Macroeconomic dynamics in a dollarised economy: A BVAR Approach

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Abstract

This paper investigates the impact of domestic and external shocks in a dollarised economy. We estimate a Bayesian VAR model using Zimbabwean data for the period 2010M10 to 2014M12. Our results tend to suggest the presence of contractionary fiscal expansion. We also show that a positive shock to the US Fed rate has no significant impact on output and inflation.

Key words: Bayesian VAR, Dollarisation, Fiscal policy, interest rate, Money
JEL Code: C11, E62, E43, E51

1 Introduction

How does a dollarised economy respond to domestic and external shocks? Answers to these important questions are scarce in literature yet they are very useful for evidence based policy formulation.

This paper uses a BVAR analysis to investigate macroeconomic dymanics in Zimbabwe. Specifically, the paper examines the transmission mechanism of fiscal policy shocks in a dollarised economy. Although there exists wide ranging debates on the impact of fiscal policy shocks in optimal currency areas such as the European Union, dollarised economies have received less attention. Keynesian theory predics that fiscal expansion increases output and inflation while non keynesians suggested that positive fiscal shocks can be contractionary if the transmission of fiscal policy through the demand channel is dominated by other channels.

Empirical studies focusing on fiscal policy effects in dollarised economies are particularly important given that there exists evidence that the countries continue to face fiscal slippages. Precisely, fiscal slippages in Panama a country with more than a century of experience with full dollarisation have been found to be rule rather than an exception.

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This paper also investigates the impact of domestic interest rates, US dollar supply shocks and the Fed rate shock on a dollarised economy. Existing studies tend to suggest that a deterioration in domestic funding conditions weigh down output and inflation.

Rojan, (2005) posits that negative shocks on the quantity of US dollars can cause negative consequences on a dollarised economy. US dollar shortages in a dollarised economy have been found to emanate from an overvalued exchange rate, excessive government expenditures, sudden stop of external dollar inflows, bank runs on dollars, and and unsustainable balance of payment position. Precisely, if the the economy has less dollars than what is demanded by economic agents, US dollar interest rates will increase and this results in a decline in both aggregate economic activity and inflation.

We also show the impact of the US fed shock on inflation and output. The transmission of the US shocks Fed rate on a dollarised economy depends on trade links and financial market integration. In the case of countries with high levels of integration with the US economy in the goods and financial markets, then the impact of shocks to US monetary shocks on macroeconomic variables tends to be pronounced. Cosequently, a US monetary policy contraction would spillover to domestic interests but, however, the responses of macroeconomic variables could depend on the nature of dollarisation.

Canova, (2005) finds that the output responses of US monetary shocks in panama are not clear, however, inflation slightly increases. Willams, (2013) investigates the effects of a US monetary policy contraction for Equador El Salvador and Panama and finds that it leads to a fall in prices but, however, the impact on output does not show a clear response. Cordahi and Goux, (2007) opines that the impact of a US fed rate hike on Lebanese inflation and output is small and negligible.

This paper uses three variable BVAR models derived from a large structural VAR model to investigate the effect of domestic and external shocks on the Zimbabwean economy. We find the following results. First, evidence supporting the contractionary effects of fiscal expansion. Second, a positive shock to government expenditure tends to increase domestic interest rates which in turn cause inflation and prices to fall. Third, an increase in money supply tends to cause domestic interest rates to decline. Fourth, a fed rate hike has no significant impact on inflation and output

The rest of the paper is organised as follows: Section 2 reviews stylised facts of the Zimbabwean economy. Section 3 reviews empirical literature. The methodology is discussed in Section 4. Section 4 describes the data. Section 5 analyses the empirical findings and Section 6 Concludes

2 Stylized facts of the Zimbabwean economy under dollarisation

Zimbabwe dollarised in February 2009 after the government legalised the use of multi-currencies. This followed a a hyperinflation triggered economy wide substitution of the local currency with foreign currencies. This halted excessive money printing by the central bank leading to an abrupt end to hyperinflation. During the first year of dollarisation the country recorded negative inflation as a result of price corrections following an episode of pronounced price distortions.

Economic growth accelerated from 5.6% in 2009 to reach a peak of 11.9% in 2012 making Zimbabwe one of the fastest growing economies in the world at a time when the rest of the world was in a recession with US Fed rates approaching Zero Lower Bound.

