The Journal of Developing Areas
Volume 54 No. 4 Fall 2020

THE EFFECTIVENESS OF MONETARY POLICY IN SOUTH AFRICA UNDER INFLATION TARGETING: EVIDENCE FROM A TIME-VARYING FACTOR-AUGMENTED VECTOR AUTOREGRESSIVE MODEL

Goodness C. Aye
University of Pretoria, South Africa
Mehmet Balcilar
Eastern Mediterranean University, Turkey
Rangan Gupta*
University of Pretoria, South Africa

ABSTRACT

In the 1970s and 1980s, the economies of several developed and developing countries witnessed much volatility in output growth, inflation and other macroeconomic variables. Thereafter, these became considerably low and more stable. This latter development has been named the "great moderation" with first observation in the US and comparable evidence for other developed and developing economies including South Africa. However, the 2007/2009 economic and financial crisis resulted into heightened uncertainty and volatility. This brings to question the role of monetary policy and its effectiveness in the economy. This paper examines the transmission mechanism of shocks to monetary policy in South Africa using quarterly data from 1980:1 to 2012:4. We also in addition identify demand and supply shocks. Our analyses are based on a factor-augmented vector autoregression with time-varying coefficients and stochastic volatility (TVP-FAVAR), which allows us to simultaneously analyze the changing impulse responses of a set of 177 macroeconomic variables covering the inflation, real activity, asset prices and monetary series. We also have intangible variables, such as confidence indices, and survey variables. These data capture the broad trends in the South African economy. Our results based on the impulse response functions, are consistent with economic theory as we observe no price puzzle that is often associated with the standard VAR models. We find evidence of modest time variation in the transmission of shocks. Overall, the macroeconomic variables seemed to have responded slightly more to the monetary policy shocks in the post -2000 (inflation targeting) sub-period than the pre-2000 period, albeit the differences in the effects are statistically insignificant. The forecast error variance decomposition results show the changes in the macroeconomic variables are largely determined by the demand shock relative to the monetary policy shock although the contribution of the latter increased slightly over time. Our results suggest the need for a more efficient role of the monetary authority as this will both improve its credibility and greater economic stability. As inflation still remains within the upper portion of the 3–6% target range, appropriate mix of supply and demand side policies could be explored alongside monetary policy to reduce inflationary pressures.

JEL Classifications: C32, C54, E31, E52
Keywords: Monetary policy, Transmission Channel, Inflation Targeting, Time-varying FAVAR
Corresponding Author's Email Address: goodness.aye@gmail.com.

INTRODUCTION

The recent global economic and financial crisis between 2007 and 2009 which began as a subprime mortgage crisis is an episode in the history of the world that has heightened interest among policy makers and researchers. The crisis introduced a period of sustained uncertainty and volatility in world economic conditions. This crisis and its ensuing great recession broke the calm of the great moderation. The recovery from the crisis has been quite slow. The tensions due to the crisis raises questions about the suitability and effectiveness of the predominant policy framework – inflation targeting – employed by central banks around the world, including in South Africa (Marcus 2014).

The structural changes in many economies and the recent disruption of the era of “great moderation” by the financial crisis underlines the importance of understanding the nature and causes of the great moderation. This may assist policy makers in aiding its resumption. Three possible causes of the great moderation in South Africa were hypothesized by Burger (2008). These include better monetary policy, a more efficient financial sector, and improved inventory management. These three could be classified under the “structure and good policy” headings. His evidence supported two of the hypotheses, that is, better monetary policy and a more efficient financial sector contributed to greater economic stability, while better inventory management did not. This is consistent with earlier empirical evidence that monetary policy explains a large part of the great moderation in South Africa, with fiscal policy also contributing to this event (Du Plessis 2006; Du Plessis, Smit and Sturzenegger 2007, 2008). We will be considering the effectiveness of monetary policy pre- and post- the inflation targeting era.

The South African Reserve Bank (SARB) adopted the inflation targeting framework in February 2000 following the announcement by the Minister of Finance during the budget speech. Since then, the sole objective of the SARB has been to achieve and maintain price stability by aiming to keep the CPIX inflation rate within the target band of 3–6%, using discretionary changes in the short-term interest rate (Repurchase) rate) as its main monetary policy instrument. Aside the first and fourth quarter of 2016 when inflation went above the upper target (precisely 6.2%), it has remained within the target from 2016 to 2018 with the value for 2018: Q3 standing at 4.1% (SARB 2018). This may connote some success but how this translates to economic performance is a question that needs to be investigated.

A number of studies have investigated the effect of monetary policy on certain macroeconomic variables in some advanced countries but mostly in the US. The results are at best mixed as is evident in the literature review section. This paper assesses the impact of monetary policy shocks on the real, monetary and financial sectors of the African economy. This country specific analysis is important given that South Africa is a middle-income emerging economy while US where most studies have focused is an advanced and about the largest economy in terms of GDP per capita. Report by Economy (2019) shows that the US GDP per capita is about four times more than South Africa whereas inflation and unemployment in South Africa is about three times more than the US just to mention a few. Unlike South Africa, which adopted inflation targeting framework of 3-6% as early as 2000, the US Federal Reserve Bank did not have explicit inflation target until 2012 when a target of 2% was set (Federal Reserve Bank 2015). However, U.S has always had a concern for keeping inflation low and as such regularly announced a desired target range for inflation of usually between 1.7% and 2%. Perhaps some similarities worth mentioning is that both economies have well developed financial markets and both are well integrated into the world economy and as such are very responsive to global shocks such as the recent global financial and economic crisis. We exploit a data-rich environment that includes 177 quarterly series, during the pre-inflation and post-inflation period. Given the large number of variables involved, one of the econometrically feasible methods would be a factor-augmented vector autoregression (FAVAR).To the best of our knowledge, this is the first study in South Africa to compare the effectiveness of monetary policy on the dynamics of macroeconomic economic variables pre- and post-inflation targeting periods using a time-varying factor augmented VAR (TVP-FAVAR) approach. In contrast to the constant FAVAR developed by Bernanke, Boivin and Eliasa (2005), the TVP-FAVAR allows for time-varying coefficients in the VAR transition equation and for heteroscedastic shocks and is also capable of accommodating variations in the volatility of the underlying series (Ellis, Mumtaz and Zabczyk 2014).

The remainder of the paper is organized as follows: Section 2 presents the related literature. The data and econometric model is discussed in section 3. Empirical results are presented and discussed in section 4. Section 5 concludes.

LITERATURE REVIEW

In this section, we provide a review of recent related studies. For instance, Korobilis (2013), used a FAVAR model with time-varying coefficients and stochastic volatility, and 143 post-World War II quarterly variables, to show that both endogenous and exogenous shocks resulted in the high inflation volatility during the 1970s and early 1980s in the US. He also finds that for other indicators, GDP, investment, exchange rates and money showed the largest response to unanticipated monetary policy shock.

Using a new measure of monetary policy shocks derived from Fed Funds futures contracts and a 3 monthly variable VAR estimated for the period 1988:12-2008:06., Barakchian and Crowe (2013) find that over the post-1988, there is a small but statistically significant negative effect of contractionary monetary policy on output with maximum impact at the two year horizon and also almost 50% of output variability (at a 3 year horizon) can be explained by monetary policy shocks. Baumeister, Liu and Mumtaz (2013) use a time-varying FAVAR and find evidence of a substantial decline in the dispersion of disaggregate price responses over time. They also find that many disaggregate prices rise temporarily in response to a monetary tightening in the early part of the sample, whereas no evidence of a price puzzle was found at the aggregate level. However, the share of disaggregate prices that exhibit the price puzzle diminishes from the early 1980s onwards. There is also evidence of a substantial decline in the dispersion of disaggregate price responses over time.

