# Monetary policy, asset prices and consumption: Evidence from South Africa using the FAVAR approach

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# Abstract

This study is an addition to the useful application of the FAVAR method in estimating the effects of monetary policy shocks on the economy. It also fills a gap to the literature on the wealth channel effect of monetary policy through shocks on stock prices. We recognize further that very little work has been done in analyzing this wealth channel on African countries and therefore aim to provide explanations using the South African economy. We find results consistent with economic theory and literature using a few macroeconomic data variables on the South African economy. Firstly, consumption is a slow-moving variable and it takes at least one quarter before households completely adjust their consumption habits in response to the interest rate shock. We also find that interest rate changes vary the opportunity cost of holding money causing households to shift their money balances in response to the policy shock. This means consumption and short-term monetary policy shocks have a negative correlation. We also find asset markets to be weak form efficient, that is, stock prices react efficiently to policy announcements but with a lag. The speed of adjustment is delayed. This explains the results obtained which show a smooth concave response which means asset prices react positively to interest rate shocks in the short run, and negatively in the long-run.

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# INTRODUCTION

Monetary policy has numerous channels of affecting the real economy. Among many of these policy transmission channels, the real economy can be affected via the wealth channel, which can be summarised as the mechanism through which financial markets respond to economic news and policy changes, while households adjust their consumption patterns respectively in response to the changes in their market values, Ludvigson *et. al* (2002). Hence the wealth channel is only functional if, first, monetary policy can affect the value of wealth, while these shocks on household wealth have enough momentum to influence consumption.

Mishkin (1996) provides a theoretical explanation of the transmission channels that monetary policy shocks follow until the shock affects consumption through asset prices. He explains the mechanism in two ways: (a) using the q theory by James Tobin and (b) using the wealth channel. The q theory defines a path that monetary policy shocks follow to affect the real economy and how the effects of the shock spread to consumption through the market value of equities, see Tobin (1969). In this paper, we define q as the ratio of firm value to the cost of replacing capital owned by the firm. A high q means firm value is relatively high as compared to the replacement cost of capital, which implies that the cost of acquiring or replacing properties and machinery is cheap when compared to the business firm's fair market value. Firms can therefore issue shares and get a high price on them relative to the cost of buying new plant and equipment. Thus, a small issue of equity can buy more investment goods meaning investment spending will rise.

How then does monetary policy transmit to consumption through asset prices? In a monetarist sense, money supply increases leave the households with more money than they desire therefore they try to reduce the holdings spending. One way of spending is through buying equities, which increases the demand for equities and consequently raising their prices. From a Keynesian viewpoint, expansionary monetary policy reduces interest rates making equities more attractive than bonds causing the price of equities to rise drawing to the same conclusion as monetarists. Combining these views with Tobin's q theory, higher stock prices lead to a higher q which leads to higher investment spending which further increases output hence disposable income which finally affects consumption spending.

Alternatively, monetary transmission through asset prices occurs via the wealth effects on consumption. This channel is greatly attributed to Modigliani and his MPS model see Modigliani (1971). In his life-cycle model, Modigliani contends that consumption spending is a determinant of the lifetime resources of consumers which are made up of human capital (H), real capital (K) and financial wealth (A). Financial wealth is made up of equity and bonds. Increases in stock prices increase the financial wealth, which should increase the household lifetime wealth which finally increases consumption. Since we have already shown that expansionary monetary policy can lead to a rise in stock prices, we therefore have developed another monetary policy transmission mechanism.

Following the developments in economic literature on the monetary policy mechanism, this paper aims to contribute to the gap by investigating the dominant transmission channel in the South African economy using modern methodologies. We are interested in learning how much consumption reacts to asset price movements, the effects being triggered by monetary policy shocks. We employ the Factor Augmented Vector Auto Regression (FAVAR) analysis for two main reasons: firstly, to check its usefulness in estimating monetary policy effects and secondly, as a comparison to existing methodologies of the similar properties that have been employed specifically on the South African economy, which is the economy under investigation in this paper.

## LITERATURE REVIEW:

Literature on the wealth channel is vast, dating back to Keynes' *General Theory* and Fisher (1933) who noted in the aftermath of the stock market crash of 1929, that a decline in stock markets could suggest the coming of an economic depression. Further studies led to the development of a theoretical framework for the channel that emanated from an econometric model of the U.S. economy, which specifically traced the link between changes in asset markets and changes in monetary policy instruments, de Leeuw and Gramlich (1969); Modigliani (1971).

Among the vast literature that assesses financial market's reaction to monetary policy is Cook and Hahn (1989), who examined the one-day response of bond rates to changes in the target funds rate between 1974 and 1979. They regressed the change in the bill, note and bond rates on the change in the target Federal funds rate for a sample consisting of the 75 days on which the Federal Reserve changed the funds target rate.

The results show that the response to target rate increases was significantly positive at all maturities and reduced hugely towards end of the yield curve: "a one percentage point increase in the Fed funds target led to an increase of 55 basis points in the three-month Treasury bill rate, but only a 10-basis point increase in the 30-year bond yield", www.econ.berkerley.edu. To eliminate the possibility that Fed actions may have been anticipated, Cook and Hahn (1989) further examined the relationship between interest rate changes and future changes in the target rate. However, they found little evidence that changes in the target rate were anticipated.

In another paper, Rigobon and Sack (2004) use a more innovative approach to measure how asset prices respond to changes in monetary policy shocks. In their methodology, they develop a heteroskedasticity based estimator that identifies the response of asset prices to heteroskedastic monetary policy shocks. They particularly assume that the variance of monetary policy shocks is higher around days of monetary policy announcements when a great deal of news hitting markets is about monetary policy. The paper further shows that the identification method can be implemented as an instrumental variable (IV) regression or as a generalized-method-of-moments (GMM) estimator.

Using the instrument variable (IV) approach, the four stock market indexes[1] considered have a significant negative reaction to monetary policy. An unanticipated 25-basis point increase in the short-term interest rate results in a 1.7% decline in the indexes on average. The GMM estimates are very similar in magnitude to the IV estimates, and they fail to reject the hypothesis that the two estimates are equal. In addition, the standard errors of the GMM-based estimates are slightly smaller than those for the IV-based estimates. This indicates that there may be a marginal improvement in efficiency from incorporating the additional moment conditions into the estimation. These findings suggest that monetary policy news is the primary determinant of asset prices during

[1] The four indexes considered are the S&P 500, Nasdaq, Dow Jones Industrial index and the Wilshire 5000.

those days. However, one should not ignore the presence of other types of news on the same days.

Bernanke and Kuttner (2005) use the same methodologies used in Rigobon and Sack (2004) and find comparable results. The stock market reacts negatively to surprise rate changes while anticipated changes in funds rates have little, if at all, effects on the futures markets which proxy the equity market. Another interesting finding is that future cash flows in terms of expected dividends are negatively affected by tight monetary controls which resultingly negatively affects stock prices.

Another piece of empirical work conducted by Craine and Martin (2003) finds comparable results as above. They use a factor model of demeaned yields and demeaned stock returns as an estimate of the effects of monetary policy shocks on security markets. In their econometric specification, they make use of the assumption that equity returns, and their yields are correlated with systematic risk. The study estimates the model using the GMM methodology.

Results from the factor model show that the response of the yield curve to monetary innovations perfectly follows the theoretical description. An interest rate target surprise causes short term yields to increase more than intermediate term yields while long term yields do not react to policy surprises. They also find that common information shocks affect only the level of the yield curve. More importantly, Craine and Martin (2003) find that the stock markets dominate the wealth channel in the short run despite that most textbooks or empirical studies do not consider them. They contend particularly that debt markets respond less rapidly to monetary innovations than equity markets. They find that the response in debt markets is about half the response in equity markets. The wealth effect was also found to be dominant in equity markets than debt markets.

Another set of studies named Event-study models which explain observed variation and responses to the short run rate on event days as exogenous shocks. Alternatively, different authors use different rates to explain central policy innovations. For example, changes in the one-month Eurodollar rate, Cochrane and Piazessi (2002) while others authors suggest changes in the Fed Funds Futures rate, Kuttner (2001) and Poole and Rasche (2003). We regress changes in the yield on variations in the short-term target rate to estimate the effects of the monetary surprise on or just before the event day. These models assume that no common shocks exist on event days to identify the monetary shock. Craine and Martin (2003) note that the only study that was able to explain the short run effects of both monetary and information surprises in the same model is by Poole, Rasche and Thornton (2002). They therefore augment their model with information shock to the short-term interest rate specification.

Results from these studies are consistent with the hypothesis that there is a connection between monetary policy and asset prices. For example, Kuttner (2001), Poole, Rasche and Thornton (2002) and Poole and Rasche (2003), all conclude that treasury rates are significantly affected by unanticipated target rate variations, and very little by anticipated target changes. Bordo and Wheelock (2004); Alessi and Detken (2009) find more evidence on the link. They find that more liquid financial markets increase stock prices in developed countries.

