South Africa's economic response to monetary policy uncertainty

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Abstract

Purpose – The purpose of this paper is to study the evolution of monetary policy uncertainty and its impact on the South African economy.
Design/methodology/approach – The authors use a sign restricted SVAR with an endogenous feedback of stochastic volatility to evaluate the sign and size of uncertainty shocks. The authors use a nonlinear DSGE model to gain deeper insights about the transmission mechanism of monetary policy uncertainty.
Findings – The authors show that monetary policy volatility is high and constant. Both inflation and interest rates decline in response to uncertainty. Output rebounds quickly after a contemporaneous decrease. The DSGE model shows that the size of the uncertainty shock matters – high uncertainty can lead to a severe contraction in output, inflation and interest rates.
Research limitations/implications – The authors model only a few variables in the SVAR – thus missing perhaps other possible channels of shock transmission.
Practical implications – There is a lesson for monetary policy: monetary policy uncertainty, in isolation from general macroeconomic uncertainty, often creates unintended adverse consequences and can perpetuate a weak economic environment. The tasks of central bankers are incredibly difficult. Their models project output and inflation with relatively large uncertainty based on many shocks emanating from various sources. It matters how central bankers react to these expectations and how they communicate the underlying risks associated with setting interest rates.
Originality/value – This is the first study that looks into monetary policy uncertainty into South Africa using a stochastic volatility model and a nonlinear DSGE model. The results should be very useful for the Central Bank as it highlights how uncertainty, that they create, can have adverse economic consequences.

Keywords DSGE, Volatility, Nonlinear, Uncertainty

Paper type Research paper

1. Introduction

> As you are aware, heightened uncertainty is one of the defining characteristics of the monetary policy environment in many emerging market countries Daniel Mminele (Deputy Governor of the South African Reserve Bank (2015).

This quote from the Deputy Governor of the South Africa Reserve Bank (SARB) points to the importance of uncertainty in monetary policy. How does the SARB deal with uncertainty, and more importantly, how does monetary policy uncertainty affect the economy? Even if this speech is most likely related to economic and financial uncertainty, the weights that the SARB attaches to inflation and output should induce uncertainty into monetary policy actions.

To illustrate how uncertainty features in the daily operations of policy makers we take two tangible examples. The speech by Mr Mminele at an IMF/WB spring meeting mentions uncertainty seven times in slightly over five pages. The SARB's latest Monetary Policy Review – a frequently published document that discusses the inflation and economic outlook,

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mentions uncertainty 18 times. The emphasis on uncertainty in this document is further illustrated by a plot of a "fan chart" (Monetary Policy Review, 2015). These charts show possible forecast paths for inflation – and evident is the upside risks to inflation. These risks are model derived and represent the forecast errors from a system of equations. The width of the fan chart is thus model dependent and reflects the economic state of the model. As an example a three variable system consisting of output, inflation and interest rates will use the conditional forecast errors to obtain the fan chart. Given that the SARB's mandate is price stability, and inflation forecasts have a wide range – due to its past forecast errors and conditional link to the rest of the economy, it is not that surprising that monetary policy uncertainty should exist.

Anchored inflation expectations should minimize monetary policy uncertainty with a clear single target – such as constraining inflation to fall between a 3 and 6 per cent corridor. If reasonable measures of inflation expectations exist and monetary policy is credible then achieving its objective should be easier. This is where monetary policy communication is an important element to reducing uncertainty.

One can gauge the extent of uncertainty by reviewing market expectations of interest rate decisions. Before each monetary policy committee (MPC) meeting in the SARB markets price in expectations changes to interest rates. Some Bloomberg measures at a frequent interval the implied probability of an interest rate change and hence capture some of the market's expectations. These probabilities change at each MPC meeting. If analysts price in non-constant probabilities of interest rate changes, how much more, or perhaps less, ordinary citizens price in monetary policy changes? How does this uncertainty impact the economy? How do we measure this uncertainty in light of anchored expectations? We address these issues using a VAR with stochastic volatility and compare the results to a nonlinear DSGE model. The choice of the VAR with stochastic volatility allows us to measure the endogenous response of the economy to uncertainty shocks that emanate from monetary policy and allows us to identify the shocks in such a way as to avoid measurement error. Uncertainty is thus model dependent, unlike recent studies that use dummy variables or quantifying uncertainty based on forecast errors and articles containing the word uncertain. The empirical strategy allows the data to tell a consistent story of uncertainty. We attempt to understand the transmission mechanism of policy uncertainty shocks in a nonlinear DSGE model.

