Financial Liberalization and the Effectiveness of Monetary Policy on House Prices in South Africa

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This paper investigates 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 in 1985. Using both impulse response and variance decomposition analyses performed on Structural Vector Autoregressive (SVAR) models, the paper finds that irrespective of house sizes, during the period of financial liberalization, interest rate shocks had relatively stronger effects on house price inflation. However, given that the size of these effects was nearly negligible, the result seems to indicate that house prices are exogenous and, at least, are not driven by monetary policy shocks.

Introduction

In the last four decades or so, South Africa, like many other industrialized and developing countries, has experienced large changes in house prices. It is generally believed that changes in monetary policy have been an important factor behind the inflation and deflation of house prices. In addition, it is also agreed that financial liberalization may have played a direct role in these fluctuations (International Monetary Fund, 2000; and Iacoviello and Minetti, 2003). But little, if not nothing, seems to be known, especially for South Africa[1], on the possible (indirect) role that financial liberalization could have had in affecting the sensitivity of house prices to monetary policy decisions. This paper takes a preliminary step in investigating this issue. Note, following Ludi and Ground (2006) and Du Plessis *et al*. (2007), liberalization of the domestic financial sector in South Africa has been identified with the recommendations of the De Kock Commission in 1985, which suggested the abandoning of quantitative controls in favor of market-based instruments.

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[1] The only other evidence of the effect of monetary policy on house prices, before and after financial liberalization, can be found in Iacoviello and Minetti (2003) in their analysis of European housing markets.

The main aim of this analysis is to deduce whether monetary policy plays an important role in affecting house price inflation in South Africa, and whether or not the result is sensitive to deregulations in the financial market. The importance of the analysis lies in determining whether house price inflation is purely exogenous, i.e., explained only by itself, or is determined by monetary policy actions. The question is particularly relevant for South Africa, given its inflation targeting framework, and with housing being an important component of the Consumer Price Index (CPI) (Appendix 1). Moreover, recent studies on housing market, business cycles and monetary policies by Iacoviello (2002) and Iacoviello and Minetti (2008) indicate that the housing market might have an important role to play in the monetary transmission mechanism, especially the bank-lending channel of monetary policy. Hence, our analysis also aims to form the prelude to more elaborate analyses of the credit channel of monetary policy[2] in the South African context by accounting explicitly for the role of housing market and financial liberalization. Note, movements in the housing market are likely to play an important role in the business cycle. This is not only because housing investment is a very volatile component of demand (Bernanke and Gertler, 1995), but also because changes in house prices tend to have important wealth effects on consumption (International Monetary Fund, 2000) and investment (Topel and Rosen, 1988). Hence, if we do find worthwhile impact of monetary policy shocks on house price inflation, it would make a strong case for analyzing the credit channel of monetary policy in South Africa by incorporating variables relating to the housing market.

To investigate the effects of monetary policy shocks on house prices and the sensitivity of the same in the pre- and post-periods of financial liberalization, we estimate a Structural Vector Autoregressive (SVAR) model over two subsamples—1967Q1-1983Q3 and 1983Q4-2006Q4[3]—using data on the growth rate of GDP, real Treasury bill rate (nominal Treasury bill rate less the percentage change in CPI), and real house price inflation (percentage change in the real house price measured by the housing price index deflated by the CPI). Once the SVAR model is estimated, we use impulse response and variance decomposition analyses to investigate the impact of financial liberalization on the effect of monetary policy on housing prices. Note, given that the housing market in South Africa is quite different based on house sizes we are looking at (Kang and Stulz, 1997; Choe *et al.*, 1999; Dahlquist *et al.*, 2003; and Christoffersen *et al.*, 2006; Burger and van Rensburg, 2007; and Gupta and Das, 2008), we carry out the analysis separately by using data for prices of large-, medium- and small-sized houses, besides prices for all-sized houses. To the best of our knowledge, this is the first attempt to analyze the effectiveness of monetary policy in the South African housing market in pre- and post-periods of financial liberalization.[4]

2 *See* Sichei (2005) and Ludi and Ground (2006) for analyses of the credit channel of monetary policy in South Africa. While Sichei (2005), using GMM estimation on bank-level panel data, finds the credit channel to be active, Ludi and Ground (2006) find no such evidence based on a Vector Error Correction (VEC) framework.

3 *See* Du Plessis *et al*. (2007) for an explanation of the breakup of the sample period.