In 2013, economic growth started slowing down and this also coincided with the end of the Government of National Unity. Signs of economic distress emerged. The country's exports started declining, partly as a consequence of a slump on global commodity prices and the worsening of real effective exchange rate following the strengthening of the US dollar against major global currencies. Domestic output plummeted and inflation tumbled. Figure (1) shows some key macro-economic indicators

Figure 1: Key macroeconomic indicators: Source RBZ and ZimStat

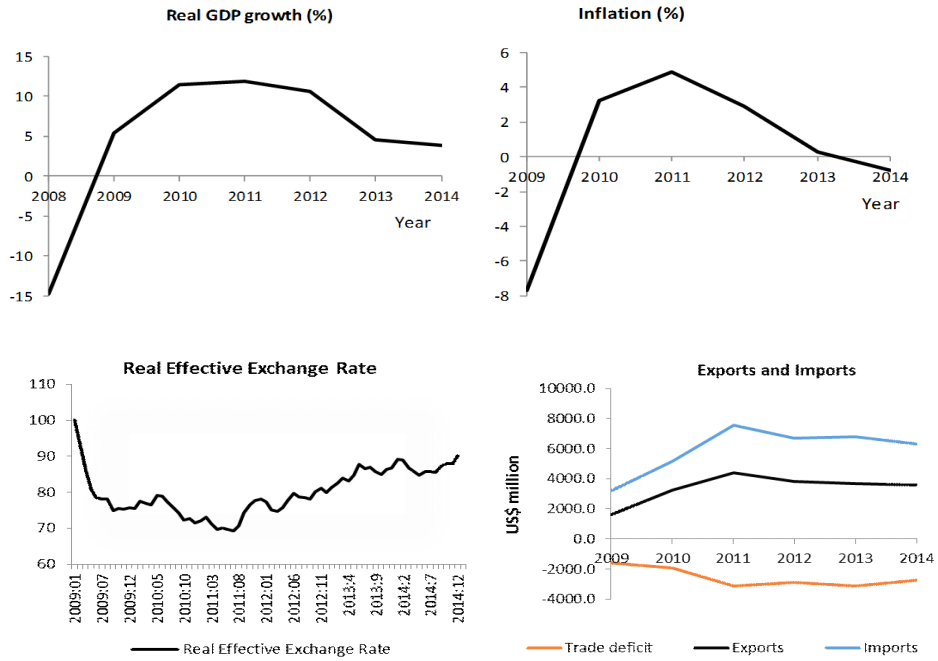


Figure 2: Fiscal indicators: ZimTreasury

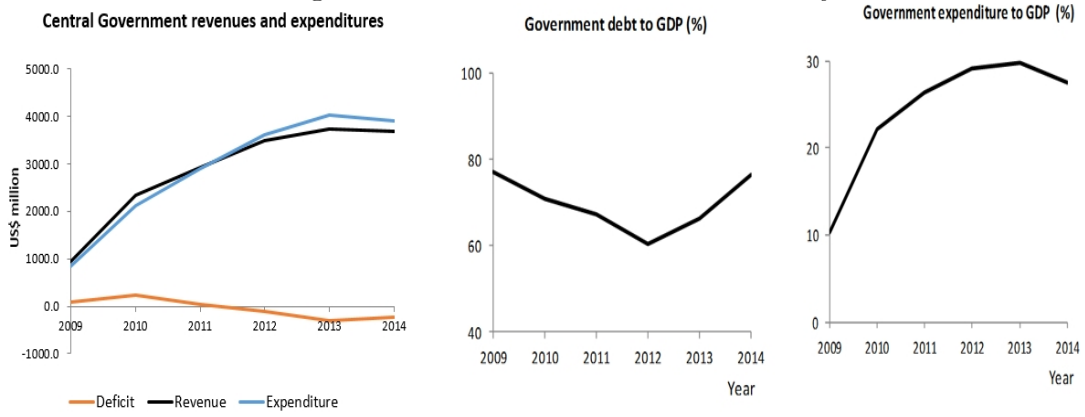


Figure 3: Fiscal indicators: ZimTreasury

2.1 Government Finances

Dollarisation in Zimbabwe was not supported by meaningful economic stabilisation financing. Zimbabwe, was a receipient of IMF SDR500 million in 2009, following a decision by IMF to boost the reserves qualifying member countries. The government of Zimbabwe, however, remained in arrears on its debts to local and domestic creditors and this impacted on the country's sovereign risk profile. In addition the there was no evidence an irreversible commitment to change the level and structure of Government expenditures. During the first four years of high economic growth fiscal revenues increased and the country's debt to GDP ratio declined. Economic growth started slowing down in 2012, in part as a consequence of higher imports and lower exports leading to a decline in government revenues. Government expenditures, however, remained largely sticky downwards resulting in the widening of fiscal deficits. We show fiscal indicators in Figure (3).

