Doctor of Philosophy Thesis

ESSAYS ON THE DETERMINANTS AND SPILLOVERS OF SOUTH AFRICAN

HOUSING MARKET

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➢ *To Almighty GOD who has been my constant source of inspiration despite all difficulties.*

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ABSTRACT

This study investigates the relevant factors that drive house prices in South Africa with the aim of facilitating a better understanding of the dynamic relationship between house prices and key macroeconomic variables. This can serve as a prerequisite to the ability of policymakers to maximize the positive externalities associated with housing development, while implementing measures to reduce the unexpected effects.

The thesis consists of five independent papers corresponding to five chapters. The first chapter examines the economic sources underlying the comovement of real house prices across provinces in South Africa. First, a dynamic factor model is estimated on quarterly provincial-level data to disentangle the national component of real house price movements from the local (provincial or region-specific) component. Second, a Structural Vector Autoregressive (SVAR) model is applied to investigate the extent to which macroeconomic shocks are responsible to the common component of real house prices. Using theoretically motivated short run restrictions to identify macroeconomic with portfolio and monetary policy shocks playing greater roles. We also find evidence shocks, results indicate that comovement in real house prices is due to the combined effects of favourable and unfavourable structural shocks emanating from different sectors of the economy, of significant feedbacks from the housing sector to the real economy which theoretically channel through the wealth and /or collateral and balance sheet effects on consumption and investment, respectively.

The second chapter implements a Panel Vector Autoregression (PVAR) approach on provincial level data to analyse the role of house prices in determining the dynamic behaviour of consumption. Unlike individual regression, this approach accounts for individual heterogeneities characteristic of provincial housing markets. Based on the standard recursive identification, we find that house prices exhibit an asymmetric effect on consumption: a positive shock to house

price growth has a positive and significant effect on consumption, while the negative impact of an anticipated house price causes an insignificant reduction in consumption.

Because consumption is a significant component of Gross Domestic Product (GDP), the effect of house prices on consumption serves as a key link between the housing market and economic activity. The third chapter, therefore, exploits panel time series methods to examine the impact of house price changes on economic growth across provinces. This framework offers a variety of tools designed to address econometric issues such as heterogeneity, endogeneity and spatial effects which have been found to be prominent in regional housing markets. Specifically, Fixed effect (FE) and Random coefficient (RC) models are used to address the issue of heterogeneity. The potential endogeneity is accounted for using SYSTEM-Generalised Method of Moments (SYS-GMM) while the Feasible Generalised Least Squared (FGLS) and the Seemingly Unrelated Regression (SUR) are used to control for spatial effects. Accounting for these above issues leads to a significant effect of house price changes on provincial economic growth in South Africa.

Since house prices affect the business cycle, monetary policy might not be neutral to house price movements. Moreover, one may expect asymmetric response of monetary policy to house price shocks giving the boom/bust nature of house price dynamics. In light of these considerations, the fourth chapter links South African housing market dynamics to the interest rate setting behaviour by relying on Markov-Switching Vector Autoregressive (MS-VAR). This technique allows identifying the bull and bear regimes in the South African housing market and therefore helps examining asymmetries in the impact of monetary policy shocks on the house prices during bull and bear regimes. The impact of the monetary policy on house prices is found to be larger in the bear regime than in the bull regime; indicating the role of information asymmetry in reinforcing the financial constraint of economic agent. Unsurprisingly, monetary reaction to a positive house price shock is found to be stronger in the bull regime. This suggests that central banker are more concerned in bull regime given the potential crisis related to the subsequent bust in house prices bubbles which are more prominent in bull markets.

Finally, changes in house prices induce an adjustment of consumption and investment decisions which could be reflected as a trade surplus or deficit. The fifth chapter characterises the dynamic relationship between house prices and the trade balance based on a Bayesian Vector Autoregressive (BVAR) approach with sign restrictions. The results indicate that 1 percent

decline in house prices can improve the trade balance by 0.2 percent; suggesting that house prices represent an additional instrument for trade-balance adjustment besides the traditional exchange rate channel. Further, we find that the contribution of house price shocks to the historical path of the trade balance is less prominent in 2000s; possibly substantiating the effectiveness in the conduct of South African monetary policy, which has been shown to be incorporating house price movements in its interest rate setting behaviour.

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Introduction

1.1. Background

The 2007/2008 global financial crisis attributed to the subprime crisis demonstrates the role of house price movements in generating financial and business cycle dynamics. This has made housing dynamics an important policy issue for both developed and developing countries. In general, housing represents a substantial share of household total asset and as such changes in house prices affect household wealth and expenditure which in turn influence the performance of the real economy. Moreover, movements in house prices affect the capacity of homeowners to borrow for consumption or production, hence transmitting their effects to the financial system.

Although the interaction between housing sector and the real economy has been extensively studied, housing and housing related issues are yet to be widely explored in developing countries. Unlike developed nations, residential investment in developing countries faces critical challenges including the lack of capacity of the construction sector, an uncertain economic environment, lack of accurate data, poverty and poor infrastructure and lack of integrated research (Du Plessis, 2001). Moreover, for a number of reasons, housing study requires country-specific analysis. These include heterogeneity in the housing markets, cross-country differences in household behaviour, spatial differences in the national distribution of housing wealth and different economic conditions prevailing across countries. Therefore, this study focuses on South Africa with the aim of characterising the dynamic relationship between housing market and the real economy which is relevant to macroeconomic policy analysis.

In South Africa, property ownership was regulated on a racial basis. One of the major tenets of apartheid was the introduction of the Group Areas Act designed to separate residential areas in urban regions to the black, coloured, Indian and the white communities. As a result, considerable disparities in development, income and urbanisation between South Africa's provinces have induced significant differences in the provincial housing markets.

Until mid 1980s, the mortgage market in South Africa was financed mainly through building societies. Legislation pertaining to building construction was progressively amended over years, with the most important recommendation introduced following the so-called De Kock commission (during 1982 to 1985) that had levelled the playing field between banks and buildings societies. The United Building Society which had been the biggest building society for decades, was used in the early 1990s as the merger vehicle to create the South Africa's largest banking group, Amalgamated Banks of South Africa Limited (ABSA). Currently, banks are responsible for more than 90% of mortgage lending; making the banking sector the most important provider of mortgage finance for housing loans in South Africa. In the second half of 2003, mortgage loans comprised 32% of the total loans and advances on the bank's balance sheets (Luüs, 2005).

Although the high homeownership rate[1] in South Africa, the housing sector is characterised by the existence of a dual market: the low-income market and the middle and upper income market. The middle and luxury segments (upper and middle income market) are well developed while the affordable segment dominated by low-income households still faces critical challenges in housing deliveries. Despite a number of government schemes (such as subsidy, guarantee or management of bad debts) designed to promote lending in the low-income sector, the housing finance system has had little effect on the low-income market.

