



University of Pretoria
Department of Economics Working Paper Series

**The Effect of Monetary Policy on Real House Price Growth in
South Africa: A Factor Augmented Vector Autoregression
(FAVAR) Approach**

Rangan Gupta

University of Pretoria

Alain Kabundi

University of Johannesburg

Working Paper: 2009-05

January 2009

Department of Economics
University of Pretoria
0002, Pretoria
South Africa
Tel: +27 12 420 2413
Fax: +27 12 362 5207

THE EFFECT OF MONETARY POLICY ON REAL HOUSE PRICE GROWTH IN
SOUTH AFRICA: A FACTOR AUGMENTED VECTOR AUTOREGRESSION
(FAVAR) APPROACH

Rangan Gupta* and Alain Kabundi#

Abstract

This paper assesses the impact of monetary policy on real house price growth in South Africa using a factor-augmented vector autoregression (FAVAR), estimated based on a large data set comprising of 246 quarterly series over the period 1980:01 to 2006:04. The results based on the impulse response functions indicate that, in general, house price inflation responds negatively to monetary policy shock, but the responses are heterogeneous across the middle-, luxury- and affordable-segments of the housing market. The luxury-, large-middle- and medium-middle-segments are found to respond much more than the small-middle- and the affordable-segments of the housing market. More importantly, we find no evidence of the *home price puzzle*, observed previously by other studies that analyzed house prices using small-scale models. We put this down to the benefit gained from using a large information set.

Keywords: Monetary Policy; Real House Price Growth; FAVAR.

JEL Classification Codes: C32; E52; R2.

* Associate Professor, Department of Economics, University of Pretoria, Pretoria, 0002, South Africa, Email: Rangan.Gupta@up.ac.za. Phone: +27 12 420 3460, Fax: +27 12 362 5207.

Corresponding author: Senior Lecturer, University of Johannesburg, Department of Economics, Johannesburg, 2006, South Africa, Email: akabundi@uj.ac.za. Phone: +27 11 559 2061, Fax: +27 11 559 3039.

1. Introduction

The recent global economic downturn attributed to the sub-prime crisis in the US with rapid contagion worldwide, particularly in the housing sector, has attracted the attention of academics, policymakers, and economic agents at large. Stock and Watson (2003) pointed out that housing prices are leading indicators for real activity, inflation, or both, and, hence, can serve as an indicator as to where the real economy is heading. Evidence in the recent literature, for example, Iacoviello (2005), Case et al. (2005), Iacoviello and Neri (2008) and (Vargas-Silva, 2008a, 2008b) amongst others, show a strong link between the housing market and economic activity in the US. Moreover, the recent emergence of boom-bust cycles in house prices have been an issue of concern for policy makers (Borio et al, 1994; (Bernanke and Gertler, 1995, 1999), since the bust of the house price bubble is always followed by significant contractions in the real economy (Iacoviello and Neri (2008)). Given this, it is crucial for central banks to analyze thoroughly the effects of monetary policy on asset prices in general, and real estate in particular, which, in turn, would lead to the understanding of the effects of policy on the economy at large.

In this backdrop, this paper assesses the impact of monetary policy shocks on real house price growth, i.e., the growth rate of ratio of the nominal house price to the Consumer Price Index (CPI), for the affordable, large-, medium- and small-middle-segment and luxury housing for the South African economy¹ by exploiting a data-rich environment that includes 246 quarterly series, such as income, interest rates, construction costs, labor market variables, stock prices, industrial production, and consumer confidence index over the period 1980:01 to 2006:04. For this purpose, the framework used in this paper is a factor-augmented vector autoregression (FAVAR) model proposed by Bernanke et al. (2005). As Bernanke et al. (2005) indicates, monetary authorities analyze literally thousands of variables in their decision-making process, hence, it is aberrant for anyone, who tries to mimic actions of a central bank, to ignore this fact. Furthermore, the recent literature Stock and Watson (2004); and ((Rapach & Strauss, 2007, 2008; (Das et al., 2008a, 2008b, 2009) gives evidence of the fact that numerous economic variables are potential predictors of house price growth. Intuitively, the FAVAR approach boils down to extracting a few latent common factors from a large matrix of many economic variables, with the former maintaining the same information contained in the original data set without running into the risk of the degrees of freedom problem.² Note, the motivation to use the three major segments of the housing market, with the middle-segment subdivided further into three categories based on sizes, and not just the aggregate housing market, emanates from the fact that the market for different house-types are found to behave differently (Burger and van Rensburg, 2008). Clearly then, the

