ASSESSING MONETARY POLICY IN SOUTH AFRICA IN A DATA-RICH ENVIRONMENT

ALAIN KABUNDI* AND NONHLANHLA NGWENYA**

Abstract
This paper examines the efficacy of monetary policy in the South African economy using a data-rich framework. We use the Factor Augmented Vector Autoregressive (FAVAR) methodology which contains 110 monthly variables for the period 1985:02 to 2007:11. The results, based on impulse response functions (IRF), provide no evidence of the *price puzzle* observed in traditional Structural Vector Autoregressive (SVAR) analysis and confirm that monetary policy in South Africa is effective in stabilising prices. Unlike the traditional Vector Autoregressive (VAR) approach, the FAVAR methodology allows further analysis of a large number of variables. Variables from real and financial variables react negatively to a contractionary monetary policy shock. Finally, we find evidence of the importance of a confidence channel transmission following a monetary policy shock.
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1. INTRODUCTION

In an emerging economy such as South Africa, the role of monetary policy and the actions of the monetary policy committee are debated and contrasted against developmental objectives (du Plessis and Smit, 2007). Inherent in the debate is the concern about how a developing economy meets its growth objectives and addresses the issues of unemployment and economic growth while attaining a stable macroeconomic environment. Viegi (2006) states that the role of macroeconomic policy is to achieve both nominal and real stability. With the primary objective of monetary policy being price stability, the distortions to the private sector are limited and the optimum environment for economic growth is established. This approach is used as the rationale for the adoption of price stability as the single objective of monetary policy. However a main opponent of this view has been the union body, the Congress of South African Trade Unions (Cosatu). Cosatu (1998) find that the impact of monetary policy has been negative and restrictive, making the attainment of real economic goals difficult. Thus it is important to establish the extent to which monetary policy determines nominal prices and shapes real economic outcomes.

This paper seeks to determine empirically the impact of monetary policy on nominal variables, the real economy, the financial sector, and the importance of the confidence channel. To achieve these objectives, we use the most recent Factor Augmented Vector Autoregressive (FAVAR) methodology proposed by Bernanke, Boivin and Eliasz (2005), which improves on the traditional Structural Vector Autoregressive (SVAR) method by including more variables without the risk of running out of degrees of freedom. The data-rich environment exploited by the FAVAR approach solves the *price puzzle* observed in traditional Vector Autoregressive (VAR) models. The popularity of this new approach is attributed to the fact that it mimics the environment that prevails when monetary policy authorities decide on an appropriate action. As argued eloquently by Bernanke et al. (2005), central bankers consider literally thousands of variables when making their decision. Failing to take the complexity of the decision-making process into account leads to

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a misspecified model and hence one can observe a *price puzzle*, which is opposite to what economic theory predicts. Finally, since the model contains many variables, it is possible to determine the impact of a monetary policy shock on any variable included in the panel, instead of assessing its impact on only the few variables included in small-scale VAR. To the best of our knowledge, this is the first attempt to assess the reaction of nominal, real, and financial variables to a contractionary monetary policy shock in South Africa in a data-rich environment. Besides the traditional channels of the transmission mechanism, the paper assesses the importance of confidence channels. Gupta, Kabundi, and Modise (2010) use the same framework in assessing the impact of a monetary shock in South Africa in the pre- and post-inflation-targeting regime. The drawback of such an approach is that, by dividing data into two sub-samples, the two data sets are short. Since VAR models are very sensitive to sample sizes, most of the impulse responses are statistically insignificant.. Hence, this paper uses monthly data from 1985:02 to 2007:11. Similarly, Gupta, Jurgilas, and Kabundi (2010) use a FAVAR model including 246 quarterly variables for the period 1980:01 to 2006:04 to assess the impact of monetary policy on house price inflation in South Africa. Both these studies solve the *price puzzle* issue and consider the reaction of more variables than those included in traditional VAR models.

Khabo and Harmse (2005) examine the impact of monetary policy on economic growth in South Africa for the period of 1960 to 1997, using the ordinary least squares method. They find that the orthodox view prevails in explaining economic growth, with GDP being adversely affected. A more rigorous study was undertaken by Aron and Muellbauer (2002) who use Instrumental Variables (IV) to measure a structural model of monetary policy for the period 1986 to 1997. Using the Taylor rule they model interest rates as a feedback between the deviation of inflation from inflation targets and the output gap. They find that the focus of M3 targeting in this period was on stabilising output rather than inflation. A similar study by du Plessis and Smit (2007) estimates the impact of South African monetary policy on output stability over the period 1981-2002. They use business cycles to identify peaks and troughs in economic activity and examine the co-movement of interest rates and economic cycles. They find the concordance index in the sample to have been low and insignificant, thus indicating the inability of monetary policy to reduce the impact of business cycles. They further find that monetary policy has been ineffective in stabilising the economy since the 1980s and, in effect, that it increased the impact of economic downturns. The restrictiveness of the modelling process often creates flawed results about the effectiveness of monetary policy, with conflicting conclusions about the impact on inflation and the real economy.

Du Plessis, Smit and Sturzenegger (2007) apply SVAR methodology to study the cyclicality of monetary and fiscal policy using quarterly data from 1960 to 2006. Using a three-variable SVAR model they disaggregate fiscal and monetary policy shocks. The variables used are output, government consumption as a ratio of GDP, and real interest rates. They apply a long-run identification restriction such that monetary and fiscal policies have no long-run impact on output and that monetary policy does not affect fiscal policy. The results of the analysis show that, in the period before 1994, monetary policy was counter-cyclical, whilst since 1994 it has been pro-cyclical and thus has had a greater impact on stabilising real output. Overall they conclude that monetary policy has played a role in stabilising the South African economy. Once again there is conflict over the overall impact of monetary policy in South Africa and the conclusion is reliant on the post-1994 era when the South African economy was experiencing increasing growth prospects. The results are likely not to be robust because of the issues related to the identification of small VAR models (Sims, 1992). Further, the above studies are limited to the variables included in the model and which are assumed to model the monetary policy shock impact correctly.