1.2. Problem statement and motivations

It is increasingly clear that strong housing cycles have been an overriding feature of the South African economy for the last two decades. In South Africa where poverty remains the biggest development challenge, the problem of housing development is not simply a problem of affordability; it is also one of the key issues of sustainable development. Housing is both consumption and investment good. Therefore, conditions in the housing market can have serious consequences on economic activities. If economic development entails the improvement in macroeconomic performance (output, consumption, investment, interest rates, inflation), then

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[1] South Africa is among the highest in the world according to Statistics South Africa (89% in 1992, 76% in 1996, 70.4% in 2002 and 75.8% in 2008).

the crucial question about housing is how do conditions in the housing market contribute to or detract from economic empowerment?

The Permanent Income Hypothesis (PIH) asserts that house price inflation increases the expected lifetime wealth of homeowners and hence their desired consumption. Based on the assumption that homeowners are willing to smooth consumption over their life time, increases in house prices would result in higher life time wealth which allows homeowners to consume more. This is known as the wealth effect. The collateral effect, on the other hand, postulates that increases in house prices relax homeowners' financial constraints since housing wealth can be collateralised. Higher house prices enhance the borrowing capacity of homeowners and enable them to borrow and spend more, while making it easier for firms to finance investment opportunities. Thus, housing development spills over onto the real economy through the wealth and /or collateral and balance sheet effects on consumption and investment, respectively.

Despite the positive effect that housing wealth may have on homeowners' consumption and investment, its aggregate effect is not obvious. High house prices raise some distributional issues since increases in real house prices change the distribution of welfare towards the owners who become better off and away from renters who feel poorer. In addition, strong housing market cycles affect the affordability of housing which in turn impacts the job market conditions through relocation costs (Holmes, 2007). It follows that housing market may stimulate the economy or may trigger economic recession as vindicated by the recent global financial turmoil which had its roots in the subprime crisis in the US.

Empirically, the relationship between house prices and the macroeconomy has been widely explored in the recent literature. While many studies (see for example Benjamin *et al.*, 2004; Case *et al.*, 2005; Kishor, 2007; Campbell and Cocco, 2007; Bostic *et al.*, 2009 amongst others) substantiate the positive effect of house price growth on consumption, there is some evidence that house prices inflation is not favourable to consumer optimism. These studies point to the existence of down-payment and transaction costs in the housing market (Engelhardt, 1996; Song, 2010) and the risky nature and uncertainty in the value of housing (Phang, 2004) as the main reason why house prices may have unexpected effects on consumption. Furthermore, a number of studies have explored the dynamic relationship between the housing market and monetary policy. Results from these studies suggest a dual causality between interest rate setting and house price fluctuations(Jarocinski and Smets, 2008; Gupta and Kabundi, 2010, Gupta *et al.,* 2010;

Giuliodori, 2005, Mishkin, 2007, Demary, 2010; Andre *et al.*, forthcoming; Perotti *et al.*, forthcoming). More recently, few authors have documented the positive impact of house price inflation on economic growth (Holly *et al.*, 2010; Miller *et al.,* 2011). However, all these studies:

➢ either focus on developed countries, but their findings cannot be generalised to developing countries since housing is country specific and depends on the level of development;

➢ or use national level data which assume homogeneity of housing markets whereas housing markets are heterogeneous (Meen, 1996).

In South Africa, housing accounts for 29.40% of households' assets and 21.68% of total wealth (Das *et al.*, 2011) compared to the US which happens to be 37.78% and 47.92% respectively (Iacoviello, 2011). According to Aron *et al.* (2006), the marginal propensity to spend for housing wealth in South Africa is slightly larger than for illiquid financial assets, though the difference is not statistically significant. Besides the existence of a large property database including provincial-level data these statistics are quite enough to make it interesting to carry out housing analysis in South Africa.

The existence of a dual mortgage market is also a critical challenge for South Africa. The middle and upper income market performs well while a significant part of the population faces housing delivery in the low-income market. Considering significant differences in average house prices between the two markets, an important development goal is to reduce housing inequalities. Left unabated, housing inequalities are likely to widen disparities in income and urbanisation among South Africa's provinces and this has consequences on the economic growth and development. By carrying out housing analysis at both aggregated and provincial levels, results from this research will provide policy makers with information as to how inequalities in regional housing markets within the South African economy may contribute to the socio-economic imbalances among provinces. This, in turn, will enable targeted interventions to be devised in areas which are lagging behind.

1.3. Research objectives and contributions

One of the major challenges in tackling housing issues in South Africa is the lack of empirical research to facilitate effective policy formulation. This study investigates the relevant factors that drive house prices in South Africa with the aim of facilitating a better understanding of the

dynamic relationship between house prices and key macroeconomic variables. This can serve as a prerequisite to the ability of policymakers to maximize the positive externalities associated to housing development, while implementing measures to reduce the unexpected effects. Specifically, the study seeks to:

➢ Determine the relevant shocks that drive house prices in South Africa;

➢ Evaluate the direct channel through which house prices affect consumption;

➢ Assess the role of house price movements in explaining the dynamic behaviour of output;

➢ Investigate whether monetary policy has an asymmetric effect on housing dynamics and if the central bank reacts to house price shock asymmetrically;

➢ Examine the dynamic relationship between house prices and the trade balance.

Relying on both panel and Vector AutoRegressive (VAR) models, these objectives are addressed in five independent papers corresponding to five chapters. In general, panel set up is well known for its ability of mitigating the issue of unobservables such as heterogeneity, cross-sectional dependence and endogeneity, characteristics of the regional housing markets (Meen, 1996). On the other hand, the VAR methodology accounts for joint dynamics between variables and hence, represents adequate tools for spillover analysis.

Chapter 2 uses a Structural Vector AutoRegressive (SVAR) framework with short run restrictions to analyse the economic forces behind house price fluctuations in South Africa. Besides the efficiency of structural VARs in tackling a number of inconsistencies commonly observed with the recursive VAR models, this methodology has the merit to identify multiple shocks. In addition, structural VARs with short run restrictions yield more accurate inference in the context of dynamic responses to structural shocks (Christiano *et al.*, 2006) compared to long run restrictions which do not necessarily lead to unique short run dynamics (Faust and Leeper, 1997). Chapter 3 employs a Panel Vector Autoregression (PVAR) approach to analyse provincial housing market spillovers on provincial consumption. Unlike individual regression, the panel set up involves different cross-sections which are typically characterised by the individual heterogeneity. Thus, besides the well known benefit of modelling the joint dynamics and causal relations among a set of variables, this technique has the advantage to account for unobserved individual heterogeneity which improves the consistency of the estimates.

Chapter 4 exploits panel time series methods to examine the impact of house price changes on economic growth across provinces. This set up offers a variety of tools designed to address econometric issues such as heterogeneity, endogeneity and spatial effects which have been found to be prominent in regional housing markets. Fixed Effect (Baltagi, 2008) and Random Coefficient (Swamy and Tavlas, 1995) models are used to address the issue of heterogeneity. The potential endogeneity is accounted for using SYSTEM-Generalised Method of Moments (Arellano and Bover, 1995 and Blundell and Bond, 1998) while the Feasible Generalised Least Squared (Podesta, 2002) and the Seemingly Unrelated Regression (Baltagi, 2008) are used to control for spatial effects.

