estimate the appropriate channels to carry out this objective .

⁴see [Blanchard and Quah \(1988\)](#) p.657 for further clarifications

Zha (1995) to place the contemporaneous restrictions in the model. This allows shocks to aggregate demand and shocks to aggregate supply to be distinguished by modelling structural contemporaneous restrictions across different equations, rather than a recursive structure.

2.3.2 Empirical Literature

Following the oil price shocks of 1973, most macroeconomics researchers focused their attention on the economy's response to sudden and permanent decreases in the price of oil and the subsequent adjustment to the shock in developed economies (Shah and Yuanyuan 2012, Peersman and Van Robays 2009, Kilian and Park 2009, Kilian 2005). For example, Belke et al. (2010), Lunieski (2009), Bernanke et al. (1997) argue that there is causation between commodity price shocks and monetary policy. Frankel 1986, Cody and Mills 1991 and Marquis and Cunningham 1990 state also that commodity prices contain vital information that can help predict the future trajectory of monetary policies, following the overshooting model of Dornbusch (1976). Regardless of the difference in their findings, we can draw the conclusion that a key feature in most of the results is how commodity price shocks have affected the implementation of macroeconomic policies in developed economies, specifically that commodity price shocks determine most macroeconomic fluctuations globally.

Other researchers focused specifically on understanding the fluctuations of world prices of commodities apart from oil in developing economies (Deaton and Laroque 2003, Deaton 1999, Deaton and Miller 1996, Mendoza 1995, Deaton and Miller 1995, 1993, Deaton and Laroque 1992). These studies came into sharp focus with the argument that most developing countries are net oil importers, except for a few, and the conclusions drawn for developed economies cannot be drawn for low income countries. This is because, apart from suffering the oil price shocks, these countries also face declining prices of their agricultural commodity exports. Therefore these studies moved their focus from developed economies to assess the macroeconomic effects of commodity prices while incorporating the stylised facts of developing economies. They found that commodity price fluctuations have a significant affect on the macroeconomic conditions of developing countries.

Much of the literature supports the view that commodity price shocks have a serious effect on macroeconomic variables in developing economies, other studies have asserted the contrary, and the results remain mixed. For example, Raddatz (2007) analyse the impact of external shocks such as commodity price fluctuations, natural disasters and the role of the international economy in LIEs, and found that external shocks only explain a

small fraction of a typical low income country's volatility in output. He argues that the effect of external shocks on output is small in absolute terms, but relevant to the historic performance of these countries, and internal causes are the main source of macroeconomic fluctuations. This argument is also shared by [Bjornland \(2000\)](#) and [Dehn \(2000b\)](#). Specifically, [Dehn \(2000b\)](#) examines commodity price uncertainty in 113 developing countries and argues that there is no obvious link between a country's experience of uncertainty and the type of commodities that dominate its exports. He states that there is no link between a country's regional affiliation and its exposure to uncertainty, except for oil producing countries, which face greater uncertainty. He further questions the generalisation of the effects of commodity price shocks put forward by [Deaton and Miller \(1996\)](#), [Deaton and Miller \(1995\)](#), [Deaton and Laroque \(1992\)](#).

In contrast, recent studies seem to support earlier findings by [Deaton and Miller \(1996\)](#), [Deaton and Miller \(1995\)](#), [Deaton and Laroque \(1992\)](#) that there is a strong link between a country's experience of uncertainty, the type of commodities that the country exports, and its macroeconomic fluctuations. For example, [Iwayemi and Fowowe \(2011\)](#) finds that in Nigeria shocks to oil prices result in volatile macroeconomic variables and a rise in oil prices provides more foreign exchange earnings and leads to increased government revenue. [Fernandez \(2014\)](#), [Mohaddes et al. \(2012\)](#) and [Conforti et al. \(2010\)](#) recognise that energy price shocks have a worse effect on low income economies. However, they point out that these countries' macroeconomic conditions are worsened by fluctuations in commodity prices. They note that fluctuations in international prices of commodities, especially agricultural commodity prices, have serious implications for macroeconomic variables of LIEs. In addition, recent studies find evidence that commodity price fluctuations lead to an increase in the volatility of macroeconomic variables in LIEs. [Fernandez \(2014\)](#), [Conforti et al. \(2010\)](#), [Diao et al. \(2002\)](#) have shown that countries with only a single commodity in their export basket are the worst hit when they face declining prices of their export commodity. A study by [Mohaddes et al. \(2012\)](#), [Conforti et al. \(2010\)](#), [Kargbo \(2007\)](#) argues that countries that face declining commodity prices of their exports face large international debt repayments.

Despite evidence from the empirical literature on the effects of commodity price shocks on developing economies, it is hard to generalise these results to all countries and this highlights the need for case studies. This is because these studies use cross country datasets of developing economies to explore the nexus between commodity price shocks and the dynamics of the macroeconomic variables which control for cross-country heterogeneity, cross-sectional dependence and biases associated with simultaneity, and unobserved country specific effects [Deaton and Laroque 2003](#), [Diao et al. 2002](#), [Deaton 1999](#), [Deaton and Miller 1996, 1995](#), [Dehn 2000a](#). Some of these studies therefore conclude that the nega-

tive growth effects of commodity terms of trade volatility may offset the positive impact of commodity booms, because these studies do not exploit the heterogeneity that differentiates countries exporting purely agricultural commodities from those that export non-agricultural crops (Fernandez 2014, Mohaddes et al. 2012, Conforti et al. 2010).

Empirically, countries have shown to respond differently to the same shocks because of differences in their economic, structural and political set up (Akinleye and Ekpo 2013). For instance, countries that export purely agricultural commodities may respond differently to those that export non-agricultural crops when faced with the same type of shock. This is because the supply of factors of production for countries that rely on imported intermediate inputs such as agricultural commodities can be greatly affected by natural disasters because unlike oil, these commodities are perishable. A bad harvest which reduces the supply of agricultural products would lead to a rise in prices which may persist to clear the market. Since African economies export a large percentage of their primary commodities, fluctuations in prices of primary commodities entail the vulnerability of their fragile economies, which can only be captured by carrying out case studies in those countries.

In addition, Deaton (1999) and Katrak (1973) have argued that there are difficulties in handling commodity price fluctuations in LIEs and policy making in these countries is often dysfunctional. With price booms and slumps having serious consequences for the economy, case studies can assist us to understand specific commodity price shocks and provide the ability to forecast their effects adequately. This is done by moving away from the usual reliance on ordinary least squares models to explain macroeconomic models because the literature on LIEs argues that most of the commodities exported by LIEs are not factors of production for exporters, but for importers, and respond to aggregate demand and aggregate supply shocks. The interpretation of the effects of commodity shocks as the sole response of output to fluctuations in inputs leads to misspecification errors. As does using production functions to explain the effects of structural shocks on macroeconomic variables. These researchers therefore advocate for the use of structural models to better explain the effect of the shocks. Most of the investigations in the empirical literature have used vector autoregressive models (VAR) to assess the implications of oil prices on both developed and developing economies. These models have attractive features, especially their forecasting power compared to more complex simultaneous equations models (Ngalawa and Viegi 2011). In addition, these models are synonymous with country specific studies.

While studies of the effects of commodity price fluctuations on low income economies have generated mixed results, the cause may be a lack of case studies to provide results

that can be attributed to a specific economy. Therefore, to fill this gap, we contribute to the literature on commodity price shocks and macroeconomic dynamics by carrying out a case study by analysing the effects of international tobacco price fluctuations on the macro-economy of Malawi. The next section describes the theoretical approach to analysing tobacco price shocks.

2.4 Data and Identification Issues

2.4.1 Data, Sources and Measurement of Variables

We analyse quarterly time series for the period 1980:1 to 2012:4. This period was chosen because of the availability of data, and it is consistent with the period when tobacco production was fully established in the economy. In addition, this period is synonymous with different economic policies, including policies that were prescribed by the IMF and the World Bank that were meant to stabilise the economy. The data was sourced from the Reserve Bank of Malawi (RBM)⁵. Where the series was missing, especially on inflation and GDP, additional information was sourced from the International Monetary Fund (International Financial Statistics), the World Bank and National Statistical Office (NSO) of Malawi.

Tobacco price TP_t , defined as the international price of tobacco in US\$ per metric tonne, is included in the model to control for systematic responses to supply shocks, following [Kim and Roubini \(2000\)](#) and [Cover et al. \(2002\)](#). The restrictions placed on the tobacco price take into account that the variable is contemporaneously exogenous to any variable in the model and only responds contemporaneously to its own shocks. Because the country is heavily dependent on a single export crop (tobacco), the international price of tobacco leaf causes greater variability in the country's macroeconomic variables. Because tobacco price shocks are exogenous, the inclusion of tobacco prices as an exogenous variable will assist in identifying the channel through which the exogenous changes affect the economy through the aggregate supply function. This means a decline in domestic output cannot be interpreted solely as a result of tight domestic monetary policy, but also as a response to negative supply shocks, following [Kim and Roubini \(2000\)](#). Tobacco price enters the model as an aggregate supply productivity shock represented by θ in the theoretical specification.

⁵Only annual data for GDP is published for Malawi. E-views is used to transform the data to quarterly time-series.

GDP_t , defined as real GDP, is included in the model as a measure of real output. It is measured as the country's gross domestic product at 2005 constant prices. The variable is included to indicate the response of output from tobacco price shocks (aggregate supply shocks). Tobacco contributes a large proportion to GDP and thus fluctuations in tobacco prices are likely to affect output. [Deaton and Miller \(1993\)](#) argues that African countries grow faster when the prices of their exports are increasing than when they are falling, and one fifth of the decline in the rate of economic growth in Africa in the 1980s was attributed to the behaviour of commodity prices. Therefore, GDP will determine the effects of tobacco price shocks to the economy's real output. GDP is defined by a variable y for both aggregate demand and aggregate supply in the theoretical specification.

Following the studies of [Awokuse and Yang \(2003\)](#), [Bernanke et al. \(1997\)](#), [Cody and Mills \(1991\)](#) and [Furlong and Ingenito \(1996\)](#), consumer prices CP_t are introduced as Malawi All Items National Composite Consumer Price Index with base year 2005. Consumer prices are included in the model to capture the response of inflation to tobacco price changes. Low tobacco leaf prices generate low foreign exchange revenue and low foreign reserves. But since Malawi is import dependent, low reserves fail to support the high import bills from importers, which leads to high prices of foreign currency and high prices of basic goods (which are imported) through imported inflation which is passed on to consumers. This variable enters in both the aggregate demand and aggregate supply specifications in the structural VAR theoretical specification and it is represented by cp .

Finally, the real exchange rate is measured as the nominal exchange rate deflated by the price level⁶, and is included in the model because tobacco leaf, which is sold on the auction floors in the country, uses the United States dollar as the invoicing currency. We follow [Kim and Roubini \(2000\)](#) and define the exchange rate as a jump variable that responds contemporaneously to all the shocks in the economy. So, as the dollar weakens relative to the domestic currency, tobacco buyers will be willing to pay more dollars for tobacco. However, since this leads to an appreciation of the exchange rate, it will hurt the country's competitiveness in terms of exports. In contrast, an appreciation of the dollar depreciates the real exchange rate and makes tobacco competitive to buyers. This means that tobacco price shocks have implications for the real exchange rate, since tobacco revenue comprises about 65% of the country's export earnings and tobacco comprises 70% of the total exports for Malawi. Therefore, the real exchange rate will capture the reactions of the economy, especially the exposure of the external sector to tobacco price fluctuations.

⁶ defined as $\frac{MK}{US\$} * \frac{P^*}{P}$ where P^* is the foreign price and P is the domestic price.

2.4.2 Unit Root Tests

All variables are expressed in natural logarithms. We employ the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods to test the unit root properties of the variables and to determine their stationarity. The ADF can sometimes be biased and fail to determine the availability of unit root in a variable. Therefore it is advisable to further confirm the stationarity of the variable with an alternative test, and we employ the PP test on the variables. Table 2.2 reports the results.

Table 2.2: Unit Root Tests

levels	LTP	LGDP	LCP	LEXR
ADF	0.399	0.977	0.824	0.137
PP	0.699	0.977	0.868	0.150
First-difference				
ADF	0.000*	0.013*	0.002*	0.000*
PP	0.000*	0.000*	0.000*	0.000*

*Note: *indicates significance at 5% level*

The stationarity test results shown in Table 2.2 indicate that all series are non-stationary in levels but stationary after first difference, thereby failing to reject the null of the presence of a unit root at 5% level. Both the ADF and PP methods provide similar results, confirming the non-stationarity of the variables in levels and their stationarity after first difference, indicating that all variables are I(1).

2.4.3 Vector Auto-Regressions

Haug et al. (2005), Johansen (1988) and Davidson (1998) argue that the vector error correction model (VECM) with cointegration analysis produces more precise and efficient parameter estimates than VAR in levels when used on non-stationary data and it allows for intensive modelling, especially of long run relationships. VECM mimic the existence of a long-run equilibrium among the time series, and this is a possible solution for non-stationarity. Although VECM mimic properly the long-run relationships among the variables, Sims et al. (1990) demonstrates that transforming data to stationary forms by difference or cointegration practices when it appears to be integrated is not necessary because hypotheses of interest can be tested without transforming the data. One such example of a VECM is a study carried by Clarida and Gertler (1997) in their estimation of the Bundesbank's monetary policy, which did not yield the desired results.

This study is interested in the relationships between the variables in the model. We there-

fore proceed with the estimation of a SVAR in levels consistent with standard practice, as in [Ngalawa and Viegi \(2011\)](#), [Bernanke and Mihov \(1997\)](#) and [Bernanke and Mihov \(1998a\)](#). This is because, despite arguments against the estimation of SVAR in levels, more focus has been placed on the interrelationships among the variables in VAR estimations because coefficients are not of much importance. For example, [Kim and Roubini \(2000\)](#) argue that it is better to estimate a SVAR in levels than to impose incorrect restrictions on the model, because, if false restrictions are imposed the inferences from such a model will be incorrect.

More recent studies have therefore adopted the estimation of SVAR in levels (see for example, [Ngalawa and Viegi 2011](#), [Dungey and Pagan 2000](#), [Brischetto and Voss 1999](#) and [Bernanke and Mihov 1998a](#)). [Bernanke and Mihov \(1997\)](#)⁷ demonstrate this argument by including output, price, and reserve measures in their levels estimation despite, the variables being non-stationary. They point out that the interrelationships among the variables matter more than the significance of the coefficients, and the statistics of interest often have distributions that are unaffected by non-stationarity. This study aims to establish the relationships between the variables in the model, using a SVAR in levels. This will assist us to create a link between the SVAR in levels and the SVAR using stationary data, and contribute to the inclusive debate on whether the results from SVAR of the transformed data perform better than the SVAR in levels. We also estimate a SVAR on the stationary differenced data as robustness checks. We further test for cointegration to determine the long-run relationships of the variables and if cointegration exists. We estimate a cointegrating VAR to account for long-run relationships in the data as additional robustness checks.

2.4.4 Structural VAR Framework

We make use of the structural vector autoregressive (SVAR) model to assess the dynamic effects of tobacco price shocks on selected macroeconomic variables in Malawi. We choose a SVAR model following the empirical literature on the effects of various shocks on macroeconomic variables in both developed and developing economies ([Akinleye and Ekpo 2013](#), [Davis 2012](#), [Ngalawa and Viegi 2011](#), [Bjornland 2000](#), [Cody and Mills 1991](#), [Blanchard and Quah 1988](#)). These studies have used structural vector auto-regressive

⁷ In their study of the German Bundesbank, [Bernanke and Mihov \(1997\)](#) includes output, price, and reserve measures in their model in levels, despite the variables non-stationarity. They maintain the levels specification will yield consistent estimates, whether cointegration exists or not. ...p.17 footnote, 6.

(SVAR) models because of their superiority to more complex traditional simultaneous equation models, especially in their forecasting power. In addition, SVARs have become a common feature in assessing the dynamics of commodity price shocks, but are also synonymous with country specific studies (see for example [Akinleye and Ekpo 2013](#), [Davis 2012](#), [Bjornland 2000](#), [Cody and Mills 1991](#), [Blanchard and Quah 1988](#)). This is because SVARs have the ability to control for endogeneity by including theoretical restrictions in the identification of the model. Some studies use dynamic stochastic general equilibrium (DSGE) models to model firms' response to terms of trade shocks (e.g. [Kose and Riezman 2001](#), [Mendoza 1995](#)). However, SVARs have also performed well in studies of the dynamic behaviour of macroeconomic variables and are generally preferred because of their lack of complexity in analysis ([Ngalawa and Viegi 2011](#), [Bjornland 2000](#)).

Therefore, to fit a SVAR for our model, we assume that the economy is described by a structural form equation:

$$G(L)y_t = e_t \quad (2.3)$$

where $G(L)$ is a matrix polynomial in the lag operator, Ly_t is an $n \times 1$ data vector, and e is a vector of $n \times 1$ structural disturbances which are serially uncorrelated. $Var(e_t) = \Omega$ is a diagonal matrix where its elements are the variances of the structural disturbances. The structural disturbances are assumed to be mutually uncorrelated. We can estimate a reduced form VAR as:

$$y_t = B(L)y_t + u_t \quad (2.4)$$

where $B(L)$ is a matrix polynomial (without the constant term) in lag operator L and $var(u_t) = \Sigma$. To recover the parameters in the structural form equations from the estimated reduced form equation, we make use of the generalised identification method also used in [Kim and Roubini \(2000\)](#). Here, the non-recursive structures are allowed to provide restrictions to contemporaneous structural parameters. Suppose the non-singular coefficient matrix of L^0 in $G(L)$ is G_0 , which is the contemporaneous coefficient matrix in the structural form, and also letting $G^0(L)$ to be the coefficient matrix in $G(L)$ without the contemporaneous coefficient G_0 , then:

$$G(L) = G_0 + G^0(L) \quad (2.5)$$

which provides the relationship between the parameters in the structural form equation and the reduced form equation as:

$$B(L) = -G^{-1}G^0(L) \quad (2.6)$$

The structural disturbances and the reduced form residuals are related by $e_t = G_0 u_t$, implying that:

$$\Sigma = G^{-1}\Lambda G^0(L) \quad (2.7)$$

We can obtain the maximum likelihood (ML) estimates of A and G_0 through sample estimates of Σ . Since $G^{-1}\Lambda G^0(L)$ is an $n(n+1)$ parameters to be estimated, and Σ has $n(n+1)/2$ parameters. Therefore, we need at least $n(n+1)/2$ restrictions to be imposed by equation (7). We need at least $n(n-1)/2$ restrictions on G_0 to achieve identification.

There are many approaches for identifying structural shocks in a VAR and restrictions can be imposed in a number of ways. For example, one way is to make use of [Sims \(1980\)](#) recursive factorisation based on Cholesky decomposition, where the matrix G_0 is assumed to be triangular. While many models are consistent with this assumption, it is, however, controversial and many studies have adopted other approaches to identifying restrictions (see [Mountford and Uhlig 2009](#), [Bernanke and Mihov 1997](#), [Sims and Zha 1995](#) and [Sims 1986](#)). Therefore, we adopt a structural factorisation approach in line with the relevant economic literature to place restrictions to identify the SVAR. We follow this approach because recent research on SVAR that uses a similar approach to SVAR argues that G_0 can be any structure as long as it possesses enough restrictions ([Sims and Zha 2006](#), [Bernanke and Mihov 1997](#))⁸. The implication is that identification of the structural shocks is dependent on the ordering of variables, with the most endogenous variable ordered last. In this framework, the system is just identified.

2.5 Estimation and Inferences

A number of studies have advanced the modelling of commodity price shocks, and of great significance are the ground-breaking specifications of modelling supply and demand

⁸For our purposes, the exact channels through which tobacco pricing affects the economy are not crucial. What matters is that we can identify an exogenous movement in the price of tobacco leaf that has a significant and plausible reduced-form impact on the economy.

shocks by [Blanchard and Quah \(1988\)](#). They revealed that supply shocks have permanent and persistent effects on output and demand shocks have temporary effects. This interpretation is also supported by [Cover et al. \(2002\)](#) who identified demand and supply using the aggregate demand and aggregate supply in a VAR. In line with the literature on the subject, this chapter identifies aggregate demand and aggregate supply shocks in the SVAR framework to assess the effects of tobacco price shocks on the macro-economy.

In the model, we include four variables given by the data vector (TP, GDP, CP, EXR) where TP is tobacco prices, GDP is gross domestic product as a proxy for real output, CP is consumer prices that capture inflationary expectations and EXR is the real exchange rate. All variables are in logs.

We modify the model as in [Kim and Roubini \(2000\)](#) to place restrictions on the contemporaneous structural parameters to fit our SVAR model based on (7), where $e_t = G_0 u_t$. Assuming that we have:

$$\begin{bmatrix} e_{AS} \\ e_{AD} \\ e_{tp} \\ e_{\varepsilon} \end{bmatrix} = \begin{bmatrix} 1 & g_{12} & g_{13} & 0 \\ g_{21} & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ g_{41} & g_{42} & g_{43} & 1 \end{bmatrix} \begin{bmatrix} u_{cp} \\ u_y \\ u_{tp} \\ u_{\varepsilon} \end{bmatrix} \quad (2.8)$$

where the structural disturbances e_{AS} , e_{AD} , e_{tp} , e_{ε} are aggregate supply shocks, aggregate demand shocks, tobacco price shocks and exchange rate shocks, respectively, and u_{π} , u_y , u_{tp} , u_{ε} are the residuals in the reduced form equations representing unexpected movements of each variable. The aggregate supply function is assumed to be the reaction function that sets the level of output and tobacco price after observing the current value of consumer price. While exchange rate feeds through to domestic consumer price, there is evidence to suggest that the exchange rate pass-through to inflation is not instantaneous, but varies, becoming slower over time (see [Kim and Roubini 2000](#) & [Goldberg and Knetter 1996](#)). Therefore we make the assumption that the aggregate supply does not contemporaneously respond to movements in the exchange rate. We assume, as in [Sims and Zha \(1995\)](#) and [Kim and Roubini \(2000\)](#), that the aggregate supply feedback is based on information delays that do not allow output to respond within the same period. It is also worth noting that the contemporaneous restrictions placed on the structural parameters of the G_0 without further restrictions on the lagged structural parameters, indicate that the shocks that cannot affect a specific variable contemporaneously can still affect its lagged values.

Similarly, shocks to aggregate demand are assumed to affect the level of prices and the exchange rate, while determining output. At the same time, aggregate demand does not respond contemporaneously to exchange rate shocks, due to information delays that impede policy makers' ability to react immediately to economic activity. Therefore, there is an incomplete pass-through of any exchange rate effect⁹. The justification for this exclusion is that monetary authorities care more about unexpected changes in exchange rate than other monetary policy tools, as in [Kim and Roubini \(2000\)](#).

2.5.1 Model Results

Considering the correlation between tobacco prices and the three variables in the model, Table 2.3. shows that tobacco prices are positively correlated with GDP, implying that a positive shock to tobacco prices is likely to result in an increase in real output, indicating an outward shift of the aggregate supply function (or an increase in the aggregate supply function). This downward movement along the aggregate demand curve will eventually bring inflation down, leading to a fall in consumer prices, (see [Bjornland 2000](#)). This is indicated by the negative correlation between tobacco prices and consumer prices, as depicted in Table 2.3, which is -0.098. However, since a positive tobacco shock raises output, as it works through the money market, money demand increases. This also raises the real exchange rate, which subsequently decreases the exchange rate, resulting in an appreciation of the real exchange rate. This is evidenced by a negative correlation between tobacco prices and the real exchange rate, as shown in Table 2.3.

Table 2.3: Correlation Coefficients

	LTP	LGDP	LCP	LEXR
LTP	1.000	0.142	-0.098	-0.118
LGDP	0.142*	1.000	-0.018	-0.078
LCP	-0.098*	-0.018	1.000	0.448
LEXR	-0.118*	-0.078	0.448	1.000

**Indicates result of the variable of interest in the model*

2.5.1.1 Estimated Structural VAR

VAR models are sensitive to the number of lags, and thus the lag length has strong implications for the modelling choice and the subsequent results. Therefore lag selection criteria and lag exclusion tests were carried out to determine the appropriate lag length

⁹Exchange-rate pass-through is the percentage change, in local currency, of import prices resulting from a one percent change in the exchange rate between the exporting and importing countries, or the degree to which a country's prices change in response to a change in its exchange rate.

for the model, and 4 lags were selected as the optimal lag length, which takes care of all autocorrelation¹⁰. Structural VAR model specification was used to assess the impact of tobacco shocks on the economy of Malawi through the analysis of impulse response functions (IRFs), following [Ngalawa and Viegi \(2011\)](#), [Bernanke and Mihov \(1997\)](#) and [Sims et al. \(1990\)](#). Table 2.4 reports the estimated contemporaneous structural parameters.

Table 2.4: Estimated Contemporaneous Structural Parameters

$$\begin{bmatrix} 1 & -4.61 & 0.35 & 0 \\ 0.47 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -1.02 & 0.44 & 0.17 & 1 \end{bmatrix} \begin{bmatrix} lcp_t \\ lgdp_t \\ ltp_t \\ lexr_t \end{bmatrix} = \begin{bmatrix} 0.07 & 0 & 0 & 0 \\ 0 & 0.02 & 0 & 0 \\ 0 & 0 & 0.03 & 0 \\ 0 & 0 & 0 & 0.08 \end{bmatrix} \begin{bmatrix} lcp_{t-1} \\ lgdp_{t-1} \\ ltp_{t-1} \\ lexr_{t-1} \end{bmatrix} + \begin{bmatrix} e_{cp} \\ e_y \\ e_{tp} \\ e_\varepsilon \end{bmatrix} \quad (2.9)$$

Where e_{cp} , e_y , e_{tp} , e_ε are structural disturbances of consumer prices, output, tobacco prices and real exchange rate respectively. All restrictions are on contemporaneous structural parameters. This allows non-zero interactions by imposing zero restrictions on contemporaneous structural parameters, and no restrictions on all the lagged structural parameters. From table 2.4, g_{12} is negative at -4.61 and g_{13} positive at 0.35 , suggesting that the monetary authority decreases consumer prices upon observing the unexpected increases in tobacco prices. In this case, monetary authorities seem to react to a positive tobacco price shock. This acts as a positive and deflationary supply shock by taking an expansionary position when faced with deflationary pressures. From Table 2.4, all the estimated parameters have the required signs which are consistent with standard economic theory. That is, a decrease in consumer prices, which entails a decrease in inflation, tends to affect the exchange rate negatively by appreciating the real exchange rate, given that the coefficient for inflation g_{41} in the exchange rate equation is negative, with a coefficient of -1.02 .

Given the importance of tobacco leaf in the economy, we assess the dynamics of output, consumer prices, and exchange rate in response to a shock to tobacco prices, using impulse response functions from the estimated structural VAR model. Impulse response functions display the effects of a shock on the adjustment path of the variables. Figure 2.4 presents the results.

¹⁰To determine the appropriate lag length, lag order selection criteria was employed and Likelihood Ratio (LR), Final Prediction Error (FPE), AIC and Hannan-Quinn information criteria (HQ) tests selected 4 lags while the SC selected 1 lag. Using the Final Prediction Error (FPE) test, 4 lags were selected as appropriate for the model. Results can be provided upon request.

Figure 2.4: Impulse Responses for the Estimated Structural Vector Autoregressive Model

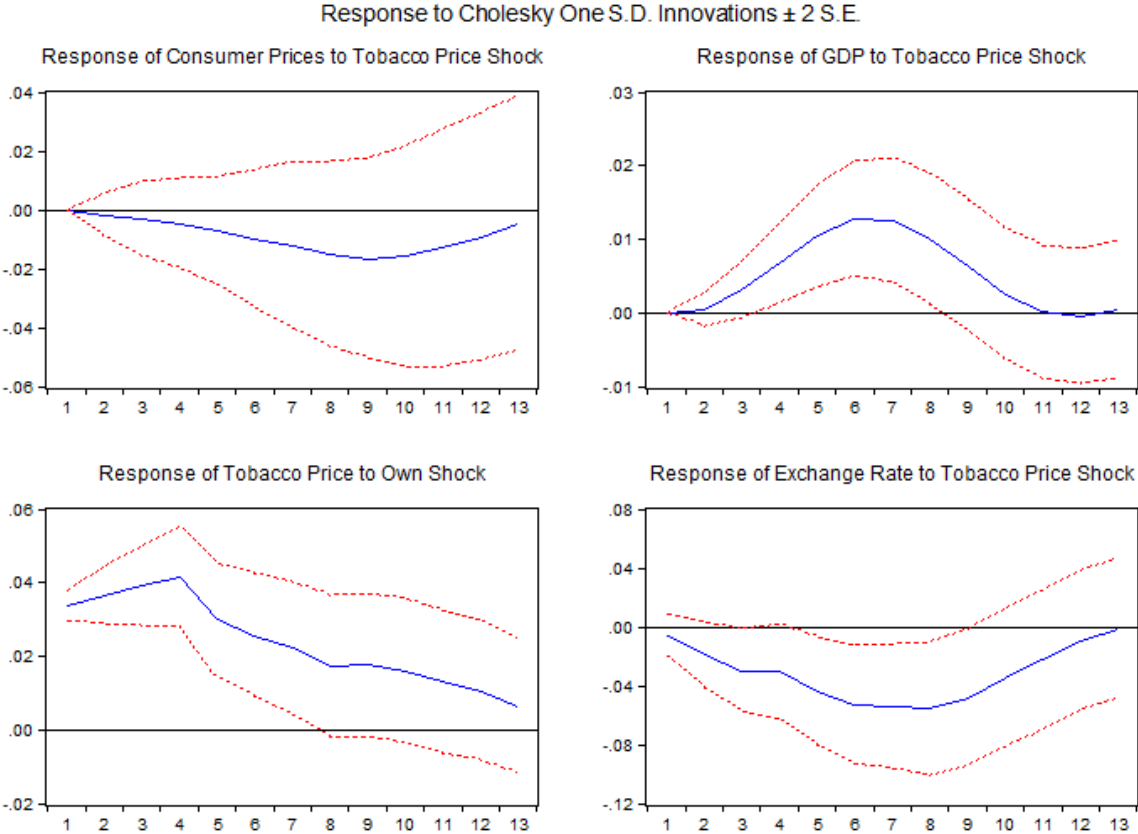


Figure 2.4 shows the response of the variables to a one standard deviation shock to the tobacco price. The first figure indicates the response of consumer prices to a percentage¹¹ change in the tobacco price, while the other figures show the responses of GDP, tobacco price (own shock), and exchange rate to a shock to tobacco price. The first figure in the first column shows that consumer price falls in response to a positive tobacco price shock, depicted by a decline in the IRF of the consumer price which proceeds to decline in the following quarters. Consumer price only reaches its lowest (trough) decline in the 9th quarter, at 0.018 percentage points, and thereafter continues to rise, and reaches 0.001 percentage points, and thereafter, the effect on the price dies out completely in the 13th quarter.

Clearly, a positive tobacco price shock has a significant and negative effect on consumer prices. As the tobacco price increases on impact, the country generates an increased level of foreign exchange which eases the pressure on foreign reserves created by the demand for imports. This effect appreciates the exchange rate, as total exports increase. As a result, GDP at factor prices increases and consumer price level falls. This is an expected

¹¹A 1 percentage point increase indicates a move from say 2% to 3%.

result and it is the opposite of the results reached by [Diao et al. \(2002\)](#), when the effects of a decline in tobacco prices are estimated. Because the consumer price level falls as tobacco price rises, we therefore approximate a decline in inflation. This result is also substantiated by the fact that consumer prices in Malawi react to import and food prices, because the country is import dependent and significantly poor. The inflation basket is heavily determined by the food prices. In this case, favourable tobacco prices ease the pressure on food and import prices, and leads to a general decline in consumer price levels.

The second figure in the first row provides the impulse response of GDP to a positive tobacco price shock. A positive shock to tobacco prices results in an increase in GDP after the first quarter to about 0.001 percentage point, rising to reach its maximum in the 7th quarter, at 0.08 percentage points. Thereafter, GDP starts to fall soon after the 7th quarter and reaches the original level of impact and dies out completely in the 12th quarter. The positive effect. Our results are expected because tobacco exports contribute about 40% to GDP, such that any increase in world price of tobacco is likely to lead to an increase in the country's GDP, a result that is consistent with the results obtained by [Diao et al. \(2002\)](#), although our results are the opposite of their results. [Diao et al. \(2002\)](#) argue that the effect of a change in the world price of tobacco depends on how important the tobacco sector is in the economy. In their assessment of the effects of a decline in world tobacco prices in China, Turkey, Malawi and Zimbabwe, [Diao et al. \(2002\)](#) further argue that output can fall by more than 50% if the world price of tobacco falls by about 40%. They further show that exports would fall by 66% because the tobacco crop constitutes a large percentage of total exports. In the same argument, a positive change in the world tobacco price increases output by increasing exports and aggregate demand. Therefore, our result is consistent with the results in the literature on the effect of changes in prices of mono-crop export countries, and also consistent with most of the related literature on developing economies' responses to positive commodity price shocks (see [Deaton 1999](#)).

The impulse response function of the second figure in the second row shows the effect of own shock to tobacco price. The tobacco price reacts to an own positive shock by rising significantly to 0.035 percentage points on impact. The positive effect of own shock to tobacco price persists until the 4th quarter, from where it begins to fall, reaching 0.001 percentage points in the 13th quarter. Thereafter, the shock converges. The effect on tobacco is therefore expected, and often leads to oversupply in the next tobacco growing season as farmers become attracted to the increase in the tobacco price of the previous period. The increase in tobacco leaf supply on the world market pulls the price of tobacco down, leading to low prices in that season. When producers observe the lower prices of that period, they decrease production and raise the price of tobacco in the next period because of high demand for tobacco leaf. Our results conform to the responses of most

agricultural commodities, and tobacco in particular, as indicated by [Mitra and Boussard \(2008\)](#) and [Masanjala \(2006\)](#) who argue that most agricultural commodities follow a Cobweb-type of price effect.

An increase in the tobacco price leads to a fall in real exchange rate, again generating the expected outcome of an appreciation of the real exchange rate due to a positive tobacco price shock. The IRF of the real exchange rate shows that a positive tobacco price shock induces an exchange rate appreciation on impact, but leads to a further appreciation in the following quarters, reaching the highest level of about 0.038 percentage points in the 8th quarter. From the 9th quarter, the exchange rate starts depreciating, reaching its maximum and completely dying out after the 12th quarter, indicating a short run appreciation of the exchange rate after a tobacco price shock. Our result is also the opposite of the conclusions reached by [Diao et al. \(2002\)](#) who estimate the effects of a decline in tobacco price. Their model predicted that a decline in the tobacco price will have serious repercussions for the economy because of the importance of the crop in the country. Because tobacco generates over 60% of export earnings, a fall in the tobacco price will depreciate the exchange rate by 5-10% and this also leads to a fall in both exports and imports, but consumer price rises by 0.8 - 3.5%. However, since in our model we are interested in the effects of a positive tobacco price, the exchange rate appreciation is in line with the expected results.

Our results are an indication of the importance of tobacco production and the effect that the crop has on the economy. As displayed in the IRFs, most of the responses to the shock persist until the 13th quarter, in the period chosen for the analysis. It is important to note that the effect of a positive tobacco price is consistent with the effect identified in much of the commodity shocks literature (see for example [Williams and Wright 2005](#), [Deaton and Laroque 2003](#), [Diao et al. 2002](#), [Williams et al. 1999](#)). Our results also confirm the view that supply shocks are more persistent in the economy than demand shocks, as evidenced by the smooth representations of the IRFs which do not show extremely large peaks and troughs. The IRFs in the model do not die out instantly but persist up to the very last quarters of the period under analysis, indicating that the shock is more persistent in the economy.

While the impulse response functions indicate the responses of the variables to a one standard deviation shock in the variable of interest (thus the total effect of the shocks), it is important to assess the contribution of tobacco price shocks to total variations in the variables. The variance decomposition shows how much of the variation in GDP, consumer prices, and exchange rate are explained by shocks to tobacco prices. This is done by decomposing the total variation in the variables and singling out the resulting

variation due to tobacco price shock. Table 2.5 provides the results.

