The effect of external shocks on macroeconomic performance and monetary policy in a small open economy: evidence from Zambia

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Abstract: This study investigates the impact of external shocks on domestic macroeconomic variables and monetary policy of a small open economy, Zambia using a structural VAR estimated with quarterly data covering the period Q1 2000 to Q1 2016. Results indicate that monetary policy is pro-cyclical in response to external shocks, while the dominant external shocks are commodity price shocks followed by financial shocks. This implies that external shocks are clear determinants of monetary policy direction in Zambia owing to their effect on key macroeconomic variable. In addition, results from impulse responses indicate that external shocks have significant effects on Zambia’s macroeconomic performance. Specifically, commodity price shocks have significant effects on output and exchange rate while financial shocks have significant effects on prices and exchange rate.

Keywords: external shocks; monetary policy; SVAR; monetary aggregate targeting; inflation targeting; impulse response function; forecast error variance decomposition; FEVD.


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1 Introduction

Over the past three decades, developing economies such as Zambia have become more integrated in the global economy through the globalisation process. The results of this process are evidenced by increase in the size and volume of trade and private financial flows across nations (WTO, 2014). In particular, Africa’s trade volume rose to US $1,148.59 billion in 2014 from US $265.61 billion in 2000 while the size of financial flows to Africa rose to US $46.07 billion from US $6.73 billion over the same period. The growing volume of trade helped emerging and developing countries to access larger markets for their products while larger capital inflows these economies to bridge the gap between their low savings and investment finance needs. However, the consequence of these tighter commercial and financial linkages is the susceptibility of these countries, especially those in Africa, to adverse external shocks. Researchers’ interest in the effects of external shocks, especially negative shocks, on developing countries has been ignited following the negative effects of external shocks in the last two decades with negative implications for sustainable growth. Figure 1 clearly demonstrates that external shocks affect economic growth emerging and developing economies.

Figure 1  Trends in economic growth of emerging and developing economies and selected episodes of external shocks (see online version for colours)

Source: Compilation from World Bank and business monitor international (BMI) databases.

Although countries in Sub-Saharan Africa (SSA) possess all characteristics that enhance the transmission of external shocks making economic growth sustainability a big challenge, very little research has been done on the region. In addition, countries in the...
region have experienced the negative effects of external shocks in recent years requiring appropriate policy response. In this regard, a study on the effects of external shocks on macroeconomic performance and the response of monetary policy using data from a country in the region is important. Zambia like other commodity dependent small open economies in the SSA region is faced with a challenge of sustaining its economic growth for poverty reduction. However, external shocks, especially adverse ones, make achieving sustainable growth a big challenge. Against this background, this study attempts to investigate the effects of external shocks on macroeconomic performance and the response of Zambia’s monetary policy to these shocks. Hence it attempts to answer the following questions:

1. What external shocks affect Zambia?
2. Do external shocks affect domestic economy?
3. Through which channel are external shocks transmitted?
4. Is monetary policy pro-cyclical or counter-cyclical?

The rest of the study is organised as follows: Section 2 provides an assessment of Zambia’s vulnerability to external shocks; Section 3 discusses empirical literature on the subject; Section 4 outlines the study methodology; Section 5 provides empirical results and discussions; and Section 6 concludes and gives policy recommendations.

2 External shocks, macroeconomic performance and monetary policy

2.1 Assessment of Zambia’s vulnerability to external shocks

Literature reveals that the degree and extent to which external shocks are transmitted to the domestic economy depend on a number of characteristics (Allegr et and Benkhodja, 2011; UNDP, 2014; Mimir and Sunel, 2015; Shousha, 2016). Characteristics which enhance the transmission of external shocks include:

1. Lack of flexibility of the exchange rate
2. A strong concentration of exports, especially with a bias to commodities
3. The level of integration in the global economy
4. Limited productive capacities
5. Lack of export competiveness
6. Overdependence on aid
7. Inadequate foreign reserves
8. Openness of the capital account.

Here an assessment of Zambia’s vulnerability to external shocks is done.

Figure 2 shows trends of total trade to GDP. Figure 2 shows that compared to its peers, Zambia is relatively a more open economy. Zambia’s total trade (exports plus imports) as % of GDP has stayed above its peers and the world average since the 1970s, with an exception of the 2000–2009 periods. In addition, it has a very high export
concentration with mineral exports in the last 15 years averaging more than 79% of total exports compared to 14.1% for SSA. This high dependence on commodity exports makes it very vulnerable to commodity price shocks. Furthermore, Table 1 shows that Zambia imports most of its consumer, intermediate and capital goods averaging 33.1% of GDP over the same period, marginally above the SSA average of 32.4% thereby making it vulnerable to foreign price shocks as well as exchange rate movements.