Chapter 5 links South African housing market dynamics to the interest rate setting behaviour by relying on Markov-Switching Vector Autoregressive (Ehrmann *et al.*, 2003). This technique allows identifying the bull and bear regimes in the South African housing market and therefore helps examining asymmetries in the interdependency between monetary policy and house prices during bull and bear regimes. Finally, Chapter 6 characterises the dynamic relationship between house prices and the trade balance based on a Bayesian Vector Autoregressive approach with sign restrictions (Uhlig, 2005). This methodology allows to distinguish housing demand shock from other types of shocks including aggregate demand, monetary policy and fiscal policy shocks, which could yield similar behaviour of the variables in the system.

The overall aim of the present study is to explore how housing market development can help improving macroeconomic performance in South Africa; particularly, to develop an understanding of the links between the housing sector and the real economy for sustainable development. The lack of empirical evidence handicaps attempts by policymakers to devise evidence based targeted interventions essential for further improvement of the housing sector. Thus, this research extends the housing literature in developing countries by filling the knowledge gap in housing studies in South Africa. In addition, giving that provincial housing cycle may not be synchronous with the aggregate housing cycle (Ghent and Owyang, 2010); we are contributing by using both national and provincial levels data which provide more informative results.

Chapter 2

Macro shocks and house prices in South Africa[*]

2.1. Introduction

The recent sub-prime crisis in the US demonstrates that the boom-bust nature of property price fluctuations can dramatically affect macroeconomic and financial stability. Increasing house prices are likely to boost housing finance (particularly when interest rates are low) and encourage consumer spending which in turn sustains the performance of the economy. Falling real estate prices, on the other hand, tend to exert downward pressure on the financial institutions which causes a deterioration of the balance sheets of borrowers. This implies that housing dynamics affect the ability of households to borrow for consumption or production; thus, transmitting their effects to the financial system. As a result, procyclical movements in the financial conditions of borrowers can amplify investment and output fluctuations through their primary effects on wealth and aggregate spending (Iacoviello, 2000; Aoki *et al.,* 2004). Additionally, because housing represents a significant component of household's individual portfolio, changes in real estate prices increase house price risk which is widely considered as one of the major financial risks. In light of these considerations and given the role of house prices in generating financial and business cycle dynamics, it is crucial to identify the determinants of house price movements. Particularly, the role of macroeconomic factors is of key interest and is thus, the focus of this study.

In South Africa, the entire residential market covers nine regional housing markets corresponding to the nine provinces. Since the late 1990s, house prices have been rising very fast across provinces (See Figure 2.1), in a relatively favourable macroeconomic context. From 1999:1 to 2007:4, provincial house prices have increased at a quarterly average nominal rate of about 4%. Over the same period, average nominal output growth has been about 1.6% with low inflation (1.3%) and an average nominal interest rate of 9.5%. The similarity of the rising house

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[*] Forthcoming in the *Journal of Real Estate Portfolio Management*.

prices pattern for all the provinces raises a concern about the existence of common factors affecting provincial house prices, perhaps due to national macroeconomic conditions. Empirical evidence of Baffoe-Bonnie (1998), for instance, points to significant linkages between real estate prices and both regional and national macroeconomic variables. This indicates that provincial housing price co-movements are at least partially determined by common exposure to national business cycles.

Against this backdrop, the following questions arise: Does the widespread increase in South Africa's provincial house prices reflect a national phenomenon or is it attributable to what is referred to as "local bubbles"? What is the relative contribution of monetary policy and other factors such as portfolio, demand, supply innovations in moving house prices? The aim of the chapter is therefore to assess the economic sources underlying the comovement of provincial real house prices in South Africa; the main contribution being to disentangle the national housing factor from regional and province-specific factors. From a policy perspective, it is important to distinguish between national and local dynamics of house prices as the latter is ascribed to situations that are specific to each geographic market, rather than general macroeconomic conditions which are identical across the country and hence, are more likely to determine the national component of the housing cycle.

Following Neely and Rapach (2011), the issue of a potential national housing cycle in South Africa is addressed by estimating a dynamic factor model on provincial-level house price indexes. This allows us to separate the component of the changes in house prices that is common to all provinces (national factor) from the idiosyncratic component (local factors). In the second stage, the estimated factor is used in a VAR with other variables (real output, inflation and the interest rate) to study the dynamic relationship between housing market and the general macroeconomic conditions. The chapter proceeds as follows. The second section reviews the relevant literature while the third section briefly presents the dynamic factor model and discusses the identification procedure within a SVAR framework. The fourth section describes the data. The fifth section reports the empirical results and the last section concludes.

2.2. Literature review

In the housing literature, there are two major determinants of house prices dynamics: the fundamental and non fundamental factors. Unlike fundamental factors which relate house price

fluctuations to macroeconomic variables, non fundamental factors include a wide range of considerations. Some authors identify the mispricing due to inflation and monetary illusion (Brunnermeier and Julliard, 2008) or "extravagant expectations" about the future price movements with its social contagion (Schiller, 2007; Glindro *et al.*, 2011), laxity in mortgage markets due to the perceived lower risk (Demyanyk and Van Hemert, 2011) as the main drivers of house price dynamics. Others focus on endogeneous factors such as supply lags and the historical dependence of investment decisions (Zhu, 2003) which contribute to deviations of property prices from their long-run equilibrium values. However, Beltratti and Morana (2010) point out that non fundamental based mechanism is less likely to affect the national component of housing cycles. Moreover, it is usually agreed that macroeconomic factors are important driving forces behind asset price oscillations although housing markets have a number of specific features[2] compared to other types of asset which, plausibly, may lead to different responses of house prices to macroeconomic shocks.

Accounting for these specific features, Demary (2010) identifies three transmission mechanisms between macroeconomic variables and real estate prices based on economic intuition: (1) The interest rates channel asserts that a contractionary monetary policy leads to an increase in mortgage rate which translates into higher costs of financing housing activities. This discourages housing demand resulting in a decrease in house prices; (2) The inflation channel states that an increase in inflation may stimulate or dampen real estate projects leading to an increase or decrease in house prices. In the first scenario, economic agents believe that housing is a good hedge against inflation. Thus, an increase in inflation encourages residential investment since economic agents try to protect their wealth which, in turn, leads to an increase in real estate prices. The second scenario conforms to the view that the monetary authority is likely to respond to rising inflation by increasing interest rates. This will lead to an increase in housing finance which lowers the demand for real estate and hence real estate prices; and, (3) The output channel refers to the situation where a positive shock on output increases firm's labour demand which raises households' labour revenue. The resulting increase in labour income can be either invested in real estate or consumed (in housing and non housing goods). As the economy is booming,

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[2]Apart from the dual nature of housing as both consumption and investment good, Iacoviello (2000) characterises housing market by a number of specific factors such as heterogeneity, relatively high cost of supply, durability, locational fixity, constrained liquidity due to the existence of high transaction costs; and the possibility to increase loans against housing collateral.

having a job qualifies for cheap mortgage loan and firms need more office space. This will trigger the demand for housing which will translate into an increase in house prices.

