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Monetary policy *developments* and the minerals industry

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Abstract

This paper analyses the reaction of the minerals industry to monetary policy *developments* in South Africa. This is achieved using a Taylor (1993) rule type central bank monetary policy reaction function, where the total, or economy wide, output is substituted with output of the minerals industry. The reaction of the minerals industry to monetary developments is then compared to the standard monetary policy reaction function with economy wide output. The results show that, following an increase in the monetary policy interest rate, output of the minerals industry begins to decrease after 4 months and bottoms out after 8 months, following which it progressively increases and gradually tends towards its equilibrium, or steady state, level. Output of the minerals industry is statistically significant from 6 months up to 15 months following the surprise increase in the central bank monetary policy interest rate. The paper, thus, concludes that the central bank monetary policy interest rate has an important role in management and stabilisation of aggregate economic activity as well as the minerals industry.

JEL Classification:C10, E30, E50, L70
Keywords: Monetary policy, Minerals industry, Economic cycles

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Introduction

Calibrating policy formulation, as well as investment and consumption decisions, to economic fluctuations necessitates understanding how different industries behave relative to the economic cycle. Different economic sectors and industries respond differently to endogenous and exogenous economic shocks, according to Diebold and Rudebusch (1970) and Romer (1993). A case in point is the widely accepted phenomenon, or notion, that the trend break, as well as the protracted underperformance of South Africa's minerals industry, relative to the total economy, since the 1970s was a problem of structural misalignments, hence the sector cannot be affected by changes in economic stabilisation policies, such as financial, monetary and fiscal policies. The South African minerals industry output stagnated in real terms, while it has declined progressively as a percentage of Gross Domestic product (GDP), in recent decades. Paradoxically, the aggregate economy has been growing at rates of about 4 percent between 2000 and 2010 as well as at rates above 2 percent overall in the post 2010 period.

Studying the economic cycle is a long tradition in macroeconomics, where the literature highlights the importance of the different shocks to the economy, that include the demand and supply side policies, market rigidities as well as investor and consumer sentiments, while it also emphasises the effects of shocks during the different phases and components of the economy. According to Blanchard et al. (1986), Shapiro (1987), Blanchard and Quah (1988), Shapiro and Watson (1988), Quah (1988) and Gali (1992), the short term, or transitory, economic fluctuations are determined by demand shocks while the long term, or permanent, economic fluctuations are determined by supply shocks. Thus, short term, or transitory, economic fluctuations emanate from changes in monetary, fiscal and financial market policies as well as consumer and business sentiment. The long term, or permanent, economic fluctuations emanate from the structural rigidities that include changes in technological advancement, privatisation, deregulation as well as multilateral agreements. The discussion on the interaction of macroeconomic policies and the economic fluctuations can be found in (Nelson and Plosser, 1982), Kydland and Prescott (1990), Christiano et al. (1999), Christiano et al. (2005) and Nelson (2005) while Diebold and Rudebusch (1970), Blanchard et al. (1986) and Campbell and Mankiw (1987).

A consensus view has emerged concerning the empirical effects of monetary policy shocks on the aggregate economy. This view is that monetary policy should control the level of some nominal variable, for instance, the stock of money, inflation and the price level. Christiano et al. (1999) reviews recent research on the question of What happens after an exogenous shock to monetary policy, while several theories have been advanced to this effect, including Clarida et al. (1999), Clarida et al. (2000), Svensson (2000), Woodford (1999), Woodford (2001), Svensson and Woodford (2004), Woodford and Walsh (2005), Gali and Gertler (2007), Svensson (2010) and Walsh (2010), among others. Companies normally raise capital for capital expansion programs through either debt or equity financing. Consequently, as interest rates increase, the hurdle rates, or the minimum rate of return required on a project or investment, also go up hence some investment projects can no longer go ahead as they become impracticable. The presence of such economic distortions calls for central bank monetary policy interest rate to trade off some stability of inflation and real economic activity to ensure the stability of financial and the goods and services markets, according to Walsh (2009). Such policy formulation, along with investment and consumption decisions, necessitates the understanding of how endogenous and exogenous shocks affect different industries during the different phases of the economic cycle.

