House Prices, Monetary Policy and the Macroeconomy:

What does the Common Trends Approach on South African Data Suggest?

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by

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Abstract

The increased volatility of asset prices in both developing and developed economies seems to be a growing concern for economic policy makers. Whilst there is a growing literature investigating the link between monetary policy and its implications for asset price volatility there remains uncertainty regarding the overall effects of macroeconomic shocks on long-term asset prices. Using a VAR framework and South African house price data from 1970 to 2006, this paper takes a preliminary step towards identifying how this asset price responds to macroeconomic shocks and the relative importance of these shocks.

The paper has shown that the dynamics of house prices can be analysed in South Africa using a tractable VAR framework. The empirical results suggest that the behaviour of the housing market is in line with the theoretical expectations of a perfect capital market and that house prices do not play a large role in the monetary transmission mechanism.

It does however show that adverse monetary shocks do have a significant negative impact on house prices and the timing of the response of house prices matches output. This paper also finds that short-run house price fluctuations are largely explained by inflation and demand shocks whilst, in the long-run, supply factors explain a large amount of the variation in house prices.

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1 Introduction

In the last few decades, central banks were given the necessary autonomy to pursue the objectives of monetary policy. As a result, the political business cycle was successfully eliminated in countries that have adopted these reforms and the inflation outlook has improved in both these developing and industrialised countries. However, after having achieved a stable monetary environment economic policy makers are now being confronted with increasing asset price volatility.

Whilst it is felt that macroeconomic factors and the monetary stance were key factors behind asset price fluctuations,[1] there is uncertainty over the overall effects of these factors on long-term asset prices - such as real estate and equities - and the relative importance of these factors. Furthermore, while it is agreed that central bankers ought to look at asset prices in the context of an overall strategy for monetary policy, less is known on how to respond to asset price movements and the impact of macroeconomic shocks on asset prices.

Using a VAR framework and South African house price data this paper takes a preliminary step towards identifying how this asset price responds to macroeconomic shocks and the relative importance of these shocks. It is therefore useful to disentangle the effects of how much variability in house prices is attributed to monetary and other factors such as demand and supply disturbances. Furthermore, the paper provides some qualitative and quantitative evidence on the interrelationship between the housing market and the wider economy and gives some indication of the degree to which monetary policy affects real house

[1] See Hutchison(1994) and Bernanke and Gertler (1999)

prices.

The empirical results suggest that the housing market behaviour is in line with the theoretical expectations of asset price behaviour in an environment of relatively perfect capital markets. Further, house prices are found not to play a large role in the transmission mechanism as they are neither consistent with the standard monetarist model nor the "credit channel" view. The results do however show that adverse monetary shocks have a significant negative impact on house prices and the timing of the response of house prices matches output. The results indicate that short-run house price fluctuations are largely explained by inflation and demand shocks.

The paper is laid out as follows: Section 2 reviews the relevant literature on the relationship between the macroeconomy, house prices and monetary policy. Section 3 lays out the econometric methodology which relies on the common trends approach developed by King, Plosser, Stock and Watson (1991) and provides the motivation for using this framework to describe the main macroeconomic forces driving house prices. Section 4 provides a description of the data and the empirical results are analyzed in Section 5.[2] Finally, Section 6 provides some concluding remarks on house price movements in South Africa.

[2] I thank Anders Warne for providing the RATS code for estimating common trends.

2 House prices, monetary policy and the macroeconomy

Researchers are increasing looking at the role that asset prices might play in the monetary transmission mechanism and in the macroeconomy. This idea is not entirely new and can be traced back to Fisher (1933). The debate concerning asset prices and monetary policy have wide ranging views.

The first view suggested by Alchian and Klein (1973) supports the view that asset prices should be included in traditional measures of inflation. They argue that traditional measures of inflation such as CPI and the GDP deflator are inadequate as consumers are not only concerned about the price of goods today but also changes in prices that affect consumption tomorrow. If consumers were to anticipate higher inflation in future periods, these traditional measures would not take into account this pessimistic view of inflation as they reflect past price pressures. Asset prices such as stock and housing market prices rise immediately in anticipation of higher inflation in the future. Therefore, inflation measures should take asset prices into account.

Other proponents of including asset prices in inflation measures base their decision on the belief that asset prices predict future movements in CPI. Whilst stock prices do not predict future inflation (Stock and Watson (1999)) housing prices have been found to be significant predictors of future inflation. In particular, Goodhart and Hofmann (2000) find that house prices are significant predictors of future in inflation in twelve countries, which included both developed and developing countries. Whilst Filardo (2000) and Gilchrist and Leahy (2002) find that although house prices are significant predictors of future inflation, they are only able to marginally improve the prediction of future inflation.

However, Filardo (2000) adds an important qualifier to his results. The paper notes that if monetary authorities are confident that asset prices are sending reliable inflationary signals, the benefits of including asset prices would outweigh the costs.

There are two remaining arguments that discuss the role of assets prices in the monetary transmission mechanism. The first is a standard monetarist model which allows for relative price changes when there is a monetary shock. The standard monetarist model highlights that a monetary shock changes the stock of money relative to the stocks of other domestic and foreign assets. This changes the marginal utility of money relative to both the marginal utility of other assets and the marginal utility of consumption.[3] Money holders attempt to restore equilibrium by equating the ratios of marginal utilities to the relative prices of assets, current production and consumption. This involves changes in relative prices, in spending and asset portfolios. Social and private productivity of money arises when there is uncertainty over the persistence of monetary shocks, other shocks and relative prices. Therefore, relative prices reflect the balance of opinion that follows the new shock.

Using house prices, Meltzer (1995) finds evidence that monetary shocks are

[3] See Meltzer (1995).

transmitted through relative price changes and changes in real money balances. The pattern of changes in relative prices and real money balances differ between countries and varies from cycle to cycle. Various shocks also change relative prices in different ways. For instance, a housing boom changes relative prices differently to an export led boom. According to Meltzer (1995), the simple monetarist model can be expanded to include the role of financial intermediation. The transmission of monetary shocks is not qualitatively different in this extended framework.

The second argument is the "credit channel" view of Bernanke and Gertler (1995, 1999) and Kiyotaki and Moore (1997). This view looks at the role that financial intermediation (particularly credit) plays in the monetary transmission mechanism. Bernanke and Gertler (1995, 1999) modify a standard dynamic New Keynesian model to allow for financial accelerator effects. This differs from the standard dynamic New Keynesian framework primarily in assuming the existence of credit-market frictions. The presence of these frictions gives rise to a "financial accelerator" that affects output dynamics. In particular, self-financing is more expensive than external financing in which entrepreneurs have no collateral to offer. External finance costs decrease with the value of collateral supplied by the entrepreneur. Therefore, if the financial position of borrowers improves, the costs of external finance declines, amplifying investment and output fluctuations compared to a credit market without frictions.

Both the modified New Keynesian model and monetarist view are alike in that they agree that lending and credit markets play an important role in the transmission mechanism. However, as Meltzer (1995) notes they differ in two important respects. The transmission process in the monetarist model focuses on relative prices. It also distinguishes between, money, loans and securities and real capital while the "credit channel" model focuses on the shifts in the distribution of small and big borrowers, and the principal assets and liabilities are money, bank loans, and a combination of securities and real capital.

In addition, using the "financial accelerator" model described above, Bernanke and Gertler (1999) investigate whether there is any role of asset prices in the formulation of monetary policy in a flexible inflation-targeting framework. Bernanke and Gertler (1999:78) conclude that:

> "The inflation targeting approach dictates that central banks should adjust monetary policy actively and preemptively to offset initial inflationary and deflationary pressures. Importantly, for present purposes, it also implies that policy should not respond to changes in asset prices, except in so far as they signal changes in expected inflation."

Cecchetti, Genberg, Lipsky, and Wadhwani (2000) claim, however, that a more general case can be made for central banks to react to asset prices in the normal course of policy making. They argue that monetary authorities can improve macroeconomic performance by reacting to asset price misalignments but do not advocate asset price targeting. Therefore, monetary authorities that are concerned with both hitting an inflation target and smoothing output and price adjustments are likely to achieve superior performance by adjusting its policy instruments not only to inflation (or to its inflation forecast) and the output gap, but to asset prices as well. This conclusion is based on results from simulations of two theoretical macroeconomic models one of which is the Bernanke and Gertler (1999) model described above.

