Fiscal policy developments and the minerals industry

Raputsoane, Leroi

2 October 2024

Fiscal policy *developments* and the minerals industry

Leroi Raputsoane*

October 02, 2024

Abstract

This paper analyses the reaction of the minerals industry to fiscal policy *developments* in South Africa. This is achieved by augmenting a Taylor (1993) rule type central bank monetary policy reaction function with Government expenditure. According to the results, an unexpected, or surprise, increase in Government expenditure causes output of the minerals industry to decrease slightly and bottom out after 9 months, where it then gradually increase and tends towards its equilibrium, or steady state, level after 17 months. Conversely, an unexpected increase in output of the minerals industry causes Government expenditure to decrease and bottom out after 13 months, where it recovers and subsequently increases before it progressively and tends towards its equilibrium, or steady state, level after 23 months. However, the effect of surprise increase in Government spending on output of the mining industry is statistically insignificant in all periods, while the effect surprise increase on output of the mining industry is statistically significant immediately and such effect lasts up to 19 months. The results are generally consistent with countercyclical fiscal policy, hence Government should continue to monitor and manage spending to support overall economic activity as well as the minerals industry.

JEL Classification:C10, E50, E60, L70
Keywords: Fiscal policy, Minerals industry, Economic cycles

*Leroi Raputsoane, lraputsoane@yahoo.com, Pretoria

Introduction

Conventional macroeconomic models present two policy "anchors" to stabilise the cyclical behavior of economic activity. These policies comprise monetary policy, or the control of the supply of money stock in the economy, and fiscal policy, or the control of Government spending and taxation to influence the economy. Whereas a consensus view has emerged concerning the empirical effects of monetary policy shocks, such a consensus view to provide robust stylised facts on the effects of fiscal policy shocks on economic activity remains mysterious, according to Hemming et al. (2002). Fiscal policy has historically been used as a policy tool, predominantly to jump start economic growth, support the financial system and mitigate the general impact of the crises through transfer payments and benefits as well as other social spending, while in contrast, the automatic stabilisation policy is pursued during the normal times. In particlular, Governments influence the economy by changing the level and types of taxes, the extent and composition of expenditure, as well as the degree and form of borrowing.

Whereas monetary and fiscal policies are typical demand side management policies, fiscal policy can also be used as a supply side management policy. For instance, demand side policies are transitory in nature, focusing on macroeconomic stabilisation, while supply side policies aim to improve productivity and efficiency and, thus, support long run aggregate supply. As discussed, a consensus view has still not emerged concerning the empirical effects of fiscal policy on aggregate economic activity, in a similar manner, empirical effects of fiscal policy on the minerals industry remains unexplored. Attempts to study the relationship between fiscal policy and the minerals industry are limited to the developmental themes, including Atkinson and Hamilton (2003), Arezki (2011), Hamilton and Ley (2012) and Hadri (2011). The macroeconomic effects of fiscal policy, however, are well documented, where ample evidence has achieved mixed results in both the short run and the long run. Cuddington (1989), Kaminsky et al. (2004) and Rigobon (2004), among others, provide evidence that monetary and fiscal policies tend to be procyclical in most developing countries, particularly in commodity exporting countries.

According to Diebold and Rudebusch (1970) and Romer (1993), different economic sectors and industries respond differently to endogenous and exogenous economic shocks. A case in point is the widely accepted phenomenon, or notion, that the trend break, as well as the protracted underperformance, of the minerals industry relative to the total economy since the 1970s was a problem of structural misalignments. The sector is, thus, perceived not to be affected by changes in economic stabilisation policies, such as financial market, monetary and fiscal policies. Although empirical evidence has so far struggled to provide robust stylised facts on the effects of fiscal policy shocks, such literature has strongly influenced the recent theoretical modeling of fiscal policy. Notable contributions to this literature include Taylor (2000), Blanchard and Perotti (2002), Mountford and Uhlig (2009), Perotti (2005), Eichenbaum and Fisher (2005), Cavallo (2005) and Perotti et al. (2008), while the contributions post European sovereign debt crisis concentrate on the inability of some Eurozone states to repay or refinance their Sovereign debt obligations, or to bail out their over indebted financial institutions.

Demand side and supply side economic management paradigm suggest the need to decompose the macroecomomic indicators into their transitory and permanent components to facilitate the analysis of fiscal policy effects over the economic cycle. A detailed literature on the isolation of macroeconomic variables into their short and long run components can be found in Kydland and Prescott (1990), Romer (1993) and Stock and Watson (1999). Hodrick and Prescott (1997) and Baxter and King (1999), as will be discucssed later. According to Blanchard et al. (1986), Shapiro (1987), Blanchard and Quah (1988), Shapiro and Watson (1988), Quah (1988) and Gali (1992), short term, or transitory, economic fluctuations emanate from changes in financial market, monetary and fiscal policies, including consumer and business sentiment. The long term, or permanent, economic fluctuations emanate from the nominal rigidities that include changes in technological advancement, deregulation as well as multilateral agreements. The short term economic fluctuations are, therefore, determined by demand side shocks, while long term economic fluctuations are determined by the supply side disturbances.

This paper analyses the reaction of the minerals industry to fiscal policy *developments* in South Africa. This is achieved by augmenting a Taylor (1993) rule type central bank monetary policy reaction function with Government expenditure. Understanding the reaction of the minerals industry to fiscal policy *developments* over the economic cycle is important to mining authorities and policymakers alike. For instance, the comovement, or divergence, of the fluctuations of different economic sectors and industries, as with the minerals industry, could be because they behave differently to the common endogenous and exogenous shocks. As opposed to the macroeconomics literature, according to the European Central Bank (ECB) (2012) and Morgan Stanley Capital International (MSCI). (2014), the investment literature distinguishes between types of industries, categorised into defensive, cyclical and sensitive industries, based on how they respond to economic fluctuations over the economic cycle. Keynesian economics view fiscal expansions, via Government spending increases or tax cuts, as beneficial to stimulate economic growth, which has been the subject of a long standing debate about both the theoretical validity and the practical importance of fiscal policy to macroeconomic fluctuations.

The paper is organised as follows. The next section discusses the data. This is followed by the specification of the model and the estimation technique. The subsequent section reports the empirical results and last is the conclusion, together with recommendations and areas of further research.