¹ Data on house prices are obtained from the ABSA Housing Price Survey, with ABSA being one of the leading private banks of South Africa. The ABSA Housing Price Survey, distinguishes between three price categories as --- luxury houses (R 2.6 million to R9.5 million), middle-segment houses (R226,000 to R2.6 million) and affordable houses (R226,000 and below with an area in the range of 40 m² -79 m²); and further subdivides the middle segment category based on the square meters of house area into small (80 m² -140 m²), medium (141 m² -220 m²) and large (221 m² -400 m²).

² See Section 2 for further details.

impact of monetary policy on the different segments of the South African housing market is less likely to be homogenous. This is more so, when one realizes that the different housing segments cater to different income-groups.

To the best of our knowledge, this is the first study to analyze the effect of monetary policy on real house price growth in South Africa using a FAVAR. The only other paper that deals with the impact of monetary policy on the South African housing market is that by Kasai and Gupta (2008). The authors investigated the effectiveness of monetary policy on house prices in South Africa, before and after financial liberalization, with financial liberalization being identified with the recommendations of the De Kock Commission (1985). Using both impulse response and variance decomposition analysis performed on three-variable structural VARs (SVARs), comprising of the growth rate of the real GDP, house price inflation and the treasury bill rate, estimated separately on the three categories of the middle-segment of the housing market, the authors found that irrespective of house sizes, during the period of financial liberalization, interest rate shocks have had relatively stronger effects on house price inflation. But, given that the size of these effects were nearly negligible, the result seems to indicate that house prices are exogenous, and, at least, are not driven by monetary policy shocks.

Though insightful, the paper by Kasai and Gupta (2008), just like Iacoviello (2002), McCarthy and Peach (2002), (Iacoviello and Minetti; 2003, 2008)³, Vargas-Silva (2008a), is based on a small-scale model, which, in turn, limits it to only three variables. In fact, all the other studies, being based on either reduced-form Vector Autoregressive (VAR), Vector Error Correction (VEC), SVAR or DSGE models, could handle at most 8 to 12 variables only. Arguably, and as indicated above, there are a large number of variables that affects monetary policy and the housing market, and not including them often leads to puzzling results, for example the *home-price puzzle*⁴ in McCarthy and Peach (2002) and Kasai and Gupta (2008), that are not in line with economic theory due to the small information set (Sims, 1992; Walsh, 2000). Moreover, in these studies, the authors often arbitrarily accept specific variables as the counterparts of the theoretical constructs (for example the gross domestic product as a measure of economic activity or the first difference of the logarithm transformed consumer price index as a measure of inflation), which, in turn, may not be perfectly represented by the selected variables. In addition, previous studies can only obtain the impulse response functions (IRFs) from those few variables included in the model, implying that in each VAR, VECM, SVAR or DSGE, the IRFs are typically obtained with respect to only one variable related to the housing market. Given its econometric construct, the FAVAR model solves all these problems.

At this juncture, it is important to point out that our paper is similar in spirit to the recent work by Gupta and Kabundi (2009). This paper assessed the impact of monetary policy

³ Note, besides the empirical part of the paper, Iacoviello and Minetti (2003) uses a calibrated Dynamic Stochastic General Equilibrium (DSGE) model to analyze the impact of monetary policy on house prices. More recently, Iacoviello and Neri (2008) used a more elaborate estimated DSGE model for this purpose. However, the model is restricted in the sense that it used only 10 macroeconomic variables including only a few housing market variables.

⁴ The *home-price puzzle* occurs when the home price increases, instead of declining, following a contractionary monetary policy.

on house price inflation for the nine census divisions of the US economy using a FAVAR, estimated based on a data set comprising of 126 quarterly series over the period 1976:01 to 2005:02.⁵ The results based on the impulse response functions indicated that, in general, house price inflation responds negatively to monetary policy shock, but the responses are heterogeneous across the census divisions. In addition, the findings suggested the importance of South Atlantic, East South Central, West South Central, Mountain and the Pacific divisions, in particular, in shaping the dynamics of US house price inflation.⁶

The remainder of the paper is organized as follows: Section 2 briefly discusses the FAVAR framework, while, Section 3 discusses the data and the identification structure. Section 4 reports and analyzes the impulse response functions, and Section 5 concludes.

