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MACROECONOMIC EFFECTS OF COMMODITY PRICE SHOCKS IN A LOW-INCOME ECONOMY: THE CASE OF TOBACCO IN MALAWI

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Abstract
A major concern for developing economies is a dependence on commodities when their prices are volatile as a major change in the international commodity price can have important implications for 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 autoregression (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, decreasing consumer prices and inducing real exchange rate appreciation. The results are robust to alternative specifications of a SVAR on difference stationary data and cointegrating VAR. The cointegrating VAR confirms the existence of a long run-relationship among the variables and causality that runs from tobacco prices.
JEL Classification: E3, F18, F31, F35
Keywords: Tobacco, commodity price shocks, low-income economies, SVAR

1. INTRODUCTION

There has been considerable debate over the implications of developing countries' dependence on commodity exports for growth (Diao *et al.*, 2002). Little attention has been paid to the effects of commodity price shocks and their dynamics in developing economies which is surprising given that that low-income economies (LIEs) may be prone to instability in international commodity prices due to an over-dependence on commodity exports. This is true in mono-crop export countries, which typifies most low income Sub-Saharan African (SSA) economies (Addison and Ghoshray, 2013). A large empirical literature that argues that commodity exporters face a decline over time in the relative prices of their products, with the resource curse literature depicting a negative relationship between a country's resource wealth and dependence and their economic growth (Sachs and Warner, 1999, 2001), and the "Dutch disease" literature showing how the resource sector can drive up the value of the local currency, damaging the competitiveness of manufacturing exports

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(Adam and Bevan, 2003; Fielding and Gibson, 2012; Linklater, 2013). These findings suggest that commodity price shocks might 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 1973–1974 and 1979–1980 were visible events that preceded the turmoil in various markets in both developed and developing economies, with 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 Organisation of Petroleum Exporting Countries (OPEC) members' disagreements and the Iraqi invasion of Kuwait led to collapses in the price of oil and economic recession, which was preceded by a 9% reduction in world oil production due to uncertainty in the oil markets (Hamilton, 2005, 2009; Kilian, 2005; Kilian and Park, 2009).

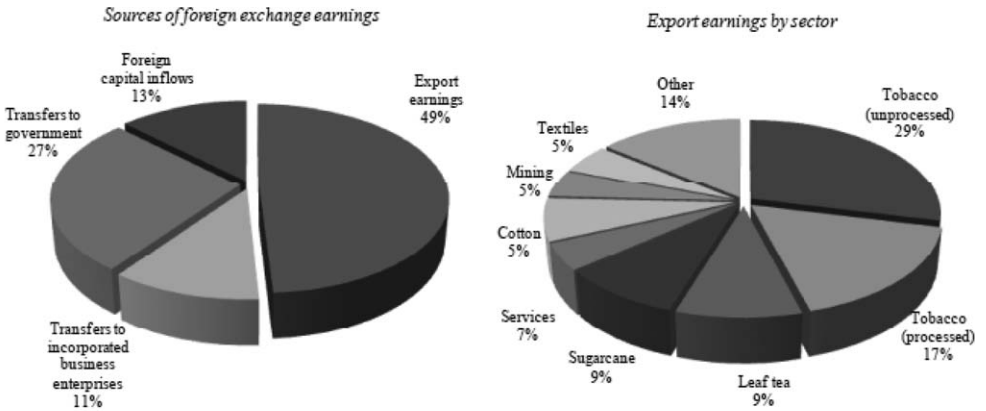
Most of the existing literature on commodity price shocks focuses on the effects of commodity prices when explaining business cycles of high-income economies (Hamilton, 2005, 2009; Kilian, 2005; Kilian and Park, 2009; Iwayemi and Fowowe, 2011). Those studies that do focus on developing economies are based on cross country datasets, especially on resource curse and Dutch disease issues. Despite the fact that cross country studies fail to address problems of heterogeneity within and between countries, there are only a few case studies of small open economies (Sachs and Warner, 1999, 2001). There is a clear need to incorporate the characteristics of LIEs in macroeconomic models to forecast properly the effects of commodity price fluctuations. Factors such as the structure of the economy, the effectiveness of the domestic policy-making process and the ease in handling price fluctuations have a greater impact on the responses of macroeconomic variables to price shocks and need to be taken into account (Deaton and Miller, 1996; Kose and Riezman, 2001).