A more recent study conducted by Steinbach, Mathuloe and Smit (2009) apply a Dynamic Stochastic General Equilibrium (DSGE) model for the South African economy. The authors build a New Keynesian model of South Africa as a small open economy and take into consideration the pass-through impact of exchange rates. In this environment the external economy is used to model the South African domestic economy. They use the repurchase rate as policy instrument. Thus monetary policy transmission works on both aggregate supply and aggregate demand. It influences aggregate demand by influencing consumption expenditure and output. Aggregate supply is affected through nominal interest rates and the exchange rate. In this

context CPI is affected by changing terms of trade and import prices. A contractionary monetary policy shock results in a contraction in inflation and output. However, the negative impact on inflation is high and peaks within two quarters, which is earlier than theoretically expected. The results improve on traditional VAR studies as they solve the *price puzzle,* correctly model the monetary policy impact and begin to trace the monetary policy impact. Once again the analysis is limited to the few variables used in the model.

The literature on monetary policy reveals the lack of agreement on the impact of monetary policy, especially in the real sector. Within this framework, this paper introduces the use of FAVAR methodology. The FAVAR approach, of Bernanke *et al.* (2005), allows the researcher to take advantage of a data-rich environment by incorporating a larger set of information than in VAR. VAR modelling has remained popular in monetary analysis as it is computationally simple and enables the examination of the impact of monetary policy shocks on macroeconomic variables. However VAR results are disputable due to their limited macroeconomic predictability and conflicting results (Bernanke, Boivin and Eliasz, 2005 & Boivin and Giannoni, 2006). The FAVAR methodology uses both unobserved and observed variables and does not require that the researcher or the monetary policy maker have a complete view of the system under investigation. This view is more realistic of the environment in which decision makers' function. Since VAR models use few variables, Boivin and Ng (2006) find that using factor-augmented models allows for a structured method of including and determining relevant information in a system. Thus, factor-augmented models improve on the reliability and predictive power of VAR models (Stock and Watson, 2005). Also of contention is the resultant *price puzzle* which is often predicted when using the VAR approach and which does not conform to expected theory (Bernanke and Blinder, 1992). The *price puzzle* occurs when a contractionary monetary policy shock results in an increase in nominal prices (inflation), which contradicts monetary policy theory. This has led to research to attempt to explain the existence of the *price puzzle* found in VAR analysis (Balke and Emery, 1994). Even by using commodity prices, as proposed in VAR literature, the *price puzzle* persists (Banbura *et al*., 2010). Bernanke *et al.* (2005), however, find that this stems from an incorrectly specified VAR of the true economic environment due to the "smallness" of the VAR model. Bernanke *et al.* (2005) and Brunner (2000) further contend that the small dataset used in VAR modelling requires the researcher or central bank to identify all observed variables that represent the economic system. As it is debateable what truly represents economic activity, this further increases the likelihood of an incorrectly specified VAR. Attempts at increasing the number of variables that can be included in a VAR leads to instability and renders the VAR computationally complex (Stock and Watson, 2005). With FAVAR methodology improving on VAR analysis, its introduction to South African empirical analysis is important. Thus far its application to South African data has been limited to an analysis of housing dynamics by Gupta, Jurgilas, and Kabundi (2010) and in assessing pre- and post-inflation-targeting monetary policy by Gupta, Kabundi, and Modise (2010). To this end the FAVAR approach is outlined and serves as the model applied in the analysis.

The rest of the paper is organised as follows: Section 2 outlines the FAVAR methodology and model estimation. Section 3 discusses the data. Section 4 presents and discusses the results and section 5 concludes the paper.

2. THE FAVAR MODEL

The FAVAR model improves on the reliability of the simple VAR by summarising the information contained in a large data set into a group of latent factors. The FAVAR model followed in this paper replicates the FAVAR approach laid out by Bernanke *et al.* (2005) in the South African context.

The FAVAR approach assumes that there are Y_t economic time series variables that are observable, which form a $M \times 1$ matrix. The VAR approach to modelling this data typically would use only Y_t and assumes that the model is fully representative in measuring the dynamic interactions of these variables. The FAVAR approach, however, in addition to observed variables, includes unobserved variables. The unobserved variables, F_t, are $K \times 1$ common factors, extracted from the big cross-section matrix of time series. K is assumed to be small and

thus K is less than M ($K < M$). Bernanke *et al.* (2005) define the unobserved factors as representing economic variables that cannot be defined easily by one time series but are represented by a wider number of economic variables such as economic activity.
Including both observed (Y_t) and unobserved variables (F_t), we have

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + v_t \quad (1)$$

where $\Phi(L)$ is the polynomial lag structure of the relationship between F_t and Y_t and v_t is the error variable which is assumed to have a mean of zero and a constant-variance matrix Q. Equation 1 is thus a factor-augmented vector autoregression model (FAVAR) i.e. the standard VAR model has been augmented by the unobserved factors F_t. Thus Equation 1 can be reduced to a VAR model if the unobserved term F_t is zero. However if a standard VAR model is used when the FAVAR model is the correct representation, the resultant VAR estimates will be biased and incorrect due to misspecification.

Since the variables in F_t are unobserved they cannot be directly estimated from Equation 1. The FAVAR approach uses a large matrix X_t of economic time series data that is informative, from which factors are created that summarise information carried in a large set of data (Boivin, Giannoni and Mojon, 2009). This time series X_t is of matrix size $N \times 1$ and can be larger than the length of the time series *t*. Matrix X_t is thus a large set of informative data and the unobservable factors F_t can be determined from the larger matrix X_t. The size of X_t is thus greater than *K*. This matrix is also larger than the combined matrices F_t and Y_t ($M + K < N$). It is assumed that X_t is related to both the observed variables Y_t and unobserved factors F_t as follows in Equation 2.

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \quad (2)$$

where Λ^f is a $N \times K$ matrix of factor loadings, Λ^y is $N \times M$, and e_t is a $N \times 1$ vector of the error term, which is weakly correlated with mean zero. In essence Y_t and F_t are common forces that drive the dynamics of X_t. Note that it is not restrictive to assume in principle that X_t is dependent on the current value of F_t, as factors can always capture arbitrary lags of some fundamental factors. In this paper, we follow a realistic framework by assuming that the central bank and the econometrician observe only the monetary policy instrument, the repo rate; i.e. $Y_t = R_t$.