Empirically, a number of studies[3] have attempted to analyse the dynamic relationship between house prices and the macroeconomics, but only few authors have investigated the comovement of house prices across countries or across regions within a given country. Notable and recent exceptions include Otrok and Terrones (2005), Del Negro and Otrok (2007) and Beltratti and Morana (2010). Otrok and Terrones (2005) show a large degree of synchronisation in the growth rate of real house prices for a panel of 13 industrialised countries. Then, using a Structural Vector Autoregressive (SVAR) approach with sign restrictions, they find that much of this comovement is due to the common dynamics in the interest rates compared to other macroeconomic aggregates (real output, consumption and residential investment) which are of little contribution to the house price fluctuations across these countries. Similarly, Beltratti and Morana (2010) use a Factor Vector Autoregressive (FVAR) model to examine the link between general macroeconomic conditions and the housing market for G-7 countries. Their result indicates that global-supply side shocks are important determinants of the common components of G-7 house price fluctuations.

While these studies focus on cross-country analysis, the current research is closely related to Del Negro and Otrok (2007) who employ a SVAR with sign restrictions to show the role of monetary policy shocks in driving the national co-movement in house prices across US states. Given the limited evidence on the nature and sources of co-movement in real house prices, we extend the literature by investigating the specific case of South Africa. Therefore, the contributions of this study are twofold: First, it underlines the importance of national, regional and idiosyncratic factors in explaining house price movements of different provinces in South Africa. Second, it identifies the relevant shocks that drive the national house prices.

Differently from Del Negro and Otrok (2007) who focus on the effects of only monetary policy disturbances, the proposed study relies on a short run restrictions procedure which allows identifying the effects of all shocks. This methodology has been applied by Li *et al.* (2007) to analyse the impact of monetary policy on stock prices and offers several advantages. Besides the efficiency of structural VARs in addressing a number of inconsistencies commonly observed

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[3] See for instance Baffoe-Bonnie (1998), Iacoviello (2000 and 2002), Kasparova and White (2001), Tsatsaronis and Zhu (2004), Adams and Füss (2010) amongst others.

with the recursive VAR models, structural VARs with short run restrictions yield more accurate inference in the context of dynamic responses to structural shocks (Christiano *et al.*, 2006) compared to long run restrictions which do not necessarily lead to unique short run dynamics (Faust and Leeper, 1997). Further, it has the merit to identify multiple shocks compared to the newly developed identification technique based on sign restrictions whose accuracy is constrained by the number of shocks to be identified (Uhlig, 2005; Busch *et al.*, 2010). Moreover, Chudik and Fidora (2011) argue that the sign restrictions procedure leads to imprecise inference as it relies on only weak information.

2.3. Econometric methodology

The empirical methodology consists of two steps as in Del Negro and Otrok (2007) and Neely and Rapach (2011). In the first step, a dynamic latent factor model developed by Neely and Rapach (2011) is estimated using Bayesian techniques to distinguish between the common component of house price fluctuations and region- or province-specific movements. The second step examines the macroeconomic shocks that lie behind the comovement in house prices within a SVAR framework.

2.3.1. Dynamic latent factor model

The dynamic factor model postulates that growth rates in provincial-level house price indexes are given by the following specification:

$$hp_{i,t} = \beta_i^n f_t^n + \beta_i^r f_{j,t}^r + \varepsilon_{i,t} , \tag{1}$$

where $hp_{i,t}$ is the demeaned growth rate of house price index for province i ($i=1,...,N$) from $t-1$ to t ($t=1,...,T$). The national factor, f_t^n, is common across all the N=9 provincial house price growth rates considered. The regional factors, $f_{j,t}^r$ ($j=1,...,J$), are common to the provinces in each of J=2 specific regions. The regional factors are defined economically in terms of the level of development. The first region includes Gauteng, KwaZulu Natal, Eastern Cape and Western Cape. These provinces contribute above two-thirds to the national economy and are also densely populated. The second region comprises of the rural areas and includes North West, Northern Cape, Free State, Limpopo and Mpumalanga. These regions also have low population density.

The loadings, β_i^n and β_i^r, measure the responses of an individual province's house price growth to changes in the national and regional factors, respectively. A higher β_i^n, for example, means that province i's house price growth responds more strongly to the national factor. Thus, a province with $\beta_i^n = \beta_i^r = 0$ will have a house price growth that is absolutely idiosyncratic; exhibiting no covariation with other provinces' house price growth. The province-specific or idiosyncratic component of province i's house price growth is captured by $\varepsilon_{i,t}$.

As explained by Neely and Rapach (2011), equation (1) is a dynamic latent factor model because f_t^n, $f_{j,t}^r$, and $\varepsilon_{i,t}$ are characterised by autoregressive (AR) processes. The national and regional factors are generated by AR(q) processes and similarly, each province-specific component follows an AR(p) process.

$$f_t^n = \varphi_1^n f_{t-1}^n + \ldots + \varphi_q^n f_{t-q}^n + u_t^n, \tag{2}$$

$$f_{j,t}^r = \varphi_{1,j}^r f_{j,t-1}^r + \ldots + \varphi_{j,t-q}^r f_{j,t-q}^r + u_{j,t}^r \, (j = 1, \ldots, J), \tag{3}$$

$$\varepsilon_{i,t} = \varphi_{i,t-1}\varepsilon_{i,t-1} + \ldots + \varphi_{i,p}\varepsilon_{i,t-p} + u_{i,t}, \tag{4}$$

where

$u_t^n \sim N(0, \sigma_n^2), \; u_{j,t}^r \sim N(0, \sigma_{j,r}^2), \; u_{i,t} \sim N(0, \sigma_i^2)$, and

$E(u_t^n u_{t-s}^n) = E(u_{j,t}^r u_{j,t-s}^r) = E(u_{i,t} u_{i,t-s}) = 0$ for s≠0.

As commonly set in the literature, the shocks in (2) to (4) are assumed to be uncorrelated contemporaneously at all leads and lags so that the national, regional and province-specific factors are orthogonal. As pointed out Del Negro and Otrok (2007), the attempt to comply with this assumption justifies the inclusion of region factors in the analysis which explicitly capture possible sources of co-movement across provinces. In fact, omitting important sources of co-movements may result in inconsistent estimates.

The order of the AR processes is set to 2 when estimating the dynamic factor model given that the results are not sensitive to the lag length. Further, the signs and scales of the factors and factors loadings are separately identified in (1) so that multiplying the national factor by -2 and the loadings on that factor by -1/2 would produce exactly the same model. The scales are normalised by assuming that each of the factor variances is equal to 1[4]. Moreover, the signs of the factors/loadings are normalised following Kose *et al.* (2003) by restricting the loading on the national factor for Gauteng and the loadings on the regional factors for Western Cape and Mpumalanga to be positive. These representatives from the national and each of the two regions are made arbitrarily as the sign and scale normalisations do not have any economic substance and do not affect any economic inference. For instance, these normalisations leave invariant the variance decomposition which represents the central point of the analysis (Neely and Rapach, 2011). Instead, sign normalisations help to provide convenient interpretations as they make most of the means of the loading posterior distributions positive[5], implying that real house price growth is positively related to the factors.