Figure 2  Trends in total trade to GDP data (see online version for colours)

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<tbody>
<tr>
<td>Zambia</td>
<td>Commodities export % of total exports</td>
<td>87.7</td>
<td>72.8</td>
<td>68.5</td>
<td>84.1</td>
<td>75.5</td>
<td>79.8</td>
</tr>
<tr>
<td></td>
<td>Imports % of GDP</td>
<td>36.8</td>
<td>33.8</td>
<td>36.6</td>
<td>29.1</td>
<td>37.0</td>
<td>33.1</td>
</tr>
<tr>
<td>SSA</td>
<td>Commodities export % of total exports</td>
<td>7.0</td>
<td>9.2</td>
<td>13.8</td>
<td>14.4</td>
<td>14.4</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td>Imports % of GDP</td>
<td>25.9</td>
<td>29.9</td>
<td>31.0</td>
<td>33.5</td>
<td>32.7</td>
<td>32.4</td>
</tr>
</tbody>
</table>

Furthermore, the enhanced integration into the global financial system has made Zambia vulnerable to external financial shocks. For example, Zambia relies heavily on external financing for most of its investment needs. Since the 1970s, Zambia’s private capital inflows as a percentage of GDP has been higher than the average for SSA (see Figure 3). And the financial reforms of the 1990s which saw Zambia move to a free floating exchange rate in 1991 and complete liberalisation of capital and current account in 1994 imply that the rising net private capital inflow make Zambia very vulnerable to reversals, especially short-term portfolio flows which move in search higher yields. The IMF (2013) report categorises Zambia as having a floating regime with no pre-determined path for the exchange rate. While on the other hand, Zambia’s Index of Financial Openness has risen to 2.44 which indicate the highest degree of financial openness/integration from 1.79 in 1997, and hence high degree of capital mobility (Chinn and Ito, 1997–2013). In addition, the IMF (2013) notes that Zambia has no controls on
trade in capital market securities, money market instruments, derivative market, commercial credits, financial credit or foreign direct investment in any sector. The higher level of financial integration and a liberal capital account coupled with flexible exchange rate makes Zambia’s macro-economic performance more vulnerable to external financial shocks. For example, tightening of monetary policy in a significant country such as the USA (FED raising interest rates) leading to higher yield rates on US securities could trigger an outflow of capital resulting in a depreciation of the domestic currency. Domestic currency depreciation will directly lead to inflationary pressures through imported goods and indirectly through increased cost of production.

**Figure 3** Net private financial inflows % of GDP for SSA and Zambia, 1970–2014 (see online version for colours)

Source: Computations by authors from world development index database.

### 2.2 Macroeconomic performance and external shocks

Figure 4 shows that over the last decade, commodity prices experienced a sustained rise only disturbed by the global financial crisis. The rise in real commodity prices have been more pronounced for metals and energy which were almost triple those of a decade ago while approaching the high levels reached in the 1970s. This rise in commodity prices is attributed to sustained economic growth in emerging economies such as China, India, and Brazil (Heap, 2005). However, in the recent past commodity prices have changed course as they have endured long spells of falls: crude oil, for example, after peaking at US $116 a barrel in nominal terms in April 2011 have consistently fallen reaching US $47 in January 2015 while those of copper which peaked at US $9,868 per metric ton in February 2011 have fallen, below US $5,000 in March of 2016. The volatile nature of commodity prices has had significant impact on the macroeconomic performance of African countries, especially economic growth and inflation.

Figure 5 clearly shows that economic growth of emerging and developing economies closely track the performance of commodity prices on the international market. It shows that during the commodity boom of the 1970s and 2000s, the economic growth was stronger compared with the slump of the 1980–1990s and the slump after 2011 in the three regions with the highest concentration commodity exports. Specifically, SSA region had growth of 4.0% in the 1970s boom falling to 1.8% in the 1980s and 1990s slump and rising to 4.7% during the 2000s boom before falling slightly to 4.5% in slump that started in 2012. On the other hand, the impact on growth in the Middle East and North Africa (MNA) is much stronger. Although the Latin and Caribbean regions (LAC) had similar
The effect of external shocks on macroeconomic performance and monetary
trends in the 1970s boom as well as the 1980s and 1990s slump, in the recent slump it
seems to have weathered the storm better (see Figure 5). Zambia’s economic growth has
also followed a similar pattern to other commodity exporting countries. During the
commodity boom of the 1970s it grew by 1.78% falling to 1.28% during 1980s slump.
During the 2000s boom average growth was 7.1% but it fell to 5.6% during the recent
slump.

Figure 4  World real commodity prices (see online version for colours)

Source: IMF commodity prices database and calculations by author. The real
commodity price is calculated as the US CPI normalised to 100 in
2010. The green lines indicate the log cycle peaks while the red lines
indicate the troughs.

Figure 5  Economic growth of developing countries over the last six decades (see online version
for colours)

Source: Compilation by author using the WDI database.

Inflation is another economic indicator that tracks commodity prices. In general Table 2
indicates that inflation is lower during commodity booms compared to periods of
commodity price slump. Specifically, the average inflation for commodity exporters was
7.3% during the commodity booms of the 1970s then rising to 17.5% in 1980–2000s
price slumps then falling to 7.1% during the 2000s boom period. Further, Zambia’s
inflation is generally lower during commodity booms and higher during slumps. This
could be attributed to the fact that the majority of finished products consumed in these countries are imported and the positive effect on the exchange rates associated with commodity price boom periods tend to reduce the price of these imported goods.