This view by Cecchetti et al. (2000) contrasts with the popular belief that there is little hope of being able to infer anything from asset price movements that is useful for monetary policy purposes, partly because asset prices are so volatile and partly because central banks do not possess more information about equilibrium valuations than the private sector.

In response to their findings, Bernanke and Gertler (2001) introduce a second source of shocks that influence asset prices. Whereas their original work examined the consequences of non-fundamental bubbles alone, now they include the possibility of fundamental technology shocks as a source of movements in equity values. Using this model their original findings do not change.

Bernanke and Gertler (2001) also allow for investor sentiment to affect investment decisions. This extended model includes exogenous bubbles in asset prices by allowing the market price of capital to differ from capital's fundamental value. They find that asset prices are significant only to the extent that they signal potential inflationary and deflationary forces but these are difficult to distinguish. Therefore, if the central bank has a strong commitment to stabilizing expected inflation, it is unnecessary for monetary policy to react to asset price fluctuations as this adds little to stabilizing output and inflation.

As a result Cecchetti, Genberg and Wadhwani (2002) provide new estimations and analysis and conclude that the results differ largely from Bernanke and Gertler (2001) due to different assumptions about whether a central bank can distinguish between financial and technology shocks. The most comparable set of simulation results is the one in which there are no shocks to the fundamentals. Bernanke and Gertler (1999) show that monetary authorities reacting to asset prices instead of reacting to the output gap results in inferior economic performance. This implies that the central bank should not ignore the output gap and treat asset prices as a substitute for other information about the economy. Cecchetti et al. (2002) agree to this. However, they also argued that taking account of asset prices in the process of setting monetary policy leads to an improvement of economic performance once inflation and the output gap has been accounted for and they continue to believe that this is the case. Their results confirm that both the output gap and the asset price should be included in the information that the central bank uses.

The analysis by Cecchetti et al. (2002) still reiterates that monetary authorities should try to infer from information in financial markets as to what kind of underlying disturbance is affecting the economy and that some useful information can be obtained from asset price movements. They are not persuaded that one should ignore asset price misalignments simply because they are difficult to measure. Rather monetary authorities should try to use econometric methods to extract the signal as this is common practice in the use of statistics in a policy making environment.

The large literature on the link between asset prices and the macroeconomy, reviewed above, agrees that asset prices affect economic activity and the channels through which this is achieved is important but there is no consensus on whether they should be included in monetary policy. A closer reflection of the literature reveals that although there is general agreement that asset prices have a role to play in monetary policy decisions the inability to distinguish whether the asset price fluctuations are sending reliable inflationary signals makes it difficult to include them into these decisions.

Therefore, given the difficulties in extracting a reliable inflationary signal, it is important to identify the channels by which movements in asset prices are transmitted through the economy and to determine the quantitative importance of these effects. This paper takes a preliminary step towards quantifying the importance of these effects in South Africa by trying to explain how house prices react to shocks that are thought to drive economic fluctuations and the role they might play in the monetary transmission mechanism. [4]

3 Econometric Methodology

This paper exploits the fact that long-run propositions of economic theory can be used to identify the main sources of economic fluctuations as suggested by Blanchard and Quah (1989). In particular, the common trends methodology used by King, Plosser, Stock and Watson (1991) (KPSW henceforth) and Warne (1993) is followed to help disentangle permanent innovations from transitory

[4] Interestingly, whilst there exists little support for including stock prices as a predictor of future consumer price inflation, there is evidence that house prices improve forecasts of inflation even if it is by a small amount.

fluctuations in a simple macroeconomic model.

The common trends methodology uses the fact that any equilibrium relationship among a set of nonstationary variables implies that their exists linear combinations of the level series which ensure that the trends average out, i.e., the residuals obtained from the linear combination is stationary. This implies that their time paths are influenced by their deviation from their long-run equilibrium. Hence, the short-run dynamics must be influenced by the deviation from the long-run relationship. The model that is commonly used to analyze these short-term dynamics from equilibrium is the vector error-correction model (VECM). Using this model King et al. (1991) and Warne (1993) show that a distinction can be made between structural shocks that can have permanent effects on the level of variables and those with temporary effects.

3.1 Vector Autoregressions and Common Trends

The following exposition follows Warne (1993) and Fischer, Fackler and Orden (1995). A common trends model consists of a vector of trends and a vector of stationary variables. KPSW show that there is a common duality between the concept of cointegration and common trends. The cointegrating restrictions determine the number of independent trends and how a vector of observed values is related to all independent trends. In other words, if $\{x_t\}$ is a vector of time series such that $x_t = x_t^P + x_t^S$ where x_t^P represents a vector of trends of x_t, while x_t^S is a stationary residual and if β is a cointegrating vector, then $\beta' x_t^P = 0$ for $\beta' x_t = \beta' x_t^S$ to be stationary. Since these restrictions do not in anyway identify what a certain trend is related to - e.g. a technology shock - it is necessary to consider further identifying assumptions. Therefore, Section 3.1.1 will explain the mathematical structure of common trends and cointegration while Section 3.1.2 describes how to identify common trend parameters.

3.1.1 Common Trends and Cointegration

To determine how we can estimate the model we assume that $\{x_t\}$ is generated by the unrestricted vector autoregression (VAR) of order P:

$$FX_t = F_1 X_{t-1} + ... + F_P X_{t-P} + \mu Z_t + u_t \tag{1}$$

where u_t is a $n \times 1$ vector of white noise and mutually orthogonal behavioural shocks that drive the economy over time and Z_t is a vector of deterministic variables such as a constant and dummy variables. The F's and μ's are unknown coefficients.

Given the structural model depicted by Equation (1), the reduced form model is:

$$X_t = A_1 X_{t-1} + ... + A_P X_{t-P} + \mu Z_t + \varepsilon_t \tag{2}$$

where $\varepsilon_t = F^{-1} u_t$, $A_i = F^{-1} F_i$ and $cov(\varepsilon_t) = \Sigma$.

This model can be reparameterised as

$$\triangle X_t = \pi X_{t-1} + \pi_1 \triangle X_{t-2} ... + \pi_{P-1} \triangle X_{t-P+1} + \mu Z_t + \varepsilon_t \tag{3}$$

where $\triangle$ is the difference operator, $\pi = (A_1+A_2+....+A_k-I)$ and $\pi_i = -(A_{i+1}+ ... + A_k)$. If the series are nonstationary and cointegrated this representation is the VECM. The matrix π provides information about the long-run relationships among the series. In particular, we have $0 < r = rank\ \pi < n$.

The major difference between Equation (2) and Equation (3) is that the latter relationship is based on cointegration ($\pi = \alpha\beta'$ where α is $n \times r$ matrix) while the former is merely consistent with unit roots.

Using a moving average representation of Equation (3), the common trends methodology separates the permanent and temporary shocks. The temporary shocks are equal to the number of cointegrating relationships. The permanent shocks are the common stochastic trends. The number of stochastic trends is therefore equal to $n - r$, the number of variables less the number of cointegrating relationships. A detailed exposition of the common trends methodology is provided in the next section.

To write and identify this as a common trends model it is necessary to rewrite Equation (3) as a moving average representation:

$$A(L) \triangle X_t = \pi X_{t-1} + \mu Z_t + \varepsilon_t \tag{4}$$

Warne (1993) shows that from the stochastic part of Equation (4), that it is possible to get a vector moving average (VMA) representation:

$$\triangle X_t = C(L)\varepsilon_t \tag{5}$$

This is obtained as follows. Define a transformation matrix:

$$M \equiv \begin{bmatrix} P' \\ \beta \end{bmatrix} \text{ with } \beta' P = 0$$

and the matrices

$$D(L) \equiv \begin{bmatrix} I_{n-r} & 0 \\ 0 & (1-L)I_r \end{bmatrix}$$

and

$$D_{\perp}(L) \equiv \begin{bmatrix} (1-L)I_{n-r} & 0 \\ 0 & I_r \end{bmatrix}$$

this implies that $D(L)D_{\perp}(L) = (1-L)I_n$.