Having laid out the FAVAR approach above, it can be shown that the FAVAR method can be reduced to the VAR method if there are no interactions between the unobserved variables and Y_t and thus the VAR model is nested within the FAVAR approach. However, in a data-rich environment where monetary policy is informed by observing many data series, the FAVAR approach is appropriate, as the VAR will not be reflective of the true macroeconomic environment.

2.1 Estimation

The estimation procedure consists of a two-step approach proposed by Bernanke, Boivin, and Eliasz (2005), which provides a way of uncovering the common space spanned by the factors of X_t, $C(F_t, Y_t)$. In the first step, the space spanned by the factors is estimated using the first $K + M$ principal components of X_t, $\hat{C}(F_t, Y_t)$. $\hat{F}_t$ is obtained as the part of $\hat{C}(F_t, Y_t)$, which is not spanned by Y_t. In the second step, the FAVAR model is estimated by a standard VAR method where F_t is replaced by $\hat{F}_t$. As in standard VAR, when measuring the effect of monetary

policy, the repo rate is ordered last with the assumption that unobserved factors do not react to monetary policy shocks contemporaneously, which, in turn, produces orthogonal residuals. The reduced-form VAR then has the following structural form:

$$\Gamma(L)\begin{bmatrix}\hat{F}_t \\ Y_t\end{bmatrix} = u_t \tag{3}$$

where $\Gamma(L)$ is a conformable lag polynomial of finite order p and u_t is a vector of structural innovations. Given this, we compute the impulse response functions (IRFs) of $\hat{F}_t$ and Y_t as follows:

$$\begin{bmatrix}F_t \\ Y_t\end{bmatrix} = \Psi(L)u_t \tag{4}$$

where $\Psi(L)$ is a lag polynomial of order h and $\Psi(L) = \Gamma(L)^{-1}$.

Given that X_t is estimated by $\hat{X}_t = \hat{\Lambda}^f \hat{F}_t + \hat{\Lambda}^y Y_t + e_t$, based on Equation 2, the IRFs of $\hat{X}_t$ are given by:

$$\hat{X}_t = \begin{bmatrix}\hat{\Lambda}^f & \hat{\Lambda}^y\end{bmatrix}\begin{bmatrix}\hat{F}_t \\ Y_t\end{bmatrix} = \begin{bmatrix}\hat{\Lambda}^f & \hat{\Lambda}^y\end{bmatrix}\Psi(L)u_t \tag{5}$$

3. DATA

The data set contains monthly time series observed from February 1985 to November 2007, obtained from the South African Reserve Bank. This period of analysis was chosen as it encompasses a large cross section of monetary policy and economic activity in South Africa. The data set is segmented by macroeconomic groups and contains a balanced panel with 110 variables over 274 months. The data set includes data such as exchange rates; credit and financial market data; real variables (production volumes as a proxy of economic activity), inflation data, inventories and intangible variables (business and consumer confidence indices). The data was segmented into two, into fast and slow-moving variables. Fast-moving variables include mainly financial variables, which react contemporaneously to a monetary policy shock. On the other hand, slow-moving variables comprise mainly real and nominal variables which react slowly to a monetary policy shock. Variables are made stationary through differencing[1].

The first task in factor analysis is to determine the number of factors to include in FAVAR. We use two tests, the Bai and Ng (2002) (henceforth BN) test and the Alessi, Barigozzi and Capasso (2008) (henceforth ABC) test. The BN, as shown in Table 1, suggests on the one hand six factors based on PC_{P1} and PC_{P2} and seven factors based on PC_{P3}. On the other hand, it proposes four factors based on IC_{P1} and IC_{P2} and eight factors based on IC_{P3}. These results are inconclusive. Using the cumulative variance share, we observe that the fifth factor has an eigenvalue less than 0.05, which is used mainly as the threshold. Hence, based on cumulative variance share, the four factors would be appropriate. Recently the BN approach has been improved by the ABC approach, especially when working with finite samples. Figures 1 and 2 show that the ABC approach sets the number of factors to five. However, the results do not change by using four or five factors. We therefore use five factors in this paper. Similar to Gupta, Jurgilas and Kabundi (2010), and Gupta, Kabundi and Modise (2010), the lag length is determined using the Schwarz information criterion (SIC) in such a way that no serial correlation is left in the error term. The optimal lag length is four months.

[1] The appendix contains the list of variables included, together with adequate transformation.

Table 1. The BN tests

K	*PCp1*	*PCp2*	*PCp3*	*ICp1*	*ICp2*	*ICp3*	Cumulated Variance Share
1	0.8775	0.8797	0.8708	-0.1085	-0.1042	-0.1213	0.15
2	0.8445	0.8489	0.8312	-0.1285	-0.1199	-0.1542	0.21
3	0.8198	0.8265	0.7999	-0.1433	-0.1304	-0.1818	0.26
4	0.8008	0.8097	0.7742	**-0.1551**	**-0.1379**	-0.2065	**0.31**
5	0.7930	0.8042	0.7597	-0.1543	-0.1328	-0.2186	0.35
6	**0.7893**	**0.8026**	0.7493	-0.1502	-0.1244	-0.2273	0.38
7	0.7905	0.8061	0.7439	-0.1403	-0.1102	-0.2303	0.41
8	0.7937	0.8116	0.7405	-0.1291	-0.0947	**-0.2320**	0.43
9	0.7992	0.8192	**0.7393**	-0.1159	-0.0772	-0.2316	0.46
10	0.8060	0.8283	0.7394	-0.1019	-0.0589	-0.2304	0.48