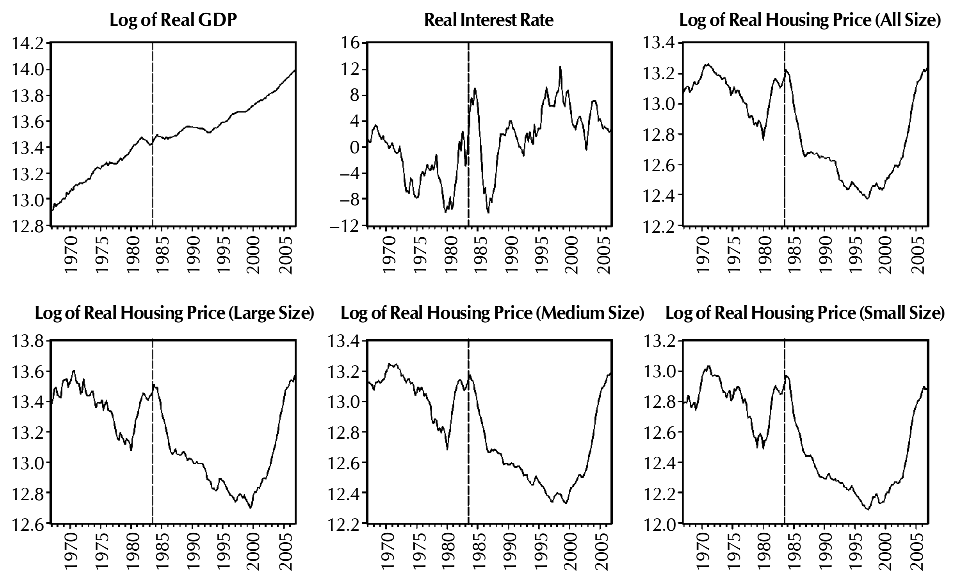
4 It must be pointed out that our analysis is different from that of Iacoviello and Minetti (2003) in at least two regards: first, unlike, Iacoviello and Minetti, we explicitly take account of the stationarity of the variables and use a SVAR and not a simple VAR; and second, we also check for the robustness of our analysis by looking at house price inflation of alternative house sizes, besides all houses, as in Iacoviello and Minetti.

The rest of the paper is organized as follows: It discusses issues relating to financial liberalization in the South African housing market. The empirical methodology and the findings are subsequently presented, and finally, some concluding remarks are offered.

Financial Liberalization in the South African Housing Market

First of all, it is of utmost importance to identify the trend of the variables of interest, namely log of GDP, real interest rate and log of real housing prices. The trend and date of liberalization (indicated by the position of vertical discontinued lines) are shown in Figure 1. As is evident from Figure 1, the trends before and after financial liberalization are quite different, especially for the log of real housing prices. Thus, there is a real need for analyzing the impact of financial deregulation on the effectiveness of monetary policy on house prices. A perusal of Figure 1 indicates a general downward trend in prices of each house size from 1983Q3, the period marking the end of financial regulation, to approximately the middle of the second half of the 1990s. From then on, house prices increased and seem to have reached the average level of the period of financial regulation.

Figure 1: Trend and Date of Financial Liberalization



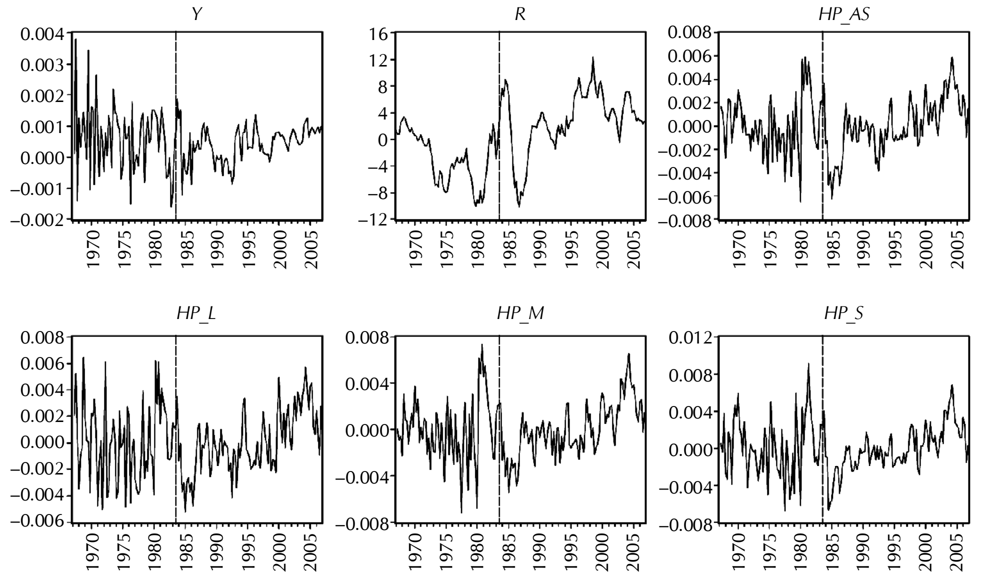
With the need to use a stable SVAR[5] model, based on stationary variables, South African quarterly data on real GDP and real housing prices were transformed into their respective growth rates.[6] In Figure 2, we present the movements of the change in the log of GDP (Y), real short-term interest rate (R), and change in the log of real housing price (HP) for all size

[5] Stability requires that no roots should lie outside the unit circle.

[6] The results of unit root tests have been provided in Appendix 2 and discussed in further details in the following section.

(_AS), large (_L), medium (_M) and small (_S) sized houses. Again, as in Figure 1, the date of liberalization is indicated by discontinued vertical lines.