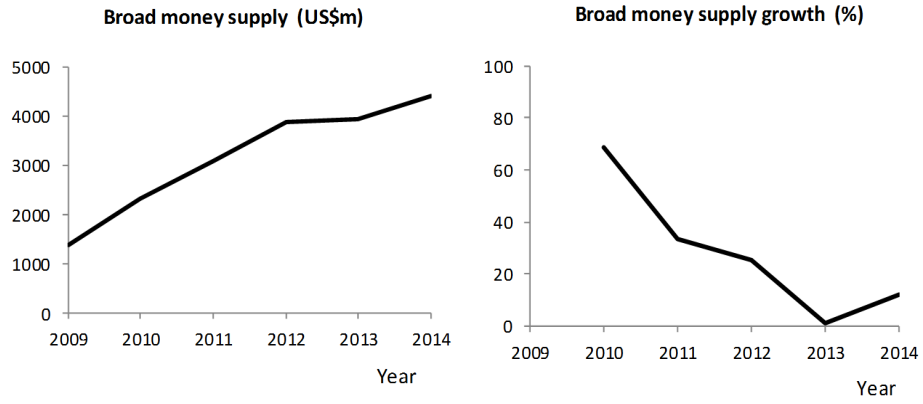
2.2 Liquidity developments

Following dollarisation of Zimbabwean economy, the major sources of US dollars in the economy were largely attributable to exports of (raw commodities, manufactured goods and services), foreign direct investment, aid, grants, remittances. The sources of liquidity amplified fragility of of the economy in the event of a sudden stop of dollar inflows. Table (1) shows that foreign currency inflows increased sharply from 2009 to 2012 and declined sharply in 2013 and 2014. On the other hand, external payments increased sharply leading to the deterioration of the foreign currency situation.

As expected the banking sector in Zimbabwe benefited immensely from a massive growth of US dollar inflows in the first four years of dollarisation as we show in Figure (4). The decline in economic activity and the the ensuing net US dollar outflows, however, amplified banking sector fragility due to a slowdown in US dollar supply as

shown in Figure (4)

Figure 4: Broad money supply: RBZ



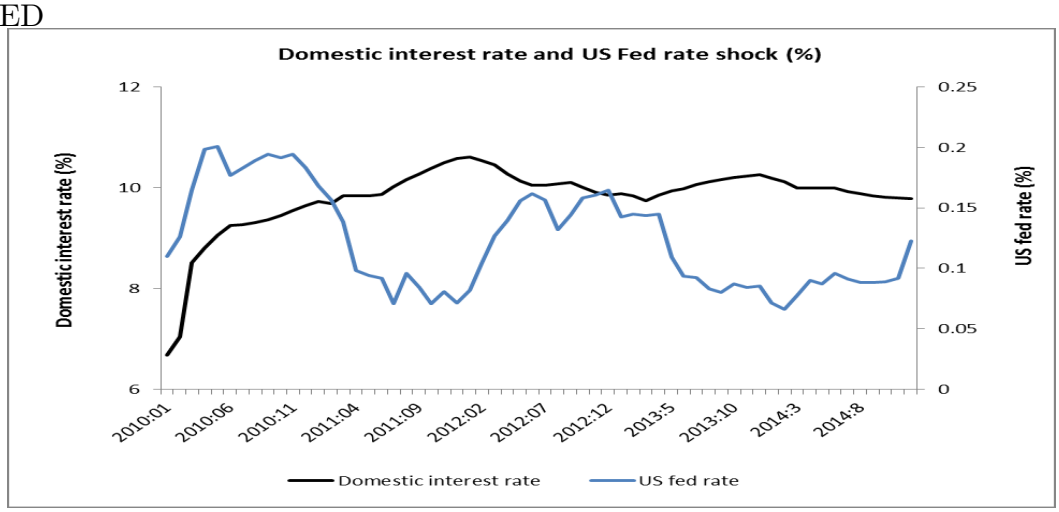
2.3 Domestic interest rate

The Reserve Bank of Zimbabwe has limited control over domestic interest rates. Interest rates are determined by banks based on domestic pricing conditions. Given that the US dollar is a dominant currency in Zimbabwe, it would be expected that the US Fed rate would be closely related to domestic interest rates but this is not the case. This could be expected because the US Fed kept interest rates low and made no significant changes to the rates during our period of analysis. Therefore, high of domestic interest rates largely reflect inherent risk factors. Part of the risk could be sovereign given that the Government of Zimbabwe has been accumulating accumulated arrears on its external debt since 1999. Figure (5) below shows domestic interest rates and the Fed rate for the period 2010 to 2014.