A distinction from the onset should be made between economic uncertainty and policy uncertainty. The latter describes uncertainty regarding policy decisions from monetary or fiscal authorities. Economic uncertainty encapsulates both policy uncertainty and economic uncertainty such as uncertainty arising from stock market returns. Here we focus specifically on monetary policy uncertainty as represented by a common stochastic component that is model consistent.

What does uncertainty mean in the context of monetary policy? As mentioned previously, forecast errors and changing perceptions influence the manner in which people and firms make decisions. If a central bank is credible (i.e. small forecast errors and hence small policy errors) it will usually increase interest rates when future or expected inflation is above the target. However, given the scope of error as displayed by a fan chart, individuals or firms might be uncertain about the interest rate changes, the size and the time of change (a good example of this is the 25 basis points hike in June 2014, the hike is the smallest increase in South Africa's history since 1991). If the SARB continuously warns about a hike cycle (as is done in the latest MPR) firms and consumers might cut back or hold out on consumption and investment decisions that require debt exactly because they fear an interest rate hike. This would suppress consumption and economic activity leading to a decline in inflation. At the same time lower inflation would reduce interest rates. Thus an intended future hike might in actuality lead to a decrease in interest rates. When interest rates decrease firms and consumers might spend again, which would offset an initial fall in output.

We do not discuss how this affects monetary policy credibility. We also make clear that our interpretations of uncertainty falls under the concept of objective uncertainty ("unknown outcomes whose odds of happening can be measured or at least learned from" Guerron-Quintana, 2012) as opposed to subjective risk where uncertainty is not describable.

The economic response to policy uncertainty is an active field of study and recently reinvigorated since Bloom (2009). It is common to believe that uncertainty affects output adversely – the source of the shock is disputed however. In Bloom's (2009) seminal paper he studies the impact of economic uncertainty on the economy in a structural framework. Uncertainty, in that model, leads to inaction in firms' decisions which leads to a decrease in investment, employment and output. Inaction causes firms to scale back any plans, or delay them. Inaction subsides as soon as uncertainty decreases. This then leads to a rebound in investment, employment and output.

The empirical literature has identified a number of methods to quantify the effects of uncertainty shocks on the economy[1]. There are also many interesting applications in the study of policy uncertainty on the economy. Fernández-Villaverde *et al.* (2011) study the economic impact of fiscal policy uncertainty in a DSGE framework. Fiscal policy uncertainty exists due to timing issues regarding consolidation and the mix of fiscal instruments to consolidate the budget given the wide disparity of multipliers in the literature. They estimate fiscal rules with time varying volatility and assume that the change in volatility represents uncertainty (although admittedly the definition of uncertainty here is closer to risk). Their measure of uncertainty is the log of the standard deviation that follows an AR(1). Their measure of uncertainty controls for the persistence of the unconditional standard deviation of volatility – in essence they control for both level and volatility shocks. Since the model incorporates volatility it has to be solved with third-order perturbation methods. This measure would then not only capture changes in legislation, but also effects such as bracket creep or changes in revenue collection strategies. One of the important points raised in that paper is that endogeneity is not a major concern for their measure of volatility. Another neat feature of their specification is that it compares well with other constructed measures of uncertainty – such as the policy uncertainty index created by Baker *et al.* (2012). Their structural framework serves as a basis for other theoretical models, such as ours, that study uncertainty.

In a more related paper, Mumtaz and Zanetti (2013) study the role of monetary policy volatility on the US economy using an SVAR. Volatility is time varying via a stochastic volatility specification – i.e. volatility shocks are not necessarily homoskedastic. In contrast to Primiceri (2005) their SVAR specification allows for a direct feedback of volatility shocks on the level variables of interest. Mumtaz and Zanetti (2013) highlight that volatility is important for at least three reasons: volatility of structural shocks have increased (this corresponds to the size of volatility estimates obtained by Primiceri, 2005); volatility is a concern for policy makers; and a key number of papers have identified channels in which uncertainty affects the economy. Their paper complements the work by Bloom (2009) and Fernández-Villaverde *et al.* (2015) in providing an empirical channel of volatility shocks on the economy where the source emanates from the monetary policy authorities. They show that an increase in monetary policy uncertainty decreases interest rates, inflation and output. Inflation and output fall due to the model specification – assuming that central banks follow a Taylor rule with both inflation and output as objectives. It should be noted that their specification allows for both a mean change in volatility as well as changing the spread in values of volatility. In their model higher volatility leads to an increase in consumption volatility. Due to Jensen's inequality, higher consumption volatility reduces expected consumption. The same holds for inflation that is concave. A fall in both consumption and inflation will lead to lower interest rates.