Figure 2: Trend (Using Changes in log GDP and log Real Housing Prices) and Date of Financial Liberalization



It can be seen that after financial liberalization, the change in the log of real house prices seems to be less volatile. Although it is not our main aim, it is important to notice that the graphs detect how financial liberalization in South Africa has led to lesser price volatility in the housing industry. Similar evidence on the reduction of price volatility resulting from financial liberalization has also been reported by Domowitz *et al*. (1998) for other emerging market economies.

Empirical Analysis

Empirical Methodology

We use an SVAR model to assess the impact of financial deregulation on the effectiveness of monetary policy on the prices of different house sizes—large, medium and small, besides all sizes considered together. For comparison purpose, we split the data series into two subsamples, before and after financial liberalization, with the former period being captured by 1967Q1-1983Q3, and the second by 1983Q4-2006Q4.

To determine if monetary policy affects differently house prices in the two subsamples, we estimate two SVAR models for each house size. We use quarterly data[7] to estimate the three-variable SVAR models, with the variables ordered in the following way: the growth

[7] Data on the real GDP, Treasury bill rate, and the CPI were obtained from the *SARB Quarterly Bulletins*, while information on the house prices was derived from the *ABSA Housing Price Review*. Note the base year considered for real GDP and CPI was 2000.

rate of the real GDP (Y), real short-term interest rate (R), and growth rate of real house price (HP). According to Iacoviello and Minetti (2003), the aforementioned ordering reflects the possibility that innovations in the interest rate can affect output only with a lag, whereas they can immediately affect the growth rate of house prices. The theoretical justification for this ordering can be found in Iacoviello and Minetti (2003). The authors point out that output takes one period to be produced, thus reacting with one-period lag to an interest rate shock, whereas real house prices respond immediately to variations in the real interest rate.

For the second subsample, political change was viewed as having an immediate and permanent impact. As such, we include a dummy variable[8] that takes on the value of zero prior to 1994Q1 and unity beginning in 1994Q1. The reasonable alternative was to model the impact of political change as a gradually increasing process over the year 1994. Although the stability of the VAR models was not an issue, the latter alternative was providing results with lesser theoretical support. Hence, it was reasonable to use the first alternative, which recommended a jump from zero to unity in 1994.

To check for stationarity of the data, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Dickey-Fuller with GLS detrending (DF-GLS), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests were conducted for the two subsamples, and it was found that all the variables are stationary at their levels, except for the real interest in the first subsample, which was found to be integrated of order one (see Appendix 2). For each of the eight unrestricted SVAR models, we chose one lag, since it was found sufficient to induce noise like residuals, according to the Schwarz information criterion.

Following Iacoviello and Minetti (2003), we analyze the impact of deregulation on the effectiveness of monetary policy in the housing market by first contrasting the impulse responses of real house price inflation to monetary policy innovations for the two subsamples, capturing the periods before and after financial liberalization. Second, a variance decomposition analysis is done to identify the relative importance of the random innovation of monetary policy on the growth rate of house prices for the same two subsamples.

Functional Specification

Enders (2004) suggested that when we are not confident that a variable is actually exogenous, a natural extension of the transfer function analysis is to treat each variable symmetrically. As the longest lag length is unity in each of our three variable models, we have the following first-order system:

$$Y_t = b_{10} - b_{12}R_t - b_{13}HP_t + \gamma_{11}Y_{t-1} + \gamma_{12}R_{t-1} + \gamma_{13}HP_{t-1} + \varepsilon_{yt} \quad \text{...(1)}$$

$$R_t = b_{20} - b_{22}Y_t - b_{23}HP_t + \gamma_{21}Y_{t-1} + \gamma_{22}R_{t-1} + \gamma_{23}HP_{t-1} + \varepsilon_{Rt} \quad \text{...(2)}$$

$$HP_t = b_{30} - b_{32}Y_t - b_{33}R_t + \gamma_{31}Y_{t-1} + \gamma_{32}R_{t-1} + \gamma_{33}HP_{t-1} + \varepsilon_{HPt} \quad \text{...(3)}$$

[8] Results are not supported by theory when we do not include the dummy for the South African political change of 1994.

where (1) Y_t, R_t and HP_t are stationary; (2) It is assumed that ε_{yt}, ε_{Rt} and ε_{HPt} are white noise disturbances with standard deviations of σ_Y, σ_R and σ_{HP} respectively; and (3) ε_{yt}, ε_{Rt} and ε_{HPt} are uncorrelated white noise disturbances.