This paper analyses the reaction of the minerals industry to monetary policy *developments* in South Africa. This is achieved using A Taylor (1993) rule type central bank monetary policy reaction function where the total, or economy wide, output is substituted with output of the minerals industry. The reaction of the minerals industry to monetary developments is then compared to the standard monetary policy reaction function with the economy wide output. The quest to understand how the minerals industry reacts to monetary policy *developments* over the economic cycle is paramount to mining authorities and society as well as the policymakers alike. For instance, the comovement, or divergence, of the fluctuations of different economic sectors and industries could be because they behave differently to the common endogenous and exogenous shocks. 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. Macroeconomics literature, however, seldom distinguishes between and categorise the different types of industries in a similar manner.

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. The variables comprise mining and quarrying output, total, or economy wide, output, inflation rate and monetary policy interest rate. Mining, or mining and quarrying industry, output is Gross Value Added (GVA) of the mining and quarrying industry and total, or economy wide, output is Gross Value Added (GVA) of the South African economy. Inflation rate, or the change in annual Consumer Price Index (CPI), is the annual headline consumer price inflation and the 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. The data on mining and total output as well as inflation rate 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. Output of mining and quarrying is denoted $GVAMng$, total, or economy wide, output, is denoted $GVAAll$, consumer price inflation is denoted CPI, while $CBRate$ is monetary policy interest rate.

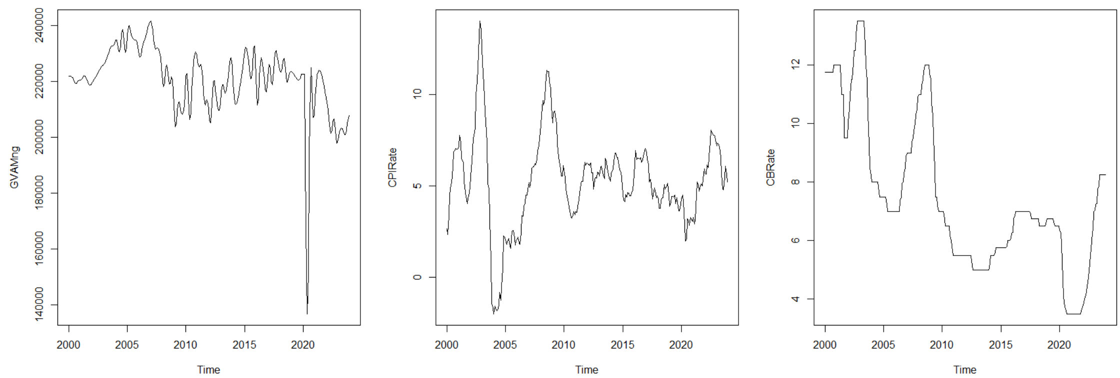
The evolution of the variables are depicted in Figures 1 and 2. Output of the mining and quarrying, or the minerals industry, increased between 2003 and 2007, where it reached a peak, and decreased significantly to 2009. The decrease in output of the mining and quarrying was due to the onset of the Global 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. The movements in output of mining and quarrying were closely mirrored by the movements in total, or economy wide, output. Although it was also affected by the onset of the Global financial crisis in late 2008 and the Covid 19 pandemic in early 2020, total, or economy wide,

Variable	Denotation	Description
Mining output	GVAMng	Gross Value Added (GVA) of the mining and quarrying, or minerals, industry
Total output	GVAAll	Total, or economy wide, output is Gross Value Added (GVA) of the South African economy
Inflation rate	CPIRate	Inflation rate, or annual Consumer Price Index (CPI), is the annual headline consumer price inflation
Interest rate	BCRate	Central bank policy rate and is the rate at which private sector banks borrow from the central bank

Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarying output is denoted $GVAMng$, total, or economy wide, output, is denoted $GVAAll$, consumer price inflation rate, is denoted CPI and central bank monetary policy interest rate, is denoted $CBRate$.

Table 1: Description of the variables

output was on upward trend during the sample period between 2000 and 2023, contrary to output of the minerals industry. Inflation rate, or the change in annual Consumer Price Index (CPI), increased from 2000 and reached a peak in about 2003 where it decreased significantly and bottomed in 2004.