Further, let $\alpha^* = \begin{bmatrix} 0_{n\times(n-r)} & \alpha_{n\times r} \end{bmatrix}$. It can be verified[5] that $\alpha(\beta' X_t) = \alpha^*(D_{\perp}(L)MX_t)$. Now pre-multiply both sides of Equation (4) by M. This gives the following result:

$$\begin{aligned} MA(L)\triangle X_t &= M\pi X_{t-1} + M\mu Z_t + M\varepsilon_t \\ &= M\alpha(\beta' X_{t-1}) + M\mu Z_t + M\varepsilon_t \\ &= M\alpha^*(D_{\perp}(L)MX_{t-1}) + M\mu Z_t + M\varepsilon_t \end{aligned} \tag{6}$$

Rewriting Equation (6) as:

$$\begin{aligned} M(A(L))M^{-1}D(L)D_{\perp}(L)MX_t - M\alpha^*(D_{\perp}(L)MX_{t-1}) &= M\mu Z_t + M\varepsilon_t \\ M(A(L)M^{-1}D(L) - \alpha^* L)X_t^* &= M\mu Z_t + M\varepsilon_t \\ R(L)X_t^* &= M\mu Z_t + M\varepsilon_t \end{aligned} \tag{7}$$

where $X_t^* = D_{\perp}(L)MX_t$ and $R(L) = M(A(L)M^{-1}D(L) - \alpha^* L)$. Rearranging

[5] See Warne (1993).

Equation (7) in terms of X_t^* yields:

$$X_t^* = R(L)^{-1}M\mu Z_t + R(L)^{-1}M\varepsilon_t \tag{8}$$

Abstracting from the deterministic components and noting that $\triangle X_t = M^{-1}D_{\perp}(L)X_t^*$ gives:

$$\triangle X_t = M^{-1}D(L)R(L)^{-1}M\varepsilon_t \tag{9}$$

Therefore,

$$C(L) = M^{-1}D(L)R(L)^{-1}M \tag{10}$$

To develop the KPSW approach to identification it is necessary to obtain a moving average representation for the stochastic component of $\triangle X_t$. The important result here is that we have found a simple mathematical connection to VMA representation. Hence, the restricted VAR (Equation (7)) is well suited to estimating a common trends model. Therefore, the result of Equation (10) is important as we move toward identifying permanent and transitory shocks.

Leaving the algebra aside for now, the basic idea is to use the fact that $C(1)$ has a reduced rank under the assumption of cointegration. Accordingly, only $k = n - r$ elements of $C(1)\varepsilon_t$ result in (linearly) independent permanent effects on X_t. Further, subject to identification, a corresponding structural moving average representation is:

$$\triangle X_t = F^{-1}u_t + C_1F^{-1}u_{t-1} + C_2F^{-1}u_{t-2} + C_3F^{-1}u_{t-3} + ... = \Gamma(L)u_t \quad (11)$$

where $\Gamma_0 = F^{-1}$ and $\Gamma_i = C_iF^{-1}(i = 1, 2, ...)$.

$\Gamma(1)$ measures the permanent effects on the levels of the variables in the system of structural shocks. Engle and Granger (1987) have shown that the columns of $C(1)$ are orthogonal to the cointegrating vectors β, so $\beta' C(1) = 0$. Thus, any basis for n-dimensional vectors can be divided into a space spanned by the $k = n - r$ linearly independent columns of $C(1)$.

3.1.2 Identification of permanent and transitory shocks

From Equation (11) we can see that the relationships between the reduced-form and structural parameters are:

$$C(1) = \Gamma(1)F \quad (12)$$

$$\varepsilon_t = F^{-1}u_t \quad (13)$$

To exactly identify the model, $\frac{n(n-1)}{2}$ restrictions need to be imposed. KPSW propose the following to identify the model:

1. Partition $\Gamma(1)$ such that $\Gamma(1) = [P|0]$, where P is a $n \times k$ matrix with columns that are orthogonal to the cointegrating vectors. This identification restriction can be interpreted as there are k structural shocks, $\omega_{k,t}$

with permanent effects given by the columns of P. Since there are r structural shocks that have only transitory effects this partitioning assumption imposes kr identifying restrictions. Given this, partitioning F consistent with $\Gamma(1)$, with its first k rows as F_k and the last r rows as F_r, we have

$$C(1) = \Gamma(1)F = PF_k \tag{14}$$

$$C(1)\Omega C(1)' = PP' \tag{15}$$

2. An additional $\frac{k(k-1)}{2}$ restrictions need to be imposed. This is imposed by assuming P to be lower triangular. This is because when $k > 1$, KPSW propose that P be assumed to be lower triangular. The interpretation of this structure is that there is one variable only affected by one structural shock in the long-run, a second variable affected by at most two shocks in the long-run, a third variable affected by at most three shocks in the long-run and so on. Therefore the variables in X_t need to be ordered appropriately.

3. Choleski decomposition programs cannot be used to determine the structural parameters as $C(1)\Sigma C(1)'$is not of full rank. Given that step two of KPSW imposes a lower triangular structure on P, this problem can be overcome by defining $P = \widetilde{P}\Theta$, where the coefficients of $\widetilde{P}$ are known *a priori* as they are specified by economic theory and Θ is a $k \times k$ lower triangular matrix of parameters to be estimated.

4. To solve this, assume D is a $(k \times n)$ matrix that solves $C(1) = \widetilde{P}D$ such

that $D = (\widetilde{P}'\widetilde{P})^{-1}\widetilde{P}'C(1)$. In such a matrix D, $\widetilde{P}D\varepsilon_t = \widetilde{P}\Theta\omega_{k,t}$ and $D\Sigma D' = \Theta\Theta'$. The lower triangular matrix of $D\Sigma D'$ yields the unknown coefficients of Θ. Use Θ to calculate P.

5. Given that $C(1) = PF_k = \widetilde{P}\Theta F_k = \widetilde{P}D$ we have that $F_k = \Theta^{-1}D$. We can therefore obtain the structural shocks u_t with permanent effects by premultiplying the reduced form residuals ε_t by F_k.The equations for the k common trends are obtained by multiplying Equation (3) by F_k to obtain:

$$F_k \triangle X_t = F_k \pi_1 \triangle X_{t-1} + ... + F_k \pi_{P-1} \triangle X_{t-P+1} + F_k \eta^* Z_t + \omega_t \quad (16)$$

Thus in this methodology the the structurally identified shocks with permanent effects determine the common trends.

6. Once F_k is estimated, the dynamic impacts on X_t of the structural shocks with permanent effects can be computed from the first k columns of $\Gamma(L)$ given by:

$$\Gamma(L) = C(L)[F^{-1}]_k = C(L)\Sigma F_k' \quad (17)$$

where $[F^{-1}]_k$ are the first k columns of F^{-1}. The forecast-error variances at various horizons due to shocks with permanent effects can also be computed from Equation (17) and can be compared to the total forecast-error variance (derived from the reduced-form) to determine the relative importance of these shocks over time.

7. Identification of the structural parameters associated with the shocks with

only transitory effects can be derived from:

$$\begin{bmatrix} 0 & I_r \end{bmatrix}_{r \times n} = \begin{bmatrix} F_r \Sigma F_k & F_r \Sigma F_r' \end{bmatrix} \tag{18}$$

We then identify F_r by imposing a triangular structure on it.

4 The Data

4.1 Data Description

Following Icaviello (2000), a five dimensional VAR, X_t is specified to capture the relationship between house prices and the macroeconomy. The vector $X_t = [y \; mp \; hp \; i \; \pi]$ comprises of: 1) real income (y), where y is the natural logarithm of seasonally adjusted real gross domestic product; 2) a measure of real balances (mp), where mp is the natural logarithm of deflated M3 money balances; 3) an index of real house prices (hp), where hp is the log of deflated house prices; 4) a nominal interest rate (i), where i is the 3 month treasury bill rate; and 5) inflation (π), where π is measured by the year-on-year change in the GDP deflator.[6] The data on house prices in South Africa are from the residential house price index calculated by ABSA Bank.[7] The remaining series were obtained from the South African Reserve Bank Bulletin.[8] The sample period covers quarterly data from 1971 to 2006.