Note that the model can be called an SVAR (or a primitive system) because each of the three variables has a contemporaneous effect on the others. Using matrix algebra, we can write Equations (1) to (3) as follows:

$$\begin{bmatrix} 1 & b_{12} & b_{13} \\ b_{21} & 1 & b_{23} \\ b_{31} & b_{32} & 1 \end{bmatrix} \begin{bmatrix} Y_t \\ R_t \\ HP_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \\ b_{30} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ R_{t-1} \\ HP_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{Rt} \\ \varepsilon_{HPt} \end{bmatrix} \quad ...(4)$$

or

$$\begin{aligned} Bx_t &= \Gamma_0 + \Gamma_1 x_{t-1} + \varepsilon_t \\ x_t &= B^{-1}\Gamma_0 + B^{-1}\Gamma_1 x_{t-1} + B^{-1}\varepsilon_t \end{aligned} \quad ...(5)$$

where,

$$x_t = \begin{bmatrix} Y_t \\ R_t \\ HP_t \end{bmatrix}; B = \begin{bmatrix} 1 & b_{12} & b_{13} \\ b_{21} & 1 & b_{23} \\ b_{31} & b_{32} & 1 \end{bmatrix}; \Gamma_0 = \begin{bmatrix} b_{10} \\ b_{20} \\ b_{30} \end{bmatrix}; \Gamma_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix}; \varepsilon_t = \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{Rt} \\ \varepsilon_{HPt} \end{bmatrix}$$

It is important to mention that the terms ε_{yt}, ε_{Rt} and ε_{HPt} are pure innovations (or shocks) in Y_t, R_t and HP_t, respectively. With Y, R and HP aligned as variables by 1, 2 and 3 respectively, if b_{ij}^{th} coefficient is different from zero, ε_{jt} has an indirect contemporaneous effect on x_{it}. Note such a system is used to capture the feedback effects, because Y_t, R_t, and HP_t are allowed to affect each other.

The above SVAR is different from the VAR in standard form, which when presented in reduced-form is as follows:

$$x_t = A_0 + A_1 x_{t-1} + e_t$$

where $A_0 = B^{-1}\Gamma_0$; $A_1 = B^{-1}\Gamma_1$ and $e_t = B^{-1}\varepsilon_t$

It is important to note that the error terms (e_{yt}, e_{Rt} and e_{HPt}) are composites of the three shocks ε_{yt}, ε_{Rt} and ε_{HPt}. In our study, we use the AB-Model (Giannini, 1992), which looks as follows:

$$\begin{aligned} BA(L)x_t &= B\varepsilon_t \\ B\varepsilon_t &= Ae_t \end{aligned} \quad ...(6)$$

where A and B are (3 x 3) invertible matrices.

$$B(\varepsilon_t \varepsilon_t')B' = A(e_t e_t')A'$$

The structural innovations are assumed to be orthonormal, i.e., its covariance matrix is an identity matrix:

$$E(\varepsilon_t \varepsilon_t') = I_n \qquad \text{...(7)}$$

The assumption of orthonormal innovations imposes the following identifying restrictions on A and B.

$$A \sum A' = BB' \qquad \text{...(8)}$$

where $\sum = E(e_t e_t')$

This imposes a set of $n^2 - \left(\frac{n(n+1)}{2}\right)$ nonlinear restrictions on the parameters of the A and B matrices. This leaves one with $\left(\frac{n(n+1)}{2}\right)$ free parameters to be estimated. Following the identification strategy proposed by Sims (1980), the Choleski decomposition of the 3 x 3 matrices is as follows:

$$A = \begin{bmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix}, B = \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{bmatrix}$$

The necessary condition for identification requires that the maximum number of parameters contained in the two matrices must be equal to $\left(\frac{3(3+1)}{2}\right) = 6$. In other words, this condition makes the number of equations equal to the number of unknowns in the system.

The above model corresponds to a recursive economic structure and is just-identified. Given the above information, we can write the following Choleski decomposition:

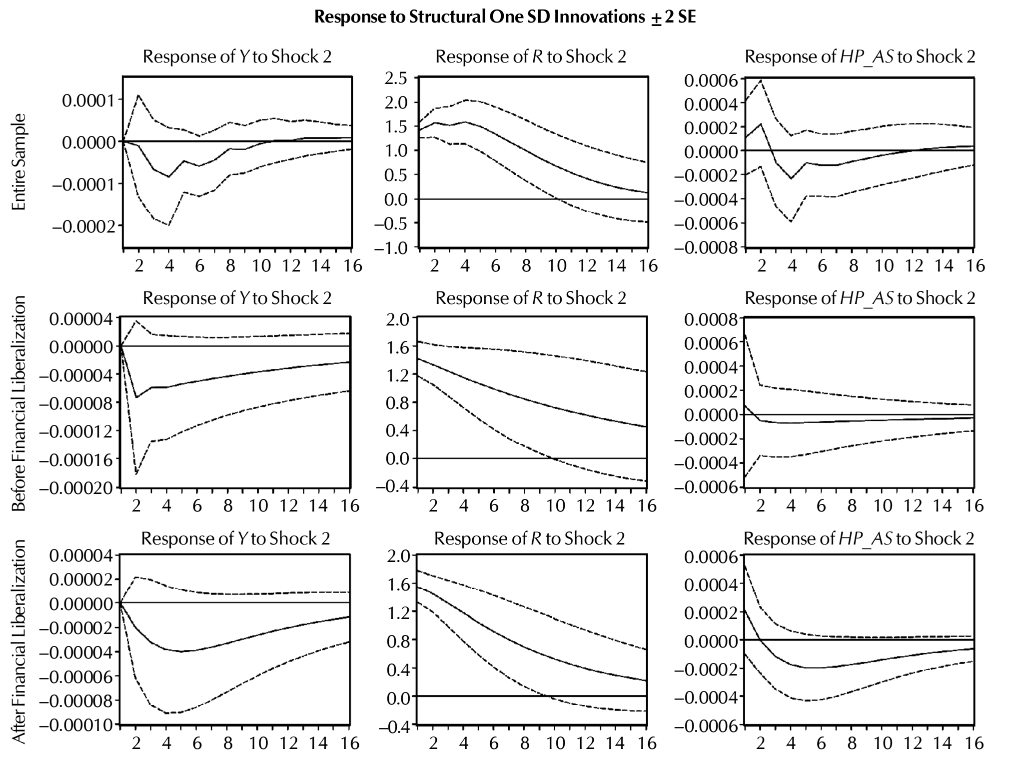
$$\begin{aligned} e_{yt} &= b_{11}\varepsilon_{yt} \\ e_{Rt} &= -a_{21}e_{yt} + b_{22}\varepsilon_{Rt} \\ e_{HPt} &= -a_{31}e_{yt} - a_{32}e_{Rt} + b_{33}\varepsilon_{HPt} \end{aligned} \qquad \text{...(9)}$$

As required by the Choleski decomposition in the system above, all elements above the principal diagonal must be zero.

Empirical Findings

Figure 3 displays the estimated impulse responses of a contractionary monetary shock, respectively, for the entire sample (1967Q1-2006Q4), the first subsample (1967Q1-1983Q3) and the second subsample (1983Q4-2006Q4) for houses of all sizes combined together.

Figure 3: Impulse Responses (All Size)



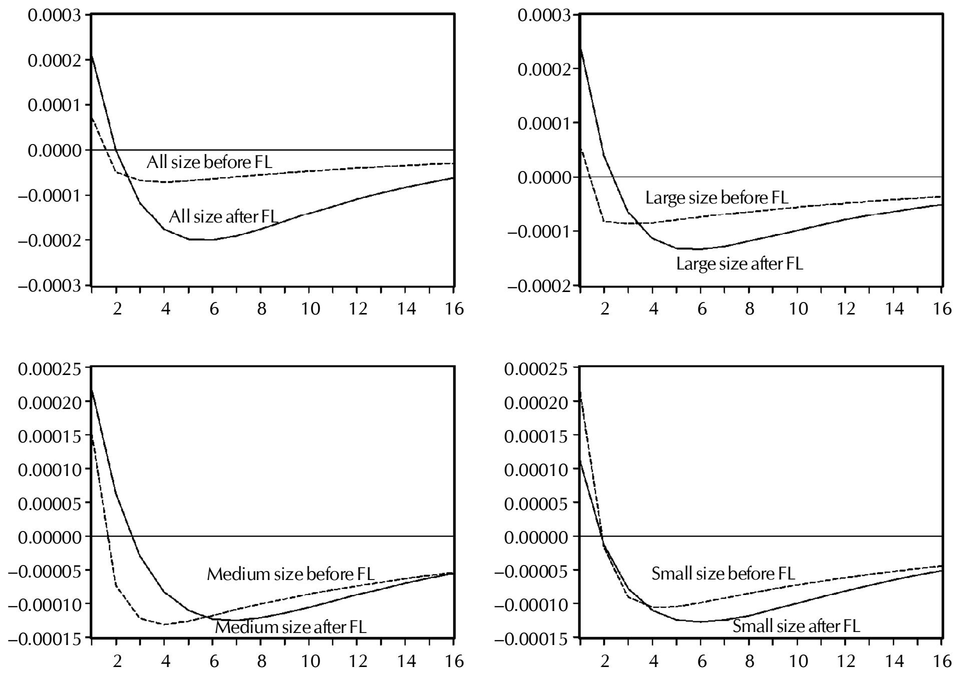
In general, the main findings can be summarized as follows: first, corresponding to a one standard deviation contractionary structural innovation to the interest rate shock, the real Treasury bill rate increases and then falls steadily. This, in turn, causes the growth rate of output to fall initially and then rise, with the size of the effect being quite small.[9] Output growth follows a hump-shape, with the effect being more persistent in the post-liberalization period, compared to the overall sample and the pre-deregulation era. As with the growth rate of output, the effect of a contractionary monetary policy shock on real house price inflation is quantitatively quite small. Interestingly, the initial monetary contraction causes the real house price inflation to first increase[10] and then decline steadily, reaching initial values after 11 quarters for the entire sample period. The effects are, however, much more persistent when one considers the pre- and the post-liberalization eras separately. Importantly, as claimed in the literature, the disinflation in the real house price is relatively more pronounced in the second subsample corresponding to the post-liberalization period.