The role of uncertainty on the economy has been contested. Born and Pfeifer (2014) suggest that policy uncertainty has a small effect on business cycle fluctuations. However, policy uncertainty has a larger affect on the economy than uncertainty regarding total factor productivity. Born and Pfeifer also emphasize that the economic direction of uncertainty shocks are not well-known despite frequent results of adverse effects. As an example, during adverse times firms and consumers might insure themselves by working harder and creating a buffer in the event of a negative fundamental shock. During the uncertain period economic activity might increase as opposed to contract. They argue that in terms of monetary policy, authorities react fairly quickly to changes in the economy, which dampen the effects of volatility (i.e. volatility has only a small, if any, impact on the economy). In addition, Jensen's inequality may increase investment if the marginal revenue of capital is convex. They also use stochastic volatility estimates for uncertainty.

One might be tempted to ask why monetary policy uncertainty should matter when: monetary policy uses forward guidance; and inflation expectations are anchored? In South Africa there seems be to some evidence that inflation expectations are not well anchored (Kabundi and Schaling, 2013), despite lower and more stable inflation since the adoption of inflation targeting[2]. Forward guidance is also a fairly new concept at the SARB. It can also be argued that monetary policy uncertainty arises from difficult decisions such as intervening when the exchange rate depreciates materially, or when inflation is hovering close to or slightly above the upper target limit. As an example it is not completely certain how the SARB reacts to exchange rate depreciations – especially considering that pass-through effects to inflation are time varying (Jooste and Jhaveri, 2014). Uncertainty about future policy affects agents' expectations such that perceived changes have real and nominal effects (Mumtaz and Zanetti, 2013).

Furthermore, if all variables are close to their respective steady states then volatility and uncertainty shocks should have no economic effects. As an example, inflation deviations from steady state (or the inflation target), typical of a linearized model, is zero and would not be affected by volatility shocks. However, in the nonlinear economy characterized by Mumtaz and Zanetti (2013) all variables might be far from steady state which is allowed due to higher order perturbation terms.

Motivated by Baker *et al.* (2012), Redl (2015) constructs an index of policy uncertainty for South Africa using disagreements among professional forecasters on key economic variables and the word uncertain in various SARB and newspaper publications. Redl (2015) uses this index in a recursive VAR to study the impact of economic uncertainty in South Africa. The uncertainty index seems to capture the volatile economic periods of South Africa well[3]. This index, however, represents economic uncertainty, which may contain the effects of policy uncertainty. Redl (2015) shows that economic uncertainty decreases output, employment and investment while inflation increases. The rise in inflation can be motivated due to sticky prices in a New Keynesian DSGE model where firms increase prices as a precautionary measure against uncertain future demand. An interesting extension of this line of research would be to model sources of uncertainty – different sources of uncertainty might not produce the same effects, in both size and sign, on main economic variables.

It should be noted that these constructed indices are not model consistent and may contain significant measurement error. Failure to account for measurement error can lead to biased estimates on the effects of uncertainty on economic variables (Carriero *et al.*, 2013). This is mainly due to the correlation between the dependent variables and the residuals due to measurement errors. Carriero *et al.* (2013) control for measurement error in an SVAR setup in using the uncertainty variable as an instrument. The instrument is assumed to be correlated by the fundamental shock and is assumed to be orthogonal to the other shocks. They test the standard recursive VAR against the proxy VAR with the instrument using simulated data from a DSGE model. They show that the proxy VAR does better at fitting the data than the standard VAR where the coefficient on the uncertainty variable is biased downwards – thus reducing the effects of uncertainty on the economy. On the other hand a VAR with model consistent uncertainty might be misspecified when omitting key variables – i.e. the model is non-fundamental and hence the uncertainty variable might not be well defined. Both approaches, the constructed uncertainty measure and the model consistent measure, have their pros and cons.