Table 2.5: Variance Decomposition

Period	LCP	LGDP	LTP	LEXR
1	0.951	1.980	97.069	0.000
2	2.160	3.192	94.171	0.476
3	2.459	5.722	91.084	0.735
4	2.356	11.055	85.967	0.621
5	2.213	18.655	78.068	1.064
6	1.985	26.097	70.362	1.556
7	1.763	32.065	64.090	2.082
8	1.598	36.141	59.494	2.766
9	1.479	38.116	57.155	3.250
10	1.420	39.050	56.000	3.531
11	1.400	39.588	55.365	3.648
12	1.409	40.001	54.953	3.636
13	1.440	40.629	54.338	3.592

The variance decomposition results presented in Table 2.5 show that tobacco price shocks have a small impact on the variations of all three variables in the first quarters. All variables registered a zero effect in the first quarter, showing that tobacco price shocks cause 97% of the variations in own price. GDP only registered 1.98% of its total variation as coming from tobacco price shocks, while consumer prices registered approximately 0.95%, and the real exchange rate 0% of the variations in the first quarter. The variations emanating from tobacco price shocks become larger at longer horizons with 19% of the variations in output explained by tobacco prices in the 5th quarter, and thereafter increasing in the following quarters, reaching 36% in the 8th quarter and 40.6% in the 13th quarter. The same effect applies to the other two variables, with consumer prices showing a slightly higher increase in variations in the 5th quarter, at 2.2% which is higher than the variations in real exchange rate that are explained by tobacco price shocks at only 1.1% in the same quarter. For the period under analysis, tobacco prices explain close to 40% of the variations in output on average, indicating persistence of some sort of tobacco price shocks in explaining fluctuations in output.

While tobacco prices contribute about 18% of the variations in GDP in the 5th quarter, it contributes 2.2% of the variation in consumer price in the same quarter. The importance of tobacco prices in explaining variation in consumer prices reduce significantly from the 9th quarter, reaching 1.5%, thereafter remaining in the range of 1.4% until the last quarter of the period under analysis. This indicates that, apart from consumer prices falling in the economy in response to other macroeconomic phenomena, tobacco price shocks do not explain a significant amount of the variations. This is because a large percentage

of the variation in consumer prices in Malawi can be attributed to factors other than fluctuations in the tobacco price. For example, consumer prices in Malawi are more responsive to factors that affect food supply and its availability. Thus a bumper maize crop harvest ensures low consumer prices and vice versa. In this case, the appreciation of the real exchange rate following a tobacco price shock may cause imports to rise. But since most goods are imported in Malawi, inflation may respond to such increased imports by raising imported inflation, which pushes overall inflation up. Therefore, we can state that the effect of tobacco prices on consumer prices, though minimal, is quite significant.

The decomposition of the variations in the real exchange rate shows that, while the exchange rate is affected by changes in tobacco prices, the importance of tobacco price shocks in explaining the variations in exchange rates is slightly higher than the importance of tobacco price shocks in explaining variations in consumer prices. Decomposing the fluctuations in the real exchange rate indicates that tobacco prices explain 1.1% (indicating a 1.1% appreciation of the exchange rate) of the total variations (total appreciation in exchange rate) in the 5th quarter. The importance of tobacco prices in explaining fluctuations in the exchange rate increases in longer horizons, reaching 2.8% of the total variation in the exchange rate in the 8th quarter. Thereafter, the effect continues to increase, although slowly, hovering between 3.5% and 3.6% in the 10th and 13th quarters respectively, indicating that the importance of the tobacco price when determining the fluctuations in exchange rate is significant. Our results are also consistent with results by [Diao et al. \(2002\)](#), although because of reasons provided earlier, the results are the opposite of those reached by [Diao et al. \(2002\)](#). We expect this result because the correlation between tobacco price and exchange rate indicates a negative relationship between the two variables, meaning that the exchange rate declines as a result of a positive tobacco price. An increase in the tobacco price has a positive effect on output and money demand, and, in response to the level of the money demand interest rates rise, inducing an appreciation of the exchange rate in the process, confirming the findings in the literature on commodity price shocks in low income economies (see [Deaton and Miller 1993](#)).

Determining the stability of the estimated SVAR is very important in the VARs estimations, since instability of the model leads to invalid standard errors and impulse response functions. The stability results provided in Appendix A indicate that all the variables estimated in the model have their roots inside the unit circle, denoting stability of the estimated VAR models. The results indicate that there is no serial correlation and all the standard errors are homoscedastic and normally distributed. Table A1 and Figure A1 in Appendix A provide the results, which indicate that no root lies outside the unit circle, therefore the VAR satisfies the stability condition.

2.5.2 Robustness Checks

2.5.2.1 SVAR on the Difference Stationary Data

While the levels estimation produces desired results, we estimate a differenced stationary structural VAR model to determine the robustness of the results, because [Engle and Granger \(1987\)](#) emphasize taking first differences in a VAR analysis prior to estimation so that estimations can be carried out on stationary data. We therefore run a SVAR on the differenced data and the graphs are presented in the immediate Appendix IA, soon after this chapter. Some of the results are presented in Table 2.6.

Table 2.6: Estimated Contemporaneous Structural Parameters

$$\begin{bmatrix} 1 & -1.36 & 0.14 & 0 \\ 0.11 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -0.95 & 1.05 & 0.09 & 1 \end{bmatrix} \begin{bmatrix} dlcp_t \\ dlgdp_t \\ dltp_t \\ dlexr_t \end{bmatrix} = \begin{bmatrix} 0.03 & 0 & 0 & 0 \\ 0 & 0.01 & 0 & 0 \\ 0 & 0 & 0.04 & 0 \\ 0 & 0 & 0 & 0.08 \end{bmatrix} \begin{bmatrix} dlcp_{t-1} \\ dlgdp_{t-1} \\ dltp_{t-1} \\ dlexr_{t-1} \end{bmatrix} + \begin{bmatrix} e_{cp} \\ e_y \\ e_{tp} \\ e_\varepsilon \end{bmatrix} \quad (2.10)$$

The model shows that a positive shock to the tobacco price leads to a decline in consumer prices soon after the impact, reaching 0.039 percentage points, but this continues to fall to 0.006 percentage points in the 5th quarter, before rising and tapering off. The impulse response of consumer prices converge completely in the 60th quarter. Tobacco price increases by about 0.03% in response to a positive shock to itself, but cycles and converges faster in this model than in the SVAR in levels. Likewise, the real exchange rate appreciates on the impact of a positive shock to the tobacco price, and continues so in the following quarters, before depreciating in the 10th quarter. After the 11th quarter, the real exchange rate tapers off, before dying out completely in the 40th quarter.

The IRFs of the model indicate that the model produces the same effect of a tobacco price shock on the variables in the differenced data as in the SVAR in levels. A positive shock to the tobacco price increases output on impact, and reduces consumer prices, leading to a fall in inflation in the process, but also appreciates the real exchange rate on impact. This effect raises the level of the tobacco price prevailing on the market. The model further reveals that the tobacco price shock dies out in the economy after the 45th quarter, especially in GDP, tobacco price, and the real exchange rate. The effect on consumer prices takes more time to completely die out, compared to other variables in the model. Therefore, the two models show that the direction of the shock in the economy is the same. The AR roots graph in Appendix A confirms that the estimated SVAR is stable, since no root lies outside the unit circle.

2.5.2.2 Cointegrating Vector Autoregressive (CVAR) Model

Estimating the co-integrating VAR yields all the expected results, similar to those obtained in the previous models. Tobacco price shock increases GDP, reduces consumer prices and induces an appreciation of the exchange rate (see Appendix A.3 for estimation procedure and detailed results). The direction of the shock is similar to the results obtained from the SVAR in levels and the differenced data. However, the variables in the CVAR do not show any convergence, indicating a permanent effect of a tobacco price shock on the economy. This is substantiated by the coefficient of the error term for the model, which has the expected negative sign and is significant at 5% level. This indicates that if in period $t - 1$ the error term was positive, then tobacco leaf price was too high in relation to the equilibrium relationship with the other variables. As a result, tobacco leaf prices would fall to be in equilibrium. The model yields a low adjustment coefficient of 27%, which indicates that if there is a disequilibrium in the model caused by the shock to the tobacco price, then the speed of adjustment to equilibrium to correct this disequilibrium is 27%, which is very low.

We confirm the argument that supply shocks take some time to disappear in the economy, compared to demand shocks. Our results broadly support the model and the theoretical hypothesis on which the model is formulated. The long-run relationship between tobacco price, exchange rate, consumer prices, and GDP is underlined by the co-integration analysis, with a co-integrating error term of -0.27 having explanatory power for the effect of tobacco price shock. The deviation of GDP from its long-run equilibrium explains the implications of fluctuations in tobacco prices on output in the economy. Analysing the AR roots graph, we note that the CVAR generates 3 unit roots, indicating that it is not stable. We further argue that there is evidence to attribute the exchange rate and inflation effects to a commodity price phenomenon, thereby concurring with the ideas put forward by [Davies \(2003\)](#), [Conforti et al. \(2010\)](#) and [Diao et al. \(2002\)](#).

We conclude that the results in the CVAR provide similar results to those in the two SVAR models, with the dynamics and the directions of the variables showing the same variability, with a slight difference in the magnitudes of the impulse responses of the variables. In addition, the impulse responses of output, consumer prices, and real exchange rate in response to a shock to tobacco prices show the same results as in the previous analysis by SVAR. Results are presented in the immediate Appendix IA after this chapter.

We further proceed with the estimation of an unrestricted VAR as further robustness checks for the model, with the ordering LTP, LGP, LCP, LEXR. The results are not very different from the results of the Structural VAR in the previous sections.

Figure 2.5: Unrestricted Vector Autoregressive Model

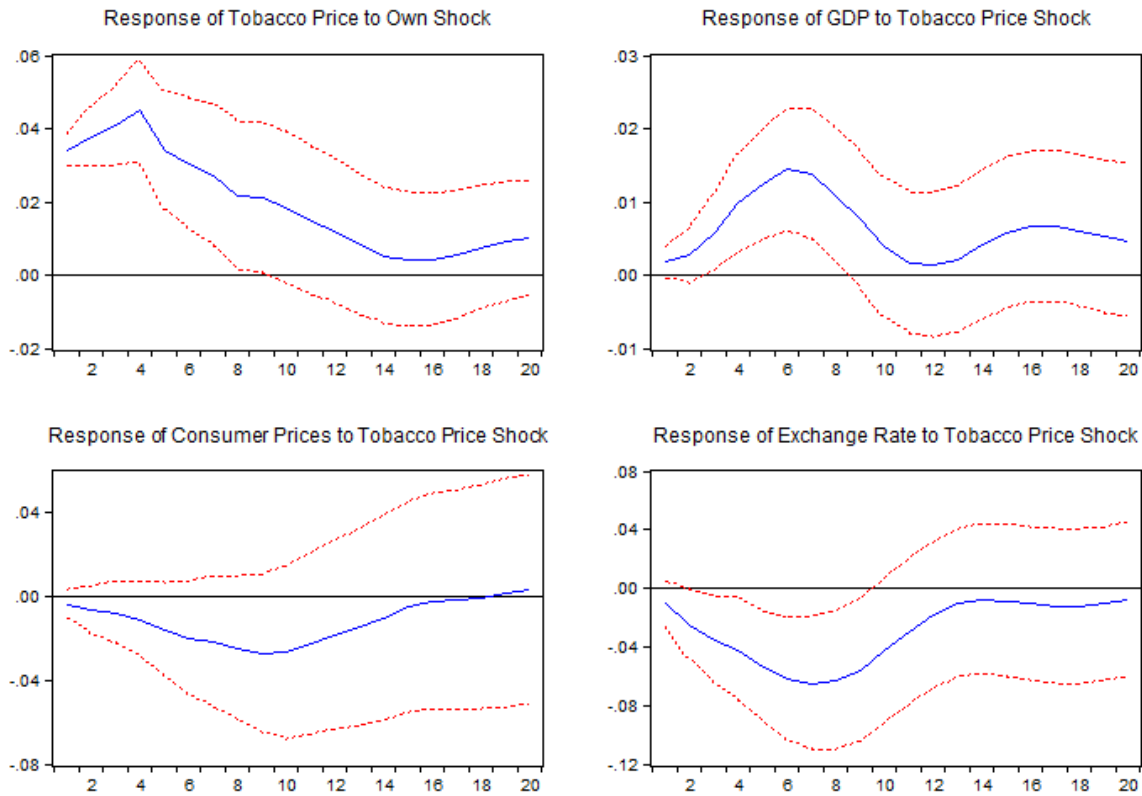


Figure 2.5 shows that tobacco prices respond positively to own shock with a 0.036 percent increase while at the same time GDP rises by 0.02 percent at impact. The real exchange rate depreciates by 0.01 percent at impact while consumer prices fall. These results are not different from the SVAR results, indicating that the results are robust to different model estimations.

2.6 Conclusion

We set out to answer the broad question: what are the macroeconomic impacts of commodity price shocks on output, consumer prices, and the exchange rate in a low income economy? Specifically, we aimed at answering the question: How do shocks to tobacco prices propagate in the Malawian economy? To do this, we used a structural vector autoregressive (SVAR) model to analyse the dynamic effect of tobacco price shocks on output, consumer prices, and the exchange rate using quarterly data for Malawi. The main empirical results of this chapter are the following: At a country level, export prices of commodities explain much of the variability in key macroeconomic variables. In addition, the prices convey useful information on output, consumer prices, and the real exchange rate, which are important for both aggregate demand and aggregate supply.

Therefore, we conclude that fluctuations in the tobacco price lead to fluctuations in key macroeconomic variables. A positive shock to the tobacco price tends to increase output in the economy from the first quarter, which continues to rise for the first periods 10 quarters, after which the shock begins to die out.

We also find that, as output increases in response to an increase in tobacco prices, the consumer price falls from the first quarter and continues to fall until the 12th quarter, and then converges in the 13th quarter. The exchange rate declines (appreciates) in the period under analysis as a response to a positive tobacco price shock, before converging completely in the 12th quarter. We are in agreement with the results by [Diao et al. \(2002\)](#) that tobacco crops are as important in Malawi now as they were three decades ago. This implies that a decline or an increase in the international tobacco price has serious implications for macroeconomic variables in the country. In this case, a shock to the tobacco price tends to stay in the economy, as it usually takes more than 3 years to die out completely in the economy. Our results are in line with the theory of aggregate demand and aggregate supply discussed in section 2.3, where supply shocks are said to have a lasting effect on the economy and they are mostly permanent.

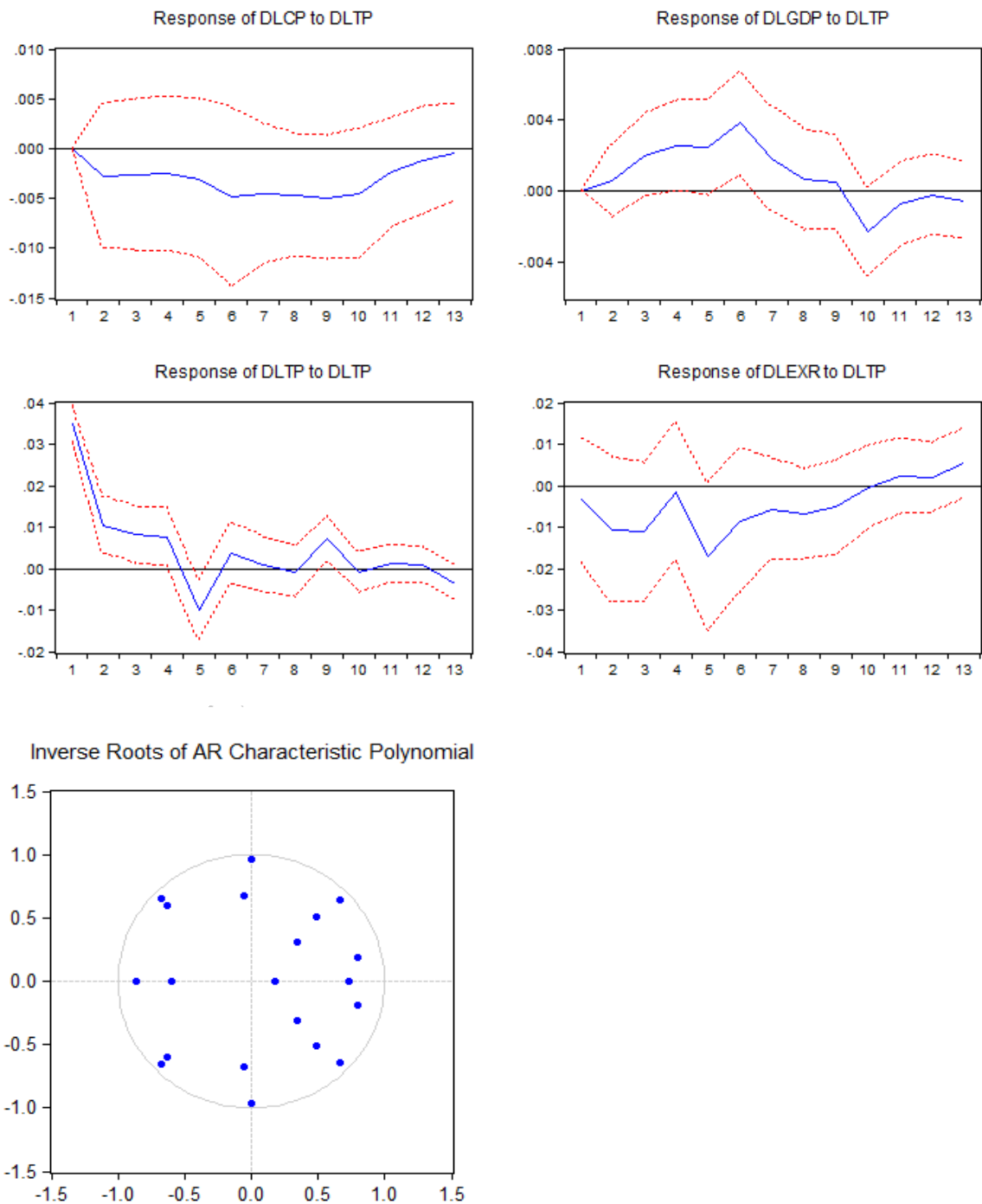
We also find that the forecast variance decomposition indicates that a tobacco price shock causes significant variations in GDP, with the exchange rate and inflation having almost the same proportions of variations in response to tobacco price shocks. This is not surprising when we consider the conclusions drawn from the literature on commodity price shocks and macroeconomics of low income economies. This literature argues that commodities that hold a greater share of the total export basket and that contribute a sizeable amount to GDP, say 10%, have a serious effect on the economic conditions of the country when their price fluctuates ([Diao et al. 2002](#), [Deaton 1999](#), [Mendoza 1995](#)).

Therefore, it is important that the government intensifies its diversification programs, aimed at reducing the production of tobacco in Malawi. This will enable the country to explore other export crops that are less labour intensive, but are able to generate almost the same amount of foreign exchange. Reducing tobacco production and focussing on other crops will lessen the effects of tobacco price fluctuations and also widen the country's export base.

Appendix

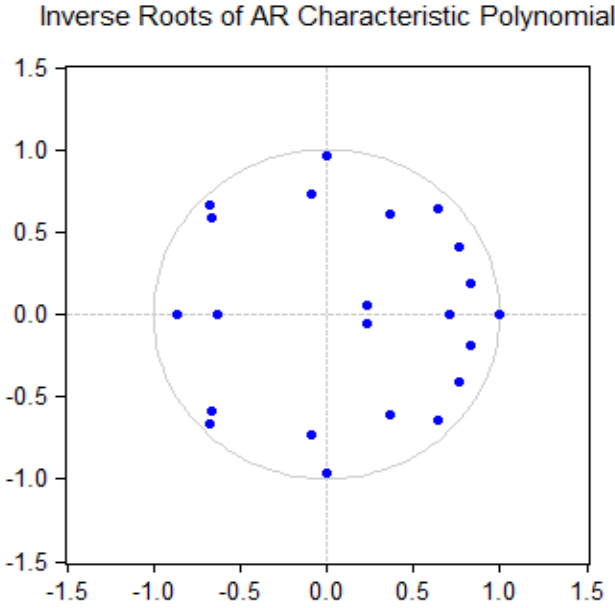
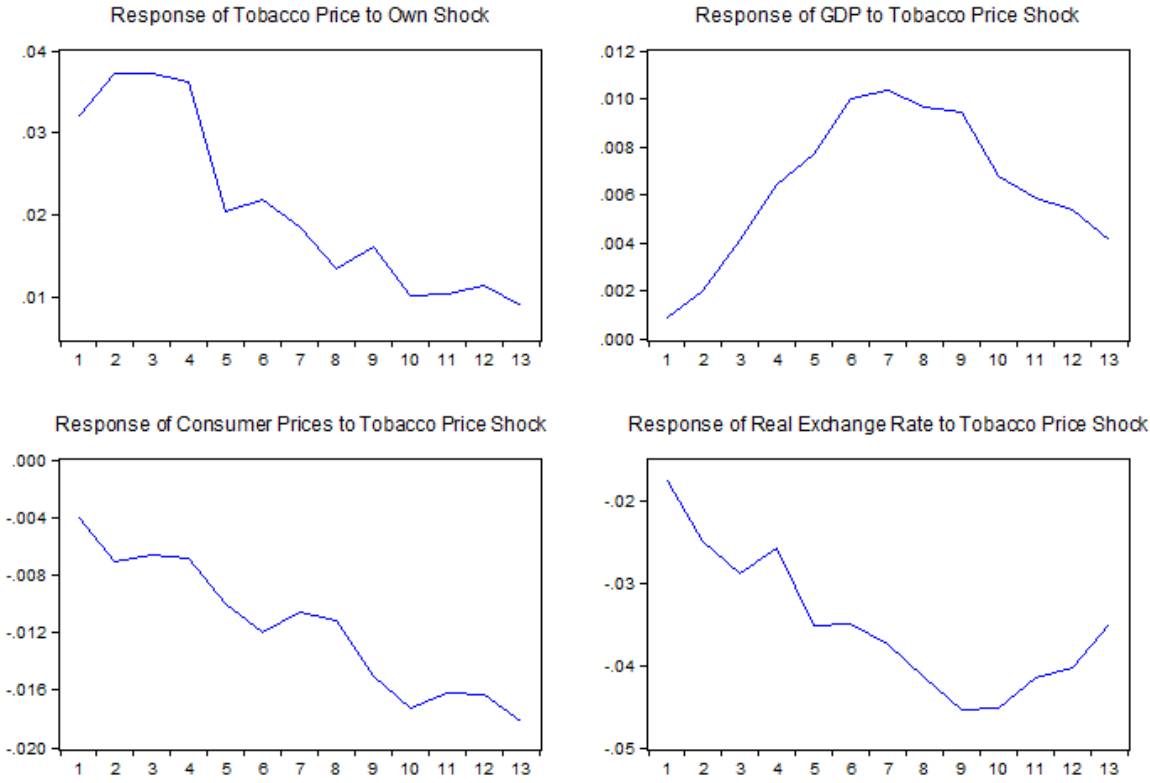
Impulse Response Functions for the Differenced SVAR

Figure IA.1: Structural Vector Autoregression Model on Differenced Data



Impulse Response Functions for the Cointegrating VAR (CVAR)

Figure IA.2: Cointegrating Vector Autoregression Model



Chapter 3

Macroeconomic Dynamics in a Foreign Exchange Constrained Small Open Economy

3.1 Introduction

In the 1980s, most developing countries suffered a decline in foreign exchange reserves which led to a decline in total imports (Moran 1989). Sub-Saharan African countries' imports fell by 9%, leading to a fall in exports and per capita output, while non-oil exporting economies remained stagnant. The same period experienced a major shift in the composition of total imports in developing countries from consumer goods to intermediate goods and capital. This pushed research into models that relate output growth to foreign exchange resources via the aggregate production function, but consider foreign exchange as a scarce resource and imports as factors of production, and not final products. (Lensink 1995, Moran 1989). There has been a growing concern about foreign exchange imbalances and short-run macroeconomic policy in developing economies (Porter and Ranney 1982). While most developing countries have experienced a substantial rise in foreign reserves, many low income¹ Sub-Saharan African (SSA) countries have, by contrast, experienced declining levels of foreign reserves (ibid). The accumulation of reserves in emerging economies attracted a wide range of research (see for example, Fukuda and Kon 2008). Recent debate centres on the macroeconomic implications of declining levels

¹In our analysis a 'typical' low income economy (LIE) is defined using the World Bank definition of a LIE with PPP-adjusted income per capita of less than US\$1,000 per year since we take into consideration that some countries with higher incomes per capita share many characteristics with typical LIEs.

of foreign exchange reserves in SSA countries. These argue that holding minimum levels of foreign reserves (say three months of import cover) is justified by fundamentals. However, holding too low levels can have serious implications for the economy (McCormack 2015). For example, continuous shortages of foreign exchange in a country can be a signal of some macroeconomic and financial stress which constrains economic growth, and may lead to balance of payments pressures on the economy (McCormack 2015, Porter and Ranney 1982).

Despite the growing concerns about foreign exchange shortages in SSA, little attention has been paid to analysing the dynamics of monetary and fiscal policies in low income economies, particularly in SSA where the problem of declining foreign exchange reserves has been observed since the 1980s. This is because SSA countries are prone to weak international export commodity prices that lead to fluctuations in foreign exchange earnings and capital flows, and unstable macroeconomic policies (Addison and Ghoshray 2013, Claessens and Ghosh 2013). Understanding the dynamics of monetary policy in LIEs can provide insights into whether responses of macroeconomic variables may be used as early warning signs for potential instability in the economy that may require instant intervention. To the extent that they are not able to generate enough foreign exchange from their exports, these countries also face credit constraints. This is because they have poor access to international credit markets, and are highly dependent on foreign financial inflows (Lensink 1995). This makes them susceptible to foreign shocks that destabilise the economy when the level of foreign financial inflow is low (Lensink 1995).

The recent literature on the implications of declining foreign exchange reserves has a unifying thread, stating that firms in LIEs import most of their intermediate inputs and capital for production, and face foreign exchange shortages (Kose and Riezman 2001, Lensink 1995, Moran 1989). However, most of the research focusing on developing countries has been based on cross-country datasets, and concerned with the effects of declining foreign exchange reserves (Stiglitz et al. 2006, Lensink 1995, Moran 1989). A few case studies that exist on the low income economies of SSA have concentrated largely on the relative importance of the motives, costs, and adequacy of foreign reserve accumulation (Elhiraika and Ndikumana 2007, Balamoune-Lutz and Ndikumana 2007).

Among these LIE case studies, a study carried out by Senbeta 2013 explored the dynamics of macroeconomic variables in foreign exchange constrained economies in a dynamic stochastic general equilibrium (DSGE) framework. Calibrated to the Ethiopian economy, the study concluded that the modified model of foreign exchange constraints generates greater variability than a standard DSGE model, where a contractionary monetary policy generates an expansion in output and consumption is followed by a contraction in employ-

ment (Senbeta 2013, 2011a). In addition, he points out that, despite the characterisation that LIEs face high exposure to external shocks, they also have a weak ability to absorb these shocks.

This additional characterisation of low income economies suggests that it is more important to understand the dynamics of shocks in a foreign exchange constrained economy, and therefore there is a need for country case studies. The literature suggests that policies that produce desired results in other countries might generate opposite and unfavourable results in foreign exchange constrained economies (Senbeta 2011a, Stiglitz et al. 2006).

This chapter contributes to the available literature on the dynamic responses of macroeconomic variables in a foreign exchange constrained economy. It does this by providing a case study of a LIE SSA country that has experienced extreme foreign exchange shortages for over a decade. We carry out the study on Malawi. The country relies on a single export crop, tobacco, for a large proportion of export earnings, and depends on foreign financial inflows to finance about half of its national government budget. We investigate the dynamic responses of various macroeconomic variables to different macroeconomic policies in a foreign exchange constrained economy when importing firms face foreign exchange constraints in the importation of the intermediate inputs. Using a four sector DSGE framework, we model a foreign exchange constrained Malawian economy.

The next section discusses the problems of foreign exchange in Malawi and highlights macroeconomic interventions for the recurring problem of foreign exchange unavailability in Malawi. Section 3.3 reviews the empirical literature on the problems of declining foreign exchange reserves in developing economies. Section 3.4 builds the New Keynesian DSGE model for a foreign exchange constrained, small, open economy. Section 3.5 calibrates the model and describes the choice of its parameters and discusses the results. Section 3.6 provides the conclusion to the chapter.

3.2 The Foreign Exchange Problem in Malawi

Foreign exchange reserves help maintain confidence in a country's currency, allowing the central bank to intervene in the foreign exchange market when there is a need to influence the exchange rate (Williams 2006). Foreign exchange reserves permit central banks to limit the vulnerability of the country to external shocks, give confidence to the public, and reassure credit rating agencies and international financial institutions about the soundness of the economy (Ubok-Udom 1982). However, holding very low levels of reserves erodes confidence in the economy and economic growth can seem elusive (ibid). In

addition, foreign exchange shortages can cause instability in firms by limiting their ability to buy adequate factors of production to stabilise production across the years, in the same way a rise in the world price of imports, or a decline in export earnings impacts firms (Senbeta 2013, Moran 1989). For countries with undiversified exports, fluctuations in world prices lead to fluctuations in export earnings (Agénor and Montiel 2008b). Malawi has experienced declining levels of foreign reserves for a long period of time, worsened by fluctuations in international prices of the country’s single export crop of tobacco leaf.

Figure 3.1: Imports and Exports to GDP ratio in Malawi



Figure 3.1 shows that the country’s trade deficit widened and exports have always been lower than imports. This indicates that the country experienced a negative trade balance for a long time and the current account deficit widened from 1984 onwards. This reveals the effect of foreign aid on LICs, which complements the income generated from exports. It further reveals that the current account deficit has been widening over the years. The country has since been spending more on foreign trade than it has been earning, meaning that it has been borrowing foreign capital to make up for the deficit. In addition, Malawi floated the exchange rate in 1994, thus, the Kwacha was floating officially but not in reality. This was contradicted by continuous interventions in the foreign exchange market by the Reserve Bank of Malawi (RBM) (Simwaka and Mkandawire 2008). More often than not, these interventions in foreign exchange markets affected the value of the Malawi currency,

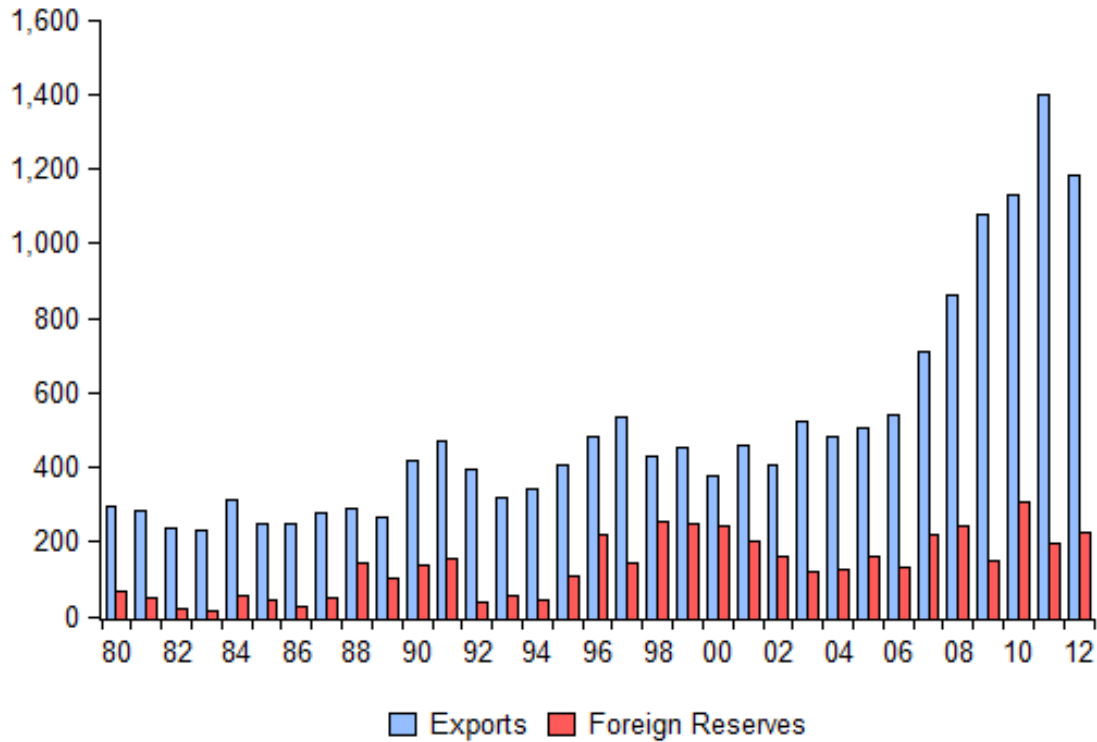
the Malawi Kwacha (MK) by overvaluing it (ibid). This is because research on optimal exchange rate policies seem to lie between the theoretical extremes of complete flexibility and fixity of exchange rates (Doroodian and Caporale 2001). In this case, optimal policy responses to shocks to the economy are a function of the nature of the shocks and the degree of capital mobility in the economy (Simwaka and Mkandawire 2008, Simwaka 2004, Doroodian and Caporale 2001).

It is widely known that countries that practice fixed exchange rate regimes may respond differently to an exogenous shock to their export commodities than those countries that float their exchange rates. Malawi has for more than four decades practised a fixed exchange rate regime and a managed float to keep the currency (Malawi Kwacha) strong (Simwaka and Mkandawire 2008). The country's monetary policy is conducted in an environment characterised by fiscal dominance, excessive dependence on donor aid, a non-competitive banking structure, and exogenous shocks where central bank independence is lacking (Mangani 2011, Simwaka and Mkandawire 2008). In addition, the political and institutional set-up for Malawi has made implementation of monetary policy difficult, which has also worsened the macroeconomic environment in the country (IMF 2012). Thus, the environment does not permit policies to yield their desired results. The country's main exports are tobacco, tea, cotton, and sugar, and tobacco is the major export crop, making Malawi the largest producer of tobacco in Africa. The tobacco industry in Malawi is by far the largest employer after the government, and the crop earns 20 times more than the value of tea (WHO 2001).

Because of the managed exchange rate regime practiced over the years, the problem of shortage of foreign reserves seems a recurrent phenomenon. During the 1980s, after the debt crisis that engulfed practically all developing countries, the Malawian economy has experienced tough macroeconomic imbalances. This was compounded by weak agricultural commodity prices of exports on the international market (Simwaka and Mkandawire 2008, Simwaka 2006). Furthermore, fluctuations in the level of foreign exchange reserves in Malawi have always coincided with fluctuations in tobacco revenues every year. The reason is that prices of tobacco on the selling auction floors determine the amount of export revenues to be generated, so that when tobacco fetches low prices, it leads to low export earnings and levels of foreign exchange generated, and therefore to low foreign reserves. The country's heavy dependence on tobacco exports contributes immensely to fluctuations in export revenues. Weak tobacco prices lead to fluctuations in foreign exchange revenues, and low tobacco prices means low levels of foreign reserves (see Figure 3.2).

Malawi's total reserves (minus gold) did not rise when reserves in the SSA region were

Figure 3.2: Exports and Reserves (Million US\$)

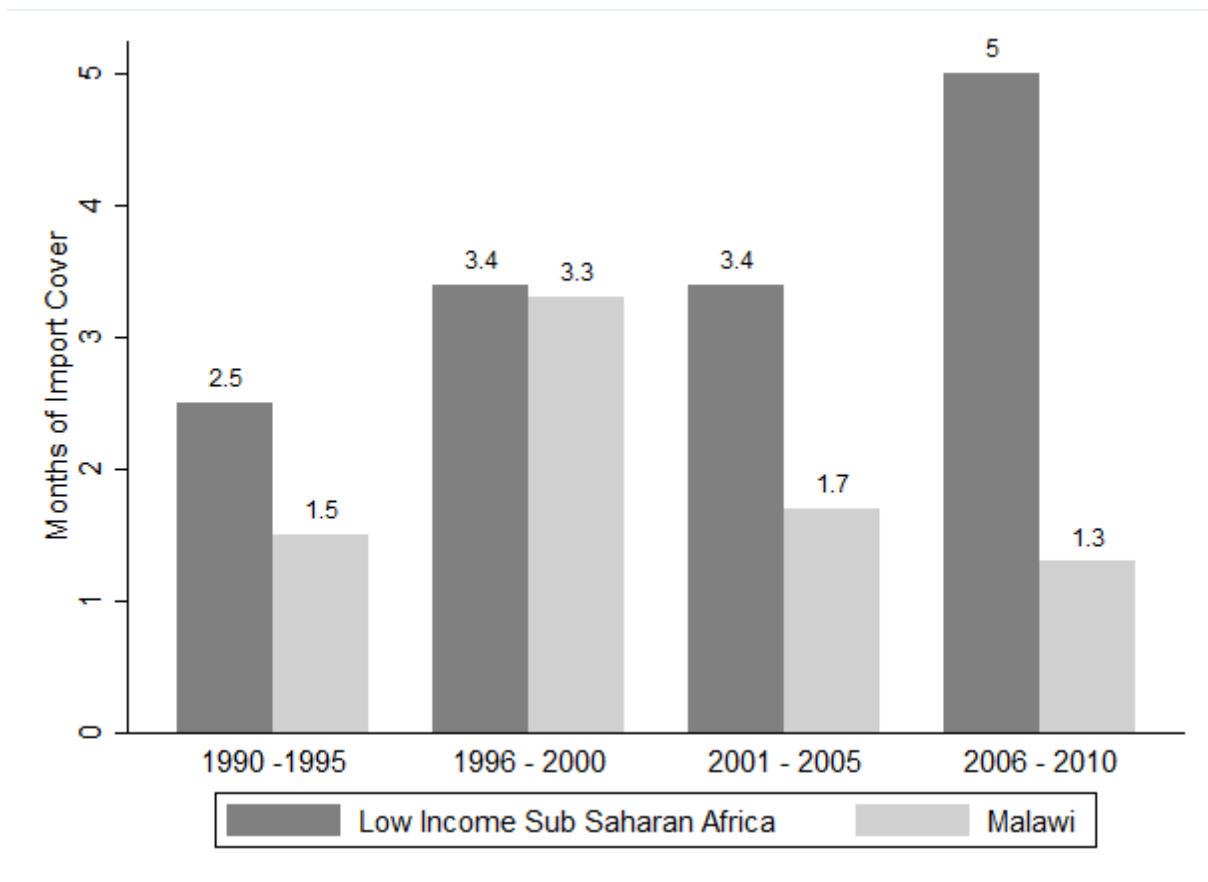


rising, and of all the countries in the SSA, Malawi has the lowest reserve levels and the difference Malawi's reserves and the SSA reserves is large (see Figure 3.3). Having inadequate export revenues which fail to cover the high import bill, and facing a growing international debt with inadequate debt-servicing capacity, has worsened the foreign exchange problem in the country and constrained output growth (Munthali 2004). In a bid to revive the economy, the country implemented the World Bank's structural adjustment reforms from 1981 to liberalise the economy, broaden and diversify the production base towards non-primary products, and allocate resources to more productive sectors. However, the reforms failed to achieve intended results and led to more macroeconomic problems.

The failure to meet key the economic stabilisation targets of low inflation, low interest rates, and prudent spending, led the country to incessant volatility in foreign reserves in the 1990s. This was when Malawi's traditional donors withheld economic reform funds, leading to the first ever floatation and a 74% depreciation of the exchange rate in 1994 to resolve the foreign exchange crisis. This was exacerbated by the 1992/93 drought which reduced the country's exports (Simwaka 2006, Munthali 2004).

Between 1990 and 1995, Malawi experienced declining foreign reserves with about 1.5

Figure 3.3: Reserves (Months of Import Cover)



Source: The IMF 2012 Presentation on Economic Reforms and Economic Recovery Plan (Malawi)

months of import cover in contrast to other SSA countries which had 2.5 months of import cover (see Figure 3.4). Between 1995 and 1997, the country implemented a fixed exchange rate, which was maintained by running down foreign reserves. The low inflation rate attained at the end of 1997 was achieved at the expense of huge reserves (Simwaka 2006). However, the country experienced high levels of foreign exchange inflows between 1996 and 2000 after the first referendum, when a new multiparty government was ushered into power. This saw most donors who withdrew their aid during the previous government restore their provision of aid. Consequently, the real exchange rate appreciated, thereby creating a current account imbalance during the period of fixed exchange rate, which further worsened the foreign reserve status. By August 2003, the Malawi Kwacha was stabilised at MK103 to 1 US\$ in response to serious economic disequilibrium that followed the suspension of the first IMF Poverty Reduction Growth Facility (PRGF) (Simwaka 2006).

The Kwacha has been free-falling since 2003, depreciating more than 300% with a worsening of the foreign exchange problem in 2010. The country had a growing trade deficit, partly because of the declining prices of tobacco leaf exports and rising prices of imports, which put pressure on low foreign reserves. This was exacerbated by withdrawal

of foreign aid because of the government's poor macroeconomic policies, poor leadership, and misappropriation of government and donor funds (MCC 2012, Malawi-Government-Publications 2011). The country experienced extreme shortages of foreign exchange from 2011 to 2012, when the parallel market price of the US dollar was 200% more than the official prices of the foreign currency. This led to devaluation of the Malawi Kwacha by 20% in September 2011, and another 50% in May 2012, when the IMF indicated that the Kwacha was overvalued (IMF 2012). Regardless, the Reserve Bank of Malawi constantly intervenes in the foreign exchange market to reduce, but not reverse, exchange rate depreciation² (Mangani 2011, Simwaka and Mkandawire 2008, Simwaka 2006).

The country is facing declining tobacco prices, with tobacco as the main source of export revenue and main foreign exchange earner. Increasingly poor macroeconomic performance and the deterioration of the economy over the past years have also contributed to the withdrawal of most aid from Malawi recently, sending the level of import cover to a record low level of 1.3 months.

3.3 Related Literature

The two key stylised facts of LIEs is that they rely on imported intermediate inputs and physical capital, and they frequently experience shortages of foreign exchange (Senbeta 2013). The shortage of foreign exchange constrains growth by limiting a country's ability to finance external payment imbalances to smooth current consumption, but also through delaying implementation of government programs (Craigwell et al. 2003). In addition, LIEs fail to intervene in the foreign exchange market and fail to provide a buffer to cushion the economy against future fluctuations in the exchange rate, thereby creating lack of confidence in investors leading to capital flight. More importantly, the ability of LIEs to import intermediate inputs and capital determines the performance of the firms that operate in these countries, such that the availability and cost of foreign exchange play a huge role in the production process of LIEs.

Most empirical studies on the implications of foreign exchange on LIEs macroeconomic performance are cross country studies and have found a strong link between the availability and cost of foreign exchange and macroeconomic performance (see Agénor and Montiel 2008a, Stiglitz et al. 2006, Lensink 1995, Porter and Ranney 1982, Moran 1989). For example, using a 'standard LIE model' of aggregate demand and aggregate supply, Porter and Ranney (1982) found that standard macroeconomic policy prescriptions often produce

²See Simwaka (2006) for a detailed analysis on the interventions carried out by the Reserve Bank of Malawi in the foreign exchange market and the effectiveness of such interventions.

non-standard results, where expanding output without increasing costs of production in the short-run is possible only if foreign exchange is located to purchase the needed imported raw materials. In addition, [Lensink \(1995\)](#), [Moran \(1989\)](#), and [Marquez \(1985\)](#) argue that the availability of foreign exchange in LIEs defines the macroeconomic policy dynamics of LIEs which depend on imported intermediates. For instance, [Moran \(1989\)](#) observe that declines in foreign lending, declines in terms of trade, and debt service costs in the 1980s reduced foreign exchange availability and limited the import capacity of most developing countries. SSA countries experienced a significant fall in imports, which in turn led to a decline in investment and per capita output. [Moran \(1989\)](#) argues that economic growth in LIEs depends on the availability of foreign exchange and imported intermediate inputs. Declines in foreign exchange inflows constrain production by limiting the amount of imported intermediate inputs and therefore growth.

Recent empirical research underscores the importance of foreign exchange by stressing that imported intermediate inputs, the costs and the availability of foreign exchange, are important determinants of private investment behaviour in LIEs ([Agénor and Montiel 2008a](#), [Stiglitz et al. 2006](#), [Polterovich and Popov 2003](#)). [Agénor and Montiel \(2008a\)](#) argues that the specifications of relative factor prices in LIEs should not be restricted to wage rate and capital costs, but should take into account the domestic currency price, as well as the availability of imported inputs. This is because a domestic depreciation may result in higher revenues for exports and higher costs of imports, resulting in an ambiguous net effect, depending on the degree of reliance on imported inputs. This is the reason [Stiglitz and Charlton \(2006\)](#) argues that the principal limiting factor of economic activity in LIEs is the availability of foreign exchange, because shortages of foreign exchange (supply constraint), outweighs demand constraints and forces firms to produce below capacity.

In the literature on the effects of declining foreign exchange inflows and the effect it has on imported intermediate inputs and macroeconomic fluctuations of LIEs, three studies have recognised the importance of imported intermediate inputs in a case study analysis using a DSGE framework ([Senbeta 2013](#), [Kose and Riezman 2001](#)). For example, [Kose and Riezman \(2001\)](#) uses the real business cycle (RBC) version of a small open economy multi-sector DSGE model to examine the role of external shocks (fluctuations in export prices of primary commodities, imported capital goods and intermediate inputs) to explain macroeconomic fluctuations in African countries. They conclude that trade shocks account for half of the fluctuations in aggregate outputs. they show that adverse trade shocks cause prolonged recessions by inducing a significant decrease in aggregate investment. [Kose and Riezman \(2001\)](#) incorporate intermediate inputs into their assessment of macroeconomic fluctuations in LIEs in a DSGE framework. However, they fail

to recognise the importance of foreign exchange availability to determine the amount of imported inputs, which [Senbeta 2013](#) managed to incorporate into their model. [Senbeta 2013](#) compares the variability of the standard and modified foreign exchange constrained DSGE models that were calibrated to the Ethiopian economy for specific monetary policy shock. [Senbeta 2013](#) finds that contractionary monetary policy leads to an expansion in output and consumption and a contraction in employment. Furthermore, the impulse responses of the two models in [Senbeta 2013](#) shows that the modified model generates more variability than the standard model.

This chapter adds to the evidence provided in [Senbeta 2013](#) in the following ways: First, we examine the effects of aid shocks on the macroeconomic fluctuations of LIEs. Aid is a prominent form of development finance in most LIEs, at times constituting over 40% of the total government budget and consisting of the lion's share in GDP of most LIEs. [Adam et al. \(2009b\)](#) and [Mwabutwa et al. \(2013\)](#) argue that erratic flows of aid to LIEs influence the achievement of the broader macroeconomic objectives of stable exchange rates and sustainable economic growth. Second, we incorporate stylised features of a small, open economy LIE, which depends on a single export agricultural commodity. Fluctuations in international prices worsens this LIE's economic conditions by determining the amount of foreign exchange available in the economy. Third, we consider an alternative study area: Malawi. Malawi is an ideal country to analyse the effects of foreign exchange constraints on macroeconomic fluctuations because of its economic make-up. For instance, the country relies heavily on aid; which contributes 40% to the national budget and is a source of most development finance that the country generates annually. In addition, the country's main export (tobacco) faces declining international prices, exerting constant pressure on the levels of export generated revenues annually. Given the country's macroeconomic status, the impulse response functions to a chosen policy are unlikely to provide standard results and the consequences of any effect on the economic policy may not be obvious. The results may depend on the extent of the decline in foreign exchange flows or the degree of the economy's dependence on imported intermediate inputs and the ability of the country to import the needed intermediate inputs.

The DSGE framework is used in most empirical works which examine developed economies, and on South Africa. This is due to a number of factors: First, the models are micro-founded, derived from the micro-foundations of decision makers who are constrained by available resources. That is, they describe an allocation of a general equilibrium, where the agents dynamically maximise their objectives subject to resource constraints ([Ngalawa and Viegi 2013](#)). The models are structural and each equation provides an economic interpretation. Thus policy interventions and transmission mechanisms can be clearly identified, thereby facilitating a discussion of alternative policies. The behaviour of agents

in the model are in terms of structural parameters that cannot change as a result of changes in economic policy, which renders the models impervious to the Lucas Critique (Woodford 2003). These features make DSGE models more appealing in the analysis of macroeconomic policies, compared to standard models. However, difficulty in parameterising economic data, especially in low-income economies, makes them cumbersome to estimate (Peiris and Saxegaard 2007). This problem is overcome by using calibrations of parameters from previous studies, and we follow the studies of Senbeta 2013, Senbeta 2011a and Kose and Riezman (2001) to employ a DSGE model to analyse the foreign exchange constrained economy of Malawi.

The next section presents the DSGE model for a foreign exchange constrained low income economy.

3.4 A DSGE Model of Foreign Exchange Constraints

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, monetary authorities, and the external sector. The household maximises inter-temporal utility function separable in consumption and labour with its financial resources coming from labour income and returns from holding bonds.

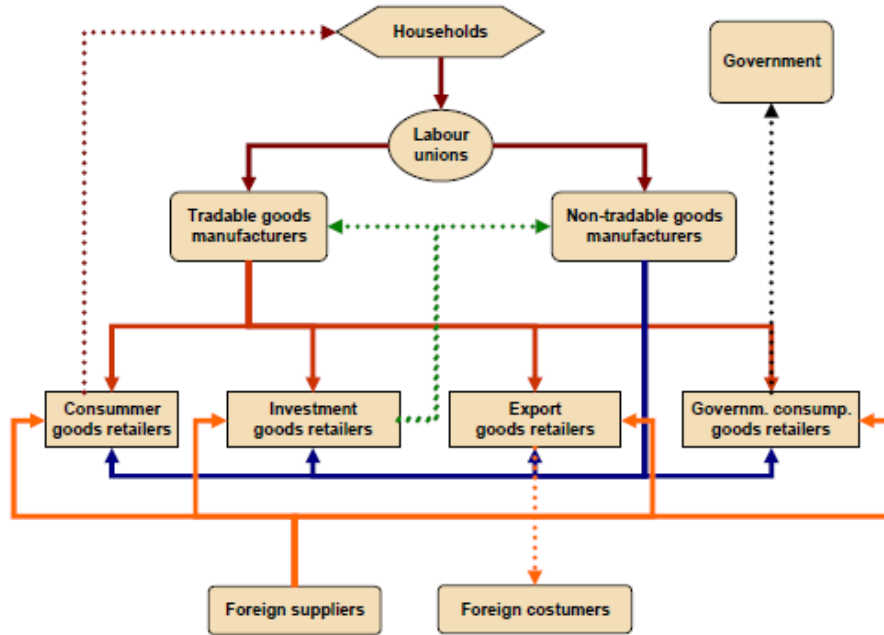
The firms consist of domestic producers and importing firms, and their price setting behaviour follows Calvo 1983 where the price setting mechanism allows for partial indexation of domestic and imported prices to their past inflation to provide additional nominal rigidities to the staggered price setting framework as in (Justiniano and Preston 2004). In addition, we assume incomplete pass-through of exchange rate movement while habit formation provides real rigidity in the model.

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 foreign exchange equation. This is to capture the salient features that are specific to most LIEs that depend heavily on commodity exports and aid as their main sources of foreign financial inflow.

We provide a flow-chart of the economy in Figure 3.4. We will add government consump-

tion in the next chapter.

Figure 3.4: Flow Chart of the Economy



3.4.1 Household Behaviour

The infinitely lived representative household maximises inter-temporal utility subject to an inter-temporal budget constraint. The objective function is:

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t \quad (3.1)$$

where

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{(C_t - hC_{t-1})^{1-\nu}}{1-\nu} - \chi \frac{(N_t)^{1+\varphi}}{1+\varphi} \right\} \quad (3.2)$$

E is the expectation operator and β is the subjective discount factor of the representative household's utility. The household derives utility from consumption of a composite good and disutility from providing labour. C_t , N_t are household consumption and labour time supplied to the market. ν is the inverse of the elasticity of inter-temporal substitution in consumption, h is the coefficient of habit persistence, φ is the inverse of the elasticity of labour supply and χ is the marginal disutility of work. Since consumption is a composite good comprising the home and foreign goods, it is given by a CES aggregator as:

$$C_t = \left[(1 - \alpha_1)^{\frac{1}{\rho_1}} C_{H,t}^{\frac{(\rho_1-1)}{\rho_1}} + \alpha_1^{\frac{1}{\rho_1}} C_{F,t}^{\frac{(\rho_1-1)}{\rho_1}} \right]^{\rho_1/(\rho_1-1)} \quad (3.3)$$

And $C_{H,t}$, $C_{F,t}$ are consumption of home and foreign goods respectively, ρ_1 measures the

elasticity of intra-temporal substitution of consumption between the home and foreign goods. As ρ_1 becomes larger, then the goods become perfect substitutes. In addition, α_1 measures the proportion of foreign goods in the household's consumption and the representative household maximises the utility from consumption of both goods. The consumer minimises expenditure on the two goods while facing the overall consumer price index given as:

$$P_t = [(1 - \alpha_1)(P_{H,t})^{1-\rho_1} + \alpha_1(P_{F,t})^{1-\rho_1}]^{1/(1-\rho_1)} \quad (3.4)$$

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

$$P_t C_t = P_{F,t} C_{F,t} + P_{H,t} C_{H,t} \quad (3.5)$$

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

$$C_{H,t} = (1 - \alpha_1) \left(\frac{P_{H,t}}{P_t} \right)^{-\rho_1} C_t \quad (3.6)$$

$$C_{F,t} = \alpha_1 \left(\frac{P_{F,t}}{P_t} \right)^{-\rho_1} C_t \quad (3.7)$$

The household's income comes from wages and dividends from firms. 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 which is governed by the function ϕ_t to close the model. The debt elastic interest premium takes the form: $\phi_t B_t^*$ ³. ϕ_t increases with foreign debt of the domestic economy (d_t) where $\phi_t = \exp[-\eta(d_t + \omega_t)]$ where (ϕ_t) is the risk premium shock. $d_t \equiv \frac{\varepsilon_{t-1} B_{t-1}^*}{Y P_{t-1}}$ ⁴ as in Justiniano and Preston (2010). The financial inter-mediation sector is excluded and as such we also ignore this channel in the dynamics of the economy. The household maximises lifetime utility subject to a budget constraint:

$$P_t C_t + B_t + \varepsilon_t B_t^* \leq W_t N_t + D_t + r_{t-1} B_{t-1} + \varepsilon_{t-1} r_{t-1}^* B_{t-1}^* \phi_t + \varepsilon_t P_t^* A_t \quad (3.8)$$

Where B_t is government bonds earning interest r_t . Thus the household expenditure consists of expenditure on consumption C_t and purchases of government bonds B_t and

³see [Benigno \(2004\)](#) for a good discussion on how households face additional costs of borrowing in the international markets. One might also look at [Schmitt-Grohé and Uribe \(2003\)](#) on how to close small open economies and how this term ensures stability of the model.

⁴Is the real outstanding foreign debt expressed in terms of domestic currency as a fraction of steady-state output.

foreign bonds B_t^* . Income is comprised of dividends, D_t , wage income from supply of labour 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. A_t captures all net foreign transfers, both institutional and private since a large percentage of household income in most LIEs are transfers. Its log linearised function follows an AR(1) process as follows:

$$a_t = \rho_a a_{t-1} + \epsilon_{a,t}, \quad 0 < \epsilon_{a,t} < 1 \quad (3.9)$$

where $\epsilon_{a,t} \sim i.i.d.N(0, \sigma_\epsilon)$. Therefore the consumer maximises the utility in equation (1) subject to the budget constraint in equation (8) by choosing C_t , N_t , B_t , B_t^* . The first order conditions derived from the optimisation problem are given as:

$$(C_t - hC_{t-1})^{-\nu} = \lambda_t P_t \quad (3.10)$$

$$\chi(N_t)^\varphi = \lambda_t W_t \quad (3.11)$$

$$\beta E_t \lambda_{t+1} r_t = \lambda_t \quad (3.12)$$

$$\beta E_t \lambda_{t+1} \epsilon_{t+1} r_t^* \phi_{t+1} = \lambda_t \epsilon_t \quad (3.13)$$

Combining equations (11) and (12) gives the marginal rate of substitution between consumption and labour:

$$\chi(N_t)^\varphi (C_t - hC_{t-1})^\nu = \frac{W_t}{P_t}$$

while (11) and (13) gives us the consumption Euler equation for the household as:

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

Furthermore, the combination of (13) and (14) gives the uncovered interest parity (UIP) condition as:

$$\frac{r_t}{r_t^* \phi_{t+1}} = E \frac{\epsilon_{t+1}}{\epsilon_t}$$

3.4.2 Firms

3.4.2.1 Domestic Production

There exists a continuum of identical, monopolistic, competitive firms which produce domestic goods using capital, labour, and imported intermediate inputs. We introduce the foreign exchange constraint in the model by assuming that importation of intermediate inputs by firms depends solely on the availability of foreign exchange. When the country faces declining levels of foreign exchange, it is unable to provide the required amount of the needed foreign exchange for the importation of inputs, and this acts as a constraint to the importing firms. We assume the free mobility of capital and labour in the economy for simplicity and these inputs are therefore homogeneous.

Firms use labour (N) and imported intermediate inputs (M) to produce tradable goods as in [Senbeta \(2013\)](#) while capital is assumed fixed. As such, capital is excluded from the model. We assume a linear technology with constant returns to scale and the firm's production function is given as:

$$Y_{H,t} = A_{H,t} N_{H,t}^{\sigma_1} M_{H,t}^{\sigma_2}, \quad (\sigma_1, \sigma_2 > 0, \quad \sigma_1 + \sigma_2 = 1) \quad (3.14)$$

where $A_{H,t}$ represents total factor productivity and follows a first order autoregression process as follows:

$$\ln A_{H,t} = \rho_H \ln A_{H,t-1} + e_{H,t}, \quad 0 < \rho_H < 1 \quad (3.15)$$

$e_{H,t}$ is i.i.d. $N(0, \sigma_{eH})$. The cost minimisation problem by the representative firm given the production level is:

$$\text{Min}_{N_{H,t}, M_t} (W_t N_t + P_{F,t} M_t), \text{ s.t. } Y_{H,t} = A_{H,t} N_{H,t}^{\sigma_1} M_{H,t}^{\sigma_2} \quad (3.16)$$

The resulting input demand functions are as follows:

$$N_t = \left(\frac{\sigma_1}{\sigma_2} \right)^{\sigma_2} P_{F,t}^{\sigma_2} W_t^{-\sigma_2} Y_{H,t} A_{H,t}^{-1} \quad (3.17)$$

$$M_t = \left(\frac{\sigma_2}{\sigma_1} \right)^{\sigma_1} P_{F,t}^{-\sigma_1} W_t^{\sigma_1} Y_{H,t} A_{H,t}^{-1} \quad (3.18)$$

Substituting the input demand functions into the objective function we obtain the total cost function, which when differentiated with respect to output, gives us the marginal cost function (3.19):

$$MC_{H,t} = \left[\left(\frac{\sigma_2}{\sigma_1} \right)^{\sigma_1} + \left(\frac{\sigma_1}{\sigma_2} \right)^{\sigma_2} \right] \frac{P_{F,t}^{\sigma_2} W_t^{\sigma_1} A_{H,t}^{-1}}{P_t} \quad (3.19)$$

The real marginal cost function is in terms of total productivity, output, input prices and the share parameters.

3.4.2.2 Price Setting Behaviour

Following [Calvo \(1983\)](#) each domestic firm can set price with probability $1 - \theta$ every period. For those prices that have been changed, we use $P_{H,t}^*$. Therefore, θ_H is used to describe the proportion of goods for which the current price, $P_{H,t}$, is equal to that of the previous period (i.e. $P_{H,t-1}$), that is to say, firms which face sticky prices as in [Justiniano](#)

and Preston (2010)⁵, and their prices are adjusted according to the indexation rule:

$$\ln P_{H,t}(j) = \ln P_{H,t-1}(j) + \zeta_H \pi_{H,t-1} \quad (3.20)$$

which is simply

$$P_{H,t}(j) = P_{H,t-1}(j) \left(\frac{P_{H,t-1}}{P_{H,t-2}} \right)^{\zeta_H} \quad (3.21)$$

where $0 \leq \zeta_H \leq 1$ measure the degree of the firm's indexation to the past period's inflation rate. The re-optimising firm's price index evolves according to:

$$P_{H,t}(j) = \left[(1 - \theta_H) P_{H,t}^{*(1-\rho_1)} + \theta_H P_{H,t}(j)^{1-\rho_1} \right]^{1/(1-\rho_1)} \quad (3.22)$$

Assuming that the preferences are symmetrical between domestic and foreign goods, then the demand curve for the firm in period $t+k$ setting its price in period t becomes:

$$C_{H,t+k} = \left(\frac{P_{H,t}^*}{P_{H,t+k}} \left(\frac{P_{H,k-1}}{P_{H,t-1}} \right)^{\zeta_H} \right)^{-\rho_1} (C_{H,t+k} + C_{H,t+k}^*) \quad (3.23)$$

where $C_{H,t+k}^*$ is the foreign consumption (domestic exports). Then the price setting firm aims to maximise the expected discounted profits given by:

$$E_t \sum_{k=t}^{\infty} \theta_H^{k-t} \beta_{t,t+k} C_{H,t+k} \left[P_{H,t}^* \left(\frac{P_{H,t+k-1}}{P_{H,t-1}} \right)^{\zeta_H} - P_{H,t+k} MC_{H,t+k} \right] \quad (3.24)$$

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 presented as:

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

Such that:

$$P_{H,t}^* = \frac{\rho_1}{\rho_1 - 1} \frac{E_t \sum_{k=0}^{\infty} \theta_H^k [\beta_{t,t+k} C_{H,t+k} P_{H,t+k} MC_{H,t+k}]}{E_t \sum_{k=0}^{\infty} \theta_H^k [\beta_{t,t+k} C_{H,t+k} (P_{H,k-1}/P_{H,t-1})^{\zeta_H}]} \quad (3.25)$$

3.4.2.3 Importing Firms

Importing firms import two types of goods: First, they use foreign currency to import final goods which are sold to domestic retailers in domestic currency and are consumed directly by the consumers. Second, these firms import intermediate goods which are used in the production of other final products. This representation is as in Justiniano and Preston (2010) and Christiano et al. (2011) and the only difference is that firms in Christiano et al. (2011) do not face a foreign exchange constraint. In practice, the central bank is often not able to supply the required amount of foreign exchange to importers,

⁵See Clarida et al. (1999) on price rigidity.

and this creates excess demand for foreign currency. We assume at the beginning of the period, the central bank has to distribute a certain amount of foreign exchange $P_t^*Y_{F,t}$ equally to identical importing firms who also face the same foreign exchange constraint $P_t^*Y_{jF,t}$. Therefore, at the aggregate level, $P_t^*Y_{F,t} = \int_0^1 P_t^*Y_{jF,t}di$. However, because of the insufficient flow of foreign exchange in the country, suppose an importing firm requests to import $Y_{F,t}(j)$ but the central bank provides only a fraction of the total amount of foreign exchange demanded by a firm, $\varrho_{F,t}$, where $0 \leq \varrho_{F,t} \leq 1$.

The amount of foreign exchange provided to each importing firm during foreign exchange constraints is given as $Y_{F,t}(i) = \varrho_{F,t}P_t^*Y_{jF,t}(i)$, causing the firms to import fewer final goods and intermediate inputs, causing them to raise their prices because they sourced the additional foreign exchange at a premium in parallel markets. We define import demand differently from Senbeta (2013), and we move away from estimating the central bank's loss function. We limit our analysis to estimating a foreign exchange constrained import demand that defines the imported consumption goods and the intermediate inputs to the production process. We define the aggregate quantity of imported intermediate inputs and consumption goods demanded as: $Y_{F,t} = C_{F,t} + M_T$, where C is the imported consumption goods and M is the imported intermediate inputs. The foreign exchange constraint exists when the central bank can only satisfy a fraction $\varrho_{F,t}$ of the demanded quantity of foreign exchange. We also assume that the constraint is binding except at the steady state where the quantities are equal and $\varrho_{F,t} = 1$. The actual constrained imports demand is denoted:

$$Y_{F,t} = \varrho_{F,t}(Y_{F,t}), \quad 0 < \varrho_{F,t} < 1 \quad (3.26)$$

Since we assume that the importing firm j faces the same foreign exchange constraint $P_t^*Y_{F,t}$, its production function is given as:

$$Y_{F,t} = \left[\int_0^1 Y_{F,t}(j)^{1-\frac{1}{\rho_2}} di \right]^{\frac{\rho_2}{\rho_2-1}}$$

Solving the profit maximisation problem for a perfectly competitive importing firm that imports $Y_{F,t}(j)$ gives the demand function for each input as:

$$Y_{F,t}(j) = \left(\frac{P_{F,t}(j)}{P_{F,t}} \right)^{-\rho_2} Y_{F,t} \quad (3.27)$$

To assess the effects of the foreign exchange constraint on the firm and the quantity imported, we compare the outcomes under the two conditions by first outlining the optimal price of an importing firm without the constraint, which takes the price and the demand of its imports $Y_{F,t}(j)$ to maximise its profits, such that:

$$\underset{P_{F,t}(j)}{\text{Max}} (P_{F,t}(j) - \varepsilon_t P_t^*) Y_{F,t}(j) \quad (3.28)$$

subject to 26 . Solving this problem, the optimal mark-up price that the unconstrained

firm charges for its imports is given as:

$$P_{F,t}(j) = \frac{\rho_2}{\rho_2 - 1} \varepsilon_t P_F^* \quad (3.29)$$

However, when a firm faces a foreign exchange constraint, the quantity of their imports is less than they would like to import without the foreign exchange constraint. The objective of the importing firm that faces the foreign exchange constraint is to maximise profits with respect to the foreign price of imports, the demand function it faces and the foreign exchange constraint it is experiencing;

$$\underset{P_{F,t}(j)}{\text{Max}} (P_{F,t}(j) - \varepsilon_t P_t^*) Y_{F,t}(j) \text{ s.t. } Y_{F,t}(j) \leq \varrho_{F,t}(Y_{F,t})$$

gives us the optimal price that the firm under constraint charges, and thus;

$$P_{F,t}(j) = \frac{\rho_2}{\rho_2 - 1} \varepsilon_t P_F^* (1 + \varpi_{F,t}) \quad (3.30)$$

where $\varpi_{F,t}$ is the additional mark-up on the price that the firm charges as a result of a change in foreign exchange quantity. This is equal to zero if there are no foreign exchange constraints and is greater than 0 when constraint is binding, indicating that the optimal price that the firm charges under constraint is always greater than the price the firm charges without the foreign exchange constraint; a result which is consistent with intuition and economic theory (Senbeta 2013). In addition, when the constraint is binding, the quantity restriction imposed by the foreign exchange constraint allows the importers to charge a higher price than the price that they would charge when the constraint is not binding. This happens because we assume that the demand for the imported goods that the firms face remains unchanged under foreign exchange constraint and in unconstrained times.

3.4.2.4 Price Setting by Importing Firms

Price setting by importing firms is the same for domestic producers. As was the case for domestic firms, the importing firms set their prices according to Calvo (1983) where $(1 - \theta)$ represents the proportion/fraction of firms that can reset their prices and θ is the fraction of firms that index their prices to the past period's inflation as follows:

$$P_{F,t}(i) = P_{F,t-1}(i) \left(\frac{P_{F,t-1}}{P_{F,t-2}} \right)^{\zeta_F} \quad (3.31)$$

where $0 \leq \zeta_H \leq 1$ measures the degree of the firm's indexation to the past period's

inflation rate. The firm's price index evolves according to:

$$P_{F,t}(i) = \left[(1 - \theta_F) P_{F,t}^{*(1-\rho_1)} + \theta_F \left(P_{F,t-1} \left(\frac{P_{F,t-1}}{P_{F,t-2}} \right)^{\zeta_F} \right)^{1-\rho_2} \right]^{1/(1-\rho_2)} \quad (3.32)$$

Assuming that the preferences are symmetrical between domestic and foreign goods, then the demand curve firm in period $t+k$ setting its price in period t becomes:

$$y_{F,t+k} = \left(\frac{P_{F,t}^*}{P_{F,t+k}} \left(\frac{P_{F,t+k-1}}{P_{F,t-1}} \right)^{\zeta_F} \right)^{-\rho_2} (Y_{F,t+k}) \quad (3.33)$$

Therefore, the price setting firm aims to maximise the expected discounted profits

$$E_t \sum_{k=t}^{\infty} \theta_F^{k-t} \beta_{t,t+k} y_{F,t+k} \left[P_{F,t}^* \left(\frac{P_{F,t+k-1}}{P_{F,t-1}} \right)^{\zeta_F} - P_{F,t+k} MC_{F,t+k} \right] \quad (3.34)$$

β_{t+k} is the usual stochastic discount factor and MC_{t+k} is the real marginal cost function for the consumption goods importing firms. The firm's first order condition which is the aggregate price index is given as:

$$E_t \sum_{k=0}^{\infty} \theta_F^k \beta_{t,t+k} Y_{F,t+k} \left[P_{F,t} \left(\frac{P_{F,t+k-1}}{P_{F,t-1}} \right)^{\zeta_F} - \frac{\rho_F}{\rho_F - 1} P_{F,t+k} MC_{F,t+k} \right] = 0$$

and so:

$$P_{H,t}^* = \frac{\rho_2}{\rho_2 - 1} \frac{E_t \sum_{k=0}^{\infty} \theta_F^k [\beta_{t,t+k} Y_{F,t+k} P_{F,t+k} MC_{F,t+k}]}{E_t \sum_{k=0}^{\infty} \theta_F^k [\beta_{t,t+k} Y_{F,t+k} (P_{F,t+k-1}/P_{F,t-1})^{\zeta_F}]} \quad (3.35)$$

Recall that importing firms charge a mark-up on the original prevailing price.

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

The law of one price indicates that commodities will have the same price when exchange rates are taken into consideration. The ratio of the foreign price to the domestic price should equal 1; but the law of one price gap only shows that the law of one price fails to hold. [Monacelli \(2005\)](#) states that the law of one price fails to hold when the ratio of two currencies is not equal to one. Therefore, the gap is given by the ratio of the index of foreign price in terms of domestic currency to the domestic currency price of imports (which is not equal to 1) as:

$$\Psi_t = \frac{\varepsilon_t P_t}{P_{F,t}} \quad (3.36)$$

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

$$Q_t = \frac{\varepsilon_t P_t^*}{P_t} \quad (3.37)$$

And terms of trade is defined the domestic price of imported goods divided by the domestically produced good. here terms of trade is given as $s_t = \frac{P_{F,t}}{P_{H,t}}$. However, apart from the risk sharing assumptions, we introduce a country specific risk premium shock which follows an AR(1) process as $risk_t = \chi_{risk} risk_{t-1} + \epsilon_{risk}$. This shock captures time-varying country risk premia as in [Alpanda et al. \(2010\)](#).

3.4.4 Monetary Policy

Most recent research in the DSGE literature indicates that LIEs employ monetary policy regimes that are very different from HIEs and therefore different from the standard simple Taylor rule ([Mwabutwa et al. 2013](#), [Senbeta 2013](#)). Most central banks in developing economies use foreign exchange market intervention as a macroeconomic stabilisation tool. This enables them to buy foreign exchange and build up reserves that will help moderate exchange rate fluctuations apart from their main role of stabilising inflation and promoting output growth ([Simwaka 2006](#)).

According to [Mangani \(2011\)](#) and [Mwabutwa et al. \(2013\)](#), the Reserve Bank of Malawi (RBM) targets broad money and reacts to inflation while moderating the exchange rate in setting the monetary base. The bank rate determination is influenced by the desire to correct the disequilibria rather than economic developments. Clearly, the central bank managed the exchange rate in the period under analysis, resulting in numerous foreign exchange unavailability problems, and constant depreciation of the Kwacha. This indicates that the central bank should also respond to changes in the foreign exchange rate. Therefore, we modify the Taylor rule to incorporate the fact that changes in the foreign exchange rate affect key macroeconomic variables, where the central bank reacts to changes in the nominal exchange rate apart from the standard reactions of deviations in inflation and output. We term this a 'simplified' Taylor rule because the main focus is not on monetary policy in Malawi. Thus, the monetary authority is assumed to stabilise inflation, output, and exchange rate. In log-linearised form it is given as:

$$r_t = \rho_r r_{t-1} + (1 - \rho_r)(\phi_{r\pi}\pi_t + \phi_{ry}y_t + \phi_{re}\Delta e_t) + \epsilon_{r,t} \quad (3.38)$$

where $\phi_{r\pi}, \phi_{ry}, \phi_{re}$ are weights that allow the monetary authorities to control inflation, output and nominal exchange rate. Δe is nominal exchange rate, ρ_r is the smoothing

parameter which indicates the persistence of interest rate. 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 $(0_{er}, \sigma_{er})$.

Reserve Accumulation

The central bank accumulates foreign reserves as an important instrument in its implementation of monetary policy, since it continuously faces foreign exchange problems. The country relies heavily on a single agricultural export commodity which makes the economy vulnerable to international prices and creates an unstable flow of export earnings. The country also relies on the constant flow of developmental aid which supplements the reserves inflow. Any withdrawal of aid coupled with fluctuations in international prices of the main agricultural commodity reduces the inflow of foreign exchange, with serious implications for the economy. The RBM influences the quantity of imported goods, because it decides on how much is allocated to imports every month. The current account for the country is represented by

$$\epsilon_t B_t^* = r_{t-1}^* \epsilon_t B_{t-1}^* \phi_t + \epsilon_t A_t + P_t^* C_{H,t}^* - \epsilon_t P_t^* Y_{F,t} \quad (3.39)$$

with $\epsilon_t B_t^*$, $r_{t-1}^* \epsilon_t B_{t-1}^* \phi_t$, $\epsilon_t A_t$ being net foreign assets and $P_t^* C_{H,t}^* - \epsilon_t P_t^* Y_{F,t}$ are net exports. $P_t^* C_{H,t}^*$ represents domestic exported goods, or foreign consumption of domestically produced goods. The variables are defined in the previous sections of the model. Therefore, the foreign exchange holdings evolve according to:

$$res_t = res_{t-1} + r_{t-1}^* \epsilon_t B_{t-1}^* \phi_t + \epsilon_t A_t + P_t^* C_{H,t}^* - \epsilon_t P_t^* Y_{F,t} \quad (3.40)$$

where res_t is the foreign exchange holdings this year. Thus, the reserves this year depend on last year's reserves, returns on last year's foreign bond, foreign aid, export earnings minus import expenditures. We assume that the central bank has an operational target for foreign exchange reserves, and if the reserves are below that target, the country fails to import the required amount of intermediate inputs and capital needed for production and therefore reducing growth.

3.4.5 The External Sector

The domestic economy is relatively small, therefore we model it as a closed economy, since it cannot affect world prices. The foreign economy is modelled as exogenous with the foreign interest rate r_t^* , foreign inflation π_t^* , foreign output or income y_t^* being determined by a vector of autoregression processes of order one, i.e. AR(1) process (Monacelli 2005). We implicitly assume that foreign output, inflation, and exchange rate are independent of each other. The processes are given as:

$$y_t^* = \rho_{y^*} y_{t-1}^* + \epsilon_{y^*,t} \quad (3.41)$$

$$\pi_t^* = \rho_{\pi^*} \pi_{t-1}^* + \epsilon_{\pi^*,t} \quad (3.42)$$

$$r_t^* = \rho_{r^*} r_{t-1}^* + \epsilon_{r^*,t} \quad (3.43)$$

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-deviations from the steady state. $\epsilon_{i,t}$ is i.i.d $(0, \sigma_i)$.

3.4.6 General Equilibrium

The model equilibrium is where households maximise utility subject to budget constraints, producers of home produced and importers of intermediate inputs maximise profits, thus equilibrium is where the domestic goods market requires output to equal the sum of domestic and foreign consumption for it to clear. Therefore

$$Y_t = Y_{H,t} = C_{H,t} + C_{H,t}^* \quad (3.44)$$

but

$$C_{H,t} = (1 - \alpha_1) \left(\frac{P_{H,t}}{P_t} \right)^{-\rho_1} C_t \quad (3.45)$$

then the consumption of foreign residents (domestic exports) is given as:

$$C_{H,t}^* = \alpha_1 \left(\frac{P_{H,t}}{P_t} \right)^{-\rho_1} C_t^* \quad (3.46)$$

While assuming that all households in the economy face the same budget constraints, the aggregate foreign assets in the economy minus net exports is provided as:

$$\varepsilon_t B_t^* = r_{t-1}^* \varepsilon_t B_t^* \phi_t + \varepsilon_t A_t + P_t^* C_{H,t}^* - \varepsilon P_t^* Y_{F,t}$$

the variables are as defined in the previous sections.

3.4.7 Model Solution

The model solution for the system of linear equations presented in the previous section and the detailed representations in Appendix 3 characterise the model to consists of both lagged variables (for example c_{t-1}) and expected future endogenous variables (e.g. $E_t c_{t+1}$). This indicates that the model consists of backward looking and forward looking variables. Therefore we can write the unique solution of the model in matrix representation as follows:

$$Ay_t = BE_t(y_{t+1}) + Cy_{t-1} + Dz' \quad (3.47)$$

$$z_t = Kz_{t-1} + v_t \quad (3.48)$$

where y_t is a vector of endogenous variables, z_t is a vector of shocks, A, B, C, D and K are matrices of structural (unknown) parameters which are functions of deep parameters. In addition, v_t is a vector of disturbances in the model. Therefore, the closed-form solution is given by:

$$y_t = Py_{t-1} + Qz_t \quad (3.49)$$

$$z_t = Kz_{t-1} + v_t \quad (3.50)$$

where P, Q are reduced form parameters of the model and we can rewrite the whole model in compact form as:

$$x_t = \Phi x_{t-1} + \Theta \varepsilon_t \quad (3.51)$$

which is a VAR(1) model where $x_t = (y_t', z_t)'$ and $\varepsilon_t = (0', v_t)'$ is a vector of errors.

3.5 Calibration

DeJong and Dave (2007) states that calibration is the quickest way to estimate the usefulness of successive extensions or modifications of a model to be able to compare the dynamics of fundamental macroeconomic variables in response to various shocks affecting the economy. We need to know whether the modifications that we introduce to an otherwise standard model are supported by facts about the economies under analysis and their overarching theories. Thus parameters of the model are calibrated to simulate the model and compare the responses of these variables. However, the problem that exists in many low income studies is the lack of data to carry out calculations specific to a single economy. Studies rely on calibrations made by other studies which provide a close representation of the country under analysis. We use parameters that have been used in studies similar to ours. Where a specific parameter is unavailable, it is calculated using Malawian data.

Several parameter values have been adopted from the literature, where the values are fairly standard. 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 Saxe-

gaard (2009) and Adam et al. (2009b). The common value for intertemporal elasticity of substitution for low income Sub-Saharan African countries is 0.34 ($\nu = 2.96$) as estimated by Ogaki and Park (1997) which was also adopted by Berg et al. (2012) and Senbeta (2013) while the elasticity of labour supply φ is assumed to be 2 as in Berg et al. (2010) supported by Mwabutwa et al. (2013). Since evidence from many countries indicates that time spent working does not vary dramatically, we adopt 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).

Some parameter values are obtained from the quarterly data under analysis to obtain the steady state values. For example, χ_r , the ratio of imports to foreign exchange reserves is approximated at 1 since we assume that the Central Bank's aim is to at least have an operational target that is fixed at 3 months of import cover, as recommended by the IMF. We take the most plausible level of 1 month, as reported by the World Bank's Economic Indicators, which show that the central bank of Malawi has been struggling at 1.3 months of import cover for most years. In addition, consumption to GDP ratio χ_g is assumed to be 0.8, total imports to GDP ratio χ_f approximated to be 0.4750, 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 IMF Country Reports.

A full summary of the parameter values is presented in Table 3.1 and the sources are provided in Appendix B.

Data used for calculation of some of the parameters and the steady state values is sourced from the IMF's International Financial Statistics, World Bank's World Development Indicators (WDI) database, IMF's International Financial Statistics (IFS) and the Reserve Bank of Malawi's Economic Reviews and Financial Statements and National Statistics Office of Malawi. DYNARE⁶ is used to solve the model numerically and generate impulse response functions to domestic and external shocks. The parameters used are listed in the appendix and were selected on the basis that they are estimated for LIEs such as Mozambique, as in Peiris and Saxegaard (2007), for Malawi, estimated by Mwabutwa et al. (2013), Sub-Saharan African countries, as in Berg et al. (2010), Ogaki and Park (1997) and other LIE studies (Senbeta 2011a).

⁶Dynare is a free software that is used for the analysis of dynamic stochastic general equilibrium (DSGE) and overlapping generations (OLG) models which runs in Matlab. Dynare can be downloaded at <http://www.dynare.org/download>.

Table 3.1: Calibration of the Model

Parameter	Value	Description
χ_a	0.12	Ratio of net aid to imports
χ_r	1	Ratio of imports to foreign exchange reserves
χ_c	0.3	Ratio of imported consumption goods in total imports
χ_g	0.8	Consumption to GDP ratio
χ_f	0.48	Total imports to GDP ratio
χ_m	0.7	Ratio of imported intermediate inputs in total imports
β	0.99	Household discount factor
ν	0.34	Intertemporal elasticity of substitution in consumption
φ	2	Elasticity of labour
χ	0.24	Marginal disutility of working
ρ^1	0.83	Elasticity of substitution between imported and home goods
θ_f	0.56	Elasticity of substitution between varieties of imported goods
α_1	0.5	Share of imported goods in consumption
h	0.25	Coefficient of habit persistence
χ_{risk}	0.92	Risk premium parameter
σ_1	0.74	Share of labour in production of home goods
σ_2	0.26	Share of intermediate inputs in production of home goods
ς_F	0.5	Weight attached to past inflation for importing firms
ς_H	0.5	Weight attached to past inflation by domestic producers
θ_F	0.5	Fraction of importing firms that index their prices
θ_H	0.5	Fraction of domestic producers that index prices
ρ_H	0.66	Persistence of total productivity shock
ρ_r	0.73	Persistence of interest rate
ϕ_π	1.6	Inflation stabilisation
ϕ_y	0.057	Output stabilisation
ϕ_e	0.18	Exchange rate stabilisation
ρ_a	0.12	Persistence of aid shock
ρ_{y^*}	0.54	Persistence of foreign income shock
ρ_{π^*}	1.2771	Persistence of foreign inflation shock
ρ_{r^*}	0.8	Persistence of foreign interest rate shock

3.5.1 Simulations, Results and Inferences

The model is simulated to analyse the foreign exchange problem as a constraint to importing firms in an otherwise standard DSGE model, and to assess the dynamics of certain macroeconomic variables. An analysis is made of the impact of shocks to: Aid, terms of trade, domestic monetary policy, foreign monetary policy, domestic productivity, and imports on output, consumption, marginal costs, CPI inflation, domestic inflation, imported inflation, nominal depreciation, real exchange rate and imports. We examine the dynamics of the variables in response to these shocks by analysing the impulse response functions and forecasting the error variance decomposition of the shocks to the variables. We assume that all the shocks are temporary and show the basis point change of the variables from their steady state levels. The next section provides the analysis of the

impulse response functions.

3.5.1.1 Foreign Monetary Policy Shock

Figure 3.5: Impulse Responses to Foreign Monetary Policy Shock

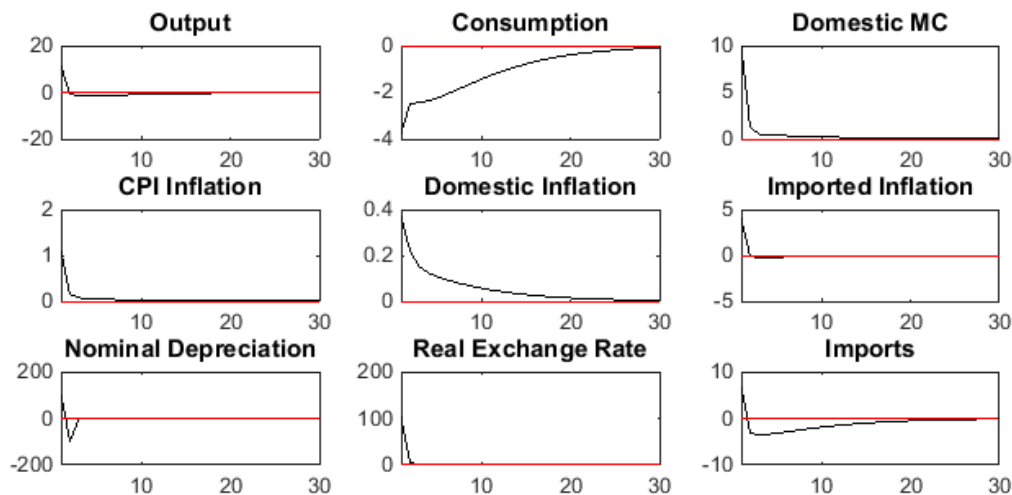


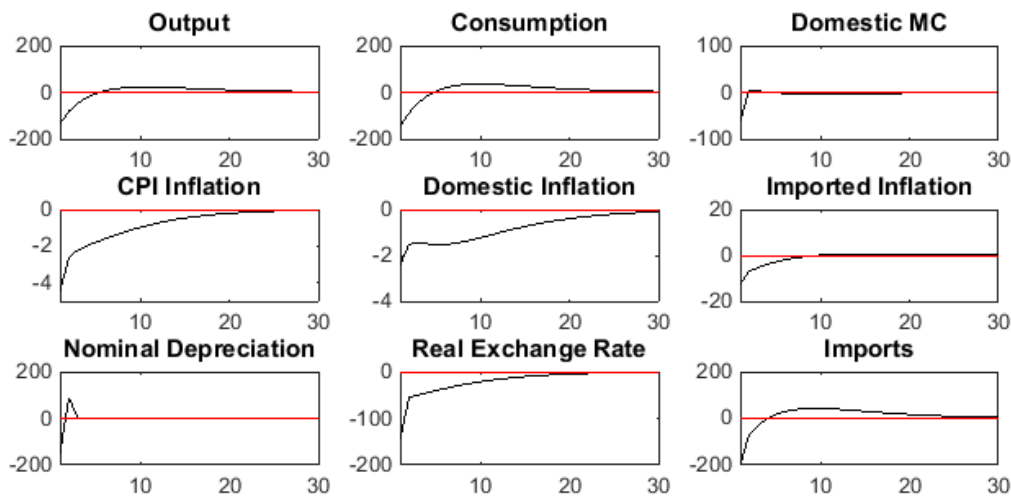
Figure 3.5 shows a 100 basis point innovation in the foreign monetary policy, as a contractionary monetary policy increases output on impact by about 10 basis points, which then falls and converges in the 10th period. This result is different from the response of output to a foreign monetary policy shock in [Senbeta \(2013\)](#) who report that both output and consumption fell in a foreign exchange constrained economy. The model of [Senbeta \(2013\)](#) postulates a contractionary effect on the economy. However, consumption falls by approximately 4 basis points at impact but starts to rise immediately and converges to its steady state level in the 28th period. An increase in the foreign interest rate results in a nominal depreciation of the domestic currency and also depreciates the real exchange rate at impact. Both the real and nominal exchange rates gradually appreciate to their steady state levels, an effect that makes exports competitive and imports expensive. As imports become expensive, imports start falling, which also reduces imported inflation and overall inflation. This can be seen by the fall in consumption and thereafter in output, with an increase in imported inputs and consumption goods.

A rise in imports at impact raises both imported inflation and domestic inflation, which leads to a rise in the overall CPI inflation in the economy. However, an increase in imported intermediate inputs and consumption goods leads to an increase in productivity. As a result, output and consumption begin to rise. The amount of total imported intermediate inputs and consumption goods starts to fall, as the exchange rate appreciates

gradually. This also decreases domestic marginal costs, which reduces imported inflation, domestic inflation, and CPI inflation at the same time. In our model, the outcome of a tight foreign monetary policy differs slightly from that of [Senbeta \(2013\)](#) where both output and consumption fall when tight monetary policy leads to a depreciation of the domestic currency, raising the costs of imported intermediate inputs and consumption goods. This makes both output and consumption fall after the impact, and gradually to recover as they move to their steady state levels.

3.5.1.2 Domestic Monetary Policy Shock

Figure 3.6: Impulse Responses to Domestic Monetary Policy Shock



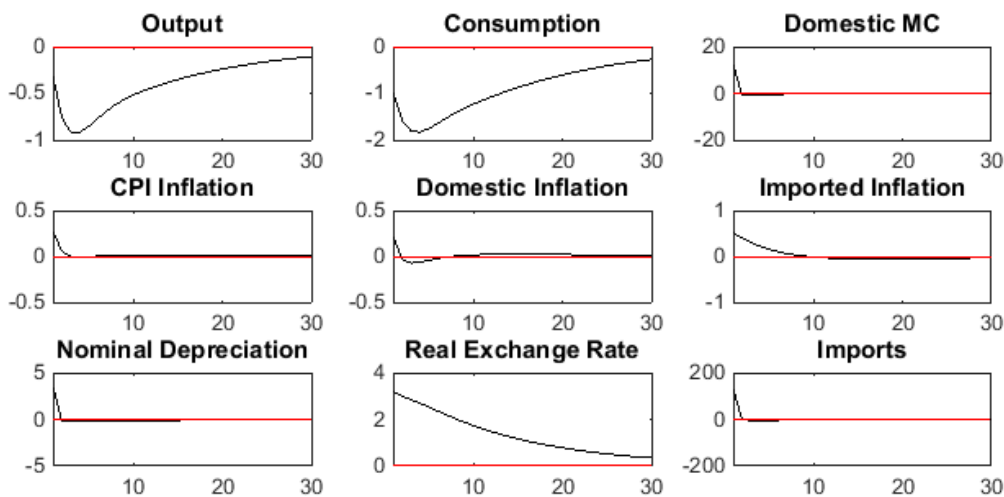
A contractionary domestic monetary policy shock decreases output, consumption, marginal costs, imported inflation, domestic inflation, and CPI inflation in the economy on impact, but all gradually rise and converge to their steady state levels. There are two channels through which a contractionary monetary policy shock affects the economy. First, increasing interest rates lead to appreciation of the nominal exchange rate. This induces a real appreciation of the exchange rate, because the domestic price index tends to adjust slowly. This real appreciation of the exchange rate decreases demand for domestic exports, making imports cheaper. According to [Senbeta \(2013\)](#), the decrease in exports and increase in imports reinforce each other, leading to a fall in domestic income, consumption and output. In addition, the currency appreciates by more than 500 basis points while imports also decrease. This is in line with theory and it achieves what a contractionary monetary policy is set to achieve. As a result, an 80 basis point contractionary monetary policy contracts output and consumption by more than 100 basis points. In addition, the economy experiences a real appreciation of both nominal and real exchange rate of more than 100 basis points, while imports fall by 200 basis points. Due to the fall in imports, imported inflation falls, leading to a fall in both the CPI and domestic inflation. This

indicates that all other variables change by more than 80 basis points, except for marginal costs, which declines by 50 basis points, as shown in Figure 3.6.

3.5.1.3 Import Shock

Figure 3.7 presents impulse response functions for a positive innovation in imports (both intermediate inputs and consumption goods). A positive shock to imports decreases output and consumption, which is an expected result. A positive shock to imports increases both the real and nominal exchange rates, causing a real and nominal depreciation and improving trade competitiveness for the country. However, since the country is import dependent, a real depreciation increases the costs of imported intermediate inputs and consumption goods, thereby increasing production costs and imported inflation which translates into high domestic marginal costs and inflation. This is evidenced by the rise in domestic marginal costs and domestic and CPI inflation..

Figure 3.7: Impulse Responses to Import Shock



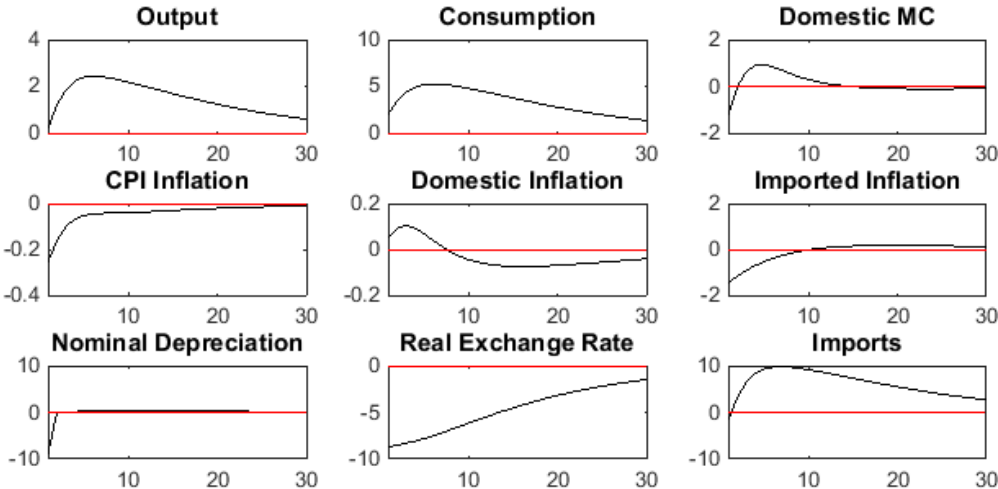
The rise in inflation reduces domestic consumption more, while the increased marginal costs reduce production. This impacts negatively on unemployment and wages in the economy, as unemployment increases and incomes fall. This leads to a fall in private consumption, as imported consumption goods become expensive. As a result, output and consumption fall, with consumption falling more than output at impact (1 basis point fall in consumption as compared to 0.5 basis points fall in output).

3.5.1.4 Aid Shock

A positive shock to aid results in an increase in output and consumption, in line with the standard theory of aid, which postulates that the effect of aid surges in an economy depends on whether the aid is absorbed or accumulated as reserves. [Berg et al. \(2010\)](#)

states that when aid is fully absorbed and spent in the economy, a situation which is rare in LIEs, government increases investment, and aid finances the resulting rise in net imports without creating a balance of payments problem. A real appreciation is required to enable the reallocation of resources. Therefore, in line with this theory, the responses of the variables to a positive aid shock are surprising. They reproduce the theoretical responses: output and consumption increase, as government increases expenditure. However, this positive aid shock also results in nominal and real appreciation of the exchange rate, leading to cheaper imports and low imported inflation. As imported inflation falls, domestic marginal costs are reduced, as firms import the inputs at a lower price.

Figure 3.8: Impulse Responses to Aid Shock



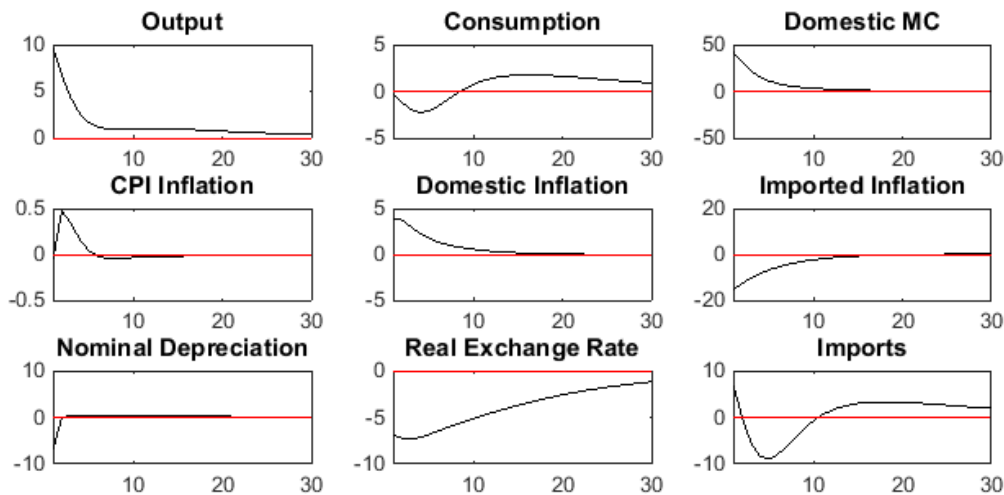
Due to lower imported inflation and lower marginal costs, domestic inflation and CPI inflation fall. But because the country depends on its exports for foreign exchange inflows, the real appreciation of the exchange rate could worsen the current account position of the country. This is because it threatens the competitiveness of the export sector, which may be critical for long-run economic growth. A fall in Malawian exports could mean a fall in foreign exchange inflow available for importation of the intermediate inputs and consumption goods, and this could also cause imports to fall in the long run. But because this results in low inflation and interest rates, it creates a good economic environment, and therefore a good outcome for both donors and the government. Since this is in the short-run, the impact may not be visible in the output and consumption results in Figure 3.8 as explained by [Mwabutwa et al. \(2013\)](#). However, the result may be different in the long run.

In addition, this result is consistent with the conclusions reached by [Rajan and Subramanian \(2011\)](#) who argues that aid inflows harm recipient nations by reducing the relative growth rate of exportable industries. They find evidence that inflows of aid cause real

exchange rate appreciation, and ultimately find little evidence supporting the views that aid leads to economic growth. This indicates that the response of the economy to aid can be contrary to conventional responses, because aid is mostly associated with exchange rate depreciation in most LIEs (see [Mwabutwa et al. 2013](#), [Berg et al. 2010](#)).

3.5.1.5 Terms of Trade Shock

Figure 3.9: Impulse Responses to Terms of Trade Shock

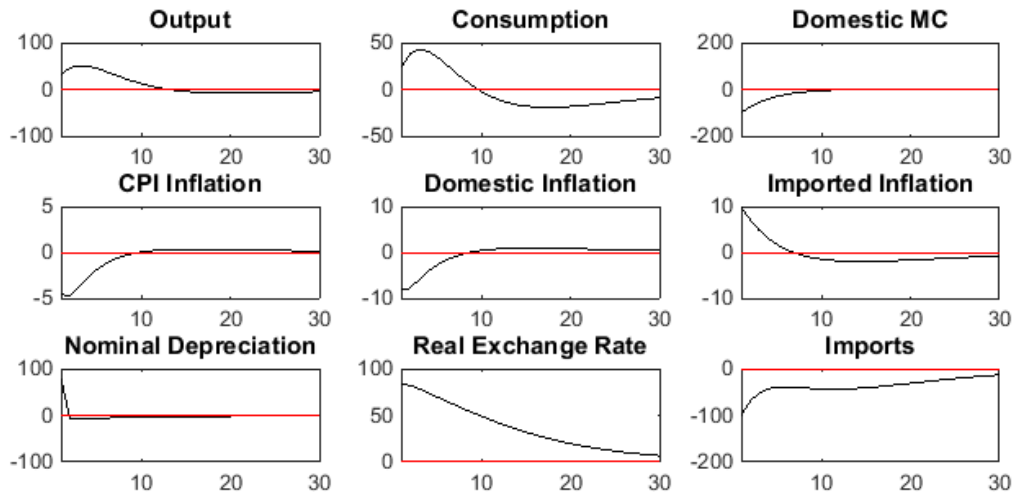


Likewise, an improvement in terms of trade induces an increase in output as the country increases imports of intermediate inputs and therefore production. Terms of trade is defined as a ratio of domestic currency price of home produced tradable goods to the domestic currency price of imports. An increase in terms of trade in Figure 3.9 leads to real and nominal appreciation of the exchange rates which make exports expensive. This makes imports cheaper and the country increases the importation of inputs and consumables. This appreciation of the exchange rate does not put pressure on imported goods thereby reducing imported inflation, while at the same time putting pressure on domestic goods and hence raising the domestic inflation and CPI inflation altogether. This therefore makes consumption fall. Marginal costs also increase as imports increase, due to high the dependency of the country on imported intermediate inputs.

3.5.1.6 Productivity Shock

Finally, a positive shock to domestic productivity increases employment, and therefore output and consumption, and decreases marginal costs. Both output and consumption increase on impact. They then start declining as rising demand for labour increases wages

Figure 3.10: Impulse Responses to Domestic Productivity Shock



which results in rising production costs, leading to declining consumption and output after impact, as marginal cost begins to rise. This is complemented by a fall in inflation on impact, which gradually increases. As in conventional monetary policy, the increase in productivity leads to an appreciation of the real exchange rate, thereby hurting the export sector and generating less foreign exchange necessary for the flow of imports into Malawi. Therefore imports decline on impact. However, in this model, both the real and nominal exchange rates depreciate. Because this is an import dependent economy facing foreign exchange problems, a depreciation will make imports expensive, and imports fall. As the changes in the economy start to take shape, imports begin to rise and gradually converge. Output and consumption begin to fall, as imported inflation falls, followed by domestic inflation and CPI inflation, with the real exchange rate depreciating gradually, before all the variables return to their steady state level, depicted in figure 3.10.

Having analysed the impulse response functions of the variables to different shocks in the model, the next section discusses the forecast error variance decomposition of the shocks to the variables.

3.5.1.7 Forecast Error Variance Decomposition (FEVD)

Forecast error variance decomposition⁷ measures the contribution of each type of shock to the forecast variance by providing information on how shocks to economic variables reverberate through the system. The shocks that provide cyclical fluctuations through the

⁷The IRFs provide all the shocks that are analysed in the model. However, the contribution of some of the shocks to the forecast error variance decomposition of the variables are minimal and they are left out of the analysis.

propagation of macroeconomic mechanisms are at the same time sources of forecasting uncertainty. Therefore, FEVD determines how much of the forecast error variance of each variable is explained by exogenous shocks to the other variables. Table 3.2 provides the results.

The output in the model is affected greatly by shocks to domestic monetary productivity, domestic monetary policy, terms of trade, domestic productivity, and foreign monetary policy, with minimal effect emanating from shocks to aid and imports. Domestic monetary policy shocks account for about 59% of the total variations in the one quarter ahead forecast of output. This is the maximum, as its contribution diminishes in longer horizons, 34% in the five period ahead forecast, 32% in the 10th and hovering around 32% and 31% in the remaining periods up to the 30th period. The importance of domestic productivity shocks in explaining the variation in output cannot be over-emphasised, contributing about 16% in the one quarter ahead forecast but increasing significantly in the following quarters with the highest being about 58%. Thereafter the contribution remains above 50%. Terms of trade shocks contribute 23% to the variations in output in the first quarter but their contribution diminishes over the years. The results are in line with the effects of monetary policy on a domestic economy (Senbeta 2013). However, since Malawi has an import dependent and aid dependent economy, we expect imports and aid to contribute significantly to fluctuations in output in the economy, which is not the case with these results.

Likewise, domestic productivity and monetary policy shocks contribute immensely to fluctuations in consumption, with about 9% and 85% in the first quarter and 54% and 34% in the 5th quarter respectively. They continue in the same vein, contributing above 50% and 30% respectively. Foreign monetary policy shocks lag behind, explaining only 6% of variation in consumption in the first quarter, but increasing substantially in the following quarters. They reach above 20% in the 5th and 10th quarter, and then drop down to 14%. Terms of trade, imports, and aid shocks were insignificant in explaining fluctuations in consumption.

At most, 88% of variation in imported inflation is explained by terms of trade shocks, and the contribution is large even at longer horizons. This result is unsurprising for a small open economy in which imports and exports are a function of terms of trade, and unsurprising for the economy under analysis, because most of the intermediate inputs and capital are imported. The high imported inflation is also a function of terms of trade. In addition, terms of trade shocks explain the variation in domestic inflation, from 47% in the one quarter ahead forecast, 58% in the five quarters ahead forecast, and about 60% in the remaining forecasted quarters. Domestic monetary policy shocks seem to explain almost

66% of all the fluctuations in CPI inflation, a value that is maintained throughout the forecasted quarters, even at longer horizons. Again this result is unsurprising, as inflation is one of the monetary policy tools used to influence output in the economy. Imported inflation influences the domestic and CPI inflation of the economy as the economy is import dependent.

Table 3.2: Forecast Error Variance Decomposition of 1,5, 10 and 30 Quarters Ahead (in %)

<i>Shock / Variable</i>	<i>Aid</i>	<i>Domestic Productivity</i>	<i>Domestic M Policy</i>	<i>Foreign M Policy</i>	<i>TOT</i>
<i>(1 Quarter) Output</i>	<i>0.00</i>	<i>16.55</i>	<i>58.76</i>	<i>1.46</i>	<i>23.22</i>
<i>Consumption</i>	<i>0.03</i>	<i>8.76</i>	<i>84.84</i>	<i>6.05</i>	<i>0.17</i>
<i>Marginal Cost</i>	<i>0.00</i>	<i>54.42</i>	<i>15.99</i>	<i>2.98</i>	<i>26.08</i>
<i>CPI Inflation</i>	<i>0.01</i>	<i>26.33</i>	<i>62.84</i>	<i>10.64</i>	<i>0.00</i>
<i>Domestic Inflation</i>	<i>0.00</i>	<i>31.79</i>	<i>19.86</i>	<i>1.12</i>	<i>47.19</i>
<i>Imported Inflation</i>	<i>0.01</i>	<i>4.44</i>	<i>6.15</i>	<i>4.28</i>	<i>85.08</i>
<i>Nominal Depreciation</i>	<i>0.05</i>	<i>19.36</i>	<i>59.11</i>	<i>49.37</i>	<i>1.59</i>
<i>Real Exchange Rate</i>	<i>0.05</i>	<i>23.71</i>	<i>25.06</i>	<i>49.37</i>	<i>1.69</i>
<i>Imports</i>	<i>0.00</i>	<i>32.07</i>	<i>27.66</i>	<i>2.39</i>	<i>1.02</i>
<i>(5 quarters) Output</i>	<i>0.02</i>	<i>53.66</i>	<i>34.23</i>	<i>2.85</i>	<i>9.15</i>
<i>Consumption</i>	<i>0.11</i>	<i>38.35</i>	<i>38.4</i>	<i>20.34</i>	<i>2.36</i>
<i>Marginal Cost</i>	<i>0.00</i>	<i>47.17</i>	<i>20.65</i>	<i>2.16</i>	<i>29.72</i>
<i>CPI Inflation</i>	<i>0.01</i>	<i>21.74</i>	<i>69.06</i>	<i>7.34</i>	<i>1.76</i>
<i>Domestic Inflation</i>	<i>0.00</i>	<i>22.55</i>	<i>18.71</i>	<i>0.66</i>	<i>58.06</i>
<i>Imported Inflation</i>	<i>0.01</i>	<i>3.87</i>	<i>5.43</i>	<i>2.48</i>	<i>88.18</i>
<i>Nominal Depreciation</i>	<i>0.05</i>	<i>18.37</i>	<i>27.95</i>	<i>51.98</i>	<i>1.51</i>
<i>Real Exchange Rate</i>	<i>0.06</i>	<i>39.18</i>	<i>21.67</i>	<i>35.84</i>	<i>3.06</i>
<i>Imports</i>	<i>0.01</i>	<i>28.08</i>	<i>43.06</i>	<i>3.06</i>	<i>1.1</i>
<i>(10 quarters) Output</i>	<i>0.04</i>	<i>58.62</i>	<i>30.26</i>	<i>3.53</i>	<i>7.42</i>
<i>Consumption</i>	<i>0.18</i>	<i>33.81</i>	<i>42.84</i>	<i>20.26</i>	<i>2.3</i>
<i>Marginal Cost</i>	<i>0.00</i>	<i>46.56</i>	<i>20.43</i>	<i>2.15</i>	<i>30.56</i>
<i>CPI Inflation</i>	<i>0.01</i>	<i>22.44</i>	<i>68.4</i>	<i>7.29</i>	<i>1.77</i>
<i>Domestic Inflation</i>	<i>0.00</i>	<i>21.7</i>	<i>17.71</i>	<i>0.65</i>	<i>59.92</i>
<i>Imported Inflation</i>	<i>0.01</i>	<i>3.55</i>	<i>5.11</i>	<i>2.43</i>	<i>88.89</i>
<i>Nominal Depreciation</i>	<i>0.05</i>	<i>18.34</i>	<i>27.73</i>	<i>52.23</i>	<i>1.51</i>
<i>Real Exchange Rate</i>	<i>0.07</i>	<i>46.93</i>	<i>21.22</i>	<i>27.82</i>	<i>3.77</i>
<i>Imports</i>	<i>0.04</i>	<i>27.13</i>	<i>43.71</i>	<i>4.21</i>	<i>1.39</i>
<i>(30 Quarters) Output</i>	<i>0.05</i>	<i>56.84</i>	<i>31.82</i>	<i>3.57</i>	<i>7.55</i>
<i>Consumption</i>	<i>0.18</i>	<i>40.96</i>	<i>40.98</i>	<i>14.21</i>	<i>3.14</i>
<i>Marginal Cost</i>	<i>0.00</i>	<i>46.49</i>	<i>20.41</i>	<i>2.15</i>	<i>30.66</i>
<i>CPI Inflation</i>	<i>0.01</i>	<i>22.76</i>	<i>68.07</i>	<i>7.27</i>	<i>1.78</i>
<i>Domestic Inflation</i>	<i>0.00</i>	<i>22.32</i>	<i>17.56</i>	<i>0.68</i>	<i>59.42</i>
<i>Imported Inflation</i>	<i>0.01</i>	<i>4.03</i>	<i>5.11</i>	<i>2.55</i>	<i>88.27</i>
<i>Nominal Depreciation</i>	<i>0.05</i>	<i>18.54</i>	<i>27.7</i>	<i>52.05</i>	<i>1.53</i>
<i>Real Exchange Rate</i>	<i>0.07</i>	<i>51.66</i>	<i>20.54</i>	<i>23.35</i>	<i>4.19</i>
<i>Imports</i>	<i>0.05</i>	<i>31.33</i>	<i>42.37</i>	<i>3.97</i>	<i>1.64</i>

Finally, variations in nominal depreciation and the real exchange rate are largely explained by domestic monetary policy in the one period ahead forecast, providing 59% and 25% respectively while foreign monetary policy shocks explained 49% of the variations in both variables in the same quarter. In addition, domestic productivity shocks explain 19% and 24% respectively, while contributions of terms of trade, imports, and aid to variations in nominal depreciation and real exchange rate are very minimal. However, at longer

horizons, foreign monetary policy and domestic productivity contribute significantly to fluctuations in nominal depreciation and the real exchange rate. Foreign monetary policy shocks explain over 50% of the variations in nominal depreciation and more than 20% of the variations in the real exchange rate. Domestic productivity shocks explain more than 50% of the variation in the exchange rate and about 20% of variation in real exchange rate, a result that is not surprising. However, this result is worth noting since almost all the variations in nominal depreciation are explained by deviations from UIP. However, foreign exchange constraints have attributed a huge variation in nominal depreciation and exchange rate to productivity shocks.

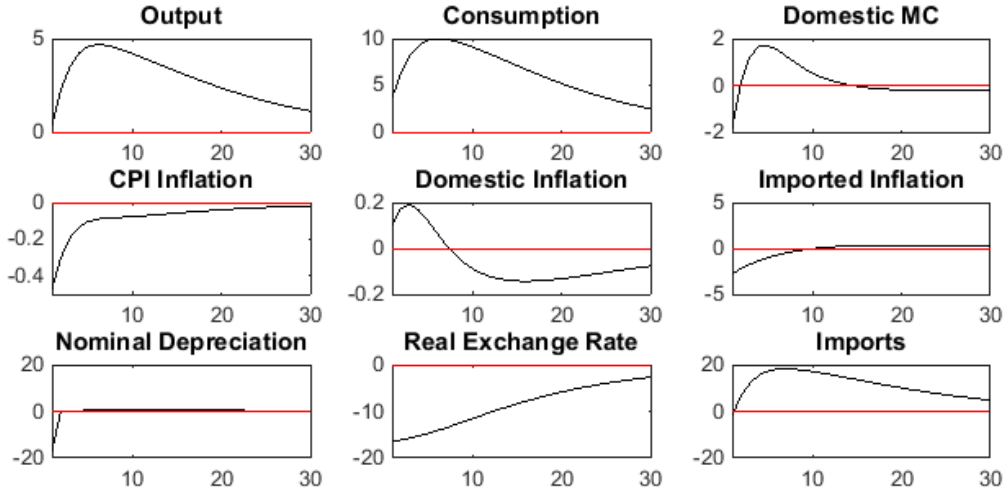
3.5.1.8 Sensitivity Analysis

Sensitivity analysis is used to determine how different the results would be given different assumptions from the ones on which the model is formulated. This is a way to predict the outcome of a decision if a situation turns out to be different to key predictions. As robustness checks on the results obtained earlier, we carry out this analysis to verify the validity of the results discussed in the previous section. First, we assume that the ratio of net foreign aid inflows to imports is twice the previous amount, at 0.24. This effect increases the level of the impulse response functions, but does not change the direction of the responses of the variables. We further adjust the elasticity of substitution between imported and home produced goods to be 0.3, assuming imperfect substitutability of home produced inputs for foreign produced ones. This means that there is some rigidity in the economy for firms to substitute imported intermediate inputs for home produced intermediate inputs.

The model indicates that the impulse response functions to all the shocks analysed in the model do not change the direction of the shock, but the magnitude is amplified. Assuming the persistence of aid doubles in a foreign exchange constrained economy, both output and consumption double because the problem of foreign exchange will be eased by the large amount of aid coming into the economy. This indicates an increase in imports and a fall in marginal costs, despite the appreciation of the exchange rate, resulting in high productivity and increased output. Figure 3.11 provides the results.

Second, we assessed the impulse responses of innovations to selected shocks in the model when the constraint is not binding, and we do not have the problem of foreign exchange availability in the economy. The results show that when we have no foreign exchange problems, innovations to foreign monetary policy, domestic monetary policy, aid, terms of trade, imports and domestic productivity result in an increase in the magnitude of

Figure 3.11: Impulse Responses to Aid Shock when Persistence Doubles



the responses of the macroeconomic variables under investigation. The responses of the variables become larger than the responses of the same variables in a foreign exchange constrained model. For example, a foreign contractionary monetary policy leads to real exchange depreciation and competitiveness in the export sector, but because the economy is import dependent, imports fall. A real depreciation still makes imports expensive and raises marginal costs and imported inflation, which leads to a rise in domestic inflation and CPI inflation, while output and consumption fall. Despite the changes being the same, the magnitudes differ, thus the IRFs for the unconstrained model have less variability than the constrained model. This can be seen in the rise in inflation of 3 basis points in the unconstrained model compared to 7 basis points in the constrained model.

in addition, some variables replicate the stylized responses of the variables to a shock in an otherwise standard DSGE model. For example, contractionary monetary policy shocks seem to lead to a fall in all the variables, while a positive aid shock increases output, consumption, and imports, despite its effect of inducing the appreciation of nominal exchange rate and real exchange rate. This effect leads to an increase in imports, which also increases marginal costs for firms and domestic inflation. However, the overall result is a positive effect.

Therefore, we conclude that the IRFs for unconstrained model still predict almost the same directions in most of the responses, to shocks of the assessed macroeconomic variables in a foreign exchange constrained economy. However the magnitudes of the responses differ. Relaxing the assumption results in the economy being more productive than when the constraint is binding. (IRFs are provided in Appendix B.2).

3.6 Conclusion

We aim to establish the importance of the availability of foreign exchange to an import dependent economy such as Malawi. We calibrated a New Keynesian DSGE model of foreign exchange constraints where firms faced foreign exchange constraints in importation of intermediate inputs and consumption goods. In addition, we introduced a country specific risk in addition to the assumption of risk sharing with the foreign economy in the [Senbeta \(2013\)](#) model. Using impulse response functions we showed that imports constituted a vital part of the production process in Malawi and the unavailability of foreign exchange amplified the variability of the macroeconomic shocks in the Malawian economy. In addition, the model indicated that the effect of the additional risk is so small such that it has no clear effect on the dynamic paths of the variables. However, the country risk rises when the domestic currency appreciates and falls when the currency depreciates.

We show that, contrary to findings by [Senbeta \(2013\)](#), our model produces the conventional results of domestic contractionary monetary policy. A contractionary monetary policy in our model leads to a decline in both output and consumption. This is mainly because increasing interest rates leads to an appreciation of the exchange rate, which worsens the terms of trade conditions for the economy. The worsening terms of trade lead to a decline in exports and foreign exchange earnings from exports. Malawi depends on imports for most of its production processes. Therefore, as long as exports are fewer than imports, and thus $(X-M)$ is lower, aggregate demand will fall, which will lead to low economic growth. This may be the reason why strong economic growth has been elusive in Malawi for a long time, as the exchange rate has always been over-valued. This has been followed by a decline in export demand, with greater spending on imports for production. This has not increased production over the years but has resulted in an import dependent economy with foreign exchange shortages. Until recently, when the exchange rate was floated, the strong Kwacha always worsened the country's terms of trade (*ibid*). Policy makers should therefore let market forces determine the value of the Kwacha, intervening only when necessary. This would help the currency stabilise, reducing the foreign exchange problems that exist in the country.

We also reveal that, for low income economies such as Malawi, an aid shock has the same effect as net foreign transfers, because it eases the foreign exchange problems in the economy by providing much needed foreign exchange. This works to decrease marginal costs and CPI inflation, when both imported and domestic inflation fall. Aid has a marked effect on economies such as Malawi's, where about 40% of national government budget is donor funded annually. We therefore conclude that the exchange rate appreciates by

aid inflow when the constraint is binding, but, it does not worsen the economy, because it increases government expenditures and imports, raising production, output, and private consumption.

Policy makers in LIEs need to be aware that both a depreciation and appreciation of the exchange rate affects the economy negatively if the economy is dependent upon imported intermediate inputs and consumption goods. An appreciation worsens the macroeconomic environment more than a depreciation. An appreciation, though it makes imports cheaper, makes exports expensive. Because the economy relies on export earnings for foreign exchange, this leads to a decline in export earnings and therefore, low levels of foreign exchange which cannot sustain the country's high import bill. As a result, foreign exchange problems occur, which only worsen the macroeconomic environment further. On the other hand, a depreciation of the exchange rate makes imports expensive, but leads to the favourable terms of trade conditions necessary for demand for exports. When exports improve, the economy improves, since this leads to an inflow of foreign exchange from export earnings. However, consumers feel the effect of the depreciation through the high costs of acquiring goods and services which are passed on to consumers by producers and importers. It is important that policy makers realise that increasing imports to increase production in the economy may only result in high prices of goods and services for consumers. However, it is necessary that the Central Bank allows market forces to determine the value of the currency, since politically motivated interventions in foreign exchange markets only worsen the economy.

Chapter 4

Fiscal Policy and Adjustment in a Foreign Exchange Constrained Economy

4.1 Introduction

While monetary policy has received attention in the literature, until recently, fiscal policy has not been as well covered. In the aftermath of the 2007 financial crisis, many countries either cut taxes or increased spending, in an effort to stabilize their economies. This raised questions about the impact and efficacy of fiscal policy, and brought fiscal policy to the attention of researchers. The lack of coverage of fiscal policy in research meant there was little academic engagement around key debates on the role of fiscal policy and the macroeconomic importance of government spending and taxation (Bhattarai and Trzeciakiewicz 2012, Fatás et al. 2001). The combination of rising fiscal activism and limited research on the effects of fiscal policy spawned a literature, primarily focused on the effects of government purchases on consumption and other macroeconomic aggregates. Research findings on the effects of fiscal policy on consumption have been inconclusive. For example, Jooste et al. (2013), Galí et al. (2007), Mountford and Uhlig (2009) and Blanchard and Perotti (1999) show that consumption increases with increased government expenditure, while Smets and Wouters (2003) and Ramey and Shapiro (1998) show negative effects of government expenditure on consumption.

While most macroeconomic models agree on the positive relationship between government expenditure and output, they often differ on its implications for consumption. The

textbook IS-LM models predict a positive relationship between government expenditure and private consumption. In contrast, standard RBC models postulate a negative relationship. Recent studies using new Keynesian dynamic stochastic general equilibrium (DSGE) models (that account for real frictions and nominal rigidities) have also indicated a negative relationship (Linnemann and Schabert 2003, Smets and Wouters 2003, Goodfriend and King 1997). For example, Smets and Wouters (2003), extends the standard New Keynesian DSGE model to capture the high degree of persistence that characterises macroeconomic time-series. Their study finds a strong negative response of private consumption to an increase in government expenditure.

The literature states that the assumptions of consumption behaviour of the agents in Real Business Cycle (RBC) models make consumption respond negatively to increased government expenditure. This is because any increase in government expenditure reduces the amount of labour income for households. With this realisation, recent studies on fiscal policy in DSGE models have focused on interrogating the strong negative response of private consumption to government expenditure shocks predicted by Smets and Wouters (2003). This is done by including a description of alternative households in the economy, non-Ricardian households¹, along with the usual rational Ricardian agents (Bhattarai and Trzeciakiewicz 2012, Furceri and Mourougane 2010, Forni et al. 2009, Coenen and Straub 2004). The empirical literature making use of RBC and DSGE models which generate a positive effect of government spending shocks on consumption have relied on the inclusion of these rule-of-thumb households (see for example, Stork 2011, Furceri and Mourougane 2010, Yasuharu 2009, Galí et al. 2007, Perotti 2005).

Although fiscal policy re-emerged recently as a stabilisation tool in macroeconomics, studies that have analysed the adjustment of macroeconomic variables to fiscal policy shocks are mostly on developed economies (Furceri and Mourougane 2010, Forni et al. 2009, Chamley 1985). Those that have assessed the effects of fiscal policy shocks on developing economies have shown that consumption responds positively to an increase in government spending (Jooste et al. 2013, Galí et al. 2007, Perotti 2005).

The past few years have witnessed a growing focus on the implications of declining foreign exchange reserves on LIEs. LIEs are often importers of intermediate inputs and capital, and have for the past years practised fixed or managed exchange rates necessitated by the need to correct persistent balance of payments disequilibrium. This mispricing of the exchange rate has often resulted in low foreign reserves and high prices of foreign

¹These are also called 'rule-of-thumb' or 'hand-to-mouth' households, which are usually credit constrained and cannot smooth their consumption behaviour inter-temporally. Non-Ricardian households are those that do not own any assets or have any liabilities, and consume their current labor income. We may use these names interchangeably.

currency. Thus if the exchange rate was liberalised in these countries, the official exchange rate (OER) and parallel exchange rate would converge. However, inelastic demand for imports, and deteriorating terms of trade, require demand management measures. For example, Malawi's current account (CA) worsened from 2001, and by 2005, it had reached 26% of GDP (Nkuna 2013). The worsening of the CA (which included official transfers) as a share of GDP began in 2001 declining by 6.9% of GDP in that year, influenced by a large inflow of imports. In 2003, the deficit worsened by 3.1 % of GDP to 22.1% in 2002, mainly due to importation of relief maize, but deteriorated further in 2006 by 25.4% of GDP due to importation of fertilisers for the Farm Input Subsidy Program. With the high costs of fertilisers and petroleum, the overall CA deficit reached 31% in 2008 and by 2012, the CA balance worsened by 16% of GDP because of lower commodity prices on the global market. Continuous deficits of net exports of goods and services continued and the country posted negative a CA balance up to 2014, and this is projected to continue. Even after the Highly Indebted Poor Countries (HIPC) relief, the current account was still unsustainable (ibid). Figure 4.1 shows the evolution of the current account in Malawi from 1980.

Figure 4.1: Evolution of Malawi's Current Account (1980-2010)

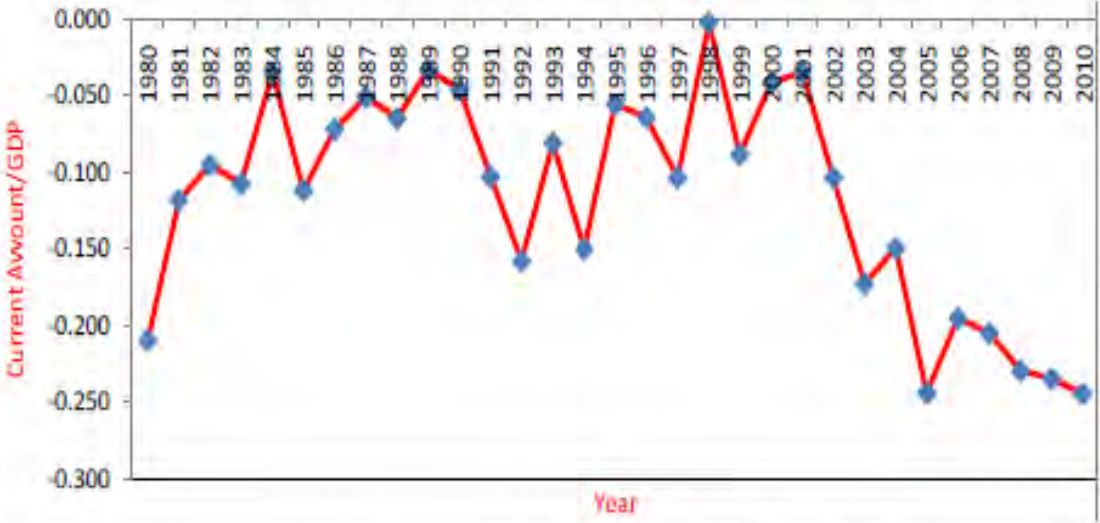


Figure 1. Current account balance (excluding grants) as a percentage of GDP, 1980-2010. Source: Reserve Bank of Malawi.

Adapted from Nkuna, O (2013). 'Sustainability of the Malawian current account deficit: Application of structural and solvency approaches'. *Journal of Economics and International Finance*.

Despite negative annual trade balances, most LIEs continue to increase imports in a bid to expand their economies. This effort is compromised by a shortage of foreign exchange which constrains the amount of imported inputs in these countries. This also affects the distribution channel, through high imports of petroleum in oil importing economies. In

addition, continuous devaluations attributed to foreign exchange shortages have widened the output gap by making intermediate inputs expensive and raising the cost of production, which outstrips the growth in exports. It remains to be seen whether models that take into account foreign exchange as a scarce resource, and imports as intermediate inputs, can perform in the same way as models that cater for high income economies which do not experience these productivity bottlenecks. The literature has indicated the need for case studies. However, studies that explore the effects of fiscal policy in LIEs have not accounted for some characteristics of LIEs, such as reliance on foreign financial inflows, credit constraints, and foreign exchange shortages. This is despite these being a recurrent feature in these economies which may influence the outcome of their findings.

The problem of foreign exchange shortages is a recurrent feature in most LIEs and affects the dynamics of macroeconomic variables. LIEs do not have access to international markets to easily borrow to mitigate the low foreign exchange earnings from agricultural commodity exports. Shortages of foreign exchange limit firms ability to import intermediate inputs and constrain productivity in these countries. Firms in LIEs also have to pay numerous levies that are imposed by government for revenue generation. This brings an additional cost to their production costs, and survival of these firms tends to be different from those operating in high income economies. Because of this, governments in low income economies fail to realise enough revenue from tax collection, and often implement inhibiting tax levies that do not make the business environment conducive to investment.

Fiscal policy in LIEs is often cumbersome and its big challenge is to balance revenue collection with policy implementation that does not chase away investors. This is the case because in most LIEs, especially in Malawi, the Reserve Bank of Malawi does not have a Policy Reaction Function, such that there is no automatic adjustment of the exchange rate (Mangani 2011). In addition, the lack of independence of the RBM jeopardises its policy making function. Although the RBM's monetary Policy Committee can, in principle, recommend movements in the exchange rate, in reality these have to be sanctioned by fiscal authorities. Thus this chapter seeks to contribute to the literature on macroeconomic effects of fiscal policy shocks in a number of ways: We follow Stork (2011) and Yasuهارu (2009) and introduce fiscal policy in a New Keynesian DSGE framework, but depart from these studies by assuming that agents in LIEs are rational, and therefore, maximise their utility intertemporally. We assume that the economy is populated by Ricardian households only, and assess the behaviour of private consumption in a situation where most households do not have access to financial markets and the financial markets are not fully developed. However, we assume that most low income economies have rational households, which smooth their consumption behaviour inter-temporally, with little or no government benefits. Ngalawa and Viegi (2013) argue that households

in LIEs smooth their consumption by either borrowing or lending in the informal financial sectors (IFS). Therefore, we can argue that although these households are formally credit constrained, they are rational and maximise their utility inter-temporally, subject to a budget constraint. We take the view that these agents may be unable to participate in formal financial institutions. We assume that they are, however, able to participate fully in informal financial services and therefore able to spread their consumption across periods. Therefore, we model the households as Ricardian (asset holder) households. We incorporate the foreign exchange constraint feature faced by importing firms of LIEs to examine the distortionary effects of foreign exchange constraints, apart from those of 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, labour income tax, import tax, and aid.

The next section discusses fiscal policy implementation in Malawi. Section 4.3 reviews the related literature and section 4.4 presents extensions to the foreign exchange constrained DSGE model. Section 4.5 presents model parameter calibration, results, and sensitivity analysis, and section 4.6 concludes the chapter.

4.2 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% and pay as you earn (PAYE) tax, which contributed 24% between the years 2000 and 2010. These two remain the highest sources of revenue, generating more than corporate tax annually.

Although taxes succeeded in raising revenue from 1970 through to 1990, this was inconsistent with long-term objectives for Malawi and compromised the sustainability of the reforms that were being implemented in the country (Chiumia and Simwaka 2012). Most taxes had many goals, for example, the surtax which was meant to be a revenue tax,

also acted as protection for domestic industry when applied to imports, which attracted a higher rate (ibid). In addition, taxes that were introduced as a proxy for devaluation were retained even after devaluation (Chiumia and Simwaka 2012, Chamley 1985). A series of reforms followed, after these concerns were raised in the 1990s, when a medium-term program of reducing taxes was launched. This shifted government revenue generating mechanisms from income tax to consumption tax, see Table 4.1 (Chiumia and Simwaka 2012).

Table 4.1: Contributions of Taxes to Total Tax Revenue (%)

Year	PAYE	Corp.	Withh	Tot. Direct	VAT/Surt	Imp. Duty	Excise	Tot. Ind.
1970-80	13	28	0	41	23	25	7	55
1981-90	13	24	0	37	31	24	4	59
1991-00	18	12	1	31	39	22	4	65
2001-10	24	5	1	30	37	14	11	62

Source: Chiumia and Simwaka (2012), RBM

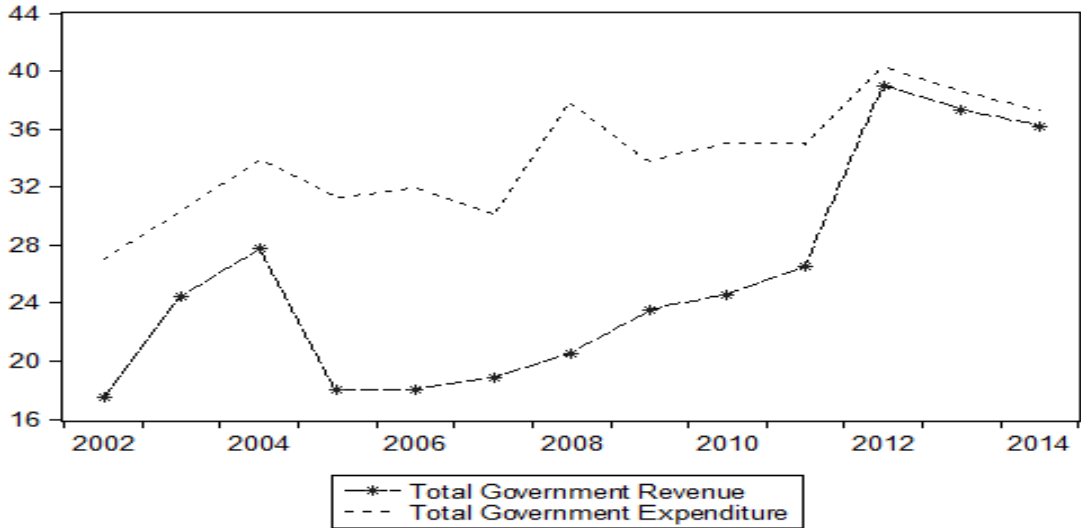
Between 2001 and 2010, taxes were reformed to align the country with Southern African Development Community (SADC) countries, leading to a fall in contribution by direct taxes (from 41% to 30%). In addition, there was an increase in indirect taxes' contribution to revenue from 55% to 62%, as government shifted from reliance on import duties to VAT. This reduced import duties from 25% to 14 % and increased VAT from 23% to 40% (Chiumia and Simwaka 2012). Taxes in Malawi are of two types, income taxes such as PAYE, and consumption taxes such as VAT.

Despite the success of the tax reforms in Malawi, government revenue has not always exceeded expenditures. From the 1970s, with fairly high GDP growth, the country resorted to foreign borrowing to finance government projects. This contributed to debt service default in the late 1970s as the country could no longer afford to pay the high debt it accumulated over the years, because of declining foreign exchange earnings due to low export prices. This volatility led to bad investments and low production, which in turn led to low export earnings (Fagernäs and Schurich 2004). The country's fiscal management and economic condition worsened from the 1980s owing to a series of external shocks, such as increased debt, poor domestic policy, and the disruption of the Nacala Development Corridor (which handles 90% of Malawi's trade) in the Indian Ocean due to the Mozambican war (Fagernäs and Schurich 2004). Because the country is land-locked, the disruption of the Nacala Development Corridor reduced Malawi's exports and imports which affected the country negatively. This prompted the IMF and the World Bank to suggest implementation of the structural adjustment program in Malawi from 1980.

After implementation of the structural adjustment program (SAPs) by the IMF and the

World Bank, donors on several occasions withdrew assistance due to non-compliance with the conditions put in place by donors, and mismanagement of donor funds (Chiumia and Simwaka 2012, Fagernäs and Schurich 2004). Nevertheless, government employment and government projects started to increase in the 1980s. These increased the composition of government spending over the years. However, the increase in interest payments on debt, droughts, weak performance of the parastatals, and commodity price fluctuations further complicated fiscal policy management in Malawi in the 1980s. The country resorted to supplementary budgets, with increased domestic borrowing, to cover expenditure which was always above revenue despite 40% of the government’s annual budget being donor funded (Chiumia and Simwaka 2012). Figure 4.2 shows the widening budget balance between 2004 and 2011 its reduction from 2011.

Figure 4.2: Government Revenue and Expenditure (Million US\$)



Source: Malawi Ministry of Finance

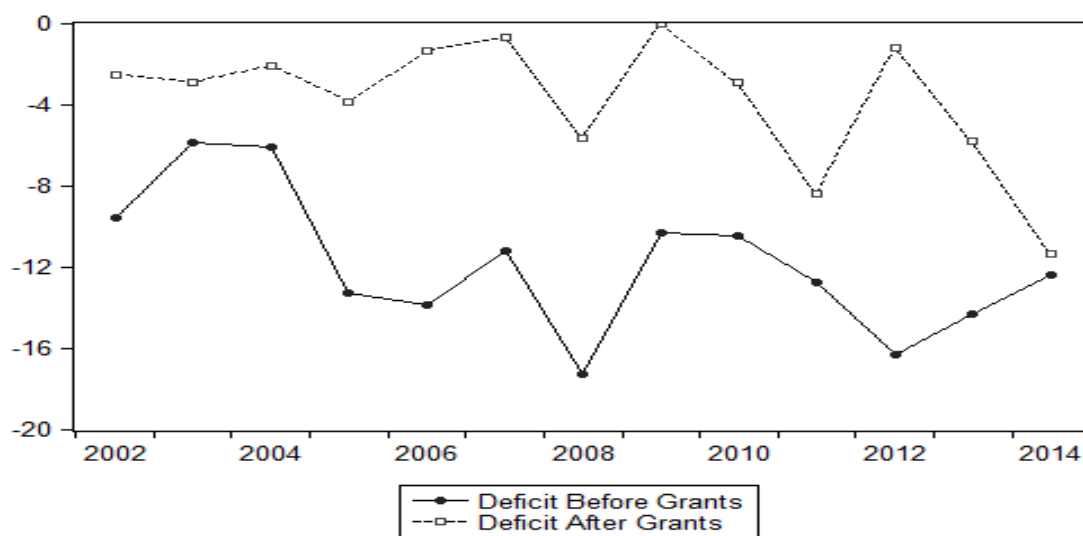
The country has experienced a deficit in government revenue for a long time, and total government expenditure has always been above domestic revenue. From the 1980s, grants and foreign loans each represented 15% of total financing, while domestic revenue in total financing rose from 50% in the 1970s to 80% in the 1990s. Although total expenditure fluctuated, it averaged at around 30% of GDP between 1970 and 1990. From 1993, the government increased expenditure due to drought and the uncontrolled fiscal spending of the previous regime, which was worsened by the withdrawal of foreign aid to enforce multiparty democracy in the country (Fagernäs and Schurich 2004). The inflow of aid resumed after the multiparty election in 1994, but by 2000, aid totalled 40% of the government’s budget and the deficit between government expenditure and revenue widened (ibid). Figure 4.2 indicates the deficit and increase in grants to about 13% of GDP in

2005.

Between 2005 and 2006, the Government implemented reforms to for fiscal discipline (World-Bank 2013). The country's expenditure and deficit, excluding grants, declined by 3.3 percent to GDP in addition to the increased access to debt relief in the same fiscal year. In addition, Malawi completed the HIPC completion point in 2006, and further qualified for Multilateral Debt Relief Initiative (MDRI) in the same year (Mussa 2015). This reduced the country's external debt from 160 percent of GDP in 2005 to 20 percent of GDP by the end of 2006 (World-Bank 2013). Malawi also received Poverty Reduction Support Grants (PRSGs) from the IMF, and the development partners under the Common Approach to Budget Support (CABS), which was also resumed as a budget support in 2006 (Mussa 2015). Therefore, Malawi received, on average, grants amounting to about 10 percent of GDP between 2006 and 2010, but did not reduce its budget deficit.

Government expenditure increased from 2004 because of the presidential elections campaign (World-Bank 2013). The increased expenditure by government continued between 2004 and 2009 in a bid to correct the economic woes inherited from the previous government. However, this worsened the macroeconomic environment . The country started implementing fiscal discipline when donor funding was withdrawn after 2009 due to poor public fund management and a shortage of foreign exchange (IMF 2012, World-Bank 2013). Figure 4.3 indicates that deficits before grants rose significantly from 2000. Although the country received HIPC debt forgiveness in 2009, deficit widened further in the years after 2009.

Figure 4.3: Government Deficit Before and After Grants to GDP (Million US\$)



Source: Malawi Ministry of Finance

From 2004, government expenditure increased significantly, which widened the deficit up to 2008, when the country started implementing fiscal restraint (Chiumia and Simwaka 2012). Since aid constitutes 40% of the government budget, it has also assisted in minimising the constraints that occur with fluctuations in export earnings. Aid contributes a large amount of foreign financial inflows and contributes to the level of foreign reserves in Malawi. Table 4.2 shows the performance of selected fiscal indicators for Malawi from 2008 to 2014 (October) and 2015 (October).

Table 4.2: Key Fiscal Indicators (in Billions of Kwacha)

	2008	2009	2010	2011	2012	2013	2014	2014(O)	2015(O)
Total revenue	160.8	169.7	291.2	267.6	363.3	476.9	535.9	50.8	60.8
Domestic Revenue	126.7	140.5	200.3	229.4	265.2	373	483	48.8	59.3
Grants	34.2	29.2	91	38.2	97.9	103.4	52.9	2	1.5
Total Expenditure	204.1	222.8	264.8	300.2	388.6	539.3	593.1	46.9	73.5
Recurrent	190.7	206.3	203.5	240	349.8	459.9	534.4	41.7	62.8
Development	13.4	16.4	61.3	60.2	72.1	79.4	58.7	5.1	10.7
Deficit/GDP ratio (after Grants)	-7.8	-8.2	4	-7.5	-6.5	-3.4	-2.6	0.2	-0.4

Source: RBM October 2015 Monthly Economic Review

Table 4.2 shows that total revenue rose from MK 161 billion in 2008 to about MK536 billion in 2014. This trend can also be seen in other economic indicators, with grants rising from MK34.2 billion in 2008 to 103.4 in 2013. However, grants decreased from 2014 onward with only MK53 billion in 2013 and MK1.5 billion by October 2015. Deficit to GDP ratio has not been reduced, at about MK7.8 billion in 2008 to MK7.5 billion in 2012, after which it started to fall to about MK2.6 billion by 2014.

Foreign exchange constraints have affected the implementation of fiscal policy in the past, and have compromised critical areas of government expenditures, meaning some government projects could not be completed on time. Some of these projects are aimed at reducing hunger and ensuring food sustainability in the country because when food is available, the country's inflation is manageable. However, there have been reported cases where the Farm Input Subsidy Program (FISP)² was nearly compromised due to shortages of foreign exchange (Chirwa and Dorward 2014). In some cases, the inputs reached the farmers after the planting season, when crops were already grown. 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. This led to low harvests in the following year and also led to food shortages in many parts of the country. In addition, the shortage

²FISP is a program which is being implemented by the Government of Malawi to provide subsidised agricultural seeds and fertiliser to farmers.

of foreign currency led to shortages of fuel and other basic commodities in the country, affecting the implementation of government programs nationwide (ibid). It is therefore important to incorporate the foreign exchange constraint problem in Malawi.

4.3 Related Literature

Before 2008, monetary policy was aimed at managing fluctuations, as economists pointed out the immense role of fiscal policy in smoothing macroeconomic fluctuations (Furceri and Mourougane 2010). However, research has shown mixed effects of fiscal policy on countries' economies (see Jooste et al. 2013, Mountford and Uhlig 2009, Smets and Wouters 2003, Galí et al. 2007). This has led to a lack of theory to unify fiscal policy, as is the case of monetary policy. The reason for this is that the functioning of financial markets strongly accommodates monetary policy, while at the same time high public borrowing may push sovereign debt yields and crowd out private demand (ibid). Regardless of these circumstances, fiscal policy is beginning to claim attention, especially the effect of a rise in government expenditure on private consumption.

Most macroeconomic models predict that increasing government purchases leads to an expansionary effect on output. However, they differ on the effects of government spending on private consumption (see Jooste et al. 2013, Mountford and Uhlig 2009, Smets and Wouters 2003, Galí et al. 2007). For example, New Classical Economics postulates that economic agents are Ricardian³ and forward looking. This means that changes in taxes that lead to a change in government expenditure will lead to changes in their consumption patterns (Jooste et al. 2013). This has led to general consensus that increasing government spending generally leads to a negative wealth effect on inter-temporal optimising households in DSGE frameworks, because government expenditure is financed with taxation that reduces their inter-temporal consumption (Jooste et al. 2013, Yasuharu 2009, Ramey and Shapiro 1998). Recent studies on fiscal policy in the New Keynesian DSGE approach therefore rely on the introduction of imperfectly competitive set-ups, such as that of Rotemberg and Woodford (1992). Others have opted to use the Galí et al. (2007) framework with sticky prices, while introducing the non-Ricardian households to generate the theoretical positive effect of government spending on consumption.

Several studies have considered the inclusion of non-Ricardian households to estimate the dynamic effects of fiscal policy on output and consumption in a DSGE framework (Bhat-

³Ricardian consumers are forward looking and they internalise the government's budget constraints when making their consumption decisions such that a change in tax that leaves the government budget unchanged does not affect their consumption pattern.

tarai and Trzeciakiewicz 2012, Furceri and Mourougane 2010, Galí et al. 2007, Yasuهارu 2009, Coenen and Straub 2004). For example, Galí et al. (2007) include a sufficient share of non-Ricardian households in a simple DSGE model. They include the assumptions of sticky prices and deficit financing to show the possibility of a crowding-in effect of government on consumption. They find that a positive government spending shock leads to a significant positive increase in consumption, but investment falls or does not respond significantly. Although in agreement with Galí et al. (2007), Yasuهارu (2009) argues that the financing behaviour of government spending determines the macroeconomic effects of fiscal policy. He finds that a tax rule combination is an important determinant of fiscal policy effectiveness with non-Ricardian households.

On the other hand, several studies have shown that a positive shock to government spending leads to an increase in consumption, when the effect is analysed in a VAR framework. This has produced a heated debate and studies have shown that including government spending shocks in a standard VAR has some pitfalls, as shown in a number of studies such as Ramey (2011) and Leeper et al. (2010). These studies argue that the type of government spending is crucial if one is testing a neoclassical model versus a Keynesian model. This is because government spending shocks resulting from education, public order, and transportation expenditures enter the production function. In this case, they interact with private consumption and therefore have consequences that military expenditure may not. In addition, Shapiro and Watson (1988) argues that the standard VAR has difficulty in separating shocks from true shocks and anticipated shocks. This may lead to faulty timing, which might show as an increase in consumption following an increase in government expenditure.

The literature on fiscal policy shocks is expanding, especially research on how output and consumption respond to an increase in government spending in developed economies (Afonso and Sousa 2012, Furceri and Mourougane 2010, Mountford and Uhlig 2009 and Galí et al. 2007). However, few studies have demonstrated the responses of output, consumption, and other key variables to fiscal policy shocks in Sub-Saharan African countries. In one of these studies, Jooste et al. (2013) analyse the effect of aggregate government spending and taxes on output for South Africa. Using three types of models, a calibrated DSGE model, a structural vector error correction model (SVECM) and a time-varying parameter VAR (TVP-VAR), they capture possible asymmetries and time variations of fiscal impulses. Their results indicate that an increase in government expenditure has a positive impact on GDP in the short run, and the impact is insignificant in the long run. They also find that an increase in tax decreases GDP over the short run and is negligible over longer periods. However, there are still few explanations for how fiscal policies affect macroeconomic variables in low-income SSA countries that are not large and do not have

well developed financial markets. In addition, these studies fail to incorporate the shortage of foreign exchange that acts as a constraint to importing firms in the economy, and this is how we are motivated.

We contribute to the literature on fiscal policy and adjustment mechanisms in LIEs in a number of ways. First, we examine the response of output, consumption, and other key macroeconomic variables to fiscal policy shocks in a foreign exchange constrained environment. We include the foreign exchange constraint as a problem of availability for firms which rely on imported intermediate inputs for production, and whose productivity capacity is constrained by shortages of foreign exchange. Second, we omit non-Ricardian households and we assume that the economy is populated by Ricardian households only. We assess the behaviour of private consumption in an LIE in which most households do not have access to financial markets, and the financial markets are not fully developed. [Ngalawa and Viegli \(2013\)](#) argue that in LIEs, agents smooth their consumption by either borrowing or lending in the informal financial sector (IFS). Therefore, we can argue that, although these households are formally credit constrained, they are rational and maximise their utility inter-temporally, subject to a budget constraint. Third, we modify the government budget constraint to include aid as an additional source of income for government, apart from income from tax on imports and tax on labour income.

The next section describes the model as an extension of the foreign exchange constrained New Keynesian DSGE framework of Chapter 3.

4.4 Foreign Exchange Constrained DSGE Model Extensions

4.4.1 Consumption Behaviour

We use the same model discussed in Chapter 3 but the model is extended. In the same foreign exchange constrained environment specified earlier, we introduce fiscal policy specifications by introducing tax on wage income as pay as you earn tax (PAYE), and international trade tax as import 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, as before. The objective function is given as:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{(C_t - hC_{t-1})^{1-\nu}}{1-\nu} - \chi \frac{(N_t)^{1+\varphi}}{1+\varphi} \right\} \quad (4.1)$$

E is the expectation operator and β is the subjective discount factor of the representative household's utility. The household derives utility from consumption of a composite good and disutility from labour having an instantaneous utility function which is isoelastic. C_t , N_t are household consumption and labour time supplied to the market. ν is the inverse of the elasticity of inter-temporal substitution in consumption, and h is the coefficient of habit persistence described as $0 < h < 1$, φ is the inverse of the elasticity of labour supply and χ is the marginal disutility of participating in the labour market.

Incorporating the taxes into the household's budget constraint, the lifetime utility is now maximised subject to:

$$PC_t + B_t + \varepsilon_t B_t^* \leq (1 - \tau_t^w)W_t N_t + D_t + r_{t-1}B_{t-1} + \varepsilon_t r_{t-1}^* B_{t-1}^* \phi_t(d_t) + \varepsilon_t P_t^* A_t \quad (4.2)$$

Where τ_t^w is personal income tax and the other variables are described as before.

The introduction of the fiscal sector changes the model in the following ways. First, we can rewrite a household's maximisation problem as the household maximising utility in equation (4.1) subject to the modified budget constraint that includes the taxes in equation (4.2). This yields the following first order conditions:

$$(C_t - hC_{t-1})^{-\nu} = \lambda_t P_t \quad (4.3)$$

$$\chi(N_t)^\varphi = \lambda_t (1 - \tau_t^w) W_t \quad (4.4)$$

$$\beta E_t \lambda_{t+1} r_t = \lambda_t \quad (4.5)$$

$$\beta E_t \lambda_{t+1} \varepsilon_{t+1} r_t^* \phi_{t+1} = \lambda_t \varepsilon_t \quad (4.6)$$

Combining equations (4.3) and (4.4) provides the marginal rate of substitution between consumption and labour, given as:

$$\chi(N_t)^\varphi (C_t - hC_{t-1})^\nu = \frac{(1 - \tau_t^w) W_t}{P_t} \quad (4.7)$$

while (4.3) and (4.5) gives us the consumption Euler equation for the household as:

$$\beta E_t \frac{(C_{t+1} - hC_t)^{-\nu} P_t}{(C_t - hC_{t-1})^{-\nu} P_{t+1}} = \frac{1}{r_t} \quad (4.8)$$

Furthermore, the combination of (4.5) and (4.6) yields the uncovered interest parity (UIP) condition as:

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

which can be simplified to:

$$\frac{r_t}{r_t^* \phi_{t+1}} = E \frac{\varepsilon_{t+1}}{\varepsilon_t} \quad (4.9)$$

After describing the consumer preferences and their first-order conditions, the next section describes the firm's and their behaviour in the model.

4.4.2 Firms

4.4.2.1 Domestic Production

Proceeding as in Chapter 3, introducing fiscal policy changes how firms choose labour and imported intermediate inputs into the production process. In this model, the firm has to take into account the tax on wage income and international trade tax when making decisions on how much labour to employ and how many intermediate inputs to import. However, as before, 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 to import the required amount of intermediate inputs when the level of foreign exchange is low, and the firm 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 high price. The firms are already constrained by the problem of foreign exchange availability, and also have to face the introduced import taxes as an additional cost in importation of intermediate inputs. 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:

$$Y_{H,t} = A_{H,t} N_{H,t}^{\sigma_1} M_{H,t}^{\sigma_2} \quad (4.10)$$

where we assume a 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:

$$\ln A_{H,t} = \rho_H \ln A_{H,t-1} + e_{H,t} \quad (4.11)$$

Where $0 < \rho_H < 1$. The term $e_{H,t}$ is i.i.d $N(0, \sigma_{eH})$. 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 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:

$$\text{Min}_{N_{H,t}, M_t} (WN_t + (1 + \tau_t^m) P_{F,t} M_t) \text{ s.t. } Y_{H,t} = A_{H,t} N_{H,t}^{\sigma_1} M_t^{\sigma_2} \quad (4.12)$$

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:

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

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

When we assume that $\sigma_1 + \sigma_2 = 1$, the inputs demand functions collapse to:

$$N_t = \left(\frac{\sigma_1}{\sigma_2} \right)^{\sigma_2} (1 + \tau_t^m)^{\sigma_2} P_{F,t}^{\sigma_2} W_t^{-\sigma_2} Y_{H,t} A_{H,t}^{-1} \quad (4.13)$$

$$M_t = \left(\frac{\sigma_2}{\sigma_1}\right)^{\sigma_1} (1 + \tau_t^m)^{-\sigma_1} P_{F,t}^{-\sigma_1} W_t^{\sigma_1} Y_H A_{H,t}^{-1} \quad (4.14)$$

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

$$MC_{H,t} = \left[\left(\frac{\sigma_2}{\sigma_1}\right)^{\sigma_1} + \left(\frac{\sigma_1}{\sigma_2}\right)^{\sigma_2} \right] \frac{(1 + \tau_t^m)^{\sigma_2} P_{F,t}^{\sigma_2} W_t^{\sigma_1} A_{H,t}^{-1}}{P_t} \quad (4.15)$$

Equation (4.15) gives us the real marginal cost function in terms of total productivity, output, input prices, import taxes and the share parameters.

4.4.2.2 Price Setting Behaviour by Importing Firms

The price setting behaviour in this model is similar to the price setting behaviour that is discussed in Chapter 3. 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. $P_{H,t-1}$), that is to say, those firms that face sticky prices (and cannot change their prices in period $t + 1$) 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 past period's inflation rate. The re-optimising firm's price index evolves according to:

$$P_{H,t}(j) = \left[(1 - \theta_H) P_{H,t}^{*(1-\rho_1)} + \theta_H \left(P_{H,t-1} \left(\frac{P_{H,t-1}}{P_{H,t-2}} \right)^{\zeta_H} \right)^{1-\rho_1} \right]^{1/(1-\rho_1)} \quad (4.16)$$

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

$$E_t \sum_{k=t}^{\infty} \theta_H^{k-t} \beta_{t,t+k} C_{H,t+k} \left[P_{H,t}^* \left(\frac{P_{H,t+k-1}}{P_{H,t-1}} \right)^{\zeta_H} - P_{H,t+k} MC_{H,t+k} \right] \quad (4.17)$$

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:

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

And solving for the domestic price of the traded goods provides:

$$P_{H,t}^* = \frac{\rho_1}{\rho_1 - 1} \frac{E_t \sum_{k=0}^{\infty} \theta_H^k [\beta_{t,t+k} C_{H,t+k} P_{H,t+k} MC_{H,t+k}]}{E_t \sum_{k=0}^{\infty} \theta_H^k [\beta_{t,t+k} C_{H,t+k} (P_{H,k-1}/P_{H,t-1})^{\zeta_H}]} \quad (4.18)$$

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, the difference is that firms in [Christiano et al. \(2011\)](#) do not face foreign exchange constraints. In practice, 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.

Most of the model characteristics are the same as in Chapter 3, with slight modifications of the model taking into account the fiscal properties of the model under analysis. It is worth remembering that firms in this section charge a little 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 realised in areas other than the Central Bank or formal financial institutions (FFIs) at a high price.

4.4.3 Fiscal Policy

A simple fiscal policy tool is presented to bring in the importance of fiscal policy in the foreign exchange constrained economy. This is to incorporate the dynamics of fiscal policy in the model to avoid the introduction of an ad-hoc policy rule that may lead to unintended implications⁴.

4.4.3.1 Government Budget

The fiscal authorities purchase the final goods, G_t , issues bonds, B_t , and levies tax on wage and imports $\tau_t^w W_t N_t$ and $\tau_t^m P_{F,t} M_t$, such that:

⁴See [Ascari et al. \(2007\)](#) for more details.

$$\tau_t^w W_t N_t + \tau_t^m P_{F,t} M_t + B_t + \varepsilon_t P_t^* A_t = r_{t-1} B_{t-1} + P_t G_t \quad (4.19)$$

where G_t is government purchases or consumption, B_t is government bonds or debt, M_t are imports and A_t is aid . The left hand side spells out the revenues and the right hand side provides expenditures. The government generates most of its revenue from taxes, especially personal income tax revenues and import duties as the country is import dependent. However, if we assume a simple case of a balanced budget such that $B_{t-1} = B_t = 0$, then the government cannot issue bonds to cover its expenditures. Therefore the budget constraint reduces to:

$$\tau_t^w W_t N_t + \tau_t^m P_{F,t} M_t + \varepsilon_t P_t^* A_t = P_t G_t$$

However, we assume that each year the government budget does not balance. Therefore, the government supplements its revenue by issuing debt, B_t , either domestically or internationally. Letting the the deviations of the fiscal variables (government expenditure and taxes) from their respective steady state values to be g_t and t_t respectively, then we can define the $g_t \equiv (G_t - G)/Y$, and $T_t = \tau_t^w W_t L_t + \tau_t^m M$. Such that $t_t \equiv (T_t - T)/Y$ 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:

$$t_t = \phi_b b_t + \phi_t g_t \quad (4.20)$$

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 purchases⁵ are assumed to evolve exogenously according to a first order auto-regressive process:

$$g_t = \rho_g g_{t-1} + \epsilon_{g,t} \quad (4.21)$$

where $\epsilon_{g,t}$ is government spending shock and ρ_g is a positive coefficient such that $0 < \rho_g < 1$. In addition, ϵ_t is i.i.d. with constant variance σ_ϵ^2 . To simulate the fiscal policy measures, we follow Stork (2011) and decompose taxes as follows:

$$\tau_t = \bar{\tau}^x + \hat{\tau}_t^x$$

⁵In deviations from the steady state

where τ_t is the respective tax rate, $\bar{\tau}^x$ is the steady state value of tax rate and $\hat{\tau}_t^x$ 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;

$$\hat{\tau}_t^x = \rho_t \hat{\tau}_{t-1}^x + \epsilon_{\tau,t} \quad (4.22)$$

where ρ_t is the estimated tax parameter and ϵ_t is a tax shock having $\epsilon_{\tau,t}$ is i.i.d. with constant variance $\sigma_{\epsilon_\tau}^2$. The steady state values of taxes are derived from data on Malawi. We do not cover all the sources of government taxes in the economy and restrict the model to the main objectives of the chapter 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:

$$\tau_t^w = \frac{T_t^w}{W_t N_t} \quad (4.23)$$

where T_t^w is government revenue from wages and government revenue from tax on imports, T_t^m is given as:

$$\tau_t^m = \frac{T_t^m}{P_{F,t} M_t} \quad (4.24)$$

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

The law of one price gap shows that 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:

$$\Psi_t = \frac{\varepsilon_t P_t}{P_{F,t}} \quad (4.25)$$

where ε_t is nominal exchange rate, P_t is 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:

$$Q_t = \frac{\varepsilon_t P_t^*}{P_t} \quad (4.26)$$

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.

4.4.5 Monetary Policy

In Malawi, the RBM targets monetary aggregates but reacts to inflation while moderating the exchange rate. Most of the literature states that the Taylor Rule prescribes how the Central Bank should adjust interest rates when responding to economic shocks. However, we modify the Taylor Rule to incorporate the effect that changes in the foreign exchange rate has on key macroeconomic variables, when the Central Bank reacts to changes in the nominal exchange rate. This is apart from the standard reactions of deviations in inflation and output, as stated in Chapter 3. The monetary authority is assumed to stabilise inflation, output and exchange rate. In log-linearised form it is given

$$r_t = \rho_r r_{t-1} + (1 - \rho_r)(\phi_{r\pi}\pi_t + \phi_{ry}y_t + \phi_{re}\Delta e_e) + \epsilon_{r,t} \quad (4.27)$$

where $\phi_{r\pi}, \phi_{ry}, \phi_{re}$ are weights that allow the monetary authorities to control inflation, output and nominal exchange rate. ρ_r is the smoothing parameter which indicates the persistence of interest rate. 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 $(0_{er}, \sigma_{er})$. In addition, the Reserve Bank of Malawi accumulates foreign reserves because of the continuous foreign exchange problems that the country experiences. Foreign exchange is earned from export earnings and aid, as the country relies heavily on foreign financial inflows. The dynamics of the current account and reserve accumulation is given in equation (39) and (40) in Chapter 3 while the log-linearised equation of foreign reserves is provided as:

$$\rho_{res} res_t = \rho_{res} res_{t-1} + \rho_{debt}(r_{t-1} + \varepsilon_t + b_{t-1} + \phi_t) + \rho_a(\varepsilon_t + a_t) + \rho_{ex}(p_t + c_{H,t}^*) - \rho_m(\varepsilon_t + p_{F,t} + y_{F,t}) \quad (4.28)$$

where $\rho_{res}, \rho_{debt}, \rho_a, \rho_{ex}, \rho_m$ are ratios of reserves to GDP, debt to GDP, aid to GDP, exports to GDP and imports to GDP respectively while the variables $res_t, \varepsilon_t, a_t, p_t, c_{H,t}^*$ 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). This entails reserves at the end of this period, period t , are a function of reserves at the end of the last period, returns on last year's foreign bonds, this year's aid inflows, export earnings less import payments during this period.

4.4.6 The External Sector

As explained in Chapter 3, we assume that the economy is small and therefore it cannot affect the world economy. It is therefore modelled as a closed economy as in [Monacelli \(2005\)](#). The foreign economy on the other hand is exogenous and requires some flexibility in specifying the external variables. Therefore, 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, i.e. AR(1) process such that:

$$y_t^* = \rho_{y^*} y_{t-1}^* + \epsilon_{y^*,t} \quad (4.29)$$

$$\pi_t^* = \rho_{\pi^*} \pi_{t-1}^* + \epsilon_{\pi^*,t} \quad (4.30)$$

$$r_t^* = \rho_{r^*} r_{t-1}^* + \epsilon_{r^*,t} \quad (4.31)$$

with $0 < \rho_{y^*}, \rho_{\pi^*}, \rho_{r^*} < 1$, and y_t^*, π_t^*, r_t^* are foreign output, inflation and interest rate respectively in log-deviations from the steady state. $\epsilon_{i,t} \sim N(0, \sigma_i^2)$.

4.4.7 Market Equilibrium

The model is in equilibrium when households maximise utility subject to a budget constraint and when the markets clear, thus:

$$Y_t = Y_{H,t} = C_{H,t} + C_{H,t}^* \quad (4.32)$$

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

$$c_{H,t} = -\rho_1(p_{H,t} - p_t) + c_t \quad (4.33)$$

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 $c_{H,t}^* = \rho_1 \alpha_1 s_t + \rho_1 q_t + c_t^*$.

4.5 Calibration

To identify the long-run dynamic properties of the model, the system is log-linearised to determine the steady state values of the variables, assuming that all the variables are on their equilibrium path. This indicates that they are either constant or growing exponentially within the constant growth rate (Stork 2011).

The system of log-linearised equations provided in Appendix C shows the determination of the main macroeconomic variables and their dynamics in the model. We calibrate the parameters following DeJong and Dave (2007) who state that this is the quickest way to estimate structural models because it provides an easier way to modify specifications. One is also able to compare the dynamics of fundamental variables to different specifications. Most of the parameters were adopted from the literature, as described in the previous chapter, where the values seem standard to LIEs. Because this model is an adjustment of the previous foreign exchange constrained DSGE model, most of the parameters used in the previous chapter are calibrated for this model, using the same sources as before. 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. (2009b).

It has been noted in the literature that 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 adopt 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 from quarterly data under analysis, to obtain the steady state values. For example, χ_r , the ratio of imports to foreign exchange reserves is approximated at 1 since we assume that the Central Bank's aim is to at least have

an operational target that is fixed at 3 months of import cover, as recommended by the IMF. However, we take the most plausible level of 1 month of import cover for Malawi, as reported by the World Bank's Economic Indicators which states that the Reserve Bank of Malawi has been struggling at 1.3 months of import cover for many years.

In addition, consumption to GDP ratio χ_g is assumed to be 0.8, total imports to GDP ratio χ_f is approximated to be 0.4750, ratio of imported consumption goods in the 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 IMF Country Reports. Table 4.3 provides the additional parameters used in the model and their values, while a full table of the parameters used in the model (and their sources) is provided in Appendix C.

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, 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; how output, private consumption, firm's marginal cost, imports, CPI inflation, household labour income, labour supply, and government debt respond to shocks to government policy, such as government expenditure, import tax and wage tax, apart from the usual aid shocks.

Table 4.3: Calibration of the Model Parameters

Parameter	Value	Description
ρ_{τ^w}	0.3	Speed of convergence of wage tax
ρ_{τ^m}	0.4	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
$\rho_{\tau^m g}$	0.34	Ratio of import tax revenue to GDP

4.5.1 Simulations, Results and Inferences

The main focus of the chapter is to analyse the short-run and long-run effects of macroeconomic adjustments in reaction to fiscal policy shocks in a foreign exchange constrained economy. The model is simulated and the impact of wage tax shock ϵ_t^w , import excise tax shock ϵ_t^m , government expenditure shock ϵ_t^g and a shock to aid ϵ_t^a on the economy are analysed. We assess the effects of these shocks on output, consumption, marginal costs, CPI

inflation, imported inflation, imports, wages, labour supply, and government debt. Our focus is mainly on fiscal policy adjustments in a foreign exchange constrained economy. However, the response of the variables to aid shocks is included to assess the effect that aid has on the implementation of fiscal policy in the economy. This is because about 40% of Malawi’s annual government budget is donor funded, and thus aid constitutes a large amount of foreign financial inflow into Malawi. As such, aid has serious implications for the implementation of fiscal policy and the adjustment of the variables in the economy. Upon simulating the model, the next section examines the impulse response functions of the variables as they respond to various shocks in the model.

4.5.2 Labour Income Tax Shock

To determine the response of the economy to various shocks, we analyse the impulse response functions of the variables to a one percentage change in labour income tax shock, import tax shock, government expenditure shock, and aid shock. Figure 4.4 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.

Figure 4.4: Impulse Responses to Labour Income Tax Shock

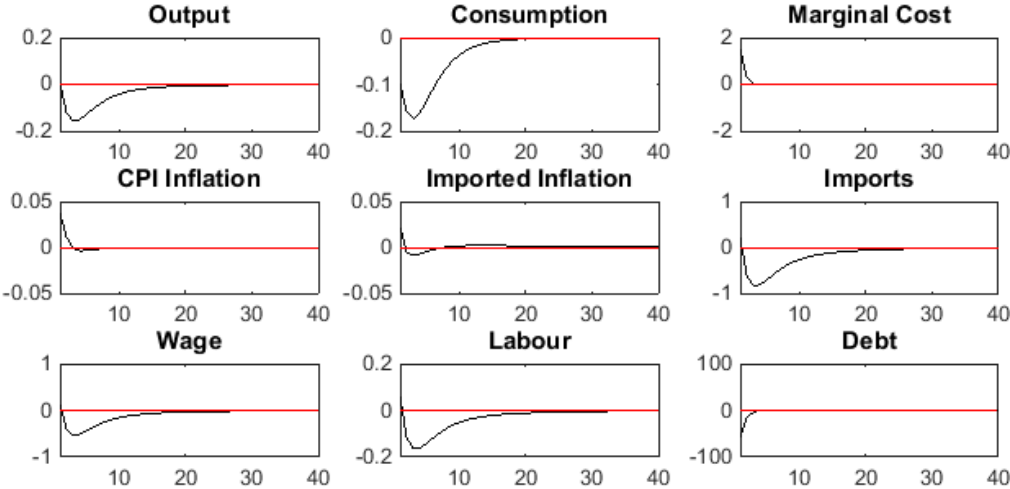
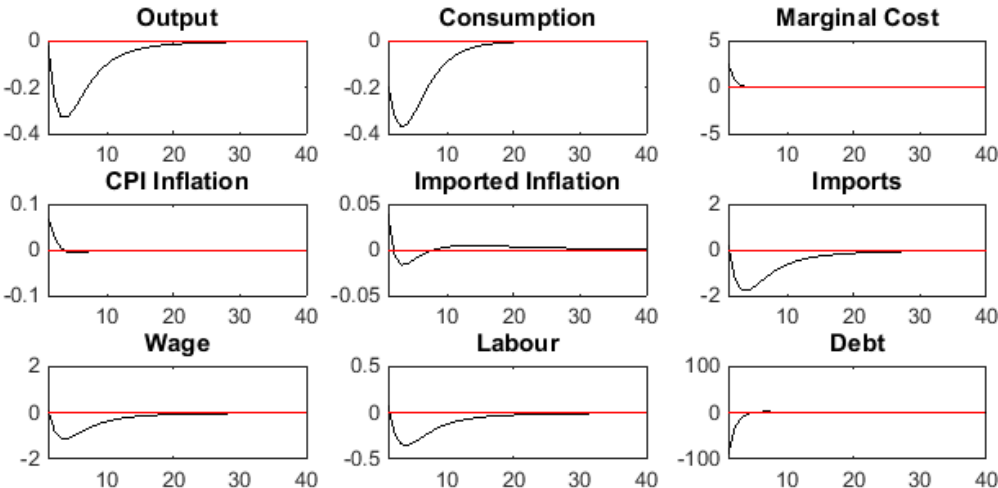


Figure 4.4 shows the impulse responses of the variables to a shock to labour income tax. The IRF shows that an increase in the labour income tax rate has a small contractionary effect on output, consumption, and labour supply, as labour income decreases with the effect of the tax. Output and consumption fall by about 0.2 percentage points, as households 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 1 percentage point. This indicates that the effect of a positive change in labour income tax has minimal effects on the supply of labour and also labour income.

Furthermore, a positive change in labour income tax decreases the imported inputs and consumption goods, as total imports decline on impact. This is probably because of the reduction in wages as consumers shift consumption from imported goods to domestically produced goods (which may be cheaper than imported goods) in an effort to match their reduced budget. 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 and how it influences wages and labour supply. A cut in wage tax will have an opposite effect in that it will increase labour supply, wages, consumption, and output (see Yasuharu 2009). This result is in tandem with the effect of a distortionary labour income tax in an economy.

4.5.3 Import Tax Shock

Figure 4.5: Impulse Responses to an Import Tax Shock



The effect of an increase in import excise tax is shown in Figure 4.5. Augmenting import tax sets in motion certain mechanisms in the economy. As imported goods and services become more expensive, firms decrease total imports, making production with low inputs costly. This is because, if factors of production are not being utilised efficiently, the marginal costs of production for firms rise. Since the economy consists of only Ricardian households, demand for private consumption falls about 0.03 percentage points. This is more than the fall in output of 0.01 percentage points on impact. This fall in consumption and output yields a 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 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. Stähler and Thomas

(2012) reach the same conclusions when they estimate the effects of the VAT rate in their medium scale DSGE model for fiscal simulations for Spain. They reached this conclusion though by estimating a permanent change in the VAT rate, and not a temporary change, which led to slightly different results.

For a country like Malawi in which almost everything is imported, such a tax leads to a decline in private consumption, as the imported goods became more expensive on impact. 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 the previous 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 4.5. 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, as shown in figure 4.5. Overall, the effects of an increase in import taxation are similar to the effects of 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.

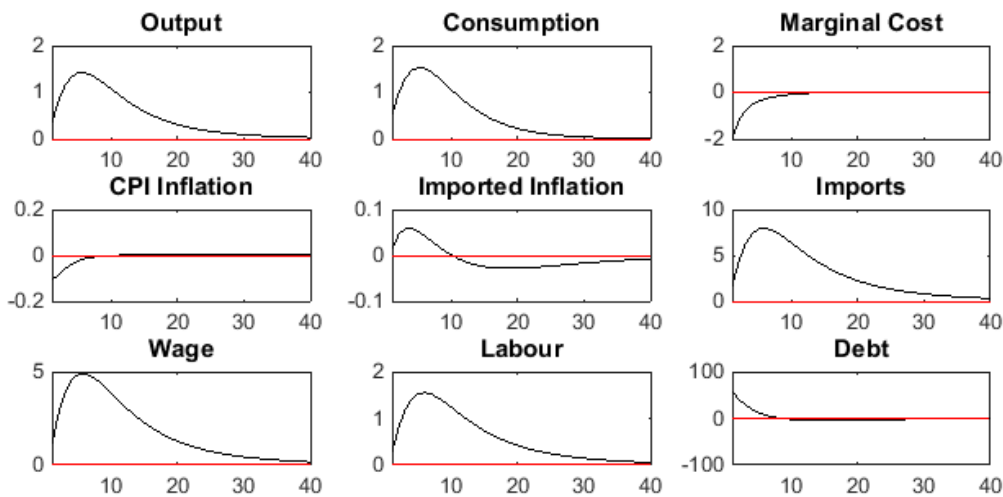
4.5.4 Government Expenditure Shock

Figure 4.6 presents the impulse responses of the variables after an increase in government expenditure in a foreign exchange constrained economy. The effect of a rise in government expenditure seems to defy the constraining effect of the unavailability of foreign exchange. Increasing government expenditure raises private output and private consumption immediately by 0.8 percentage points, which rise further before gradually falling. In this case, there is an immediate and rather large increase in production, and, therefore, GDP, because of high public demand. In addition, optimising households increase consumption because, in most LIEs, government expenditure does not increase with increased tax, but increases with foreign financial inflows such as aid. In addition, governments in LIEs facing foreign exchange problems usually have limited access to financial markets. They therefore finance their expenditure by borrowing domestically, which in turn, also increases government debt.

In theory, private demand is supposed to decrease with an increase in tax that finances government expenditure. However, this decrease in private demand is alleviated by an increase in public demand, and private production and GDP start to rise despite a decline

in consumption in Ricardian households. Despite the rise in aggregate demand, firms reduce prices because their marginal costs have declined. The reduction in marginal costs reduces the operating costs of firms, although they experience foreign exchange problems which hamper their access to intermediate inputs. They maintain their labour force, and so employment is maintained, and wages also rise. Due to lower marginal costs, all the variables (CPI inflation, output, private consumption, wages, labour, imports, and debt) begin to fall and converge to zero. Therefore, despite experiencing foreign exchange problems, increasing government expenditure through borrowing can push aggregate demand more, and overshadow the decline in private consumption. As a result, overall consumption tends to rise, as debt by government also rises.

Figure 4.6: Impulse Responses to a Government Expenditure Shock



A 1 percentage point increase in government expenditure increases output by less than 1 percentage point at impact, but this rises above 1 percentage point soon after the impact. Thereafter, the effect of the shock starts to fall in the following periods, before dying out in the long-run. This result is consistent with most of the literature on DSGE estimations (see [Blanchard and Perotti 1999](#)). Inflation falls (Figure 4. 6) although the literature postulates an increase in inflation under such circumstances. This is because the increase in debt leads to an increase in government expenditure. This increased expenditure might come in the form of increased farm inputs, subsidised by the government. This increases the availability of food and reduces CPI inflation, although imported inflation seems to rise with the increase in imports. As a result, consumption rises with almost the same proportions 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. In addition, some of the programs that governments in these countries implement, cater for the whole economy if implemented properly. These, for example, FISP, may help the attainment of food sustainability and therefore reduce inflation, which always respond to the availability of food. If inflation is manageable, private consumption can increase, despite the economy experiencing foreign exchange problems. This means the 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 negative effect of taxes on consumption.

4.5.5 Aid Shock

Figure 4.7: Impulse Responses to an Aid Shock (when fully spent)

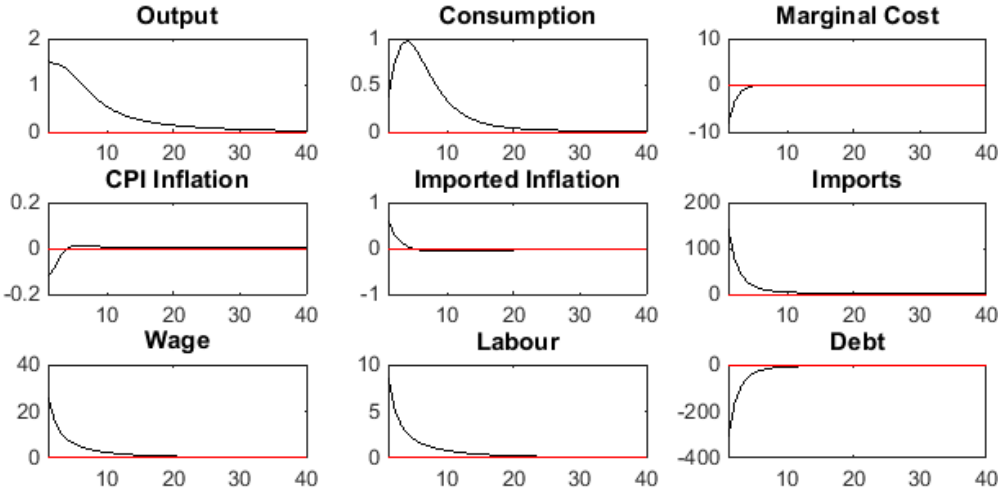


Figure 4.7 shows that the effect of a 1 percentage point increase in aid leads to an increase in output and consumption and decreases government debt. This is applicable when aid is fully spent and is used to increase the amount of imported intermediate inputs, which influences output growth. This is because the government may decide to fully spend the incoming aid or may decide to sterilise it. In this case, 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 worsens the prices of exports and therefore exports decline, leading to low export foreign exchange earnings. This outcome can worsen the problem of shortage of foreign exchange in the economy and further affect the amount of imported inputs and consumption goods. However, if the appreciation is small it will not affect the economy much, because output and consumption still rise when aid inflows are positive and are fully disbursed.

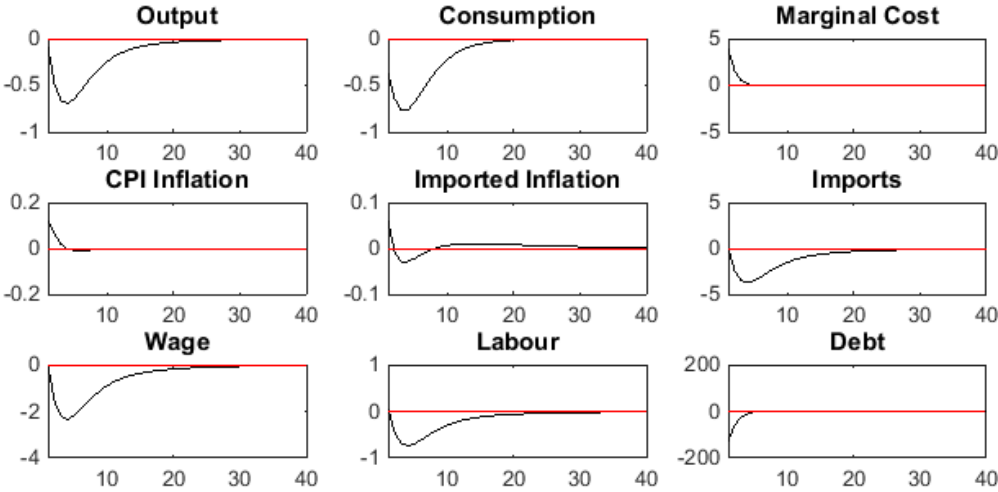
A positive inflow of aid in a foreign exchange constrained economy eases the foreign exchange pressures caused by excess demand for foreign exchange by importers. A positive inflow of aid improves the macroeconomic conditions of the domestic economy by reducing the level of taxes levied on both wage income and imports of goods and services, and therefore increasing government expenditure. 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 of terms of trade in the domestic economy, the positive inflow of aid increases imported inputs, which also increases production by firms and output also increases. In response to positive production by firms, labour income and employment rise, thereby raising overall output. Because aid reduces taxes and increases government expenditure, labour income rises. This leads to an increase in private consumption and output.

Furthermore, a positive inflow of aid which has been fully spent by the government reduces the amount of debt that the government has. This can be seen in Figure 4.7. This is because an inflow of aid supplements government revenue and therefore reduces the need for government to borrow more. Positive aid inflows therefore lead to a decline in government debt.

The effect of an increase in aid when aid is fully spent in the domestic economy results in an improvement of 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) further show that net domestic borrowing in Malawi 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 mostly through aid inflows and not through taxation.

Another direction is indicated when aid is not fully spent, and therefore its effects are sterilised in the economy. Figure 4.8 reports the impulse responses to aid shock when aid is not fully spent. We therefore reduce the ratio of the aid to GDP ratio from 0.12 to 0.01. We assume that not all aid is kept by the government, a certain proportion of aid enters into the economy. This leads to a reduction in government debt. However, the other variables fail to respond positively because the aid that has been let into the economy is minimal. It is thus not adequate to elicit the positive impacts of aid inflow in the economy that would occur when aid is fully spent. This amount of aid is not enough to ease foreign exchange constraints in the economy. However, since the economy is a predominantly importing economy, a decline in imports leads to low production by firms and therefore prices rise as firms try to recoup their costs (which are characterised by a rise in marginal costs in figure 4.8). This is indicated by a rise in the CPI inflation at impact. At the same time, output and private consumption reduce because this effect leads to a decline in the factors of production and also a decline in aggregate demand. In an economy such as Malawi's therefore, sterilising aid has negative consequences. It fails to ease the foreign exchange shortage in the country, and leads to a fall in importation of intermediate inputs and constrains productivity and imports and reduces productivity.

Figure 4.8: Impulse Responses to an Aid Shock (when not fully spent)



4.5.6 Sensitivity Analysis

We carry out a sensitivity analysis to determine how the results provided in the previous section would change given different assumptions from the ones in the model. This is a way to predict the outcome of a decision if a situation turns out to be different to the key predictions. As with robustness checks on the results obtained earlier, we carry out

this analysis to verify the validity of the results in the previous section. To determine the validity of the results in this chapter, while fixing the persistence parameters, we adjust the policy parameters of tax on labour income $\rho_{\tau_g^w}$ to 0.33 and tax on imports $\rho_{\tau_g^m}$ to 0.44 respectively. Thus in the model we increase the tax burden on households, while increasing revenue for the government.

Observing the IRFs of labour income tax, the variables in the model respond in the same way as in the original model, and changing the degree of the shock only changes the magnitude of the fluctuations. The speed of convergence seems to be faster in the sensitivity analysis model. This is because the shock to output, consumption, wage, labour supply, CPI inflation, and imported inflation seem to die out in the 10th period. In the original model the shock died out when approaching the 30th period. The remaining variables converge before reaching the 5th period but the fall in output and consumption is less in the sensitivity analysis model than the fall in output in the original model. The results of the IRFs of the variables from an import shock are similar to the responses of the variables in the previous model. They differ in magnitude and speed of convergence of labour income tax in the sensitivity analysis model. The results showing the IRFs of the variables responding to the changes in the tax rate in the sensitivity analysis are presented in Appendix C.

A second sensitivity analysis is carried out to determine how the economy performs in the absence of the foreign exchange constraint. This means we assess the responses of the variables when the constraint is not binding. Figures 4.9 to 4.12 provide the results.

Figure 4.9: Wage Tax Shock

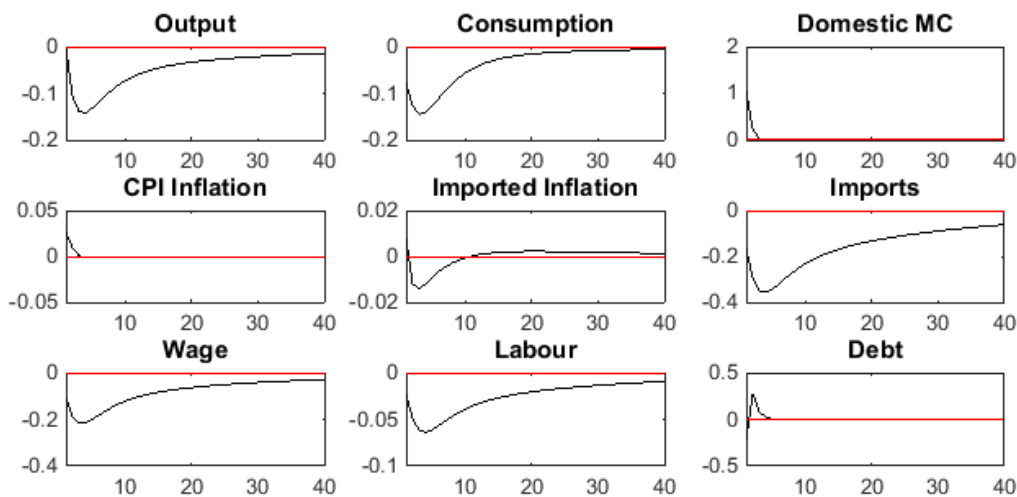


Figure 4.9 shows that when foreign exchange problems are not present, a positive wage tax shock reduces output, consumption, wages, and employment level at impact. The

mechanism is the same as in Figure 4.4. 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% in Figure 4.9 which is less than the approximately 0.2% when the economy faces foreign exchange problems.

The same trend is observed in Figure 4.10 with a positive import tax shock. The only difference is the magnitude of the fall in the variables and not the direction of the shocks.

Figure 4.10: Import Tax Shock

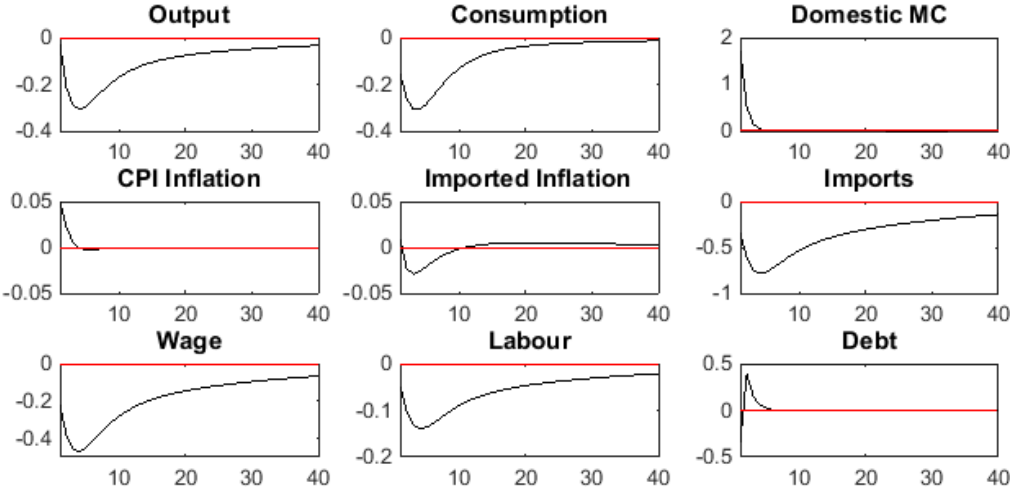
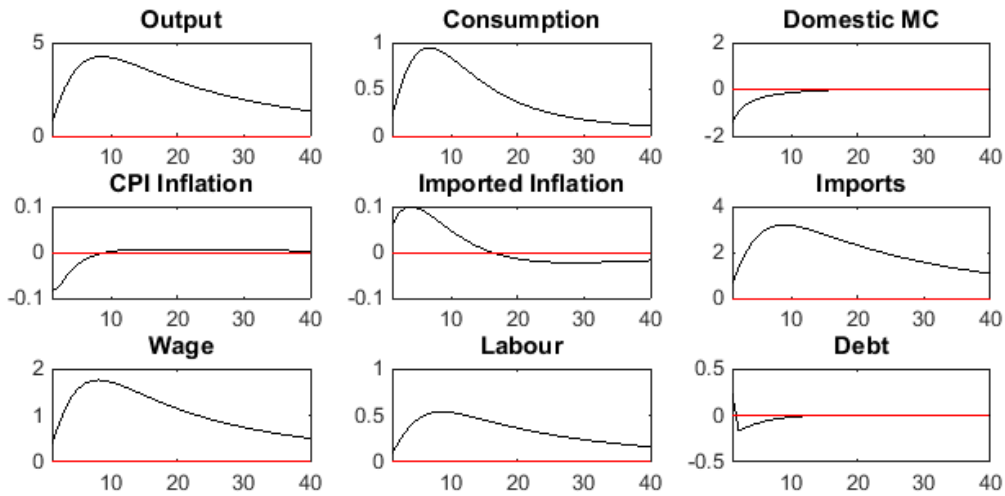


Figure 4.11 shows the effect of positive government expenditure when the constraint is not binding. There is a huge improvement in output when foreign exchange is available. Output increases by 1% while consumption increases by only about 0.4% at impact. The increase reaches its peak at 4% and 1% respectively. The reluctance of consumption can be explained by the increase in imported inflation, which is generally passed on to consumers. The same effect is also observed in Figure 4.12 following a positive aid shock.

Figure 4.11: 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. This indicates that the problem of foreign exchange constrains the productivity of the economy and leads to macroeconomic imperfections.

Figure 4.12: Aid Shock (when fully spent)

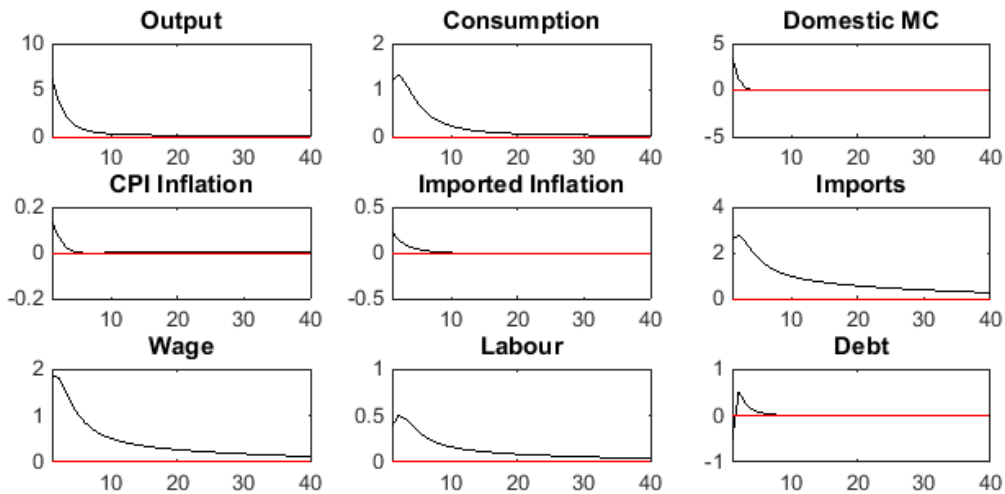


Figure 4.12 shows that despite the rise in imported inflation, CPI inflation falls. The fall in CPI inflation can be attributed to the availability of food and other consumables, which are easily imported when foreign exchange is readily available. However, we can conclude that the shocks have only increased in magnitudes here, although there are minor changes in the direction.

4.6 Conclusion

In this chapter, we contributed to the literature in two ways: First, we present a calibrated model of fiscal policy and an adjustment in a DSGE framework of a small open economy. In our model, fiscal policy is conducted in a foreign exchange constrained economy, a feature that has been largely omitted in the literature when estimating low income economy DSGE models. Second, we estimate the fiscal policy DSGE model to assess the effects of an increase in government expenditure on consumption and other variables. We move away from the the recommended method of including non-Ricardian households in the model, which generates a positive response of consumption to government expenditure. We rather assumed that the economy is populated by rational 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.

Our main findings are as follows: First, a positive tax rate on labour income and imports provides the usual results, contracting output and private consumption, and decreasing wage income and employment levels, leading to a rise in unemployment in both cases. However, government debt falls and CPI inflation rises in both scenarios. Second, an increase in government expenditure results in successive increases in both output and consumption which rises more after the 5th quarter and thereafter starts to decline, as changes in the rest of the variables also decline. The increase in government expenditure does not lead to a fall in consumption, which was predicted, due to the usual income effect of tax on wage. In this case, private consumption, wages, and employment increase, but this also increases government debt. In the foreign exchange constrained economy under review, the effect of tax does not outweigh private consumption, which rises as public expenditure rises, a result which is different from findings by [Fatás et al. \(2001\)](#).

In our model, 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 of terms of trade of the domestic economy by the appreciation of the exchange rate, imported inputs increase and therefore labour, wages, and outputs increase. This is because aid reduces taxes by increasing government expenditure, leading to an increase in private consumption and output. Therefore, the effect of an increase in aid in the domestic economy is an improvement of the economy, despite the appreciation of the exchange rate, which also leads to a reduction in debt as it substitutes for domestic borrowing ([Fagernäs and Schurich 2004](#))

The results indicate that policy makers need to be cautious when implementing fiscal policy, because in the absence of aid inflows, government debt rises with an increase in its expenditure. 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 supports earlier evidence of constant interventions in the foreign exchange market by the Central Bank in Malawi, to manage exchange rate fluctuations to stabilise domestic prices. We conclude that the availability and cost of foreign exchange in our model increases the cost of production for firms operating in countries facing foreign exchange constraints. This probably increases the price of the final products and imported consumer goods. However, we maintain the argument that the problem itself does not change the course of the dynamic responses of key macroeconomic variables in these countries. Foreign exchange constraints therefore 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.

Chapter 5

Summary and Conclusion

In Chapter two of this study we investigate three related implications of foreign exchange constraints, and the concentration of commodity exports on the dynamic behaviour of key macroeconomic variables in LIEs, using Malawi as a case study. We employ innovation accounting in a structural vector auto-regressive (SVAR) model with short-run restrictions to examine the macroeconomic impacts of commodity price shocks on output, consumer prices, and exchange rate, using export prices of tobacco in Malawi. Using quarterly time-series data covering the period 1980:1 to 2012:4, we establish that a positive tobacco price shock has a significant positive impact on the country's gross domestic product (GDP). As output increases, consumer prices fall and the real exchange rate appreciates. This result indicates that monetary authorities lower consumer prices upon observing an unexpected increase in output that comes with rising tobacco prices. This effect acts to induce an appreciation of the exchange rate.

The impulse response function of output shows that the tobacco price is positively related to GDP. On impact, output increases and reaches its maximum increase in the seventh quarter. Thereafter, output remains positive and converges at the very last period, indicating a lasting effect of tobacco price shock on GDP. This effect is similar to the effect of a productivity shock to aggregate supply. The model further reveals that there is a negative correlation between tobacco price and consumer prices, which approximate a decline in the level of inflation in the economy, following an increase in the tobacco price. This effect is captured by the impulse response of consumer prices to a one standard deviation shock in the tobacco price. Consumer prices decline significantly in the 10th quarter before the shock cycle again almost converges in the last periods. This indicates that the tobacco price has a [something can't be almost temporary, it is either temporary or not] temporary effect on consumer prices. Furthermore, a positive tobacco price shock

induces an appreciation of the exchange rate, but the shock is permanent, as shown by the impulse response function of exchange rate to tobacco price shock, where the shock converges completely in the 38th quarter. The results indicate the persistence of a tobacco price shock in the Malawian economy, because the effect of the shock persists until the last period of analysis.

We also assess the contribution of tobacco price shocks to variations in GDP, consumer prices, and the exchange rate, by decomposing the total variation in the variables. The variance decomposition results illustrate that the tobacco price shock at the maximum contributes 68% of the variation in itself, 28% of the variation in output, 6% of the variation in consumer prices, and 26% of the variation in the real exchange rate, with longer horizons providing larger contributions of tobacco price shocks to variations in the variables. This is an indication of the importance of the tobacco sector in Malawi. Monetary authorities have to take the effect of tobacco price changes into account to pursue price stability, growth, and employment objectives. Because a positive tobacco price shock induces an appreciation of the exchange rate and encourages imports, Malawi relies on exports to generate the necessary foreign exchange. An appreciation of the exchange rate worsens the country's terms of trade although, it raises output in the economy. The model also reveals that, although other factors may contribute to fluctuations in output and real exchange rates, tobacco price fluctuations cause a large percentage of the fluctuations in output and real exchange rate. A sensitivity analysis on the implications of tobacco price shocks using alternative VAR models produce the same results. Neither the direction nor the magnitude of the shock on the variables changes when other model specifications are used. This validates the findings of the SVAR model.

In the third chapter we employ a four sector dynamic stochastic general equilibrium (DSGE) model of foreign exchange to assess the dynamic effects of foreign exchange constraints on output, consumption, inflation, and exchange rate in a LIE. Calibrated to the Malawian economy, the model incorporates the foreign exchange constraint feature as a constraint faced by importing firms, when importing intermediate inputs and consumption goods. This is drawn from observation that most LIEs face foreign exchange constraints. In addition, LIEs' total imports comprise a large proportion of imported intermediate goods and capital. Firms in LIEs are thus constrained because at the time of importing the necessary inputs, they are unable to find the required foreign exchange to enable them to transact. The firms therefore source the foreign exchange at parallel markets at a high price, which further increases their production costs.

Focussing on six experiments examining a positive foreign monetary policy shock, domestic monetary policy shock, import shock, aid shock, terms of trade shock, and domestic

productivity shock, we demonstrate that a foreign contractionary monetary policy increases domestic output while at the same time decreasing domestic consumption on impact. This is because an increase in the foreign interest rate results in the depreciation of the real exchange rate, which gradually appreciates along the way to its steady state, making imports expensive. Expensive imports lead to low production, since the economy uses many imported intermediate inputs. This is seen from the fall in output and consumption after the period of impact. Another important finding is that domestic contractionary monetary policy produces the theoretical results, as both output and consumption fall, while the effect of a positive import shock leads to a fall in all key variables in the economy.

The model also demonstrates that a positive aid shock eases the foreign exchange constraint. The variables respond positively, in line with theory, to an increase in aid. An aid shock increases output and consumption, as government expenditure increases. This effect induces a real appreciation of the exchange rate and leads to an increase in imports of intermediate inputs. In this case, output increases because although the appreciation of the exchange rate worsens the terms of trade for Malawi, there is still availability of foreign exchange to be used for imports, with the increase in aid. However, the outcome of a positive aid shock seem to be inconsistent with theory. This is because positive aid inflows are associated with exchange rate depreciation and not appreciation, as is the case with the domestic economy in the model. However, this result is an outcome of the type of aid that harms the recipient economy because an appreciation of the exchange rate will likely reduce the relative growth rate of the exportable sector, and increase the growth rate of the importable sector.

The model further demonstrates that a positive terms of trade shock in a foreign exchange constrained economy induces an appreciation of the exchange rate. This works to increase imported intermediate inputs, which increases production, as observed in the impulse response of output and consumption. However inflation falls, as the appreciation of the exchange rate does not put pressure on imported inflation, which also lead to low domestic inflation. Because of the country's dependence on imported inputs, marginal costs rise in the process. The model further shows that a positive productivity shock increases employment, output, and consumption but marginal costs, inflation and real exchange rate fall, indicating that the effect induces an appreciation of the exchange rate.

We employ a DSGE model to examine the dynamic effects of government financing behaviour in a foreign exchange constrained economy on output, consumption, wages, and labour supply, among other variables, in a foreign exchange constrained economy. Recent studies on fiscal policy in DSGE models makes use of non-Ricardian households to

generate a positive effect of a positive shock to government expenditure. We leave out that assumption and incorporate the Ricardian households only. However, we modify the government budget constraint to include aid as a source of income, in addition to income from tax on imports and tax on labour income. The literature argues that LIEs rely on foreign financial inflows to stabilise the domestic economy. In this regard, we include aid as a source of additional income to government revenue.

Calibrated to the Malawian economy, we find that consumption, wages, and labour supply decrease with increased labour income tax and import tax, while inflation increases. This result is expected because tax reduces labour income and imported inputs, and therefore consumption goods fall. Rational consumers will in therefore decrease consumption, and firms will reduce production, leading to a fall in output. Popular arguments state that government expenditure is inversely associated with private consumption in DSGE model estimations. This is thought to be due to the effect of reduced labour income. However, consumption in our model responds positively to increased government expenditure. Despite the foreign exchange constraints that the economy is facing, the increase in government expenditure could come from an increase in aid inflow and not from taxes only. To the extent that the expected funds that government is to receive materialise, the government will resort to borrowing to supplement the planned budget. This will therefore lead to increased government debts in the absence of expected inflows of aid. Therefore the model reproduces the stylised atheoretical responses of the variables to government expenditure, wages, and import tax shocks without the inclusion of non-Ricardian households.

The last experiment in the model is on the effect of positive aid shocks to the dynamics of the variables when the country experiences foreign exchange constraints. The model demonstrates that a positive aid shock has serious implications for the economy in that it induces exchange rate appreciation. This is because an increase in aid induces an appreciation of the real exchange rate on impact. Because this is an open economy, the appreciation of the exchange rate worsens the price of exports, and therefore exports decline, leading to low export foreign exchange earnings. This outcome could worsen the problem of shortage of foreign exchange in the economy and it could further affect the amount of imported inputs and consumption goods in the country. Therefore, this effect could lead to a decline in imports. In this case, import tax and the worsening of the foreign exchange problem work to reduce imports in the economy. Because the economy depends heavily on imported intermediate inputs and capital, the decline in imports affects the production process, as the amount of labour needed for production is reduced. Unemployment increases, and labour income decreases, which could lead to a fall in both output and consumption, as wages also decline.

However, in our case, 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 of terms of trade of the domestic economy by the appreciation of the exchange rate, imported inputs increases and therefore labour, wages, and output increase. This is because aid reduces taxes by increasing government expenditure, leading to an increase in private consumption and output. Therefore, the effect of an increase in aid in the domestic economy is an improvement of the economy, despite the appreciation of the exchange rate. In addition, aid leads to a reduction in debt, as it substitutes for domestic borrowing (Fagernäs and Schurich 2004).

We conclude that countries with a high concentration of commodity exports in their total exports experience significant macroeconomic fluctuations when the price of the export commodity fluctuates. This means that unfavourable prices effect the economy negatively while favourable prices improve the economy. In mono-crop countries such as Malawi, there is need for diversification of exports to widen the export base and diversify away from tobacco production. This will lessen the effect of negative tobacco price fluctuations on the macro-economy of Malawi, since the risk will be spread among several export commodities. In addition, policy analysts should take into consideration the implications of commodity price shocks when implementing policies, to avoid aggravating the effects of fluctuations in commodity prices.

We emphasise that the availability and cost of foreign exchange in LIEs increases the cost of production for firms operating in countries facing foreign exchange constraints. This can increase the price of the final products and imported consumer goods. However, we accrue that the problem itself does not change the course of the dynamic responses of key macroeconomic variables in these countries. Foreign exchange constraints increase the magnitude of most of the exogenous shocks to the economy. Since intermediate inputs and exports are important to low income small, open economies, any shock that affects the exchange rate has serious implications for the economy. In this case, an appreciation of the exchange rate may worsen the foreign exchange problem, and therefore contract production and decrease output and private consumption. A depreciation, on the other hand, will increase exports and generate the foreign exchange required for imports, which will expand production, and increase output and consumption.

This study of the effect of government financing behaviour on a foreign exchange constrained economy has generated different results to similar studies, especially the response

of consumption to an increase in government expenditure. Consumption, labour income, and labour supply are shown here to increase with an increase in government expenditure. This effect can only be explained as the result of increased aid inflow into the economy. As 40% of the Malawian government's budget is foreign aid, the effect of aid cannot be overlooked. Although government taxes labour income and imports, a large proportion of an increase in government expenditure may emanate from an increase in aid. This reverses the direction of the dynamic response of private consumption to increased government expenditure, because aid reduces the amount of tax on labour income. In this case, private consumption increases, despite government consumption increasing. This explains the positive response of labour income and employment in the model to increased government expenditure.

We make four crucial conclusions: First, the characteristics of LIEs separate these countries from developed economies, and including these features when modelling their economies may improve the findings of the models. Inclusion of LIE characteristics enhances our understanding of these economies by explaining certain outcomes. This study therefore concludes that the fragility of most LIEs seems to emanate from their dependence on commodity exports. At a country level, there is support for the argument that international commodity prices explain much of the variability in macroeconomic variables. These prices convey useful information on output, consumer prices, and the real exchange rate, all of which are important for aggregate demand and supply. Fluctuations in commodity prices lead to fluctuations in key macroeconomic variables, and a positive shock to commodity prices improves the economy. Mono-crop countries are the worst hit by fluctuations in commodity prices because they do not respond well to macroeconomic fluctuations. Therefore there is a need for countries to diversify their export baskets, to minimise the price shocks to their export commodities by spreading that risk.

Second, the thesis study establishes the importance of the availability of foreign exchange in low income import dependent economies. This is because foreign exchange shortages increase the variability of shocks to macroeconomic variables in these countries. However, we demonstrate that that foreign exchange constraints do not generally change the direction of the responses of the variables to shocks, with the exception of a few variables, and contractionary monetary policy produces the conventional results.

Third, the thesis shows that in LIEs, a positive tax rate on wages and imports provides the usual result of contracting output, private consumption, labour income, and labour supply, but reduces government debt. In addition, an increase in government expenditure results in an increase in output and consumption, even after ignoring the assumption that includes non-Ricardian households. This result shows the effect of aid, which reduces tax

in LIEs and increases government expenditure. Lastly, a positive inflow of aid induces an appreciation of the exchange rate, but still leads to an improvement in the economy.

Finally, we make some propositions for Malawi. Monetary authorities should realise that increasing interest rates in the domestic economy that are implemented when the economy is facing constraints in foreign exchange discourage investment and will therefore lead to a fall in output. In addition, although the fiscal policy model shows the superiority of aid in LIEs by overturning the effect of government tax on labour income and imports, the situation cannot fully explain what happens to these economies. Therefore government policymakers should exercise caution in decisions to increase taxes on consumption goods, income, and imports, because increasing government expenditure may still crowd out private consumption and investment, and lead to an economic slowdown.

We also suggest that some adjustments to the model could have improved both the formulation of the models and the results. For example, because of data constraints, most of the parameters used in the model were taken from similar studies which provide a standard value for LIEs. However, if the true parameters were to be calculated, we cannot rule out different outcomes.

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Appendix A of Chapter 2

AR Roots Graph and Table

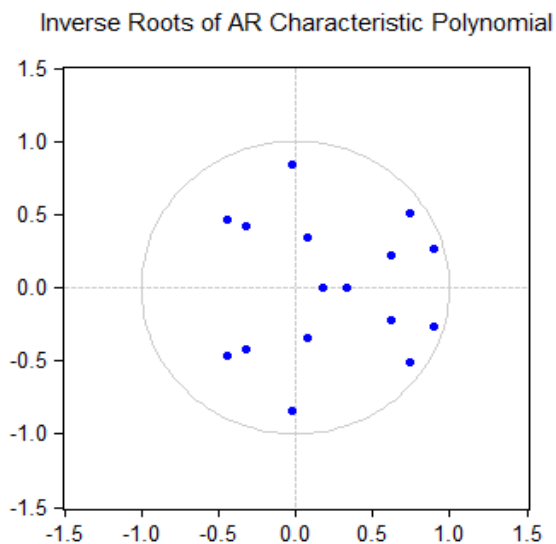
Figure A.1: AR Roots Table and Graph

Endogenous variables: LCP LGDP LTP LEXR

Exogenous variables: C

Lag specification: 1 4

Roots	Modulus
$0.897 - 0.268i$	0.937
$0.897 + 0.268i$	0.937
$0.742 - 0.514i$	0.902
$0.742 + 0.514i$	0.902
$-0.018 - 0.084i$	0.841
$-0.018 + 0.841i$	0.841
$0.619 - 0.218i$	0.657
$0.619 + 0.218i$	0.657
$-0.445 - 0.459i$	0.639
$-0.445 + 0.459i$	0.639
$-0.321 - 0.422i$	0.530
$-0.321 + 0.422i$	0.530
$0.083 - 0.347i$	0.356
$0.0827 + 0.347i$	0.356
0.337	0.337
0.181	0.181



From the table and the graph, we conclude that no root lies outside the unit circle. Therefore, the VAR satisfies the stability condition

Robustness Check

Figure A.2: Differenced Data SVAR

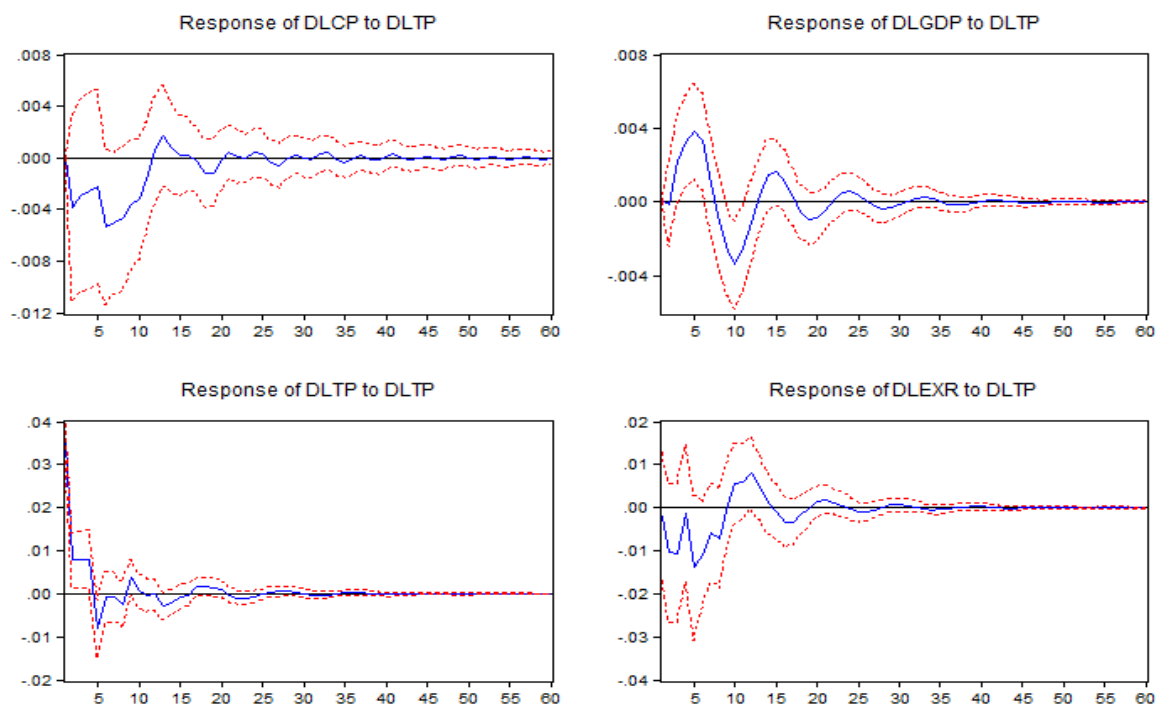
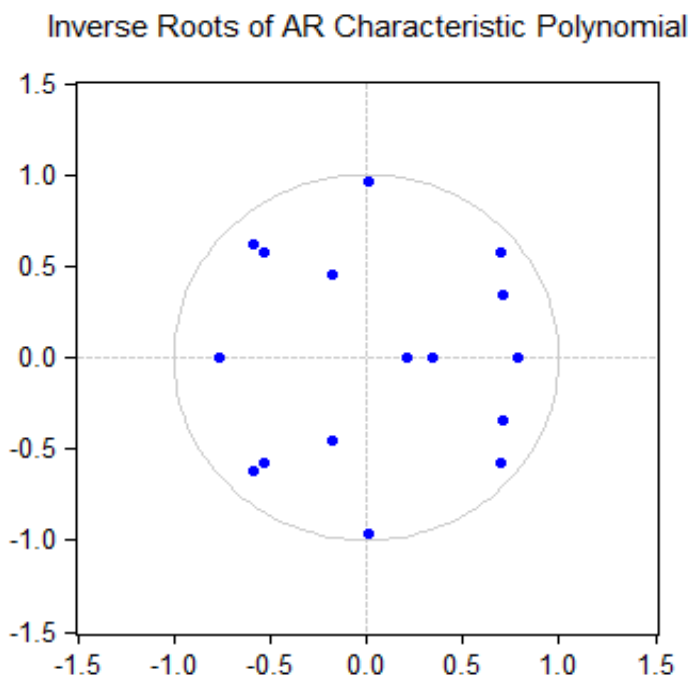


Figure A.3: AR Roots Differenced Data SVAR



From the table and the graph, we can see that no root lies outside the unit circle. Therefore, the VAR satisfies the stability condition

Cointegrating Vector Autoregression (CVAR) Model

We proceed with robustness checks on the results obtained by the SVAR model. Since after testing for unit root test of the series, we establish that the variables are all I(1), indicating that they are not stationary in levels but are stationary after first difference, we therefore test for cointegration¹ to determine if a long-run relationship exists among the variables. Table A2 presents the results.

Table 4.1: Cointegration Test Results

No. of CE(s)	Eigen value	Trace Stat	95% CV	Max-Eigen Stat	95% CV
r = 0	0.26	51.87(0.02)	47.86	37.12(0.00)	27.58
r = 1	0.08	14.76(0.80)	29.80	11.03(0.64)	21.13
r = 2	0.03	3.73(0.92)	15.49	3.65(0.89)	14.26
r = 3	0.00	0.08(0.78)	3.84	0.08(0.78)	3.84

Trace test indicates 1 co-integrating equation at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

where CV is critical value. According to the Johansen Trace and Maximum Eigenvalue test statistics in Table A2, the null hypothesis of no co-integration is rejected. The LR trace test statistics fail to reject the hypothesis of $p - r = 1$ common trends and $r = 1$ co-integrating relations at 5% significance level for the data set. This result is also supported by the maximum eigenvalue test which also indicates that there exists 1 co-integrating equation at 5% significance level in the model, showing that a long-run relationship exists between the variables under analysis. The

results of the normalized long-run equation are provided:

$$ltp = -1.11(0.11)lgd p - 0.24(0.07)lcp + 0.36(0.06)lexr \quad (4.1)$$

Standard errors are presented in parenthesis in equation (A1).

¹Cointegration occurs when two or more series are non-stationary, but a linear combination of them is stationary. The co-integration rank is determined according to the Johansen Likelihood Ratio (LR) test (Johansen 1995).

Table 4.2: The Just-identified Long-run Cointegration Relation for $r = 1$

	LTP	LGDP	LCP	LEXR
β	1	-1.108 (-10.070)	-0.236 (-3.511)	0.360 (6.154)
	Δ LTP	Δ LGDP	Δ LCP	Δ LRER
α	-0.268 (-4.304)	0.019 (-0.979)	0.071 (-0.449)	-0.458 (-2.269)

Note: t-values in brackets

Estimating the co-integrating VAR yields all the expected results, as in the previous models, except for consumer price, which is supposed to decline following a positive tobacco shock. However, this difference in results may be attributed to the long-run dynamics of consumer prices, which may rise after a certain period of time. Table A3 shows that the error term for the model has the expected negative sign and is significant at 5% significance level. This indicates that if in period $t - 1$ the error term was positive, then the tobacco leaf price was too high, compared to the equilibrium relationship with the other variables. Therefore, the tobacco leaf price would fall to be in equilibrium. In addition, the model yields a low adjustment coefficient of 27%, indicating that if there is a disequilibrium in the model caused by shocks in tobacco prices, the speed of adjustment to equilibrium to correct this disequilibrium is 27%, which is very low. This confirms the argument by [Blanchard and Quah \(1988\)](#) that supply shocks take a long time to disappear in the economy, compared to demand shocks.

Consumer prices have been on a swing since early 2011, as headline inflation peaked at 37.9%. The common culprit that affects prices is the continued depreciation of the Malawian Kwacha in recent years, which puts pressure on food prices during the dry season. The central bank does not target inflation but formulates policies to keep consumer prices and inflation low. Therefore we estimate an over-identified CVAR model to reflect this identifying assumption, by restricting the coefficient of consumer prices to zero. Table A4 provides the results of the over-identified model with a long-run co-integration relation of $r = 1$.

Table 4.3: The Over-identified Long-run Cointegration Relation for $r = 1$

	LTP	LGDP	LCP	LEXR
β	1	-1.269 (-10.832)	0 NA	0.153 (8.262)
	Δ LTP	Δ LGDP	Δ LCP	Δ LRER
α	-0.261 (-4.681)	0.008 (0.443)	0.023 (0.364)	-0.185 (-1.171)

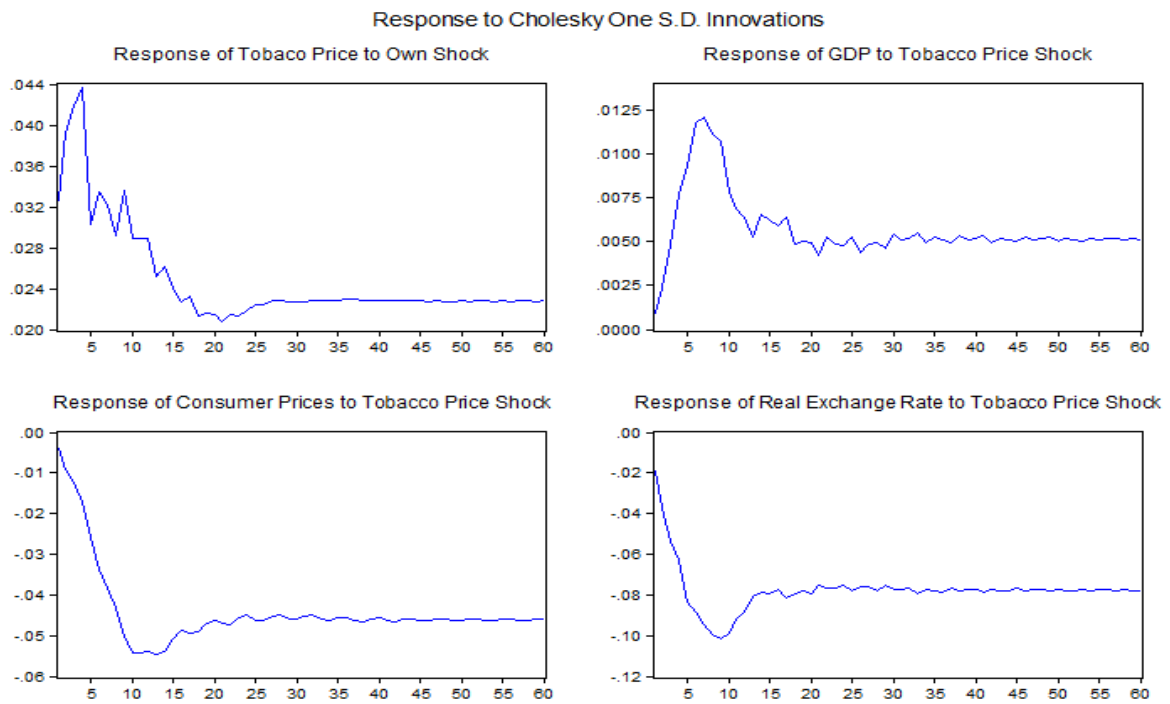
Note: t-values in brackets

The likelihood ratio (LR) test statistic of 8.802 and a p-value of 0.003 indicate that the restriction imposed is not rejected, and supports the theoretical hypothesis. With the proposed long-run proportionality between international tobacco prices and inflation in Malawi, the coefficients for GDP and real exchange rate are statistically significant and with the correct signs, supporting the view that GDP and the real exchange rate are determined by tobacco prices in the long-run. The error term for the model does not change much, as the speed of adjustment to equilibrium still remains 27% and is also significant. This adjustment to equilibrium is still slow, indicating long periods of adjustment to the shock in the international prices of tobacco.

The results broadly support the model and the theoretical hypothesis on which the model is formulated. The long-run relationship between tobacco prices, exchange rates, consumer prices, and GDP is underlined by the co-integration analysis, with co-integrating error term of -0.27 having explanatory power for the effect of tobacco prices. The deviation of GDP from its long-run equilibrium explains the implications of fluctuations in tobacco prices on output in the economy and we can argue that there is evidence to identify the exchange rate and inflation effects as commodity price phenomena, thereby concurring with the ideas put forward by [Conforti et al. \(2010\)](#), [Davies \(2003\)](#) and [Diao et al. \(2002\)](#).

We can conclude that the results in the CVAR are similar to those in the SVAR and unrestricted VAR. The dynamics and the direction of the variables show the same variability, with a slight difference in the magnitude of the impulse responses of the variables. In addition, assessing the impulse responses of output, consumer prices, and real exchange rate in response to a shocks to tobacco prices indicates the same results as in the previous analysis by SVAR. That is, a positive tobacco price shock increases output, lowers inflation, and appreciates the real exchange rate. Figure A4 reports the results.

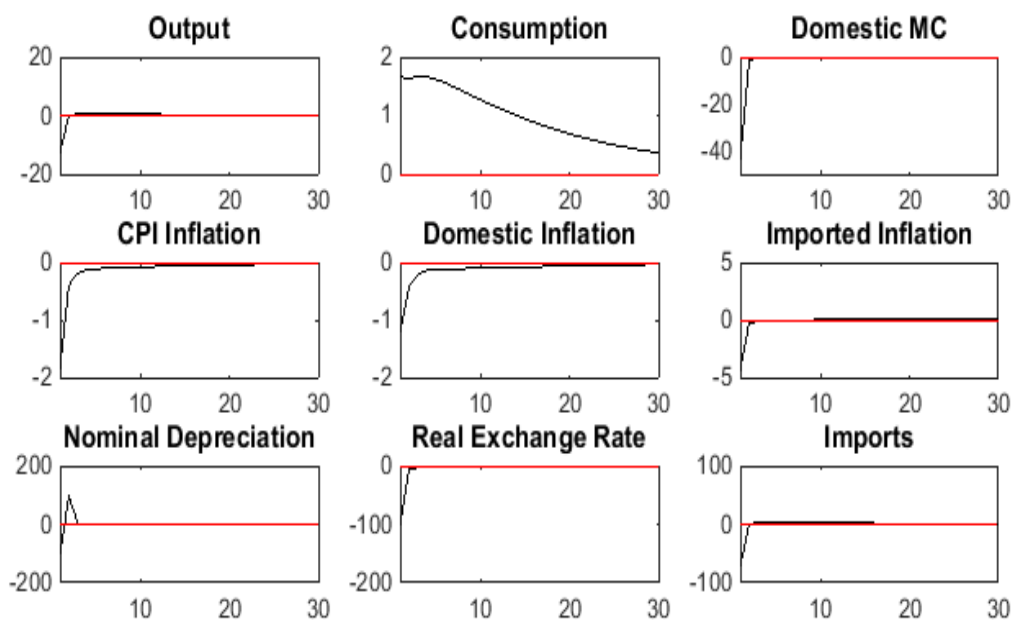
Figure A.4: Impulse Responses to Shock to Tobacco Price (Cointegrating VAR)



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Appendix B of Chapter 3

Figure B.1: Impulse Responses to Domestic Risk



Responses of the variables when the foreign exchange constraint is relaxed.

Figure B.2: Impulse Responses to Foreign Monetary Policy Shock

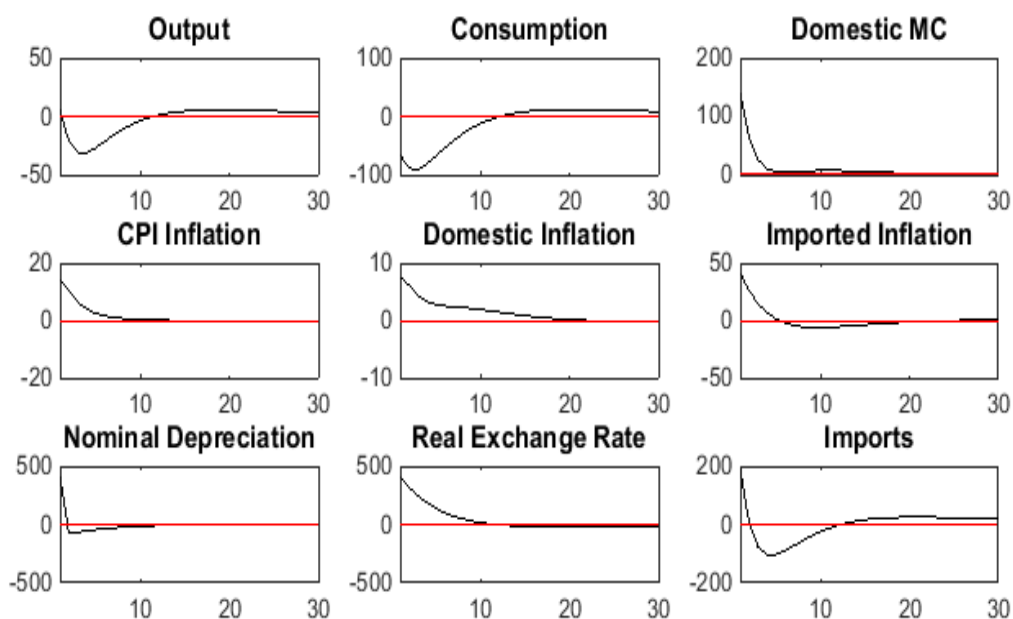


Figure B.3: Impulse Responses to Domestic Monetary Policy

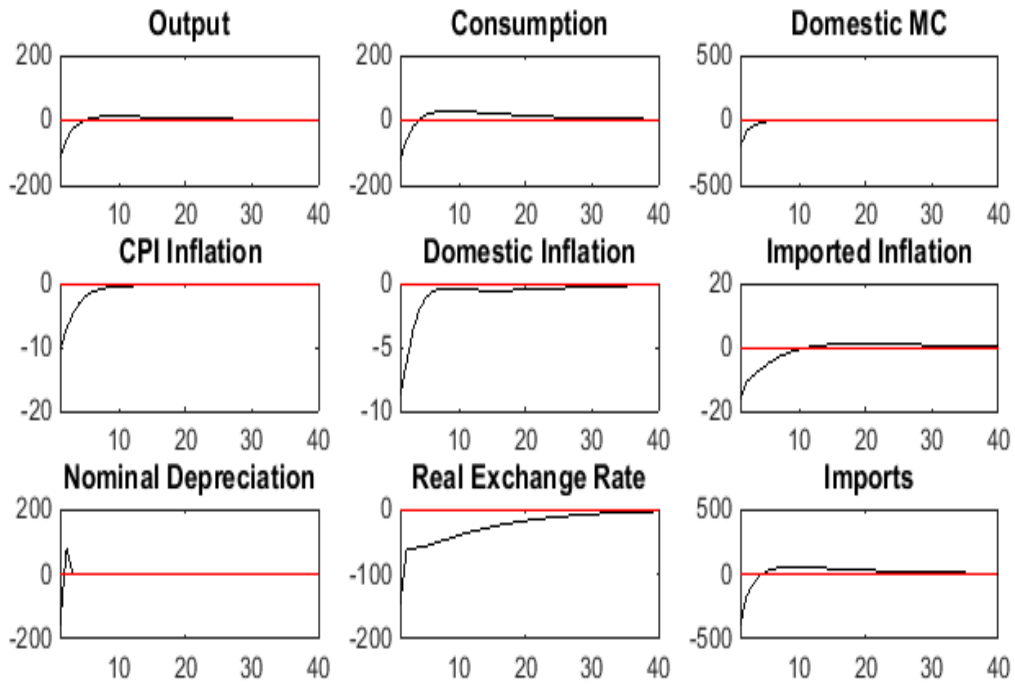


Figure B.4: Impulse Responses to Aid Shock

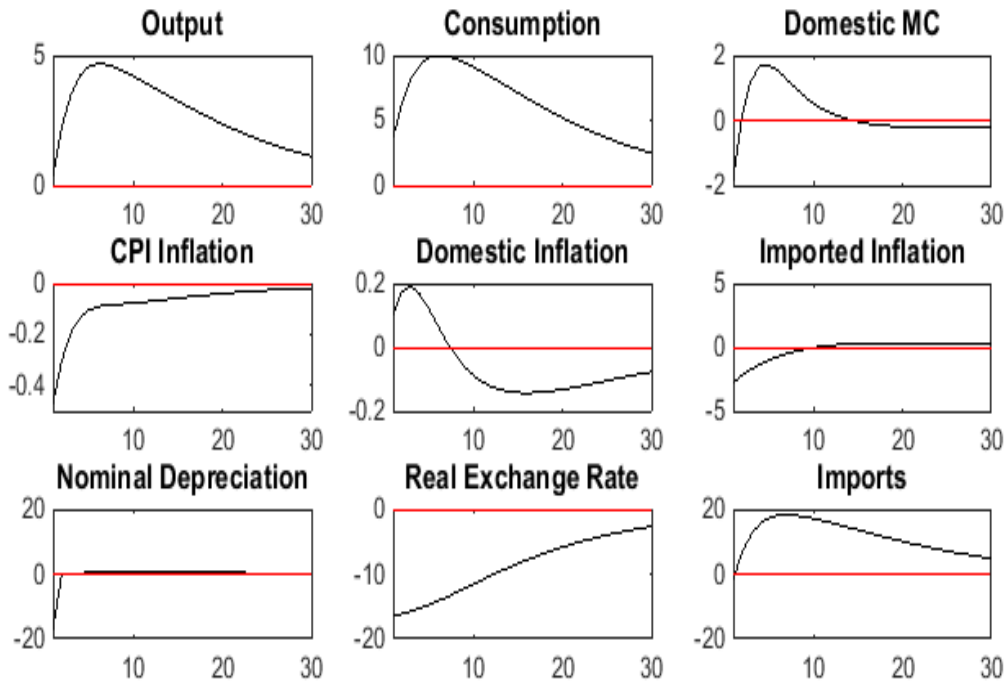


Figure B.5: Impulse Responses to Terms of Trade Shock

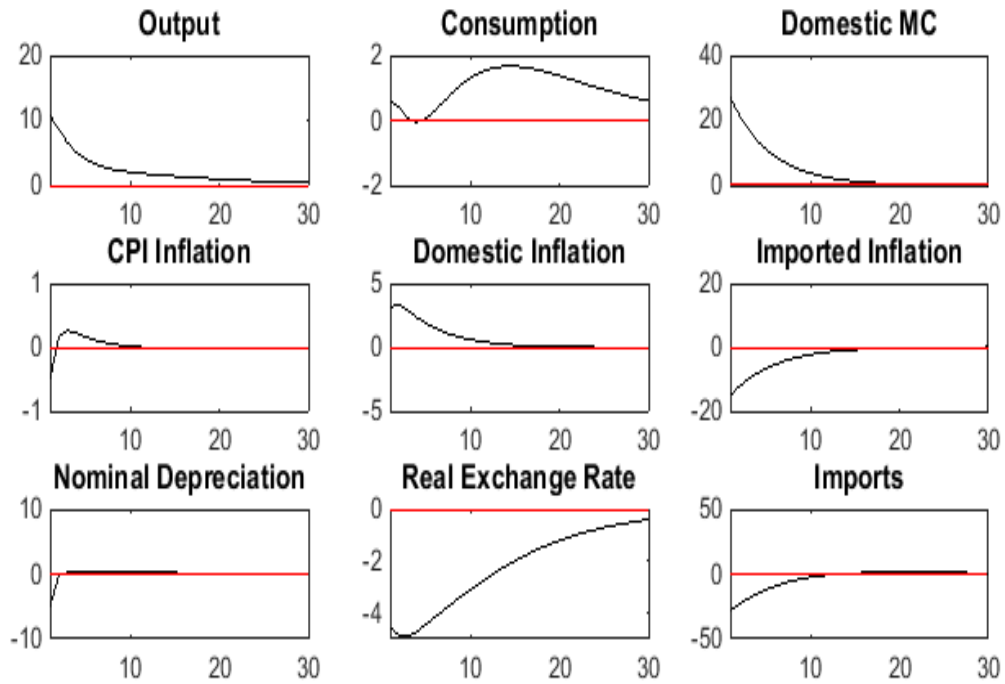


Figure B.6: Impulse Responses to Domestic Productivity

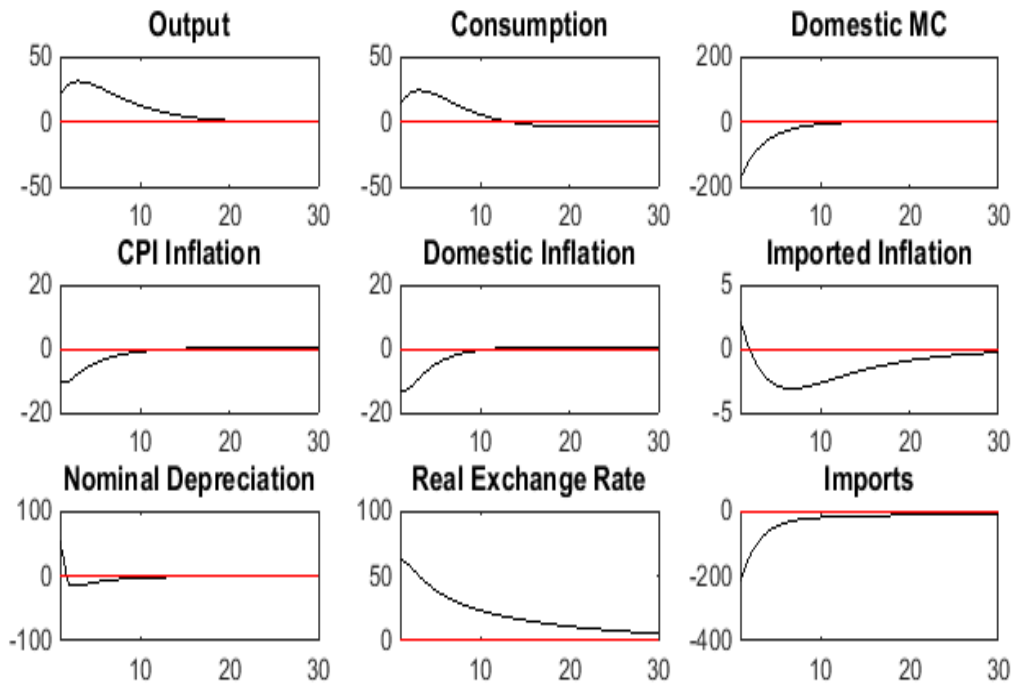
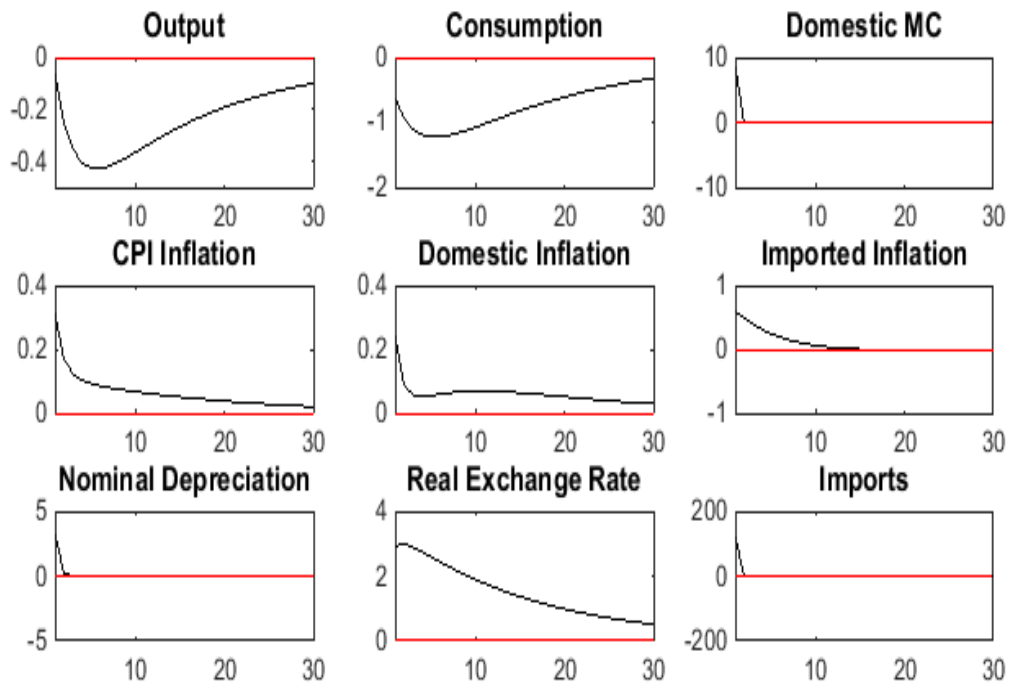


Figure B.7: Impulse Responses to Imports



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Parameter Description and Sources

Table B.1: Descriptions and Sources

Parameter	Description and Source
χ_a	Ratio of net aid to imports (Mwabutwa et al., 2013; Ngalawa and Viegi, 2013)
χ_r	Ratio of imports to foreign exchange reserves (World Bank Econ. Indicators)
χ_c	Ratio of imported consumption goods in total imports (NSO)
χ_g	Consumption to GDP ratio (Mwabutwa et al., 2013)
χ_f	Total imports to GDP ratio (IMF country reports, RBM & World Bank Ecoc Indicators)
χ_m	Ratio of imported intermediate inputs in total imports (Senbeta, 2013)
β	Household discount factor (Mwabutwa et al., 2013; Gali and Monacelli, 2005)
ν	Intertemporal elasticity of substitution in consumption (Berg et al. 2007)
φ	Elasticity of labour (Berg et. al., 2010)
χ	Marginal disutility of working (Senbeta, 2013)
ρ^1	Elasticity of substitution between imported and home goods (Calibrated)
θ_f	Elasticity of substitution between varieties of imported goods (Calibrated)
α_1	Share of imported goods in consumption (Senbeta, 2013)
h	Coefficient of habit persistence (Senbeta, 2013)
χ_{risk}	Risk premium parameter (Alpanda, Kotze and Woglom 2010)
σ_1	Share of labour in production of home goods (Mwabutwa et al., 2013)
σ_2	Share of intermediate inputs in production of home goods (Senbeta, 2013)
ς_F	Weight attached to past inflation for importing firms (Senbeta, 2013)
ς_H	Weight attached to past inflation by domestic producers (Senbeta, 2013)
θ_F	Fraction of importing firms that index their prices (Senbeta, 2013)
θ_H	Fraction of domestic producers that index prices (Senbeta, 2013)
ρ_H	Persistence of total productivity shock (Senbeta, 2013)
ρ_r	Persistence of interest rate (Ortiz and Sturz, 2007)
ϕ_π	Inflation stabilization (Alpanda, Kotze and Woglom, 2010)
ϕ_y	Output stabilization (Senbeta, 2013)
ϕ_e	Exchange rate stabilization (Senbeta, 2013)
ρ_a	Persistence of aid shock (IMF Country Report)
ρ_{y^*}	Persistence of foreign income shock (Alpanda, Kotze and Woglom, 2010)
ρ_{π^*}	Persistence of foreign inflation shock (Alpanda, Kotze and Woglom, 2010)
ρ_{r^*}	Persistence of foreign interest rate shock (Alpanda, Kotze and Woglom, 2010)

The Estimated Linearised Model

The solution to the structural model presented in the previous sections is the log-linear approximations to steady state of the equations presented in this section and this is the model that is to be calibrated². Inflation is calculated as $\pi_t = \ln P_t - \ln P_{t-1}$. The estimated equations contain shocks to endogenous variables to capture the dynamic responses of the variables to a percentage change or a unit change in a variable. The full log-linear

²Deviations to steady state are taken in such that $x_t = \ln X_t - \ln \bar{X}_t$, \bar{X} is the steady state value of X_t .

equations are presented in the appendix, however, here we just present the model that is to be calibrated.

Log-linearising the marginal rate of substitution between consumption and labour:

$$w_t - p_t = \varphi l_t + \frac{v}{1-h} c_t - \frac{hv}{(1-h)} c_{t-1} \quad (\text{B.1})$$

The consumption Euler becomes:

$c_t - hc_{t-1} = E_t(c_{t+1} - hc_t) - v^{-1}(1-h)(r_t - E_t\pi_{t+1}) + v^{-1}(1-h)$ or

$$c_t = \frac{1}{1+h} E_t c_{t+1} + \frac{h}{1+h} c_{t-1} - \frac{(1-h)}{v(1+h)} (r_t - E_t\pi_{t+1} + \epsilon_{g,t}) \quad (\text{B.2})$$

where $\epsilon_{g,t} = \rho_g \epsilon_{g,t-1}^g + \varepsilon_t^g$, $\varepsilon_t^g \sim i.i.d.N(0, \sigma_g^2)$ is a demand shock.

From 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 is the household's optimal holding of domestic and foreign bonds, it implies that

$$c_t = \frac{1}{1+h} E_t c_{t+1} + \frac{h}{1+h} c_{t-1} - \frac{(1-h)}{v(1+h)} (r_t - E_t\pi_{t+1}) \quad (\text{B.3})$$

Using the usual definitions of ϕ_t , then the

$$\ln \phi_{t+1} = -\eta d_t - \eta \omega_{t+1}$$

$$\ln \phi_{t+1} - \ln \bar{\phi} = -\eta d_t - \epsilon_{rps,t}$$

Therefore;

$$r_t - E_t\pi_{t+1} = r_t^* - E_t\pi_{t+1}^* + E_t\Delta q_{t+1} - \eta d_t - \epsilon_{rps,t} \quad (\text{B.4})$$

and q_t is the real exchange rate.

Real Exchange Rate, Terms of Trade and Incomplete Pass-through

Linearising (34) the Law of one price gap and finding its evolution by subtracting one

period lag:

$$\psi_t - \psi_{t-1} = e_t - e_{t-1} + \pi_t^* - \pi_{F,t} \quad (\text{B.5})$$

and linearising (35) the real exchange rate

$$q_t = e_t + p_t^* - p_t \quad (\text{B.6})$$

since $p_t = (1 - \alpha_1)p_{H,t} + \alpha_1 p_{F,t}$, using the log-linearised definition of the law of one price gap, then the real exchange rate can be written as $q_t = \psi_t + p_{F,t} - (1 - \alpha_1)p_{H,t} + \alpha_1 p_{F,t}$ which can be simplified as

$$q_t = \psi_t + (p_{F,t} - p_{H,t}) - \alpha_1(p_{F,t} - p_{H,t})$$

Linearising the terms of trade condition we have $s_t = p_{F,t} - p_{H,t} \iff \Delta s_t = \pi_{F,t} - \pi_{H,t}$

Using this definition of terms of trade and re-writing the real exchange rate equation, we have:

$$q_t = \psi_t + (1 - \alpha_1)s_t \quad (\text{B.7})$$

and the terms of trade definition comprising the terms of trade shock is given as:

$$s_t = s_{t-1} + \pi_{F,t} - \pi_{H,t} + \epsilon_{tot,t} \quad (\text{B.8})$$

Firms

Domestically produced goods inflation (New Keynesian Phillips curve) is given as:

$$\pi_{H,t} - \varsigma_H \pi_{H,t-1} = \beta E_t(\pi_{H,t+1} - \varsigma_H \pi_{H,t}) + \kappa_H m_{CH,t} \quad (\text{B.9})$$

where $\kappa_H = \frac{(1-\theta_k)(1-\theta_k\beta)}{\theta_k}$

Log-linearising the real marginal cost function (20) yields

$$mC_{H,t} = \sigma_1 w_t + \sigma_2 p_{F,t} - p_t - a_{H,t}$$

using (37) and substituting for w_t gives the marginal cost as:

$$mC_{H,t} = \sigma_1 \left(p_t + \varphi l_t + \frac{v}{(1-h)} c_t - \frac{hv}{(1-h)} c_{t-1} \right) + \sigma_2 p_{F,t} - p_t - a_{H,t}$$

$$mC_{H,t} = \sigma_1 \left(\varphi l_t + \frac{v}{(1-h)} c_t - \frac{hv}{(1-h)} c_{t-1} \right) + \sigma_2 p_{F,t} + \sigma_1 p_t - p_t - a_{H,t}$$

$$mC_{H,t} = \sigma_1 \left(\varphi l_t + \frac{v}{(1-h)} c_t - \frac{hv}{(1-h)} c_{t-1} \right) + \sigma_2 p_{F,t} - (1 - \sigma_1) p_t - a_{H,t}$$

$$mC_{H,t} = \sigma_1 \left(\varphi l_t + \frac{v}{(1-h)} c_t - \frac{hv}{(1-h)} c_{t-1} \right) + \sigma_2 p_{F,t} - \sigma_2 p_t - a_{H,t}$$

$$mC_{H,t} = \sigma_1 \left(\varphi l_t + \frac{v}{(1-h)} c_t - \frac{hv}{(1-h)} c_{t-1} \right) + \sigma_2 (1 - \alpha_1) s_t - a_{H,t} \quad (\text{B.10})$$

Importing firms

The New Keynesian Phillips curve for importing firms

$$\pi_{F,t} - \varsigma_H \pi_{F,t-1} = \beta E_t (\pi_{F,t+1} - \varsigma_F \pi_{F,t}) + \kappa_F (mC_{F,t} - p_{F,t}) \quad (\text{B.11})$$

and $\kappa_F = \frac{(1-\iota_F)(1-\iota_F\beta)}{\iota_F}$

Marginal cost for importing firms with the mark-up on price: $MC_{F,t} = \varepsilon_t P_t^* (1 + \varpi_t)$

and log-linearising, it becomes $mC_{F,t} = e_t + p_t^* + \hat{\varpi}_t$.

Subtracting $p_{F,t}$ from both sides, we have

$$mC_t - p_{F,t} = (e_t + p_t^* + \hat{\varpi}) - p\psi_{F,t} = \psi_t + \hat{\varpi}.$$

But, the log-linearised version, given the output as $(y_{F,t})$ is given as :

$$\hat{\varpi} = \frac{1}{\rho_2} y_{F,t} \quad (\text{B.12})$$

Market Clearing Conditions

Goods market clear when

$$Y_{F,t} = C_{H,t} + C_{H,t}^*$$

which is log-linearised as

$$\bar{Y}_{yt} = \bar{C}_H c_{H,t} + \bar{C}_H^* c_{H,t}^*$$

Where

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

$$\text{using } p_t - p_{H,t} = \alpha_1 s_t, \text{ then } C_{H,t} = \rho_1 \left(\frac{P_{H,t}}{\varepsilon_t P_t^*} \right)^{-\rho_1} C_t^* = \alpha_1 \left(\frac{P_{H,t}}{\varepsilon_t P_t^*} \right)^{-\rho_1} C_t^*$$

and log-linearising, we have

$$c_{H,t}^* = \rho_1 \alpha_1 s_t + \rho_1 q_t + c_t^*$$

therefore, a balanced trade steady state implies

$$\bar{C}_H^* + \bar{A} = \bar{Y}_F \iff \bar{C}_H^* = \bar{C}_F + \bar{M} - \bar{A}$$

dividing through by \bar{C}_H^* , then $1 = (1 - \alpha_1)\chi_g + \alpha_1\chi_g + (\chi_m - \chi_a)\chi_f$,

Letting $\frac{\bar{C}}{\bar{Y}} = \chi_g$, $\frac{\bar{M}}{\bar{Y}_F} = \chi_m$, $\frac{\bar{Y}_F}{\bar{Y}} = \chi_f$, $\frac{\bar{A}}{\bar{Y}_F} = \chi_a$, then

$$\bar{C}_H^*/\bar{Y} = \alpha_1\chi_g + (\chi_m - \chi_a)\chi_f$$

Therefore, the domestic goods clearing condition becomes:

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

If we define the steady state proportion of imported consumption goods and intermediate goods in total imports as: $\chi_c = \bar{C}_F/\bar{Y}_F$ and $(1 - \chi_c) = \bar{M}/\bar{Y}_F = \chi_m$,

Then from $Y_{F,t} = C_{F,t} + M_t$, we have the log-linearised function as :

$$y_{F,t} = \chi_c c_{F,t} + (1 - \chi_c)m_t,$$

And using the definition of foreign imported goods consumption and intermediate inputs

and substituting for p_t we have:

$$c_{F,t} = -\rho_1(1 - \alpha_1)s_t + c_t$$

The log-linearised imported inputs becomes:

$$m_t = -\sigma_1 p_{F,t} + \sigma_1 w_t - a_{H,t} + y_{H,t}$$

$$m_t = \sigma_1(w_t - p_{F,t}) - a_{H,t} + y_{H,t}$$

which becomes:

$$m_t = \varphi l_t + \frac{\sigma_1 v}{(1-h)} c_t - \frac{\sigma_1 h v}{(1-h)} c_{t-1} - a_{H,t} + y_{H,t} - \sigma_1(1 - \alpha_1)s_t \quad (\text{B.13})$$

This follows from Senbeta (2013) and the debt evolves according to: Appendix

$$d_t = \frac{1}{\beta} d_{t-1} + (\chi_a + (1 - \chi_a)\rho_1 - 1)q_t + \chi_a a_t + (1 - \chi_a)((\rho_1 - 1)\alpha_1 s_t + y_t^*) - y_{F,t} \quad (\text{B.14})$$

and the log-linearised foreign exchange holdings is given as:

$$res_t = \rho_{res} res_t = \rho_{res} res_{t-1} + \rho_{debt}(r_{t-1} + \varepsilon_t + b_{t-1} + \phi_t) + \rho_a(\varepsilon_t + a_t) + \rho_{ex}(p_t + c_{H,t}^*) - \rho_m(\varepsilon_t + p_{F,t} + y_{F,t}) \quad (\text{B.15})$$

Appendix C of Chapter 4

Sensitivity Analysis Results

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

Figure C.1: Sensitivity Analysis of Wage Tax Shock

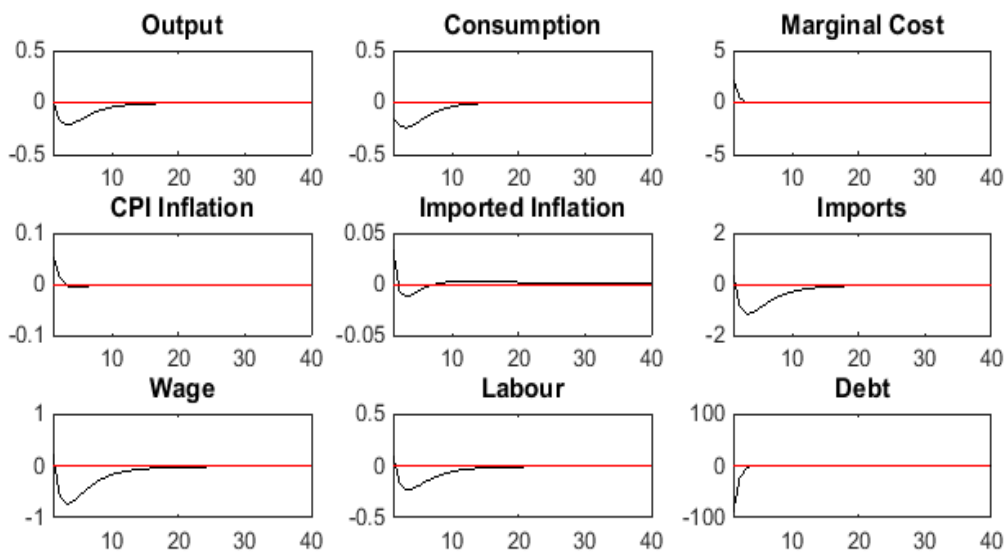


Figure C.2: Sensitivity Analysis of Import Tax Shock

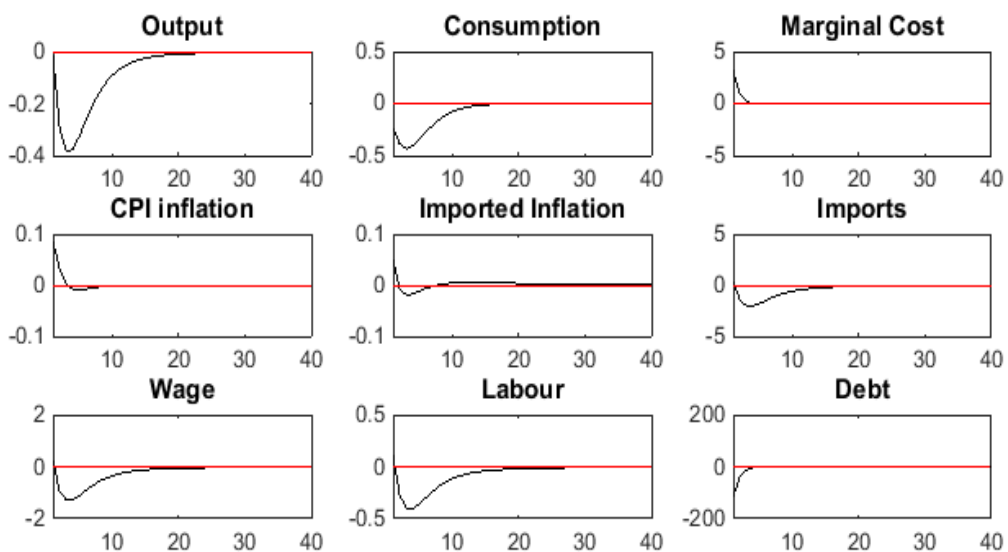
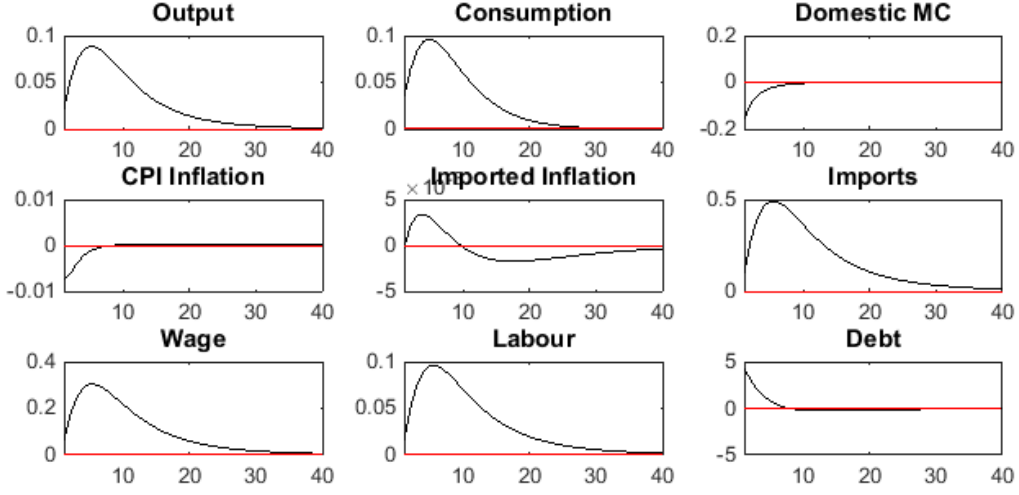


Figure C.3: Sensitivity Analysis of Government Expenditure Shock



Estimated Linearised Model

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

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

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

The Optimal holdings of domestic and foreign assets:

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

The marginal rate of substitution becomes

$$\varphi_l t + \frac{\nu}{1-h} c_t - \frac{h\nu}{1-h} c_{t-1} = w_t - \tau_t^w w_t - p_t \quad (\text{C.3})$$

Wage equation is given as:

$$w_t - p_t = \varphi_l t + \frac{\nu}{1-h} c_t - \frac{h\nu}{1-h} c_{t-1} + \tau_t^w w_t \quad (\text{C.4})$$

Labour equation becomes:

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

The goods market clearing condition is given as:

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

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

$$s_t = p_{F,t} - p_{H,t} \quad (C.7)$$

The real exchange rate is given as q_t , then:

$$q_t = e_t + p_t^* - p_t \quad (C.8)$$

Time-differencing the terms of trade gives:

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

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:

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

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

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

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

$$\pi_{H,t} - \varsigma_H \pi_{H,t-1} = \beta E_t(\pi_{H,t+1} - \varsigma_H \pi_{H,t}) + \kappa_H m_{CH,t} \quad (\text{C.12})$$

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

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

$$m_{CH,t} = \sigma_2 (1 + \tau_t^m) - \sigma_1 (1 - \tau_t^w) + \sigma_1 \left(\varphi l_t + \frac{\nu}{(1-h)} c_t - \frac{h\nu}{(1-h)} c_{t-1} \right) + \sigma_2 (1 - \alpha_1) s_t - a_{H,t} \quad (\text{C.13})$$

The Government Budget is given as:

$$\rho_{\tau_t^w} (\tau_t^w + w_t + n_t) + \rho_{\tau_t^m} (\tau_t^m + p_{F,t} + m_t) + \rho_{b^s} (b_t - (r_{t-1} + b_{t-1}) \beta^{-1} - 1) + \rho_{a_t} (q + a) = \rho_{gg} g_t \quad (\text{C.14})$$

Parameter Values and Description

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)