[9] In terms of the magnitude of the monetary policy shock on output growth, similar results were also found by Du Plessis *et al.* (2007).

[10] This result is in line with the price puzzle. Note the effect is small, temporary and insignificant, but still puzzling. As pointed out by Walsh (2000), one most commonly accepted explanation for such a puzzling movement of real house price inflation is a reflection of the fact that, perhaps, the variables included in the SVAR models do not span the complete information set to the monetary authority in setting the interest rate.

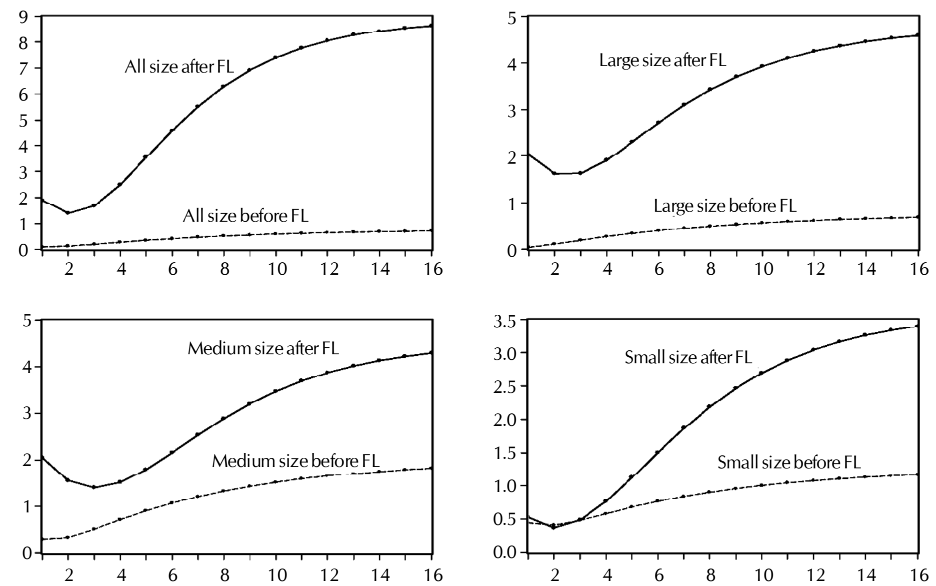
So, as far as monetary policy effectiveness vis-à-vis financial liberalization is concerned, the results support the thesis that during the period of financial liberalization, interest rate shocks had more powerful effects on the real house price inflation. Figure 4 indicates that on average, a contractionary monetary policy is found to affect the inflation rate of house prices more in the second subsample in terms of both magnitude and persistence of responses. Following a monetary contraction, after an initial increase in real house price inflation for a period ranging from one to three quarters, there is a persistent decrease in the same, which, in turn, tends to last for more than two years for the subsamples. The results are robust across different house sizes, though, understandably, the contractionary effect on real house price inflation of large houses tends to be smaller in magnitude when compared to medium- and small-sized houses, since large-sized house prices tend to be much more stable in general (Burger and van Rensburg, 2007; and Gupta and Das, 2008).

Figure 4: Comparison of Impulse Responses for the Two Subsamples



A related but different question is: To what proportion do the Treasury bill rate shocks contribute to the volatility of real house price inflation in the two sub-periods? To answer this question, we resort to the variance decomposition analysis. The results are shown in Figure 5, which, for each quarter, essentially plots the fraction of the *n*-step-ahead forecast error variance of real house price inflation explained or caused by the real interest rate shocks. Note, again we compare the results across the before and after periods of financial liberalization. Here as well, the results are in line with those obtained from the impulse response analysis. We find that the share of the variation in real house price inflation, accounted for by the monetary policy shock measure, is larger at all horizons in the post-liberalization period, but again the fraction of the forecast error variance explained by the interest rate shock is relatively small.

Figure 5: Variance Decomposition for Different House Sizes



Altogether, the results broadly support the thesis that during the period of financial liberalization interest rate shocks had more powerful effects on the inflation of relative price of houses. However, these effects are quite small in magnitude, especially when one compares our results to those of Iacoviello and Minetti (2003). These authors found interest rate shocks to account for nearly 15% to 25%, on average, of the forecast error variance of house prices before financial liberalization, while this figure jumped to around 35% to 50% in the post-liberalization phase. As Appendix 3 shows, most of the forecast error variance in the inflation of real house price comes from the shock to itself.

Conclusion

This paper investigates the effectiveness of monetary policy on housing prices before and after financial liberalization, with financial liberalization being identified with the recommendations of the De Kock Commission in 1985, which suggested the need for abandoning the quantitative controls in favor of market-based instruments. To account for differences in the effects of monetary policy between the pre- and post-periods of financial liberalization, the data have been divided into two subsamples—1967Q1-1983Q3 and

1983Q4-2006Q4. Using both impulse response and variance decomposition analyses performed on an SVAR model, we find that financial liberalization has resulted in a regime shift by increasing the effectiveness of monetary policy on house price inflation. No matter what the size of the houses are, empirical results show that after financial liberalization the response of inflation in real house prices was much more prominent for innovations in the monetary policy, measured by real Treasury bill rate. It is also found that the dynamics of growth rate of real house prices exhibit more persistence under deregulated market following an interest rate shock. However, and perhaps more importantly, these effects are quite small in magnitude.