	2009	**2010**	**2011**	**2012**	**2013**	**2014**
Total foreign currency inflows (US$m)	**2,486**	**3,389**	**5,668**	**7,502**	**7,648**	**6,498**
Banked Export Receipts	1,618	2,287	3,281	4,454	4,535	3,678
International Remittances	727	993	1,831	2,030	1,822	1,756
External loans	28	43	167	477	688	825
Income receipts	104	66	237	291	203	77
Foreign investments	9	0	152	250	400	162
Total foreign currency outflows (US$m)	**2,486**	**2,496**	**6,100**	**8,200**	**8,887**	**8,706**

Table 1: Foreign currency inflows and outflows

Figure 5: Domestic interest rate and Fed rate shock: Source Own calculations and FRED



3 Methodology

In this paper, we use Bayesian estimation of vector auto regressive models, VARs popularised by Sims (1980) to analyse macroeconomic dynamics in Zimbabwe. The popularity of VAR models in macroeconomics is largley attributtable to: their ability to allow all the variables to be endogenous in the system and also accommodate the imposition of restrictions on the system dynamics to improve the forecasting performance. VAR models, however, have weaknesses. The identification of VARs needs to be complemented by theoretical assumptions and institutional knowledge. In addition, the models suffer from the dimensionality curse. As the number of variables in the model increases so does the number of parameters to be estimated. This results in the loss of degrees of freedom and increases data requirements for the model to be estimated. Consequently, data requirments create challenges in the estimation of VAR models for countries with a short data series such as Zimbabwe. The Bayesian implementation of VAR models, however, overcomes overparameterisation, Litterman (1980). Precisely, Bayesian VARs shrink an over parameterised VAR by introducing prior distributions (Banbura, Giannone and Reichlin , 2010). Resultantly, BVAR models, have gained wide usage the models in literature, as an alternative for VAR techniques, Litterman (1980). This study uses BVARs proposed by Koop and Korobolis, (2010) to analyse macroeconomic dynamics in Zimbabwe.

3.1 Standard Vector Autoregressive model

We describe the macroeconomic dynamics of the Zimbabwean economy using a dynamic system presented as follows:

$$Ay_t = c + \Omega_1 y_{t-1} + \Omega_2 y_{t-2} + ...\Omega_p y_{t-p} + B\varepsilon_t \tag{1}$$

Where, y_t is an $M \times 1$ vector of M macroeconomic variables for $t = 1...T$,

A is a matrix of coefficients that describes the contemporaneous relationships of the macroeconomic variables; Ω_i

is an $M \times M$ matrix of coefficients of lagged macroeconomic variables for $i = 1...p$; ε_t is an $M \times 1$ vector of uncorrelated errors that are white noise; B is an $M \times M$ matrix, with non zero diagonal elements that allow for direct effects of some shocks to macroeconomic variables in the system. Following Koop and Korobolis, (2010) we present equation 1 as follows:

$$y_t = \Phi_0 + \sum_{x=1}^{p} \Pi_i y_{t-i} + \mu_t \tag{2}$$

where $\Phi_0 = A^{-1}c$; $\Pi_i = A^{-1}\Omega_i$ and $\mu_t = A^{-1}B\varepsilon_t$ where $\mu_t \tilde{} iidN(\Sigma, 0)$.

The vector y_t is a vector made up of the following monthly data series namely: Three month Fed rate (FR_t), banking sector money supply ($M\$_t$) both with are unrelated exogenous processes; Output (Y_t) proxied by the manufacturing index; prices (CPI_t), Inflation (INF_t),Government expenditure (G_t) and domestic interest rate (R_t); Π_i is a matrix of auto-regressive coefficients while μ_t denotes a matrix of errors that are normally with zero mean and constant variance.

After Estimating (1) and obtaining estimates of the reduced for structural VAR we can separate structural shocks from the estimated reduced form residuals by imposing restrictions on parameters on matrices A and B in the following equation

$$A\mu_t = B\varepsilon_t \tag{3}$$

3.2 Identification of the structural model

We use Cholesky decomposition discussed in Sims (1980) on matrix A. Matrix B consists of diagonal elements. The ordering of variables for matrices A and B follows proposals by Favero (2001) who posits that the most endogenous variable is ordered last. Our identification structure assumes that Fed rate has no effect on money supply, output has no effect on money supply, prices have no immediate effect on output, government expenditure has no effect on prices and domestic interest rates. We present a system that separates the reduced form shocks and structural disturbances as shown below

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ a_{13} & a_{23} & 1 & 0 & 0 & 0 \\ a_{14} & a_{24} & a_{34} & 1 & 0 & 0 \\ a_{15} & a_{25} & a_{35} & a_{45} & 1 & 0 \\ a_{16} & a_{26} & a_{36} & a_{46} & a_{56} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^{FR} \\ \mu_t^{M\$} \\ \mu_t^{Y} \\ \mu_t^{CPI} \\ \mu_t^{G} \\ \mu_t^{R} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{FR} \\ \varepsilon_t^{M\$} \\ \varepsilon_t^{Y} \\ \varepsilon_t^{CPI} \\ \varepsilon_t^{G} \\ \varepsilon_t^{R} \end{pmatrix} \tag{4}$$

Our ordering of money supply and the Fed rate takes into account that Zimbabwe in a dollarised economy. Foreign interest rate and money supply are exogenous processes. The third and fourth equations suggests that ecomomic growrg responds with a lag to government expenditure and domestic interest rate. Government expenditure is assumed to be affected by all variables save for domestic interest rates. The Government of Zimbabwe borrows at market interest rates because the central bank can not print money. We assume that domestic interest rates are affected by all variables in the economy following Ngalawa and Viegi, 2011.

3.3 Estimation and scope of analysis

Given the short nature of the Zimbabwean data used in this study we analyse macroeconomic dynamics in Zimbabwe by estimating 5 trivariate Bayesian VAR Models using different data combinations using Koop and Korobolis, (2010). We shrink the parameter using the the minesota prior. Precisely,we investigate how the economy responds to domestic and external shocks. First . Second we analyse the effect of government expenditure shock on output and prices. Third we investigate the impact of fiscal expenditures on domestic interest rates and output. Fourth, we study the effect of domestic interest rates on output and prices. Fifth, we study the the impact of money supply shock on domestic interest rates and government expenditure. Our last analysis investigates the effect of a Fed rate shock on output and inflation experiment investigates

4 Data

All variables are seasonally adjusted and expressed in logarithms except for domestic interest rates and the Fed rate that are expressed in percentages. All variables have monthly frequency for the period 2010:M1 to 2014:Q14. The sources for our measure of output (manufacturing index[1]), Consumer Price Index and inflation are all sourced from the ZimStat quarterly digest of statistics. Money supply, (M3) represented is by broad money is sourced from the Reserve Bank of Zimbabwe monetary survey. The source of government expenditure is the ZimTreasury government outturn. The domestic interest rate is the weighted domestic interest rate for financial institutions derived from own computations. The US Fed rate rate is sourced from the Federal Reserve Bank of St Louis, FRED database.

[1]Monthly GDP data is unavailable

5 Results and Analyis

We estimate a Bayesian VAR model using Zimbabwean data for the Period 2010M1 to 2014M14. We set lag order to one due to the short nature of the Zimbabwean data. We shrink parameters using the Minnesota prior[2] with hyper-parameters set as $(a_1, a_2) = (0.5, 0.5)$ and $a_3 = 100$ and iterate over 10000 draws. We report the results for one standard deviation shocks to the fed rate, government expenditure, money supply and domestic interest rate.

5.1 Government spending

5.1.1 Government spending shock

We analyse the macroeconomic dynamics of a fiscal expenditure shock using a trivariate BVAR model comprising of the following variables:

$$y_t^{'} = [Y_t, CPI_t, G_t] \tag{5}$$

Following the identification scheme outlined in (5) the fiscal policy model is identified as follows:

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{34} & 1 & 0 \\ a_{35} & a_{45} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^Y \\ \mu_t^{CPI} \\ \mu_t^G \end{pmatrix} = \begin{pmatrix} b_{33} & 0 & 0 \\ 0 & b_{44} & 0 \\ 0 & 0 & b_{55} \end{pmatrix} \begin{pmatrix} \varepsilon_t^Y \\ \varepsilon_t^{CPI} \\ \varepsilon_t^G \end{pmatrix} \tag{6}$$

We find that government expenditure effects in Zimbabwe are non-Keynesian. Blanchard (1990), Giavazzi and Pagano (1990, 1991, 1996), were the first to find non-keynesian effects of fiscal policy when they popularised the Expansionary Fiscal Contraction (EFC) terminology. These were were followed by McAleese (1990), Alesina and Ardagna (1998), Blanchard (1990), Barry and Devereux, (1992), Sutherland (1997) Alesina, Perotti and Tavares (1998) and Perotti (1999) among others. These studies found that a fiscal contraction can result in an increase in output and inflation. Our paper finds the opposite of this terminology i.e. Contractionary Fiscal

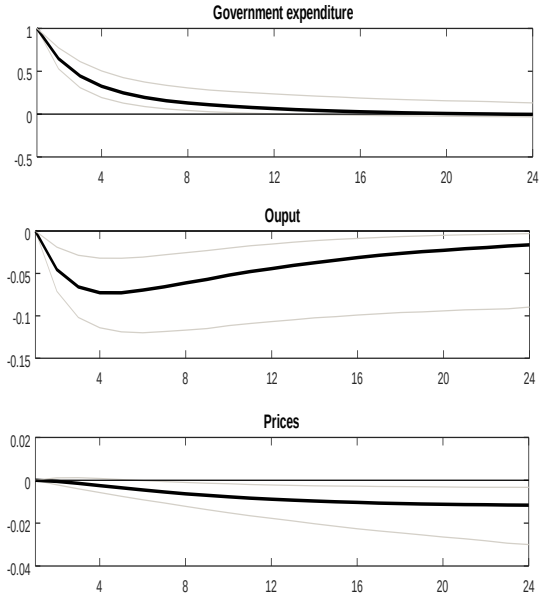
[2]The Minnesota prior idea was originally developed by Bob litterman to shrink certain coefficients of b to zero and reduce over fitting challenges, Doan, Litterman and Sims, (1984) and Litterman, (1986).Since then variants of the minnesota prior have been used in literature, see Banbura, Giannone and Reichlin (2010) and Korobolis and Koop, (2010) among others. This paper uses the minnesota prior version discussed in Korobollis and Koop, (2010) summarised below: The Minnesota prior assumes that

$$b \tilde{} N(0, \underline{V}_{MIN})$$

Where, $\underline{V}_{MIN}$ is a diagonal co-variance matrix which has ii diagonal elements denoted by:The shrinkage simplifies the specification of $\underline{V}_{MIN}$ elements with a vector of pres-elected hyper-parameters a_1, a_2,and a_3,where $(a_3 \geq a_2 \geq a_1)$. Precisely the prior shrinks the VAR by imposing a penalty for increasing lag length and also ensures that own lags are important compared to lags of other variables i.e $a_2 \geq a_1$. Further, the prior requires Σ to be known in advance and the posteriors take the prior distribution form.

Expansion. Precisely, a one standard deviation increase in government expenditure leads to lower output and prices. These findings are simple to explain. The accumulation of arrears by Government with domestic and foreign creditors is likely to be amplifying the dominance of the transmission of fiscal policy through the sovereign risk premium over the demand channel in Zimbabwe. Figure (6) shows the impulse responses of the fiscal policy shock.

Figure 6: Government Spending Shock responses



5.1.2 Government spending shock

We investigate the macroeconomic dynamics of an unanticipated government expenditure shock on domestic interest rate and output using a trivariate BVAR model. The endogenous variables included in y_t are presented below:

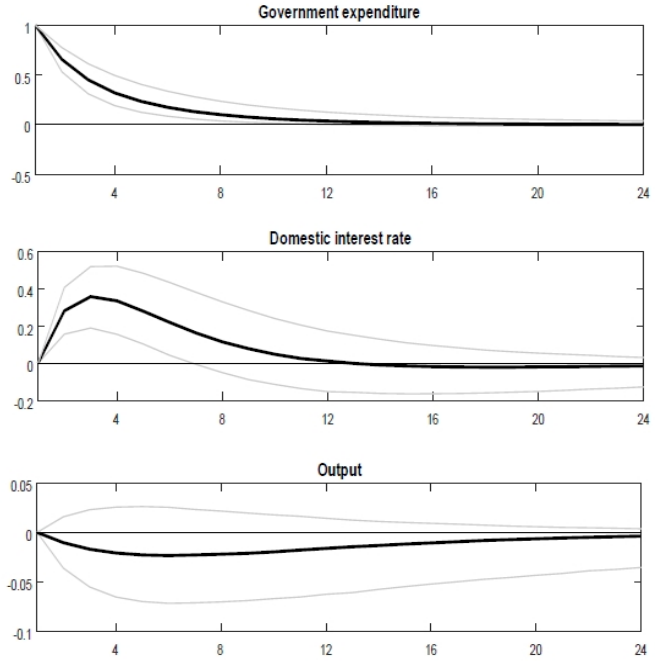
$$y_t^{'} = [Y_t, G_t, R_t] \tag{7}$$

Our identification for the fiscal model follows the identification scheme outlined in (7) and is presented as follows:

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{35} & 1 & 0 \\ a_{36} & a_{56} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^Y \\ \mu_t^G \\ \mu_t^R \end{pmatrix} = \begin{pmatrix} b_{33} & 0 & 0 \\ 0 & b_{55} & 0 \\ 0 & 0 & b_{66} \end{pmatrix} \begin{pmatrix} \varepsilon_t^Y \\ \varepsilon_t^G \\ \varepsilon_t^R \end{pmatrix} \tag{8}$$

We find more evidence that add to support the non keynesian effects of fiscal policy. Precisely, we show that fiscal policy is transmitted through the sovereign risk premium channel. A government expenditure shock leads to higher domestic interest rates rates and lower output. Overall, we that sovereign risk premium in Zimbabwe is significant, to the extent that the transmission of fiscal policy through the sovereign risk premium channel dominates the demand channel. Figure (7) shows the impulse responses of a government expenditure shock.

Figure 7: Response to Government Spending Shock



5.2 Domestic interest rate shock

We analyse the domestic interest rate BVAR model that incorporates output, prices and domestic interest rate as our endogenous variables shown below:

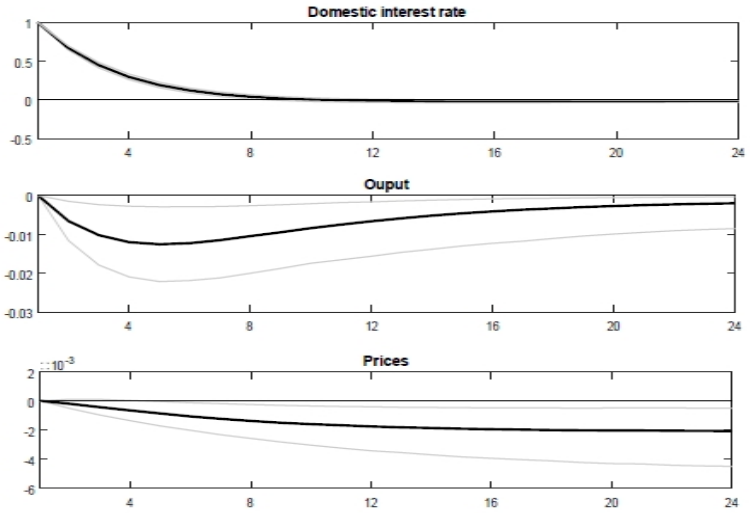
$$y_t^{'} = [Y_t, CPI_t, R_t] \tag{9}$$

Using the identification scheme in (9) we our identification for the interest rate model is as follows

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{34} & 1 & 0 \\ a_{36} & a_{46} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^Y \\ \mu_t^{CPI} \\ \mu_t^R \end{pmatrix} = \begin{pmatrix} b_{33} & 0 & 0 \\ 0 & b_{34} & 0 \\ 0 & 0 & b_{66} \end{pmatrix} \begin{pmatrix} \varepsilon_t^Y \\ \varepsilon_t^{CPI} \\ \varepsilon_t^R \end{pmatrix} \tag{10}$$

Our results on domestic interest rate shock are in line with empirical suggetions that tend to show an increase in interest rate causes output and inflation to decline. Specifically, a one standard deviation increase domestic interest rate leads to a decline in output and inflation. These findings support propositions by Rojan, (2005) that an increase in US dollar domestic interest rates negatively affect output and inflation. The impulse responses of a positive shock to domestic interest rate shock are shown Figure (8).

Figure 8: Response to domestic interest rate shock



5.3 Money supply shock

We investigate the dynamics of a money supply shock using a three variable BVAR model. The model endogenous variables are government expenditure and domestic interest while money supply is an exogeous variable as shown below:

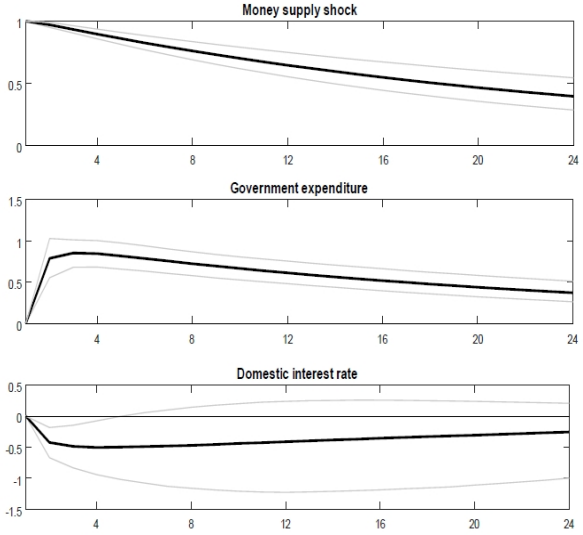
$$y_t^{'} = [R_t, G_t, M\$_t] \tag{11}$$

Following the identification scheme presented in (11) the identification of the money supply model is presented as shown below:

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{25} & 1 & 0 \\ a_{26} & a_{56} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^{M\$} \\ \mu_t^{G} \\ \mu_t^{R} \end{pmatrix} = \begin{pmatrix} b_{22} & 0 & 0 \\ 0 & b_{55} & 0 \\ 0 & 0 & b_{66} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{M\$} \\ \varepsilon_t^{G} \\ \varepsilon_t^{R} \end{pmatrix} \tag{12}$$

Our results tend to support evidence of a liquidity effect i.e money has a role to play in explaining macroeconomic dynamics in Zimbabwe. Precisely, a one standard deviation in money supply tends to result in decline in domestic interest rates and a increase in government expenditure. Our findings by Rojan, (2005) who suggests taht there is a negative relationship between the quantity of dollars and domestic interest rate in a dollarised economy. In addition our results support empirical evidence from Cagan and Gandolfi, 1968; Gibson, 1968, Cagan, (1972), John Corchrane, (1989), Christiano, (1990), Gordon and Leeper (1994), Bernanke, (1998) on the existance of a liquidity effect. Figure (9) shows the impulse responses of a money supply shock.

Figure 9: Response to money supply shock



5.4 Fed rate shock

We investigate the macroeconomic dynamics of a US Fed rate shock using a three variable BVAR model using the Fed rate, output and inflation as shown below:

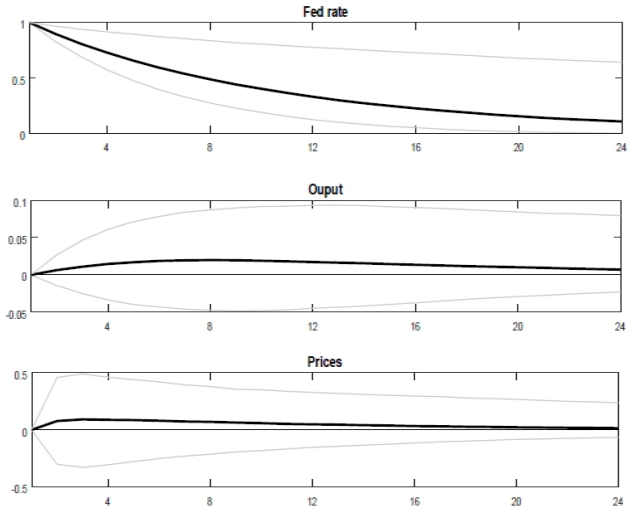
$$y_t^{'} = [FR_t, Y_t, INF_t] \tag{13}$$

Using (13) we present a relationship between the model structural shocks and estimated residuals in reduced form as shown below:

$$\begin{pmatrix} 1 & 0 & 0 \\ a_{13} & 1 & 0 \\ a_{14} & a_{34} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^{FR} \\ \mu_t^{Y} \\ \mu_t^{P} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 \\ 0 & b_{33} & 0 \\ 0 & 0 & b_{44} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{FR} \\ \varepsilon_t^{Y} \\ \varepsilon_t^{CPI} \end{pmatrix} \tag{14}$$

Our results show that following a one standard deviation shock to the US Fed rate shock, the responses of output and prices are small and statistically insignificant. This is somewhat expected because the weak integration of the Zimbabwean economy to the US economy and also because the US Fed rate did not change much during the period under study. Figure (10) shows impulses responses of a US Fed rate shock.

Figure 10: Response to a Fed Rate Shock



6 Conclusions

This paper provides results on macroeconomic dynamics in a dollarised economy during the period 2010M1 to 2014M12. We use trivariate Bayesian VAR models with different combinations of macroeconomic time series. We find evidence of non keynesian effects of fiscal policy. In particular we observe Contractionary Fiscal Expansion. Our findings show that an increase in domestic interest rate causes output and prices to decline. We empirically show that that.the quantity of dollars in a dollarised economy is negatively related with domestic interest rates . Lastly, we find results that tend to support that the responses of inflation and output to a positive Fed rate shock are statistically insignificant. Future studies on dollarisation in Zimbabwe can charecterise the economy using a structural DSGE model and reconcile the macroeconomic dynamics with the VAR evidence.

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