Ellis, Mumtaz and Zabczyk (2014) use a time-varying factor-augmented VAR and find that monetary policy shocks in the UK had a bigger impact on inflation, equity prices and the exchange rate during the inflation targeting period; and the median of disaggregated prices became more negative and cross-sectional patterns pointing to a decrease in the role of cost channels. Yoshino and Taghizadeh-Hesary (2015) use quarterly data from 1994 to 2014 and a simultaneous equation model (SEM) and find that easing monetary policy has no real effects on Japanese economy as aggregate demand, which includes private investment, did not increase significantly in Japan with lower interest rates.

Balcilar et al. (2017) investigated the role of U.S. economic policy uncertainty on the effectiveness of monetary policy in the Euro area. Evidence from a structural Interacted Vector Autoregressive (IVAR) model showed that policy uncertainty dampens the effect of monetary policy shocks in the Euro area. Primus (2018) assessed the relative effectiveness of the use of direct and indirect monetary policy instruments in Barbados, Jamaica and Trinidad and Tobago, using a restricted Vector Autoregressive model with Exogenous Variables (VARX). The results indicate that a positive shock to the policy interest rate has a direct effect on commercial banks' interest rates, but the transmission to the real variables is weak. Using SVAR and quarterly data from 1995 to 2010, Anwar and Nguyen (2018) examined the monetary policy transmission mechanisms in Vietnam, they found that monetary shocks have a strong influence on Vietnam's output. and that Vietnam's monetary policy is relatively more susceptible to foreign inflationary and output shocks.

Aside Gupta, Kabundi and Modise (2010) and Gupta, Jurgilas and Kabundi (2010) on South Africa, other studies have basically focused on the effect of monetary policy on inflation and/or output (Woglom 2003; Burger and Marinkov 2008; Gupta and Uwilingiye 2010, 2012). Woglom (2003) use simple Taylor rule functions and conclude that inflation targeting has led to modest changes in the conduct of monetary policy and also that the credibility of the inflation target has probably fallen as unit labor costs accelerated from the 5.5 per cent range in the first half of 2002 to over 11 per cent in the third quarter. While Gupta and Uwilingiye (2010, 2012), use cosine-squared cepstrum and modified Barro-Gordon model of time inconsistency respectively to provide evidence that CPI inflation in South Africa has become more volatile in the inflation targeting regime, Burger and Marinkov (2008) find that the explicit regime has been marginally more successful in keeping inflation at lower level based on results from the Taylor rule three-equation model.

Given the mixed findings, the effectiveness of monetary policy on the economy is inconclusive. This therefore requires that more country specific studies be conducted.

DATA AND EMPIRICAL MODEL

We use a quarterly data set for the South African economy which spans the period from 1980:1 to 2012:4. The starting and ending dates for our sample is determined by availability of data on all the macroeconomic variables used for analysis at the time of writing this paper. Note that, ending in 2012:4, also has the added advantage in the sense that, it basically splits the sample period equally between the two monetary policy regimes, associated with unofficial inflation targeting over 1990 to 2000 and the post-official inflation targeting era since 2001. A similar approach was taken by Gupta, Kabundi and Modise (2010). Note that, the first 40 quarters are used as a training sample to calibrate the priors as in Ellis, Mumtaz and Zabczyk (2014). The time varying FAVAR estimation is based on 177 macroeconomic variables which cover the inflation, real activity, asset prices and monetary series. We also have intangible variables, such as confidence indices, and survey variables.[1] These data capture the broad trends in the South African economy. The data used were obtained from different data providers including the SARB, Statistics South

Africa, Bureau for Economic Research (BER), South Africa, ABSA Group Limited, South Africa, National Association of Automobile Manufacturers of South Africa, OECD statistics, Oxford Economics, and IMF International Financial Statistics.

The FAVAR model we use is written in state space form following Ellis, Mumtaz and Zabczyk (2014). Consider the observation equation:

$$\begin{pmatrix} X_{1,t} \\ . \\ . \\ X_{N,t} \\ R_t \end{pmatrix} = \begin{pmatrix} \Lambda^{11} & . & \Lambda^{K1} & \Psi^{11} \\ . & . & . & . \\ . & . & . & . \\ \Lambda^{1N} & . & \Lambda^{KN} & \psi^{1N} \\ 0 & . & 0 & 1 \end{pmatrix} \begin{pmatrix} F_t^1 \\ F_t^2 \\ . \\ F_t^K \\ R_t \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \\ . \\ e_{Nt} \\ 0 \end{pmatrix} \quad (1)$$

Where $\mathbf{x}_t = (X_{1,t},...X_{N,t})$ is a set of variables that contains information about real activity, inflation, money and asset prices in the South Africa, while F_t^1 to F_t^K denote the K latent factors. Incorporating large amount of information helps to avoid the problem of non-fundamentalness. $e_t \sim \mathrm{N}(\mathbf{0},\mathbf{U})$ where $e_t = (e_{1t},...,e_{Nt})$ and U is a diagonal matrix. The dynamics of the South African economy is assumed to be captured by these K factors whereas Λs denote their loadings. Following Bernanke, Boivin and Eliasz (2005) and Ellis, Mumtaz and Zabczyk (2014), the only 'observed factor' in the model is the short term interest rate which is proxied by the Reserve Bank Repo Rate (EP) and denoted from hence forth as Bank Rate, R_t. The transition equation of the system is a time-varying VAR model given as:

$$\mathbf{z}_t = \mathbf{c}_t + \sum_{l=1}^{L} \beta_{l,t}\mathbf{z}_{t-l} + \mathbf{v}_t, \quad \mathbf{v}_t \sim N(\mathbf{0},\mathbf{\Omega}_t) \quad (2)$$

Where $\mathbf{z}_t = (F_t^1, F_t^2,..F_t^K, R_t)$ and L is fixed at 2 consistent with Ellis, Mumtaz and Zabczyk (2014). The law of motion for the coefficients $\boldsymbol{\varphi}_t = \mathrm{vec}(\{\mathbf{c}_t;\boldsymbol{\beta}_{1,t},..,\boldsymbol{\beta}_{L,t}\})$ is postulated as:

$$\boldsymbol{\varphi}_t = \boldsymbol{\varphi}_{t-1} + \boldsymbol{\eta}_t, \boldsymbol{\eta}_t \sim N(\mathbf{0},\mathbf{Q})$$

With the innovation ($\mathbf{v}_t$) covariance time-varying matrix $\mathbf{\Omega}_t$ factored as

$$\mathbf{\Omega}_t \equiv \mathrm{E}[(\mathbf{v}_t - \mathrm{E}\mathbf{v}_t)(\mathbf{v}_t - \mathrm{E}\mathbf{v}_t)'] = \mathbf{A}_t^{-1}\mathbf{H}_t(\mathbf{A}_t^{-1})' \quad (3)$$

Where the time-varying matrices $\mathbf{H}_t$ and $\mathbf{A}_t$ are assumed to evolve as random walks. To introduce time variation into the model, we allow for drift in the coefficients and the error covariance matrix of the transition equation. This flexible specification ensures that our model can account for the possible structural breaks.