[6] The change in the GDP deflator is a proxy for inflation measured using domestic prices since it excludes imports. Since this paper analyses the impact of policy on domestic prices, the inflation rate measured by the GDP deflator provides an accurate measure.

[7] See ABSA (2005).

[8] See South African Reserve Bank Quarterly Bulletin (2006).

Over this period average house price growth in South Africa has been positive. Figure 1 portrays quarter-on-quarter growth in real house prices, real output and real money demand. Table 1 displays the correlation coefficients for these variables. The Figure shows that housing prices have fluctuated around typical business cycle frequencies and the Table indicates that house prices and GDP move together for the entire sample. Also, increases in real money balances are shown to be positively correlated with real house prices. These results are as expected.

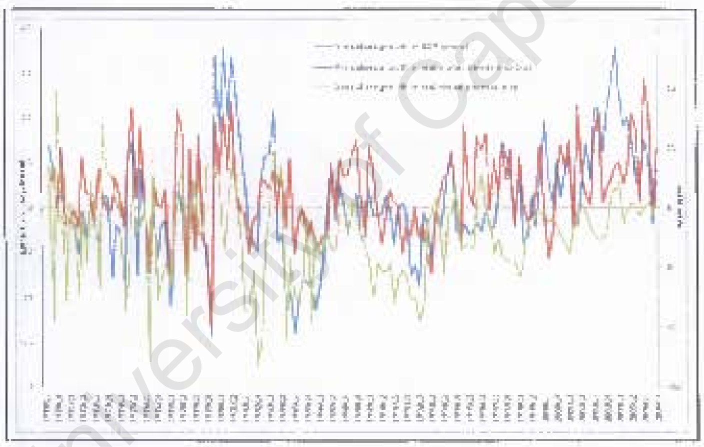

Figure 1: Growth in real house prices, real output and real money balances

Of interest is the plot of house price inflation against the inflation rate depicted in Figure 2. Over the entire period there is no consistent pattern between house price inflation and the inflation rate. The Figure shows, that during the 1970s, peaks in house price inflation and the traditional measure of inflation seem to coincide. In the 1980s this relationship breaks down in the light of political instability. Once again, in the 1990s, the two measures of inflation

		hp	y	mp
All	hp	1.0000		
	y	0.5060	1.0000	
	mp	0.5941	0.6134	1.0000
1970s	hp	1.0000		
	y	0.6152	1.0000	
	mp	0.7039	0.5573	1.0000
1980s	hp	1.0000		
	y	0.5214	1.0000	
	mp	0.6364	0.4193	1.0000
1990s	hp	1.0000		
	y	0.2675	1.0000	
	mp	0.6099	0.5658	1.0000
2000s	hp	1.0000		
	y	0.5531	1.0000	
	mp	0.2066	0.1270	1.0000

Table 1: Correlation between the growth in real variables

move together. After adopting the inflation targeting framework, since early 2000, peaks in housing inflation occur before peaks in the inflation rate. This supports the finding of Goodhart and Hofmann (2000) that asset price inflation is a good predictor of future inflationary pressures.

Taking a closer look at real house price growth since 2000 we find that large increases in house prices have been recorded since the year 2000. Real house price growth has been surging since then, growing at double digit levels year-on-year since 2003, reaching a peak of 27.6 percent in the third quarter of 2004. Although growth in house prices has moderated in the recent past, the increase in house prices were during a period of strong economic growth, a low inflation and interest rate environment, strong credit growth and the emergence of the Black middle class.[9]

[9] See Nel & Mbeleki (2005).

Since South Africa is an emerging market country it is unclear whether this underlying boom is a symptom of these underlying transformations in the economy. Therefore, it is important to establish what are the main factors driving house prices over the period and the relevant importance of these factors.[10]

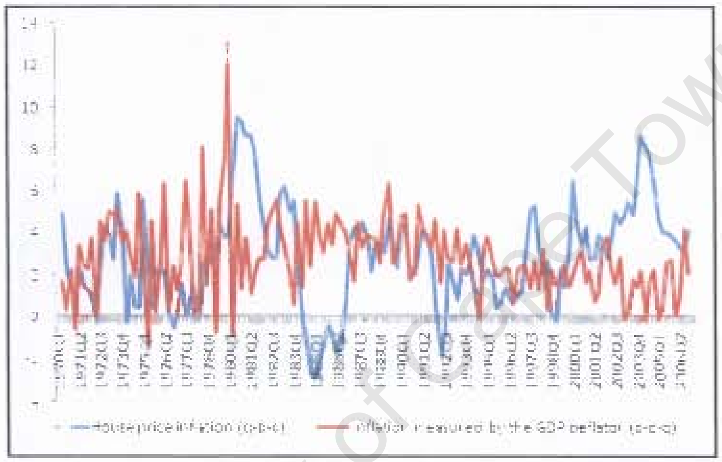

Figure 2: House Price Inflation and Inflation measured by GDP deflator

4.2 Univariate Characteristics of the Data

To correctly specify the model, we need to test for stationarity and determine the number of cointegrating relationships. The augmented Dickey-Fuller test with four lags was used to determine stationarity. The test indicates that all the variables are integrated of order one except for the inflation rate. However, the plot of inflation reveals that although inflation has a constant mean the variance is nonconstant, indicating that inflation is an I(1) variable.

[10] In Section 5 we will try and distinguish the main driving forces behind house price fluctuations over the sample period using the common trends methodology.

Furthermore, closer inspection of the macroeconomic data indicates a need for three dummy variables. The first is in 1985 for the Rubicon speech, the second after the Russian currency crisis and the last in 2002 is to account for the sudden Rand depreciation.

Variables	ADF Statistic
Income (y)	0.54
Real Money Supply (mp)	1.20
Real House Price Index (hp)	-1.73
Nominal Interest Rates (i)	-2.57
Inflation (π)	-3.71

Critical value -2.8818

Table 2: ADF Test Statistics

5 Empirical Evidence

5.1 Hypothesis about cointegration

Following Icaviello (2000), we consider the relationship between real house prices, real output, interest rates and real money balances. We expect to find three equilibrium relationships between these variables. The first cointegrating relationship we expect to find is between money, output and interest rates, the second is the long-run housing supply curve, defining the relationship between house prices and output, and the last is the Fischer equation which describes the link between the interest rate and the inflation rate.

1. **Money, Output and Interest rates:** According to Gali (1992) the desire of monetary authorities to stabilize output often results in volatility

in nominal variables. The pursuit of central banks to reduce output fluctuations may then lead to a common trend between output, money and interest rates. The relationship between these three variables may alternatively be interpreted as a traditional money demand function linking real money balances (mp) to a scale variable (y) and a measure of the opportunity cost of maintaining liquidity (i).[11]

2. **Real House Prices and Output:** One can expect to find a cointegrating relationship between house prices and GDP. This is because factors such as land, cement or construction workers are available in a fixed supply and these determine real estate supply. Therefore, the production possibilities frontier between housing and other goods is not flat. This implies a possible upward trend in house prices over the long-run.[12] Given that GDP is a measure of how much the production possibilities curve is shifting outward, Icaviello (2000) states that the cointegrating relationship between house prices and GDP can be thought of as a long-run supply curve for the housing stock. The coefficient attached to real house prices measures the elasticity of real house prices to output.

3. **Interest Rates and Inflation:** According to the Fischer equation there

[11] See Coenen and Vega (1999). However, as Icaviello (2000), notes caution must be exercised when interpreting this relation as a money demand function for the following reasons: emerging market countries are highly influenced by the global economy, with investment and interest rates responding to changes in risk perceptions held by investors; there could be alternative cointegrating vectors in a similar system. For example, an aggregate demand relation might exist between output and interest rates; measures of money are aggregates of different components with different characteristics; structural and definitional breaks cannot be disregarded; and/or the frequency of observation may affect both exogencity and cointegration.