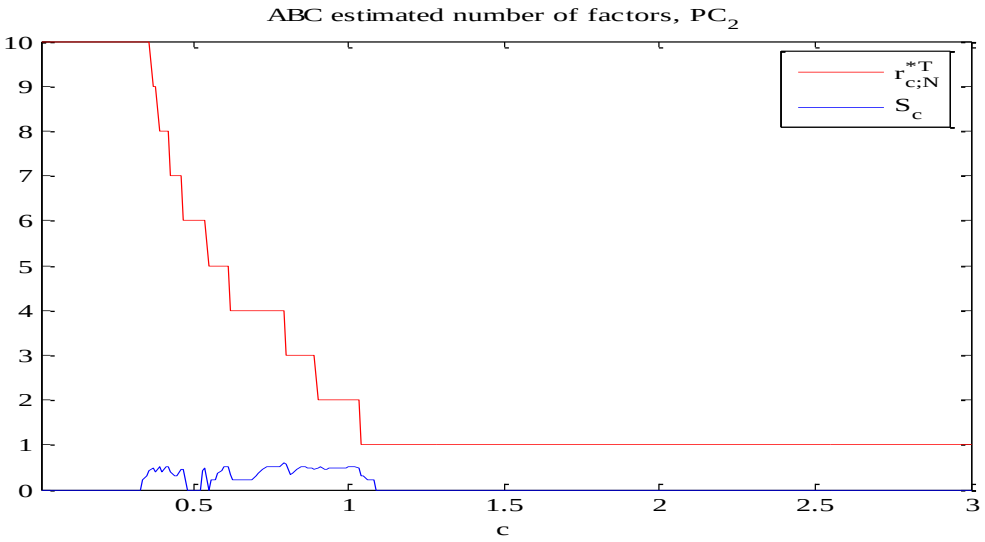

Figure 1. The ABC PC_2 test

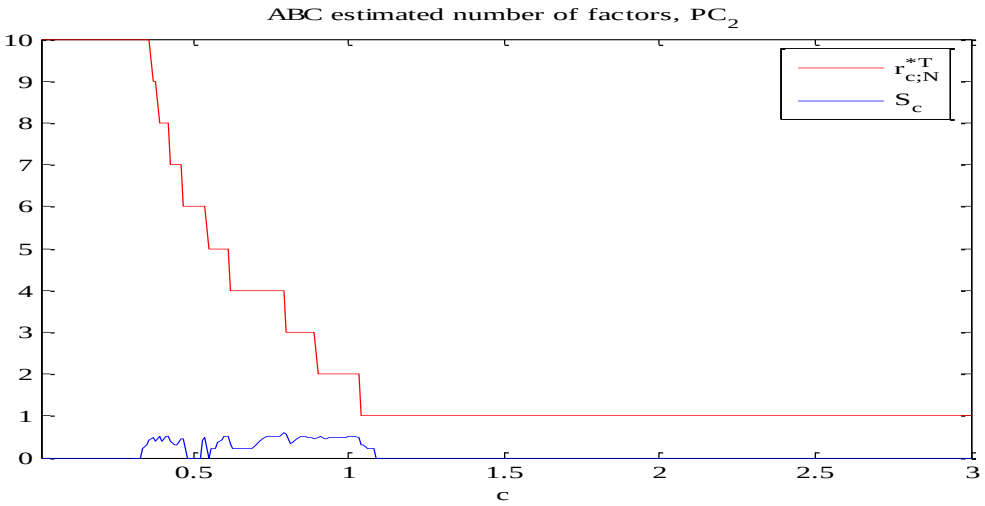

Figure 2. The ABC IC_2 test

4. EMPIRICAL FINDINGS

The adoption of the FAVAR framework has been based on the failure of VAR to estimate the impact of monetary policy correctly. Thus, before discussing the FAVAR results, a Structural Vector Autoregressive (SVAR) is estimated.

4.1 The performance of a small SVAR

We use a four-variable SVAR estimation. Besides containing output, the Consumer Price Index (CPI) and the repo rate, the VAR model is augmented with a commodity price index, a common approach in many VAR models[2], to limit the extent of the *price puzzle*. Following Sims (1992) and many other empirical studies on monetary policy shocks, we assume there is a contemporaneous impact of a commodity price shock on all other variables, but no immediate impact of the other shocks on commodity prices. An output shock contemporaneously affects price and interest rates, while price in turn affects interest rates at time *t*. This means that the monetary policy shock does not have any impact of these variables contemporaneously. Figure 3 depicts the IRFs of the SVAR estimation of contractionary monetary policy with the repo rate rising by a 100 basis points. At impact the repo rate immediately rises and is significant for twelve months. CPI reacts positively and significantly (*price puzzle)* and remains positive for twelve months. For production the VAR still results in a *price puzzle* which is statistically insignificant. This is contrary to the results found with the FAVAR approach and is mainly the consequence of the smallness of VAR models which do not take into account all important information. These results confirm the findings of Bernanke *et al.* (2005) and Babunra *et al.* (2010) who apply the same methodology to US data. Furthermore, Gupta, Kabundi, and Modise (2010) and Gupta Jurgilas, and Kabundi (2010), using South African data, find that the FAVAR methodology solves the *price puzzle,* commonly found in small-scale VAR. Commodity prices decrease right after the shock and remain negative for forty-eight months, which contradicts expectations based on economic theory.

[2] See Sims (1992) for more details.