Although we are basically interested in the monetary policy shock, our identification scheme allows us to additionally identify demand and supply shocks. Following Uhlig (2005), the identification scheme places sign restrictions on the contemporaneous response of some of the variables in $\mathbf{x}_t$ to the structural shocks. The restrictions imposed on the contemporaneous responses from the FAVAR are summarized in Table 1 following Ellis, Mumtaz and Zabczyk (2014). The expansionary monetary policy shock, associated with a decrease in the monetary policy instrument, is assumed to decrease the nominal interest rate, increase GDP growth, increase CPI inflation and lead to the depreciation of a nominal effective exchange rate (NEER).

Imposing these sign restrictions requires that: we let $\mathbf{\Omega}_t = \mathbf{P}_t\mathbf{P}_t'$ be a Cholesky decomposition of the VAR covariance matrix $\mathbf{\Omega}_t$, and we draw an $\mathrm{N} \times \mathrm{N}$ matrix, $\mathbf{J}$, from the N(0, 1) distribution. Next, we take the *QR* decomposition of $\mathbf{J}$, which provides us with a candidate structural impact matrix as $\mathbf{A}_{0,t} = \mathbf{P}_t\mathbf{Q}$, following which we compute the contemporaneous impulse response of $X_{1,t}, .., X_{N,t}$ to the shocks as

$$\begin{pmatrix} irf^0_{X_{1,t}} \\ . \\ . \\ irf^0_{X_{N,t}} \\ irf^0_{R_t} \end{pmatrix} = \begin{pmatrix} \Lambda^{11} & . & \Lambda^{K1} & \Psi^{11} \\ . & . & . & . \\ . & . & . & . \\ \Lambda^{1N} & . & \Lambda^{KN} & \psi^{1N} \\ 0 & . & 0 & 1 \end{pmatrix} \times \mathbf{A}_{0,t} \qquad (4)$$

where $irf^0_{X_{i,t}}$ represents the response of the ith variable at horizon 0. If these responses satisfy our sign restrictions, we store $\mathbf{A}_{0,t}$ and repeat the procedure at each time period until we have obtained 100 $\mathbf{A}_{0,t}$ matrices that satisfy the sign restrictions. Out of the set of 'admissible models', the $\mathbf{A}_{0,t}$ matrix with elements closest to the median across these 100 estimates is selected (Fry and Pagan, 2007).

TABLE 1: SIGN RESTRICTIONS

	GDP growth	CPI inflation	Nominal exchange rate	Short-term interest rate
Monetary policy	≥	≥	≤	≤

Notes: A '≥' ('≤') symbol denotes a non-negative (non-positive) on-impact response of the corresponding variable; the '.' symbol denotes that no restriction is imposed on the response sign.

To estimate our model, we employ the standard Markov chain Monte Carlo (MCMC) Bayesian estimation algorithm. The entire algorithm is executed 55,000 times with the first 45,000 draws discarded as burn-in. [2]

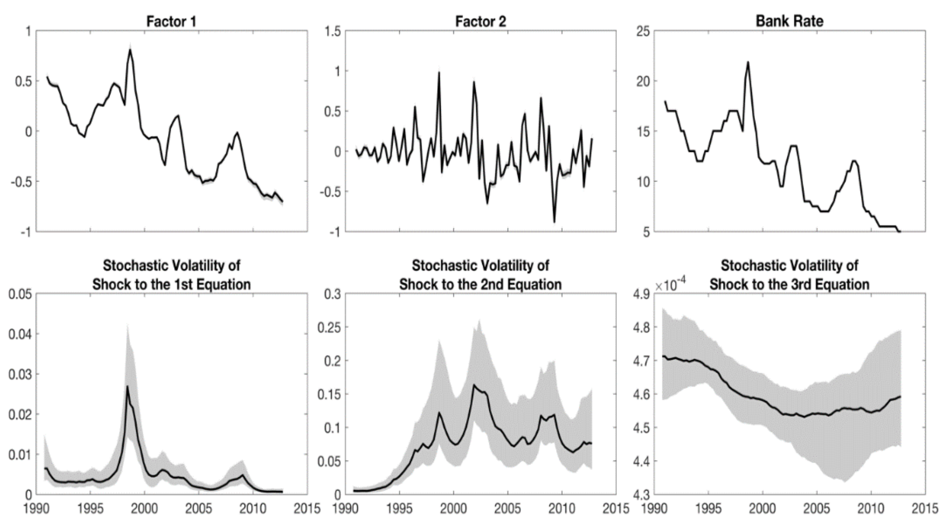
EMPIRICAL RESULTS

ESTIMATED FACTORS AND STOCHASTIC VOLATILITY

The estimated factors (factor 1 and factor 2) are shown on the top left panel of Figure 1 while the observed factor (Bank Rate) is presented in the top right panel of Figure 1.[3] Factor 1 looks far less volatile than factor 2 with the former being much lower from the 2000s compared to periods before. The volatility of the bank rate has also been low and even close to zero in recent times compared to the earlier part of the sample.[4]

Given that the three factors summarize the dynamics of all the series in our data set and, as all three stochastic volatilities associated with them appear somehow lower in the 2000s compared to pre-2000, one can to some extent claim to have first impression evidence that the South African data is characterized by the great moderation. The volatility figures also provide a natural split of the sample into two sub-periods: pre and post-2000 which corresponds to the introduction of the inflation targeting framework in South Africa. Therefore subsequent presentations and discussions of the results will be mostly done using the pre- and post- 2000 sub-periods. This does not however imply that our results are conditional on the assumption of a single structural break as none of our parameters are estimated using only sub-sample data. This is in line with Ellis, Mumtaz and Zabczyk (2014). In the discussion that follows, we will concentrate on the responses of the macroeconomic variables to a monetary policy shock though we will examine the contribution of the three shocks via forecast error variance decompostions (FEVDs).