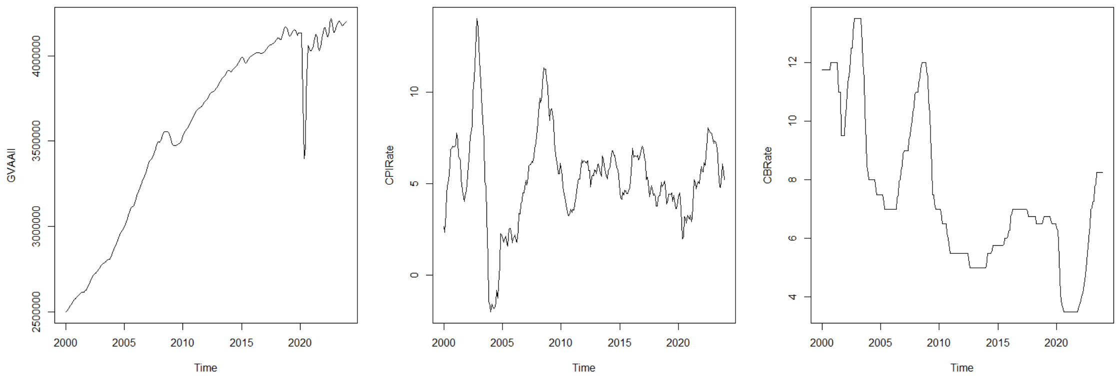


Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI and central bank monetary policy interest rate, is denoted $CBRate$. The x axis depicts the the time period.

Figure 1: Plots of the variables with output of mining and quarying

Inflation rate, or the annual change in Consumer Price Index (CPI) 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. As with output of the mining and quarrying and the total economy, the movements in 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 it bottomed out in 2005, 2013 as well as in 2021, respectively.

The variables were transformed to the deviations 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). Burns and Mitchell (1946), Friedman et al. (1963), Gordon (2007), Kydland and Prescott (1990), Romer (1993) and Stock and Watson (1999). Hodrick and Prescott (1997) as well as Baxter and King (1999) discuss detail, dating the phases of the economic time series as well as decomposing the economic time series into its components. Dating the phases of the economic time series involves indentifying the different phases of the economic, or business, cycle. Business cycles are composed of concerted cyclical upswings and downswings, or alternating phases, of economic activity that comprise expansion, peak, contraction, and trough. Economic time series data also exhibits a variety of patterns, each of which



Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Total, or economy wide, output, is denoted $GVAAll$,, consumer price inflation rate, is denoted CPI and central bank monetary policy interest rate, is denoted $CBRate$. The x axis depicts the time period.

Figure 2: Plots of the variables with output of the total economy

represents the underlying distinctive pattern, hence decomposing a time series into its components assists in understanding its unique characteristics. The components of a time series comprise the trend component, cycle component, seasonal component and the random component, or noise. The cycle is the short run, or transistory, component which is characterised by market rigidities, while the trend is the long run, or permanent, component during which all the markets clear, or are in equilibrium.

Methodology

A Vector Autoregression (VAR) model is estimated *used* to capture the reaction of the minerals industry to monetary developments. The specified Vector Autoregression (VAR) model follows Stock and Watson (2001) and Kadiyala and Karlsson (1997). Vector Autoregression (VAR) 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 all the variables in the model.

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, or lags, 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

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

where M_i is an arbitrary model among a general class of models, θ_i is the parameter vector described above, $p\left(\theta_i \mid Y_t, M_i\right)$ is the posterior model probability, $p\left(Y_t \mid \theta_i, M_i\right)$ is the marginal likelihood of the model, $p\left(\theta_i \mid M_i\right)$ is the prior model probability and $p\left(Y_t \mid M_i\right)$ 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 paper, while a brief introduction to Bayesian econometrics and Bayesian Vector Autoregression models, can be found in O'Hara (2015). A more general treatment of the 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 the Bayesian versions of these models can incorporate unit root nonstationary variables with no disadvantageous influence to the inference on the parameters of these models.

Results

A Bayesian Vector Autoregression (BVAR) model was estimated to capture the relationships between the minerals industry and monetary 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 burnin 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.