Table 2  Inflation in net commodity exporters during commodity booms and slumps

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<tbody>
<tr>
<td>Net energy exporters</td>
<td>4.9</td>
<td>7.4</td>
<td>4.7</td>
<td>7.5</td>
</tr>
<tr>
<td>Net metal exporters</td>
<td>8.4</td>
<td>7.9</td>
<td>6.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Net food exporters</td>
<td>5.7</td>
<td>7.2</td>
<td>4.8</td>
<td>7.7</td>
</tr>
<tr>
<td>Net raw materials exporters</td>
<td>5.1</td>
<td>6.9</td>
<td>5.3</td>
<td>7</td>
</tr>
<tr>
<td>Zambia</td>
<td>12.2</td>
<td>58.2</td>
<td>13.9</td>
<td>33.2</td>
</tr>
<tr>
<td>Average</td>
<td>7.3</td>
<td>17.5</td>
<td>7.1</td>
<td>12.8</td>
</tr>
</tbody>
</table>

*Source: Compilation from IMF staff calculations*

2.3 Monetary policy and external shocks in Zambia

In Section 2.2, it was shown that external shocks have important implications for emerging and developing countries such as Zambia. The review revealed that favourable shocks such as commodity price booms are associated with better macroeconomic performance while adverse shocks are associated with deterioration. The destabilising effects of external shocks, especially adverse ones require appropriate macroeconomic policy response by policy makers. It is expected that an economic downturn associated with a negative external shock be counteracted by expansionary fiscal or monetary policy and vice versa. Evidence provided in figure 6 shows that in general there is a negative relationship between the monetary policy rate and commodity prices. This implies that the central bank tends to implement contractionary monetary policy during commodity price downturns (adverse shocks) and expansionary monetary policy during commodity boom periods. In other words, monetary policy is pro-cyclical in response to commodity shocks as they respond contrary to conventional knowledge.

**Figure 6** Correlation between bank of Zambia policy rate (BoZ rate) and commodity prices

*Source: Compilation by the authors using bank of Zambia database.*
3 Review of related literature

Our review of empirical literature shows that the majority of studies investigating the effects of external shocks on emerging and developing countries emerged after the global financial crisis of 2007–2010 (Sekine, 2015; Rahman, 2015; Majuca and Pagaduan, 2015; Rohe and Hartemann, 2015; Nguyen et al., 2014; Chandra and Unsal, 2014) with very little coming from SSA (Saibu and Apanisile, 2013; Kronick, 2014).

Rahman 2015 uses quarterly data ranging from 1989 to 2013 on Bangladesh to examine the impact of external shocks on the domestic economy. Using an SVAR their results provide evidence that external shocks are important in explaining variation in domestic price level and output. Specifically, the paper found that shocks to OECD GDP as well as foreign price had significant positive impact on domestic output and prices of Bangladesh.

Nguyen et al. (2014) investigates whether external shocks from global commodity markets as well as USA play significant role in explaining the macroeconomic fluctuations of seven ASEAN countries. Using a structural VAR model they find that oil prices and U.S. monetary shocks are more important to the variance of domestic variables than U.S. output shocks. Furthermore, they find that the response of domestic variables in the ASEAN regional is symmetrical. Hence, they conclude that external shocks, especially commodity shocks, are important in explaining domestic macroeconomic fluctuations of ASEAN countries.

A study by Majuca and Pagaduan (2015) analyses the impact of external demand shocks on ASEAN economies using VAR methods. In their study, world GDP is used to represent external demand shocks. Results indicate that a 1% shock to World GDP leads to a 0.4% increase in ASEAN GDP contemporaneously and to 0.9% within a year. In particular, they find that Singapore is more vulnerable to external shocks than other member states which are less integrated in the global economy. Furthermore, they show that the main transmissions of external demand shocks in Singapore is financial while in Indonesia is trade.

Rohe and Hartemann (2015) in their study, focussed on identifying the effects of US interest rate and commodity price shocks on the monetary policy of Colombia and Brazil Using Bayesian SVAR methods, their results show that these countries are not very susceptible to external shocks. Further, results revealed that the Colombian and, to a lesser degree, the Brazilian central bank use sterilised interventions as a systematic component of their inflation targeting regimes.

Using an SVAR and monthly data, Sekine (2015) explores effects of commodity price shocks on monetary policy in five developed economies. Results from the study indicate that mineral producing countries are more vulnerable to commodity price shocks compared to non-mineral producing economies. Specifically, results indicate that monetary authorities in Australia, Canada, and in New Zealand tighten monetary policy following a positive shock to commodity prices. Specifically, results indicate that in response to an unexpected 10% increase in commodity prices the Central Bank in mineral producing countries increase their policy rate by 1%. On the other hand, results show that non-mineral producing economies (USA and UK) do not significantly respond to commodity price shocks. Furthermore, the study indicates that core inflation in all countries do not significantly respond to commodity prices shocks.
The Literature review on Africa revealed two studies similar to this study (Saibu and Apanisile, 2013; Kronick, 2014). Saibu and Apanisile (2013) examine the relative effectiveness of fiscal and monetary policies in dealing with external shocks in Nigeria. Using an ARDL model their results indicates that monetary policy has a bigger effect on growth than fiscal policy. Hence they conclude that monetary policy is more effective in dealing with the adverse effects of external shocks on the domestic economy. Kronick (2014) investigates the effect of external financial shocks on SSA countries. Using SVAR approaches, they find that adverse financial shocks negatively affect economic activity of countries with floating exchange rate while they find that it is expansionary for countries with fixed exchange rate regimes. In addition, they find that the main channel of transmission of external shocks is the interest rate and trade channels. Further, they find that shocks from the USA have greater effects than those from the EU.

4 Methodology and data

4.1 Methodology

To investigate the dynamic effects of external shocks on the domestic economy and monetary policy response, this study utilises a Structural Vector Auto-regressive (SVAR) in the spirit of Sims and Zha (1995) and Kim and Roubini (2000). This is done in order to decompose the effects of external shocks on output and other variables as well as the response of macroeconomic policy to these shocks.