This paper contributes to the literature by providing a case study of a developing economy and LIE of Malawi and investigating the interaction of positive tobacco price shocks with selected macroeconomic variables and determining their effects on the economy. This entails the identification of selected policy options that channel the effects of tobacco price shocks in the economy.

The remainder of the paper is organised as follows: Section 2 briefly 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 3 reviews the empirical literature on commodity price shocks, followed by a discussion of the chosen theoretical model. The 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

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 prioritise 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 (FAO, 2003a,b). In the 1970s, the international tobacco manufacturing companies identified Malawi as a possible ally in the fight



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

Figure 1. Sources of foreign exchange and export earnings by sector

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).

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 (FAO, 2003b). The Farmers Market Board which was later named the ADMARC was formed to fix domestic prices in relation to fluctuating global prices. In addition, the Special Crops Act (1964) prevented smallholder farmers from cultivating 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). The Act, together with a system of production quotas served to restrict production and as a primary means of allocating opportunities and distributing income and wealth in the country (FAO, 2003a,b). This has made tobacco difficult to replace as a crop and its importance cannot be over-emphasised in the current economic conditions as it remains the country's main cash crop (FAO, 2003b).

As shown in Fig. 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 gross domestic product (GDP), followed by tea, sugar and cotton, which, when combined, contribute about 20% of the nation's exports (Davies, 2003). 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).

The country faces a dilemma because, while tobacco prices are declining, Malawi relies heavily on tobacco export earnings, making it more vulnerable to external shocks. 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).

3. MODELLING SHOCKS

In considering economic shocks, the existing literature distinguishes disturbances that have a permanent effect on output as "supply" disturbances, while those that have a

temporary effect are termed "demand" effects, with Blanchard and Quah (1988) arguing 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 approach has been adopted empirically by Kilian (2014), Shah and Yuanyuan (2012), Kilian and Park (2009) and Tatom (1987) among others. Ball and Mankiw (1992) proposed 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. Since it is more controversial to define determinants of changes of inflation in the short-run, this study walks in the footsteps of many 1970s economists who emphasised the role of "supply" or "price" shocks (see Ball and Mankiw, 1992). More recently, Fernandez (2014) used an aggregate demand (AD) and aggregate supply (AS) model, with price shocks categorised 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.

Following Fernandez (2014) this paper uses the AD-AS framework to identify tobacco price shocks. We assume that tobacco price shocks are short term effects and model commodity prices as productivity shocks to AS. We assume that the AS function may shift in response to a shock in the prices of the commodity, where the shock is allowed to affect the AS directly. It is through this mechanism that commodity price shocks affect output. Using a Structural vector autoregression (SVAR) model, a structural specification of the model is defined as[1]

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

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

where AD is the aggregate demand function and AS is the aggregate supply function and y is the real GDP, cp is consumer prices, θ is productivity and ε is the real exchange rate. Equation (1) states that AD is a function of output, consumer prices, and the real exchange rate. Note that productivity here is only allowed to affect AS.[2] Consumer prices react to a positive productivity shock by declining and a positive productivity shock that increases output increases the level of money supply in the economy raises interest rates and so 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). The productivity shock is thus referred to as the international tobacco price shock impacting on the AS function which follows Kilian (2014), Shah and Yuanyuan (2012), Kilian and Park (2009), and Tatom (1987).

[1] 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.

[2] This implies that when $\theta > 0$; a higher level of productivity may imply higher AS and therefore a shift on the AS function to the right and a downward move along the AD functionsee Blanchard and Quah (1988:657) for further clarifications

We also follow Kim and Roubini (2000) and Sims and Zha (1995) in imposing contemporaneous restrictions in the model. This allows shocks to AD and shocks to AS to be distinguished by modelling structural contemporaneous restrictions across the different equations, rather than as a recursive model. In addition, Belke *et al.* (2010), Lunieski (2009), Bernanke *et al.* (1997) argue that there is causation between commodity price shocks and monetary policy, while Frankel (1986), Cody and Mills (1991) and Marquis and Cunningham (1990) argue 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 differences in their findings, a key feature is how that commodity price shocks determine most macroeconomic fluctuations globally.