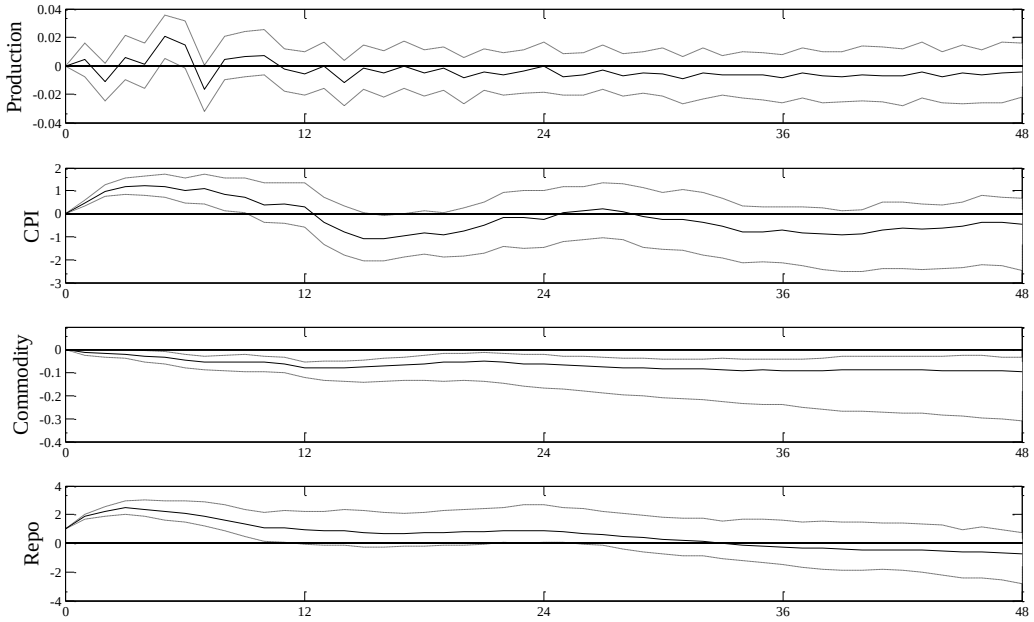

Figure 3. IRFs of SVAR

4.2 The performance of FAVAR

The results based on IRFs of FAVAR model are depicted in Figure 4. Contractionary monetary policy is estimated as a 100 basis points' increase in the repo rate. We use a 90 percent confidence interval over forty-eight months. The repo rate increases by 100 basis points and remains significant for twenty months. It is important to determine firstly the efficacy of monetary policy on price variables and to ascertain the transmission pattern. With VAR models predicting incorrectly a rise in consumer inflation with contractionary policy, the IRFs for consumer inflation in our FAVAR model predicts a modest decline and solves the *price puzzle*. At impact there is a decline that is insignificant until the 24th month. The decrease in inflation is significant for a short period before it corrects and begins to rise. The impact becomes insignificant after the fortieth month. The results further confirm that the impact of the policy variable is effective around twenty-four months, which is unlike the Steinbach, Mathuloe and Smit (2009) paper where the contraction in inflation is rapid and peaks within two quarters. As the transmission pattern shows that the impact of monetary policy is significant only after twenty-four months, monetary policy officials need to consider this when effecting multiple policy changes. We also examine the impact of the monetary policy shock on producer prices, as a large component of input costs for producers are imported and influenced by exchange rate movements. The IRF for PPI is negative and significant at impact, but the effect dies out after twelve months. Unlike consumer inflation, the impact of the monetary policy tool is larger, immediate and short-lived, as it is a leading indicator. Commodity price follows the same pattern as PPI and the effect is short-lived, which is opposite to what is observed in small-scale VAR. The IRFs for nominal variables show that the monetary policy instrument, the repo rate, is effective in controlling prices.

4.2.1 Real Activity

It is equally important to determine the impact of monetary policy on the real sector and economic outcomes, as earlier studies have disagreed largely on whether the impact is negative or positive. A closer look at the IRFs of production, utilisation of productive capacity, disposable income, fixed investment, consumption expenditure and employment, reveals these variables react negatively to a rise in short-term interest rates. We use production as a proxy for economic activity. Production falls immediately on impact and the effect is significant, attaining a maximum 0.9 percentage decline after twelve months. The effect remains significant, as production recovers

gradually, until the thirtieth month. A closer look at the effect of monetary policy suggests that contractionary monetary policy affects output more than inflation. This result is contrary to the SVAR study by du Plessis, Smit and Sturzenegger (2007), which finds monetary policy to have stabilised real output. There is further insight into economic activity in the real sector by examining leading and coincidental business indicators. The leading business indicator is considered to reflect changing business conditions and leads the business cycle. The IRF for the leading business indicator declines sharply and reaches its minimum within six months, recovers quickly and becomes insignificant after twelve months. The coincidental indicator, which represents current business activity, closely mimics production. The relationship between these indicators and production shows that they are effective in predicting the negative impact in the real sector. Overall our study shows that, within a data-rich environment monetary policy is an effective tool in managing inflation, but that the effect also is negative and does not stabilise output as suggested in previous studies.

Another important real variable worthy of examination is employment. The variables of interest are employment in the private sector (manufacturing, construction and mining) and employment in the total non-agricultural sector. The IRFs reveal that employment is sensitive to changes in monetary policy, with a pronounced decline in employment in the private sector, which reaches a maximum decline within six months. Thereafter it begins to recover and the impact is no longer significant after twenty-four months. The IRF for employment in the total non-agricultural sector resembles that of employment in the private sector, but the magnitude of the decrease is lower, indicating that the manufacturing, construction and mining sectors are likely more sensitive to changes in the monetary policy tool.

Finally, we consider the reactions of different components of consumption expenditure. The expenditure on durables; semi-durables and non-durables all exhibit a significant negative decline. However, the magnitude of effects differs somewhat. The impact is more pronounced and lasts longer for semi-durables and especially non-durable goods greater than that for durable goods, as expected. The impact on the disposable income is clearer and as expected, with a decline that is significant in the twenty-fourth period. Overall the downturns in the IRFs confirm that monetary policy has a role in determining the conditions in the real sector; these considerations ought to influence macroeconomic decision making. As can be seen from the IRF results, FAVAR methodology allows a broader examination of the real economic impact.

4.2.2 Sentiment

Few empirical studies on monetary policy analyse the importance of confidence channels, even though they are essential. Business and consumer confidence are indicative of expectations of future economic outcomes and likely inform the behaviour of economic agents. Following the implementation of contractionary monetary policy, the consumer confidence index declines gradually and attains a maximum decline of one percent after twenty-four months. Thereafter it recovers gradually and the impact dies out after approximately forty months. This result confirms the ability of monetary policy to affect economic agents' perceptions and thus their behaviour. Similarly, the business confidence index and the purchasing managers' index (PMI), which measures expected business conditions in the manufacturing industry, mimics closely the behaviour of the consumer confidence index. While the effect on the PMI is positive, but significant, at impact, business confidence reacts rapidly. The business confidence attains the maximum impact of a decline of more than one percent after twenty-four months, but the PMI displays a decrease of a lesser magnitude. As can be seen in the sentiment IRFs, there is a significant dampening in expected conditions which is analogous to that for the real sector. The similarity points to the importance of economic agents' beliefs and expectations in influencing behaviour, and thus it is likely that the perception of contractionary monetary policy leads to an expected decline in the economic environment and hence influences production and investment decisions. It is therefore essential to note that business confidence is a twelve-month leading indicator of economic activity. This is the main reason for the success of inflation-rate targeting, as it has at its core the drive to influence the expectations of economic agents.[3]

[3] Gupta, Kabundi and Modise (2010) find that the ability of monetary policy to affect key macroeconomic variables in South Africa has increased in the post-targeting period.