FIGURE 1: THE ESTIMATED FACTORS, THE BANK RATE AND THE STOCHASTIC VOLATILITY OF SHOCKS

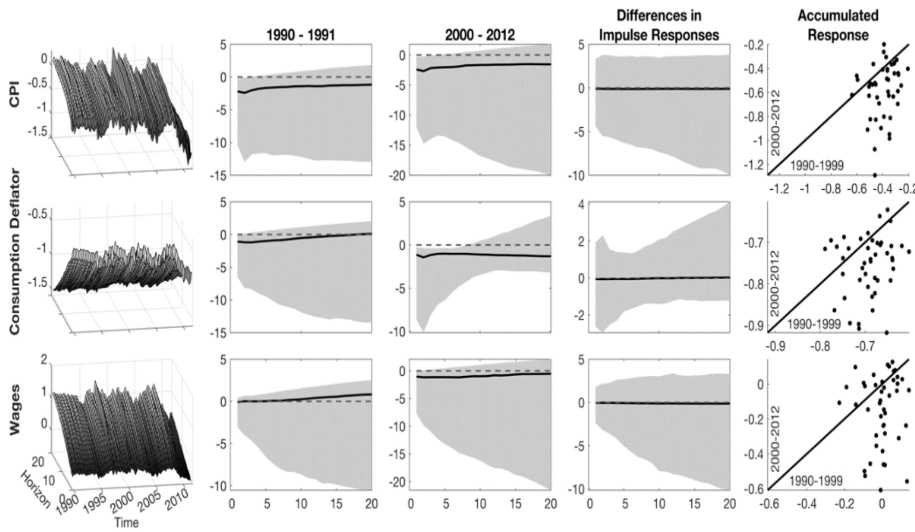


TRANSMISSION OF MONETARY POLICY SHOCKS TO MACROECONOMIC VARIABLES

INFLATION MEASURES

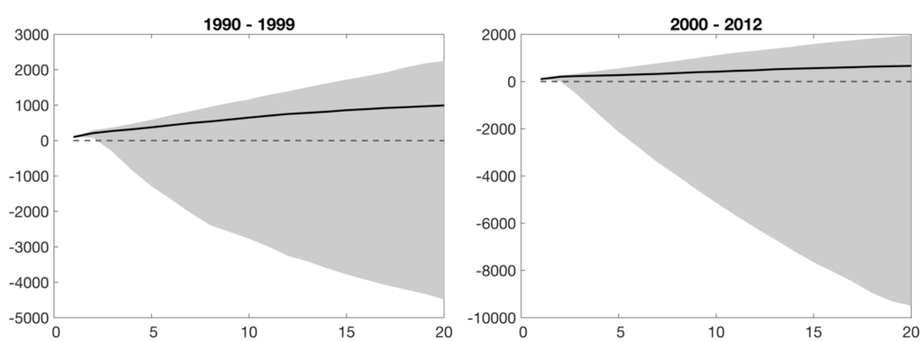
The posterior distribution of the cumulated responses of inflation measures to a contractionary monetary policy shock, normalised to increase the Bank Rate by 100 basis points on impact is presented in Figure 2. The median response in each quarter is presented in the left panel of the Figure. Our first obervation is that the immediate response of all the inflation measures to a contractionary monetary policy shock is negative showing that our time varying FAVAR model is capable of avoiding the commonly witnessed price puzzle in small scale VARs. In general, the responses of inflation measures to monetary policy shocks appear not to have changed much over time though the IRFs of CPI and wage deflator seem larger post-2000. To examine this further, we present the median responses along with the 68% HPDI over the pre and post-2000 periods in the next two panels. While there is no marked change in the response of the CPI and consumption deflator over the two sub-periods, the response of wage inflation appear to have become more negative in the post-2000 period. We test whether the responses of the inflation measures to monetary policy shock is statistically different from zero following Ellis, Mumtaz and Zabczyk (2014). The fourth panel of Figure 2 displays the plot of the median difference in impulse responses along with the associated HPDI. In all three cases, the the median difference is essentially zero suggesting that the introduction of inflation targeting has not had a statistically significant effect on inflation in South Africa over the years. An alternative perspective on the responses of changes in impulse responses was given by Cogley, Primiceri and Sargent (2010). In this approach, the plot of the estimated joint distribution of the cumulated impulse response could provide evidence of asymmetric distribution of points around the 45 degree line if there are systemantic differences between the two sub-periods. We present the plots for the 4-quarter horizon (that is one year) in the fifth panel of Figure 2 and observe that the distribution is more concentrated to the right of the line suggesting that inflation measures have responded more to monetary policy shock in post-2000 despite the fact that our statistical test in the HPDI sense did not provide evdence of significant difference.

FIGURE 2: IMPULSE RESPONSES OF INFLATION TO A MONETARY POLICY SHOCK



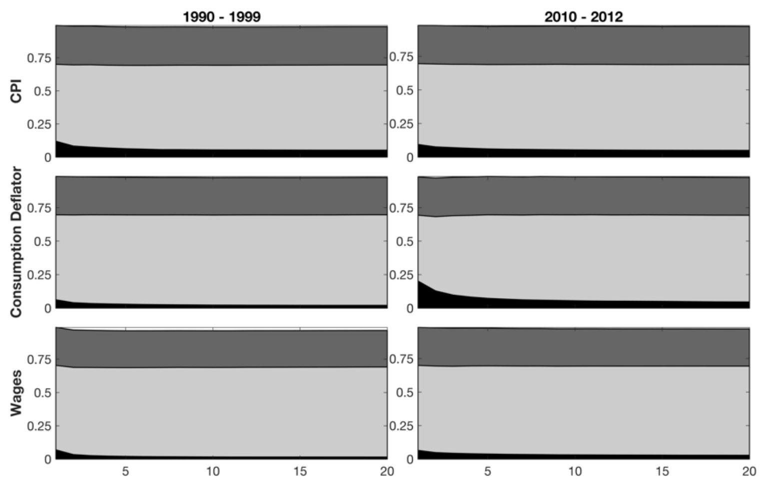
Ellis, Mumtaz and Zabczyk (2014) was of the view that impulse responses may not necessarily be indicative of changes in the trasnsmission of policy shocks. They argued that although the policy rate shock is normalised to an initial 100 basis point rise, its persistence may have increased, and that increase could mechanically account for the greater responses of inflation indicators in their results. Based on this we also present the impluse response of the Bank rate to a monetary policy shock in figure 3. As can be clearly seen, there appear to be no change in the responses to unanticipated monetary contraction prior and after the inflation targeting period.

FIGURE 3: TIME-VARYING IMPULSE RESPONSE OF THE BANK RATE TO A MONETARY POLICY SHOCK



To determine which of monetary, demand and supply shock have driven inflation measures most, we use the forecast error variance decompositions (FEVDs). The plots are presented in Figure 4 with the shaded area in black color showing the contribution of monetary policy shock, light grey relates to demand shock while dark grey relates to supply shock. Similar to Ellis, Mumtaz and Zabczyk (2014), we observe that the impact of monetary policy to inflation slightly and slowly increased over time. However, in contrast to their findings, we find that the great inflation and subsequent great moderation is mainly caused by demand shock. This finding should not be interpreted to mean that the changes in monetary policy did not contribute to falls in inflation , but may have perhaps have more dominant effect on the elements of the VAR covariance matrix, with a comparatively milder effect on the VAR coefficients as argued by Benati and Surico (2009).

FIGURE 4: FORECAST VARIANCE DECOMPOSITION OF INFLATION



Note: Shaded areas in black relate to monetary policy shock, light grey relates to demand shock while dark grey relates to supply shock.

ASSET PRICES

The impulses responses of asset prices are presented in Figure 5. We first start with the expectations channel. Following Boivin, Kiley and Mishkin (2010) and Ellis, Mumtaz and Zabczyk (2014), we use the response of 10-year government bond yield to contractionary monetary shocks as a measure of the responsiveness of inflation expectations to policy. The responses are presented in the second row of Figure 5. The response post-2000 period appears slightly larger though the difference between the two sub-periods is not statistically different from zero. Similarly, the responses of nominal effective exchange rate (NEER) and share prices as presented in the first, third and fourth rows appear to be larger post-2000. Standard theory suggests that increases in interest rates raise the return on domestic assets and lead to a currency appreciation. The currency appreciation is then argued to dampen domestic demand via expenditure switching (Ellis, Mumtaz and Zabczyk 2014). Our results provide evidence of positive response of exchange rate to a contractionary monetary policy. Consistent with the classic q theory of Tobin (1969) and the balance sheet transmission channel (Bernanke and Gertler 1989; Bernanke, Gertler and Gilchrist 1999), share prices respond negatively to contractionary monetary policy shocks both pre and post-2000 period. Expectations can have an important effect on the user cost of capital and housing spending (Case and Shiller 2003), implying that house prices should be expected to contract by more in response to a negative policy shock after 2000. However, growing competition in the housing market, combined with introduction of new financial products, may protect consumers from the immediate impact of changes in interest rates (Bennet, Peach and Peristiani 2001), implying that house prices should become less sensitive to monetary contractions. The responses of house prices in our study seem to be constant over time. This implies that house prices are not very sensitive to monetary policy and this is consistent with the finding in Ellis, Mumtaz and Zabczyk (2014) and Gathergood (2012). Evidence based on the estimated joint distribution of the accumulated responses shows that while house prices and NEER have responded more to monetary policy shock during the pre-2000 period, share prices and 10 year government bond has responded more in the post-2000 era. As with the inflation measures, the FEVDs displayed in Figure 6 shows that the demand shocks have contributed more to changes in asset prices and the contribution of monetary policy do not particularly seem to have changed much.