The developments in monetary policy have strong influence on interest rates, including the lending and deposit rates faced by economic agents, such as households and businesses, where, in turn, these interest rates influence economic activity, including the levels of output and inflation. A Taylor (1993) rule type central bank monetary policy reaction function is, thus, specified, where the economy wide output is substituted with the output of the minerals industry as follows

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

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, while $\bar{Y_t}$ is the natural rate of output. θ_π and θ_Y are the responsiveness of the nominal interest rate to the deviations of inflation from the central bank inflation target and the deviations of output 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, when output equals its steady state, or natural, level, inflation is equal to its target rate and 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 and monetary policy interest rate, denoted $CBRate_t$. Y_t in Equation 1 can, thus, be rewritten as

$$Y_t = (GVAMng_t, CPI_t, CBRate_t) \tag{6}$$

As discussed, the reaction of the minerals industry to monetary policy developments is compared to the standard central bank monetary policy reaction function with the economy wide level of output. Therefore, the list of variables in the central bank monetary policy reaction function comprises economy wide level of output, denoted $GVAAll_t$, consumer price inflation, denoted CPI_t and monetary policy interest rate, denoted $CBRate_t$. As a result, Y_t in Equation 1 can now be rewritten as

$$Y_t = (GVAAll_t, CPI_t, CBRate_t) \tag{7}$$

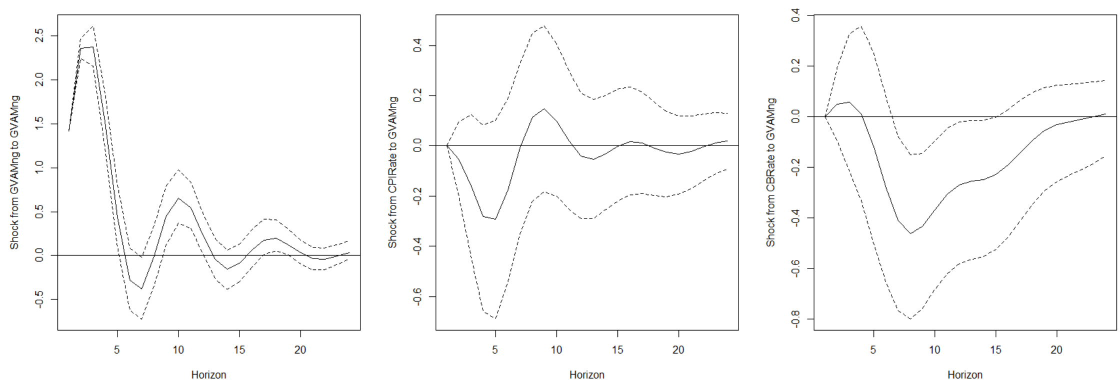
which is the vector of random variables observed at time t. Stock and Watson (2001) argue that a reduced form Vector Autoregression (VAR), on the one hand, expresses each variable as a linear function of its own past values, the past values of all other variables being considered and a serially uncorrelated 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 developments in monetary policy.

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 series and induces stationarity. As such, the variables are mean reverting, thus, the Bayesian Vector Autoregression (BVAR) 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) of the Vector Autoregression (VAR) model 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 all other errors are equal to zero. Consequently, the Impulse Response Functions (IRFs) show the effect of a unit, or 1 percentage point, change in one variable on the rest of the variables in the Vector Autoregression (VAR) model.

Vector Autoregression (VAR) models, in addition to the New KeynesianDynamic Stochastic General Equilibrium (DSGE) models, have become the most popular tools for studying the effects of monetary policy, a number of stylised facts have been broadly identified and these are summarised in Christiano et al. (1999). The Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model for the reaction of the minerals industry output to monetary policy developments are depicted in Figure 3, together with their 95 percent confidence intervals, or bands. According to the results, following an unexpected, or surprise, 1 percentage point increase in minerals industry output, output of the minerals industry initially increases and peaks at 2.37 percentage points after 3 months. The initial increase is followed by a decrease, where minerals industry output bottoms out at -0.38 percentage points after 7 months before it recovers. The surprise increase in minerals industry output remains statistically significant for about 12 months, following which its potency begins to wane and output of the minerals industry fluctuates towards its equillibrium, or steady state, level after 20 months.