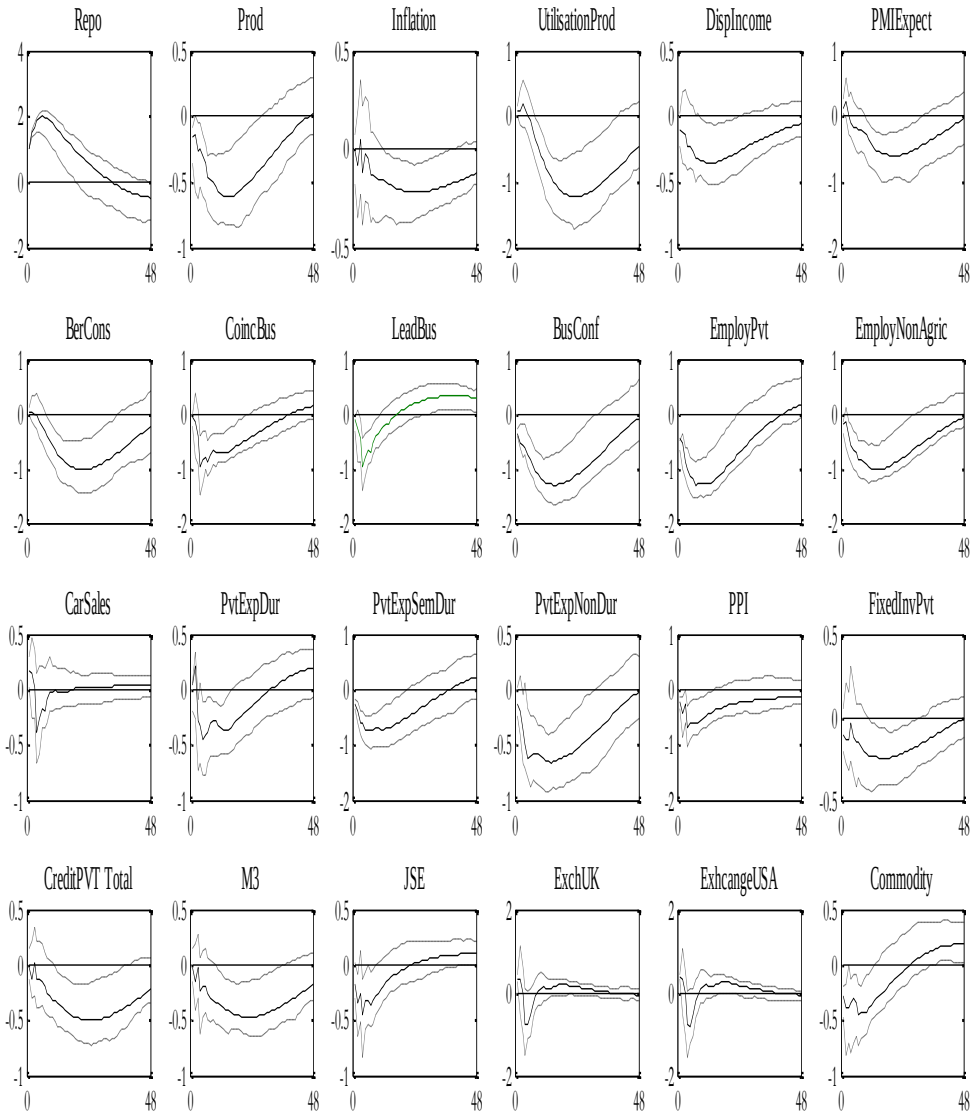

Figure 4. IRFS of FAVAR

4.2.3 Credit and Money Supply (M3)

In establishing monetary policy efficacy, it is important to determine if it has an impact on credit and money supply. The credit view is important in establishing if it is a deterrent by making credit expensive. Before the adoption of the new Credit Act in South Africa, some economists defended the thesis, referring to the inefficacity of contractionary monetary policy in curbing demand for credit. It is also worthwhile examining whether the transmission confirms the credit channel and that the decline in aggregate credit demand lags production (Bernanke and Gertler, 1995). This is as a result of an external financial premium where in the short term the private sector experiences a financial gap and this is likely to delay a decrease in the demand for credit (Bernanke and Gertler, 1995). During this period, the South African economy witnessed an increase in demand for credit, while the repo rate was also rising. It is therefore imperative to assess the validity of this argument. The IRF for total credit extended to the private sector is negative, but insignificant, at impact and only becomes significant after a year. The negative impact lasts until the second year, before an upturn and then dying out. However, this view is limited to overall private credit extension and further analysis should look into the different

components of credit extension, i.e. to business, consumers and government, to determine which group is most sensitive to monetary policy. Such analysis would improve decision making in controlling credit extension. We also examine the impact of a monetary policy shock on money supply. Figure 4 clearly shows that money supply follows exactly the same pattern as credit expanded to the private sector. The impact is significant from the twelve month, with M3 recovering in the twenty-fourth month.

4.2.4 Financial sector

With the recent financial crisis, the debate about whether or not the central bank should include in its Taylor rule some indicator of financial variables has resurfaced. This analysis includes the South African All Share Index (ALSI), which tracks the movement in share prices. The ALSI reacts negatively and quickly to a contractionary monetary policy shock. However, this impact is short-lived and stock prices recover quickly. This result confirms that the market quickly and negatively prices in the policy shock, which reveals the expected unfavourable impact on the real economy.

In addition, we also examine the reaction of the movement in exchange rates – specifically that of the South African rand against the USA dollar and the British pound. The impact on exchanges rates is negative (an appreciation of the rand) and significant for a small period. The impact dies away quickly as per the expectation for fast-moving variables. Overall the impact on financial variables is negative, with swift recovery.

4.3 Variance Decomposition

Like in most VAR analysis, it is essential to assess the strength of monetary policy shocks on key macroeconomic variables by analysing variance decomposition (VD). We estimate the fraction of the forecasting error of a variable, at a given horizon, that is attributable to a particular shock. In our case this is the 1 percentage point rise in the repo rate, as presented in table 2 (Bernanke, Boivin and Eliasz, 2005). We also include the R^2, which measures the fraction of the variance explained by the common factors for each variable of interest. While the variance decomposition assesses the impact of the policy shock on variables of interest, the R^2 measures the ability of FAVAR to model monetary policy in South Africa or, to put it differently, the role of common factors in explaining the changes in these variables. The variance decomposition measure is low and ranges between 0.9 percent and 31 percent, showing the effect of the monetary policy shock to be modest. The policy shock explains 31% of business confidence; 20% of employment in the private sector; 13% of capacity utilisation and 10% money supply respectively. The R^2 of the common component shows that the common factors are significant in explaining capacity utilisation (85%); business confidence (71%); consumer confidence (67%); the rand-dollar exchange rate (56%) and employment in the private sector (57%), but is low for money supply (16%) and the other fast-moving and private expenditure variables. The results point to the importance of expectations of economic agents' relative to monetary policy. The R^2 is fairly high and confirms that the FAVAR methodology is important in modelling the dynamics of monetary policy in South Africa.