Because of the latent nature of the factors in equation (1), the use of common regression methods is inappropriate to estimate the model. Kose *et al.* (2003) emphasise the efficiency of Bayesian techniques in cross-sectional data and factor analysis in dynamic factor models. We, therefore, follow Neely and Rapach (2011) and use the Bayesian procedure with data augmentation to estimate the model. This method entails simulating draws from the complete posterior distribution for the model parameters and factors by successively drawing from a series of conditional distributions using a Markov Chain Monte Carlo (MCMC) procedure based on 10,000 replications after 1000 burn-in replications[6]. The above described sign normalisations are implemented by discarding draws of the factor loadings that do not satisfy the restrictions[7]. Further, as in Kose *et al.* (2003), conjugate priors are used for the national and regional shocks while the prior for the idiosyncratic shock is diffuse. As indicated Neely and Rapach (2011), these priors are relatively agnostic so that the results are not sensitive to reasonable perturbations on them. Importantly, this prior information relies on stationary AR processes; implying that

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[4] See Sargent and Sims (1997); Stock and Watson (1989 and 1993) for further details.

[5] The results indicate positive national loadings for the nine provinces and 8 positive regional loadings out of 9 provinces.

[6] See Otrok and Whiteman (1998) and Kose *et al.* (2003) for estimation details.

[7] Details on the priors and the implementation of the estimation are provided in Neely and Rapach (2011).

provincial house price series are *I(0)* processes. Accounting for statonarity, we use the house price series in their log difference forms[8].

Finally, the variance decomposition is carried out to measure the extent to which each factor contributes to the provincial house price fluctuations. Assuming orthogonal factors, each factor's contribution to the total variability in provincial house price growth is computed as follows:

$$\theta_i^n = (\beta_i^n)^2 \, var(f_t^n) \, / \, var(hp_{i,t}) (i=1,...,N), \tag{5}$$

where

$$var(hp_{i,t}) = (\beta_i^n)^2 \, var(f_t^n) + (\beta_i^r)^2 \, var(f_{j,t}^r) + var(\varepsilon_{i,t}) (i=1,...,N), \tag{6}$$

and θ_i^n is the fraction of the total variability in province i's house price growth attributable to the national factor. This relative contribution depends on both the factor loadings and the relative volatility in house price growth in the specific province. The fractions of the total variability in province i's house price growth explained by the regional and idiosyncratic factors (θ_i^r and θ_i^p) are defined in the same way. Since θ_i^n, θ_i^r and θ_i^p depend on the model parameters and data, the implementation[9] of the model requires MCMC algorithm to draw from the respective posterior distributions on each statistic for each replication and for each province.

Having separated the national factor from the local co-movement in provincial house price fluctuations, an important question is what economic forces drive the national housing factor? To address this issue, we model the national housing factor and standard macroeconomic variables (namely, output, inflation and interest rates) by a multivariate process driven by portfolio, supply, demand and monetary policy shocks which are identified based on short run restrictions.

2.3.2. Structural VAR model

Consider the reduced-form VAR given by:

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[8] Again, the stationarity restrictions are met by discarding draws of the AR parameters that do not comply with the restrictions.

[9] We make use of the MATLAB code adapted by David Rapach from the GAUSS code kindly provided by Christopher Otrok through his website (http://people.virginia.edu/cmo3h/code.html).

$$Y_t = \sum_{l=1}^{p} B_l Y_{t-l} + u_t, \quad t = 1, \ldots, T \tag{7}$$

where Y_t is the vector of n endogenous variables including housing factor(fhp), output(gdp), inflation (inf) and the interest rate (Tbill). B_l is a matrix of parameters, Y_{t-l} for $l=1,\ldots,p$ is a vector of lagged Y variables. The reduced-form residuals, u_t, are linear combinations of structural shocks e_t in the form of $A_0 u_t = e_t$. Pre-multiplying equation (7) by A_0 leads to the following structural VAR representation:

$$A_0 Y_t = \sum_{l=1}^{p} A_l Y_{t-l} + e_t \tag{8}$$

where $A_l = A_0 B_l$, and $E(e_t e_t') = \Omega$. Thus, $\Sigma = A_0^{-1} \Omega (A_0^{-1})'$.

There are four structural shocks corresponding to the four endogenous variables. In order to identify these structural shocks, we follow Li *et al.* (2007) and impose a set of short run restrictions on the contemporaneous relationships in the structural VAR model (8). In contrast to Li *et al.* (2007), we focus on macroeconomic interdependence and disregard the openness shock. Arguably, openness is less likely to affect the housing market in the short run due to its specific features such as durability, locational fixity, constrained liquidity caused by the existence of high transaction costs (Iacoviello, 2000). The four structural shocks are identified as follows:

A portfolio shock (e_{PORT}) can be thought of as an exogenous shock that changes real house prices and hence affects portfolio decisions. This could result from a shift in transaction costs in the housing market leading to a change in the perceived risk of housing investment similar to an "equity-premium shock". Housing market aggregate all the information from both public and private sectors, so house prices depend contemporaneously on all the variables in the model (see equation (9), row 1).

An aggregate supply shock (e_{AS}) represents unexpected changes in productivity, mark-ups and other supply side characteristics. It is identified by assuming that real GDP depends on the lagged values of all other variables included in the model. Thus, real output is set not to react contemporaneously to all other variables (see equation (9), row 2).

An aggregate demand shock (e$_{AD}$) reflects an exogenous impact of fiscal policy (spending and revenue shocks), wage-push inflation and other demand side determinants. Aggregate demand shocks are identifying by setting aggregate demand as a function of the contemporaneous values of inflation and the lagged values of all other variables in the model. Accounting for the equilibrium condition that aggregate demand equals aggregate supply, this identification restriction is thus given by equation (9), row 3.

Finally, to identify *the monetary policy shock* (e$_{MP}$), we follow Kim and Roubini (2000) by characterising monetary policy by a feedback rule, that is, a linear function of monetary instrument and the set of information available to the central bank. Therefore, innovations to monetary policy instrument depend on a given set of conditioning variables which are essentially the contemporaneous value of the money supply as well as the lagged values of all other variables in the model (see equation (9), row 4).

The following equation summarises the above identification restrictions:

$$
\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} \\ 0 & 1 & 0 & 0 \\ 0 & a_{32} & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_{fhp} \\ u_{gdp} \\ u_{inf} \\ u_{Tbill} \end{bmatrix} = \begin{bmatrix} e_{PORT} \\ e_{AS} \\ e_{AD} \\ e_{MP} \end{bmatrix}.
\tag{9}
$$

The impulse responses from a VAR are highly non-linear functions of these coefficients. Hence, to properly assess the statistical significance of the generate point values, Monte Carlo integration needs to be applied to examine the distribution of the coefficients. In this regard the impulse response functions are generated by imposing a diffuse (Jeffrey's) prior on the VAR, i.e., $F(A,\Sigma)\alpha|\Sigma|^{-(n+1)/2}$ besides the structural factorization used to identify different shocks. In addition, we use antithetic acceleration by drawing a new value of Σ and A on the odd draws and then flipping A around the mean of the posterior (Ordinary Least Squares (OLS) estimates) on the even draws. We show the median as well as the 16 % and the 84 % quantiles for the sample of impulse responses with error bands computed based on favourable draws (Andre *et al.*, forthcoming).