The paper indicates that movements in house prices are sensitive to monetary policy shocks, but the magnitude of these effects are quite modest. So, as far as analyzing whether the credit channel of monetary policy in South Africa might be operative through the housing market, it does not seem to be quite promising, at least if one is to take the results of the preliminary analysis seriously. Nevertheless, this should not stop future analyses on the transmission mechanism of monetary policy involving the credit channel from incorporating the housing market explicitly, besides the role of financial deregulation. But the paper does seem to indicate that given that the monetary policy effects on house prices are marginal, even though being more pronounced and persistent under financial liberalization, the South African Reserve Bank (SARB)'s ability to control real house price inflation and, more importantly, CPI via the housing market is unlikely to work. In other words, with house prices weakly dependent on monetary policy and being explained mostly by itself, house price inflation is most likely an exogenous variable. Finally, we would like to conclude with a note of caution. Though the use of VARs in analyzing asset prices is quite widespread,[11] the fact that asset prices have a strong forward-looking component and with the VARs using lags, we might be missing out on important information about the dynamics of asset prices.[12]

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[11] *See* Walsh (2000) for further details.

[12] The authors are thankful to an anonymous referee for pointing this out.

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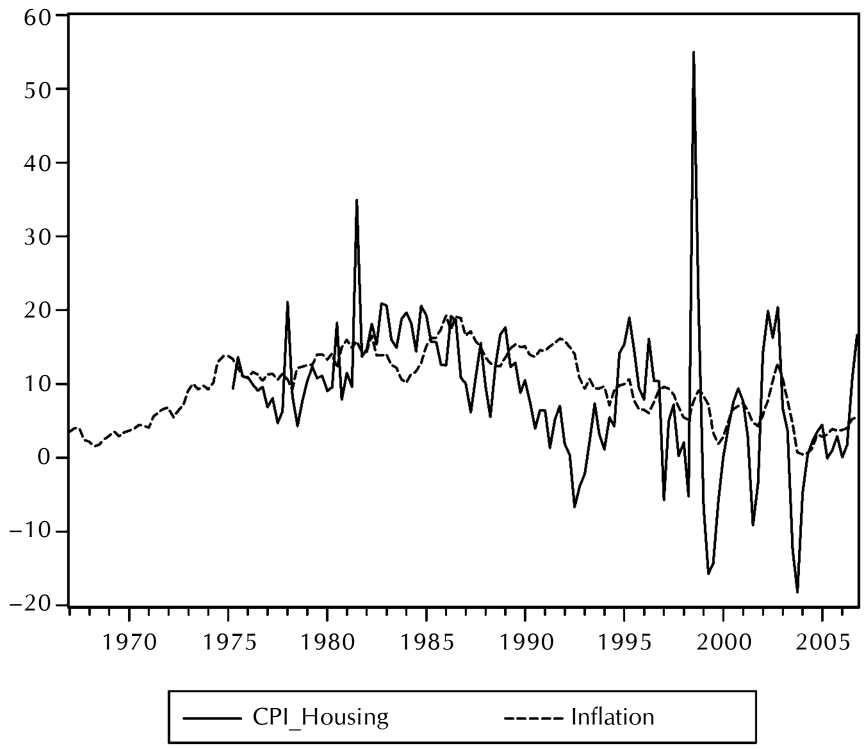
Appendix 1

Trend of the Housing CPI Inflation and the Overall CPI Inflation



Appendix 2

Results of Unit Root Tests

Panel A: First Subsample

Series	Model	ADF		PP Test	DF-GLS	KPSS	Conclusion
		τ_τ, τ_μ, τ	ϕ_3, ϕ_1				
Y	Intercept and Trend	–9.995***	49.958***	–9.807***	–9.460***	0.056***	Stationary
	Intercept	–9.537***	90.960***	–9.399***	–2.961***	0.252***	
	None	–2.205**	–	–7.763***	–	–	
r	Intercept and Trend	–0.809	1.295	–1.095	–1.153	0.1564**	Non-Stationary
	Intercept	–1.440	2.076	–1.648	–1.264	0.431*	
	None	–1.213	–	–1.364	–	–	
D(*r*)	Intercept and Trend	–4.372***	10.551***	–6.642***	–6.611***	0.077***	Stationary
	Intercept	–6.563***	43.075***	–6.566***	–6.602***	0.228***	
	None	–6.619***	–	–6.621***	–	–	
HP_AS	Intercept and Trend	–5.905***	17.492***	–5.971***	–5.768***	0.159**	Stationary
	Intercept	–5.901***	34.822***	–5.972***	–5.350***	0.178***	
	None	–5.940***	–	–6.009***	–	–	
HP_L	Intercept and Trend	–6.730***	22.675***	–6.667***	–6.562***	0.175**	Stationary
	Intercept	–6.747***	45.526***	–6.707***	–6.086***	0.231***	
	None	–6.798***	–	–6.760***	–	–	
HP_M	Intercept and Trend	–5.801***	16.843***	–5.826***	–5.878***	0.130*	Stationary
	Intercept	–5.786***	33.479***	–5.808***	–5.828***	0.165***	
	None	–5.831***	–	–5.854***	–	–	
HP_S	Intercept and Trend	–5.821***	16.959***	–5.998***	–5.894***	0.125*	Stationary
	Intercept	–5.849***	34.212***	–5.874***	–5.857***	0.131***	
	None	–5.884***	–	–6.031***	–	–	