[12] See Poterba (1984).

is reason to believe that real interest rates are stationary. In particular the nominal variables are linked by the following equation $i_t = \mu + \pi_t + \varepsilon_t$, where μ is a constant and ε_t is a stochastic variable that is *iid*.[13]

Given these hypotheses, we would expect three cointegrating vectors, $r = 3$, which incorporates the money demand function, the relationship between output and house prices and the modified Fischer equation. Therefore the β' matrix is given by:

$$\beta' = \begin{bmatrix} -b_y & 1 & 0 & b_i & 0 \\ -\tau & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 1 \end{bmatrix}.$$

5.2 The Johansen Technique

To estimate the common trends model we first need to test for the number of cointegrating vectors between house prices and the other macroeconomic variables. This section draws on the Johansen Estimation Technique,[14] which is based on estimating a Vector Error Correction Mechanism (VECM). The discussion of this methodology will be brief as this technique is well established.

In the VECM framework, for which, in the case of a set of n variables, we may have cointegrating relationships denoted r, such that $0 \leq r \leq n - 1$. This gives us a n dimensional VAR:

$$z_t = A_m z_{t-1} + \ldots + A_m z_{t-m} + \delta + v_t \tag{19}$$

[13]Fedderke and Pillay (2007) suggest that the Fischer equation for South Africa should be modified to include a measure of risk or uncertainty.
[14]See Johansen (1991) and Johansen and Juselius (1990).

where m denotes the lag length, δ a set of deterministic components and υ a Gaussian error term.

Re-parameterization provides the VECM specification:

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-k+1} + \delta + \upsilon_t \tag{20}$$

The existence of r cointegrating relationships amounts to the hypothesis that:

$$H_1(r) : \Pi = \alpha\beta' \tag{21}$$

where Π is $n \times n$, and α, β are $n \times r$ matrices of full rank. $H_1(r)$ is thus the hypothesis of reduced rank of Π. Where $r > 1$, issues of identification arise which requires the use of economic restrictions on the loading matrix (α) - the matrix representing the short run dynamics,- Γ and/or the cointegrating space, β.[15]

5.3 Johansen maximal and trace eigenvalue statistics

We first test for the number of possible relationships in the model by establishing the number of cointegrating vectors. Table 3 reveals the Johansen maximal eigenvalue and trace test statistics for the model. Both the maximal eigenvalue statistic and the trace test statistic indicates the existence of three equilibrium relationships. This is in line with theoretical expectations.

[15] See Pesaran and Shin (1995a,b), Pesaran, Shin and Smith (1996), Johansen and Juselius (1990) and Wickens (1996).

Null	Alternative	Eigenvalue statistics	95% critical value	Trace statistic	95% critical value
r=0	r=1	58.65	33.64	139.44	70.49
r≤1	r=2	39.06	27.42	80.78	48.88
r≤2	r=3	29.19	21.12	41.72	31.54
r≤3	r=4	11.64	14.88	12.53	17.86

Table 3: Johansen trace and maximal eigenvalue statistic

5.4 Johansen VECM Estimation Results

Table 4 shows three estimated cointegrated vectors with three over-identifying restrictions. The three cointegrating vectors can be interpreted as a money demand schedule, long-run housing supply curve and the Fischer equation.

Cointegrating Vectors	
Money Demand Schedule	$mp = 0.946y - 0.004i$
Long-run Housing Supply Curve	$hp = 0.034y$
Fischer Equation	$i = \pi$

Table 4: Cointegrating vectors

These results confirm our hypotheses in Section 5.1. A one percent increase in real income results in a 0.946 percent increase in real money demand while a one percentage point increase in the interest rate results in a 0.004 percent decline in real money balances.[16] It is interesting to note that it seems that money demand is not highly responsive to interest rates. House prices increase by 0.034 percent for a one percent increase in output. The Fischer equation also holds.

[16]The high coefficient on income is expected as wealth variables are omitted.

5.5 Impulse Response Analysis

5.5.1 Identifying the structural shocks

Permanent Shocks Given the hypothesis concerning the cointegrating vectors, the long-run multipliers of the permanent shocks can be identified according to the common trends methodology. Since there are five variables and three cointegrating vectors we can expect to find two common trends (permanent shocks). Therefore, the common trends matrix, P, has a dimension of 5×2.

Recall from Section 3.1.2 that one technical difficulty with estimating the structural parameters of P is that even when P is lower triangular, standard Choleski decomposition programs cannot be used to determine the structural parameters as $C(1)\Omega C(1)'$ is not of full rank. To overcome this problem KPSW suggest that we can define $P = \widetilde{P}\Theta$, where the columns of $\widetilde{P}$ are known *a priori* and Θ is a $k \times k$ lower triangular matrix of parameters to be estimated.[17]

This *a priori* identification of permanent shocks can be achieved by imposing just enough restrictions so that their *long-run effect has a meaningful economic interpretation* and its columns are orthogonal to the cointegrating matrix β, i.e., $\beta'\widetilde{P} = 0$. The identification, on the basis of economic theory, describes the effects of a permanent supply shock and a permanent nominal shock on the economy.

Economic theory states that a permanent supply shock will affect real output, real money balances, real house prices and the inflation and nominal interest

[17] Recall from Section 3.1.2 that the econometric identification of the different shocks requires that Θ is a lower triangular matrix of parameters.

rates in the long run.[18] This supply shock may be attributed to a productivity increase in the economy. In contrast, a permanent nominal shock is likely to decrease real money balances whilst leaving real house prices and output unchanged. One interpretation of this shock is that there is a permanent change in the monetary policy objective of the monetary authority.[19]

The theoretical expectations of supply shocks and nominal shocks on the economy allow the following restrictions to be imposed on the P matrix:

$$P = \widetilde{P}\Theta = \begin{bmatrix} 1 & 0 \\ b_y & -b_i \\ \tau & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \theta & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ b_y - b_i\theta & -b_i \\ \tau & 0 \\ \theta & 1 \\ \theta & 1 \end{bmatrix} \rightarrow \begin{bmatrix} \text{long-run effect of shock on } y \\ \text{long-run effect of shock on } mp \\ \text{long-run effect of shock on } hp \\ \text{long-run effect of shock on } i \\ \text{long-run effect of shock on } \pi \end{bmatrix}$$

Given these restrictions the first column and second column of P represents a permanent supply shock and a nominal shock, respectively. From the above identification scheme, a permanent supply shock increases output, real balances and house prices in the long-run with parameters dictated by the estimated cointegrating relationship. Since Θ is restricted to a lower triangular diagonal matrix,[20] this shock can also change inflation and nominal interest rates in the long-run. The second column, which represents a permanent nominal shock, leaves real output and real house prices unchanged, yielding a lower level of real balances and higher inflation and interest rates in the long-run. Given our hypothesis about cointegration and the variables ordered as $[y\ mp\ hp\ i\ \pi]'$, it

[18]See Kydland and Prescott (1982), Christiano and Eichenbaum (1992) and Gali (1999).
[19]See Coenen and Vega (1999).
[20]For reasons as to why this is done see Section 3.1.2 and Warne (1993).

can be easily seen that $\beta'\widetilde{P} = 0$, fulfilling the requirement that the columns of the identification matrix are orthogonal to the cointegrating vector.

Temporary Shocks The common trends methodology assumes that transitory shocks are orthogonal to permanent shocks and will have no long-run effect on any of the variables. Following Englund, Vredin and Warne (1992), we identify the shocks in a recursive fashion and give an interpretation along the lines of the conventional VAR methodology. Following Icaviello (2000), this paper defines three separate sources of short-run variation.

The first shock is a *monetary policy shock* which does not have a contemporaneous effect on inflation and output but can immediately affect real money balances, interest rates and real house prices. The second shock is a *demand shock*. Gali (1992) identifies the demand shock by the fact that it does not have a contemporaneous effect on inflation. It contemporaneously affects GDP by affecting its spending components as well as house prices, real money balances, and interest rates. Icaviello (2000) states that this shock is most likely attributed to sudden increase in demand fuelled by self-fulfilling expectations of the appreciation in house prices. The last shock is an *inflation shock* which contemporaneously affects all variables. As Icaviello (2000) notes, this shock could be explained by some of the following:

- a temporary upward shift in the aggregate demand;
- a temporary negative supply shock;
- an exchange rate shock, that raises the prices of imported goods;

- an increase in world commodity price such as oil; and/or

- imported inflation following devaluation of the domestic currency.

Given this identification scheme, the outcomes of both permanent and temporary shocks are explained in the section that follows.