2.4. Data

The quarterly data for this study spans the period from 1974:Q1 to 2011:Q4. Housing factor (fhp) is estimated by the dynamic latent factor model using provincial-level real house price growth for nine provinces in South Africa. Output is captured by growth rate of real GDP at 2005 constant Rand. Inflation (inf) is the change in the log of consumer price index (CPI). The nominal interest rate is the 3-month Treasury bill rate (Tbill). Though other variables are available prior to 1974, the choice of the dataset is constrained by the availability of the provincial house price data, which in turn, determines the starting point of the empirical investigation. House price data are obtained from Amalgamated Bank of South Africa (ABSA); CPI and the Treasury bill rate are drawn from the International Monetary Fund's International Financial Statistics (IFS) while GDP is obtained from the South African Reserve Bank (SARB). Note that standard unit root tests, namely, Augmented Dickey-Fuller (1981) (ADF)[10], Phillips-Perron (1988) (PP), Dickey-Fuller test with generalized least squares detrending (DF-GLS), the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992) test; the Elliot, Rothenberg, and Stock (ERS) (1996) point optimal test, the Ng-Perron (2001) modified versions of the PP (NP-MZt) test and the ERS point optimal (NP-MPT) test indicate that all variables, except the interest rate are non stationary in levels. They are therefore used in their log-difference forms to ensure stationarity. Interest rate was found stationary in levels at the 10% level of significance[11].

2.5. Empirical results

2.5.1. Provincial house price fluctuations: the role of the national factor

To document the comovement properties of house prices, Figure 2.1 plots the provincial-level house prices, the national and regional factors. The top chart shows two periods of relatively high volatility in nominal house prices across provinces. The first episode which coincides with the early part of the sample covers the period from 1974 to 1985. The second from 2001 to 2011 coincides with the most recent period. Although historical movements in house prices are mainly driven by local (regional and province-specific) factors, the two episodes of housing price boom appear to be different in terms of the role played by local factors. Figure 2.2 quantifies the relative contribution of the factors for each sub-period. The gray bars represent the component

---

[10] The ADF test was initially proposed Fuller (1976) and Dickey and Fuller (1979).

[11] Details on the unit root test are available upon request from the authors.

of the average growth rates in real house prices for the period 2001-2011 that can be attributed to the national factor. For all provinces, the common component of house price fluctuations is more important in the recent period than it is in the first sub-period; indicating that the national and local factors play different roles in explaining the evolution of house prices over time. In particular, the early boom is largely driven by local factors while the national factor is behind most of the variation in the recent episode.

Figure 2.3 also depicts a strong correlation between the estimated national factor and the total South African house price growth, particularly in the second part of the sample. Consistent with the high and positive correlation coefficient between the two variables (0.86), this confirms the importance of the common component in the recent housing boom. These results are in line with Del Negro and Otrok (2007) who document that the relative importance of national shocks in driving house price dynamics across US states increases over time. Particularly, they find that US state-level housing cycles are mainly driven by local factors over the sample period of 1986 to 2005, with the national factor playing the substantial role in the most recent period (2001-2005). More interestingly, they show that a significant fraction of the cross-state heterogeneity in the recent house price boom is attributable to different state exposures to the national factor.

Accordingly in the case of South Africa, the cross-province heterogeneity in the first house price boom (1974-1985) is more likely to be driven by "local bubbles" due to the combined effect of the residential segregation and the Group Area Act 36 of 1966 which forced people of different races to live in separate residential areas, resulting in considerable disparities in provincial housing markets which led to different province exposures to national factor. Conversely, the relative importance of the national factor in explaining the recent boom is quite understandable given the number of government schemes (such as subsidy, guarantee or management of bad debts, etc) designed to address the issue of housing inequalities which may result in more synchronisation in provincial house prices.

Figure 2.1: Real House Prices and the Role of the National Factor across Provinces: 1974-2011

Data

National Factor
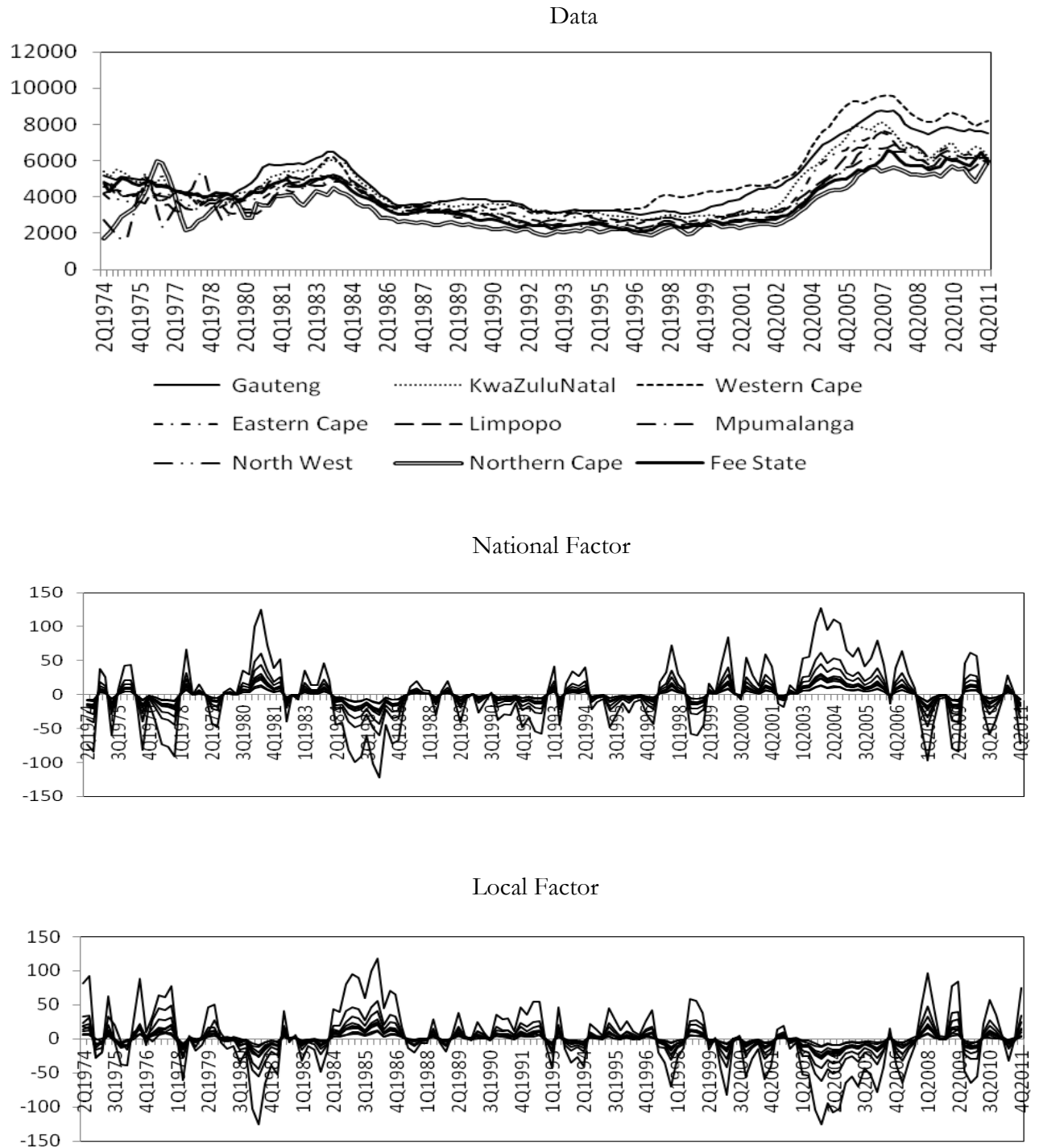
Local Factor

Notes: The top graph (Data) shows the real house price indexes for the nine provinces in South Africa. The middle graph (National factor) shows the role of national shock on each province, that is the component $\beta_i^n f_t^n$ of Equation (1). The bottom graph (Local factor) shows the combined role of regional and province-specific shocks, that is, the $\beta_i^r f_t^r + \varepsilon_{i,t}$ component of Equation (1). For all estimated values, we report the mean of the posterior distribution.