4.1.1 External shocks relevant to Zambia

A key element in developing an SVAR model that takes into account the effects of external shocks is to identify external shocks to which an economy is exposed. In this regard, the following discussion identifies the shocks relevant to Zambia. In the identification of shocks, the following issues are considered:

- **First**, changes in interest rates of a large economy may have a strong effect on the macroeconomic performance of a small open economy via the uncovered interest rate parity (UIP). Since Zambia’s capital account is open, as explained earlier, it is expected that changes in foreign interest rates may have significant impact on domestic economy via the UIP.

- **Secondly**, Zambia’s exports are dominated by commodity exports (copper) whose prices are determined in the international markets. Commodity price shocks are likely to have a huge impact on the country’s current account and consequently performance of the domestic economy. In addition, Zambia is an importer of crude oil but it is expected that shocks to oil prices will have a limited impact on the domestic prices since energy prices in Zambia are administered.

- **Thirdly**, in addition to export of commodities, Zambia’s export of non-tradition exports has been rising. Non-traditional exports crucially depend on the global economic conditions especially that of trading partners such as China and South Africa. Hence, it is expected that poor global economic growth will negatively affect the demand for goods and consequently domestic economic activity through the current account.
Finally, Zambia relies heavily on the importation of consumer, intermediate and capital goods, as discussed above. With this kind of high dependence on imports, it is expected that shocks to external prices of goods will affect domestic prices and economic activity.

Hence given the foregoing discussion, Zambia is likely to be vulnerable to external shocks in the form of changes to foreign interest rates, global economic activity, commodity prices, and foreign prices. In this paper, focus is given to financial shocks represented by the US Federal funds rate on account that US financial market represents the largest share of the global financial sector. Further, commodity price shocks are represented by copper prices. Copper price is picked because Zambia largely depends on the production and export of copper while energy prices are administered such that changes on the international market do not reflect local energy prices. Finally, to model the impact of external economic conditions GDP for USA is selected. USA GDP is chosen on account of its GDP being readily available on a quarterly basis while China’s GDP on a quarterly frequency could not be obtained.

4.1.2 SVAR model for Zambia

We assume that the structure of the Zambia economy can be described by the following structural form:

\[ AY_t = B(L)Y_{t-1} + \varepsilon_t; \varepsilon_t \sim iid(0, \Lambda) \]

In equation (1), \( Y_t \) represents an \( n \times 1 \) vector of endogenous variables while \( \varepsilon_t \) is a \( n \times 1 \) vector of structural disturbances with a zero mean and constant variance, \( \Lambda \). The specification given in (1), \( A \) is an \( n \times n \) matrix of contemporaneous coefficients while \( B \) is the matrix of lagged coefficients of interactions in \( Y_t \).

Since the structural model given in (1) cannot be estimated directly due to inadequate information, the existence of the inverse of the matrix \( A \), \( A^{-1} \) allows us to have a reduced-form of the structural model, which can be specified as follows:

\[ Y_t = A^{-1}B(L)Y_{t-1} + A^{-1}\varepsilon_t; \varepsilon_t \sim iid(0, \Lambda) \]  

or

\[ Y_t = D(L)Y_{t-1} + \mu_t; \mu_t \sim iid(0, \Sigma) \]

where

\[ D(L) = A^{-1}B(L); \text{ and } \mu_t = A^{-1}\varepsilon_t \]

Given that \( A \) is a matrix of contemporaneous coefficients in the structural model and \( B(L) \) is matrix of lagged coefficients in the structural model, we can define \( G(L) \) as the matrix of both contemporaneous and lagged coefficients as follows:

\[ G(L) = A + B(L) \]

Following Cheng (2006) and using equation (4), structural and reduced-form equations can be related by:

\[ D(L) = A^{-1}B(L) \text{ and } \delta = -A^{-1}C(L) \]
and the disturbance terms through:

$$\mu_t = A^{-1} e_t, \text{ or } e_t = A \mu_t$$

which implies,

$$\Lambda = A^{-1} \sum A^{-1} \quad (6)$$

Literature reveals a number of ways which are used to recover structural parameters from the reduced form estimates. The oldest and most popular method is the orthonagolisation of the reduced form residuals using the Cholesky decomposition as in Sims (1980). In this identification, a recursive structure is adopted with no strict adherence to economic theory (Enders, 2010). Another method is a non-recursive method known as the structural VAR in which restrictions are imposed on the contemporaneous matrix, A (Blanchard and Watson, 1986; Bernanke, 1986; Sims, 1986). These restrictions are based on economic intuition.

In our model, the data vector is given by:

$$Y_t = (FGDP, MA, Policy \ rate, CP, LR, P, GDP, FFR, ER) \quad (7)$$

where \( MA \) is a monetary aggregate (money supply), specifically M2; \( Policy \ rate \) which is the interbank rate or three-month TB rate; \( LR \) is the commercial bank lending rate; \( GDP \) is the gross domestic product; \( P \) is the domestic consumer price index; \( FGDp \) is a measure of Foreign or trade partner \( GDP \); \( FFR \) is the federal funds rate; \( CP \) is commodity price represented by copper prices; and \( ER \) is the nominal effective exchange rate. The first three variables are standard variables in an analysis of monetary policy transmission in a closed economy set up while the last four variables are used in an open economy model. The last four variables help in identifying the effects of external shocks on domestic economy and monetary policy.