5.5.2 Impulse Responses

This section examines whether the identification scheme illustrated above leads to plausible estimations of the shocks. Specifically, we answer the following questions:

1. How does output, money balances, house prices, the interest rate and the inflation rate respond to permanent and transitory shocks?

2. What is the possible transmission mechanism for the respective shocks? and

3. To what extend does monetary policy affect real house prices?

Permanent Shocks

Supply shock: Figure 3 portrays the response of output, money balances, house prices, inflation and the interest rate to a one standard deviation shock to aggregate supply. Based on the specification of the cointegration vectors and on the matrix of common trends, this shock has been identified under the assumption that it increases real output and leads to an increase in real house prices in the long-run,[21] with proportions dictated by the elasticity of house prices with respect to output - given by the coefficient τ.

Figure 3 illustrates the initial effect on output is positive rising by 0.03 percentage points in the impact period, gradually increasing and stabilizing four years later, having increased by approximately 3.14 percentage points.[22] In accordance with a simple aggregate demand aggregate supply model, consumer prices drop in the initial periods before rising to a higher level as demand increases. Higher prices and increased money supply satisfy money demand and interest rates hardly deviate from its pre-shock level. As inflation remains above the baseline the interest rate rises slowly satisfying the Fischer equation in the long-run. Note that inflation stabilises faster than interest rates and both inflation and interest rates have a negligible impact in the long-run.

Unlike France, Germany, Italy, Spain, Sweden and the UK house prices in South Africa do not initially drop before increasing to its higher steady state level.[23] It overshoots its equilibrium value before gradually adjusting toward its higher steady state value. This behaviour is in line with perfect capital markets and is not implausible given that South Africa has a extremely developed financial sector with a high level of financial deepening.[24] The supply shock generates an increase in real money balances together with real effects on overall economic activity as certain prices and wages are sticky and do not adjust

[21] Since the effect on real money balances can be positive or negative depending on the relative impact of the nominal interest rate and real output on real money balances, only house prices and output are used to identify the shock.

[22] See Table 5.

[23] See Iaviello (2000) for a discussion on the impact of supply shocks in France, Italy, Spain, Sweden and the UK.

[24] See Kularatne (2002).

pro rata. Goodhart and Hofmann (2000) state that the combination of sticky prices and flexible asset prices could lead to overshooting.[25]

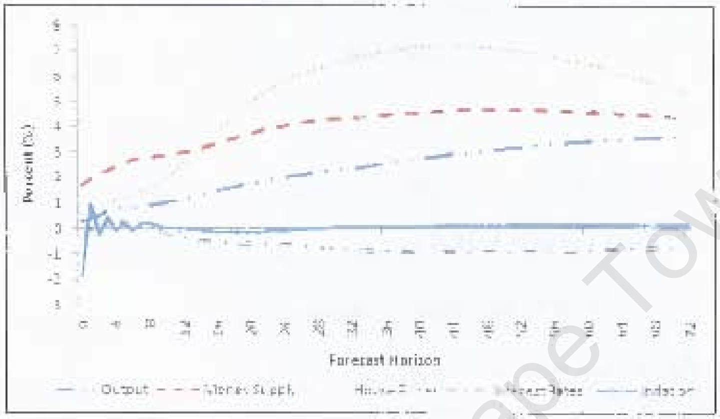

Figure 3: The impact of a permanent supply shock

Variables	Supply Shock	Nominal Shock
y	3.14	2
mp	2.95	-0.47
hp	0.11	0
i	0.04	1.17
π	0.04	1.17

Table 5: Long run impact of permanent shocks

Nominal shock: Table 5 reveals a permanent nominal innovation raises both inflation and nominal interest rates by 1.17 percentage points in the long-run. This implies that the real interest rate remains unchanged as stipulated by the Fischer equation.[26] The rise in the inflation rate reduces real money balances

[25] However, they do note the empirical evidence on overshooting asset prices is hard to uncover in practice and therefore sparse in the available literature. This is because most studies focus on developed economies with relatively flexible prices and wages.

[26] Due to the large standard errors on this shock it is inadvisable to place too much emphasis

by 0.47 percentage points. Real output in the economy remains unchanged implying that the rise in the price level is exactly matched by an increase in nominal output. Therefore, the fall in real money balances is responding to a rise in the nominal interest rate only since real output remains unchanged.

Table 5 reveals that real house prices are unaffected in the long run due to a permanent nominal shock. However, Figure 4 portrays house prices initially increase suggesting that houses are used as a hedge against inflation. As the interest rate and the inflation rate stabilize at their long run levels, real house prices return to their original level since real interest rates and real output remain unchanged.

Thus even though the nominal shock is permanent, it has no effect on the real economy but it is important to note that it takes a long time for house prices to stabilise even after the inflation rate and interest rate has stabilised. While the increase in the interest rate in response to a rising inflation rate is suggestive of an anti-inflationary policy from the monetary authority, it does not seem to have a significant impact on the housing market.

Temporary Shocks

Monetary shock: Figure 5 displays the response of the variables to a positive one standard deviation shock to the monetary aggregate. A monetary policy shock immediately places upward pressure on the nominal interest rate. The initial rise in the real interest rate contracts demand in the economy. This is

on this shock. However, the Iacoviello (2000) study of six European countries also finds large standard errors for Sweden, Italy and Germany.

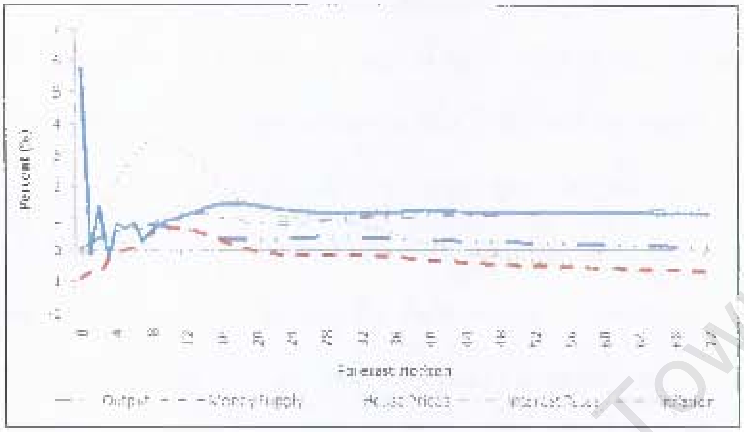

Figure 4: The impact of a permanent nominal shock

reflected by falling real house prices and real output. The inflation rate initially declines with the rise in the nominal interest rate. The declining nominal interest rate then increases the inflation rate temporarily. As the nominal interest rate returns to its pre-monetary shock level, so too does the inflation rate.

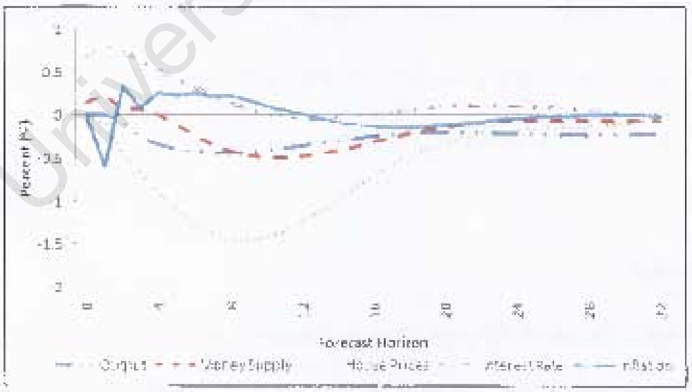

Figure 5: The impact of a temporary monetary shock

Considering the response of both house prices and the inflation rate to a monetary shock, Icaviello's (2000) analysis of six European countries finds that the short-run response in house prices is much more pronounced. The paper also asserts that house price inflation is more sensitive than consumer price inflation. In South Africa, both house prices and the inflation rate decrease, with house prices declining gradually and returning to equilibrium slowly. The maximum reduction in house prices is three times as large as the maximum decline in the inflation rate and the trough occurs much earlier in consumer price inflation. This may indicate that general prices are more flexible than house prices to a monetary innovation in the short-run, although house prices take a longer time to stabilise. The movement of house prices is similar to that of output except the former is much more responsive to a monetary shock.