2. The FAVAR⁷

Let Y_t be a $M \times 1$ vector of observable economic variable assumed to drive the dynamics of the economy, in our case, this happens to be the 91-days Treasury bills rate (TB) only. As in VARs, the monetary policy instrument is allowed to have a pervasive effect throughout the economy. Further assume that F_t is a $K \times 1$ vector of unobserved factors that summarizes additional important information, such as potential output not fully captured by Y_t . Note F_t can also represent theoretical concepts such as price pressures, credit conditions, or even economic activity that are a combination of economic variables which cannot be represented by one particular series.

Assume that the joint dynamics of (F_t', Y_t') are given by the following equation:

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

where $\Phi(L)$ is a conformable lag polynomial of finite order p and v_t is the error term with zero mean and a covariance matrix Q .

Equation 1 is a standard VAR. However, the difficulty here, compared to standard VARs, is that the vector of factors F_t is unobserved, which means that the model cannot be estimated based on standard econometric techniques, such as the ordinary least squares (OLS). The proper estimation of the model entails the use of factor analysis, as proposed by Stock and Watson (1998). For this purpose, we assume that the factors summarize

⁵ Another study that uses a FAVAR approach to analyze the effect of monetary policy on the US housing market is that of Vargas-Silva (2008b). However, instead of house prices, Vargas-Silva (2008b) studied the impact of monetary policy on housing starts, housing permits and mobile home shipments using a dataset of 120 monthly indicators.

⁶ Given that, economic conditions prevailing during a monetary policy shock are not necessarily the same across the regions (Carlino and DeFina (1998, 1999), and Vargas-Silva (2008b)), ideally, just like Gupta and Kabundi (2009), we would have preferred to use regional data for the South African housing market. However, no regional data is available for the luxury and the affordable sections of the housing market.

⁷ This paper follows the econometric framework of the FAVAR model described in Bernanke et al. (2005).

information contained in a large panel of economic time series. Let X_t be a $N \times 1$ vector of informational variables, where N is large, such that $N > K + M$. Assume X_t is related to both the observed variables Y_t and unobserved factors F_t as follows:

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

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, in turn, is weakly correlated with mean zero. In essence Y_t and F_t are common forces that drive the dynamics of X_t . Note, it is not restrictive to assume in principle, that X_t is dependent on current value of F_t , as factors can always capture arbitrary lags of some fundamental factors. Excluding the observable factors from Equation 2, we have what Stock and Watson (1998) refer as a dynamic factor model (DFM).

In this paper, we follow a realistic framework by assuming that the central bank and the econometrician observe only the monetary policy instrument, TB, i.e., $Y_t = TB_t$.

The estimation procedure consists of a two-step approach proposed by Bernanke et al. (2005), which, in turn, 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 , $\hat{C}(F_t, Y_t)$. Stock and Watson (2002) demonstrates that with a large N , and if the number of principal components is at least as large as the number of factors, the principal component recover the space spanned by both F_t and Y_t . However, \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 with F_t replaced by \hat{F}_t . As in standard a VAR, measuring the effect of monetary policy, TB 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, based on Equation 1, then has the following structural form:

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

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 IRFs of \hat{F}_t and Y_t as follows:

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

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:

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

3. Data

Besides the real house price of the five segments of the housing market, the FAVAR is estimated based on 241 other quarterly series of South Africa, with the data covering the real, nominal, and financial sectors. We also have intangible variables, such as confidence indices, and survey variables. The sample period contains data from 1980:01 to 2006:04.⁸ All series are seasonally adjusted and were made covariance stationary when estimating the DFM. The more powerful DF-GLS test, instead of the more popular ADF test, is used to assess the degree of integration of all series. All non-stationary series are made stationary through differencing. The Schwarz information criterion (SIC) is used in the selecting the appropriate lag length in such a way that no serial correlation is left in the stochastic error term. Where there were doubts about the presence of unit root, the KPSS test, with the null hypothesis of stationarity, was applied. Following Bernanke et al. (2005), we divide the data set into two categories, *slow moving* and *fast moving*. *Slow moving* variables are those that do not respond contemporaneously to unanticipated monetary policy shocks. They include variables such as industrial production, consumption, employment, and prices. In contrast, *fast moving* variables respond contemporaneously to policy shocks. They mainly comprise of financial variables. All series are standardized to have a mean of zero and a constant variance.