Table 2. Variance Decomposition

	VD	R^2
Production	0.069	0.359
Inflation	0.017	0.204
Capacity utilisation	0.132	0.851
Disposable income	0.040	0.114
PMI	0.068	0.397
Consumer confidence	0.099	0.675
Coincidence indicator	0.037	0.504
Leading indicator	0.054	0.327
Business confidence	0.314	0.716
Employment in private sector	0.204	0.570
Employment in Non-Agriculture	0.122	0.419
Car sales	0.024	0.252
Private expenditure durable	0.022	0.233
Private expenditure Semi-Durable	0.264	0.481
Private expenditure Non-durable	0.136	0.274
PPI	0.031	0.354
Fixed investment private	0.016	0.119
Credit to private total	0.059	0.177
M3	0.107	0.163
JSE	0.093	0.233
Rand/Pound	0.009	0.569
Rand/Dollar	0.009	0.629

5. CONCLUSIONS

This paper analyses the effectiveness of monetary policy in the South African economy. We assess the impact of contractionary monetary policy on real, nominal, and financial variables using a FAVAR framework, which accommodates information contained in a data-rich environment of 110 monthly variables, observed from 1985:02 to 2007:11. The results, based on IRFs, are in line with economic theory, addressing puzzling effects often observed with traditional small-scale monetary VAR models. Importantly, the results show that monetary policy is successful in affecting key macroeconomic variables. The majority of the effects are significant with the expected sign. As suggested by theory, a monetary policy shock does not have a contemporaneous impact on the real economy and its effects do not last long. Similarly, a rise in the short-term interest rate decreases prices gradually, but the impact is short lived. Although

contractionary monetary policy significantly affects financial variables, the impact lasts only one month. The results also depict the importance of confidence channels from a monetary policy shock.

As part of future research it would be interesting to conduct the same analysis using the large-scale Bayesian VAR framework developed by Bunbura *et al.* (2010), given that Bayesian methodology, by appropriate use of priors, can accommodate large data sets similar to the FAVAR methodology. More importantly, the Bayesian methodology does not need to ensure stationarity of variables, and hence it retains the original structure of variables.

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Appendix

List of data and transformations

The data listed below was sourced mainly from the South African Reserve Bank database. The data listed below is sorted by whether it is fast or slow moving (* indicates slow moving data). Below are the numerical codes for the transformations performed on the data (followed Bernanke, Boivin and Eliasz (2005) method). Variables in italics indicate variables analysed in the study.

1: No transformation stationary
2: Log transformation stationary
3: First difference stationary
4: First difference log stationary

	Variable Code	Variable Name
Exchange rates		
1.	KBP5336M	4 SA cent per Swiss franc Middle rates (R1 = 100 cents)
2.	ExchUK	4 SA cent per UK pound Middle rates (R1 = 100 cents
3.	ExchangeUSA	4 SA cent per USA dollar Middle rates (R1 = 100 cents)
4.	KBP5319M	4 SA cent per Japanese yen Middle rates (R1 = 100 cents)
5.	KBP5310M	4 SA cent per Australian dollar Middle rates (R1 = 100 cents)
6.	KBP5320M	4 SA cent per Canadian dollar Middle rates (R1 = 100 cents)
Sales		
7.	CarSales	4 * New passenger car sales – NAAMSA
Money Aggregates and Credit Extension		
8.	KBP1371A	1 Monetary aggregates : M1, annual change
9.	M1	4 Monetary aggregates : M1, NSA in millions
10.	KBP1374A	1 Monetary aggregates : M3, annual % change
11.	M3	4 Monetary aggregates : M3, SA in millions
12.	KBP1347A	1 Total credit extended to the private sector, annual change
13.	CreditPvtTotal	4 Total credit extended to the private sector, SA in millions
14.	KBP2129M	4 Mortgage loans paid out during the period
15.	KBP2132M	4 Total mortgage loans outstanding, NSA
Intangible and Financial Indices		
16.	PMIExpect	4 *PMI: Expected business conditions, Constant 2000 prices. Seasonally adjusted
17.	BerCons	1* BER: Consumer confidence – Total
18.	BerDur	1 *BER: Consumer confidence - Rating of present time to buy durables
19.	BerHH	1 *BER: Consumer confidence - Financial position of household during next 12 months
20.	BerEcon	1 *BER: Consumer confidence - Economic position in SA during next 12 months
21.	CoincBus	4 *Coincident business cycle indicator
22.	LeadBus	4 *Leading business cycle indicator
23.	BusConf	2 *Business confidence index
24.	JSE	4 JSE: All shares
25.	KMMA100A	4 Secondary Share Market: Value of shares traded

26. KMMA100D 4 Secondary Share Market: Value of shares traded, Index 2000 = 100
27. KMMB100A 1 Primary Market: Net issues of marketable Central Government stock
28. KMMC000A 4 Banks and mutual banks. Change in mortgage holdings

Interest rates

29. Repo 1 Money market interest rates: Bank rate and average Repurchase rate
30. KBP2000M 1 Yield on loan stock traded on the bond exchange: Government stock - 0 to 3 years
31. KBP2003M 1 Yield on loan stock traded on the bond exchange: Government stock - 10 years and over
32. KBP2001M 1 Yield on loan stock traded on the bond exchange: Government stock - 3 to 5 years
33. KBP2007M 1 Predominant rate on retail deposits: 1-year fixed deposits at banks
34. KBP2011M 1 Predominant rate on new mortgage loans: Banks – dwelling units
35. MMIM001A 1 Prime overdraft rate
36. KMMF003A 1 Interest Market: Banks - Real rate - 12-month deposit rate
37. KMMG012A 1 Yield Market: JSE actuaries 3-yr real bond yield