While there has been a growth in evidence in the empirical literature on the effects of commodity price shocks on developing economies, it is hard to generalise these results to all countries. 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 Miller, 1995; Dehn, 2000; Diao *et al.*, 2002; Deaton and Laroque, 2003). In addition, there are difficulties in handling commodity price fluctuations in LIEs and policy making in these countries is often dysfunctional (Katrak, 1973; Deaton, 1999). With price booms and slumps having serious consequences for the economy, case studies can assist us in understanding specific commodity price shocks and forecast their effects adequately. In LIEs most of the commodities exported are not factors of production for exporters, but for importers, and respond to AD and AS shocks. Interpretating of the effects of commodity shocks as the sole response of output to fluctuations in inputs can lead to misspecification errors, and so researchers advocate the use of structural models to better explain the effect of the shocks. Most of the investigations in the empirical literature have used VAR 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).

4. DATA AND IDENTIFICATION ISSUES

We analyse quarterly time series for Malawi for the period 1980:1 to 2012:4. This period was chosen because of the availability of data, and 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 International Monetary Fund (IMF) and the World Bank that were meant to stabilise the economy. The data was sourced from the Reserve Bank of Malawi (RBM).[3] Where series were missing, as with 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

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

Table 1. Unit root tests

Levels	LTP	LGDP	LCP	LRER
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*

*Indicates significance at 5% level.

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 AS 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, as in Kim and Roubini (2000). Tobacco price enters the model as an AS productivity shock represented by θ in the theoretical specification.

GDP_t (y_t), defined as real GDP, is measured as the country's GDP at 2005 constant prices. The variable is included to indicate the response of output from tobacco price shocks (AS shocks). Tobacco contributes a large proportion to GDP and thus fluctuations in tobacco prices are likely to affect output. Deaton and Miller (1993) argue 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.

Following Awokuse and Yang (2003), Bernanke *et al.* (1997), Cody and Mills (1991) and Furlong and Ingenito (1996), consumer prices (CP_t) are introduced using Malawi All Items National Composite Consumer Price Index with base year 2005. Consumer prices capture the response of inflation to tobacco price changes, with low tobacco leaf prices generating low foreign exchange revenue and low foreign reserves. As 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.

Finally, the real exchange rate (RER_t) is measured as the nominal exchange rate deflated by the price level,[4] 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. Following Kim and Roubini (2000) the exchange rate is defined 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. Since this leads to an appreciation of the exchange rate, it will hurt the country's competitiveness in terms of exports, but an appreciation of the dollar depreciates the real exchange rate and makes tobacco more competitive to buyers. This means that tobacco price shocks have important implications for the real exchange rate, particularly since tobacco revenue comprises about 65% of the country's export earnings and tobacco comprises 70% of the total exports for Malawi.

[4] Defined as $\frac{MK}{US\$} \times \frac{P^*}{P}$ where P^* is the foreign price and P is the domestic price.

All variables are expressed in natural logarithms and Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods were used to test the unit root properties of the variables and to determine their stationarity.[5]

The stationarity test results shown in Table 1 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).

This study is interested in the relationships between the variables in the model. We therefore proceed with the estimation of a SVAR in levels consistent with standard practice, as in Ngalawa and Viegi (2011) and Bernanke and Mihov (1998). 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.[6] More recent studies have therefore adopted the estimation of SVAR in levels (see *e.g.* Bernanke and Mihov, 1998; Dungey and Pagan, 2000; Ngalawa and Viegi, 2011). Bernanke and Mihov (1997)[7] include 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. Given these findings, this tsudy will consider SVAR in levels, but also using stationary data and stationary differenced data as robustness checks. it will also 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.

Following the empirical literature on the effects of various shocks on macroeconomic variables in both developed and developing economies including Akinleye and Ekpo (2013), Davis (2012), Ngalawa and Viegi (2011), Bjornland (2000), Cody and Mills (1991), Blanchard and Quah (1988), we specify a SVAR model that has a common feature in all studies of the dynamics of commodity price shocks[8] and we assume that the economy is described by a structural form equation:

[5] 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.

[6] 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.

[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.

[8] This is also 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 models to model firms' response to terms of trade shocks (*e.g.* Mendoza, 1995; Kose and Riezman, 2001). 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 (Bjornland, 2000; Ngalawa and Viegi, 2011).

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

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 studies have adopted other approaches to identifying restrictions (see Sims, 1986; Sims and Zha, 1995; Bernanke and Mihov, 1997; Mountford and Uhlig, 2009). 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

(Bernanke and Mihov, 1997; Sims and Zha, 2006).[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.