There are various statistical approaches in determining the number of factors in the DFM. For example, Bai and Ng (2002) developed a set of criteria to guide the selection of the number of factors in large dimensional panels. The principal component analysis (PCA) can also be used in establishing the number of factors in the DFM. The PCA suggests that the selection of a number of factors q be based on the first eigen values of the spectral density matrix of X_t . Then, the principal components are added until the increase in the explained variance is less than a specific $\alpha = 0.05$. The Bai and Ng (2002) approach proposes five static factors, while Bai and Ng (2007) suggests two primitive or dynamic factors. Similar to the latter method, the principal component technique, as proposed by Forni *et al.* (2000) suggests two dynamic factors. The first two dynamic principal components explain approximately 99 percent of variation, while the eigen value of the third component is: 0.005 (< 0.05). So we use two dynamic factors in the estimation of a FAVAR with a lag length, p , equal to 4. Furthermore, we find that increasing the number of factors further does not change the results substantially. To account for uncertainty in the estimation of the factors, a bootstrap technique based on Kilian (1998) is implemented. This is necessary in constructing the 90 percent confidence intervals of the impulse responses.

4. Empirical Results

Figure 1 displays the impulse response functions of real house price growth rate of the five segments over 20 quarters, resulting from an increase in the TB. The TB increases to

⁸Details about the data and the statistical treatment of the variables used to estimate the FAVAR are available upon request.

approximately 0.25 percent, and stays significant for a short period. Following the contractionary monetary policy, the impact on real house price growth rate across categories is negative in general. These results are in line with theory and we find no evidence of the so-called *home price puzzle* observed by Kasai and Gupta (2008). We attribute this difference to misspecification in small-scale VARs due to their inability to take into account various potential predictors of house prices. The gain witnessed here suggests that a FAVAR methodology, which exploits a large set of information, improves the accuracy of econometric models in predicting the effects of monetary policy, and therefore, could address the puzzling effects observed otherwise.