2. Methodology

Following Mumtaz and Zanetti (2013), the VAR with stochastic volatility is given by:

$$Y_t = c + \sum_{j=1}^{P} \beta_j Z_{t-j} + \sum_{j=0}^{P} \varphi_j \hat{h}_{t-j} + \Omega_t^{\frac{1}{2}} e_t \tag{1}$$

$e_t \sim N(0,\ 1)$ and $\Omega_t = A^{-1} H_t A^{-1'}$, Z_t is a matrix of the macroeconomic variables while $\hat{h}_t = \left[h_{1,t},\ h_{2,t},\ \ldots,\ h_{N,t}\right]$ is the log volatility of N structural shocks. The A matrix models the contemporaneous relationships while the structure of H_t is given by:

$$H_t = \begin{pmatrix} \exp\left(h_{1,t}\right) & 0 & 0 \\ 0 & \exp\left(h_{2,t}\right) & 0 \\ 0 & 0 & \exp\left(h_{3,t}\right) \end{pmatrix}$$

The transition equation for the stochastic volatility is given by:

$$\hat{h}_t = \theta \hat{h}_{t-1} + \sigma_t \tag{2}$$

Note that $\sigma_t \sim N(0,\ Q)$ and $E = (e_t,\ \sigma_t) = 0$.

This setup allows volatility to affect the endogenous variables. Furthermore, shocks to volatility and the structural shocks are uncorrelated. Since volatility is model dependent, the identification is free from measurement error. Carriero *et al.* (2013) shows that VAR estimates are biased when the variable of interest, uncertainty, has measurement error. They show that one can correct for this by using uncertainty as an instrument to the shock of interest. Given measurement error in uncertainty, it is necessary to assure that $E_t\left(\sigma_t,\ e_t^{\sigma}\right) = \alpha \neq 0$ and $E_t\left(\sigma_t,\ e_t^{i}\right) = 0$ where i are the other structural shocks (i.e. output, inflation and interest rates) and α measures the covariance. The setup we employ does not require this addition since volatility is model dependent with a prior that it is orthogonal to all shocks.

We use 1,000,000 replications where inference is based on 10,000 draws. The initial conditions for the VAR estimates are obtained using OLS on (1). The prior for $\hat{h}_t$ at $t = 0$ is set to $\hat{h}_0 \sim N(\ln u_0, I_3)$. The prior for the off-diagonal elements of A is $A_0 \sim N(\hat{a}, V(\hat{a}))$. $V(\hat{a})$ is set to 0.1 times the absolute value of $\hat{a}$. $Q \sim IG\left(Q_{i0}/2, 5/2\right)$. Finally $\theta \sim N(\theta_{i0},\ 0.1)$ where θ_{i0} is the AR(1) coefficients of the initial estimates of stochastic volatility.

We use quarterly seasonally adjusted GDP at constant prices, the 91-day Treasury bill (Tbill), which we assume is a proxy for monetary policy, and consumer price inflation (CPI) from 1960 Q1 to 2014 Q4. The CPI and the Tbill is sourced from the IMF's International Financial Statistics, while GDP is taken from the SARB at constant prices. We use two lags as determined by the Bayesian Information Criterion. We use sign-restrictions to identify the contemporaneous matrix given the monetary policy shock (the data were ordered as interest rate, GDP and inflation):

$$A^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ - & 1 & 0 \\ - & + & 1 \end{pmatrix}$$

2.1 *Empirical results*

Figure 1 gives an indication of the persistence and dispersion of economic volatility[4]. The Treasury bill has been volatile through the entire sample period. Interestingly the shock has been quite constant with very little persistence (i.e. volatility acts as a stationary variable with a constant)[5]. This result implies that stochastic volatility shocks dissipate quickly in the South African economy and would suggest the monetary policy uncertainty shocks are small and fade away rather quickly. The forward looking nature and communication strategy (i.e. forward guidance) could be a possible explanation for this outcome.