Figure 2.2: Cross-Provincial Heterogeneity in the House Price Boom: 1974-1985 Vs 2001-2011
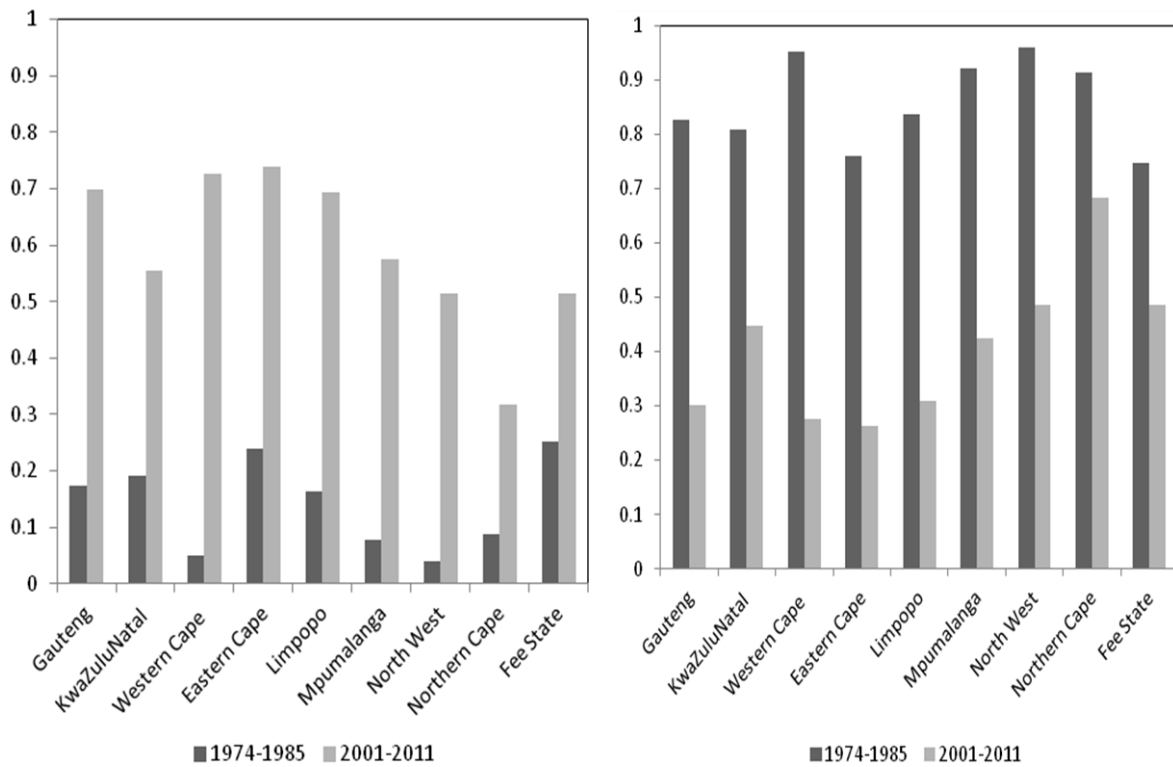
Notes: The left chart shows the importance of the national factor in driving house price inflation in the two periods of relatively high volatility in house price movements while the right chart shows the contribution of the local factor (joint impact of the regional and the province-specific shocks). For all estimated quantities, we show the mean of the posterior distribution.

Figure 2.3: The National House Price Factor and the South Africa Growth Rate in Real House Prices

Having made a case that the national factor has played an increasing role in driving housing dynamics across provinces, the next step consists of investigating the common set of economic shocks or innovations that lie behind this comovement. As mentioned earlier, house price fluctuations have often been associated to changes in macroeconomic conditions. The role of macroeconomic forces affecting the dynamic of house prices is thus investigated using a VAR that comprises the estimated common factor and standard macroeconomic variables including output, inflation and the interest rate.

2.5.2. SVAR Results

Figure 2.4 displays the dynamic responses of each variable to one standard-deviation structural shocks as specified in the model in equation (8). Unsurprisingly, the first column indicates that a positive portfolio shock associated to an exogenous decrease in equity-risk premium sharply increases real house prices in the short run while having a long lasting positive effect on the interest rate. Interestingly, real output falls after a number of quarters supporting the eventual increase in inflation. This may result from the tight monetary policy in response to the rise in house prices, which reduces aggregate demand and hence real output with a lag.

The second column displays the impulse responses to an expansionary supply shock. A positive supply shock leads to a sharp and short lived increase in real house prices and real output. Upon impact, the short-run interest rate also rises persistently; suggesting an endogenous response of the monetary authority to rising house prices, which lead to a drop in inflation. As expected, an exogenous demand shock (third column) leads to a significant and long lasting increase in inflation to which monetary authority responds by raising the interest rate. This results in a persistent decline in real output. As interest rate rises, the increase in user costs of capital translates into higher costs of financing real estate projects, leading to a fall in housing demand and consequently a decline in real estate prices.

Additionally, the dynamic responses to a contractionary monetary policy shock are consistent with the monetary business cycle literature; justifying the economically plausible interpretation that emerges from the first three shocks, and hence our identification procedure based on short-run restrictions. Specifically, an unexpected increase in interest rate leads to a gradual fall in real output and a delayed decline in inflation.