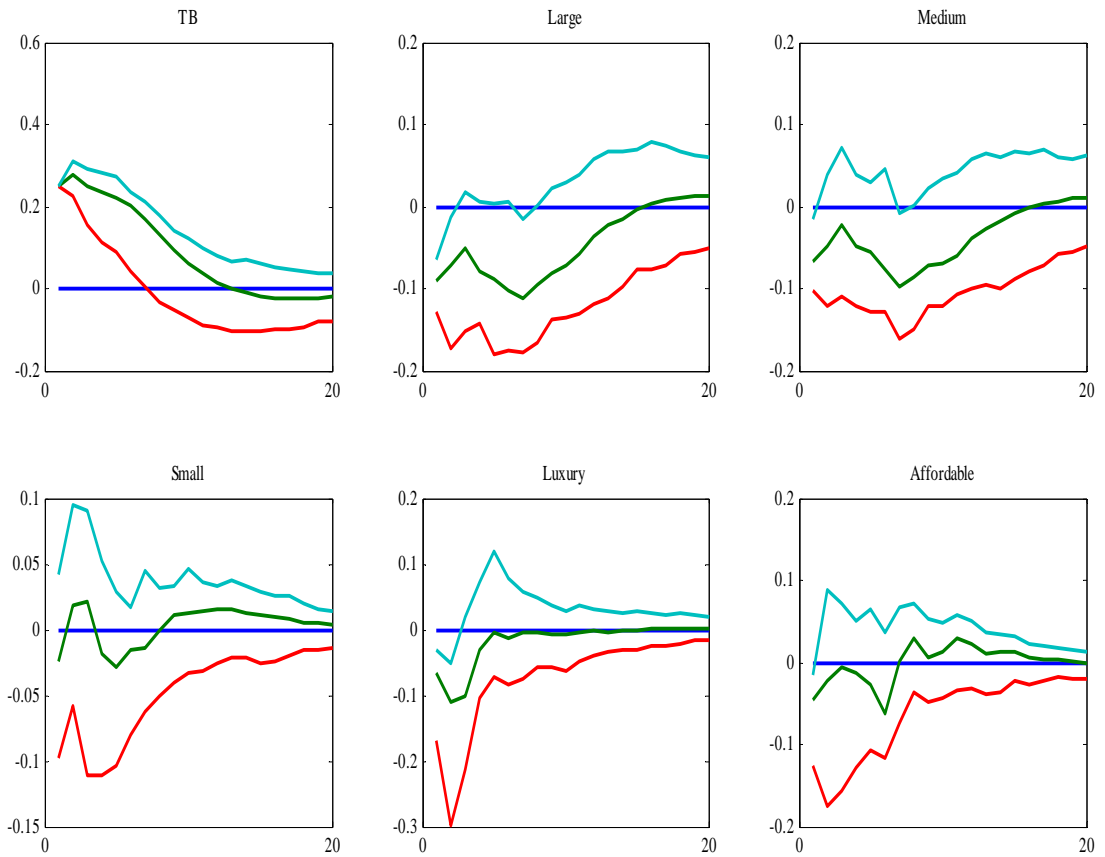


Figure 1: IRFs of house price inflation following a Monetary Policy Shock

Note that the reaction of real house price growth rate to a contractionary monetary policy shock is different, especially with regards to the size and length of the impact, across the alternative housing categories, thereby vindicating the justification of looking at different segments of the housing market. Small-middle-segment and affordable housing display a small but negative effect at the impact. Following the increase in interest rate, real house price growth rate of small-middle and affordable segments decreases by less than 0.05 percent. However, for the small-middle-segment housing, the initial negative effect turns out to be insignificant and short lived. In the case of affordable houses, the early negative

impact is significant but does not last long either. Interestingly, for both these categories, the real house price growth rates start to fall again after the initial recovery and reaches negative levels that are similar in size to their initial impact. Further, for both these categories, the real house price growth rate becomes positive at around 8 quarters, and stays that way for the remainder of the period until the effect dies off. The drop in real house price growth for the large-middle-segment, the medium-middle-segment and luxury houses are significant, and lasts relatively longer than what is observed for the small-middle-segment and the affordable housing. Real house price growth rate of the large-middle and medium-middle-segments plummet initially to approximately 0.1 percent, and rise thereafter, and drop again sharply. They stay negative for about 15 quarters, before becoming positive and then die out progressively. For the luxury-category, the real house price growth rate displays a negative and significant response of approximately 0.07 percent at the impact, followed by another drop to 0.1 percent and then a sudden recovery that causes the effect to taper off after about 5 quarters.

At this juncture, some possible explanations about the behavior of the real house price growth rates of the five segments, following a contractionary monetary policy shock, is desired. Note, except for the luxury segment, and irrespective of the size and significance of the impact, a common feature is observed amongst the four other categories of housing. We witness an initial decline of the real house price growth rate at the impact of the shock, followed by a recovery and then a decline again, before the effect starts to taper off. This we believe is possibly due to two reasons: First, this could indicate that house prices are *slow moving* variables, and second, and perhaps the more important of the two, the result is in line with Stock and Watson's (2003) suggestion that house prices lead economic activity. Hence, the delayed effect could be because of the downturn in the economy, which in turn, originated from the decline in the housing sector. The second line of explanation is in line with Iacoviello and Neri (2008), who indicate significant spillovers from the housing market into the real economy, followed by economic activity affecting further the other sectors of the economy, including housing. This downturn could cause owners of the large-middle and medium-middle segment of the housing industry to start demanding more of small-middle-segment housing, causing the price of the latter to recover much quicker, while, the real house price growth rates of the other two larger middle-segment housing have to wait for a significant period of time. Besides, Gupta and Das (2008) indicate that for the small-middle-segment housing, what seems to be more important in the determination of its price is its past own price, and hence, the role of fundamentals is not too important. This is more so for affordable housing especially when one realizes that these are government provided and as such, have a controlled and rigid pricing structure. Finally, as far as the luxury-segment of the housing market is concerned, we observe an initial decline followed by a larger decline but a quick recovery. Given that the real house price growth rate falls further after the initial negative impact, seems to suggest the sluggishness of the market for this particular housing category, where the segment gets hit by the economic downturn before it could recover. The inherent lavish nature of the luxury housing, owned by people in the highest strata of income, as well as by foreigners, makes it a difficult market for quick transactions and movements of buyers and sellers. The resultant slow moving nature of house prices is, thus, quite logical. At the same time, luxury houses being bought mainly