The evidence here shows that the timing of the response in real house prices occurs contemporaneously with output and the adjustment in house prices take several years with house prices falling in real terms before reverting to the baseline. House price adjustments are also similar to money supply and interest rate dynamics.

The observed dynamics in house prices following a monetary shock does not seem to fit with the standard monetarist model nor the "credit channel" view of the housing market. Recall that the standard monetarist model predicts that there should be a jump in asset prices followed by a smooth adjustment of the asset price toward equilibrium. On the other hand, the "credit channel" models of Bernanke and Gertler (1995) and Kiyotaki and Moore (1997) converge on the general idea that with depressed asset prices, consumption and investment might also suffer. These effects then reinforce each other due to financial frictions in the economy. However, in South Africa, despite the large response in house prices, the response in output is not very strong. Overall this seems to suggest that although house price volatility is high in South Africa, house price movements do not play a important role in the transmission mechanism.

Demand shock: Figure 6 illustrates the impact of a temporary demand shock that result in short-term output effects with consumer prices fixed in the impact period. Following Gerlach and Smets (1995), it is possible to label this disturbance a transitory demand shock as it elicits positive output and price responses. The increase in the nominal interest rate curbs inflation and output declines steadily. However, real interest rates remain positive for a long time causing a decline in house prices. The effect on real house prices only starts to die down as the Fischer equation begins to hold again. Since the nominal interest rate and real house prices experience a long adjustment period unlike the other macroeconomic variables, this indicates that real house prices are largely influenced by interest rates. Moreover, as output and house prices do not move in the same direction, the results do not lend support to the "credit channel" view of the transmission mechanism. The implication of this result is that the demand shock does not translate into exuberant investor sentiment that affects the wider economy.

Inflation shock: Figure 7 displays the impact of a temporary inflation shock. This inflation shock is driven by a decline in the nominal interest rate.

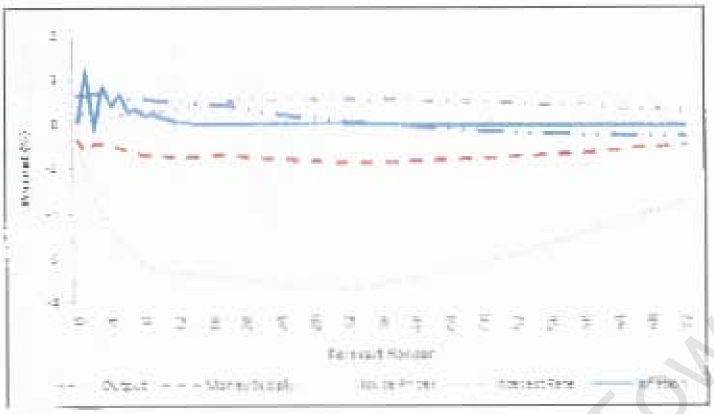

Figure 6: The impact of a temporary demand shock

This shock leads to an initial fall in real output, real money balances and real house prices with a rise in the price level. As the nominal interest rate returns to its pre-shock levels, the inflation rate declines and real output, real house prices and real money balances increase to their original level.

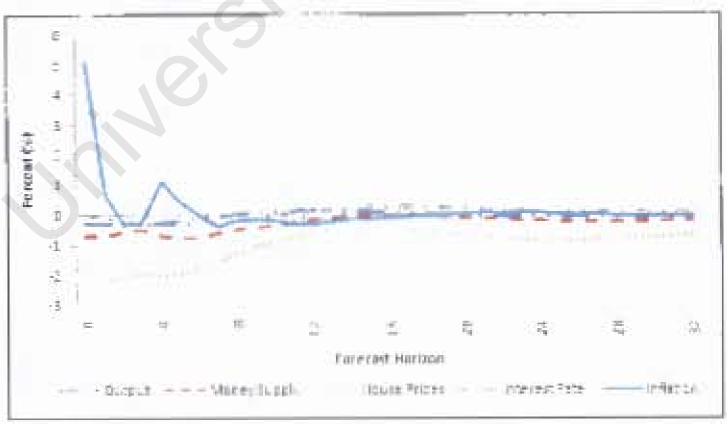

Figure 7: The impact of a temporary inflation shock

5.6 Variance Decomposition

The previous section examined the dynamic effects of supply, nominal, demand, monetary and inflation shocks on house prices. This section aims to investigate in what proportion these different innovations contribute to the volatility of house prices and output. This provides an indication of the degree of influence each macroeconomic shock has on real house prices and real output at different time horizons.

Figures 8 and 9 plot the eight year forecast error variance for output and house prices, respectively. It is important to keep in mind that the assumptions made in the identification of the permanent shocks imply (by construction) that the permanent shocks will dominate the transitory shocks as the forecast horizon grows larger.

In the short run, Figure 8 shows that the demand shock explains most of the initial variation in real output. Initially, 71 percent of the variation in real output is explained by the demand shock. This then falls to 2 percent in approximately three years. The Figure illustrates that the other temporary shocks have negligible effects on output. Overall, supply shocks and demand shocks explain most of the variation in output as expected. However, in the long run, supply shocks contribute approximately 70 percent of the variation in real output.

Unlike real output, Figure 9 illustrates that most of the initial variance of real house prices is actually driven by a inflation shock. In the first year, short run inflationary pressures explain at least 75% of the variation. Over time

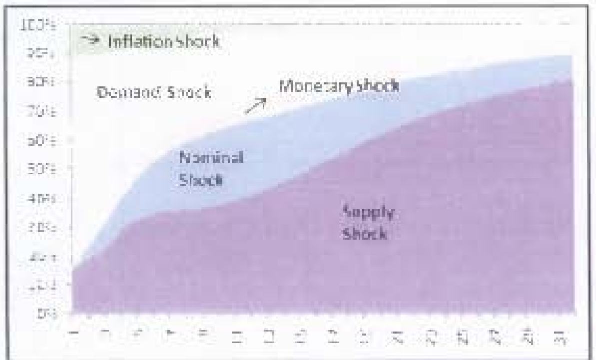

Figure 8: Forecast variance decomposition of real output

demand shocks seems to explain a large proportion of the variation. However, over time both these shocks are persistent despite being labelled as temporary shocks. This is likely due to the fact that it takes a long time for the Fischer equation to hold again. Therefore, unlike real output it seems that house prices are more responsive to interest rate movements and temporary shocks.

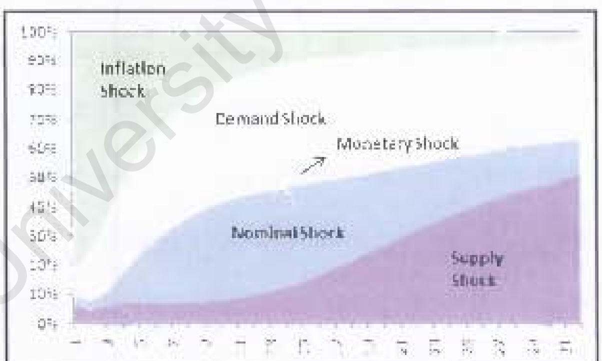

Figure 9: Forecast variance decomposition of real house prices

6 Conclusion

The increased volatility of asset prices in both developing and developed economies seems to be a growing concern for economic policy makers. Whilst there is a growing literature investigating the link between monetary policy and its implications for asset price volatility, there remains uncertainty regarding the overall effects of these factors on long-term asset prices. The contribution of this paper is to take a preliminary step toward identifying how house prices respond to macroeconomic shocks and the relative importance of these macroeconomic shocks.

The paper has shown that the dynamics of house prices can be analysed in a transition economy using a tractable VAR framework. The model is driven by five exogenous disturbances and the identification scheme yields plausible results between money, output and inflation. The empirical results suggest that the housing market behaviour is in line with the theoretical expectations of asset price behaviour in an environment of relatively perfect capital markets. Further, house prices are found not to play a large role in the transmission mechanism as they are neither consistent with the standard monetarist model nor the "credit channel" view. It does however show that adverse monetary shocks do have a significant negative impact on house prices and the timing of the response of house prices matches output. However, short-run house price fluctuations are largely explained by inflation and demand shocks.