Real Production and Income (Index=2000)

38. Utilisation Prod 2 *Per cent utilisation of production capacity
39. Prod 4 *Physical volume of production, total
40. ProdFB 4 *Physical volume of production, Food And beverages
41. ProdW 4 *Physical volume of production, Wood and wood products
42. ProdG 4 *Physical volume of production, Glass and glass non-met
43. ProdIS 4 *Physical volume of production ,Basic iron and steel
44. ProdElec 4 *Physical volume of production, Electrical machinery
45. ProdMotor 4 *Physical volume of production ,Motor vehicle, parts
46. ProdFurn 4 *Physical volume of production, Furniture and other
47. KBP6016D 4 *Gross national income
48. DispIncome 4 *Disposable income of households
49. DIFN034M 3 *Gross operating surplus as % of GDP
50. InventSalesRatio 4 *Ratio of inventories to sales in manufacturing and trade
51. GDE/GDP 3 *GDE as percentage of GDP

Fixed Investment

52. DIFA008B 4 *Gross domestic fixed investment: Mining: Residential buildings
53. DIFA009B 2 *Gross domestic fixed investment: Mining: Non-residential buildings
54. DIFA010B 4 *Gross domestic fixed investment: Mining: Construction works
55. DIFA011B 4 *Gross domestic fixed investment: Mining: Transport equipment
56. DIFA012B 4 *Gross domestic fixed investment: Mining: Other equipment
57. DIFC019B 4 *Gross domestic fixed investment of public corporations in non-residential buildings - manufacturing
58. DIFC021B 2 *Gross domestic fixed investment of public corporations in transport equipment – Manufacturing
59. DIFC022B 4 *Gross domestic fixed investment of public corporations in other equipment – manufacturing
60. DIFC023B 4 *Gross domestic fixed investment of private business enterprises in non-residential buildings – manufacturing
61. DIFC024B 4 *Gross domestic fixed investment of private business enterprises in transport equipment – manufacturing
62. FixedInvPvt 4 *Gross domestic fixed investment of private business enterprises in machinery and equipment – Manufacturing

Employment Indices (Index=2000)

63. KBP6246L 4 *Compensation of employees
64. DIFJ044S 2 *Job advertisement space: The Sunday Times Job advertisement space: The Sunday Times
65. DIFJ044P J 1 *ob advertisement space: The Sunday Times, 12-Term % change
66. DIFJ044B 4 *Job advertisement space: The Sunday Times, Seasonally adjusted
67. DIFJ003B 4 *Remuneration of employees (GDP), SA
68. DIFC012B 4 *Remuneration of employees in the sector manufacturing
69. EmployPVT 4 *Employment in the private sector (Manufacturing, construction and mining), SA
70. EmployNonAgric 4 * Employment in the total non-agricultural sector, SA
71. DIFM010M 1*Unit labour cost in manufacturing, 4term % change
72. DIFM022M 4 *Salaries and wages in the total non-agriculture sector. Constant 2000 prices SA

Inflation Indices

Consumer Inflation Indices

73. DIFN019A 4 *Total commodity price index
74. VPI1000A 4 *CPI, total (Metropolitan areas)
75. Inflation 3 * CPI annual inflation, Total(Metropolitan areas)
76. VPI2100F 1 * CPI annual inflation, Total housing services(Metropolitan areas)
77. VPI2110F 3 *Domestic workers(Metropolitan areas)
78. VPI2125F 3 *Boarding expenses(Metropolitan areas)
79. VPI2126F 1 *Interest rates on mortgage loans(Metropolitan areas)
80. VPI2220F 1 *Public transport services(Metropolitan areas)
81. VPI2221F 1 *Running cost, medical and education(Metropolitan areas)
82. VPI2400F 1 *Medical care and health expenses(Metropolitan areas)
83. VPI3220F 1 *Total food excluding soft drinks(Metropolitan areas)
84. VPI3400F 3 *Clothing & footwear(Metropolitan areas)
85. VPI3500F 3 *Furniture & equipment(Metropolitan areas)
86. VPI3530F 1 *Textiles(Metropolitan areas)
87. VPI3600F 1 *Transport goods(Metropolitan areas)
88. VPI3720F 1 *Fuel & power(Metropolitan areas)
89. VPI3750F 1 *Recreation & entertainment(Metropolitan areas)

Producer Price Indices

90. PPI 4 *PPI, Index 2000 = 100. Seasonally adjusted
91. PPI1000F 3 *PPI, 12-Term % change

Consumption Expenditure

92. PvtExpDur 4 * Private consumption expenditure: Durable goods
93. PvtExpSemDur 4 *Private consumption expenditure: Semi-durable goods
94. PvtExpNonDur 4 *Private consumption expenditure: Non-durable goods
95. PvtExpServ 4 *Private consumption expenditure: Services, 2000 constant, SA

Housing (Index=2000)

96. DIFE001I 4 *Value of building plans passed: Residential, Constant 200O prices. Index 200O = 100. Seasonally adjusted

97. DIFE002I 2 *Value of building plans passed: Non-residential
98. DIFE003D 4 *Value of building plans passed: Total
99. DIFE004I 4 *Value of building plans passed - additions and alterations: Total
100. DIFE005I 4 *Value of building plans passed: Residential buildings excluding additions and alterations
101. DIFE006I 4 *Value of building completed including additions and alterations: Residential buildings
102. DIFE007I 4*Value of buildings completed including additions and alterations: Total
103. DIFE009I 4 *Value of buildings completed, additions and alterations: Residential buildings
104. DIFE011I 4 *Value of buildings completed: Residential buildings, excluding additions and alterations
105. DIFE012I 4 *Value of buildings completed: Residential buildings, excluding additions and alterations

Inventories

106. InvenCont 1 *Change in inventories: Construction (contractors)
107. InvenWhole 1 *Change in inventories of wholesale of private business enterprises in the sector commerce. Constant SA
108. InvenMotor 1 *Change in inventories of motor trade of private business enterprises in the sector commerce
109. InvenRetail 1 *Change in inventories of retail trade of private business enterprises in the sector commerce
110. DIFF014B 4 *Book value of inventories of wholesale, retail and motor trade of private business enterprises in the sector commerce