by the most affluent of the country with diverse portfolios, and by foreigners or South African citizens residing abroad, all of who are quite well-insured against the downturn, the fast recovery is not surprising.

5. Conclusions

This paper assesses the impact of a positive monetary policy shock on real house price growth for the five-segments of the South African economy using a FAVAR estimated with 246 variables spanning the period of 1980:Q1 to 2006:Q4. Overall, the results show that real house price growth responds negatively to a positive monetary policy shock, suggesting that the framework does not experience the *home price puzzle*, encountered by Kasai and Gupta (2008) while analyzing monetary policy shocks with three-variable SVARs for the middle-segment of the South African housing market. This result points to the benefit gained by using a large information set. Not surprisingly, the reaction of real house price growth rate is found to differ across the five housing categories, indicating the segmented nature of the market. Specifically, we find the luxury, the large-middle- and the medium-middle segments to experience the biggest negative impacts following a contractionary monetary policy. However, unlike the two middle-segments, the effect on luxury housing recovers back to its original level much faster. The lower end of the market, i.e., the small-middle-segment and affordable housing witness small and short-lived negative effects.

As part of future research, it would be interesting to analyze the robustness of the results based on a large-scale Bayesian VAR (LBVAR), developed recently by Banbura et al. (2008), since just like the FAVAR, the LBVAR, given its estimation methodology, can also handle a data set of any size. Moreover, unlike the FAVAR, the LBVAR, via appropriate design of the interaction matrix of the variables, can account for spatial influences of neighboring regions and also asymmetric effects of regional variables and national variables on each other. Note regional variables are likely to have minor effects on national variables, while, the national variables are more prone to affect the regional variables strongly. However, given that regional (provincial) level house price data in South Africa is only limited to the middle-segment, we would have to restrict our analysis to this section of the housing market only. Nevertheless, a regional analysis along the lines of Gupta and Kabundi (2009) would be worth the endeavor in understanding which province(s) in South Africa plays an important role in determining the dynamics of the national house price. Finally, given that the Bayesian methodology does not require us to ensure the stationarity of variables, we can analyze house prices at levels rather than their growth rates, if necessary.

References

- Bai J, Serena Ng. Determining the Number of Primitive Shocks in Factor Models. *Journal of Business and Economic Statistics* 2007; 25; 52–60.
- Bai J, Serena Ng. Determining the Number of Factors in Approximate Factor Models. *Econometrica* 2002; 70; 191–221.
- Banbura M, Gianonne D, and Reichlin L. Bayesian VARs with Large Panels. *European Central Bank* 2008; Working Paper, 966.

Bernanke BS, Gertler M. Inside the black box: The credit channel of monetary policy transmission. *The Journal of Economic Perspectives* 1995; 9; 27–48.

Bernanke BS, Gertler M. Monetary Policy and Asset Volatility. Federal Reserve Bank of Kansas City, *Economic Review* 1999; 84;17-52.

Bernanke BS, Boivin J , Eliazs P. Measuring the effects of monetary policy: A Factor Augmented Vector Autoregressive (FAVAR) Approach. *The Quarterly Journal of Economics* 2005; 120; 387–422.

Borio CEV, Kennedy N, and Prowse SD. Exploring Aggregate Asset Price Fluctuations across Countries: Measurement, Determinants, and Monetary Policy Implications. Bank for International Settlements 1994; *Economics Paper No.* 40.

Burger P, Van Rensburg LJ. Metropolitan house prices in South Africa: Do they converge? *South African Journal of Economics* 2008; 76; 291-297.

Carlino GA, DeFina RH. The differential regional effects of monetary policy. *The Review of Economics and Statistics* 1998; 80; 572–587.