FIGURE 5: IMPULSE RESPONSES OF ASSET PRICES TO A MONETARY POLICY SHOCK

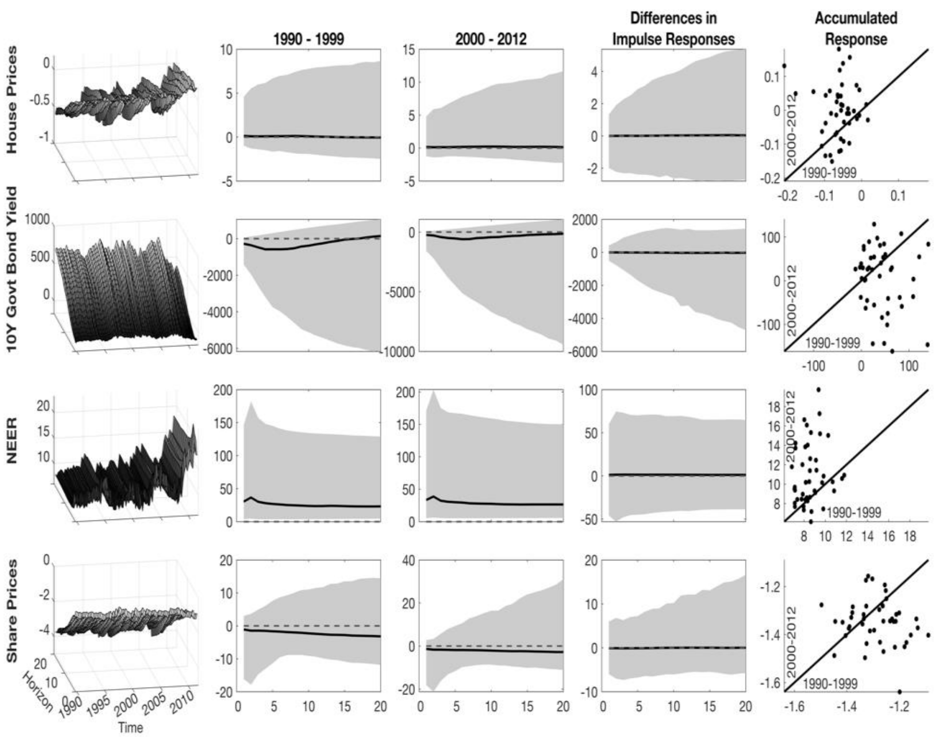
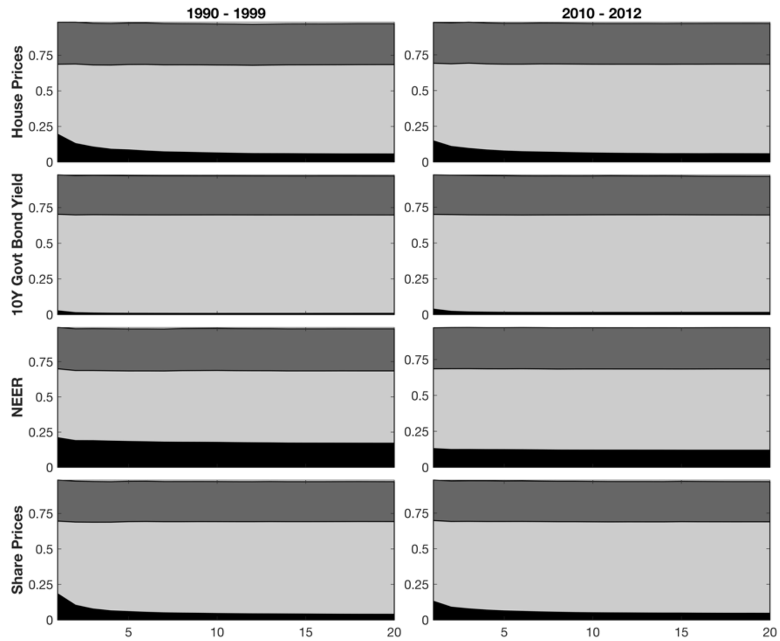


FIGURE 6: FORECAST VARIANCE DECOMPOSITION OF ASSET PRICES



Note: Shaded areas in black relate to monetary policy shock, light grey relate to demand shock while dark grey relates to supply shock.

REAL ACTIVITY

We present the impulse responses of changes in the transmission of policy shocks to measures of real activity, in Figure 7. The immediate observation in Figure 7 is that all real variables responded negatively to a contractionary monetary policy shock. An important monetary policy transmission channel to investment is through changes in the user cost of capital (Jorgenson 1963). One could also think of channel of transmission via Tobin's q. Our results show that the response of investment to unanticipated monetary policy shock is small both pre- and post-2000 sub-periods consistent with Boivin, Kiley and Mishkin (2010). However, the IRFs in the second and third panel of row 3 are slightly larger in the post-2000 period. Although the difference between the two periods are not statistically different from zero (as the HPDI includes zero), the accumulated response at the 4-quarter horizon shows that the distribution is concentrated on the right hand side, confirming that the response is more in the post-2000 period. Some cautions on interpreting these results is vital given that we focus on unanticipated policy shock (surprises), which tend to be associated with short-lived shifts in interest rates.

Another important transmission channel of policy shocks to consumption is via the lifecycle hypothesis of Ando and Modigliani (1963) that relates changes in consumption to fluctuations in lifetime resources including stock and real estate wealth. Similar to the equity and house prices, the changes in the response of consumption to a monetary policy shock is very modest suggesting that the people have low propensities to consume out of financial wealth. The short-run response of consumption to policy contractions is equal to zero but negative in both periods. Again this finding is in line with those of Ellis, Mumtaz and Zabczyk (2014) for the UK. As with investment and consumption, GDP, industrial production and employment responses appear relatively similar in both periods and very close to zero with all HPDIs of differences including zero (i.e. consistent with no-change). We note however that although the distribution of the cumulated response for GDP appear to concentrate around the 45 degree line, those of industrial production and employment are slightly skewed to the right showing that the latter may have responded slightly more in the post-2000 period despite the difference not being significant.

The plots of the FEVDs are presented in Figure 8. We note that while demand shock remain the predominant driver of changes in the real activity measures followed by supply shock, monetary policy shock has contributed less with little or no change in its contribution between the two sub-periods though the contribution seems to have changed over time in each sub-period.