The second part of the wealth channel is the relation between consumption and asset prices. The central issue surrounding this wealth channel analysis is timing. If favorable shocks to household balance sheets take years before consumption increases in response to such shocks, then the stock market effect on consumption is limited. However, prompt and powerful responses in net worth will be translated quickly to consumption after sharp changes in asset prices, Porteba (2000).

The channel through which this takes effect relies heavily on Ando and Modigliani's (1963) the life cycle model. The model in their paper defines the relation between aggregate consumption, expected disposable labour income and disposable non-labour income or property income. This is a more sophisticated variant of the standard Keynesian consumption functions which hypothesise that consumption reacts to disposable income net of taxes only. The authors argue that this new formulation is important because it differentiates consumption between two groups, one that earns labour income only and another that earns income from the ownership of assets, and accordingly expected to have a lower marginal propensity to consume.

Having established such a channel, an important question to ask is "how large is the consumption effect associated with recent wealth movements?" or Is it economically correct to attribute increases in economic activity to rising stock prices through the wealth channel? Among several studies, Porteba (2000) suggests that the aggregate consumption effect largely depends on the size of the marginal propensity to consume out of wealth. Variations of the same question are addressed in other studies such as Gale and Sabelhaus (1999) and Parker (1999). Although no consensus drawn on the optimum size of the wealth effect, these studies highlight the necessity of reducing the amount of uncertainty around the concept of marginal propensity to consume out of wealth.

Empirical estimates of the correlation between wealth and consumption span a wide range. For example, Meyer and Associates (1994) and show that a \$1 increase in stock prices increase consumption one quarter later by \$0.02, while taking a long-run view, consumption increased by \$0.042 to a \$1 shock stock market wealth. Total wealth and consumption are positively correlated with a coefficient of 0.040, Ludvigson and Steindel (1999). Brayton and Tinsley (1996) find that the marginal propensity to consume out of equity wealth is significantly less than other changes in net worth. Funke (2004) finds that equity market rises of about 10% result in a 0.2-0.4% rise in private consumption in 16 emerging economies. Peltonen, Sousa and Vansteenkiste (2012) provide comparable results and more importantly find positive financial wealth shocks affect consumption less strongly than negative shocks in emerging economies.

Most of the studies referenced in this paper examined only a part of the wealth channel, only a few analyse both parts. Results for the wealth channel links of the US economy are summarised in Lettau *et. al* (2002). A relation between monetary policy and the real economy exists, but the no consensus is reached with regards to the importance of the wealth channel in explaining economic growth. The authors further conclude that changes to household wealth caused by changes in monetary policy have a positive but minor and rarely significant impact on consumption spending.

## METHODOLOGY

In this study, we employ a factor-augmented vector autoregression (FAVAR) model, specifically following the approach taken in Bernanke *et. al* (2005) to estimate the monetary policy effects on consumption via asset prices. We believe that this methodology will solve the information and statistical problems that VAR models are susceptible to. The application of thinly dispersed information sets in monetary policy analyses using VAR methodologies begs the need to make inferences on specific variables that are observable but strongly based on economic theory. For example, "economic activity" does not correctly proxy real GDP or industrial production nor can it be measured accurately without being contaminated by measurement error. FAVAR models have become increasingly popular in empirical macroeconomics due to increases in availability of larger datasets. For example, Lagana and Mountford (2005) conclude that FAVAR models improve results compared to VAR models without factors using UK datasets. Gavin and Kliesen (2008) and Matheson (2006) also suggest that models with additional factors improve results compared to those without factors.

We open this section by presenting a theoretical framework underlying factor-augmented VAR models.

## Framework:

Let $Y_t$ be a vector of dimension $M$ x 1. This vector comprises macroeconomic variables that drive the economy and are assumed to be observable by the econometrician or the central bank. Prices, proxies for the real economy variables that are observable and indicators of policy such as interest rates can be assumed to be contained in $Y_t$.[2] Following this standard method, the next step would be to estimate a structural VAR (SVAR). In most cases, $Y_t$ does not capture all the information and supplementary information is necessary to more accurately model the time series of these macroeconomic variables. Supposedly, let another vector $F_t$ of dimension K x 1 (with K being small) represent the vector of the factors that cannot be observed. One can view the unobserved factors $F_t$ as capturing concepts motivated by economic theory such as credit conditions, price pressures, or economic activity all of which dynamically adjust together with multiples of other macro-economic series. A single series will not perfectly represent these factors.

Let the following equation represent the combined adjustments of $(F_t, Y_t)$:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Omega(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \nu_t \qquad [1]$$

Ω(L) represents a consistent lag structure with finite order *d*, and $\nu_t$ is a zero-mean error term.

Equation [1] represents a VAR in $(F_t, Y_t)$. We can interpret it as a linear rational expectations model that involves observable and unobservable variables. When the relation between $Y_t$ and $F_{t-1}$ equals zero via the terms of Ω(L); then Equation [1] nests the standard VAR in $Y_t$, else equation [1] is referred to as a factor-augmented vector autoregression (FAVAR). Equation [1] models some system that quantifies the information rich characteristics contained in $F_t$ and allows the researcher to compare the

[2] This definition comes from the basic estimation techniques in VAR literature.

results from the FAVAR with the existing VAR results. Moreover, estimating [1] formally as a VAR in $Y_t$ when in actual fact it is a FAVAR system will generate VAR results with biased coefficients.

The factors $F_t$ are unobservable, therefore it is impractical to directly estimate equation [1]. Since $F_t$ represents forces that possess the potential to affect a large set of macroeconomic variables, we hope that the various time series observations will help us observe inferences about the factors. Further assume that there exists a vector $X_t$ that represents some informational time series of dimension N x 1 where N is large and larger than T. Assume further the FAVAR consists of an N greater than the combination of factors and observables in the FAVAR, (N≫K+M). Bernanke *et. al* (2005) assume that $X_t$ is related to $F_t$ and $Y_t$[3] by the following observation equation:

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \qquad [2]$$

where $\Lambda^f$ and $\Lambda^y$ are matrices of factor loadings with dimensions of N x K and N x M, respectively. $e_t$ is an N x 1 vector of error terms with a zero mean and uncorrelated[4]. Equation [2] says that both $Y_t$ and $F_t$, are common drivers of $X_t$[5]. Note that equation [2] is not restrictive in practice even though it seems to imply that $X_t$ depends only on $F_t$ and not $F_{t-1}$. In fact, $F_t$ implicitly includes arbitrary lags of the underlying factors. Equation

[3] Remember $X_t$ is the informational time series, $F_t$ represents the unobserved factors and $Y_t$ represents the observed factors

[4] The error terms are liberated to contain some cross-correlation depending on the method of estimation. For example, the PC methodology allows $e_t$ to be correlated. The correlation must reduce to zero as N increasingly grows large. Stock and Watson (2002) provides a formal discussion on this matter.

[5] Practically $Y_t$ and $F_t$ are allowed to be correlated.

[2] without observable factors is sometimes referred to as a dynamic factor model, see Stock and Watson (1998).

## Model:

This paper tries to emphasize the effectiveness of the FAVAR estimation, which allows researchers and econometricians in the analysis of macroeconomic models to derive benefit from the information content present among hundreds of macro-economic variables. In this section we harness the idea that reserve banks continuously observe multiple macroeconomic indicators while making policy formulations. This provides enough motivation to condition any monetary policy analysis based on valuable sets of information, Bernanke and Boivin (2003).

Assume that the South African economy can be represented by a variation of the Rudebusch and Svensson (1999) model of the form:[6]

$$\pi_t = \delta\pi_{t-1} + \tau(y_{t-1} - y_{t-1}^n) + s_t \qquad (3)$$

$$y_t = \phi y_{t-1} + \psi(R_{t-1} - \pi_{t-1}) + d_t \qquad (4)$$

$$y_t^n = \kappa y_{t-1}^n + \eta_t \qquad (5)$$

$$s_t = \omega s_{t-1} + \nu_t \qquad (6)$$

$$R_t = \beta\pi_t + \gamma(y_t - y_t^n) + \mu ap_t + \varepsilon_t \qquad (7)$$

[6] At this point, we should stress that the macroeconomic model presented here is not a perfect representation of the macroeconomic dynamics prevalent in the South African economy. A richer specification of the dynamics would be needed to this effect. Instead, it is merely a general representation of any economic system where the purpose of this study is to provide a general conclusion of such using data on the South African economy.

$$C_t = \theta C_{t-1} + \rho y_t + \alpha ap_t + \Omega O_t + u_t \qquad (8)$$

Equation (3) is a Phillips curve or aggregate supply equation describing the historical relationship between inflation ($\pi_t$), lagged inflation ($\pi_{t-1}$), the lagged deviations of output from potential[7] ($y_{t-1} - y_{t-1}^n$), and a cost-push shock ($s_t$). This tradeoff relation holds only in the short-run as there is no empirical observation that it also holds in the long-run. The long-run Phillips curve can be thought of as a vertical line at the natural rate of unemployment, where inflation has no effect on the unemployment rate, Friedman (1968).