Carlino GA, DeFina RH. Do states respond differently to changes in monetary policy? *Business Review* 1999; Federal Reserve Bank of Philadelphia (July/August); 17–27.

Case K, Shiller R, and Quigley J. Comparing wealth effects: The stock market versus the housing market. *Advances in Macroeconomics* 2005; 5; 1-32.

Das S, Gupta R, and Kabundi A. Is a DFM Well-Suited for Forecasting Regional House Price Inflation? *Economic Research Southern Africa* 2008a; *Working Paper No.* 85.

Das S, Gupta R, and Kabundi A. Could We Have Forecasted the Recent Downturn in the South African Housing Market? Department of Economics 2008a; *Working Paper No.* 200831, University of Pretoria.

Das S, Gupta R, and Kabundi A. Forecasting Real House Price Growth in the Nine Census Divisions of the US. Department of Economics 2009; *Working Paper No.* 200902; University of Pretoria.

Forni M, Hallin M, Lippi M, and Reichlin L. The Generalized Dynamic Factor Model: identification and estimation. *Review of Economics and Statistics* 2000; 82; 540–554.

Gupta R, Das S. Spatial Bayesian Methods in Forecasting House Prices in Six Metropolitan Areas of South Africa. 2008; *South African Journal of Economics*; 76; 298-313.

Gupta R, Kabundi A. The Effect of Monetary Policy on House Price Inflation: A Factor Augmented Vector Autoregression (FAVAR) Approach. Department of Economics 2009; *Working Paper No.* 200902 ; University of Pretoria.

Iacoviello M. House Prices and Business Cycles in Europe: A VAR Analysis. Department of Economics 2002; *Working Paper No.* WP540; Boston College, US.

Iacoviello M. House prices, borrowing constraints, and monetary policy in the business cycle. *American Economic Review* 2005; 95; 739–764.

Iacoviello M, Minetti R. Financial liberalisation and the sensitivity of house prices to monetary policy: theory and evidence. *The Manchester School* 2003; 71; 20-34.

Iacoviello M, Minetti R. The Credit Channel of Monetary Policy: Evidence from the Housing Market. *Journal of Macroeconomics* 2008; 30; 69-96.

Iacoviello M, Neri S. Housing Market Spillovers: Evidence from an Estimated DSGE Model. Boston College Department of Economics 2008; *Working Paper No.* 659.

Kasai N, Gupta R. Financial Liberalization and the Effectiveness of Monetary Policy on House Prices in South Africa. Department of Economics 2008; *Working Paper No.*

200803, University of Pretoria.

Kilian L. Small-Sample Confidence Intervals for Impulse Response Functions. *Review of Economics and Statistics* 1998; 80; 218-230.

McCarthy J, Peach R. Monetary policy transmission to residential investment. *Economic Policy Review* 2002; 139–158.

Rapach DE, Strauss JK. Forecasting Real Housing Price Growth in the Eighth District States. Federal Reserve Bank of St. Louis. *Regional Economic Development* 2007; 3; 33–42.

Rapach DE, Strauss JK. Differences in Housing Price Forecast ability Across U.S. States. Forthcoming *International Journal of Forecasting* 2008.

Sims C. Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy. *European Economic Review* 1992; 36; 975-1000.

Stock JH, Watson MW. Diffusion Indexes. National Bureau of Economic Research 1998; Working Paper No. 6702.

Stock JH, Watson MW. Macroeconomics forecasting using diffusion indexes. *Journal of Business and Economic Statistics* 2002; 20; 147–162.

Stock JH, Watson MW. Forecasting Output and Inflation: The Role of Asset Prices. *Journal of Economic Literature* 2003; 41; 788-829.

Stock JH, Watson MW. Combination Forecasts of Output Growth in a Seven-Country Data Set. *Journal of Forecasting* 2004; 23; 405-430.

Vargas-Silva C. Monetary policy and the US housing market: A VAR analysis imposing sign restrictions. *Journal of Macroeconomics* 2008a; 30; 977–990.

Vargas-Silva C. The Effect of Monetary Policy on Housing: A Factor-Augmented Vector Autoregression (FAVAR) Approach. *Applied Economics Letters* 2008b; 15; 749-752.

Walsh CE. *Monetary Theory and Policy*, The MIT Press, Cambridge: Massachusetts; 2000.