Data

Monthly data spanning the period January 2000 to December 2023 is used to analyse the reaction of the minerals industry to fiscal policy *developments*. The variables comprise mining and quarrying output, inflation rate, monetary policy interest rate and Government expenditure. Mining, or mining and quarrying industry, output is Gross Value Added (GVA) of the mining and quarrying industry. Inflation rate, or the change in annual Consumer Price Index (CPI), is the annual headline consumer price inflation. Monetary policy interest rate, or central bank interest rate, is the short term policy rate, called repurchase rate, and is the rate at which private sector banks borrow from the central bank. Government expenditure is the general Government spending that includes all Government consumption, investment and transfer payments. The data on mining output, inflation rate and Government expenditure was sourced from Statistics South Africa, while the data on the interest rate was sourced from the South African Reserve Bank. The descriptions and sources of the variables are presented in Table 1. Mining and quarrying output is denoted $GVAMng$, inflation rate, is denoted $CPIRate$, monetary policy interest rate, is denoted $CBRate$, while $GOVExp$ is Government expenditure.

Variable	Denotation	Description
Mining output	GVAMng	Gross Value Added (GVA) of the mining and quarrying, or minerals, industry
Inflation rate	CPIRate	Inflation rate, or annual Consumer Price Index (CPI), is the annual headline consumer price inflation
Interest rate	CBRate	Central bank policy rate and is the rate at which private sector banks borrow from the central bank
Government expenditure	GOVExp	Government spending, or expenditure, includes all Government consumption, investment and transfer payments

Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarrying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI, central bank monetary policy interest rate, is denoted $CBRate$ and $GOVExp$ is Government expenditure.

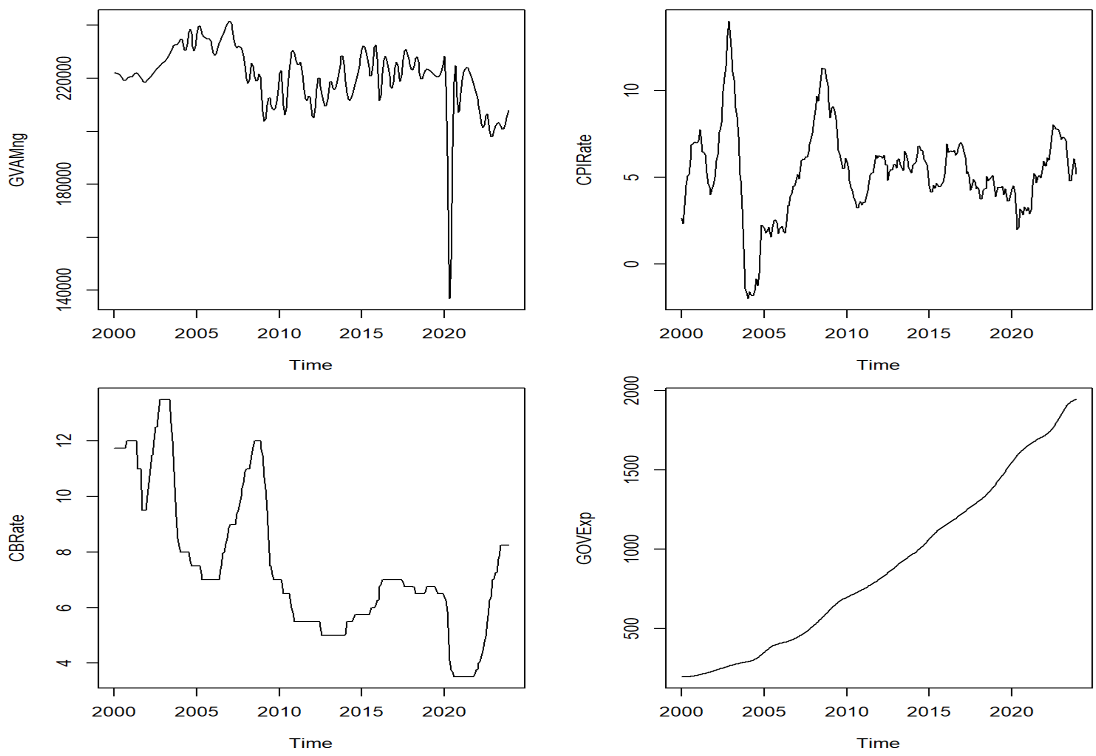
Table 1: Description of the variables

The evolution of the variables are depicted in Figure 1. Output of the mining and quarrying industry increased between 2003 and 2007, where it reached a peak, and decreased significantly to 2009. The decrease in output of the mining and quarrying was due to the onset of the Global financial crisis in late 2008. Output of the mining and quarrying industry then increased, albeit volatile, from 2010 to 2015 where it subsequently decreased from 2016 to 2023, and more so in 2022 and 2023. The significant decrease in output of the mining and quarrying in 2020 was due to the onset of the Covid 19 pandemic. Inflation rate, or the change in annual Consumer Price Index (CPI), increased from 2000 and reached a peak in 2003 where it decreased significantly and bottomed in 2004. Inflation rate increased again between 2005 and 2008 before it decreased between 2009 and 2011. The indicator then remained range bound but volatile between 2012 and 2021 where it then spiked in in 2022 before decreasing in 2023. The movements of the central bank monetary policy interest rate closely mirrored the movements in inflation rate during the sample period between 2000 and 2023. However, the interest rate, which is the rate at which private sector banks borrow from the central bank, was generally in a down ward trend between 2000 and 2023 with notable spikes and peaks in 2003, 2008 and 2003, while the opposite is true in 2005, 2013 as well as in 2021. The central bank interest rate increased substantially from early 2022 to match the rising consumer price inflation in the same period.

Government expenditure, or the Fiscal policy stance, maintained an upward trend between 2000 and 2023, or throughout the sample period. Although Government expenditure was increasing since 2000, it accelerated notably from around 2008 and peaked in 2023. The fluctuations in Government expenditure were subtle indicating a stable and consistent increase in Government consumption, investment and transfer payments throughout the sample period. The variables were transformed to the deviation from their Hodrick and Prescott (1997) trends. 24 months were forecasted at the end of each variable series to correct the Hodrick and Prescott (1997) trend end point problem following Ravn and Uhlig (2002) and Mise et al. (2005). Dating the phases of the economic time series as well as decomposing the economic time series into its short run and long run components are discussed in Burns and Mitchell (1946), Friedman et al. (1963), Romer (1986), Gordon (2007), Kydland and Prescott (1990), Romer (1993), Stock and Watson (1999). Hodrick and Prescott (1997) as well as Baxter and King (1999). Decomposing the economic time series its unobserved short term, or cyclical, as well as long term, also called permanent or trend, components facilitates the analysis of the reaction of the minerals, or mining and quarrying, industry to Government spending *developments* over the economic cycle.