Figure 2 shows the impulse responses of a 1 standard deviation shock in monetary policy volatility. The error bands represent the 16th and 84th percentiles of the shocks while

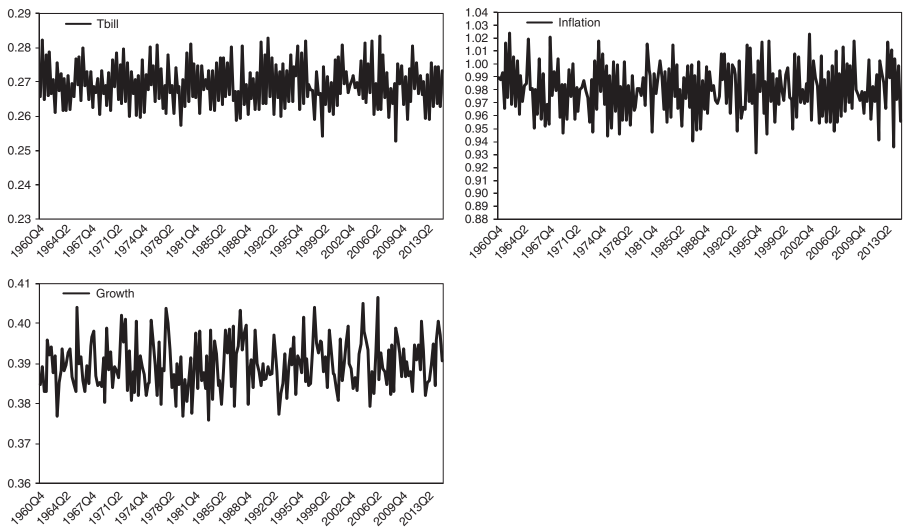

Figure 1. Volatility

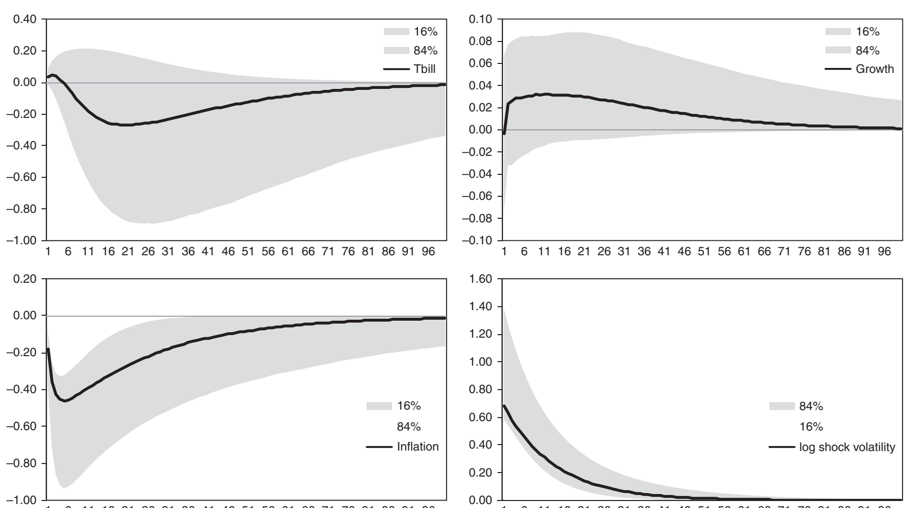

Figure 2. Economic response to a shock in monetary policy volatility

the solid line represents the median response. The persistence of the volatility shock lasts about 55 quarters. Monetary policy decreases as a result of the volatility shock and reaches a trough of about −0.21 per cent sixteen quarters after the shock. The shock lasts for about 93 quarters. The reduction in inflation is even more pronounced. Inflation decreases to a maximum of about 0.42 per cent six quarters after the shock. An unexpected result is the response of output growth to the volatility shock. While our sign restriction specification ensures that output growth decreases contemporaneously to volatility, the rebound occurs rather quickly while the median impulse response is persistently positive for many quarters. The output response is small. The interest rate and growth responses are, however, insignificant. These results remain virtually the same when we change the sample period or change the assumed signs for the contemporaneous responses. The insignificant impulse responses could be explained due to the size of stochastic volatility over the sample period. As observed from Figure 1 the size of the shocks are small relative to mean volatility and is constant.

3. Volatility shocks nonlinear DSGE model for South Africa

The DSGE setup is similar to Mumtaz and Zanetti (2013) that resembles Ireland (2004). The model is fairly standard, however, enriched with features such as habit formation, price stickiness and volatility. The model is representative of a small developing country like South Africa. In particular monetary policy in South Africa targets inflation by setting interest rates and forward guidance. Monetary policy is approximated with a Taylor rule. Habits in consumption allow for a smooth consumption profile over time regarding monetary policy shocks – this is in line with South Africa's well developed financial markets. South Africa is also characterized by a large set of monopolistic firms (Fedderke *et al.*, 2007), which justifies our price behaviour setup. The DSGE model is used to analyse the transmission mechanism of volatility shocks.