FIGURE 7: IMPULSE RESPONSES OF REAL ACTIVITY TO A MONETARY POLICY SHOCK

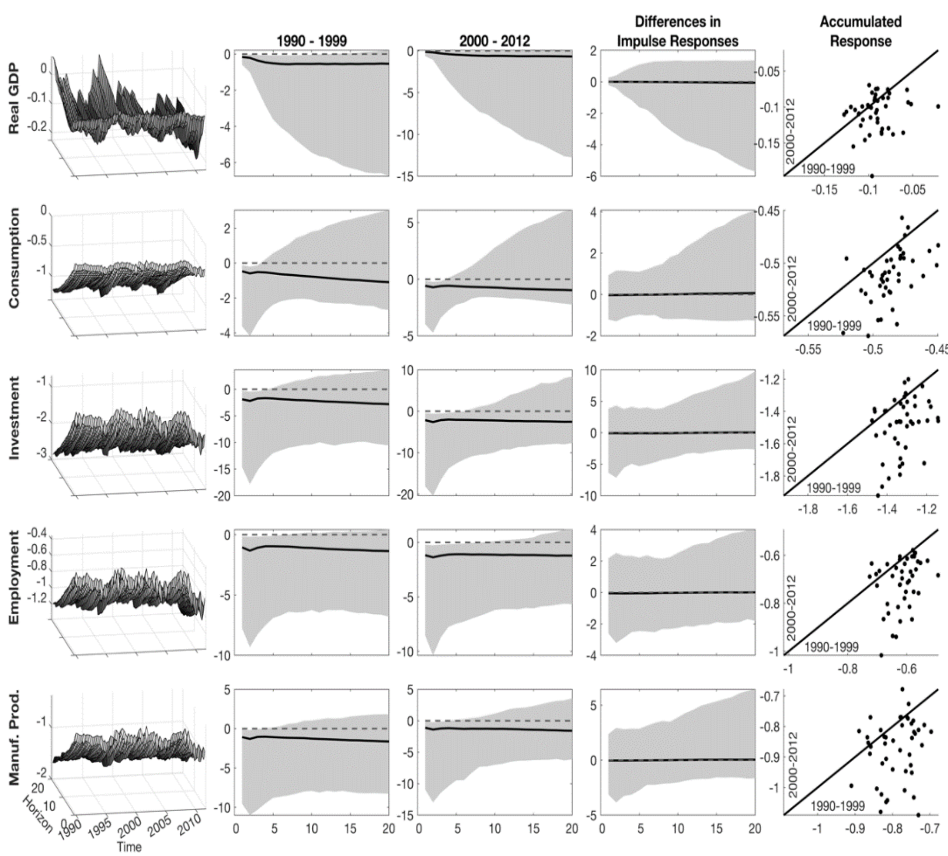
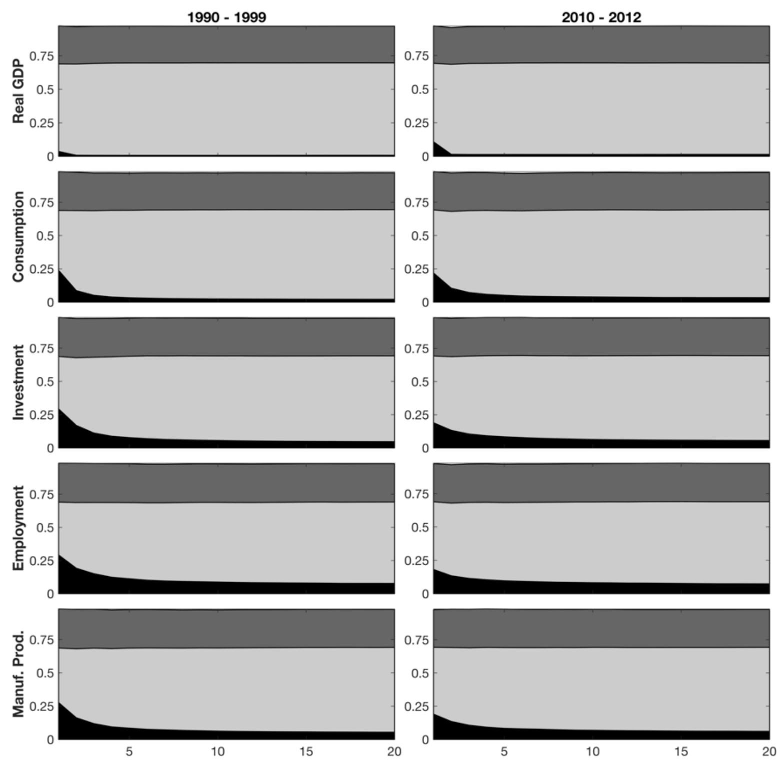


FIGURE 8: FORECAST VARIANCE DECOMPOSITION OF REAL ACTIVITY



Note: Shaded areas in black relate to monetary policy shock, light grey relate to demand shock while dark grey relates to supply shock.

MONETARY VARIABLES

Monetary policy may affect bank loan supply via the credit channel. The credit channel operates either via the bank lending channel or the balance sheet channel. If contractionary monetary policy increases banks' external finance premium, banks may respond by reducing the total amount of credit they are willing to supply (Stein 1998). This is the bank lending channel. Alternatively, contractionary monetary policy can reduce the net worth of the banks' borrowers, thereby increasing agency costs in lending. This effect is likely to be inversely related to firm net worth and may lead banks to reallocate their loan supply toward higher-net-worth firms. This implies that monetary policy impacts the distribution of loan supply across firms of different sizes (Bernanke, Gertler and Gilchrist 1996). This is the balance sheet channel. Changes in the willingness and ability of banks to extend credit may have implications for aggregate economic activity. Hence, the need to also examine the response of money measures to an unanticipated money shock. The impulse responses of the monetary variables to a shock in the monetary policy shock are presented in Figure 9. Overall, the monetary variables appear to have responded negatively to a contractionary monetary policy shock in both pre and post-2000 periods. Although the

HPDIs includes zero in all cases indicating no significant change in the responses of monetary variables between the two periods, the joint distribution shown in the last panel of column 5 suggest that all the variables with exception of credit responded relatively more to monetary policy shock in the post-2000 period. Results presented in Figure 10 points to a greater contribution of demand shock to changes in the monetary variables whereas the contribution of monetary policy though very small, appear to have in general changed slightly over time.