Methodology

A Vector Autoregression (VAR) model is estimated *used* to capture the relationship between the minerals industry and fiscal policy developments. The specified Vector Autoregression (VAR) model follows Stock and Watson (2001) and Kadiyala and Karlsson (1997). Vector Autoregression (VAR)



Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarrying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI, central bank monetary policy interest rate, is denoted $CBRate$ and $GOVExp$ is Government expenditure. The x axis depicts the time period.

Figure 1: Plots of the variables

models were introduced in applied macroeconomic research by Sims (1980), while the early contributions to their Bayesian equivalents include Litterman (1984). According to Stock and Watson (2001) and Rudebusch (1998), the Vector Autoregression (VAR) is a system of linear equations, one for each variable. In the reduced form, each equation in a Vector Autoregression (VAR) model specifies one of the variables as a linear function of its own lagged values as well as the lagged values of other variables being considered in the system and a serially uncorrelated error term. In general, for a VAR(p) model, the first p lags of each variable in the system are used as regression predictors for each variable.

The Vector Autoregression (VAR) models have become standard tools in macroeconomics structural analysis and forecasting, as argue Giannone et al. (2010), Koop and Korobilis (2010) and Koop (2013). According to Del Negro and Schorfheide (2011), these models can capture the important stylised facts about the economic time series despite their simple formulation. These include the decaying pattern in the values of the autocorrelations as the lag order increases and the dynamic linear interdependencies between the model variables. A Vector Autoregression (VAR) model is specified as follows

$$Y_t = \delta + \theta_1 Y_{t-1} + ... + \theta_p Y_{t-p} + \epsilon_t \tag{1}$$

where $Y_t = (Y_{1,t}, ..., Y_{n,t})$ is the $n * 1$ vector of random variables observed at time t. $\delta = (\delta_1, ..., \delta_n)$ is the $n * 1$ vector of constants or intercept terms, $\theta_1, ..., \theta_p$ are $n * n$ matrices of coefficients, p is the number of lags of each of the n variables and $\epsilon_t = (\epsilon_{1,t}, ..., \epsilon_{n,t})$ is the $n * 1$ dimensional white noise error terms denoted

$$\epsilon_t \sim N(0, \Sigma) \tag{2}$$

where Σ is the $n * n$ variance covariance matrix. Evans and Kuttner (1998), Rudebusch (1998) and Stock and Watson (2001) argue that the error terms are the unanticipated policy shocks, or the surprise movements, after taking the Vector Autoregression (VAR) model's past values into account.

A general matrix notation of a Vector Autoregression (VAR) model with p number of lags, or VAR(p), and no deterministic regressors, can be written as

$$\begin{bmatrix} Y_{1,t} \\ Y_{2,t} \\ \vdots \\ Y_{n,t} \end{bmatrix} = \begin{bmatrix} \delta_1 \\ \delta_2 \\ \vdots \\ \delta_n \end{bmatrix} + \begin{bmatrix} \theta_{1,1} & \theta_{1,2} & \cdots & \theta_{1,n} \\ \theta_{2,1} & \theta_{2,2} & \cdots & \theta_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ \theta_{n,1} & \theta_{n,2} & \cdots & \theta_{n,n} \end{bmatrix} \begin{bmatrix} Y_{1,t-1} \\ Y_{2,t-1} \\ \vdots \\ Y_{n,t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \\ \vdots \\ \epsilon_{n,t} \end{bmatrix} \tag{3}$$

where in this instance, p, or the number of lags, is equal to 1 for each of the n variables. A detailed discussion on Vector Autoregression (VAR) models can be found in Hamilton (1994), while recent contributions include Lütkepohl (2005), Koop and Korobilis (2010) and Giannone et al. (2015).

The Vector Autoregression (VAR) model is estimated using Bayesian methods. A Minnesota prior is specified and a Gibbs style sampler is used in estimation following Kadiyala and Karlsson (1997). At the heart of Bayesian analysis is the Bayes theorem specified as

$$P(\theta_i, \Sigma \mid Y_t, M_i)\, P(Y_t \mid \Sigma, M_i) = P(Y_t \mid \theta_i, \Sigma, M_i)\, P(\theta_i, \Sigma \mid M_i) \tag{4}$$

where M_i is an arbitrary model among a general class of models, θ_i is the parameter vector described above, $p(\theta_i \mid Y_t, M_i)$ is the posterior model probability, $p(Y_t \mid \theta_i, M_i)$ is the marginal likelihood of the model, $p(\theta_i \mid M_i)$ is the prior model probability and $p(Y_t \mid M_i)$ is the constant integrated likelihood over all models. The details on a Bayesian Vector Autoregression (BVAR) model estimation with Minnesota prior, first introduced in Litterman (1979), Litterman (1980) and Litterman (1984) and developed in Sims (1989), is used in this study, while a brief introduction to Bayesian econometrics and Bayesian Vector Autoregression models, can be found in O'Hara (2015). A more general treatment of Vector Autoregression (VAR) models, including Bayesian estimation with the different types of priors, can be found in Koop and Korobilis (2010), Canova (2011) as well as Giannone et al. (2015).

According to Rudebusch (1998), the appeal of using Vector Autoregression (VAR) models for analysing policy reaction functions is that they have the ability to identify the effects of policies without a need to specify a complete structural model of the economy. Giannone et al. (2010) contend that the Vector Autoregression (VAR) models have become popular among the empirical macroeconomists because they facilitate insight into the dynamic relationships between macroeconomic variables in a relatively unconstrained manner. Koop and Korobilis (2010) and Koop (2013) further argue that the Bayesian methods have become an increasingly popular way of dealing with the problem of over parameterisation of economic models given the limited length of standard macroeconomic datasets. Vector Autoregression (VAR) models can be used successfully in macroeconomic forecasting with a large number of variables when coupled with Bayesian estimation, as argue Sims and Uhlig (1991), due to the flexibility provided by the application of the Bayesian parameter shrinkage. Sims and Uhlig (1991) further argue that Bayesian versions of these models can incorporate unit root nonstationary variables with no disadvantageous influence on the inference of the parameters of the model.

Results

A Bayesian Vector Autoregression (BVAR) model was estimated to capture the relationships between the minerals industry and fiscal policy developments, as discussed. The estimated Bayesian Vector Autoregression (BVAR) specifies a Minnesota prior and uses a Gibbs style sampler following Stock and Watson (2001) and O'Hara (2015). The 0.05 prior was set on all coefficients except the own first lags which were set to 0.95 to account for persistence in the variables. The number of lags to include of each variable was set to 4 following the Schwarz (1978) Bayesian information criterion. The integer value for the horizon of the Impulse Response Functions (IRFs) was set to 24, corresponding to 2 years, given that monthly data is used in estimation. 10000 is the number of Gibbs sampler replications to keep from the sampling run, while 1000 is the sampling burn in length for the Gibbs sampler. Gibbs sampling, or Gibbs sampler, is a Markov Chain Monte Carlo (MCMC) technique used to sample from probability distributions, where the Gibbs sampler draws iteratively from the posterior conditional probability distributions rather than sampling from the joint posterior probability distribution.