The representative household maximizes the following utility function:

$$E_t \sum_{i=0}^{\infty} \beta^i \left(\frac{\left(C_{j,t} - hC_{j,t-1}\right)^{1-\sigma}}{1-\sigma} - \frac{\vartheta L_{j,t}^{1+\varphi}}{1+\varphi} \right) \tag{3}$$

Note that $C_{j,t}$ is consumption of individual j in time t and $L_{j,t}$ is labour supply measured in hours. The parameters σ, ϑ, h and φ are the inverse elasticity of substitution, a scale parameter for the disutility of labour, habit persistence and the inverse Frisch elasticity, respectively. The household's budget constraint is specified as:

$$P_t W_{j,t} L_{j,t} + R_{t-1} P_{t-1} B_{j,t-1} + P_t F_t = P_t C_{j,t} + \frac{P_t B_{j,t}}{\varepsilon_t^B} + P_t \tau_{j,t} \tag{4}$$

where $W_{j,t}$ is the real wage; $B_{j,t}$ the real government dent; F_t the profits; $\tau_{j,t}$ the lump sum tax; R_{t-1} the nominal interest rate; ε_t^B the exogenous premium shocks on the returns to bonds; P_t the consumer price index. Maximizing the utility function taking the constraint into account yields the standard first order conditions:

$$\left(C_{j,t} - hC_{j,t-1}\right)^{-\sigma} - E_t \beta h \left(C_{j,t+1} - hC_{j,t}\right)^{\sigma} = \lambda_t \tag{5}$$

$$\frac{\lambda_t}{\varepsilon_t^B} = \beta E_t \left(\lambda_{t+1} \frac{R_t}{\pi_{t+1}} \right) \tag{6}$$

$$\lambda_t W_t = \vartheta L_{j,t}^{\varphi} \tag{7}$$

The production function for the intermediate goods producer is:

$$Y_{n,t} = A_t L_{n,t} \tag{8}$$

where A_t is a total factor productivity shock modelled as an AR(1). The intermediate firm sells to a final producer where firm n faces $Y_{n,t} = (P_{n,t}/P_t)^{-\varepsilon^p} Y_t$ as demand. ε^p is the elasticity of substitution. The quantity of final goods is $Y_t = (\int_0^1 Y_{n,t}^{\varepsilon^p-1/\varepsilon^p} dn)^{\varepsilon^p/\varepsilon^p-1}$. The final good price index is $P_t = (\int_0^1 P_{n,t}^{1-\varepsilon^p} dn)^{1/1-\varepsilon^p}$. The intermediate producer faces quadratic adjustment costs when adjusting prices. Here we follow Rotemberg (1982) as opposed to Calvo (1983). Fernández-Villaverde *et al.* (2011) point out that Calvo and Rotemberg are not similar in a nonlinear setup – however the results remain fairly similar. In equilibrium all intermediate goods producers have the same marginal cost (MC_t):

$$\mathrm{MC}_t = \frac{W_t}{A_t}.$$

Using the Rotenberg mechanism each firm solves:

$$\underbrace{\max}_{P_{n,t},N_{n,t}} E_t \left[\sum_{i=0}^{\infty} \beta^i \frac{\lambda_{t+i}}{\lambda_{t+i}} \quad P_{n,t} Y_{n,t} - P_{n,t} W_{n,t} N_{n,t} - \frac{\phi_p}{2} \left(\frac{P_{n,t}}{P_{n,t-1}} - \pi \right)^2 Y_{n,t} \right) \right] \tag{9}$$

subject to its production function. This yields the Phillips curve:

$$1 = \frac{\varepsilon^p - 1}{\varepsilon^p} \mathrm{MC}_t - \phi_p \left[\left(\frac{\pi_t}{\pi^{1-\mu} \pi_{t-1}^{\mu}} - 1 \right) \frac{\pi_t}{\pi^{1-\mu} \pi_{t-1}^{\mu}} - \beta E_t \left(\frac{\lambda_{t+i}}{\lambda_{t+i}} \frac{\pi_{t+1} Y_{t+1}}{Y_t} \right) \left(\frac{\pi_{t+1}}{\pi^{1-\mu} \pi_t^{\mu}} - 1 \right) \frac{\pi_{t+1}}{\pi^{1-\mu} \pi_t^{\mu}} \right] \tag{10}$$

where ϕ_p determines the degree of price stickiness (in adjustment to steady state inflation, π) and μ is the extent of price indexation to previous inflation.