FIGURE 9: IMPULSE RESPONSES OF MONETARY VARIABLES TO A MONETARY POLICY SHOCK

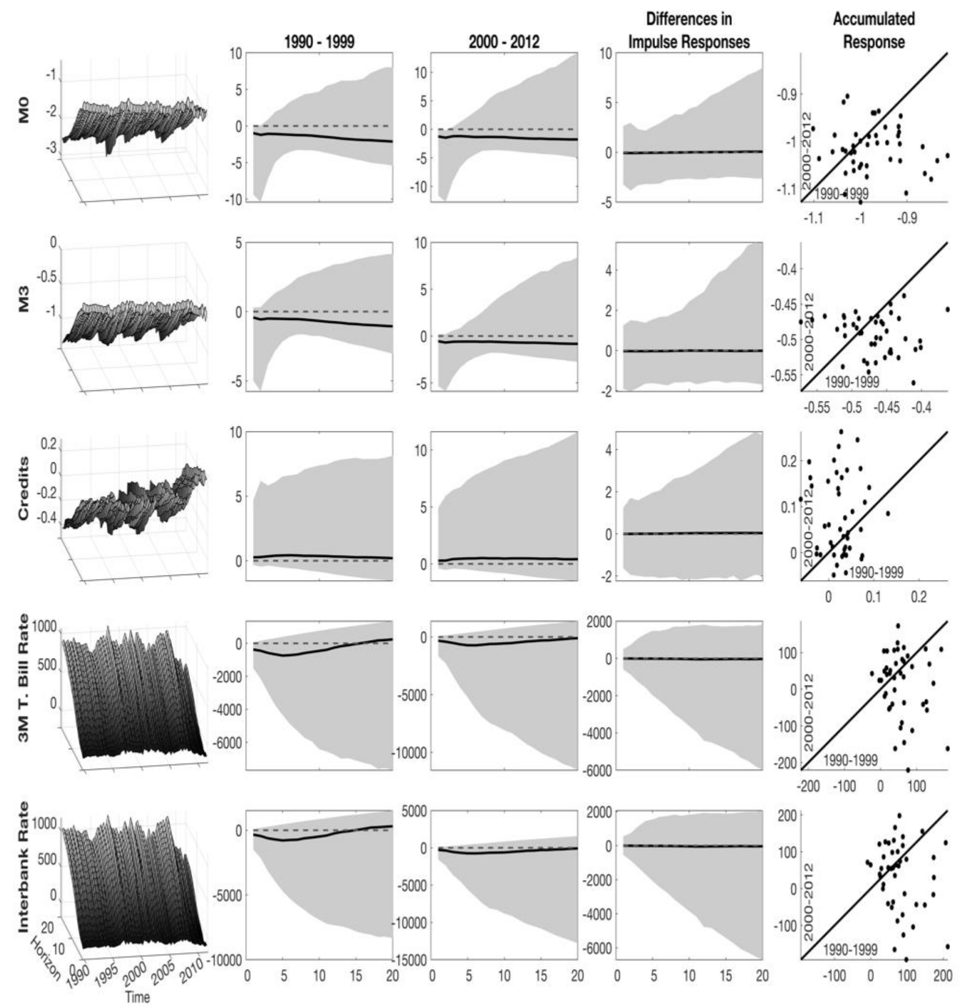
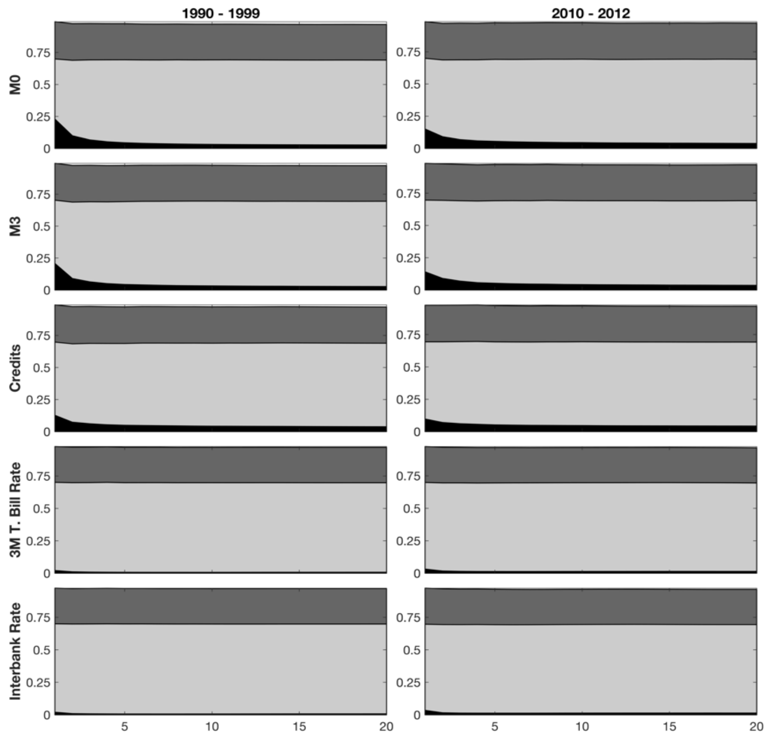


FIGURE 10: FORECAST VARIANCE DECOMPOSITION OF MONETARY VARIABLES



Note: Shaded areas in black relate to monetary policy shock, light grey relate to demand shock while dark grey relates to supply shock.

CONCLUSIONS

This paper attempts to identify the transmission mechanism of shocks to monetary policy in South Africa over the period 1980:1 to 2012:4. Our identification scheme also allows us to identify demand and supply shocks. We use a factor-augmented VAR with time-varying coefficients and stochastic volatility (TVP-FAVAR), which allows us to simultaneously analyze the changing impulse responses of a set of 177 macroeconomic variables. We examined the impulse responses of selected inflation measures, real activity, asset prices and monetary variables All three inflation measures (CPI, wage and consumption deflators) respond negatively to an unanticipated contractionary monetary policy. We find that the response of real activity measures (GDP, consumption, investment, employment and manufacturing production) is negative consistent with theory.

For the class of asset prices, while the response of share prices and 10 year government bond is negative, that of nominal effective exchange rate is positive while house prices appear to be less sensitive to changes in monetary policy shocks. The response of monetary variables (M0, M3, credits, 3 month Treasury bill and interbank rate) to a contractionary monetary policy is in general negative. Our results also show modest evidence of time variation in the transmission of shocks. Evidence from the forecast error variance decomposition suggests that demand shocks play greater role in the changes in the macroeconomic variables though the contribution of monetary policy increased slightly over time. Overall, the macroeconomic variables seemed to have responded slightly more to the monetary policy shocks in the post -2000 sub-period (official inflation targeting period in South Africa) than the period before. However, the difference in the responses between the two periods is not statistically significant in the sense that the 68% highest posterior density intervals (HPDIs) include zero for most cases. This however does not in any way connote that monetary policy in South Africa is not effective since the responses of the variables appear to be slightly more during this inflation targeting period. However, we would suggest a narrower, and possibly a lower, target band to improve the SARB's credibility and effectiveness in stabilizing inflation and hence the South African economy. Appropriate mix of supply and demand side policies such as privatization, regulation, changing tax and spending limits could be explored alongside monetary policy to reduce inflationary pressures

ENDNOTES

[*] We would like to thank an anonymous referee for many helpful comments. However, any remaining errors are solely ours.

[1] The detailed list of variables and transformations applied to achieve stationarity is available from the authors upon request.

[2] Details of the MCMC procedure we follow as well as the prior and posterior distributions can be found in Ellis, Mumtaz and Zabczyk (2014) while Koop, Pesaran and Potter (1996) details on the Monte Carlo integration procedure.

[3] The factors were determined based on the minimum deviance information criterion (DIC) and the test proposed in Forni and Gambetti (2014) that captures informational sufficiency.

[4] We examined the correlation between the estimated factors and the macroeconomic variables used and found correlation as high as between 0.81 and 0.99. These results are available from the authors upon request.

REFERENCES

Ando, A, and Modigliani, F 1963, "The "life cycle" hypothesis of saving: aggregate implications and tests", *American Economic Review*, vol. 53, no.1, pp. 55-84.

Anwar, S, and Nguyen, LP 2018, "Channels of monetary policy transmission in Vietnam", *Journal of Policy Modeling*, vol. 40, no. 4, pp. 709-729.