Equation (4) represents an Investments – Savings curve, which relates output to its previous values, the real interest rate and a demand shock $d_t$. It is a representation of a Keynesian macroeconomy implying goods market equilibrium and fixed prices in the short-run. Equation (5) and Equation (6) represent AR(1) processes of potential output and cost-push shocks respectively[8]. $d_t$, $v_t$ and $\eta_t$ are mutually uncorrelated innovations with a zero-mean value. Equation (7) assumes that the central bank follows a simple Taylor rule to set the nominal interest rate. It responds to current inflation, output deviations from potential and stock market movements ($ap_t$). Finally, (8) shows that aggregate consumption ($C_t$) depends on lagged consumption ($C_{t-1}$), disposable income, stock price movements and other streams of income that are non-stock income such as property income ($O_t$). $\varepsilon_t$ and $u_t$ are follow a normal distribution with zero mean and unit variance.

[7] Other variations of the Phillips curve specify the relation between inflation and the deviation of unemployment from its natural rate. It is sufficient for the purposes of this study to specify the relation as in equation (3) therefore no confusion should arise.

[8] Autoregressive (AR) models are a representation of a type of random process used to describe certain time-varying processes. In this case the AR model says potential output and supply shocks depend linearly on their own previous terms and a stochastic (an imperfectly predictable) term.

By assumption, this model characterizes the dynamics of the business cycle hundreds of macroeconomic indicators ($X_t$), are related to the observable variables ($Y_t$) and unobservable factors ($F_t$) in the form of equation [2], where $(F_t' \ Y_t') = (y_t^n \ \ s_t \ \ \pi_t \ \ y_t \ \ R_t \ \ C_t\ )'$. As shall be illustrated, the division of variables into $F_t$ or $Y_t$ is based on the underlying assumption classifying variables into two groups - observables and non-observables. Two cases which nest the FAVAR more realistically are worth considering here.

We firstly assume that the econometrician and the reserve bank have similar sets of information constraints; the reserve bank fails to observe for example cost push shocks or potential output but extracts the information from hundreds of indicators. This assumption leads to a FAVAR defined by $F_t' = (y_t^n \quad s_t)'$ and $Y_t' = (\pi_t \quad y_t \quad R_t \quad C_t)'$. In such a case, the true dynamics of this economy are plausibly approximated by equations [1] and [2] assuming that *N* is large.[9]

However, the case above suffers criticism for its simplicity. The argument among economists is that both the econometrician and the reserve bank fail to observe the true output ($y_t$) and inflation ($\pi_t$) levels for the following reasons: First, theoretical concepts in macroeconomics do not align precisely with data. For instance, "output" theoretically refers more to economic activity than to real GDP as a specific data series. Second, macroeconomic data series are exposed to several rounds of revisions. We therefore

[9] Important to note here is that when *N* is small, the dynamics of the system are influenced independently by the central bank's estimate of $y_t^n$, which will not be reflected in equations [1] and [2]. Detailed characterisations of equilibrium models under partial information are documents in, Aoki (2003); Svensson and Woodford (2003a, 2004).

expect them to contain margins of measurement error in any case. In practice, this says that the information constraints faced by the econometrician and the reserve bank may be even more binding than we have suggested.

A second assumption, which is an extension of the case above with a more practical description of the information structure is: the CB and the econometric officer are able to observe only the t-bill rate via announcement plus multiple other volatile indicators. This system can be now represented by equation [2] with $Y_t = R_t$ and $F_t' = (\pi_t \quad y_t \quad y_{t-1}^n \quad s_t \quad C_t)'$. The central bank derives benefit from the information content of $X_t$ when policy, which is modelled by the FAVAR more naturally. In addition, the econometrician can now policy innovations using the same FAVAR approach. In similar spirit, this paper also assumes that only the interest rate $R_t$ and a large set of other variables $X_t$, are observed which will work as our preferred empirical specification. However, for robustness, we also consider specifications in the information structure in the first case. This motivates our choice to use the FAVAR.

## Estimation

Bernanke *et. al* (2005) propose an estimation procedure for the FAVAR model in two-steps. This model suggests a non-parametric technique of exploiting the gap that common components, defined as $B_t = (F_t', Y_t')$ cover. The first step comprises of estimating the common components $B_t$ making use of the $K + M$ principal components of $X_t$, defined as $\hat{B}_t$. Important to note here is that in the first step, estimation fails to capture the observable characteristics of $Y_t$. As shall be demonstrated, when the principal components and the factors are about the same quantity, and $N$ is sufficiently large, then the principal components can consistently retrieve the gap that both $F_t$ and $Y_t$ cover, Stock and Watson (2002). Step 2, estimates equation [1] using standard methods with $F_t$ replaced by $\hat{F}_t$, where $\hat{F}_t$ is the portion of the gap that $\hat{B}_t$ and not $Y_t$ covers. In comparison to the Bayesian likelihood method that estimates the model in a single step, this two-step methodology imposes fewer distributional assumptions, easy implementation and simple to compute. It also allows cross correlation in the systematic error term $e_t$, see Stock and Watson (2002). This two-step approach implies in its second step the presence of "generated regressors", meaning implementing a bootstrapping procedure is necessary to obtain accurate confidence intervals, given the uncertainty present in the factor estimation. We follow Killian (1998) in this regard.

## Identification

In this section we discuss the importance of imposing restrictions which is necessary for the unique identification of the factors and their associated loadings. In other words, equations [1] and [2] are uniquely identified after certain restriction are imposed on them. In the two-step estimation method, if equation [2], the observation equation extracts all the factors from the principal components, then identification of the factors is standard. Restrictions are imposed on the loadings or the factors, such that: $\Lambda^{f\prime}\Lambda^{f}/N = I$ or $F'F/T = I$ respectively. In any case, the same common component $F\Lambda^{f\prime}$and the same factor space are obtained. In Bernanke *et. al* (2005), restrictions are imposed on the factors to obtain $\hat{F} = \sqrt{T}\hat{Z}$, where the $\hat{Z}$ are the eigenvectors of the $K$ largest eigenvalues of $XX'$, ordered in a descending order, allowing factors to be identified against any rotations.

An alternative method of identification involves identifying innovations in the model and presently refers to the identification of monetary policy innovations. In this study, we assume that the only variable included in $Y_t$ is the 91 days nominal treasury bill rate ($TB_t$), that is, the only observable factor is the nominal T-bill rate. We therefore treat the 91 days treasury bill (T-bill) rate as a factor and a monetary policy instrument[10] assuming that monetary policy pervasively affects the economy. As briefly highlighted above, we note again that macroeconomic data are exposed to several revisions and are expected to be contaminated by some degree of measurement error, but the 91 days T-bill rate is assumed not to contain measurement error such that we eliminate any systematic component in the monetary policy instrument. As such, because of the misalignment between theoretical concepts and specific data variables, economic activity and measure of inflation are treated as unobserved in this analysis.

The monetary policy instrument is ordered last and its innovations are treated as standard "shocks". This imposes some identifying assumption: policy innovations do not affect latent factors in the same period, in this case the same quarter, Gupta *et. al* (2010). Our implementation of this identification scheme follows the one described in Bernanke *et. al* (2005) who categorize the variables among two groups, *"slow moving"* and *"fast moving"*. Slow moving variables are not instantaneously affected by unanticipated monetary policy shocks, for example, industrial production, mining activity and prices among other variables. On the other hand, fast moving variables respond instantaneously

[10] "There is no evidence in the history of monetary policy of South Africa that could suggest that the South African Reserve Bank (SARB) was controlling for other variables, that is, using anything else than a measure of the short-term interest rate as an instrument," Bernanke et al. (2005). Also refer to Ludi and Ground (2006) for further details.

to policy shocks. These comprise mainly of financial sector indicators, for example, asset prices.

Following the two-step methodology, we control the part of $\hat{B}_t$ corresponding to the monetary policy instrument to correctly identify the model. We achieve this by initially estimating the "slow moving" factors, $F_t^s$ as the principal components of the "slow moving" variables. We estimate this equation in the second step,

$$\hat{B}_t = b_{F^s}\hat{F}_t^s + b_y Y_t + e_t$$

where $\hat{F}_t$ is obtained from $\hat{B}_t - \hat{b}_y Y_t$.[11] In the final step, we estimate and recursively identify the VAR in $\hat{F}_t$ and $Y_t$.

Based on equation [1], the reduced form VAR, takes a structural form:

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

where $\rho(L)$ represents a consistent lag structure of order $p$ while the structural innovations are represented by the vector $u_t$. The impulse response functions (IRFs) of $\hat{F}_t$ and $Y_t$ are then computed as follows:

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

[11] Note that since $\hat{F}_t^s$ and $Y_t$ are correlated, so are $\hat{F}_t$ and $Y_t$.

where $\psi(L)$ represents a consistent lag structure of order $h$ and $\psi(L) = \rho(L)^{-1}$. Given that $X_t$ is estimated by $X_t'$ where $X_t'$ is defined as:

$$X_t' = \Lambda^f F_t' + \Lambda^y Y_t' + e_t'$$

then based on equation [2], the IRFs of $\hat{X}_t$ are given by:

$$\hat{X}_t' = \left[\hat{\Lambda}^f \ \hat{\Lambda}^y\right] \begin{bmatrix} \hat{F}_t' \\ \hat{Y}_y' \end{bmatrix} = \left[\hat{\Lambda}^f \ \hat{\Lambda}^y\right] \psi(L) u_t'$$

## Data

The FAVAR estimation employed in this paper is based on the of South African macroeconomy with time series over 59 quarters. The data covers the real, nominal and financial sectors of the economy. The period under review contains data from 1990Q1 to 2015Q4. The variables in the dataset were extracted from the FRED and SARB databases. Quarterly changes in the CPI are used as a proxy for consumer price inflation. Household consumption is broken down into four categories namely: consumption expenditure in durable goods (cars), semi-durable goods (clothing), non-durable goods (cosmetics) and services. This categorization indicates where the greatest effect of monetary policy occurs. Industrial production in the manufacturing and construction industries are used as a measure of economic activity in south Africa during the period.

The choice of a monetary policy indicator looks somewhat complicated as there is no consensus on the best measure of the policy stance. Some studies use the money supply measure M2 as an instrument, while a policy interest rate is used as an instrument in other studies. In our study, we follow Bernanke *et. al* (2005) and use the 91-day treasury bill (T-bill) rate as the central bank's primary monetary policy tool. This is also supported by Ludi and Ground (2006) who suggest that there is no solid evidence that the South African Reserve Bank (SARB) has employed any other instrument except short term interest rates as an instrument for monetary policy. Lastly, asset prices are measured as the aggregate of all shares listed on the Johannesburg Stock Exchange (JSE) during the period under review. All these series are seasonally adjusted, and their descriptive statistics are displayed in Table 1.

**Table 1:** Descriptive Statistics

| Variable | Mean | Maximum | Minimum | Std. Dev. | Obs |
|---|---|---|---|---|---|
| TBILL | 10.34913 | 20.12000 | 4.950000 | 3.947135 | 104 |
| Total Consumption | 1287209. | 1857351. | 841751.0 | 343736.7 | 104 |
| Household Consumption - Durable goods | 106327.2 | 192416.0 | 58339.00 | 43886.55 | 104 |
| Household Consumption - Semi-durable goods | 94437.38 | 176189.0 | 43267.00 | 44622.30 | 104 |
| Household Consumption - Non-durable goods | 554160.5 | 699600.0 | 431976.0 | 84018.46 | 104 |
| Household Consumption – Services | 544032.5 | 804842.0 | 306203.0 | 164083.4 | 104 |
| Consumer Price Index | 71.58846 | 132.3000 | 24.20000 | 29.97912 | 104 |
| Industrial Production – Manufacturing | 0.947394 | 1.160858 | 0.728088 | 0.110020 | 104 |
| Total Share Prices - All share index | 0.612202 | 1.861000 | 0.101000 | 0.511553 | 104 |

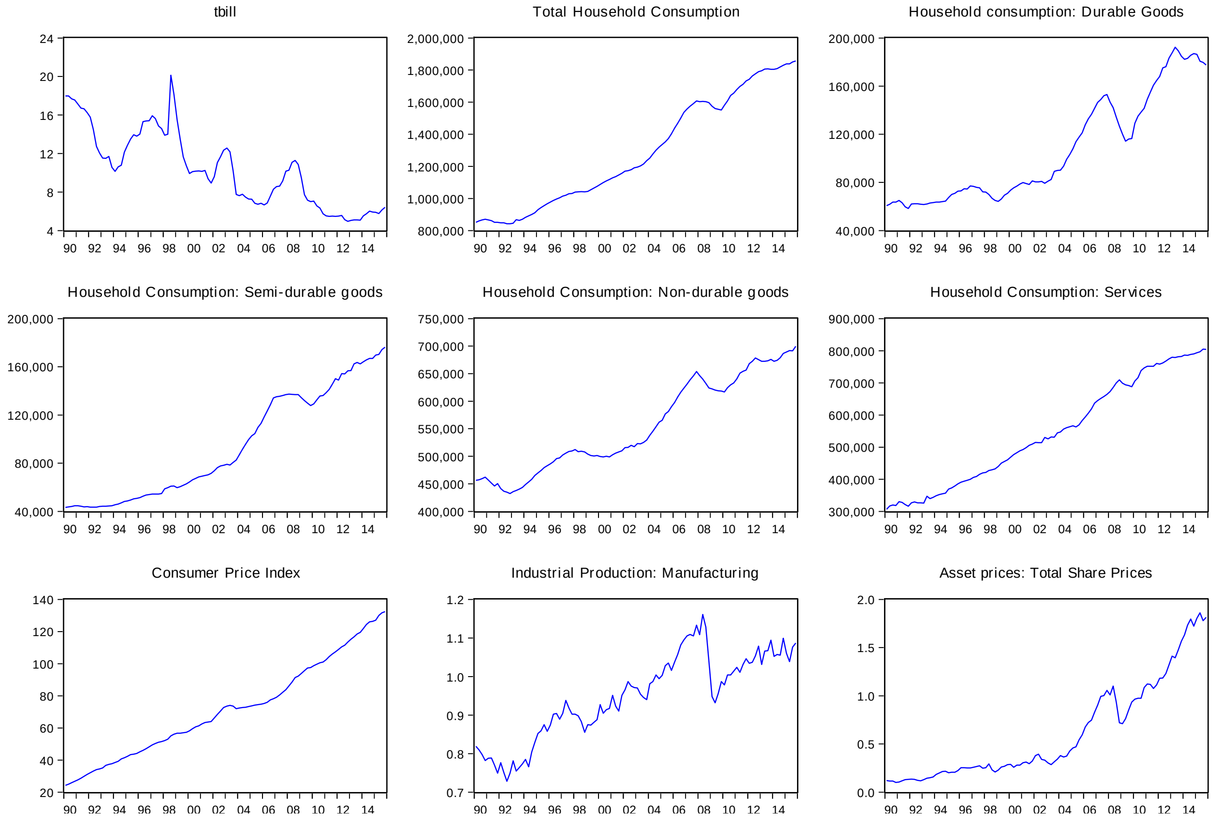
Source: IMF, StatsSA, JSE

Figure 1 also displays a graphical presentation of the data series briefly explained above. The 91-day T-bill rate shows a strong downward trend over the 104 quarters. The rest of the variables all show an upward trend over time despite the presence of a sharp drop between 2007 and 2009 in all of them. This is the period during which the global economy went through a recession due to the global financial crisis. The behavior of the South African macroeconomic variables observed on the graphs is therefore consistent with theoretical expectations.

Next, we perform stationarity and unit root tests on the data series. Following Brooks (2014), a stochastic time series is said to be stationary if it has a constant mean and variance over time and the covariance between any two periods depends only on the space between the two periods and not the specific time at which covariance is considered. Stationarity can strongly influence the behavior and properties of a data series and non-stationary series can lead to spurious regressions – regressions that show statistically significant relationships where none exist, unless the non-stationary series are cointegrated. The Augmented Dickey Fuller (ADF), Phillips Perron and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are estimated to check for unit roots before estimating the FAVAR model. All the three tests suggest the presence of a unit root in the variables within the dataset. The ADF fails to reject the null hypothesis that the variables have unit roots against the alternative of stationarity. The KPSS rejects the null hypothesis that the variables examined are stationary.

To account for this stationarity and minimize potential efficiency losses, the data is transformed into first differences before estimating the FAVAR. This follows Brischetto and Vos's (1999) who suggest that some restrictions be imposed on the data to avoid model misspecification and minimize efficiency losses. However even when faced with the possibility of efficiency losses, no penalties prevail in terms of estimator consistency in the parameters of interest, Sims et. al (1990).

**Figure 1:** Plot of Variables




In selecting the appropriate lag length to make sure that no serial correlation is left in the error term, the Akaike information criterion (AIC), which suggests a lag length of two lags is used. Results of the test are presented in Table 2 below. The principal component analysis (PCA) method is used to determine the number of factors to be estimated in the dynamic factor model. The PCA, as opposed to Bai and Ng (2007) contends that selection of factors $q$ be dependent on the eigenvalues of the density matrix of $X_t$, Gupta *et. al* (2010). The principal components are then added successively for as long as the marginal increase in the explained variance does not exceed a specific $\alpha = 0.05$. The first three dynamic principal components extracted from our dataset explain about 87% of the variation. The eigenvalue of the fourth component is approximately 0.025<0.05. We therefore estimate a three factor FAVAR with two (2) lags. In addition, we observe that adding more factors further or changing the number of lags does not change the results significantly. We employ Killian's (1998) bootstrap estimator to exploit the uncertainty present in estimating the factors, which is necessary in modeling impulse response confidence intervals.

**Table 2:** VAR Lag Order Selection Criteria

| Lag | AIC | SC | HQ |
|---|---|---|---|
| 0 | 18.88228 | 18.98913 | 18.92547 |
| 1 | 5.537445 | 6.071684* | 5.753393* |
| 2 | 5.501481* | 6.463112 | 5.890188 |
| 3 | 5.713085 | 7.102107 | 6.274551 |
| 4 | 5.889405 | 7.705818 | 6.623629 |
| 5 | 5.989266 | 8.233071 | 6.896249 |
| 6 | 6.196746 | 8.867942 | 7.276487 |
| 7 | 6.423094 | 9.521681 | 7.675593 |
| 8 | 6.63576 | 10.16174 | 8.061018 |

* indicates lag order selected by the criterion
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

## RESULTS

We realize the abstract nature of the methodology used in this study. For simplicity, conciseness and ease of understanding, we take a moment to summarize the methodology and join it with the data section so that the results obtained can give meaning to the methodology. The two-step estimation of the FAVAR can be understood in the following five steps:

1. From all the variables in the dataset, (series X1 – Z5 in Appendix 1), extract common factors that drive about 95% of the macro-economy summarized by equation [3] – equation [8].
2. Categorize the macro-economic series X1 – Z5 into slow-moving and fast-moving variables.

3. Obtain a matrix of the slow-moving variables using principal components analysis and apply rotation to the factors found in step 1 to remove any correlation with the T-bill rate. In equation form, this amounts to the following OLS regressions:

$$FACT1 = \gamma_1 + \beta_1 PCs1 + \beta_2 PCs2 + \beta_3 PCs3 + \omega Tbill_t + u_t \qquad [9]$$

$$FACT2 = \gamma_2 + \beta_4 PCs1 + \beta_5 PCs2 + \beta_6 PCs3 + \rho Tbill_t + v_t \qquad [10]$$

$$FACT3 = \gamma_3 + \beta_7 PCs1 + \beta_8 PCs2 + \beta_9 PCs3 + \kappa Tbill_t + z_t \qquad [11]$$

where FACT represents the factors, PCs are the principal components and Tbill is the T-bill rate.

4. Estimate a VAR in the Factors 1 to 3 and the T-bill rate.
5. Obtain impulse responses of the Factors to a T-bill shock from the VAR in step 4 and extract all other impulses to the macro-economy from these[12].

## EViews estimation

The steps summarized above are estimated using a computer software package. We use the FAVAR package inbuilt in EViews to estimate the model. The input we use is given in Table 3 below. The Y series represents the monetary policy shocks, which is the t-bill rate in the present analysis. The X-series represents all other macroeconomic variables in the model that respond to the shock both individually and in combination with other series. These are divided into slow and fast-moving variables. The slow-moving series are

[12] Note that the impulse responses extracted from the factors are important only for the purpose of extracting other macro-economic impulse responses relevant to our analysis. They do not possess an economic meaning in themselves but are merely a means to an end in monetary policy analysis using the FAVAR.

labelled as series X1 – X58 while the fast-moving variables are labelled Z1 – Z5 as displayed in Appendix 1. Selected IRF series are the series selected for impulse response analysis.

**Table 3:** The FAVAR model input table

| **Required Input** | **Series** |
|---|---|
| Y series | T-bill rate |
| X series | X1 - X59 |
| Slow moving series | X1 - X53 |
| Selected IRF series | X1, X5-X8, X13, X47 - X49, Z4 -Z5 |
| Number of lags | 2 |
| Number of factors | 3 |
| Number of bootstraps | 1000 |
| Time periods | 1990Q1 - 2015Q4 |
| Percentage of Confidence Intervals | 0.9 |

* A detailed description of these series is given in Appendix 1

## Estimation results

Table 4 below shows the estimation results obtained from Step 1 – 4 summarised above. This represents a VAR in the factors and the T-bill rate.

**Table 4:** Vector Autoregression (VAR) Estimates

| | _FACROT1 | _FACROT2 | _FACROT3 | Z5 |
|---|---|---|---|---|
| _FACROT1(-1) | 1.186004 | 0.520902 | 0.332837 | 0.031733 |
| | (0.11384) | (0.40426) | (0.26779) | (0.02484) |
| | [ 10.4178] | [ 1.28854] | [ 1.24292] | [ 1.27758] |
| _FACROT1(-2) | -0.178128 | -1.067693 | -0.435099 | -0.046820 |
| | (0.17291) | (0.61401) | (0.40673) | (0.03773) |
| | [-1.03016] | [-1.73888] | [-1.06975] | [-1.24105] |
| _FACROT2(-1) | 0.002156 | 0.504430 | -0.042658 | 0.002734 |
| | (0.04963) | (0.17623) | (0.11674) | (0.01083) |
| | [ 0.04344] | [ 2.86229] | [-0.36541] | [ 0.25249] |
| _FACROT2(-2) | 0.032096 | 0.318598 | -0.015364 | -0.000393 |
| | (0.05134) | (0.18230) | (0.12076) | (0.01120) |
| | [ 0.62521] | [ 1.74771] | [-0.12723] | [-0.03507] |

| | | | | |
|---|---|---|---|---|
| _FACROT3(-1) | 0.021744 | 0.043572 | 0.780633 | -0.003491 |
| | (0.07321) | (0.25997) | (0.17221) | (0.01597) |
| | [ 0.29700] | [ 0.16760] | [ 4.53300] | [-0.21855] |
| _FACROT3(-2) | -0.047838 | -0.188530 | 0.245026 | 0.002520 |
| | (0.08608) | (0.30567) | (0.20248) | (0.01878) |
| | [-0.55573] | [-0.61677] | [ 1.21011] | [ 0.13415] |
| Z5(-1) | 1.040987 | 4.218469 | 3.826864 | 1.207932 |
| | (0.50155) | (1.78099) | (1.17975) | (0.10943) |
| | [ 2.07555] | [ 2.36861] | [ 3.24378] | [ 11.0387] |
| Z5(-2) | -0.563178 | -1.456691 | -2.020022 | -0.366699 |
| | (0.78832) | (2.79931) | (1.85430) | (0.17199) |
| | [-0.71441] | [-0.52038] | [-1.08937] | [-2.13205] |
| C | 0.140850 | 0.412402 | 0.290629 | 0.052016 |
| | (0.12268) | (0.43564) | (0.28857) | (0.02677) |
| | [ 1.14810] | [ 0.94666] | [ 1.00712] | [ 1.94333] |
| R-squared | 0.998944 | 0.886143 | 0.920323 | 0.992241 |
| Adj. R-squared | 0.998800 | 0.870617 | 0.909458 | 0.991183 |

Standard errors in ( ) & t-statistics in [ ]

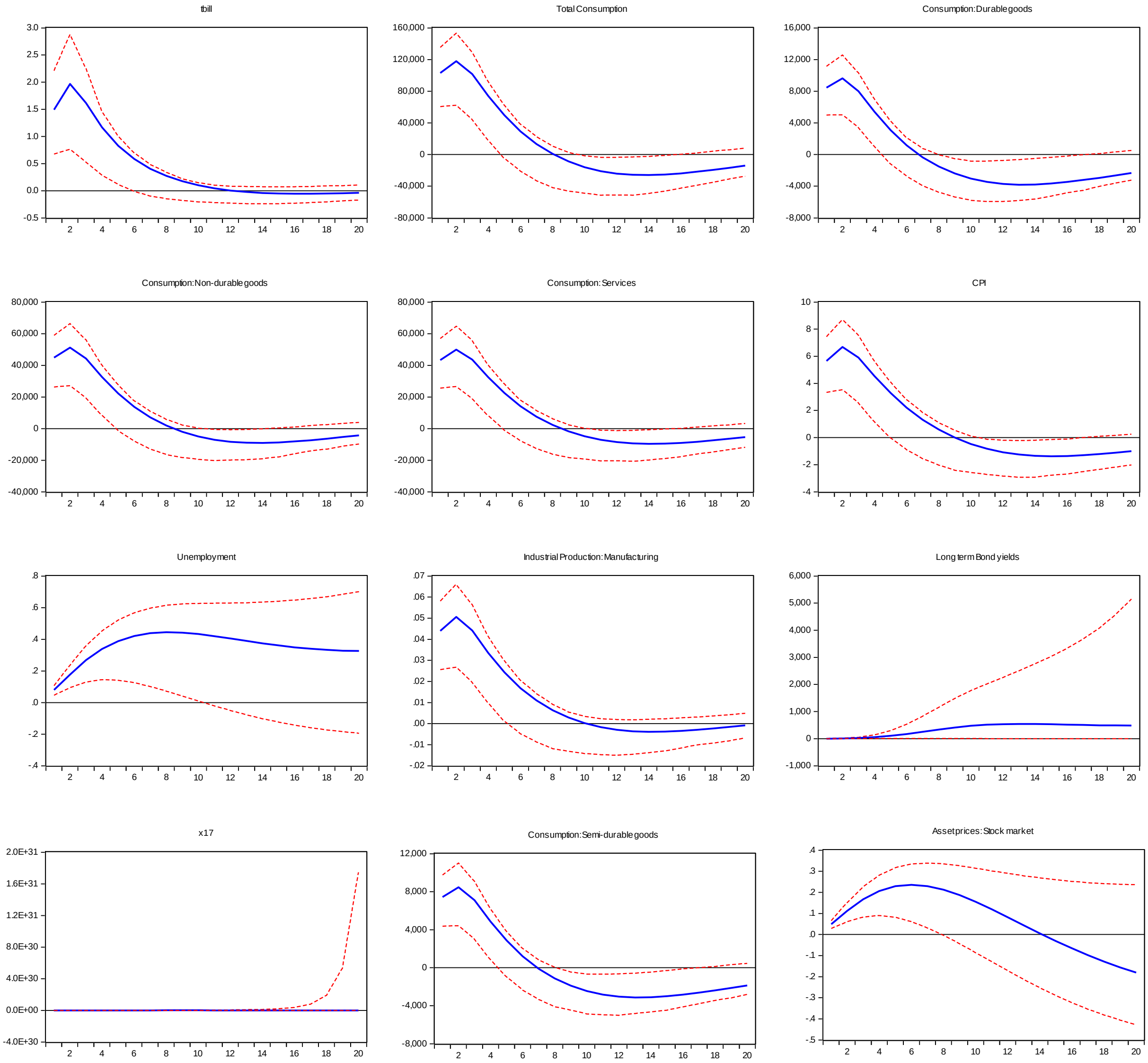
As the results show, the R-squared for all factors is significantly high with significant t-stats. In relation to Footnote 12, it is from this table that we can extract impulse response functions from which we can extract the most relevant impulse responses that have an economic interpretation in our analysis arising from a monetary policy shock. Because the impulse response functions for each of the factors in response to an interest rate shock have no direct economic interpretation, we do not provide their graphical representation here. The interested reader can find this graph in Appendix 2 at the end of this text.

Figure 2 shown below displays the impulse response functions of the four sub-categories of total consumption to shocks in the t-bill rate over 20 quarters. Also shown in the graph are impulse responses of other macroeconomic variables which include: CPI as a measure of inflation, aggregate employment levels in the private sector, the unemployment rate, industrial production in the manufacturing sector, the yield on long term government bonds and finally asset prices. The impulse responses for all variables are briefly described below.

The impulse response functions for the consumption sub categories all exhibit a downward trend, implying that consumption decreases in response to a positive shock in the treasury bill rate. With reference to the slow-moving versus fast-moving variables categorization described in the methodology section, consumption is a slow-moving[13] variable, see Campbell and Cochrane (1999) and Chetty and Szeidl (2004). This means the effects of an interest rate shock on consumer spending will not be felt at least within the same quarter that the shock takes place. Our consumption impulse responses

[13] We recognise and appreciate an idea from behavioural economics that consumption depends on habits and commitments. It is difficult or at least costly (in a transaction costs view) to adjust habits or change your commitments instantaneously to a shock in present or future income. This therefore renders consumption a slow-moving variable.

**Figure 2:** Impulse response functions




correspond with this assertion: consumption spending rises for a quarter and half before making a sharp decline. A plausible explanation for the initial hike is that consumption was driven by momentum from previous macroeconomic innovations up until the shock is absorbed into the economy.

The second segment of the consumption impulse behavior shows a gradual decline in consumer spending. Such a trend is consistent with economic theory as follows: an increase in the short-term interest rate increases the opportunity cost of holding money to households. They therefore shift their money balances from cash to short term interest bearing assets such as treasury bill notes. In short, this is an increase in savings at the expense of consumption. Consumption therefore decreases as agents adjust to new portfolio balances depending on their risk appetite. Breaking down aggregate consumption into sub-categories as described in the data section shows a similar trend graphically but also provides a richer explanation of household consumption behavior.

Firstly, consumption of durable goods decreases faster than consumption of non-durable goods in the long-run when markets fully adjust. One possible explanation to this observation is that consumption of durable goods such as cars is more elastic to interest rates in the presence of credit markets where loans are easily accessible and agents free to move from one good to another. In such a market, where transaction costs are very small and almost negligible, durable goods are bought on credit and changes in interest rates impact the cost of the good via interest repayments. However, the opposite is true in the short-run. Consumption of durable goods adjusts slower than that of non-durable goods because of the presence of commitments, Constantinides (1990); Chetty and Szeidl (2004). To illustrate this point, consider an economic agent with two goods: a passenger vehicle (car) and food[14]. When interest rates change, they affect the economic cost of owning the vehicle in terms of interest payments which further affects the agent's current disposable income. Because the agent made a commitment when they acquired the vehicle, adjusting this commitment in the short-run involves comparably larger transaction costs as compared to adjusting his bundles of food consumption which is

[14] The vehicle in this case represents a durable good while food is the non-durable good. We further assume that the vehicle is acquired in an economy with functioning credit markets.

comparatively easy. This explains the differences in the slopes for the two consumption categories in the short-run.

CPI as a measure of inflation and the unemployment rate exhibit downward and upward trends respectively over time in response to a positive interest rate shock. These trends are as expected considering that the macroeconomy follows the following channel: increases in interest rates cause the operating environment of businesses to tighten in terms of higher borrowing costs, forcing firms to decrease investment, while others downsize through laying off workers. The combined effect of this is a decrease in output and an increase in unemployment in the economy, which supports the relationships shown by the graphs. Empirical work by Locarno and Massa (2005) also accounts for the negative relation between inflation and stock prices as due to markets responding to changes in inflation outcomes that alter the outlook of an unanticipated monetary policy shock.

However, the CPI impulse responses exhibit a positive correlation with a contractionary monetary policy shock within the first two quarters, contrary to the explanation given above. Two plausible explanations are in order here. Choice between the two heavily depends on the assumptions underlying the nature of the CPI variable in the macroeconomic model. In other words, an assumption about the speed of adjustment of prices determines the plausibility of each of the explanations. First, if we assume prices to adjust quickly to innovations, that is, CPI is a fast-moving variable, then the positive correlation between interest rates and inflation is what economists refer to as a price puzzle, Bernanke and Blinder (1992), Sims (1992), and Christiano *et. al* (1994). It is a puzzle because it contradicts economic theory. This correlation can be explained following the logic that inflation targeting central banks factor in future anticipated inflation rises when formulating monetary policy decisions. However, their anticipated increase may not capture fully the rise in the price level causing interest rates and inflation to be correlated. Another way to think about it as proposed by Sims (1992) is that the information sets available to policy makers may include variables useful in forecasting future inflation that the econometrician may not have considered, see also Giordani (2004).

Secondly, if we assume that prices are slow-moving variables that adjust slowly to macroeconomic innovations then the upward trend in the first two quarters is a result of price momentum and inflationary pressures from the previous periods, see Giordani (2004). This follows Keynesian models which assume that prices are sticky in the short-run. This assumption is based on the notion that firms fear to upset their customers by adjusting prices upwards. They then become reluctant to adjust their prices implicitly implying that they view price adjustment as an economic cost. A more common explanation is that there exists a fixed physical cost (a menu cost) that firms must pay whenever they change a price, Sheshinski and Weiss (1977); Levy *et. al* (1997). Rotemburg (1982) finds empirical evidence to support the 'sticky prices' hypothesis. Cabral and Fishman (2010) find that frequent price adjustments are likely to induce consumer search which also explains sticky prices. We reasonably believe that this second assumption is the most applicable to the South African economy.

Industrial production in the manufacturing sector is used in this analysis as a measure of economic activity. This follows previous research for example, Grilli and Roubini (1996), Bernanke *et. al* (1997), Kim and Roubini (2000) and Kim (2001) who have used industrial production as a proxy for real economic activity at country level. The expected relationship between an increase in interest rates and industrial production has partly been explained above via the effect of interest rates on unemployment. Since a positive interest rate shock increases firm borrowing costs, which decrease investment spending via higher interest repayments by firms while other firms downsize, this channel should extend to a decrease in industrial production. This supports the negative relationship shown in the graph. Manufacturing production decreases over time in response to a positive interest rate shock.

However, during the first three quarters, production increases in response to the shock contradicting the channel explained above. This should not be surprising considering that manufacturing production is a slow-moving variable in an economy with sticky prices. The transmission mechanism from interest rate shocks to the time when firms respond by changing their production quantities takes a reasonable amount of time in an economy with hundreds of other macroeconomic dynamics at play. Different versions of New-Keynesian models support the same proposition. For example, Svensson (2000a and 2000b) and Romer (2000) propose a model that incorporates delays in the transmission of monetary policy. They infer that monetary policy can affect output with at least one lag. Hence, the upward trend shown by the manufacturing production impulse in the short run reflects other macroeconomic adjustments that were in motion before the monetary policy shock and are not explained by innovations in the current period.

If we however assume inflation to be a fast-moving variable, then the upward trend can be explained by the presence of a price puzzle during the same quarters in the South African economy. Demand and supply dynamics tell us that when price increases, quantity supplied also increases *ceteris paribus*. At the same level of reasoning, the increase in the price level induces firms to produce more in response to the increase in prices. This channel is temporary, it is present only in the short-run and corrects itself as the economy goes through multiple rounds of macroeconomic revisions, in this case after approximately three quarters.

Finally, we analyse the impulse response of asset prices to monetary policy shocks. The graph shows a hump shaped response to an increase in the interest rate. Stock prices respond contemporaneously to monetary policy announcements. A positive monetary shock results in an instantaneous increase in the market prices of listed companies. The impulse response graph indicates that this increase in stock prices increases at a decreasing rate during the first four quarters, flattens out for less than a quarter, then decreases over time. This reaction function can be analysed in segments, one that explains the initial increase in the share price within the first four quarters and a second segment when stock prices begin to decrease over time. We document the probable causes for such stock price movements below.

At this point, it is necessary to understand briefly how stock prices move and some of the main forces behind these price movements. The efficient market hypothesis first developed by Fama (1965, 1970), states that it is impossible for an investor to beat the market because stock prices always incorporate and reflect all relevant information that is, stock markets are so efficient that stocks always trade at their fair value on stock exchanges. In its purest form, this theory implies that in the short run, stock prices reflect financial market participants' emotional behavior - that which they believe to be true and what they expect to happen following the interest rate shock in our present case. One would envision a spike in the graph of such stock price movements following policy innovations. However, empirical evidence by Smith and Jefferis (2002), Magnusson and Wydick (2002) and Smith *et. al* (2002) found the JSE to be weak-form efficient. Mlambo and Biekpe (2007) also support this finding using data on a panel of select African countries. This finding supports the impulse responses we have, that stock prices react instantaneously but at a slow enough pace to exhibit a smooth concave path.

The negative relationship between interest rates and stock prices is consistent with economic literature and previous empirical studies. First, we shall explain this using tobin's q theory first developed by Kaldor (1966) and later extended by Tobin (1977). Q is defined as the ratio between physical asset's market value and its replacement cost. This q mimics a firm's stock price. Now an interest rate increase implies an increase in the replacement cost of capital, which decreases q, the stock price.

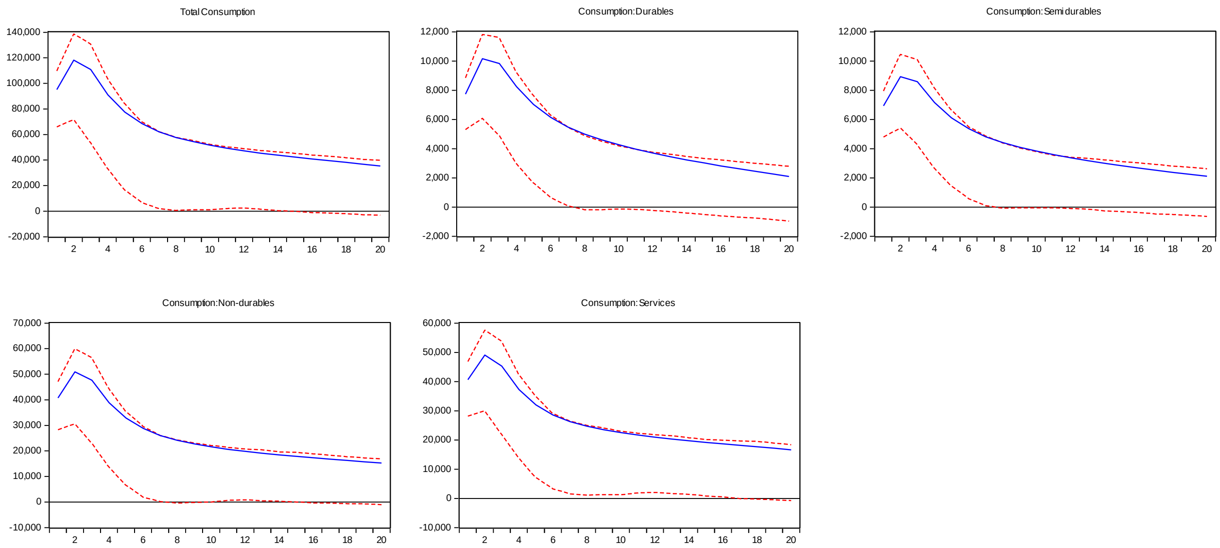
Another way to explain this channel is through the dividend discount model (DDM) as developed by Gordon and Shapiro (1956) and Gordon (1959). The DDM suggests that a firm's stock price is equal to the net present value of all future earnings that the company will generate. All future earnings are discounted at a rate equal to the difference between the cost of capital and the anticipated growth of the earnings. Monetary policy shocks therefore affect the cost of capital and hence stock prices negatively since they affect the denominator of the mathematical identity. This negative relationship between monetary policy shocks and stock prices is also supported by empirical findings for example, Dedole and Neri (2004) who find the same relationship using structural VARs in all G7 countries members and Spain.

Our analysis thus far has only investigated how various variables of interest respond to unanticipated monetary policy shocks. Of special interest was how household consumption and stock prices respond to monetary policy shocks. We found it interestingly consistent with empirical findings as well as supporting the literature. There is a negative relationship between short term interest rates and consumption of durable, semi-durable and non-durable goods and services in the medium to long-run. We also found that stock prices respond negatively to monetary policy interest announcements. Next, we focus our attention to the second part of interest in our problem statement. How much consumption spending reacts to changes in stock prices. This will be the subject in the section that follows.

Figure 3 below shows the impulse responses of the different consumption categories to a shock in the stock prices. The graphs all show a similar trend in response to a shock in the stock prices. Following the same assumptions as above that consumption is a slow-moving variable, it takes approximately two quarters before the wealth shock through stock prices affects household consumption spending and takes about nine quarters before the effect becomes null. According to these results, consumption aggregates react negatively to stock market movements. We explain the correlation using the permanent income hypothesis of consumer spending formulated by Friedman (1957). The theory states that people will spend money at a level consistent with their expectations of long term average income, that is, consumption spending is only affected by shocks that are expected to have a permanent effect on income. Temporary shocks will only affect consumption in the short run before it returns to its pre-shock level.

In the present case, the negative response to a shock in the stock price probably implies that consumers expect their income to increase in the long term due to the increase in the expected return on equities caused by the positive shock. More formally, the transmission channel triggers like this: increases in stock prices imply a future expected return on stocks assuming that households have a long-term view when deciding to hold stocks. Households who already own stocks rebalance their portfolios in favour of equities at the expense of consumption spending to capitalize on the expected future increase in wealth. This line of thought is consistent with Porteba (2000) and most South African based asset management firms' investment philosophies who believe that investment horizons should be at least three years long[15]. According to Porteba (2000), such consumer behavior may be explained by factors such as bequest and precautionary motives, that is, the potential desire to reduce consumption and accumulate wealth today with the view to finance future consumption emergencies.

**Figure 3**: Impulse responses to shocks in Stock prices




[15] Refer to fund fact sheets for different asset management companies in South Africa, for example Ashburton growth fund, Coronation growth fund and Momentum growth fund. Porteba (2000) also notes that most household who hold equities have long planning horizons spanning to thirty (30) years.

## CONCLUSION

The findings of this study on the transmission mechanism of the wealth effect are consistent with economic literature on the subject. Unanticipated monetary policy shocks affect the macroeconomic variables of the South African economy in the directions suggested by either literature on the subject or empirical studies on the transmission mechanism. For example, interest rate shocks suggest the presence of a price puzzle only in the short-run (about two quarters) before the negative relationship between inflation and interest rates is noticed. This is consistent with the findings of Gupta *et. al* (2010) and Ncube and Ndou (2011) who perfom a similar study on the South African economy. We also note that stock market reaction in the South African financial markets is weak-form efficient, that is, there is an instataneous but transitional variation in stock prices in response to a monetary policy shock. However, the stock market has a limited effect on the consumption patterns of South African households. This is as expected as the findings by the South African National Treasury report show that only less than three percent (3%) of the population in South Africa own equities.

This research can be extended by investigating the effects of monetary policy on the different industries of the stock market individually. The distribution of the monetary policy shock should not be even across all industries since we expect financial service providers to be affected more than industrial companies. Share ownership is also concerntrated meaning that breaking down the stock market and investigating the effects of monetary policy shocks will be more informative than our present study.

# APPENDIX 1

## Data description:

The table below lists all the macroeconomic variables used in estimating the FAVAR.

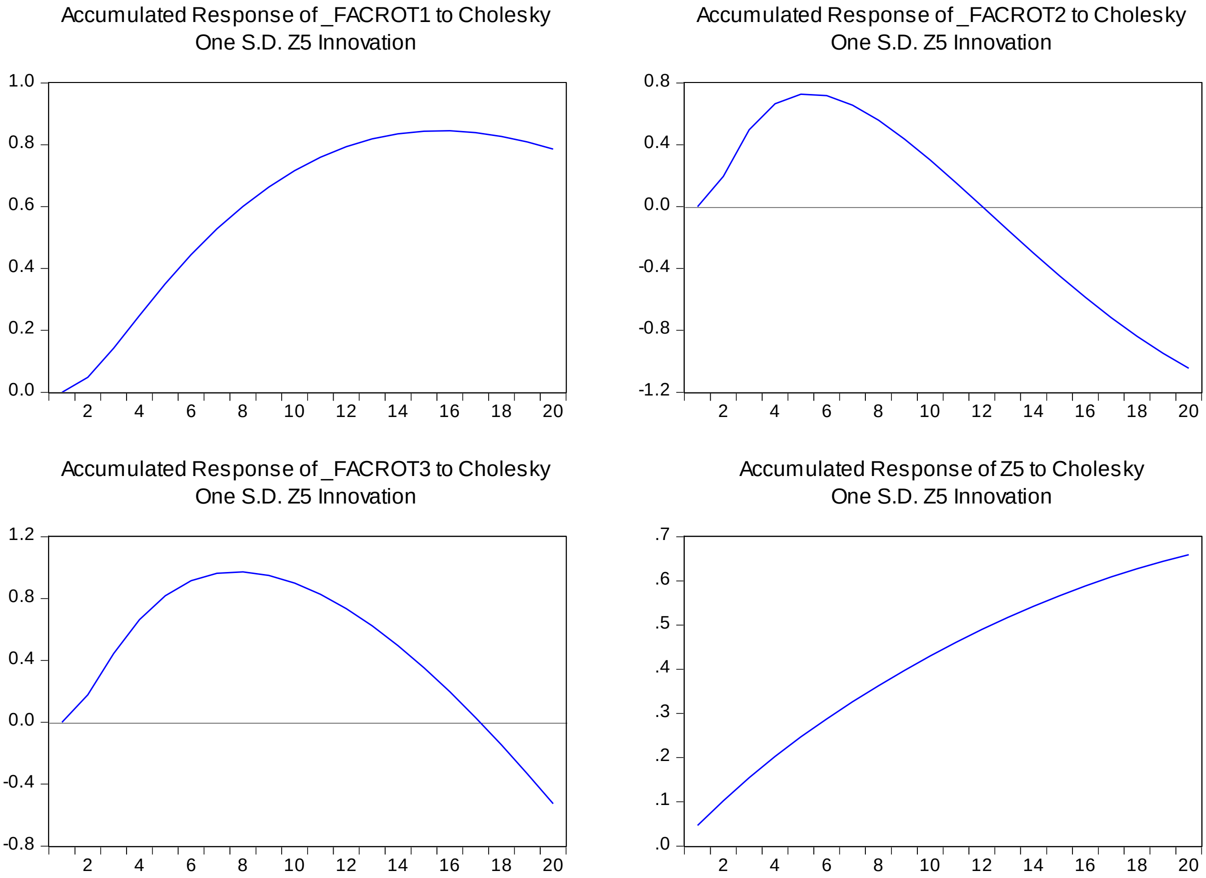
| | | |
|---|---|---|
| **Consumption factor** | | |
| 1 | X1 | Final consumption expenditure by households: Total (PCE) |
| 2 | X2 | Final consumption expenditure by households: Total (PCE) |
| 3 | X3 | Final consumption expenditure by general government |
| 4 | X4 | Final consumption expenditure by general government |
| 5 | X5 | Final consumption expenditure by households: Durable goods (PCE) |
| 6 | X6 | Final consumption expenditure by households: Semi-durable goods (PCE) |
| 7 | X7 | Final consumption expenditure by households: Non-durable goods (PCE) |
| 8 | X8 | Final consumption expenditure by households: Services (PCE) |
| **Inflation factor** | | |
| 9 | X9 | CPI: Food |
| 10 | X10 | CPI: All Items Excluding Food and Energy |
| 11 | X11 | CPI: Housing |
| 12 | X12 | CPI: Energy |
| 13 | X13 | CPI: All Items |
| **Real activity data** | | |
| 14 | X14 | Employment in the Public sector: General government |
| 15 | X15 | Total employment in the Public sector |
| 16 | X16 | Employment in the private sector: Mining |
| 17 | X17 | Employment in the private sector: Manufacturing |
| 18 | X18 | Employment in the private sector: Construction |
| 19 | X19 | Employment in the private sector: Trade |
| 20 | X20 | Total employment in the private sector |
| 21 | X21 | Total employment in the non-agricultural sectors |
| 22 | X22 | Gross value added at factor cost of non-agricultural sector (GDP) |
| 23 | X23 | Gross value added at basic prices of primary sector (GDP) |
| 24 | X24 | Gross value added at basic prices of agriculture, foresty and fishing (GDP) |
| 25 | X25 | Gross value added at basic prices of mining and quarrying (GDP) |
| 26 | X26 | Gross value added at basic prices of secondary sector (GDP) |
| 27 | X27 | Gross value added at basic prices of manufacturing (GDP) |
| 28 | X28 | Gross value added at basic prices of electricity, gas and water (GDP) |
| 29 | X29 | Gross value added at basic prices of construction (contractors) (GDP) |
| 30 | X30 | Gross value added at basic prices of tertiary sector (GDP) |
| 31 | X31 | GVA at basic prices of wholesale and retail trade, catering and accommodation (GDP) |
| 32 | X32 | Gross value added at basic prices of transport, storage and communication (GDP) |
| 33 | X33 | GVA at basic prices of finance, insurance, real estate and business services (GDP) |
| 34 | X34 | Gross value added at basic prices of community, social and and personal services (GDP) |
| 35 | X35 | Gross value added at basic prices of general government services (GDP) |
| 36 | X36 | Gross value added at basic prices of all industries (GDP) |
| 37 | X37 | Gross value added at basic prices of other community, social and personal services (GDP) |

| | | |
|---|---|---|
| 38 | X38 | Indicators of real economic activity: Mining production: Gold |
| 39 | X39 | Indicators of real economic activity: Mining production excluding gold |
| 40 | X40 | Indicators of real economic activity: Total mining production |
| 41 | X41 | Indicators of real economic activity: Building plans passed |
| 42 | X42 | Indicators of real economic activity: Buildings completed |
| 43 | X43 | Indicators of real economic activity: Trade: Number of new vehicles sold |
| 44 | X44 | Indicators of real economic activity: Electric current generated |
| 45 | X45 | Indicators of real economic activity: Trade: Retail sales |
| 46 | X46 | Indicators of real economic activity: Trade: Wholesale sales |
| 47 | X47 | Indicators of real economic activity: Manufacturing production |
| 48 | X48 | Indicators of real economic activity: Construction industry production |
| 49 | X49 | Unemployment Rate: Aged 15-64: All Persons for South Africa |
| 50 | X50 | Share of Labour Compensation in GDP |
| **Money factor** | | |
| 51 | X51 | Money stock: M1 |
| 52 | X52 | Money stock: M2 |
| 53 | X53 | Money stock: Broad Money |
| **Financial Market factor** | | |
| 54 | Z1 | South Africa / U.S. Foreign Exchange Rate, South African Rand to One U.S. Dollar |
| 55 | Z2 | Long-Term Government Bond Yields: 10-year: Main (Including Benchmark) |
| 56 | Z3 | Immediate Rates: Less than 24 Hours: Central Bank Rates |
| 57 | Z4 | Long-Term Government Bond Yields: Combined Terms |
| 58 | Z5 | Total Share Prices for All Shares for South Africa |
| **Treasury bill rate** | | |
| 59 | tbill | 3-Month or 90-day Rates and Yields: Treasury Securities |

## APPENDIX 2

Below are the impulse response functions of the extracted factor to a monetary policy shock. At this stage we do not document the mechanics behind the extraction of the impulse responses of other macroeconomic variables used in the estimation. Refer to Bernanke et al. (2005) for a detailed analysis.

**Figure 4:** Impulse responses for the Factors



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