The government finances its expenditure through taxes and issuing one period bonds:

$$g Y_t + \frac{R_{t-1} B_{t-1}}{\pi_t} = \tau_t + B_t \tag{11}$$

Finally, monetary policy is assumed to follow a Taylor rule:

$$\frac{R_t}{R} = \left(\frac{R_t}{R} \right)^{\phi_R} \left(\frac{\pi_t}{\pi} \right)^{(1-\phi_R)\phi_\pi} \left(\frac{Y_t}{Y} \right)^{(1-\phi_R)\phi_Y} \varepsilon_t^R \tag{12}$$

Volatility would enter the conditional heteroskedastic monetary policy shock, ε_t^R, which is modelled as an AR(1):

$$\log \, \varepsilon_t^R = \rho_{\varepsilon_R} \log \, \varepsilon_{t-1}^R + \sigma_t^R \eta_t^R \tag{13}$$

Policy uncertainty is then given by:

$$\log \, \sigma_t^R = \left(1 - \rho_{\sigma^R}\right) \sigma_{\varepsilon^R} + \rho_{\sigma^R} \log \, \sigma_{t-1}^R + \sigma_{\sigma^R} \eta_t^{\sigma^R} \tag{14}$$

σ_{ε^R} fixes the average standard deviation of a shock in interest rates to R_t, ρ_{σ^R} controls the persistence in the volatility shock and $\eta_t^{\sigma^R}$ is the unconditional standard deviation of the interest rate volatility shock – or the stochastic volatility component.

The market clearing condition, setting g equal to zero, is:

$$Y_t = C_t + \frac{\phi_p}{2}\left(\frac{P_{n,t}}{P_{n,t-1}} - 2\right)^2 Y_t$$

3.1 Calibration

We calibrate the model for the South African economy. The majority of the parameters are borrowed from the literature whereas the volatility parameters are taken from the empirical section. These values are summarized in Table I. It is important to note that these parameters are meant to fit the South African economy. The volatility persistence parameter is set so that deviations from the mean volatility will be short-lived as seen in the empirical section.

3.2 Volatility shocks in monetary policy

The nonlinear DSGE impulse responses are shown in Figure 3. We increase log volatility by one standard deviation. In line with the VAR results, interest rates and inflation decreases in response to an increase in volatility. The persistence of the impulse responses is shorter and the size of the responses is also smaller. The DSGE results would suggest that other features are missing in our empirical specification. More importantly, the DSGE model suggests that South African output is especially sensitive to volatility shocks. Also, in contrast to the empirical model, output decreases through the entire period – there is no rebound. Admittedly there is no active capital channel in this model. A reduction in interest rates should stimulate investment after the volatility shock dissipates. Under such a scenario one would expect the adverse effects of uncertainty to be muted.

The decline in consumption is described by the intertemporal first order condition (Equations (5) and (6)). Higher volatility in consumption, due to higher volatility in the interest rate spread will lead to a fall in the level of expected consumption – and hence a fall in output. This is due to the utility function that is concave in consumption. The concavity in the production function will similarly lead to a fall in expected inflation when interest rate volatility increases. There is a pricing bias in the Rotemberg setup – but this depends on the elasticity of demand. A low elasticity of demand and a strong commitment to inflation targeting will reduce the pricing bias and can generate a decrease in inflation (Fernández-Villaverde *et al.*, 2015).

Table I. Calibrated parameters

Parameter	Description	Value	Source
β	Discount factor	0.99	Du Plessis *et al.* (2014)
α	Labour share in production	0.67	Du Plessis *et al.* (2014)
ϑ	Labour disutility	7.5	Du Plessis *et al.* (2014)
ε^P	Price markup	11	Du Plessis *et al.* (2014)
σ	Elasticity of substitution	1.5	Du Plessis *et al.* (2014)
φ	Frisch elasticity	5	Du Plessis *et al.* (2014)
μ	Indexation: Price setting	0.5	Du Plessis *et al.* (2014)
ρ_{σ^R}	Volatility persistence	0.9235	Estimated
ρ_{ε^R}	Monetary policy persistence	0.830	Du Plessis *et al.* (2014)
σ_{ε^R}	Stdev of policy shock	0.24	Estimated
σ_{σ^R}	Stdev of uncertainty shock	1.00	Assumed
ϕ_R	Interest smoothing	0.83	Du Plessis *et al.* (2014)
ϕ_π	Taylor inflation	1.73	Du Plessis *et al.* (2014)
ϕ_Y	Taylor output	0.25	Du Plessis *et al.* (2014)
ϕ_p	Adjustment cost	118.0	Estimated
h	Habit formation	0.73	Gupta *et al.* (2015)
π	Steady state inflation	1.0114	Du Plessis *et al.* (2014)