The identification strategy employed in this study follows in the spirit of Sims and Zha (1995) and Kim and Roubini (2000) but modified to suit the Zambian economic structure. The identification scheme is presented in the system of equation (8):

$$\begin{bmatrix}
\alpha_{FGDP} \\
\alpha_{FFR} \\
\alpha_{PCop} \\
\alpha_{GDP} \\
\alpha_{CPI} \\
\alpha_{M2} \\
\alpha_{ROZR} \\
\alpha_{ALR} \\
\alpha_{ER}
\end{bmatrix}
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\begin{bmatrix}
\mu_{FGDP} \\
\mu_{FFR} \\
\mu_{PCop} \\
\mu_{GDP} \\
\mu_{CPI} \\
\mu_{M2} \\
\mu_{ROZR} \\
\mu_{ALR} \\
\mu_{ER}
\end{bmatrix} \quad (8)$$

In the identification scheme above, policy rate and monetary aggregates equations are seen as the monetary policy reaction functions. In general, it is assumed that domestic variables have no effect on external variables. First, foreign GDP or US GDP representing external demand shock is assumed to respond contemporaneously to its own
The effect of external shocks on macroeconomic performance and monetary

shocks while the FFR react to US GDP implying that US monetary authorities consider output fluctuations in their interest setting. Secondly, copper prices which represent external commodity price shocks react to own shocks and US GDP implying that global demand is a key determinant of commodity prices. Thirdly, it is assumed that domestic economic activity responds to own shocks and commodity price shocks due to the fact that Zambia’s economy relies heavily on the export of copper with important backward and forward linkages. Furthermore, the consumer prices respond to own shocks as well as domestic output and money supply as in the classical theory. Fourth, money supply (M2) is assumed to respond to consumer prices, domestic output and average lending rates as well as its own shocks. In setting the policy rate (BOZR), it is assumed that the Bank of Zambia responds to output and prices in line with its objectives. Average lending rates are assumed to respond to own shocks as well as shocks to global interest rates (FFR), domestic GDP representing aggregate demand, domestic prices, monetary supply, and the policy rate (BoZR). Finally, the exchange rate is assumed to be the most endogenous variable as it reacts to all variables in the model.

The coefficient matrix is a $9 \times 9$, so we needed $(9 \times 8) / 2 = 36$ restrictions. However, we have 49 zero restrictions making the system apparently over identified.

4.2 Data sources

In order to examine the dynamic effects of external shocks on Zambia’s macroeconomic performance quarterly data is utilised covering the period Q1 2000 to Q1 2016. Data on domestic variables namely M2, average lending rate, BoZ rate and Exchange rate is obtained from the bank of Zambia while consumer price index and GDP is obtained from the Central Statistical Office (CSO). Data on foreign variables namely Federal Funds Rate and US GDP are obtained from the FRED database of the US Federal Reserve System while Copper prices are obtained from the IMF database.

Although, all variables are available on a quarterly frequency, GDP is only available on an annual basis. Hence, quarterly data series were obtained by way of interpolation. In the analysis, GDP data is obtained by the Denton interpolation method (see, Baum, 2001; Renka, 1988). The index of industrial production (IIP) is used as the related series.

5 Empirical results

5.1 Unit root and VAR lag selection

In this study, two empirical tests are used, namely: augmented dickey fuller (ADF) and Philips-Peron (PP). Both tests are carried out under the null hypothesis of stationarity (Geda et al., 2012). Results in Table 3 indicate that all the series included in the analysis have unit roots implying that they are non-stationary. Since all the series are non-stationary, there is a strong possibility for the presence of co-integration among the variables (Ozdogan, 2009). In the presence of co-integration literature shows that both VAR in levels and vector error correction (VEC) models are consistent. Hence, this study chose a VAR in levels as literature shows that if there are co-integrating relationships using a VAR in levels is found to be consistent (Hamilton, 1994).
### Table 3

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<th>ADF</th>
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<th>PP</th>
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<tr>
<td></td>
<td>Levels</td>
<td>1st differences</td>
<td>I(d)</td>
<td>Levels</td>
</tr>
<tr>
<td>Average lending rate</td>
<td>–2.422</td>
<td>–7.462***</td>
<td>I(1)</td>
<td>–3.013</td>
</tr>
<tr>
<td>BoZ policy rate</td>
<td>–2.374</td>
<td>–7.481***</td>
<td>I(1)</td>
<td>–2.495</td>
</tr>
<tr>
<td>Consumer price index</td>
<td>–2.921</td>
<td>–9.314***</td>
<td>I(1)</td>
<td>–2.891</td>
</tr>
<tr>
<td>Exchange rate (ZMK/USD)</td>
<td>2.458</td>
<td>–5.822***</td>
<td>I(1)</td>
<td>2.792</td>
</tr>
<tr>
<td>Broad money (M2)</td>
<td>–2.467</td>
<td>–4.266***</td>
<td>I(1)</td>
<td>–2.577</td>
</tr>
<tr>
<td>US GDP</td>
<td>–1.401</td>
<td>–4.530***</td>
<td>I(1)</td>
<td>–1.301</td>
</tr>
<tr>
<td>Real copper prices</td>
<td>–1.858</td>
<td>–6.458***</td>
<td>I(1)</td>
<td>–1.764</td>
</tr>
<tr>
<td>Federal funds rate</td>
<td>–1.972</td>
<td>–4.211***</td>
<td>I(1)</td>
<td>–1.496</td>
</tr>
</tbody>
</table>

Notes: *, **, and *** Indicates significance at 10%, 5% and 1% levels. 