Balcilar, M, Demirer, R., Gupta, R, and van Eyden, R 2017, "The impact of US policy uncertainty on the monetary effectiveness in the Euro area", *Journal of Policy Modeling*, vol. 39, no. 6, pp. 1052–1064.

Barakchian, MS, and Crowe, C 2013, "Monetary policy matters: Evidence from new shocks data", *Journal of Monetary Economics*, vol. 60, no. 8, pp. 950–966.

Baumeister, C, Liu, P, and Mumtaz, H 2013, "Changes in the effects of monetary policy on disaggregate price dynamics", *Journal of Economic Dynamics and Control*, vol. 37, no. 3, pp. 543-560.

Benati, L, and Surico, P 2009 "VAR analysis and the great moderation", *American Economic Review*, vol. 99, no. 4, 1636-52.

Bernanke, B, and Gertler, M 1989, “Agency costs, net worth, and business fluctuations”, *American Economic Review*, vol. 79, no. 1, pp. 14-31.

Bernanke, B, Gertler, M, and Gilchrist, S 1996, “The financial accelerator and the flight to quality”, *The Review of Economics and Statistics*, vol. 78, no. 1, pp. 1-15.

Bernanke, BS, Gertler, M, and Gilchrist, S 1999, “The financial accelerator in a quantitative business cycle framework” in *Handbook of Macroeconomics*, eds JB Taylor, and M Woodford, vol. 1, part C., pp. 1341–93.

Bernanke, B, Boivin, J, and Eliasz, P 2005, “Measuring the effects of monetary policy: a factor-augmented vector autoregressive (FAVAR) approach”, *The Quarterly Journal of Economics*, vol. 120, no. 1, pp. 387-422.

Bennett, P, Peach, R, and Peristiani, S 2001, “Structural change in the mortgage market and the propensity to refinance”, Journal *of Money, Credit and Banking*, vol. 33, no. 4, pp. 955-75.

Boivin, M, Kiley, T, and Mishkin, FS 2010, “How has the monetary transmission mechanism evolved over time?” *Handbook of Monetary Economics*, vol. 3, no.1, pp. 369-422.

Burger, P 2008, “The changing volatility of the South African economy”, *South African Journal of Economics*, vol. 76, no. 3, pp. 335-355.

Burger, P, and Marinkov, M 2008, *Inflation targeting and inflation performance in South Africa*, TIPS working paper, South Africa. Available from: <http://www.tips.org.za/research-archive/annual-forum-papers/2008/item/1586-inflation-targeting-and-inflation-performance-in-south-africa>. [10 July 2018].

Case, KE, and Shiller, RJ 2003, “Is there a bubble in the housing market?”, Brookings *Papers on Economic Activity*, vol. 34, no. 2, pp. 299-362.

Cogley, T, Primiceri, GE, and Sargent, TJ 2010, “Inflation-gap persistence in the US”, *American Economic Journal: Macroeconomics*, vol. 2, no. 1, pp. 43-69.

Du Plessis, S 2006, “Reconsidering the business cycle and stabilisation policies in South Africa”,

Economic Modelling, vol. 23, no. 5, pp. 761-774.

Du Plessis, S, Smit, B, and Sturzenegger, F 2007, “The cyclicality of monetary and fiscal policy in South Africa since 1994”, *South African Journal of Economics*, vol. 75, no. 3, pp. 391-411.

Du Plessis, S, Smit, B, and Sturzenegger, F 2008, “Identifying aggregate supply and demand shocks in South Africa”, *Journal of African Economies*, vol. 17, no. 5, pp. 765-793.

Economy 2019, *South Africa and United States compared*, NationMaster. Available from: <http://www.nationmaster.com/country-info/compare/South-Africa/United-States/Economy>. [10 March 2019].

Ellis, C, Mumtaz, H, and Zabczyk, P 2014, “What lies beneath? A time-varying FAVAR model for the UK transmission mechanism”, *The Economic Journal*, vol. 124, no. 576, pp. 668-699.

Federal Reserve Bank (2015) *Why does the Federal Reserve aim for 2 percent inflation over time?* The Board of Governors of the Federal Reserve System. Available from : <https://www.federalreserve.gov/faqs/economy_14400.htm>. [10 July 2018]

Forni, M, and Gambetti, L 2014, “Sufficient information in structural VARS”, *Journal of Monetary Economics*, vol. 66, pp. 124-136.

Gathergood, J 2012, “How do consumers respond to house price declines?”, *Economics Letters*, vol. 115, no. 2, pp. 279–81.

Gupta, R, and Uwilingiye, J 2010, “Dynamic time inconsistency and the South African Reserve Bank”, *South African Journal of Economics*, vol. 78, no. 1, pp. 76-88.

Gupta, R, and Uwilingiye, J 2012, “Comparing South African inflation volatility across monetary policy regimes: an application of Saphe cracking”, Journal of Developing Areas, vol. 46, no. 1, pp. 45-54.

Gupta, R, Kabundi, A, and Modise, MP 2010, “Has the SARB become more effective post inflation targeting?”, *Economic Change Restructuring*, vol. 43, no.3 pp. 187–204.

Gupta, R, Jurgilas, M, and Kabundi, A 2010, “The effect of monetary policy on real house price growth in South Africa: A factor-augmented vector autoregression (FAVAR) approach”, *Economic Modelling*, vol. 27, no. 1, pp. 315-323.

Marcus, G 2014. *Fourteen Years of Inflation Targeting in South Africa and the Challenge of a Changing Mandate*. South African Reserve Bank Conference Series 2014, 30 October 2014. Available from: < https://www.bis.org/review/r141103c.htm>. [20 April 2018].

Jorgenson, DW 1963, “Capital theory and investment behaviour”, *American Economic Review*, vol. 53, no. 2, 247-59.

Koop, G, Pesaran, MH, and Potter, SM 1996, “Impulse response analysis in nonlinear multivariate models”, *Journal of Econometrics*, vol. 74, no. 1, pp. 119-47.

Korobilis, D 2013, “Assessing the transmission of monetary policy shocks using dynamic factor models”, *Oxford Bulletin of Economics and Statistics*, vol. 75, no. 2, pp. 157-179.

Primus, K 2018, “The effectiveness of monetary policy in small open economies”, *Journal of Policy Modeling*, vol. 40, no. 5, pp. 903-933.

Stein, J 1998, “An adverse selection model of bank asset and liability management with implications for the transmission of monetary policy”, *Rand Journal of Economics*, vol. 29, no. 3, pp. 466-486.

South African Reserve Bank 2018 *Monetary Policy Review, October 2018.* Available from : <https://www.resbank.co.za/Publications/Reviews/Pages/Monetary-Policy-Review.aspx.>. [12 December 2018].

Tobin, J 1969, “A general equilibrium approach to monetary theory”, *Journal of Money, Credit and Banking*, vol. 1, no. 1, pp. 15-29.

Uhlig, H 2005, “What are the effects of monetary policy on output? Results from an agnostic identification procedure”, *Journal of Monetary Economics*, vol. 52, no. 2, 381-419.

Woglom, G 2003, “How has inflation targeting affected monetary policy in South Africa?” *South African Journal of Economics*, vol. 71, no. 2, pp. 198-210.

Yoshino, N, and Taghizadeh-Hesary, F 2015, “Effectiveness of the easing of monetary policy in the Japanese economy, incorporating energy prices”, *Journal of Comparative Asian Development*, vol. 14, no. 2, pp. 227-248.