The minerals industry output initially decreases and bottoms out at -0.29 percentage points after 5 months, following an unexpected, or surprise, 1 percentage point increase in consumer price inflation. The initial decrease is followed by an increase in minerals industry output, peaking at 0.15 percentage points after 9 months. Minerals industry output subsequently fluctuates around, and progressively tends towards, its natural rate. The surprise increase in consumer price inflation on ?? is, however, statistically insignificant in all periods. Following an unexpected 1 percentage point increase in monetary policy interest rate, minerals industry output initially increases slightly and peaks after 4 months. The initial increase is followed by a decrease where minerals industry output bottoms out at -0.47 percentage points after 8 months. The surprise increase in monetary policy interest rate only becomes statistically significant after 6 months and remains significant up to 15 months, following which the effect of monetary policy interest rate on minerals industry output begins to progressively fade and output of the minerals industry gradually tends towards its equillibrium, or steady state, level.

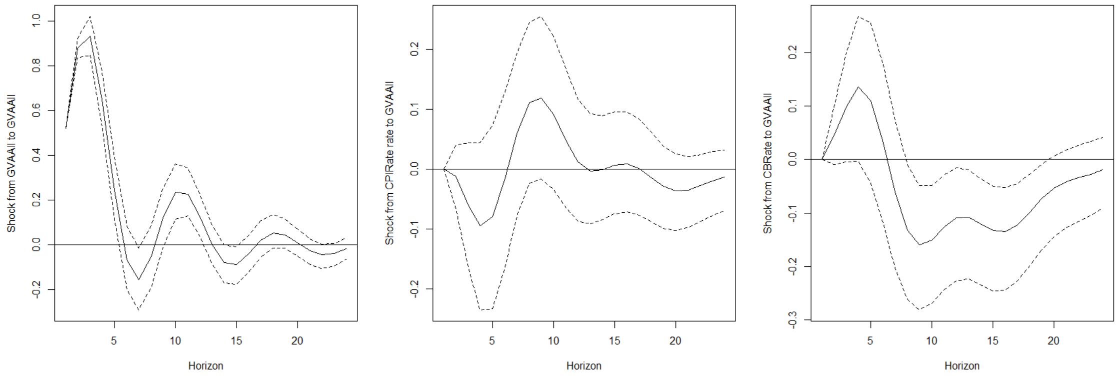


Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI and central bank monetary policy interest rate, is denoted $CBRate$. The x axis depicts the horizon of the Impulse Response Functions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

Figure 3: Impulse Response Functions (IRFs) with output of mining and quarying

The Vector Autoregression (VAR) model for the reaction of total, or economy wide, outout to monetary policy developments was also estimated to facilitate the comparison of its reaction to the reaction of the minerals industry output to monetary policy developments. The Impulse Response Functions (IRFs) of this Vector Autoregression (VAR) model are depicted in Figure 4, together with their 95 percent confidence intervals, or bands. According to the results, following an unexpected 1 percentage point increase in total output, total output initially increases and peaks at 2.37 percentage points after 3 months. The initial increase is followed by a decrease where total output bottoms out at -0.38 percentage points after 7 months. The surprise increase in economy wide output remains statistically significant for about 12 months following which its potency begins to wane and economy wide output progressively tends towards its equilibrium, or steady state, level after 20 months.

The economy wide output initially decreases and bottoms out at -0.10 percentage points after 4 months, following an unexpected 1 percentage point increase in consumer price inflation. The initial decrease is followed by an increase where economy wide output peaks at 0.12 percentage points after 9 months. The indicator 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, economy wide output initially increases slightly and peaks after 4 months. The initial increase is followed by a decrease where economy wide output bottoms out at -0.16 percentage points after 9 months. The surprise increase in monetary policy interest rate only becomes statistically significant after 7 months and remains up to 20 months following which its effect on economy wide output begins to gradually fade and economy wide output gradually tends towards its equillibrium, or steady state, level.



Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Total, or economy wide, output is denoted *GVAAll*, consumer price inflation rate, is denoted *CPI* and central bank monetary policy interest rate, is denoted *CBRate*. The x axis depicts the horizon of the Impulse Response Functions (IRFs).