5. ESTIMATION AND INFERENCES

In the model, we include four variables given by the data vector (TP, GDP, CP, RER) 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 RER 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 equation (7), where $e_t = G_0 u_t$. Assuming that we have:

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

where the structural disturbances e_{AS}, e_{AD}, e_{tp}, e_{ε} are AS shocks, AD 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 AS 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 the exchange rate feeds through to domestic consumer price, there is evidence to suggest that exchange rate pass-through to inflation is not instantaneous, but varies, becoming slower over time (Goldberg and Knetter, 1996; Kim and Roubini, 2000), so we make the assumption that the AS 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 AS feedback is based on information delays that do not allow output to respond within the same period.[10]

Similarly, shocks to AD are assumed to affect the level of prices and the exchange rate, while determining output. At the same time, AD 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.[11] 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).

[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.

[10] 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.

[11] Exchange-rate pass-through is the percentage change, in local currency, of import prices resulting from a 1% 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.

Table 2. Correlation coefficients

	LTP	LGDP	LCP	LRER
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.

5.1 Model Results

As Table 2 illustrates, 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, suggesting an outward shift (increase) of the AS function. This downward movement along the AD curve will eventually bring inflation down, leading to a fall in consumer prices as indicated by the negative correlation between tobacco prices and consumer prices (see Bjornland, 2000). 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 the negative correlation between tobacco prices and the real exchange rate.

Moving to the VAR models, lag selection criteria and lag exclusion tests were carried out and four lags were selected as the optimal lag length, which takes care of all autocorrelation.[12] Equation (9) reports the estimated contemporaneous structural parameters.

$$\begin{bmatrix} 1 & -4.61 & 0.35 & 0 \\ 0.47 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -1.02 & 0.44 & 0.17 & 1 \end{bmatrix} \begin{bmatrix} lcp_t \\ lgdp_t \\ ltp_t \\ lexr_t \end{bmatrix} = \begin{bmatrix} 0.07 & 0 & 0 & 0 \\ 0 & 0.02 & 0 & 0 \\ 0 & 0 & 0.03 & 0 \\ 0 & 0 & 0 & 0.08 \end{bmatrix} \begin{bmatrix} lcp_{t-1} \\ lgdp_{t-1} \\ ltp_{t-1} \\ lexr_{t-1} \end{bmatrix} + \begin{bmatrix} e_{cp} \\ e_y \\ e_{tp} \\ e_\varepsilon \end{bmatrix} \tag{9}$$

Where e_{cp}, e_y, e_{tp}, e_ε are structural disturbances of consumer prices, output, tobacco prices and the real exchange rate, respectively. lcp_t, $lgdp_t$, ltp_t, $lexr_t$ are the log of consumer prices, GDP, tobacco prices and the real exchange rate while lcp_{t-1}, $lgdp_{t-1}$, ltp_{t-1}, $lexr_{t-1}$ are their lagged values. All restrictions are placed on contemporaneous structural parameters. This allows for non-zero interactions by imposing zero restrictions on

[12] To determine the appropriate lag length, lag order selection criteria was employed and LR, Final Prediction Error (FPE), AIC and Hannan–Quinn information criteria (HQ) tests selected four lags while the Schwarz Criteria (SC) selected one lag. Using the FPE test, four lags were selected as appropriate for the model. Results can be provided upon request.