Conventional macroeconomic models suggest two policy "anchors" to stabilise the cyclical behavior of economic activity, as discussed, namely monetary policy and fiscal policy. According to Mishkin (2011), stabilisation of the cyclical behavior of economic activity requires planning for the possibility of substantial fiscal impacts from monetary policy and the possibility of significant fiscal pressures on monetary policy. Consequently, the central bank monetary policy interest rate cannot control the cyclical behavior of economic activity if fiscal policy provides it with no backing, while the converse is also true for fiscal policy. A Taylor (1993) rule type central bank monetary policy reaction function with the output of the minerals industry is, thus, augmented with the fiscal policy measure, or Government expenditure as follows

$$i_t = \rho + \theta_\pi(\pi_t - \pi_t^*) + \theta_Y(Y_t - \bar{Y_t}) + \theta_G(G_t - \bar{G_t}) + \epsilon_t \quad (5)$$

where i_t is the nominal interest rate, ρ is the natural rate of interest, π_t is the inflation rate, π_t^* is the central bank target for inflation, Y_t is output, $\bar{Y_t}$ is the natural rate of output, G_t is Government expenditure, while $\bar{G_t}$ is the natural rate of Government expenditure. θ_π, θ_Y and θ_G are the responsiveness of the nominal interest rate to the deviations of inflation from the central bank inflation target, the deviations of output from its natural rate and the deviations of Government expenditure from its natural rate, respectively. ϵ_t is the error term and the subscript t denotes the time period. The central bank monetary policy reaction function captures the process through which monetary policy decisions affect the price level in particular and the economy in general. The specified central bank monetary policy reaction function ensures a market clearing, or equillibrium, condition, in that when output equals its steady state level, inflation is the same as its target rate and Government spending equals its steady state level, hence the nominal interest rate is also equivalent to its natural rate.

The list of variables in the specified central bank monetary policy reaction function comprises output of mining and quarrying, denoted $GVAMng_t$, consumer price inflation, denoted CPI_t, monetary policy interest rate, denoted $CBRate_t$ and Government expenditure, denoted $GOVExp_t$. Y_t in Equation 1 can, thus, be rewritten as

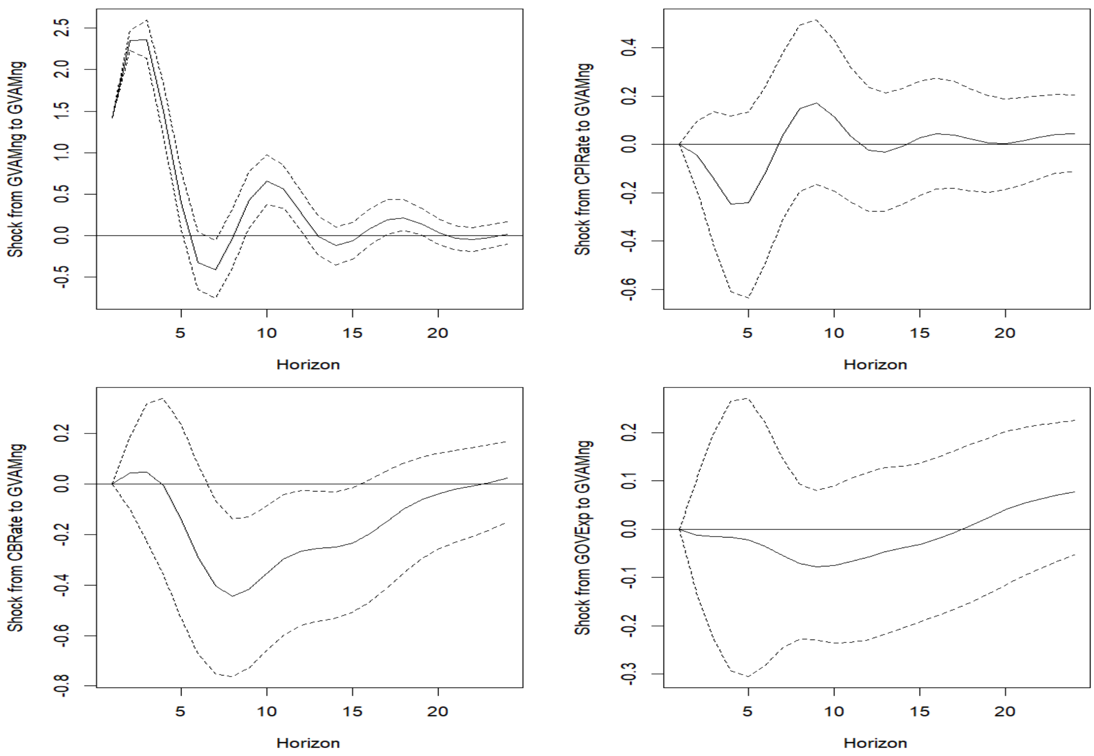
$$Y_t = (GVAMng_t, CPI_t, CBRate_t, GOVExp_t) \quad (6)$$

where Y_t is the vector of random variables observed at time t. Stock and Watson (2001) argue that a reduced form Vector Autoregression (VAR), on the one hand, expresses each variable as a linear function of its own past values, the past values of all other variables being considered and a serially uncorrelated error term. On the other hand, a recursive Vector Autoregression (VAR) constructs the error terms in each regression equation to be uncorrelated with the error in the preceding equations by including contemporaneous values as regressors. As a result, the results of a recursive Vector Autoregression (VAR) depend on the order of the variables where changing the order of the model variables changes the equations, coefficients and residuals of the Vector Autoregression (VAR).

According to Stock and Watson (2001), the standard practice in the Vector Autoregression (VAR) model analysis is to report the results from Impulse Response Functions (IRFs) and Forecast Error Variance Decompositions (FEVDs). The reason is that these statistics are more informative than the estimated Vector Autoregression (VAR) regression coefficients. Rudebusch (1998) further argues that most Vector Autoregression (VAR) model equations do not have a clear structural interpretation. Vector Autoregression (VAR) models are also atheoretical, that is, they are not built on some economic theory hence a theoretical structure is not imposed on the equations. Every variable is assumed to influence every other variable in the system, which makes a direct interpretation of the estimated coefficients difficult, according to Hyndman and Athanasopoulos (2018). Therefore, in this study, the Impulse Response Functions (IRFs) are the only model statistics that are reported given that the interest is to analyse the reaction of the minerals industry to Government spending developments.

The variables were transformed to stationarity in that they were decomposed into deviations from their long term trends. The detrending is useful conceptually because it eliminates the common steering force that time may have on each variable series and hence induces stationarity. As such, the variables are mean reverting, thus, the Bayesian Vector Autoregression (BVAR) model is assumed to be covariance stationary. As discussed above, Rudebusch (1998) and Stock and Watson (2001) argue that the residuals of the Vector Autoregression (VAR) model are unanticipated shocks, or surprise movements in the variables. According to Stock and Watson (2001), the Impulse Response Functions (IRFs) trace out the response of current and future values of each of the variables to a unit increase in the current value of one of the Vector Autoregression (VAR) errors. This error is assumed to return to zero in subsequent periods and that all other errors are equal to zero. Consequently, the Impulse Response Functions (IRFs) show the impact, or effect, of a unit, or 1 percentage point, change in the variable under consideration on the rest of the Vector Autoregression (VAR) model variables.

Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model for the reaction of the minerals industry output to innovations, or shocks, in the other variables are depicted in Figure 2, together with their 95 percent confidence intervals, or bands. According to the results, following an unexpected 1 percentage point increase in output of the minerals industry, minerals industry output initially increases and peaks at 2.36 percentage points after 3 months. The increase is followed by a rapid decrease where the minerals industry output bottoms out at -0.40 percentage points after 7 months. The initial surprise increase in minerals industry output remains statistically significant for about 12 months following which its potency begins to progressively wane, or dissipate. Output of the minerals industry, thereafter, rapidly moves towards its steady state level in about 20 months.



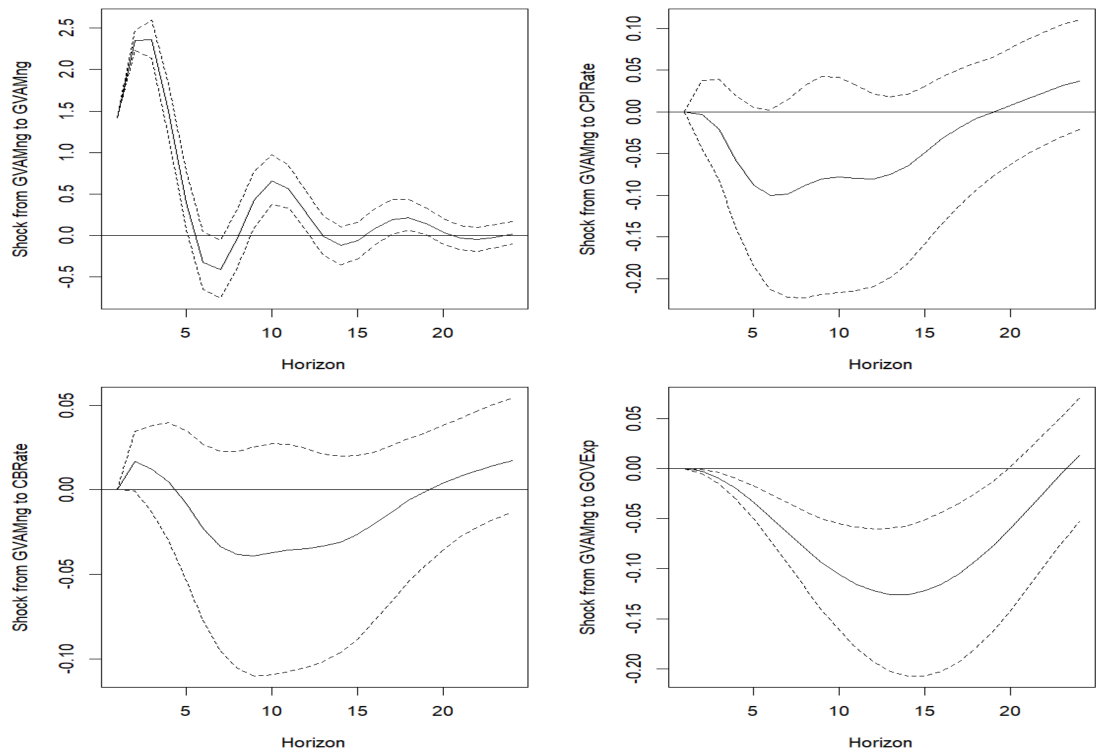
Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarrying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI, central bank monetary policy interest rate, is denoted $CBRate$ and $GOVExp$ is Government expenditure. The x axis depicts the horizon of Impulse Response Functions (IRFs).

Figure 2: Impulse Response Functions (IRFs) with shocks to output of the minerals industry

Following an unexpected 1 percentage point increase in consumer price inflation, the minerals industry output initially decreases and bottoms out at -0.25 percentage points after 5 months. Output of the minerals industry then increases, peaking at 0.17 percentage points after 9 months. Output of the Minerals industry subsequently fluctuates around, and progressively tends towards, its natural rate. The surprise increase in consumer price inflation is, however, statistically insignificant in all periods. Following an unexpected 1 percentage point increase in monetary policy interest rate, output of the minerals industry increases slightly and peaks after 4 months. The initial increase in output of the minerals industry is followed by a decrease where the minerals industry output bottoms out at -0.44 percentage points after 8 months. The effect of the surprise increase in monetary policy interest rate is, however, statistically significant between 6 and 15 periods, following which it begins to progressively fade and hence the minerals industry output gradually tends towards its steady state, level. Following an unexpected 1 percentage point increase in Government expenditure, output of the minerals industry decreases slightly and bottoms out at -0.08 percentage points after 9 months. The initial decrease in output of the minerals industry is subsequently followed by a stable increase, and gradually tends towards its equilibrium, or steady state, level after 17 periods. The effect of the surprise increase in Government spending on output of the mining industry is statistically insignificant in all periods.

Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model with innovations, or shocks, in the minerals industry output are depicted in Figure 3, together with their 95 percent confidence intervals, or bands. The results of the reaction of the minerals industry output to an unexpected 1 percentage point increase in minerals industry output, or its own innovations, are reported above. Following an unexpected 1 percentage point increase in output of the minerals industry, consumer price inflation initially decreases and bottoms out at -0.10 percentage points after 6 months.

Consumer price inflation subsequently increases progressively, tends towards and fluctuates around, its equilibrium, or steady state, level. The effect, or impact, of the surprise increase in output of the minerals industry on consumer price inflation is, however, statistically insignificant in all periods.



Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarrying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI, central bank monetary policy interest rate, is denoted $CBRate$ and $GOVExp$ is Government expenditure. The x axis depicts the horizon of Impulse Response Functions (IRFs).

Figure 3: Impulse Response Functions (IRFs) with shocks from output of the minerals industry

Following an unexpected 1 percentage point increase in output of the minerals industry, the central bank monetary policy interest rate initially increases, peaking at 0.01 percentage points after 2 months. Central bank monetary policy interest rate subsequently decreases and bottoms out at -0.04 percentage points after 8 months. Central bank monetary policy interest rate subsequently increases progressively, tends towards and fluctuates around, its equilibrium, or steady state, level. The effect of the surprise increase in output of the minerals industry on consumer price inflation is, however, statistically insignificant in all periods. Following an unexpected, or surprise, 1 percentage point increase in output of the minerals industry, Government expenditure initially decreases and bottoms out at -0.13 percentage points after 13 months. Government expenditure subsequently recovers and increases after 23 months before it progressively progressively, tends towards and fluctuates around, its equilibrium, or steady state, level. The effect of the unexpected, or surprise, increase in output of the minerals industry on Government expenditure becomes statistically significant immediately and remains statistically significant up to 19 months, consietent with the countercyclical fiscal policy.

As discussed, Keynesian economics hypothesise that, higher Government spending or lower taxes during a recession may help economic recovery, according to Abel and Bernanke (2001). In this manner, fiscal policy is referred to as countercyclical, such that discretionary spending cuts and tax increases during economic booms are compensated for by Government spending increases and tax cuts during recessions, while the opposite policy stance by Government is refereed to as Procyclical. The empirical results of the Vector Autoregression (VAR) model for the reaction of the minerals industry output to fiscal policy developments as well as the reaction of fiscal policy developments to the minerals industry output show evidence of a countercyclical Government spending in South Africa. This is particularly the case with results of the Vector Autoregression (VAR) model for the reaction of fiscal policy developments to the minerals industry output. Statistics South Africa notes that the focus of Government spending has shifted away from non financial assets and goods and services, including investment in infrastructure, towards social benefits and interest payments on Government debt. Nevertheless, the evidence of countercyclical Government spending implies that fiscal policy supports economic growth and sustainable public finances, enabling fiscal policy to adjust to the up and down movements of the business cycle and to manage sovereign indebtedness and volatility.

Impulse Response Functions (IRFs) of the empirical results of the Vector Autoregression (VAR) model for the reaction of the minerals industry output to fiscal policy developments as well as the reaction of fiscal policy developments to the minerals industry output show evidence of a countercyclical Government spending in South Africa are small relative to theoretical prescriptions. According to Christiano et al. (1999) and Christiano et al. (2011), Government spending multiplier can be somewhat above or below one depending on the exact specification of agent's preferences in the standard new Keynesian models, while they are typically less than one in frictionless Real Business Cycle (RBC) models. Blanchard and Perotti (2002), further argue that the multipliers for both spending and tax shocks are typically small, while they also present evidence that positive Government spending shocks have a positive effect on output, implying procyclical fiscal policy, whereas positive tax shocks have a negative effect. Economic theory and empirical evidence also indicate that the size of multipliers may vary across fiscal instruments and the state of the economic cycle, as argue Hemming et al. (2002) and Woodford (2011), hence it seems important to distinguish between different components of the Government budget. Empirical evidence, thus, shows that the scale, or size, of fiscal multipliers depend on the state of the economic cycle, the nature of scale policy and the level of Government debt.

Conclusion

This paper analyses the reaction of the minerals industry to Commodity price *developments* in South Africa. This is achieved by augmenting a Taylor (1993) rule type central bank monetary policy reaction function with a measure of commodity prices. According to the results, following an unexpected, or surprise, increase in Government expenditure, output of the minerals industry decreases slightly and bottoms out after 9 months, where it then increase gradually and tends towards its equilibrium, or steady state, level after 17 months. Conversely, following an unexpected increase in output of the minerals industry, Government expenditure decreases and bottoms out after 13 months, where it recovers and subsequently increases after 23 months before it progressively and tends towards its equilibrium, or steady state, level. However, the effect of surprise increase in Government spending on output of the mining industry is statistically insignificant in all periods, while the effect surprise increase on output of the mining industry is statistically significant immediately up to 19 months.

The results are generally consistent with countercyclical fiscal policy as hypotesised by Keynesian economics, of higher Government spending or lower taxes during a recession and lower Government spending or higher taxes during the economic recovery. This a particularly so for the decrease in Government spending as output of the mining industry increases. The results, therefore, support the use of short term economic stabilisation policies to manage economic activity, hence the Government should continue to monitor and manage spending to support overall economic activity as well as the minerals industry. Several economic indicators, such as the monetary policy interest rates, prices of commodities and financial assets as well as foreign exchange rate, affect economic activity, at least theoretically, hence it's important for future research to analyse their impact on the minerals industry.

References

Abel, A. B. and Bernanke, B. S. (2001). *Macroeconomics*. Addison Wesley, Boston, Massachusetts, 4th edition.

Arezki, R. (2011). Fiscal Policy in Commodity-Exporting Countries: Stability and growth. In Arezki, R., Gylfason, T., and Sy, A. N., editors, *Beyond the Curse: Policies to Harness the Power of Natural Resources*, pages 131–148. International Monetary Fund (IMF), Washington, D.C.

Atkinson, G. and Hamilton, K. (2003). Savings, Growth and the Resource Curse Hypothesis. *World development*, 31(11):1793–1807.

Baxter, M. and King, R. G. (1999). Measuring Business Cycles: Approximate Band Pass Filters for Economic Time Series. *Review of Economics and Statistics*, 81(4):575–593.

Blanchard, O. and Perotti, R. (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *Quarterly Journal of Economics*, 117(4):1329–1368.

Blanchard, O. J., Hall, R. E., and Hubbard, R. G. (1986). Market Structure and Macroeconomic Fluctuations. *Brookings Papers on Economic Activity*, 1986(2):285–338.

Blanchard, O. J. and Quah, D. (1988). The Dynamic Effects of Aggregate Demand and Supply Disturbances. *Working Papers Series*, 2737. National Bureau of Economic Research (NBER).

Burns, A. F. and Mitchell, W. C. (1946). *Measuring Business Cycles.* National Bureau of Economic Research (NBER), Cambridge, Massachusetts.

Canova, F. (2011). *Methods for Applied Macroeconomic Research.* Princeton University Press, Princeton, New Jersey.

Cavallo, M. (2005). Government Employment Expenditure and the Effects of Fiscal Policy Shocks. *Working Paper Series*, 16. Federal Reserve Bank of San Francisco (FRBSF).

Christiano, L., Eichenbaum, M., and Rebelo, S. (2011). When is the Government Spending Multiplier Large? *Journal of Political Economy*, 119(1):78–121.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1999). Monetary Policy Shocks: What Have We Learned and To What End? *Handbook of macroeconomics*, 1:65–148.

Cuddington, J. (1989). Commodity Export Booms in Developing Countries. *The World Bank Research Observer*, 4(2):143–165.

Del Negro, M. and Schorfheide, F. (2011). Bayesian Macroeconometrics. *Handbook of Bayesian Econometrics*, 1(7):293–387.

Diebold, F. X. and Rudebusch, G. D. (1970). Measuring Business Cycles: A Modern Perspective. *Review of Economics and Statistics*, 78(1):67–F77.

Eichenbaum, M. and Fisher, J. (2005). Fiscal Policy in the Aftermath of 9/11. *Journal of Money, Credit and Banking*, 37(1):1–22.

European Central Bank (ECB) (2012). Stock Prices and Economic Growth. *Monthly Bulletin*, October. European Central Bank (ECB).

Evans, C. and Kuttner, K. N. (1998). Can VARs Describe Monetary Policy? *Working Paper Series*, 9812. Federal Reserve Bank of Chicago.

Friedman, M., Schwartz, A. J., et al. (1963). *Money and Business Cycles.* Bobbs-Merrill Company, Indianapolis, Indiana.

Gali, J. (1992). How Well Does the IS-LM Model Fit Post War US Data? *The Quarterly Journal of Economics*, 107(2):709–738.

Giannone, D., Banbura, M., and Reichlin, L. (2010). Large Bayesian Vector Autoregressions. *Journal of Applied Econometrics*, 25(1):71–92.

Giannone, D., Lenza, M., and Primiceri, G. E. (2015). Prior Selection for Vector Autoregressions. *Review of Economics and Statistics*, 97(2):436–451.

Gordon, R. J. (2007). *The American Business Cycle: Continuity and Change*, volume 25. University of Chicago Press, Chicago.

Hadri, K. (2011). Primary Commodity Price Series: Lessons for Policymakers in Resource-Rich Countries. In Arezki, R., Gylfason, T., and Sy, A. N., editors, *Beyond the Curse: Policies to Harness the Power of Natural Resources*, pages 131–148. International Monetary Fund (IMF), Washington, D.C.

Hamilton, J. D. (1994). *Time Series Analysis*, volume 2. Princeton university press, Princeton, New Jersey.

Hamilton, K. and Ley, E. (2012). Sustainable Fiscal Policy for Mineral Based Economies. In Arezki, R., Gylfason, T., and Sy, A. N., editors, *Beyond the Curse: Policies to Harness the Power of Natural Resources*, pages 131–148. International Monetary Fund (IMF), Washington, D.C.

Hemming, R., Kell, M., and Mahfouz, S. (2002). The Effectiveness of Fiscal Policy in Stimulating Economic Activity: A Review of the Literature. *Working Paper Series*, 02/208. International Monetary Fund (IMF).

Hodrick, R. and Prescott, E. C. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*, 29(1):1–16.

Hyndman, R. and Athanasopoulos, G. (2018). *Forecasting: Principles and Practice*. OTexts, Melbourne, Victoria, 2nd edition.

Kadiyala, K. R. and Karlsson, S. (1997). Numerical Methods for Estimation and Inference in Bayesian VAR models. *Journal of Applied Econometrics*, 12(2):99–132.

Kaminsky, G. L., Reinhart, C. M., and Vegh, C. A. (2004). When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies. *Macroeconomics Annual*, 19:11–53. National Bureau of Economic Research (NBER).

Koop, G. and Korobilis, D. (2010). Bayesian Multivariate Time Series Methods for Empirical Macroeconomics. *Foundations and Trends in Econometrics*, 3(4):267–358.

Koop, G. M. (2013). Forecasting With Medium and Large Bayesian VARs. *Journal of Applied Econometrics*, 28(2):177–203.

Kydland, F. E. and Prescott, E. C. (1990). Business Cycles: Real Facts and a Monetary Myth. *Quarterly Review*, 4:3–18. Federal Reserve Bank of Minneapolis.

Litterman, R. (1984). Forecasting and Policy Analysis With Bayesian Vector Autoregression Models. *Quarterly Review*, Fall. Federal Reserve Bank of Minneapolis.

Litterman, R. B. (1979). Techniques of Forecasting Using Vector Autoregressions. *Working Paper Series*, 115. Federal Reserve Bank of Minneapolis.

Litterman, R. B. (1980). Bayesian Procedure for Forecasting with Vector Autoregressions. *Working Paper Series*, 274. Federal Reserve Bank of Minneapolis.

Lütkepohl, H. (2005). *New Introduction to Multiple Time Series Analysis*. Springer Books, New York.

Mise, E., Kimand, T., and Newbold, P. (2005). On Suboptimality of the Hodrick Prescott Filter at Time Series Endpoints. *Journal of Macroeconomics*, 27(1):53–67.

Mishkin, F. S. (2011). Monetary Policy Strategy: Lessons from the Crisis. *Working Paper Series*, 16755. National Bureau of Economic Research (NBER).

Morgan Stanley Capital International (MSCI). (2014). Cyclical and Defensive Sectors. *Indexes Methodology*, June. Morgan Stanley Capital International (MSCI).

Mountford, A. and Uhlig, H. (2009). What are the Effects of Fiscal Policy Shocks? *Applied Economics*, 24(6):960–992.

O'Hara, K. (2015). *Bayesian Macroeconometrics in R*. New York University Press, New York, 0.5.0 edition.

Perotti, R. (2005). Estimating the Effects of Fiscal Policy in OECD Countries. *Working Paper Series*, 168. European Central Bank (ECB).

Perotti, R., Reis, R., and Ramey, V. (2008). In Search of the Transmission Mechanism of Fiscal Policy. *NBER macroeconomics Annual*, 22:169–249. National Bureau of Economic Research (NBER).

Quah, D. (1988). Sources of Business Cycle Fluctuations: Comments. *Macroeconomics Annual*, 3:151–155. National Bureau of Economic Research (NBER).

Ravn, M. O. and Uhlig, H. (2002). On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations. *Review of Economics and Statistics*, 84(2):371–376.

Rigobon, R. (2004). When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies: Comment. *Macroeconomics Annual*, 19:62–79. National Bureau of Economic Research (NBER).

Romer, C. D. (1986). Is the Stabilization of the Postwar Economy a Figment of the Data? *The American Economic Review*, 76(3):314–334.

Romer, C. D. (1993). Business Cycles. In Henderson, D. R., editor, *The Fortune: Encyclopedia of Economics*, volume 330.03 F745f. Warner Books.

Rudebusch, G. D. (1998). Do Measures of Monetary Policy in a VAR Make Sense? *International Economic Review*, 39(4):907–931.

Schwarz, G. (1978). Estimating the Dimension of a Model. *Annals of Statistics*, 6:461–464.

Shapiro, M. D. (1987). Are Cyclical Fluctuations in Productivity Due More to Supply Shocks or Demand Shocks? *Working Paper Series*, 2589. National Bureau of Economic Research (NBER).

Shapiro, M. D. and Watson, M. W. (1988). Sources of Business Cycle Fluctuations. *Macroeconomics Annual*, 3:111–156. National Bureau of Economic Research (NBER).

Sims, C. A. (1980). Macroeconomics and Reality. *Journal of Economic Perspectives*, 48(1):1–48.

Sims, C. A. (1989). A nine Variable Probabilistic Macroeconomic Forecasting Model. *Discussion Paper*, 14. Federal Reserve Bank of Minneapolis.

Sims, C. A. and Uhlig, H. (1991). Understanding Unit Rooters: A Helicopter Tour. *Econometrica*, 59(6):1591–1599.

Stock, J. H. and Watson, M. W. (1999). Business Cycle Fluctuations in US Macroeconomic Time Series. *Handbook of Macroeconomics*, 1(Part A):3–64.

Stock, J. H. and Watson, M. W. (2001). Vector Autoregressions. *Journal of Economic Perspectives*, 15(4):101–115.

Taylor, J. B. (1993). Discretion Versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy*, 39:195–214.

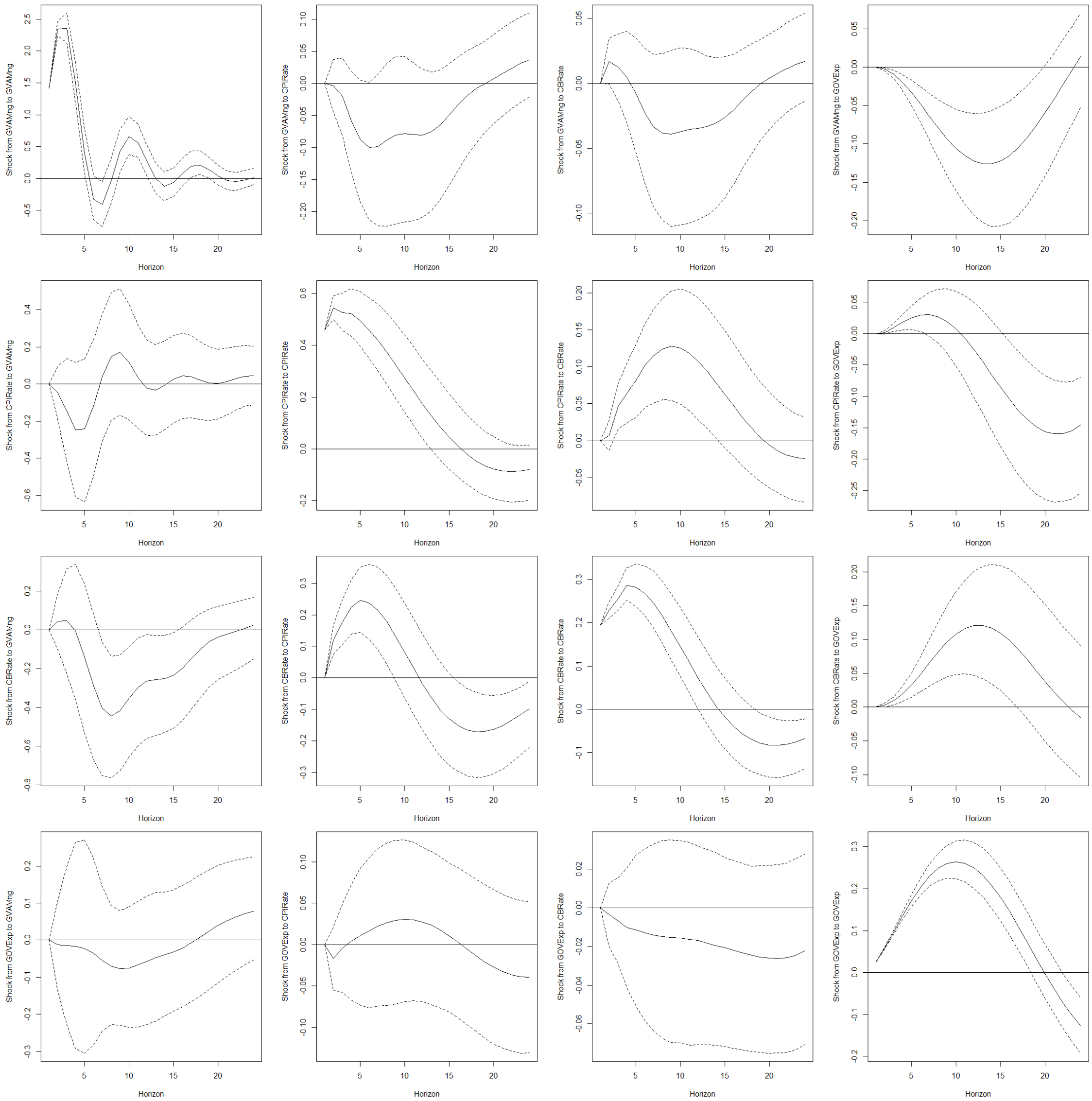
Taylor, J. B. (2000). Reassessing Discretionary Fiscal Policy. *Journal of economic Perspectives*, 14(3):21–36.

Woodford, M. (2011). Simple Analytics of the Government Expenditure Multiplier. *American Economic Journal: Macroeconomics*, 3(1):1–35.

Appendix

Appendix 1. Complete Impulse Response Functions (IRFs)

The complete Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model with Government expenditure are shown in Figure 4. This Figure is not intended to be a part of the study, but is included to demonstrate the completeness of the analysis.



Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarrying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI, central bank monetary policy interest rate, is denoted $CBRate$ and $GOVExp$ is Government expenditure. The x axis depicts the horizon of Impulse Response Functions (IRFs).

Figure 4: Complete Impulse Response Functions (IRFs) with Government expenditure