Source: Computations by author.
Another important aspect in the estimation of VAR models is the selection of an appropriate lag length that ensures the absence of serial correlation in the estimated models and ensuring that residuals are well-behaved. Lag length selection criteria results are presented in Table 4. In the selection of the optimal lag length, the study relies on the principle of parsimony which entails that if two or more models explain the same phenomena but have different lag lengths; choose the model with lower lags in order to preserve degrees of freedom (Hamilton, 1994). Hence the VAR with only one lag length indicated by the Schwarz criterion (SC) is chosen.

### Table 4  
Lag selection criteria

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>813.6301</td>
<td>NA</td>
<td>2.08e-22</td>
<td>-24.38273</td>
<td>-24.08414</td>
<td>-24.26474</td>
</tr>
<tr>
<td>1</td>
<td>1,491.902</td>
<td>1,151.007</td>
<td>2.93e-30</td>
<td>-42.48189</td>
<td>-39.49600*</td>
<td>-41.30202</td>
</tr>
<tr>
<td>2</td>
<td>1,601.587</td>
<td>156.2170*</td>
<td>1.40e-3</td>
<td>-43.35111</td>
<td>-37.67791</td>
<td>-41.10936</td>
</tr>
<tr>
<td>3</td>
<td>1,679.368</td>
<td>89.56592</td>
<td>2.22e-30</td>
<td>-43.25356</td>
<td>-34.89306</td>
<td>-39.94993</td>
</tr>
<tr>
<td>4</td>
<td>1,775.768</td>
<td>84.71568</td>
<td>3.10e-3</td>
<td>-43.72025</td>
<td>-32.67244</td>
<td>-39.35473</td>
</tr>
<tr>
<td>5</td>
<td>1,935.857</td>
<td>97.02342</td>
<td>1.46e-30</td>
<td>-46.11687</td>
<td>-32.38177</td>
<td>-40.68948</td>
</tr>
<tr>
<td>6</td>
<td>2,224.394</td>
<td>96.17905</td>
<td>1.01e-31*</td>
<td>-52.40588*</td>
<td>-35.98347</td>
<td>-45.91660*</td>
</tr>
</tbody>
</table>

Notes: *indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.

Source: Computations by the author.

### 5.2 Diagnostic tests

Once a VAR is specified, it is important to perform diagnostic tests to ensure that results are credible. Hence, this study performs the residual multivariate normal, LM auto-correlation, and the VAR stability tests. Results in Table 5, shows that the null-hypothesis is rejected indicating that the residuals do not come from normal distribution. Specifically, results indicate that the residuals have excess kurtosis which implies that they have heavier tails. However, the LM auto-correlation test indicates that residuals are not serially correlated at 5%. Finally, the stability test indicates that the estimated model is stable as all the characteristic roots lie in the unit circle (see Appendix).

### Table 5  
Residuals Multivariate Normality Test

<table>
<thead>
<tr>
<th>Test statistic</th>
<th>Degrees of freedom</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skewness</td>
<td>3.93</td>
<td>9</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>36.41</td>
<td>9</td>
</tr>
<tr>
<td>Jacque-Berra</td>
<td>40.33</td>
<td>18</td>
</tr>
</tbody>
</table>

Note: Null hypothesis: residuals are multivariate normal.
Table 6  
LM auto-correlation test

<table>
<thead>
<tr>
<th>Lags</th>
<th>LM statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>79.3</td>
<td>0.534</td>
</tr>
<tr>
<td>2</td>
<td>77.9</td>
<td>0.577</td>
</tr>
<tr>
<td>3</td>
<td>68.1</td>
<td>0.846</td>
</tr>
<tr>
<td>4</td>
<td>66.1</td>
<td>0.884</td>
</tr>
<tr>
<td>5</td>
<td>100.4</td>
<td>0.071</td>
</tr>
<tr>
<td>6</td>
<td>81.9</td>
<td>0.452</td>
</tr>
</tbody>
</table>

Note: Null hypothesis: there is no serial correlation at lag order h.

Source: Computations by the author

5.3  The dynamic effects of external shocks on domestic macro-economic variables

In this section results on the dynamic effects of external shocks on domestic macroeconomic variables are presented. To achieve this, impulse response functions (IRF) and forecast error variance decompositions (FEVD) are utilised.

Figure 7  The dynamic impulse responses of domestic variables to external commodity price shock (see online version for colours)

Source: Computations by author
The effect of external shocks on macroeconomic performance and monetary

5.3.1 Effects of external commodity price shock on domestic macroeconomic variables

Figure 7 presents the impulse response of domestic macroeconomic variables to commodity price shocks. The results indicate that a positive one standard deviation shock to commodity prices significantly increases economic activity contemporaneously. However, the impact on domestic prices of a similar shock to commodity prices is expected but insignificant as expected. The significant response of output to positive commodity shocks are expected in that an improvement in net exports due to higher commodity prices increases aggregate demand domestically and also leads to an increase in mining production which is a major economic activity in Zambia. In addition, copper price shocks lead to a significant currency appreciation as expected for a commodity dependent economy similar to findings on Columbia (Rohe and Harteman, 2015). The appreciation of the exchange rate is expected in the sense that increase in commodity prices improves the country’s current account balance and consequently the supply of
foreign exchange. Results in Figure 7 also indicate that a positive commodity price shock leads to an increase in broad money and a fall in average lending rates though not significant. Finally, the results indicate that there is a strong and significant negative reaction to a positive commodity shock contrary to findings in other studies by the Central Bank (Rohe and Hartemann, 2015; Edwards, 2015). The negative response of BoZ policy rate to an increase in copper prices indicates that monetary policy is pro-cyclical. However, this is expected in small open economy with a very high content of imported consumer and intermediate goods which makes the inflation effects of external shocks to be stronger. For example, an increase in copper prices makes consumer and intermediate prices to fall as a result of the appreciating effect it has on the Zambian kwacha leading to lower prices of imported goods and prices in general. The significant role played by the exchange rate movement in consumer prices makes this reaction of the central bank to commodity price shocks consistent with the price stability objective.

Figure 9 The dynamic impulse responses of domestic variables to external demand shock (see online version for colours)

![Response to Structural One S.D. Innovations ± 2 S.E.](image)

Source: Computation by authors
5.3.2 Effects of an external financial shock on domestic macroeconomic variables

Figure 8 presents the impulse response of macroeconomic and policy variables to an external financial shock. Results indicate that a positive one standard deviation shock to the federal funds rate leads to a significant increase in consumer price index with hump at four quarters while a similar shock has no significant impact on economic activity. A one standard deviation shock leads to a significant depreciation of the domestic currency. Furthermore, a similar shock leads to an increase in money supply and lending rates as expected but this is not significant. With regard to the response of the central bank to financial shocks, our results indicate that there is clear tendency for the BoZ policy rate to follow US interest rate setting decisions which is a sign of policy contagion. This result is expected and in line with other studies (Edwards, 2015; Rohe and Hartemman, 2015). Zambia’s monetary policy reaction to rise in USA interest rates is consistent with its depreciating effect on Zambian kwacha, which has strong effects on consumer prices through the exchange rate pass-through. Furthermore, it is expected that as interest rate rises in the USA it induce capital outflows resulting in depreciation of the domestic currency prompting the central bank to react to stem inflation pressures.

5.3.3 Effects of an external demand shock on domestic macroeconomic variables

The responses of domestic macroeconomic variables to external output/demand shock are presented in Figure 9. The results show that a positive standard deviation shock to global output leads to a rise in domestic output; fall in consumer prices; a depreciation of the exchange rate; an immediate fall in money supply; and a fall in both BoZ policy rate and average lending rate. However, a shock to the USA GDP has no significant impact on Zambia’s macroeconomic variables indicating that the country’s response to global output shocks are limited, unless they affect commodity prices.

5.3.4 The importance of external shocks in the variance of domestic variables

The relative importance of external shocks, both in comparison to each other and as a whole, can be measured in terms of the variance decomposition of domestic variables. Table 7 present the results of the variance decomposition of consumer prices and output explained by external shocks.

Results in Table 7 shows that in general external shocks tend to have persistent effects as their weight in the variation of output and consumer prices tend to increase with time. Specifically, the results show that commodity prices are the dominant external shock affecting output and consumer prices in Zambia. Copper price shocks contribute 6.5% to output fluctuations at two quarter horizon rising to 9.5% at the 4 quarters followed by US GDP at 2.3% and 3.0%, respectively. Furthermore, commodity prices account for 4.0% and 4.2% at the same horizons followed by the federal funds rate at 1.9% and 2.0%, respectively. These results are expected and similar to those obtained by studies done on similar commodity dependent countries (Allegret and Benkhodja, 2011; Kazakova, 2015; Nguyen et al., 2014).

The rest of Table 7 gives results on the contribution of external shocks to variability in domestic financial variables. With an exception of money supply, external shocks
contribute more to the variance of domestic financial variables than to real variables. For example at the two and four quarter horizons external shocks contribute 8.5% and 19.0% to average lending rates while they contribute a total of 33.4% and 31.5% for the exchange rate. Impact of external shocks, on the exchange rate is in line with the IMF de facto classification of the exchange rate (IMF, 2015) and index of financial openness (Chinn and Ito, 1997–2013). The de factor classification of exchange rate categorises, Zambia as having a free floating exchange while index of financial openness stands at 2.44 which is the highest level of financial openness. Hence, it is expected from a theoretical and practical stand point for Zambia’s financial variables to respond quickly to developments on the world market as it is a small open economy.