Figure 2.4: Dynamic Responses to Structural Shocks with Short-run Restrictions
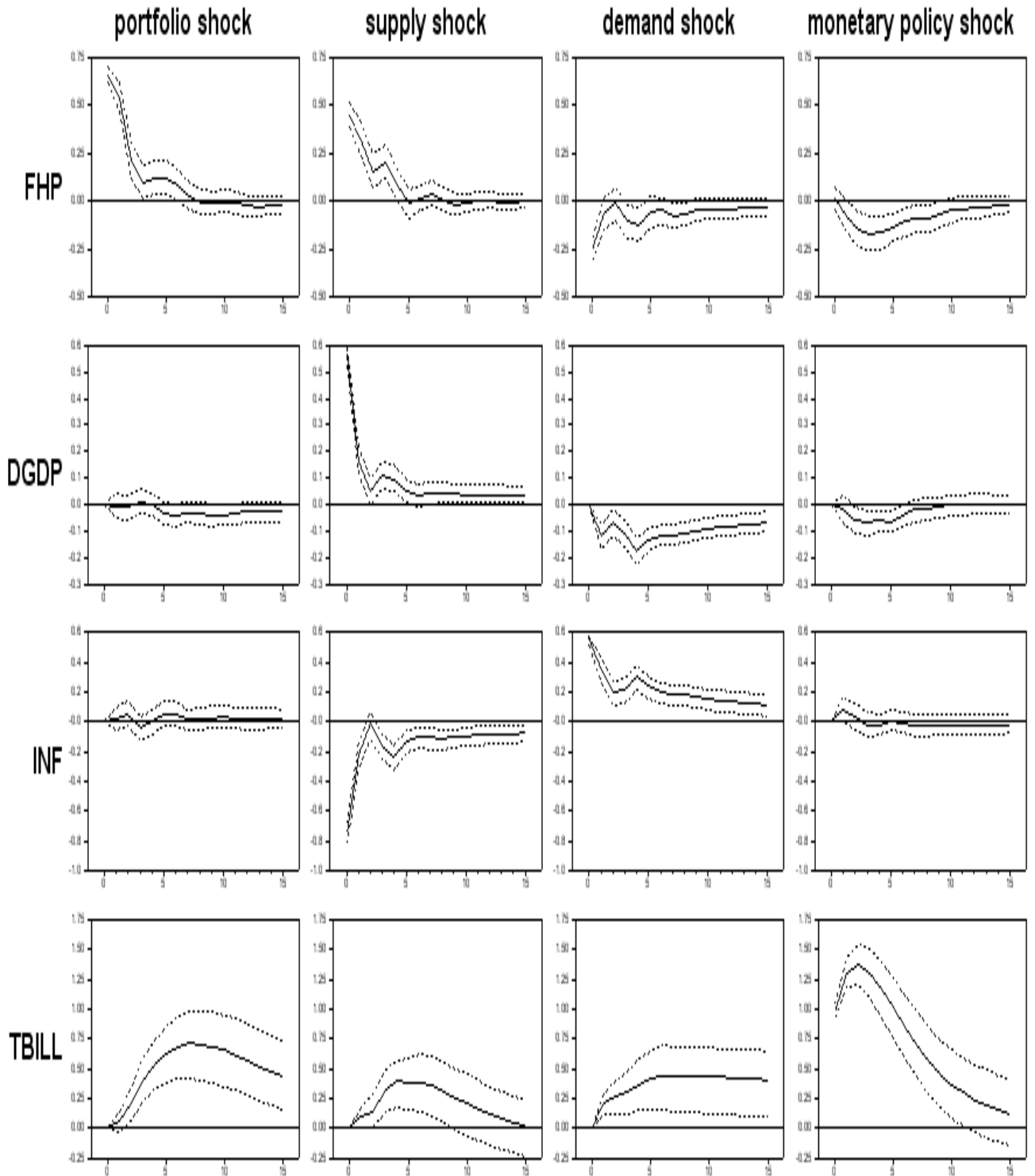
Notes: The Solid line represents the median, while the dotted lines indicate the 16 % and the 84 % quantiles for the sample of impulse responses.

The initial increase in inflation observed after three quarters confirms the evidence of "price puzzle" which is however not significant. Similarly, house prices increase immediately but not significantly in response to a contractionary monetary policy shock, and then ultimately drop by 2 basis points within a year. The fall in real house prices results from the combined effect of falling real output and rising interest rate which remains above its pre-shock level for about six quarters.

Overall, our findings suggest that several structural shocks play a substantial role in driving South African house prices. A positive shock to aggregate demand and a contractionary monetary policy shock reduce house prices persistently whereas aggregate supply and portfolio shocks have an immediate positive effect on real house prices in the short run.

Table 2.1 presents the real house price forecast error variance decompositions. It provides further information on the quantitative effect of various structural shocks on housing prices. The results suggest that the largest fraction of the variability in house prices is due to portfolio shocks which account for about 97% of the variance within the first quarter and decline monotonically with the time horizon to about 61% by the 15-quarter. The monetary policy and aggregate demand shocks also play a significant role; explaining on average respectively about 17% and 13% of the total variance in house prices over the 15-quarter horizon. At the first quarter forecast horizon, aggregate demand shocks explain about 2% of the forecast error variance compared to 0.4% due to monetary policy shocks. From the second quarter-horizon, monetary policy shocks become gradually more important than the combined influences of aggregate demand and supply shocks.

Therefore, a relatively larger proportion of the variance of house prices is attributable to monetary policy shocks whereas the aggregate supply shocks appear to be less significant. This is not surprising since the conduct of South African monetary policy has been shown to be encompassing house price movements (Gupta and Ndahiriwe, 2010; Gupta *et al.*, 2010; Ncube and Ndou, 2011 and Simo-Kengne *et al.*, 2013 and forthcoming). In fact, improvements in economic conditions tend to boost housing demand, resulting in higher house prices to which monetary policy strongly reacts in order to limit the inflationary pressure, thus maintaining the inflation within the desired target.

Table 2.1

House price forecast error variance decomposition

Horizon (Quarters)	Portfolio shocks	Aggregate Supply shocks	Aggregate Demand shocks	Monetary Policy shocks
1	97.363	0.027	2.198	0.411
2	87.103	0.042	5.964	6.892
3	77.203	0.477	9.009	13.312
4	71.013	0.781	11.047	17.159
5	68.802	1.580	11.054	18.564
6	68.515	1.659	11.082	18.744
7	67.321	1.644	11.996	19.038
8	65.381	1.621	13.421	19.577
9	63.801	1.585	14.594	20.019
10	63.002	1.632	15.169	20.196
11	62.699	1.646	15.493	20.162
12	62.363	1.638	15.944	20.055
13	61.836	1.652	16.603	19.909
14	61.324	1.669	17.237	19.770
15	60.986	1.666	17.686	19.662
Average	**69.248**	**1.288**	**12.566**	**16.898**

Notes: The table displays the percent of the variance in the reduced form innovation in house prices at horizons 1-15 attributable to each of the four shocks corresponding to the four variables in the VAR.

2.5.3. Real house prices historical decomposition

This section documents the contribution of each structural shock to the historical path of the house prices over the sample period. Figure 2.5 plots on a separate graph the actual house price growth (solid line), the based forecast (long dashed line) and the sum of the forecast and the effect of the structural innovations (short dashed line). It emerges that portfolio shocks account for most of the fluctuations in real house prices throughout the sample period. The increase in real house prices is largely due to the decline in equity premium risk which favours residential investment. Aggregate supply shocks have also helped boost real house prices but to a very limited extent. On the other hand, contractionary monetary policy shocks account for larger decrease in real house prices, while aggregate demand shocks have had less influence.

Figure 2.5: House Price Historical Decomposition

Contribution of portfolio shocks to house prices

——— Actual   - - - - Forecast   ·········· Portfolio shocks

Contribution of monetary policy shocks to house prices

——— Actual   - - - - Forecast   ·········· Monetary policy shocks

Contribution of aggregate demand shochs to house prices

——— Actual   - - - - Forecast   ·········· Agg. