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

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Abstract

One of the major concerns facing developing economies is the implications of their dependence on commodities and the implications of price changes. Considerable literature has developed from earlier work on the macroeconomic impact of oil price shocks in developed economies that have exploitable reserves. For developing economies, the implications of commodity prices can be much more profound. Commodity price shocks can become major macroeconomic concerns and a major reduction in the international commodity price can lead to a devastating slowdown in economic growth. While some cross country studies exist, there is lack of country specific studies that take into account the different characteristics of low income economies. This paper contributes to the growing literature by considering the case of Malawi and the macroeconomic impact of price shocks in its major export crop of tobacco. Using a Structural Vector Auto-regression (SVAR) approach on quarterly Malawian data from 1980:1 to 2012:4, the paper establishes that a positive tobacco price shock has a significant positive impact on the country's gross domestic product (GDP). This also decreases consumer prices and induces real exchange rate appreciation. The results are robust to alternative specifications of a SVAR on difference stationary data and co-integrating VAR. The co-integrating VAR confirms the existence of a long run-relationship among the variables and causality runs from tobacco prices.

1 Introduction

There has been considerable debate over the implications of developing countries dependence on commodity exports for growth, with recent arguments about the implications of commodity price changes on macroeconomic variables (Diao et al.; 2002). Despite growing concerns, little attention has been paid to the effects of commodity price shocks and their dynamics in developing economies, particularly, given that low income economies (LIEs)[1] may be prone to instability in international commodity prices due to the nature of their exports (Addison and Ghoshray; 2013). Understanding the implications of over-dependence on commodity exports, especially mono-crop export low income Sub-Saharan African (SSA) economies is important because the implications can provide insights into whether 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 because 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. This consequently increased the large empirical literature on oil shocks in developed economies while developing economies were largely uneplored.

Most of the existing literature on commodity price shocks has focused on how the effects of commodity prices are able to explain the 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). The studies that focused on developing economies are based on cross country data sets, with a small portion focusing on case studies of small open economies. Although cross country studies failing to address heterogeneity problems within and between countries, the literature on developing countries has proceeded in this way, but literature states that factors that affect the macroeconomic variables differ between developed and developing countries and also among different developing countries (Stiglitz and Charlton; 2006; Deaton and Miller; 1996). Unlike developed economies, developing economies tend to have highly concentrated commodity

[1] As of 1 July 2014 the World Bank classification of countries classified low-income economies as those countries with a GNI per capita that is calculated using the World Bank Atlas method of $1,045 or less in 2013,; and 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. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of $4,125. However, low and middle-income economies are sometimes referred to as developing economies. For convenience, these countries are grouped into low income economies, which include lower middle income economies and high income economies which includes upper-middle income economies.

exports, exporting a few, or single commodities, which are mostly agricultural commodities. This indicates that LIEs export earnings and domestic economies are susceptible to fluctuations in the relative international prices. Stiglitz et al. (2006) and Katrak (1973) argue that fluctuation of international prices has more serious economic implications in developing economies than in developed economies. In addition, the recent literature state that the responses of developed economies to a shock in commodity prices differ from the responses of developing economies, partly because the policies that operate in most low income economies are not effective in stabilising the economy in the same way that they would in developed countries[2] (Lin and Ye; 2009; Stiglitz et al.; 2006; Masson et al.; 1998, 1997). This therefore, warrants the need for country specific studies to specifically assess the effects of fluctuations in the prices of their commodity exports.

To incorporate the characteristics of these economies 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 recent studies on the implications of commodity price fluctuations and macroeconomic adjustments find that the responses of economic variables to shocks to commodity price depends generally on several factors, namely: the nature of the shock, the structure of the economy, the effectiveness of the domestic policy-making process, and the ease and difficulties in handling price fluctuations (Deaton and Miller; 1996, Kose and Riezman; 2001). Most importantly, the percentage of the commodity in the country's GDP, and, the percentage component of the commodity in the total export earnings determines greatly the effect of the price shock on the economy (Kose and Riezman; 2001). The higher the percentage of the commodity in the export basket, the higher is the effect of price fluctuations on the export sector and the higher is the effect on the overall economy. In addition, the higher is the contribution (or the proportion) of the export commodity to GDP, then the higher is the effect of its price fluctuations. This further means that if an economy diversifies its exports, then export price fluctuations may have a minimal effect. Unfortunately, the literature argue that this is not the case with LIEs of SSA countries (Stiglitz et al.; 2006; Deaton; 1999; Deaton and Miller; 1996, 1995). Therefore, to understand the dynamics and the determinants of commodity price shocks in LIEs, it is important to properly forecast the effects of commodity price shocks and understand the propagation of commodity price shocks in the economy.

This chapter contributes to the growing literature by providing a case study of a developing

[2]For example, Ngalawa and Viegi (2013) in their analysis of the interaction between formal and informal financial sectors in LICs, they argued that while inflation targeting is an alternative in HIC, it is an outside option for a majority of low income countries. This is because notable studies by (Masson et al.; 1998, 1997), point out that preconditions for adopting an inflation targeting framework in LIEs are not yet present.In this regard, only a few LIEs have so far adopted inflation targeting as a monetary policy operating strategy as revealed by a recent study on developing countries by Lin and Ye (2009) where out of 13 countries, only the Philippines is a LIE.

economy and particularly a LIE, namely Malawi, with the macroeconomic impact of price shocks to its major export crop. Malawi possesses most of the LIE stylised characteristics in that it has a relatively high agricultural economy, a relatively high percentage of a single-export-crop commodity (tobacco) in total exports and low industrial and financial sectors, high government debts and tobacco contributes significantly to the total export basket and GDP (FAO; 2003). Specifically, we investigate the interaction of tobacco price shocks with selected macroeconomic variables by determining the effects of fluctuations in tobacco price on selected macroeconomic variables in the economy. We further determine the channels through which tobacco price shocks are transmitted into the economy. This entails the identification of selected policy options that channel the effects of tobacco price shocks to propagate into the economy.

The remainder of the chapter is organised as follows: The next section discusses the importance of tobacco crops and their production and marketing in Malawi, and reviews the related literature on the future of tobacco production. Section 3.1 reviews the theoretical literature on commodity price shocks followed by a discussion of the related literature on commodity price shocks in section 3.2. The data, and data sources, estimation, identification and data issues are presented in section 4 with section 5 providing the estimation inferences and model results, and finally section 6 presenting the conclusion.

2 Tobacco Production in Malawi

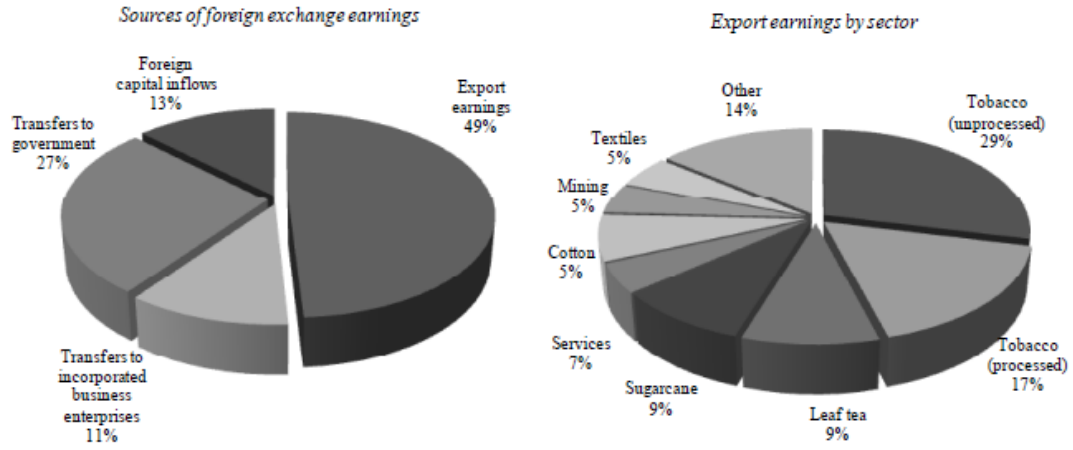
There has been an increasing trend in the production of tobacco globally over the years with recent shifts in production from developed economies to developing economies. The shift is due to numerous and increased awareness of the negative health effects of tobacco in developed economies to hinder both the production and the consumption of tobacco[3]. Due to this awareness, countries are asked to sign a treaty to reduce the production of tobacco and tobacco related products. The reduction in tobacco consumption in developed economies is impacting negatively on the prices of the tobacco leaf, as the industry continues to face declining prices for tobacco exports (Otanez et al.; 2009). Despite these measures, tobacco production continues to rise, partly because tobacco crops are the most profitable, earning about 20 times more than tea. In addition, world tobacco companies are shifting the production of tobacco from advanced countries to developing countries with a new and promising market where laws hindering the consumption of tobacco and tobacco related products are less strict. With the over-dependence of LIEs on tobacco production, it is unlikely that they can reduce production significantly since this can impact their economies negatively. This is the reason it is proving difficult for countries to diversify away from tobacco farming because exports with production and marketing

[3]See the World Health Organisation (WHO) Framework Convention on Tobacco Control (FCTC) for more information on the treaty that is meant to reduce tobacco production and consumption globally.

strategies indicate a highly established crop (Davies; 2003). Moreover, tobacco contributes immensely to the grower's economy and immediate crop replacement is far from being identified. Tobacco is currently grown in 125 countries in the world, with two-thirds of global tobacco production produced by Brazil, China, India, Turkey and the United States of America. Zimbabwe and Malawi are the largest producers in Africa, and Malawi is the second largest producer of Burley tobacco after the United States of America (see WHO; 2001).

The expansion and contractions of tobacco production remained a major aspect of the Malawian economy from its inception in the 1890s up to the present time (Chirwa; 2011). Between 1961 and 1963, the crop assumed a significant position in the economy, producing 15,000 tonnes annually. The annual growth of tobacco production increased such that by 1990, production of tobacco was 110,000 tonnes annually (FAO; 2003). Tobacco is Malawi's largest industry and currently accounts for nearly 80% 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 that includes subsidies and tax breaks, has led to domination of tobacco crops in Malawi's export market (Davies; 2003). Figure 1 provides the sources of foreign exchange earnings in Malawi and shows the percentage of tobacco contribution to the economy.

Figure 1: Sources of Foreign Exchange and Export Earnings by Sector



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

From Figure 1, Malawi earned approximately 50% of the foreign exchange earnings from tobacco export in 2004, and in 2010, tobacco export earnings reached over 65%. Tobacco contributed 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 the 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, followed by Zimbabwe. Tobacco nicknamed 'green gold' 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 and 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. Of the total tobacco exports, 30% comes from Flue-Cured and Virginia types of tobacco (FAO; 2003).

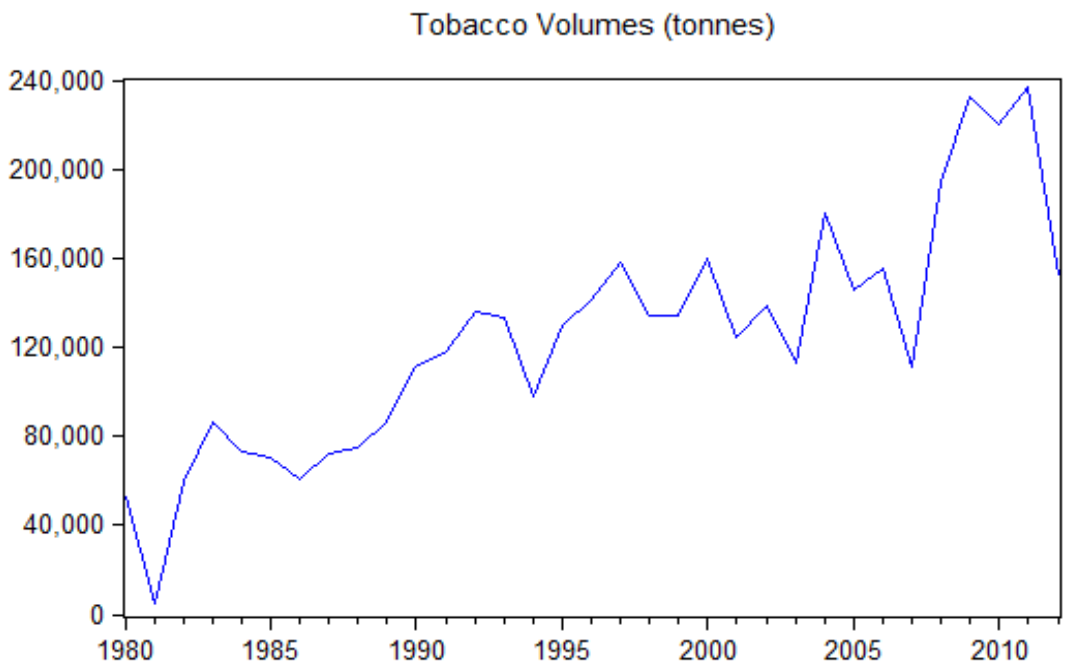
Table 1: Global Tobacco Export Earnings (million US$)

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

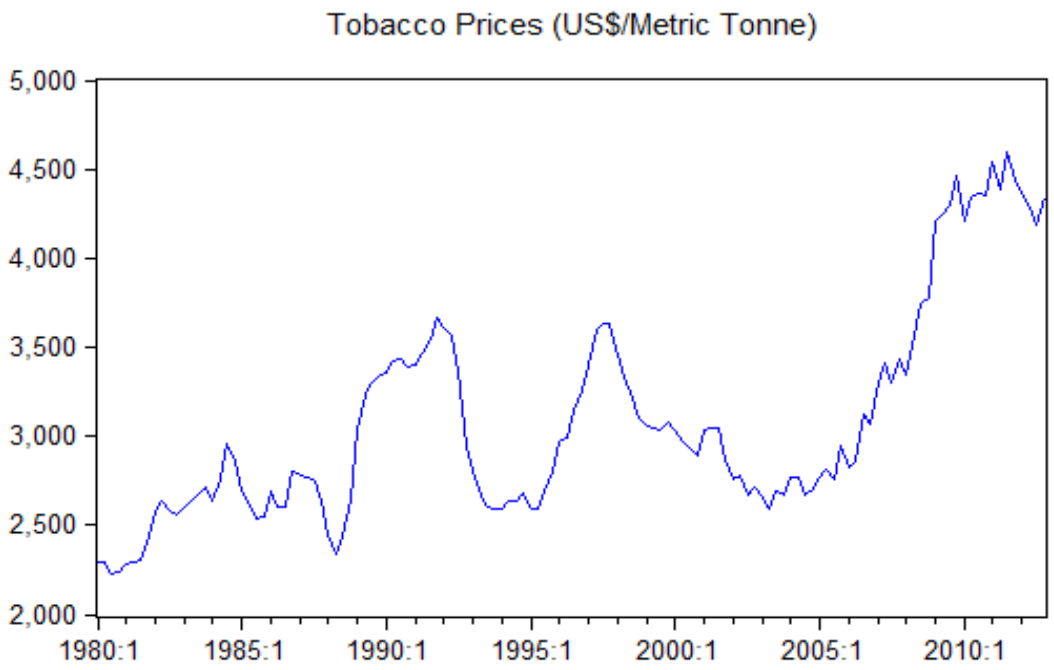
Table 1 shows that export earnings from tobacco leaf in Malawi are higher compared to top tobacco producers in the world. Despite the country being small, it has a significant production effect on the world tobacco production. Malawi is followed by Zimbabwe which also earns a large percentage of export earnings from tobacco production. The tobacco industry was intended to increase economic growth and promote development in Malawi. This has led the government to introduce laws that were meant to restrict growth of tobacco to estate farming only. Due to these laws, the tobacco crop registered a 90% increase in the early 1970s with 29,000 tonnes of total tobacco that year (FAO; 2003).

Figure 2: Trends in Tobacco Volumes in Malawi (1980-2012)



The international market prices of tobacco have declined by 50% in the past 10 years in real terms, and due mostly to campaigns against tobacco in the industrialised nations serving as 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 3). In Figure 3, tobacco production suffered lower prices in 1988 and 1995, and the period between 2003 and 2006 was marred with over production which also led to lower prices of tobacco. However, prices rose between 2007 and 2011 and thereafter declined again in 2012 leading to severe foreign exchange shortages in the country due to low tobacco foreign exchange earnings.

Figure 3: Volatility in Tobacco Prices (1980-2012)



Despite the importance that the tobacco crop commands in Malawi (as a prominent crop in the economy and social structure of Malawi) the country's role in the international tobacco market as a whole is limited, particularly due to the relative small size of the country (Jaffe; 2003). The country cannot influence the international tobacco prices and faces a dilemma because although tobacco prices are declining, the country relies heavily on tobacco export earnings. This has made the economy more vulnerable to tobacco price shocks. Tobacco price fluctuations have always put the country at a disadvantage, especially when tobacco prices are very low. This is because fluctuations in tobacco prices means fluctuations in the inflow of export earnings, and also fluctuations in the level of foreign reserves and other important macroeconomic variables. The reason for this is because almost all of the tobacco that is produced in Malawi is exported. Unlike China, where almost all of the tobacco produced is consumed domestically, the domestic market does not provide a readily available market for the tobacco produced in Malawi (Tobacco Atlas; 2014).

Facing declining prices of tobacco every year, the future of the tobacco industry in Malawi seems dark and various studies have described the tobacco industry as the 'tinted gold', the 'sinking ship' or the 'dying industry', or an industry that is 'standing on one leg' due to declining international prices of tobacco that are worsening the annual 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 2011[4] (IMF; 2012). Regardless of these dclined in tobacco prices, Malawidoes not seem to lessen the production of the commodity. Recently, production has been increasing from 168 million kilograms in 2013 to 192 million kilograms in 2014 although the average prices have been declining from $2.15/Kg in 2013 to $1.88/Kg in 2014. With the constant decline in tobacco prices, it is surprising that the Malawian government still sees tobacco as the most lucrative industry and also the most effective means of earning the much needed foreign currency for paying its loans and promoting development. As such, the government views the production of tobacco as the only vehicle for rural development by encouraging the production of tobacco as a cash crop for export.

3 Literature Review

3.1 Theoretical Framework

It is important to properly identify the model to determine the channels through which a shock propagates into the economy. Considering that output may be affected by more than one type of disturbance, imposing a priori restrictions using macroeconomic information on the variables restricts the response of output to each of the disturbances. Unlike oil where its price is mostly affected by market expectations due to its storage ability, agricultural commodities such as tobacco are perishable, and cannot be stored for a long time to influence their expected prices. Therefore, their prices are largely influenced by the average supply of the commodity. Because of this, Blanchard and Quah (1988) argued that disturbances that have a permanent effect on output are to be termed 'supply' disturbances, while those that have a temporary effect are to be termed 'demand' effects. According to Blanchard and Quah (1988), supply disturbances increase steadily, causing a slow return of variables to their original value overtime, 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. For example, using the aggregate demand (AD) and aggregate supply (AS) model, with price shocks categorized by demand and supply-side factors. Fernandez (2014) summarised 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.

Therefore, we use the AD-AS framework as described in Blanchard and Quah (1988) to identify tobacco price shocks. We assume further that tobacco price shocks are permanent in the economy and as such, they are supply shocks. Following Bjornland (2000) and Blanchard and Quah (1988) commodity prices are modelled as shocks to the aggregate supply. We assume that the aggregate demand function may shift in responses to a

[4]See the IMF presentation of 2011 on Malawi's macroeconomic environment

shock to the prices of the commodity, in instances when the shock is allowed to affect the aggregate demand directly. Another direction is when commodity price shocks are modelled as shocks to the aggregate supply function. In our model, the shock is modelled as a productivity shock as discussed in Sorensen and Whitta-Jacobsen (2010) where they argued that we can model oil price shocks as productivity shocks to the aggregate supply function. In the same line, we define tobacco price shocks as productivity shocks to the aggregate supply and it is through this mechanism that commodity price shocks affect output in the long-run. Following Cover et al. (2002), we model the tobacco price shocks as productivity shocks in the aggregate supply function using a Structural VAR model. A structural specification of the model is defined as[5]:

$$AD(y, cp, \varepsilon) \tag{1}$$

$$AS(y, cp, \theta) \tag{2}$$

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 the aggregate the supply function. We imply 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 movement along the aggregate demand function[6].

We assume that a positive productivity shock shifts the aggregate supply function outwards and 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 induces an appreciation of the real exchange rate.

This leads to the hypothesis that higher international prices of 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 of tobacco should be associated with lower output, high consumer prices and a depreciation of the real exchange rate. The productivity shock is thus referred to as the international tobacco price shock that propagates through the economy using the aggregate supply function. A negative tobacco price shock will generate the opposite of the above positive shock, that is to say, output will decline, raising the

[5] Our 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 .

[6] see Blanchard and Quah (1988) p.657 for further clarifications

domestic inflation rate and at the same time inducing a depreciation of the real exchange rate.

We identify tobacco price shocks as a shock to the aggregate supply function following Kilian (2014), Shah and Yuanyuan (2012), Rapaport (2010), Kilian and Park (2009), Elwood (2001), and Tatom (1987) . We also follow Kim and Roubini (2000) and Sims and Zha (1995) to place the contemporaneous restrictions in the model. This allow 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. In this case, we are able to restrict the responses of output to be determined by the productivity (tobacco price) shock only.

3.2 Empirical Literature

Following the oil price shocks of 1973, most macro 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) argued that there is a causation between commodity price shocks and monetary policy while Frankel; 1986, Cody and Mills; 1991 and Marquis and Cunningham; 1990 stated 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 differences in their findings, we can draw the conclusion that a key feature in most of the results is that commodity price shocks affect significantly the implementation of macroeconomic policies in developed economies, particularly that commodity price shocks determine most of macroeconomic fluctuations globally.

On the other hand, another group of researchers focused specifically on understanding the fluctuations of world prices of different 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 faced declining prices of their agricultural commodity exports. Therefore, this literature moved away 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 affect significantly the macroeconomic conditions of developing countries.

Although there is a wide range of literature in support of the view that commodity price

shocks have serious implications on macroeconomic variables in developing economies, other studies have asserted a different argument and the results remain mixed. For example, Raddatz (2007) analysed the impact of external shocks such as commodity price fluctuations, natural disasters and the role of 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 argued that the effect of external shocks on output is small in absolute terms, but significantly relevant to 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 argued that there is no evidence or 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 the country's regional affiliation and its exposure to uncertainty, except for oil producers which face greater uncertainty and therefore questioned the generalisation of the effects of commodity price shocks on the macro economy as put forward by Deaton and Miller (1996), Deaton and Miller (1995), Deaton and Laroque (1992).

In contrast, recent studies seem to support the earlier findings by Deaton and Miller (1996), Deaton and Miller (1995), Deaton and Laroque (1992) that there is a strong link between a countries experience of uncertainty, the type of commodities that the country exports and its macroeconomic fluctuations. For example, Iwayemi and Fowowe (2011) find that shocks to oil prices result in volatile macroeconomic variables in Nigeria and a rise in oil prices provide more foreign exchange earnings and lead to increased government revenue. In addition, Fernandez (2014), Mohaddes et al. (2012) and Conforti et al. (2010) recognise that energy price shocks have the worst effect on low income economies and they argued that these countries' macroeconomic conditions are worsened by fluctuations in international prices of commodities. They also argued that agricultural commodity prices have serious implications for macroeconomic variables of LIEs. Moreover, the recent studies tend to find evidence that commodity price fluctuations lead to an increase in the volatility of macroeconomic variables in LIEs. Precisely, Fernandez (2014); Conforti et al. (2010); Diao et al. (2002) have shown that countries exporting a single commodity in their export basket are the worst hit when they face declining prices of their export commodities. Other studies such as Mohaddes et al. (2012); Conforti et al. (2010); Kargbo (2007) also argue that countries that face declining commodity prices of their exports face large international debt repayments.

Despite evidence from this large empirical literature on the effects of commodity price shocks on developing economies, it is hard to generalise these results to all LIEs and brings into focus an argument for case studies. This is because these studies are based on cross country data sets of developing economies that aim at exploring the nexus be-

tween commodity price shocks and the dynamics of the macroeconomic variables but they 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). As such, some of these studies conclude that the negative growth effects of commodity terms of trade volatility may offset the positive impact of commodity booms because these studies do not exploit heterogeneity that differentiate the responses of different countries, for example, 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 the 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 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 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 is very dysfunctional. With price booms and slumps bearing serious consequences for the economy, case studies can assist to understand specific commodity price shocks and to forecast their effects adequately. This is done by moving away from the usual reliance on the production function models to explain macroeconomic models because the literature on LIEs argue that most of the commodities exported by LIEs are not factors of production for the exporters, but for importers and respond to aggregate demand and aggregate supply shocks (Senbeta; 2013). This focus makes the interpretation of the effects of commodity shocks as a sole response of output to fluctuations in inputs and using production functions to explain the effects of structural shocks on macroeconomic variables lead to misspecification errors and therefore advocated for use of structural models to better explain the effect of the shocks. Most of the empirical literature has 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 equation models (Ngalawa and Viegi; 2011). More specifically, these models are synonymous with country specific studies.

While the effects of commodity price fluctuations on low income economies has generated

mixed results, most of this gap is created with 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 to analyse the effects of international tobacco price fluctuations on the macroeconomy of Malawi. The next section describes the theoretical approach to analysing tobacco price shocks.

4 Data and Identification Issues

4.1 Data, Sources and Measurement of Variables

We employ a quarterly time series for the period 1980:1 to 2012:4. This period was chosen because of data availability issues, and it is consistent with the period when tobacco production was fully established in the economy. In addition, this period is synonymous with different macroeconomic 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). Where the series was missing, additional information was sourced from the International Financial Statistics (IFS), 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 Blanchard and Quah (1988), Kim and Roubini (2000) and Cover et al. (2002). The restrictions placed on tobacco price takes into account that the variable is contemporaneously exogenous to any variable in the model and only responds contemporaneously to its own shocks. For a country that 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 domestic tight 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.

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 such that fluctuations in tobacco prices are likely to affect output. Deaton and Miller (1993) argue that African countries grow faster when 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 studies such as 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 systematic responses of monetary policy to the economy such as inflationary shocks as a result of fluctuations in the international price of tobacco. Consumer prices operate as a policy tool for monetary authorities in response to shocks to tobacco prices. This provides an insight on the appropriate policies that dampen the shocks and minimise effects in the economy. 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 nominal exchange rate deflated by the price level[7], 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. Therefore, when the dollar weakens relative to the domestic currency, tobacco buyers will be willing to pay more dollars for tobacco, but since this leads to an appreciation of the exchange rate, it will hurt the country's competitiveness for exports. In contrast, an appreciation of the dollar depreciates the real exchange rate and makes tobacco competitive to buyers. This only 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.

All variables are expressed in natural logarithms. We employed 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 advised to further confirm the stationarity of the variable with an alternative test, and we employed the PP test on the variables. Table 2 report the results.

The stationarity test results in Table 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

[7] defined as $\frac{MK}{US\$} * \frac{P^*}{P}$ where P^* is the foreign price and P is the domestic price

Table 2: Unit Root Tests

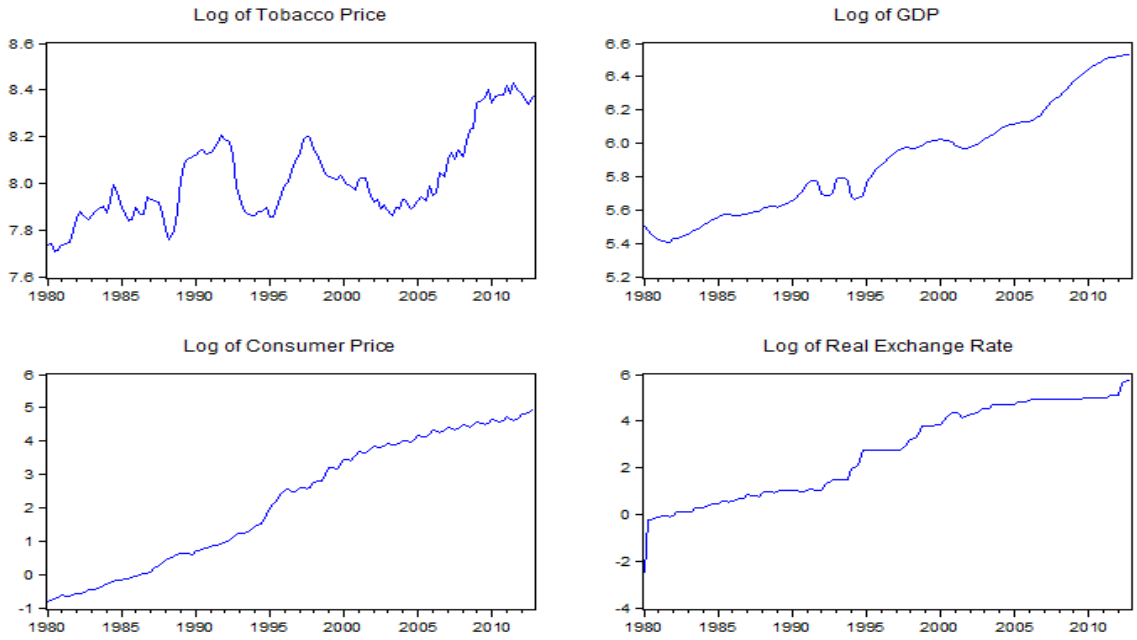
levels	LTP	LGDP	LCP	LEXR
ADF	0.399	0.977	0.824	0.137
PP	0.699	0.977	0.868	0.150
First-difference				
ADF	0.000*	0.013*	0.002*	0.000*
PP	0.000*	0.000*	0.000*	0.000*

*Note: *indicates significance at 5% level*

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).

Figure 4 provides an exploratory analysis into the movements, structure and multivariate relations between the variables.

Figure 4: Behaviour of Selected Macroeconomic Variables (1980:1-2012:4)



The graphs reveal that the three macroeconomic variables have a deterministic trend while tobacco price has a stochastic trend. The estimation of non-stationary variables in linear regressions yield spurious regressions, such that recommendations require differencing of the data to make the series stationary prior to estimation, or better still take into account of cointegration methods. We detrend the series using the Holdrick-Prescott (HP) Filter, and further subject the detrended data to a stationarity test, which reveals that all the variables are stationary. Detrending removes the time component and enables us to focus on the fluctuations in the data about the trend. This forces the mean of the data to zero, and therefore reduces variation. Studies that have advocated for detrending of the data have also argued that once the data is found non stationary and I(1), then there

is a need to proceed with the estimation of an error correction model because ignoring the existence of long-run relationships might present imprecise results. For this, Haug et al. (2005), Johansen (1988) and Davidson (1998) have argued that the vector error correction model (VECM) with cointegration analysis produces more precise and efficient parameter estimates than VAR in levels and it allows for intensive modelling, especially for long run relationships. The VECM mimics the existence of a long-run equilibrium among the time series, and this is a possible solution for non-stationarity. Although the VECM mimics properly the long-run relationships among the variables, Sims et al. (1990) argues 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 monetary policy which did not yield the desired results.

This study is interested in the relationships between the variables in the model, therefore, we 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 (1998). This is because despite the existence of a large literature that argue 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 that to impose incorrect restrictions on the model because if false restrictions are imposed, then the inferences from such a model will be incorrect. A more recent literature has 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; 1998). Bernanke and Mihov (1997)[8]demonstrate this argument by including output, price and reserves measures in their levels estimation despite the variables being non-stationary. They pointed that the interrelationships among the variables matter most than the significance of the coefficients, and the statistics of interest often have distributions that are unaffected by non-stationarity. This study aims at establishing 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 of differenced stationary data and contribute to the inconclusive debate on whether the results from SVAR of the transformed data performs 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

[8] In their study on the German Bundesbank, Bernanke and Mihov (1997) included output, price and reserve measures in their model in levels despite the variables non-stationarity because, they argued, the levels specification will yield consistent estimates whether cointegration exists or not. ...p.17 footnote, 6.

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.

4.2 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 SVAR model following a large empirical literature which has assessed the effects of various structural 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 (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 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. In the empirical literature, other studies used the dynamic stochastic general equilibrium (DSGE) models to model the firm's behaviour and how they respond to terms of trade shocks (e.g. Kose and Riezman; 2001, Mendoza; 1995). However, SVARs have also performed well in studies of 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:

$$G(L)y_t = e_t \tag{3}$$

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:

$$y_t = B(L)y_t + u_t \tag{4}$$

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:

$$G(L) = G_0 + G^0(L) \tag{5}$$

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

$$B(L) = -G^{-1}G^0(L) \tag{6}$$

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

$$\Sigma = G^{-1}\Lambda G^0(L) \tag{7}$$

We can obtain the maximum likelihood (ML) estimates of Λ 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 authors 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 and make use of relevant economic literature to place restrictions to identify the SVAR. We follow this approach because the recent literature on SVAR that also uses similar approach in SVAR argue that G_0 can be any structure as long as it possesses enough restrictions (Sims and Zha; 2006; Bernanke and Mihov; 1997)[9]. 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.

4.3 Estimation and Inferences

There is considerable literature that has advanced the modelling of commodity price shocks, and of great significance are the ground breaking specifications of modelling supply and demand shocks by Blanchard and Quah (1988). They identified that supply shocks have permanent and persistent effects on output and demand shocks have temporary

[9]For 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.

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 this growing literature, 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 by Kim and Roubini (2000) to place the 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:

$$\begin{bmatrix} e_{AS} \\ e_{AD} \\ e_{tp} \\ e_{\varepsilon} \end{bmatrix} = \begin{bmatrix} 1 & g_{12} & g_{13} & 0 \\ g_{21} & 1 & 0 & g_{24} \\ 0 & 0 & 1 & 0 \\ g_{41} & g_{42} & g_{43} & 1 \end{bmatrix} \begin{bmatrix} u_{cp} \\ u_{y} \\ u_{tp} \\ u_{\varepsilon} \end{bmatrix} \tag{8}$$

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 a large evidence that indicates that the exchange rate pass-through to inflation is not instantaneous, but varies, becoming relatively slower overtime (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 Kim and Roubini (2000) and Sims and Zha (1995) 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_o 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 effect[10]. 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).

4.3.1 Model Results

Considering the correlation between tobacco prices and the three variables in the model, Table 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 in Table 3 which is -0.098. Since a positive tobacco shock raises output as it works through the money market, money demand increases and this also raises the real exchange rate which subsequently decreases exchange rate, resulting in the appreciation of the real exchange rate. This is evidenced by a negative correlation between tobacco prices and the real exchange rate in Table 3.

Table 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*

4.3.2 Estimated Structural VAR

VAR models are sensitive to number of lags as such, 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 for the model, and 4 lags were selected as the optimal lag length where all autocorrelation can be taken care of.[11]Structural VAR model specification was used to assess the impact of tobacco

[10]Exchange-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.

[11]To 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.

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 4 reports the estimated contemporaneous structural parameters.

Table 4: Estimated Contemporaneous Structural Parameters

$$\begin{bmatrix} 1 & -3.55 & 0.20 & 0 \\ 0.34 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -0.68 & 1.09 & -0.10 & 1 \end{bmatrix} \begin{bmatrix} lcp_t \\ lgdp_t \\ ltp_t \\ lexr_t \end{bmatrix} = \begin{bmatrix} 0.06 & 0 & 0 & 0 \\ 0 & 0.19 & 0 & 0 \\ 0 & 0 & 0.03 & 0 \\ 0 & 0 & 0 & 0.07 \end{bmatrix} \begin{bmatrix} lcp_{t-1} \\ lgdp_{t-1} \\ ltp_{t-1} \\ lexr_{t-1} \end{bmatrix} + \begin{bmatrix} e_{cp} \\ e_y \\ e_{tp} \\ e_\varepsilon \end{bmatrix} \tag{9}$$

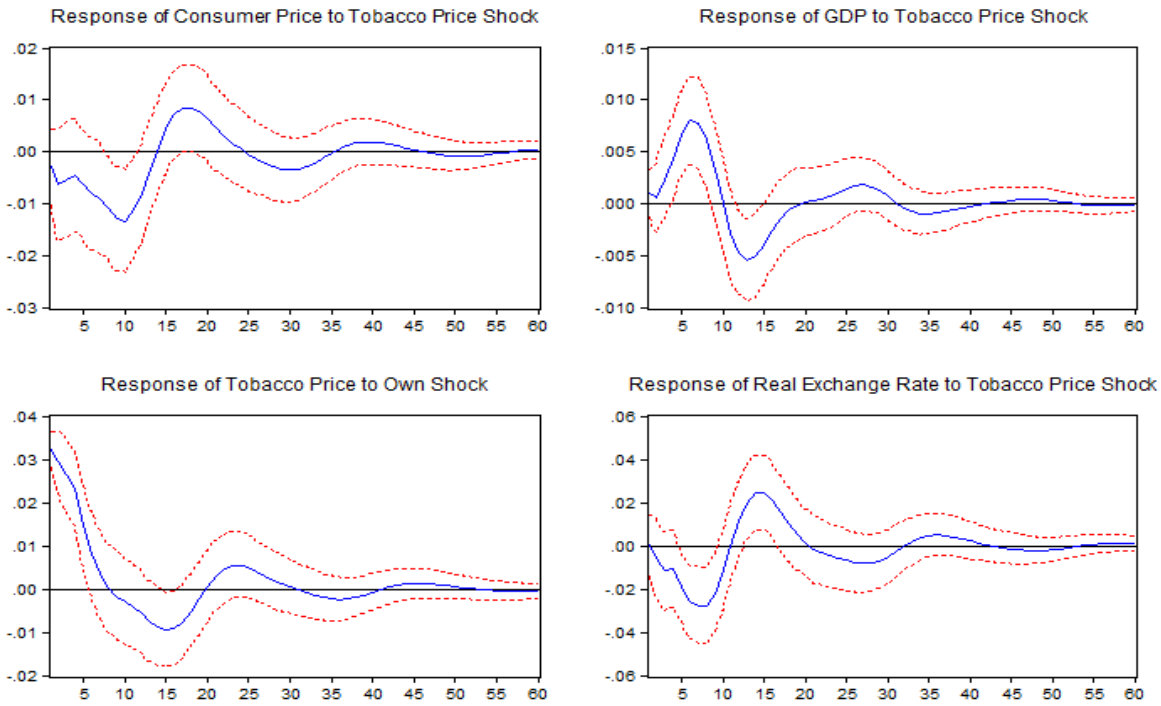
Where e_{cp}, e_y, e_{tp}, e_ε are structural disturbances of consumer prices, output, tobacco prices and real exchange rate respectively. All restrictions are on contemporaneous structural parameters, thus allowing non-zero interactions by imposing zero restrictions on contemporaneous structural parameters, and no restrictions on all the lagged structural parameters. From table 4, g_{12} is negative at -3.55 and g_{13} positive at 0.20 suggesting that the monetary authority decreases the consumer prices upon observing the unexpected increases in tobacco prices. In our model, monetary authorities seem to react to a positive tobacco price shock which acts as a positive and deflationary supply shock by taking an expansionary position when faced with deflationary pressures. From table 4, all the estimated parameters have the required signs which are consistent with standard economic theory. A decrease in consumer prices which entails a decrease in inflation tend 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 -0.68.

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 5 presents the results.

Figure 5 shows the response of the variables to a one standard deviation shock to tobacco price. The first figure indicates the response of consumer price to a percentage[12] change in 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

[12] A 1 percentage point increase indicate a move from say 2% to 3%.

Figure 5: Impulse Responses for the Estimated SVAR



by a decline in the IRF of consumer price which proceeds to decline in the following quarters. Consumer price only reaches its lowest (trough) decline in the 10th quarter at 0.12 percentage points, and thereafter persists to rise and reaches its maximum in the 19th quarter at 0.08 percentage points. Thereafter, the price proceeds to fall and then cycles before it tapers off and dies out completely in the 57th 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 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 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 lead 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 price results in an increase in GDP on impact of about 0.01 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 in the 12th quarter. The positive effect of the shock on GDP persists even after that but with a slight increase before dying out completely in the 55th quarter. Our results are expected because tobacco exports contribute about 40% to GDP, and any increase in world price of tobacco is likely to increase GDP which is consistent with the results 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 world price of tobacco depends on how important is the tobacco sector 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 argued that output can fall by more than 50% if world price of tobacco falls by about 40%. They showed that exports would fall by 66% because tobacco crop constitutes a large percentage of total exports. In the same argument, a positive change in 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 the responses of developing economies 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 10th quarter, from where it begins to fall, reaching -0.01 percentage point in the 15th quarter. Thereafter, the shock cycles in the following quarters on its way to convergence, before dying out completely in the 55th quarter. 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 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 due to high demand of 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 Cobweb-type[13] of price effect.

An increase in the tobacco price leads to a fall in real exchange rate, again generating an 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 0.028 percentage points in the 9th quarter. From the 10th quarter, the exchange rate starts depreciating reaching

[13]See Masanjala (2006) and Mitra and Boussard (2008) on a good discussion on the Cob-web model.

its maximum at 0.028 percentage points, after the shock cycles in the economy before completely dying out after the 55th quarter, indicating a long 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). Their model predicted that a decline in the tobacco price has 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, because 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 commands on the economy. As displayed in the IRFs, most of the responses to the shock persist until the 55th 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 of most 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 Blanchard and Quah (1988) discussion 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 a total effect of the shocks), it is important to assess the contribution of the shock to total variation in the variable. This is done by decomposing the total variation in the variables and singling out the resulting variation due to tobacco price shock. Table 5 provides the results.

The variance decomposition results presented in Table 5 show that tobacco price shock has a very small impact on the variations of all the three variables in the first quarters. All variables registered a zero effect in the first quarter showing that tobacco price shock causes 100% of the variations in own price. GDP only registered 5% of its total variation coming from tobacco price shock, while consumer prices registered approximately 1.453% and the real exchange rate 1.489% of the variations in the 5th quarter. The variations emanating from tobacco price shocks become larger at longer horizons with 17% of the variations in output explained by tobacco prices in the 10th quarter and thereafter, decreasing in the following quarters reaching 16% in the 30th quarter and 15.94% in the 60th quarter. The same effect applies to the other two variables with consumer prices showing a slightly higher increase in its variations than the real exchange rate from the

Table 5: Variance Decomposition

Period	LCP	LGDP	LTP	LEXR
1	0.000	0.000	100.000	0.000
5	1.453	5.062	91.996	1.489
10	6.171	17.609	70.056	6.164
15	9.926	16.601	67.473	6.000
20	10.855	16.057	66.897	6.191
25	11.071	15.831	66.781	6.317
30	11.096	16.052	66.474	6.378
35	11.356	15.974	66.248	6.422
40	11.350	15.947	66.287	6.416
45	11.395	15.943	66.225	6.437
50	11.392	15.943	66.231	6.434
55	11.410	15.941	66.209	6.440
60	11.409	15.938	66.213	6.439

10th period onward. For the period under analysis, tobacco prices explain close to 16% of the variations in output on average, indicating persistence of some sort of tobacco price shocks in explaining fluctuations in output.

While the tobacco price contributes about 5% of the variations in GDP in the 5th quarter, it contributes 1.45% of the variation in consumer price in the same quarter. The importance of tobacco prices in explaining variation in consumer price increases significantly from the 10th quarter reaching 6.2%, thereafter remained in the range of 11% until the last quarter of the period under analysis. This indicates that apart from consumer price falling in the economy in response to other macroeconomic phenomenon, tobacco price shocks explain a significant amount of the variations. This is because a large percentage of the variations in consumer prices can be attributed to other factors other than fluctuations in tobacco price in Malawi. For example, apart from import prices, consumer prices in Malawi are more responsive to factors that affect food supply and its availability. In this case, the appreciation of the real exchange rate following a tobacco price shock may cause imports to rise. Inflation may respond to such increased imports and imported inflation by rising. Therefore, we can state that the effect of tobacco prices on consumer prices though it is minimal, it is significant.

The decomposition of the variations in the real exchange rate show that while the exchange rate is affected by changes in tobacco price, the importance of tobacco price shock in explaining the variations in exchange rates is slightly lower than the importance of the shock when explaining variations in consumer prices. Decomposing the fluctuations in the real exchange rate indicates that tobacco prices contribute 1.5% (indicating a 1.5% appreciation of exchange rate) to the total variations (total appreciation in exchange rate) in the 5th quarter. The importance of the tobacco price in explaining fluctuations in the exchange rate increases in longer horizons, reaching 6% of the total variation in exchange rate in the 10th quarter. Thereafter, the effect continues to rise, although slowly,

hovering between 6.1% and 6.4% from 11th quarter until the 60th quarter, indicating that the importance of the tobacco price when determining the fluctuations in exchange rate is significant. Our results are also consistent with the results by Diao et al. (2002), although due to the same reasons provided earlier on, the results were the opposite of those reached by Diao et al. (2002). We expected this result because the correlation between tobacco price and exchange rate indicated 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, which in response to the level of the money demand, interest rates rise. This induces an appreciation of the real exchange rate in the process, confirming 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 indicate that all the variables estimated in the model have the 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 provide the results. The results indicate that no root lies outside the unit circle, therefore the VAR satisfies the stability condition.

4.4 Robustness Checks

4.4.1 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. There is an inconclusive debate on whether the SVAR in differenced data is the most appropriate. Engle and Granger (1987) emphasize taking first differences in a VAR analysis prior to estimation so that estimations be carried out on stationary data. We run a SVAR on the differenced data to compare the results with the earlier mode (SVAR in levels). The results are presented in Appendix, soon after this chapter.

Our results show that a positive shock to tobacco price leads to a decline in consumer prices soon after the impact, reaching 0.039 percentage points, but continues to fall all the way to 0.006 percentage points in the 5th quarter, before rising and tapers off. The impulse response of consumer prices converge completely in the 60th quarter. Tobacco price increased by about 0.03% percentage points 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 appreciate on impact of a positive shock to tobacco price and continues

so in the following quarters, before depreciating in the 10th quarter. After 11th quarter, the real exchange rate tapers off before dying out completely in the 40th quarter.

Therefore, the IRFs indicate that the model produces the same effect of tobacco price shocks on the variables in the differenced data as that in the SVAR in levels. A positive shock to tobacco price increases output on impact, 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 tobacco price shock dies out in the economy after the 45th quarter, especially in GDP, tobacco price and the real exchange rate while the effect on consumer prices takes more time to completely die out, as compared to all other variables in the model. 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.

4.4.2 Cointegrating Vector Autoregressive (CVAR) Model

We also estimate a CVAR upon confirming that their is a long-run relationship of order 1 (r=1) among the variables using the Johansen Cointegration test. There is a large literature that argue that we should not ignore the long-run relationship among the variables (Haug et al.; 2005, Johansen; 1988 and Davidson; 1998). Taking into account the long-run relationship, the estimated 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. 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 shock to tobacco price in 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 compared to the equilibrium relationship with the other variables. As a result, tobacco leaf price would fall to be in equilibrium. The model yields a low adjustment coefficient of 27% which indicate that if there is a disequilibrium in the model caused by the shock to tobacco price, then the speed of adjustment to equilibrium to correct this disequilibrium is 27%, which is very low. We confirm the arguments by Blanchard and Quah (1988) that supply shocks take a very long time to disappear in the economy as 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 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 be 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, but the dynamics and the directions of the variables show the same variability, with a slight difference in the magnitudes 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 shock to tobacco price, indicate the same results as in the previous analysis by SVAR. Results are presented in the immediate Appendix.

5 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 does 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 exchange rate using quarterly data for Malawi. The main empirical results of this chapter are the following: at a country level, export price 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 aspects for both aggregate demand and aggregate supply. Therefore, we conclude that fluctuations in the tobacco price lead to fluctuations in key macroeconomic variables and a positive shock to tobacco price tends to increase output in the economy on impact, 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 price, the consumer price falls in the first 14 quarters and then it cycles and almost converging in the 55th quarter. Exchange rate declines (appreciates) in the period under analysis as a response to a positive tobacco price shock, before dying out completely in the 56th 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 was three decades ago. This implies that a decline or an increase in the international tobacco price has serious implications on macroeconomic variables in the country. In this case, a shock to the tobacco price tends to stay long in the economy as it takes many periods, usually more than 5 years to die out completely in the economy. Our results are in line with the theory of aggregate demand

and aggregate supply made in section 3 before, since supply shocks are said to have a lasting effect in the economy and they are mostly permanent, and fluctuations in output, inflationa dn the real exchange rate are a commodity price phenomena.

We also find that the forecast variance decomposition indicate that the tobacco price shock causes significant variations in GDP, with the exchange rate and inflation having almost the same proportions of variations coming from 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 contributes a sizeable amount to GDP, say 10%, have serious implications on the economic conditions of the country when their price fluctuates (Diao et al.; 2002; Deaton; 1999; Mendoza; 1995). That is to say, commodity concentration of exports has an amplifying or a mitigating effect depending on the economy and the nature of the shock. We confirm evidence from earlier studies on commodity price shocks that a change in the composition of the shock helps explain the resilience of the macroeconomic environment to price surges.

Therefore, it is important that the country intensifies the diversification programs that have 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 its export base.

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Appendix

A.1 AR Roots Graph and Table

Figure A.1: AR Roots Table

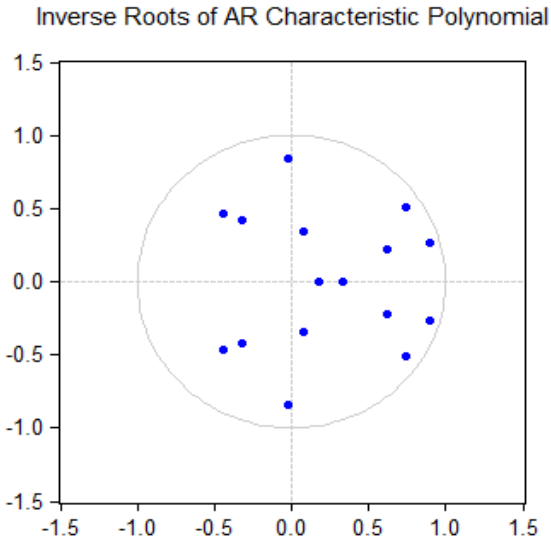


Table 1: Roots of Characteristic Polynomial for the SVAR

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

No root lies outside the unit circle; VAR satisfies the stability condition

A.2 Robustness Check

A.2.1 Impulse Response Functions for the Differenced SVAR

Figure A.2: Differenced Data SVAR

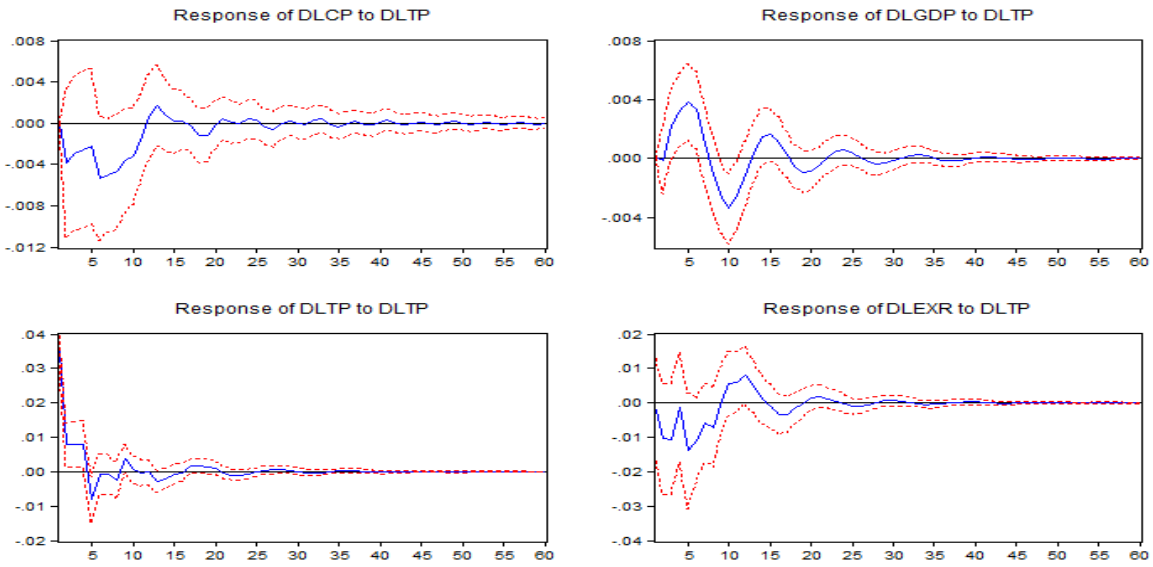
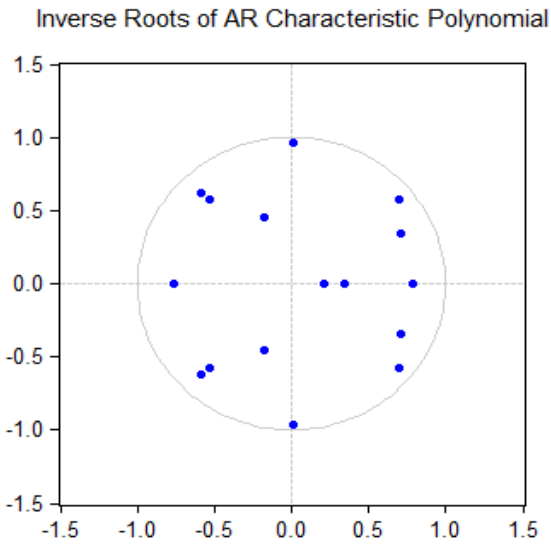
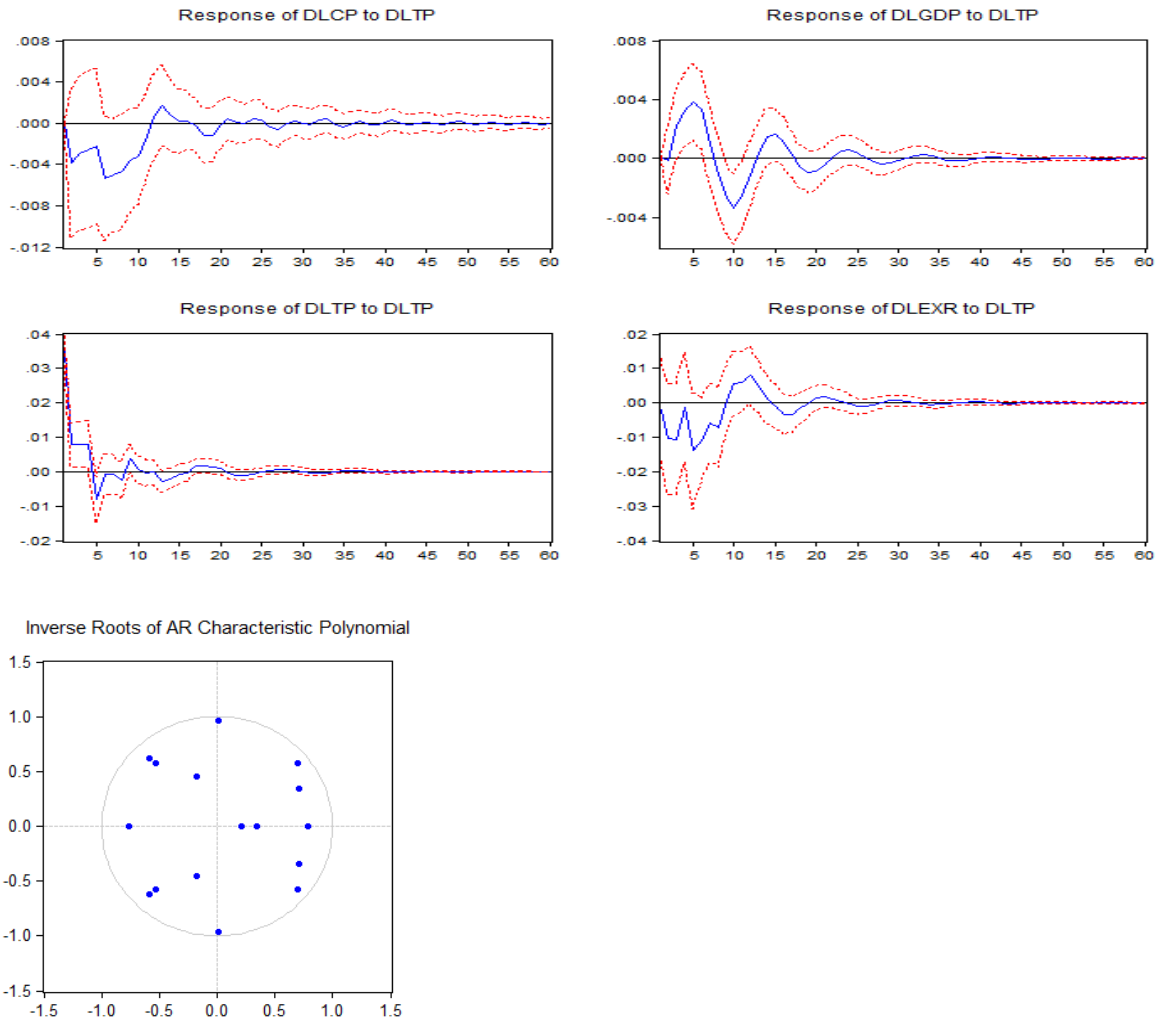


Figure A.3: AR Roots Differenced Data SVAR



No root lies outside the unit circle: VAR satisfies the stability condition

Figure A.4: SVAR on Differenced Data



A.2.2 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 established 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 cointegration[14] to determine if a long-run relationship exists among the variables. Table A2 presents the results.

[14] Cointegration 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 Johansen Likelihood Ratio (LR) test (Johansen; 1995).

Table 2: 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, entailing that there is a long-run relationship that exists between the variables under analysis. The

results of the normalized long-run equation are provided:

$$ltp = -1.11(0.11)lgdp - 0.24(0.07)lcp + 0.36(0.06)lexr \tag{A.1}$$

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

Table 3: The Just-identified Long-run Cointegration Relation for r =1

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

Note:t-values in brackets

Estimating the co-integrating VAR yields all the expected results just like 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 long-run dynamics of consumer price which may rise after a certain period of time has elapsed. It can be seen from Table A3 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 tobacco leaf price was too high compared to the equilibrium relationship with the other variables. Therefore, 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 tobacco prices, then the speed of adjustment to equilibrium to correct this disequilibrium is 27% which is very low. This confirms the arguments by Blanchard and Quah (1988) that supply shocks take a very long time to disappear in the economy as 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 Malawi Kwacha in recent years, which has put a lot of pressure on food prices during the dry season. However, the central bank does not target inflation but formulate 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: The Over-identified Long-run Cointegration Relation for r =1

	LTP	LGDP	LCP	LEXR
β	1	-1.269	0	0.153
		(-10.832)	NA	(8.262)
	ΔLTP	**ΔLGDP**	**ΔLCP**	**ΔLRER**
α	-0.261	0.008	0.023	-0.185
	(-4.681)	(0.443)	(0.364)	(-1.171)

Note:t-values in brackets

The likelihood ratio (LR) test statistic of 8.802 and a p-value of 0.003 indicates that the restriction imposed is not rejected and support 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 attribute the exchange rate and inflation effects to be a commodity price phenomenon, thereby concurring with the ideas put forward by **?**, Conforti et al. (2010) and Diao et al. (2002).

Therefore we can conclude that the results in the CVAR provide the similar results to

those in the SVAR and unrestricted VAR 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, assessing the impulse responses of output, consumer prices and real exchange rate in response to a shock to tobacco prices indicate the same results as in the previous analysis by SVAR, thus, a positive tobacco price shock increases output, lowers inflation and appreciates the real exchange rate. Figure A4 report the results.

A.2.3 Impulse Response Functions for the Cointegrating VAR (CVAR)

Figure A.5: Cointegrating VAR

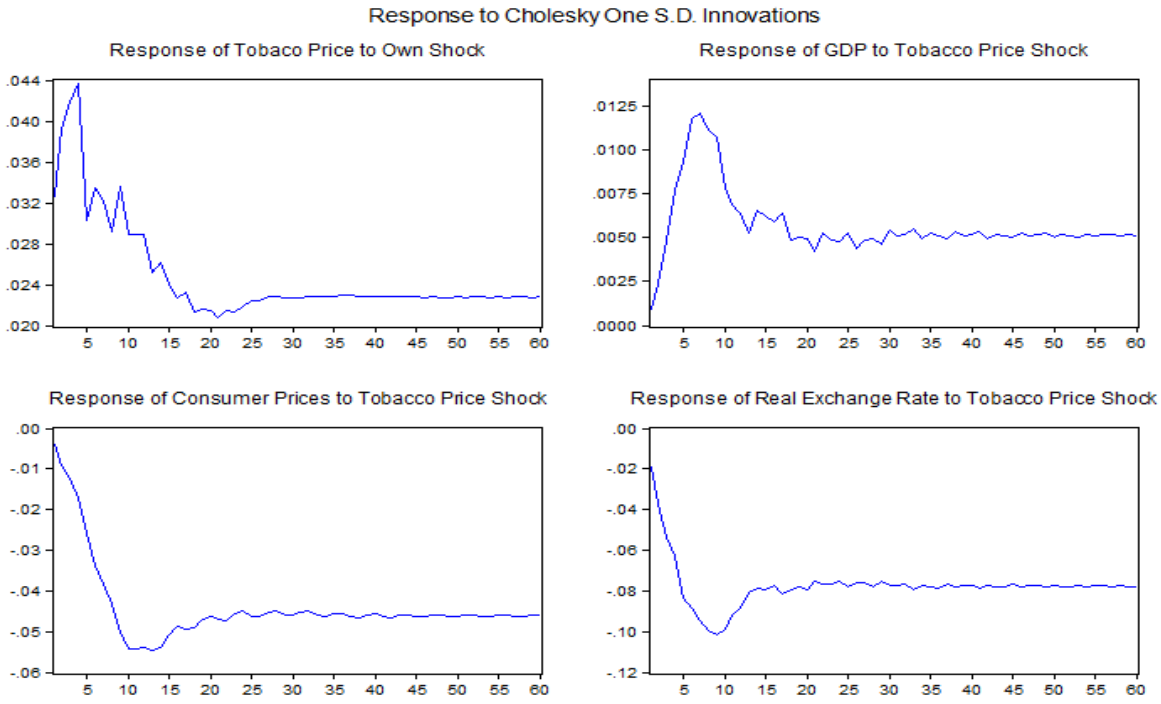


Figure A.6: AR Roots for Cointegrating VAR