Table 7  FEVD of domestic macroeconomic variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Horizons (quarters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Variance decomposition of output (GDP)</td>
<td></td>
</tr>
<tr>
<td>Copper price</td>
<td>6.5</td>
</tr>
<tr>
<td>Federal funds rate</td>
<td>0.7</td>
</tr>
<tr>
<td>US_GDP</td>
<td>2.3</td>
</tr>
<tr>
<td>Total contribution</td>
<td>9.5</td>
</tr>
<tr>
<td>Variance decomposition of consumer price index</td>
<td></td>
</tr>
<tr>
<td>Copper price</td>
<td>4.0</td>
</tr>
<tr>
<td>Federal funds rate</td>
<td>1.9</td>
</tr>
<tr>
<td>US_GDP</td>
<td>1.0</td>
</tr>
<tr>
<td>Total contribution</td>
<td>6.9</td>
</tr>
<tr>
<td>Variance decomposition of broad money (m2)</td>
<td></td>
</tr>
<tr>
<td>Copper price</td>
<td>3.7</td>
</tr>
<tr>
<td>Federal funds rate</td>
<td>3.3</td>
</tr>
<tr>
<td>US_GDP</td>
<td>1.1</td>
</tr>
<tr>
<td>Total contribution</td>
<td>8.1</td>
</tr>
<tr>
<td>Variance decomposition of average lending rate</td>
<td></td>
</tr>
<tr>
<td>Copper price</td>
<td>1.2</td>
</tr>
<tr>
<td>Federal funds rate</td>
<td>6.3</td>
</tr>
<tr>
<td>US_GDP</td>
<td>1.0</td>
</tr>
<tr>
<td>Total contribution</td>
<td>8.5</td>
</tr>
<tr>
<td>Variance decomposition of exchange rate</td>
<td></td>
</tr>
<tr>
<td>Copper price</td>
<td>20.2</td>
</tr>
<tr>
<td>Federal funds rate</td>
<td>10.2</td>
</tr>
<tr>
<td>US_GDP</td>
<td>3.0</td>
</tr>
<tr>
<td>Total contribution</td>
<td>33.4</td>
</tr>
</tbody>
</table>

Factorisation: structural

Source: Computations by authors
Generally, we can argue that copper prices and USA monetary policy shocks are more important than US output shocks in explaining Zambia’s macroeconomic fluctuations. The significant role copper prices play in explaining fluctuations of domestic economic variables especially output, prices and exchange rate is expected as mining in Zambia accounts for over 80% of foreign exchange earnings and contributing over 14% to GDP with strong forward and backward linkages. In addition, the increasing role of USA monetary policy in explaining Zambia’s economic fluctuations could be explained by the country’s increasing trade and financial openness as well as the significance of US financial markets. On the other hand, the limited role played by US output shocks is consistent with two changes in international trade. First, the role of the USA in international trade has been declining over time with its share in total trade falling to 10.6% in 2015 from a peak of 13.3%. Secondly, China has taken over from the USA as major importer and consumer of commodities which constitute the main economic activity of Zambia. These results are also consistent with the IMF 2007 world economic outlook which predicted the decreasing role of US real economy while emphasising the increasing role of its financial markets.

6 Conclusions and recommendations

The main aim of this study was to investigate the effects of external shocks on domestic macroeconomic variables as well as on policy of small open economy, Zambia. In this regard, the research questions of the study were: What external shocks is Zambia exposed to? What are the effects of external shocks on the domestic economy? How does monetary policy respond? To answer these questions the study utilises stylised fact analysis and Structural VAR methods.

Results from both stylised analysis indicate that external shocks have important effects on macroeconomic variables in Zambia. In addition, the results from both approaches indicate that monetary policy is pro-cyclical. In particular, SVAR impulse functions show that monetary policy acts in a pro-cyclical manner implying that monetary policy tightens when there are adverse shocks and vice versa, contrary to findings by other studies (Edwards, 2015; Rohe and Hartemman, 2015). Our results indicate that, in response to favourable shocks, the Bank of Zambia pursues expansionary monetary policy while monetary policy is contractionary during adverse conditions, which in essence could exacerbate the effects of external shocks on economic activity. Specifically, it was found that in response to a positive commodity price shock the central bank lowers the policy rate. On the other hand, following an adverse financial shock the central bank raises the policy rate indicating a policy contagion. These findings imply that the central bank is more concerned about price stability than output stability.

Furthermore, the study results indicate that external shocks, especially commodity price and financial shocks have important effects on Zambia’s macroeconomic performance. Specifically, Results show that commodity prices have significant positive effects on economic activity but insignificant negative effects on prices implying that recovery in commodity prices do have a stimulus effect on the economy. In addition, commodity price shocks have significant effects on the exchange rate as positive shocks where found to lead to an appreciation. On the other hand, negative (rise in USA federal
rate) external financial shock was found to have a significant positive effect on prices but no significant effects on output. Similarly commodity price shocks, it was found that the exchange rate depreciates following a negative external financial shock. Results from the FEVD indicate that the most important external shocks in explaining macroeconomic conditions in Zambia are commodity price shocks followed by financial shocks while demand shocks have minimal effects.

Given the foregoing, the following recommendations can be made:

- **There is need for Zambia and other commodity exporting countries to diversify their exports to reduce their exposure to external commodity shocks.** In this regard, the authorities should design policies aimed at financial deepening which would make more firms especially those in the export sector to access cheaper credit to improve their productivity.

- **These results also imply that the central bank should continuously monitor commercial banks’ exposure to external shocks in order to ensure financial systems stability.** For example, an adverse economic shock could lower economic activity thereby leading to an increase in non-performing loans with serious consequences for financial system stability.

- **There is need for the bank of Zambia to re-evaluate its monetary policy set-up so that monetary policy becomes counter-cyclical as opposed to being pro-cyclical.** This is because pro-cyclical monetary policy could worsen the economic activity in the face adverse external shocks. In addition, the central bank should build buffers of reserves during periods of favourable external shocks to be used in mitigating negative effects of adverse shocks when they come.

**Disclaimer**

The Researchers are economists at the Bank of Zambia. However, the comments and views expressed in this paper do not represent the views of the Board, Management and Staff of the Bank of Zambia but solely those of the researchers.

**References**


The effect of external shocks on macroeconomic performance and monetary


**Appendix**

**Figure A1** Stability table for the SVAR (see online version for colours)

Source: Computations by author.