Some caution needs to be exercised when interpreting these short-run fluctuations given the lengthy adjustment period for some temporary shocks to dissipate. This is most likely attributed to the Fischer equation. It seems that nominal interest rates remain higher than its pre-shock level even though inflation has been reigned in. This may be an indication that risk should be included as it plays a role in determining nominal interest rates and may also be a significant factor influencing house prices in South Africa, especially during the 1980's. It might also be one of the reasons behind the large standard errors in the nominal shock. Therefore, further research should investigate the possibility of including a risk measure in the model.

Further, this paper gives the average response of house prices to a series of shocks over the period 1971 to 2006 and although over the period it seems that on average house prices do not play a large role in the transmission mechanism, this may not be the case in the future. The data also indicates that although house prices have been volatile over the entire period, peaks in house prices and output occur contemporaneously for most of the sample.

However, since the adoption of inflation targeting, peaks in house prices occur before peaks in output. Therefore, given the number of political and economic changes within the South African economy, house prices may respond differently to these shocks depending on the time period. This indicates the possibility of monetary regime shifts in the sample. A possible extension of the dissertation is to allow for regime shifts over the sample period. Using the moving average component of the shocks or Markov Switching modelling, one may capture changes in the monetary environment over different regimes thus allowing us to analyse the responsiveness of house prices to different shocks. This provides a clearer understanding of factors influencing house price movements over certain periods and the role (if any) that asset prices - such as housing - might play in the monetary transmission mechanism in South Africa.

References

[1] ABSA. 2005, Residential Property Market in Economic perspectives, *ABSA Publication*: Johannesburg.

[2] Alchian, A. and Klein, B., 1973, On a Correct Measure of Inflation, *Journal of Monetary, Credit and Banking*, 5(1), 173-191.

[3] Bernanke, B. and Gertler, M., 1995, Inside the Black Box: The Credit Channel of Monetary Policy Transmission, *Journal of Economic Perspectives*, 9(4), 27-48.

[4] Bernanke, B. and Gertler, M., 1999, Monetary Policy and Asset Price Volatility, *Federal Reserve Bank of Kansas City Economic Review*, 4, 5-12.

[5] Bernanke, B. and Gertler, M., 2001, Should Central Banks Respond to Movements in Asset Prices?, *American Economic Review*, 91(2), 253-257.

[6] Blanchard,O. And Quah,D., 1989, The Dynamic Effects of Aggregate Demand and Supply Disturbances, *American Economic Review*, 69(4), 655-673.

[7] Cecchetti, S., Genberg, H., Lipsky, J. and Wadhwani, S., 2000, Asset Prices and Central Bank Policy, Geneva Report on the World Economy 2, *CEPR* and *ICMB*.

[8] Cecchetti, S., Genberg, H. and Wadhwani, S., 2002, Asset Prices in a Flexible Inflation Targeting Framework, *National Bureau of Economic Research Working Paper*, No. 8970.

[9] Christiano, L. J. and Eichenbaum, M., 1992, Current Real-Business-Cycle Theories and Aggregate Labor Market Fluctuations, *American Economic Review*, 82(3), 430-450.

[10] Coenen,G. and Vega,J-L., 1999, Identification, Long-Run Relations, and Fundamental Innovations in a Simple Cointegrated System, *Review of Economic and Statistics*, 81(1), 109-121.

[11] Engle, R.F. and Granger, C.W.J., 1987, Cointegration and Error Correction: Representation, Estimation and Testing, *Econometrica*, 55, 1-87.

[12] Englund, P., Vredin, A. and Warne, A., 1992, Macroeconomic Shocks in an Open Economy: A Common Trends Representation of Swedish Data 1871-1990, *FIEF Studies in Labor Markets and Economic Policy*, 5, Claredon Press: Oxford.

[13] Fedderke, J.W. and Pillay, N., 2007, Theory-Consistent Formal Risk Measures: Using Financial Market Data from a Middle-Income Context, *Economic Research Southern Africa Working Paper*, No. 64.

[14] Filardo, A., 2000, Monetary policy and asset prices, *Federal Reserve Bank of Kansas City Economic Review*, 85, 11-37.

[15] Fischer, L., Fackler, P. and Orden D., 1995, Long-Run Identifying Restrictions for an Error-correction Model of New Zealand Money, Prices and Output, *Journal of International Money and Finance*, 14, 127-147.

[16] Fisher, I., 1933, The Debt Deflation Theory of Great Depressions, *Econometrica*, 3(1), 337-357.

[17] Gali, J., 1992, How Does the IS-LM Model Fit Postwar U.S. Data?, *Quarterly Journal of Economics*, 107(2), 709-738.

[18] Gali, J., 1999, Technology, Employment, and the Business Cycle Do Technology Shocks Explain Aggregate Fluctuations?, *American Economic Review*, 89(1), 249-271.

[19] Gerlach, F. and Smets, F., 1995, The Monetray Transmission Mechanism: Evidence from the G7 Countries, *CEPR Discussion Paper*, No.1219.

[20] Gilchrist, S. and Leahy J.H., 2002, Monetary Policy and Asset Prices, *Journal of Monetary Economics*, 49,75-97.

[21] Goodhart, C. A. and Hofmann, B., 2000, Do Asset Prices Help to Predict Consumer Price Inflation, *Manchester School Journal*, 3, 122-140.

[22] Hutchison, M., 1994, Asset Prices Fluctuations in Japan: What Role for Monetary Policy?, *Bank of Japan Monetary and Banking Studies*, 12(2), 61-83.

[23] Icaviello, M., 2000, House Prices and the Macroeconomy in Europe: Results from a Structural VAR Analysis, *European Central Bank Working Paper Series*, No.18.

[24] Johansen, S., 1991, Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, 59, 1551-1580.

[25] Johansen, S. and Juselius, K., 1990, Maximum Likelihood Estimation and Inference on Cointegration with Applications to Demand for Money, *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

[26] King, R., Plosser, C., Stock, J. and Watson, M., 1991, Stochastic Trends and Economic Fluctuations, *American Economic Review*, 81(4), 819-840.

[27] Kiyotaki, N. and Moore,J., 1997, Credit Cycles, *Journal of Political Economy*, 105(2), 211-248.

[28] Kularatne, C., 2002, An Examination of the Impact of Financial Deepening on long-run Economic Growth: An application of a VECM structure to a middle-income context, *South African Journal of Economics*, 70(4), 647-687.

[29] Kydland, F. E. and Prescott, E. C., 1982, Time to Build and Aggregate Fluctuations, *Econometrica*, 50(6), 1345-1370.

[30] Meltzer, A.H., 1995, Monetary Credit and (Other) Transmission Processes: A Monetarist Perspective, *Journal of Economic Perspectives*, 9(4),49-72.

[31] Nel, H.F. and Mbeleki, T., 2005, Asset Prices and Monetary Policy - The Impact of a Housing Market Bubble, *South African Reserve Bank Publication*: Pretoria.

[32] Pesaran, M. H. and Shin, Y., 1995a, An autoregressive distributed lag modeling approach to Cointegration analysis, *Department of Applied Economics Working Paper*, No. 9514, University of Cambridge.

[33] Pesaran, M. H. and Shin, Y., 1995b, Long run structural modeling, *Unpublished manuscript*, University of Cambridge.

[34] Pesaran, M. H., Shin, Y. and Smith, R. J., 1996, Testing for the existence of a long-run relationship, *Department of Applied Economics Working Paper*, No. 9622, University of Cambridge.

[35] Poterba, J., 1984, Tax Subsidies to Owner-Occupied Housing: An Asset Market Approach, *Quarterly Journal of Economics*, 99, 729-752.

[36] South African Reserve Bank, 2006, Quarterly Bulletin December 2005, *South African Reserve Bank Publication*: Pretoria.

[37] Stock,J., and Watson, M., 1999, Forecasting inflation, *Journal of Monetary Economics*, 44, 293–335.

[38] Warne, A., 1993, A Common Trends Model: Identification, Estimation and Inference, *Seminar Paper*, No.555, IIES: Stockholm.

[39] Wickens, M. R., 1996, Interpreting cointegrating vectors and common stochastic trends, *Journal of Econometrics*, 74, 255-271.