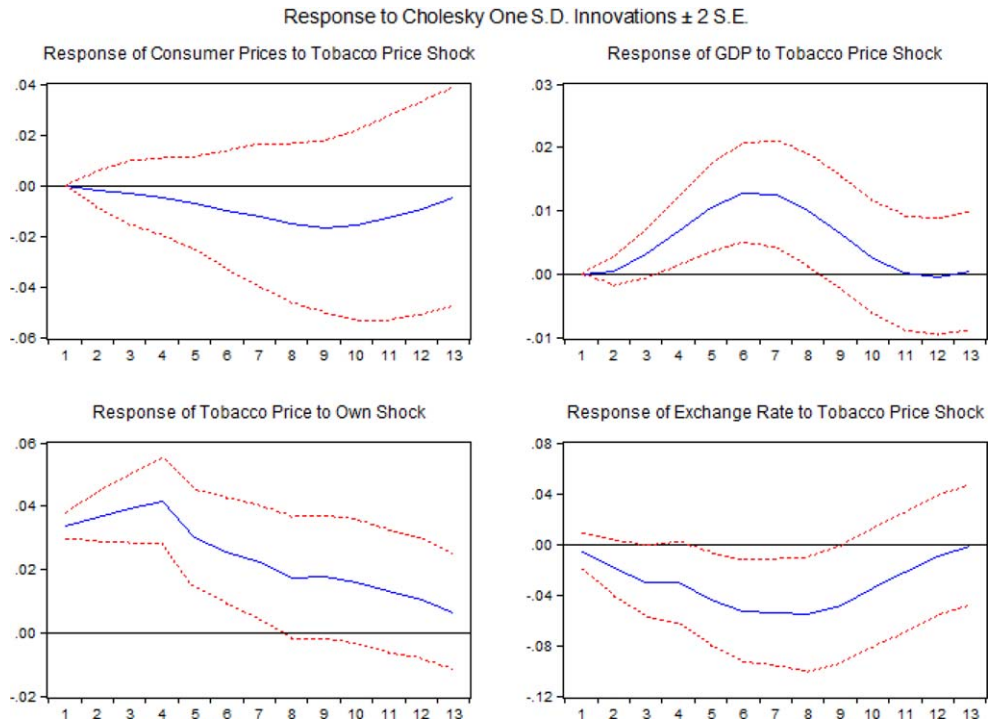


Figure 2. Impulse responses for the estimated structural vector autoregressive model [Colour figure can be viewed at wileyonlinelibrary.com]

contemporaneous structural parameters, and no restrictions on all the lagged structural parameters. From equation (9), 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, the 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 equation (9), all the estimated parameters have the required signs consistent with standard economic theory, with a decrease in consumer prices meaning a decrease in inflation, tending to affect the exchange rate negatively by appreciating the real exchange rate. 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 (IRFs) from the estimated structural VAR model.[13] Fig. 2 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 percentage[14] 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.

[13] IRFs display the effects of a shock on the adjustment path of the variables.
[14] A 1% point increase indicates a move from say 2% to 3%.

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 then declines in the following quarters. Consumer price only reaches its trough in the ninth quarter, at 0.018% points, and thereafter continues to rise, and reaches 0.001% points, and thereafter, the effect on the price dies out completely in the thirteenth quarter. Clearly, a positive tobacco price shock has a negative but insignificant 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). This is because the consumer price level falls as tobacco price rises, leading to a decline in inflation, but the response of consumer prices is insignificant because consumer prices in Malawi react to both import and food prices. When there is abundance of maize in the country, consumer prices and so inflation, seem to ease down because Malawi is import dependent and significantly poor. The inflation basket is heavily determined by the food prices. In this case, the channel for propagation of tobacco prices is that 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, which results in an increase in GDP after the first quarter to about 0.001% point, rising to reach its maximum in the seventh quarter, at 0.08% points. Thereafter, GDP starts to fall soon after the seventh quarter and reaches the original level of impact and dies out completely by the twelfth quarter. The positive effect is 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) but the opposite rises.[15] Similarly, a positive change in the world tobacco price increases output by increasing exports and AD, so 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 IRF of the second figure in the second row shows that tobacco price reacts to an own positive shock by rising significantly to 0.035% points on impact. The positive effect of tobacco price persists until the fourth quarter, from where it begins to fall, reaching 0.001% points in the thirteenth quarter. Thereafter, the shock converges. The effect on tobacco is, therefore as 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 and 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

[15] 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.

Table 3. 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 next period because of high demand for tobacco leaf. Our results conform to the Cobweb-type price responses of most agricultural commodities, and tobacco in particular, as indicated by Mitra and Boussard (2008) and Masanjala (2006). 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 in the fourth panel 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% points in the eighth quarter. From the ninth quarter, the exchange rate starts depreciating, reaching its maximum and completely dying out after the twelfth quarter, indicating a short run appreciation of the exchange rate after a tobacco price shock.[16] 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 Malawi economy. As displayed in the IRFs, most of the responses to the shock persist until the thirteenth quarter, in the period chosen for the analysis. This positive tobacco price effect is consistent with that identified in much of the commodity shocks literature (see *e.g.* Williams *et al.*, 1999; Diao *et al.*, 2002; Deaton and Laroque, 2003; Williams and Wright, 2005) and confirm that supply shocks are more persistent in the Malawian economy than demand shocks, as evidenced by the smooth representations of the IRFs which do not show extremely large peaks and troughs and persistence.

While the IRFs indicate the responses of the variables to a one standard deviation shock, 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 3 shows that tobacco price shocks to have a small

[16] 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.

impact on the variations of all three variables in the first quarters with tobacco price shocks causing 97% of the variations in own price, but GDP only registering 1.98% of its total variation 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 fifth quarter, and thereafter increasing in the following quarters, reaching 36% in the eighth quarter and 40.6% in the thirteenth quarter. The same effect applies to the other two variables, with consumer prices showing a slightly higher increase in variations in the fifth 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. While tobacco prices contribute about 18% of the variations in GDP in the fifth 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 ninth quarter.

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 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.

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 lower than the importance of tobacco price shocks in explaining variations in consumer prices explaining 1.1% (indicating a 1.1% appreciation of the exchange rate) of the total variations (total appreciation in exchange rate) in the fifth quarter increasing to reach 2.8% of the total variation in the exchange rate in the eighth quarter indicating that the importance of the tobacco price when determining the fluctuations in exchange rate.[17] This was expected given the negative correlation between tobacco price and the exchange rate. 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 LIEs (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 IRFs. The stability results provided in the Appendix indicate that all the variables estimated in the model have their roots inside the unit circle, there is no serial correlation and all the standard errors are homoscedastic and normally distributed. Table A1 and Fig. 1 in the Appendix provide the results.

[17] 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).

While the levels estimation produces the desired results, to provide useful robustness checks, we estimated a differenced stationary structural VAR model on the differenced data and the graphs are presented in the Appendix with some of the results are presented in equation (10).

$$\begin{bmatrix} 1 & -1.36 & 0.14 & 0 \\ 0.11 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -0.95 & 1.05 & 0.09 & 1 \end{bmatrix} \begin{bmatrix} dlcp_t \\ dlgdp_t \\ dltp_t \\ dlexr_t \end{bmatrix} = \begin{bmatrix} 0.03 & 0 & 0 & 0 \\ 0 & 0.01 & 0 & 0 \\ 0 & 0 & 0.04 & 0 \\ 0 & 0 & 0 & 0.08 \end{bmatrix} \begin{bmatrix} dlcp_{t-1} \\ dlgdp_{t-1} \\ dltp_{t-1} \\ dlexr_{t-1} \end{bmatrix} + \begin{bmatrix} e_{cp} \\ e_y \\ e_{tp} \\ e_\varepsilon \end{bmatrix} \tag{10}$$

These show that a positive shock to the tobacco price leads to a decline in consumer prices soon after the impact, reaching 0.039% points, but this continues to fall to 0.006% points in the fifth quarter, before rising and tapering off. The impulse response of consumer prices converge completely in the sixth 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 tenth quarter, tapers off, before dying out completely in the fortieth 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. Therefore, the two models show that the direction of the shock in the economy is the same. The AR roots graph in Appendix confirms that the estimated SVAR is stable, since no root lies outside the unit circle.

Estimating the cointegrating 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 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 cointegrating vector autoregression (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

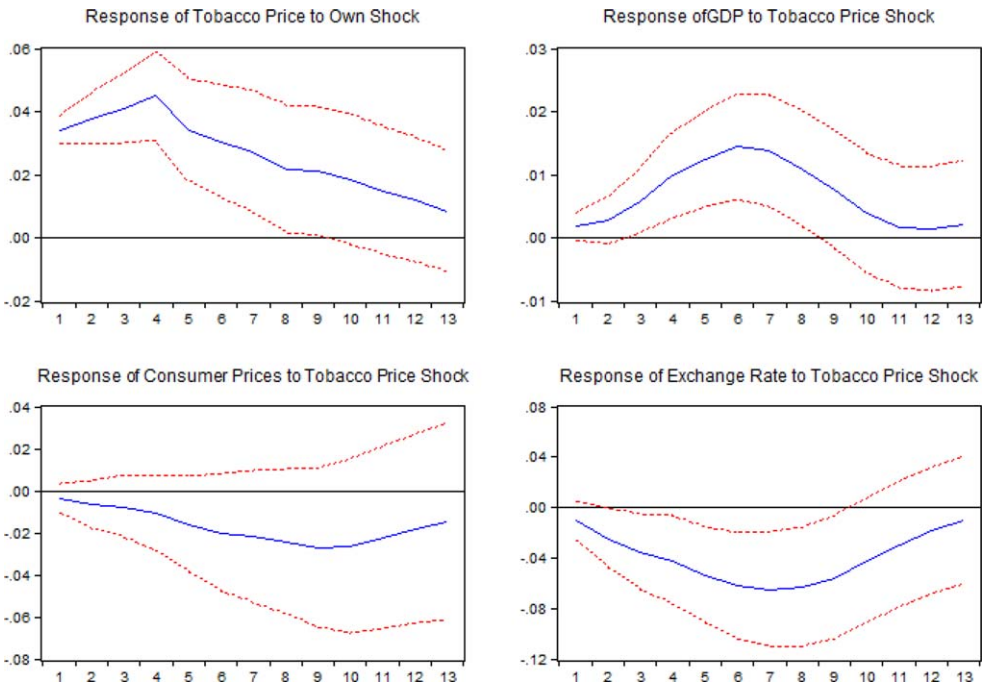


Figure 3. Unrestricted vector autoregressive model [Colour figure can be viewed at wileyonlinelibrary.com]

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.

This confirms 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 cointegration analysis, with a cointegrating 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.[18]

Thus 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

[18] Analysing the AR roots graph, we note that the CVAR generates three 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).

shock to tobacco prices show the same results as in the previous analysis by SVAR. Results are presented in the Appendix.

We proceeded with the estimation of an unrestricted VAR as robustness checks for the model, with the ordering LTP, LGP, LCP, LEXR. The results are not very different from the results of the SVAR in the previous sections. As Fig. 3 shows that tobacco prices respond positively to own shock with a 0. 036% increase while at the same time GDP rises by 0.02% at impact. The real exchange rate depreciates by 0.01% 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.

6. CONCLUSIONS

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 LIE? Specifically, we examined the effects of positive tobacco price shocks in the Malawian economy. Using a SVAR model and quarterly data for Malawi, the paper finds that export prices of commodities explain much of the variability in key macroeconomic variables. The prices convey useful information on output, consumer prices and the real exchange rate, which are important for both AD and AS. 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 ten 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 continues to fall and then converges in the thirteenth quarter. However, the effect on consumer prices is insignificant since consumer prices respond significantly to food availability in Malawi. The exchange rate declines (appreciates) in the period under analysis as a response to a positive tobacco price shock, before converging completely in the twelfth 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 AD and AS discussed in section 3, where supply shocks are said to have a lasting effect on the economy and they are mostly permanent, as in Cashin *et al.* (2014).

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 LIEs. 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 (Mendoza, 1995; Deaton, 1999; Diao *et al.*, 2002).

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APPENDIX

IMPULSE RESPONSE FUNCTIONS FOR THE DIFFERENCED SVAR

SVAR model on differenced data is shown in Fig. A1.

IMPULSE RESPONSE FUNCTIONS FOR THE CVAR

CVAR model is shown in Fig. A2.

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 cointegration[19] to determine if a long-run relationship exists among the variables. Table A1 presents the results.

where CV is critical value. According to the Johansen Trace and Maximum Eigenvalue test statistics, the null hypothesis of no co-integration is rejected. The LR trace test

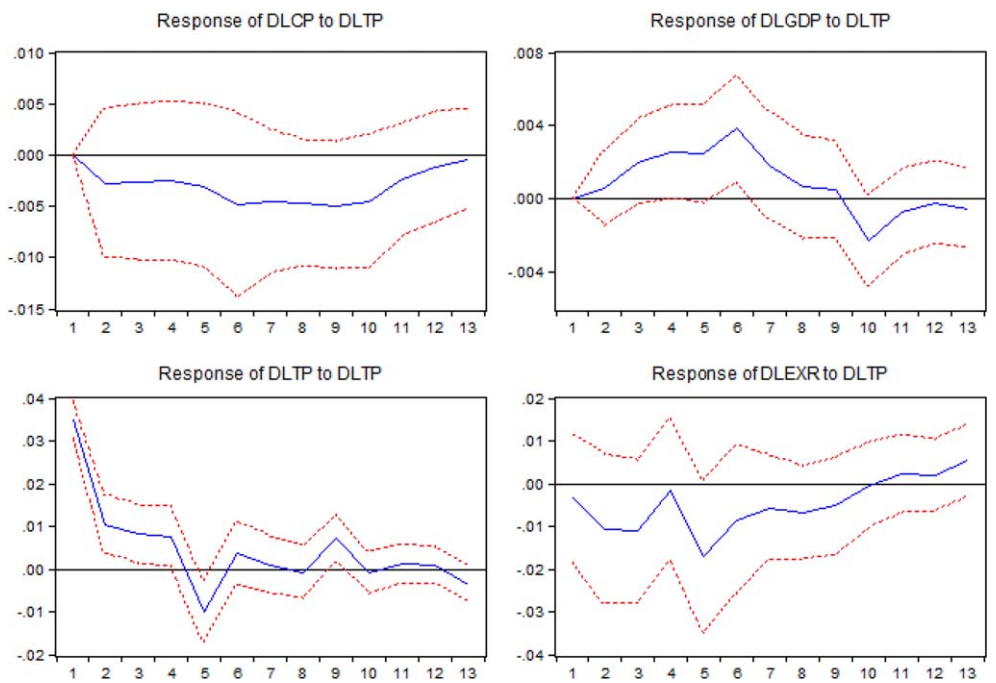

Figure A1. Structural vector autoregression model on differenced data [Colour figure can be viewed at wileyonlinelibrary.com]

[19] 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 the Johansen Likelihood Ratio (LR) test (Johansen, 1995).

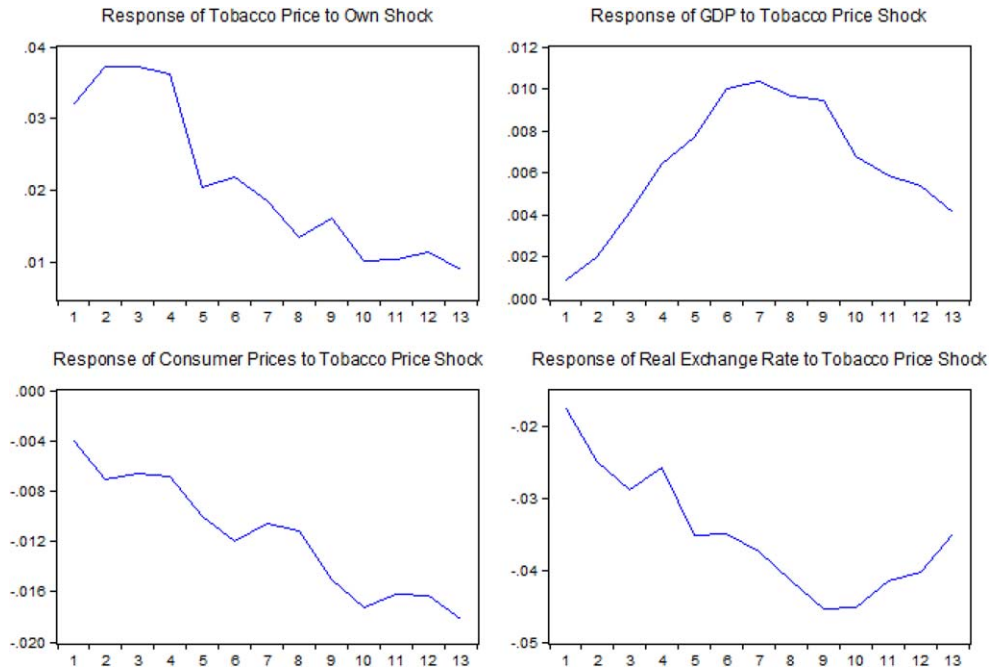

Figure A2. Cointegrating vector autoregression model [Colour figure can be viewed at wileyonlinelibrary.com]

statistics fail to reject the hypothesis of $p-r=1$ common trends and $r=1$ cointegrating 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 cointegrating equation at 5% significance level in the model, showing that a long-run relationship exists between the variables under analysis. The results of the normalised long-run equation are provided:

$$ltp=-1.11(0.11)lgdp-0.24(0.07)lcp+0.36(0.06)lexr \quad \text{(A1)}$$

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

Estimating the cointegrating 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

Table A1. Cointegration test results

No. of CE(s)	Eigen value	Trace Stat (Prob**)	95% CV	Max-Eigen Stat (Prob**)	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 cointegrating equation at the 0.05 level.
*Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values.

Table A2. 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.

dynamics of consumer prices, which may rise after a certain period of time. Table A2 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 cointegrating vector autoregression (CVAR) model to reflect this identifying assumption, by restricting the coefficient of consumer prices to zero. Table A3 provides the results of the over-identified model with a long-run co-integration relation of $r = 1$.

The 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 cointegrating error term of −0.27 having explanatory power for the effect of tobacco prices.

Table A3. 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 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 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.