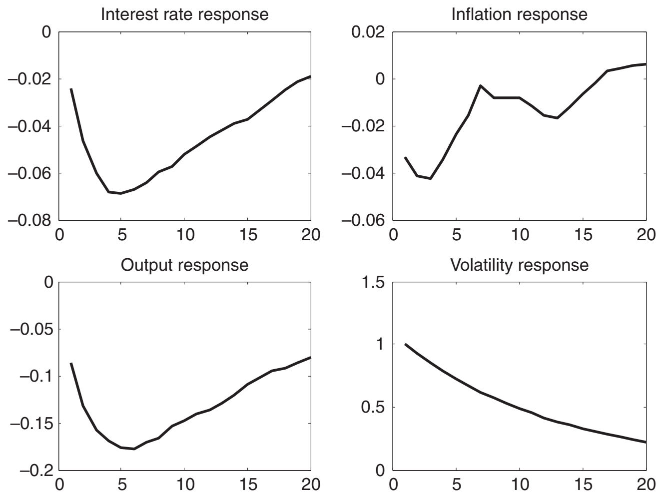

Figure 3. Economic response to a shock in monetary policy volatility

The fall in the nominal interest rate thus arises due to the fall in both expected consumption and inflation – thus the typical bond holder requires a smaller return on their bonds due to the fall in inflation and hence leads to a decrease in interest rates.

4. Conclusion

We study the effects of monetary policy uncertainty for the South African economy. We use a stochastic volatility model in a multivariate setup where the variables of interest, output, interest rates and inflation, respond endogenously. Monetary policy uncertainty is noisy with not a single period of low uncertainty in our sample. The volatile nature of monetary policy uncertainty suppresses inflation and output contemporaneously and lowers interest rates. Output, however, rebounds quickly. The empirical results are slightly smaller compared to a DSGE model. A simple DSGE model calibrated using South African data suggests that output, inflation and interest rates should decrease for the duration of the uncertainty shock.

There is a lesson for monetary policy: Monetary policy uncertainty, in isolation from general macroeconomic uncertainty, often creates unintended adverse consequences and can perpetuate a weak economic environment. The tasks of central bankers are incredibly difficult. Their models project output and inflation with relatively large uncertainty based on many shocks emanating from various sources. It matters how central bankers react to these expectations and how they communicate the underlying risks associated with setting interest rates.

As part of future research, we aim to extend the DSGE model to incorporate other forms of uncertainties related to financial markets, fiscal policy and even global uncertainties; with the latter requiring us to extend the model to an open economy framework. However, given the history of policy making in South Africa, we believe that the importance of monetary policy uncertainty is likely to be stronger than other forms of domestic uncertainties.

Notes

1. These range from GARCH models (for an application of uncertainty and inflation see Grier and Perry, 2000), stochastic volatility models and constructed indices. Jurado *et al.* (2015) emphasize that true econometric uncertainty comes from removing all forecastable variation of a series – i.e. conditional volatility is not uncertainty.
2. The latest MPR (2015) argues that inflation expectations seem to converge (i.e. little dispersion) at the upper limit of the inflation target – perhaps implying that expectations are anchored at that level.

3. By capturing conditions well we simply mean that it correlates with important events historically.
4. The results remain qualitatively the same using a different identification structure (e.g. a Cholesky decomposition). This is because the sign restrictions were only imposed on the contemporaneous impact. As robustness check stock market returns and the fiscal balance is included. Once again the results remain similar. Results are available upon request from the authors. Note since in this paper we are trying to provide theoretical and empirical evidence of the impact of monetary policy uncertainty, for the sake of consistency between theory and empirics, we will need a model of other forms of uncertainties to match the empirical evidence of the effect of equity market and fiscal uncertainties.
5. This result is robust to different prior specifications. Complete details are available upon request from the authors.

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