Appendix 2 (Cont.)

Panel B: Second Subsample							
Series	Model	ADF		PP Test	DF-GLS	KPSS	Conclusion
		τ_τ, τ_μ, τ	ϕ_3, ϕ_1				
Y	Intercept and Trend	–6.530***	21.644***	–6.509***	–3.619***	0.087***	Stationary
	Intercept	–5.685***	32.322***	–5.818***	–2.526**	0.490**	
	None	–4.378***	–	–4.362***	–	–	
r	Intercept and Trend	–3.772**	4.776	–2.596	–1.721	0.103***	Stationary
	Intercept	–2.613*	4.096***	–2.282	–1.591	0.405*	
	None	–2.127**	–	–1.975**	–	–	
HP_AS	Intercept and Trend	–6.180***	19.302***	–6.353***	–3.270**	0.053***	Stationary
	Intercept	–2.411	5.157***	–4.005***	–1.735*	0.906	
	None	–2.423**	–	–4.027***	–	–	
HP_L	Intercept and Trend	–6.075***	18.470***	–6.016***	–5.931***	0.089***	Stationary
	Intercept	–2.509	9.047***	–4.050***	–2.227**	0.942	
	None	–2.513**	–	–4.073***	–	–	
HP_M	Intercept and Trend	–5.225***	13.662***	–5.229***	–5.269***	0.080***	Stationary
	Intercept	–3.604***	12.995***	–3.604***	–2.815***	0.983	
	None	–3.623***	–	–3.623***	–	–	
HP_S	Intercept and Trend	–4.162***	6.172***	–5.307***	–4.718***	0.061***	Stationary
	Intercept	–3.055**	5.218***	–3.365**	–3.428***	0.991	
	None	–3.081***	–	–3.386***		–	

Note: *, ** and *** imply stationary at 10%, 5% and 1% levels of significance.

Appendix 3

Variance Decomposition of Real House Price Inflation due to Shock 3

Period	*HP_AS_BL*	*HP_AS_AL*	*HP_L_BL*	*HP_L_AL*	*HP_M_BL*	*HP_M_AL*	*HP_S_BL*	*HP_S_AL*
1.	94.83517	94.35800	93.93543	92.64144	96.58078	95.02577	98.79498	97.12757
2.	95.18811	95.71548	93.94731	91.75404	96.57897	96.06006	98.29311	98.00077
3.	95.13900	95.67662	93.87543	91.20251	96.42222	96.41500	98.22940	98.01023
4.	95.06040	94.93752	93.79502	90.73635	96.21497	96.38377	98.13154	97.74024
5.	94.98899	93.92862	93.72679	90.29357	96.02804	96.13959	98.03154	97.37773
6.	94.92614	92.90582	93.66723	89.88368	95.86467	95.79774	97.94201	96.99893
7.	94.87212	91.99467	93.61586	89.52265	95.72468	95.43204	97.86434	96.64125
8.	94.82577	91.23763	93.57146	89.21684	95.60509	95.08481	97.79799	96.32272
9.	94.78606	90.63371	93.53312	88.96437	95.50305	94.77650	97.74152	96.04977
10.	94.75205	90.16365	93.49999	88.75922	95.41600	94.51397	97.69353	95.82203
11.	94.72292	89.80336	93.47137	88.59413	95.34170	94.29653	97.65276	95.63556
12.	94.69796	89.52987	93.44663	88.46202	95.27829	94.11979	97.61812	95.48493
13.	94.67658	89.32358	93.42526	88.35664	95.22415	93.97803	97.58869	95.36444
14.	94.65827	89.16863	93.40679	88.27275	95.17791	93.86540	97.56369	95.26874
15.	94.64257	89.05255	93.39083	88.20604	95.13842	93.77652	97.54244	95.19315
16.	94.62913	88.96576	93.37704	88.15301	95.10469	93.70673	97.52439	95.13366

Note: *HP_i_j*, *i*= *AS*, *LS*, *MS*, *SS*; *j* = *AL*, *BL*, where *AS* = All Sizes, *L* = Large Size, *M* = Medium Size, *S* = Small Size; *BL* = Before Liberalization, *AL* = After Liberalization.

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