Figure 4: Impulse Response Functions (IRFs) with output of the total economy

The results of the Vector Autoregression (VAR) model for the reaction of total, or economy wide, output to monetary policy developments, in Figure 4, are generally consistent with the results for the Vector Autoregression (VAR) model for the reaction of the minerals industry output to monetary policy developments, in Figure 3. The similarity between these sets of results means that the minerals industry is impacted by changes monetary policy interest rate in almost a similar manner as the total, or economy wide, output. Furthermore, the sizes, or magnitudes, of the Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model for the reaction of the minerals industry output to monetary policy developments are greater than the Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model for the reaction of total, or economy wide, outout to monetary policy developments. This means that the sensitivity of the minerals industry output to changes in the monetary policy interest rate is greater than the sensitivity of the total, or economy wide, output. The greater sensitivity of the minerals industry output implies that the developments in monetary policy are more likely to affect the minerals industry compared to the total, or economy wide, output.

The results of the Vector Autoregression (VAR) model for the reaction of the minerals industry output to monetary policy developments as well as the results for the Vector Autoregression (VAR) model for the reaction of total, or economy wide, output to monetary policy developments are also consistent with the findings in Stock and Watson (2001), in particular, as far as persistence of the Impulse Response Functions (IRFs) and the conventional central bank monetary policy transmission mechanism are concerned. The results are also consistent with the findings in a number of studies that use Vector Autoregression (VAR) models to analyse the reaction of macroeconomic variables to monetary policy developments using the central bank monetary policy reaction function, including Bernanke and Gertler (1995), Christiano et al. (1999), Sims (1992) and Christiano et al. (1999), in general. Stock and Watson (2001) argues that the timing conventions in Vector Autoregression (VAR) models do not reflect the real time data hence the variables such as output and inflation are sticky and do not respond to the central bank monetary policy interest rate within the expected period.

Conclusion

This study analysed the reaction of the minerals industry to monetary policy *developments* in South Africa. This was achieved using a Taylor (1993) rule type central bank monetary policy reaction function, where the total, or economy wide, output was substituted with output of the minerals industry. The reaction of the minerals industry output to monetary developments is then compared to its reaction to the standard monetary policy reaction function with economy wide output. The results show that, following an unexpected increase in the monetary policy interest rate, the minerals industry output begins to decrease after 4 months and bottoms out after 8 months, following which it gradually tends towards its equillibrium, or steady state, level. The surprise increase in the monetary policy interest rate only becomes statistically significant after 6 months and remains so up to 15 months.

The results of the reaction of the minerals industry output to changes in central bank monetary policy interest rate are generally consistent with those of the reaction of total, or economy wide, outout to monetary policy interest rate, where the magnitude of reaction of the minerals industry output to monetary policy developmentsare is greater than the magnitude of the reaction of total, or economy wide, outout to monetary policy developments. The similarity between these sets of results means that the minerals industry is impacted by changes monetary policy interest rate in almost a similar manner as the total economy output. The results support the use of short term economic stabilisation policies to manage economic activity in South Africa, hence the monetary authorities should continue to monitor and manage the central bank monetary policy interest rate to support economic activity as well as the minerals industry. Several economic indicators, such as Government budget stance, prices of commodities and financial assets as well as foreign exchange rate, affect economic activity, at least theoretically, hence it is important for future research to analyse their impact on the minerals industry.

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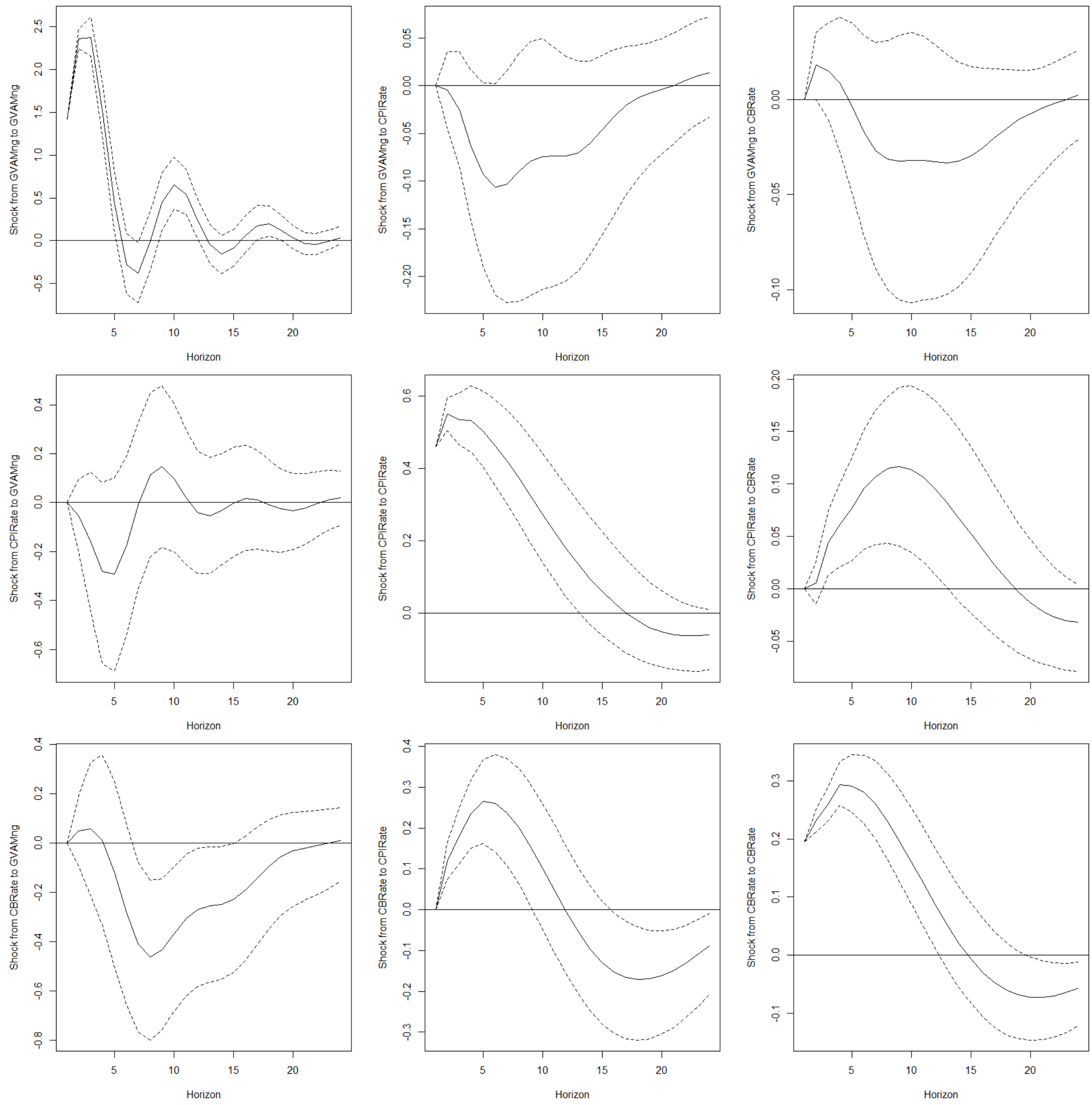
Appendix

Appendix 1. Complete Impulse Response Functions (IRFs) with output of the minerals industry

The complete Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model with mining and quarying output are shown in Figure 5. This Figure is not intended to be a part of the study, but is included to demonstrate the completeness of the analysis.

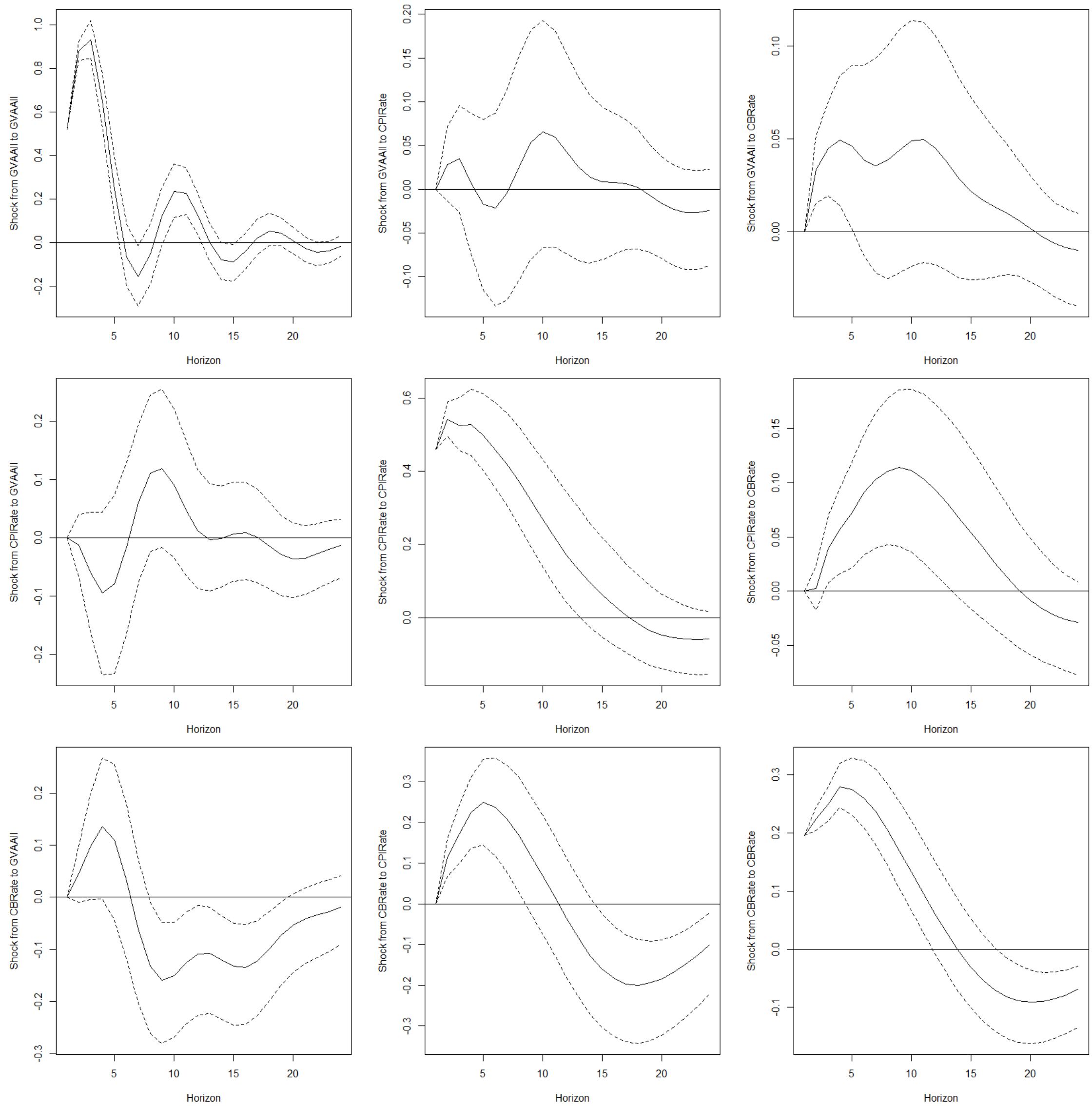


Notes: Data sourced from Statistics South Africa and South African Reserve Bank. Mining and quarying output is denoted $GVAMng$, consumer price inflation rate, is denoted CPI and central bank monetary policy interest rate, is denoted $CBRate$. The x axis depicts the horizon of the Impulse Response Functions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

Figure 5: Complete Impulse Response Functions (IRFs) with output of mining and quarying

Appendix 2. Complete Impulse Response Functions (IRFs) with output of the total economy

The complete Impulse Response Functions (IRFs) of the Vector Autoregression (VAR) model with total, or economy wide, output are shown in Figure 6. 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. Total, or economy wide, output, is denoted $GVAAll$, consumer price inflation rate, is denoted CPI and central bank monetary policy interest rate, is denoted $CBRate$. The x axis depicts the horizon of the Impulse Response Functions (IRFs).

Figure 6: Complete Impulse Response Functions (IRFs) with output of the total economy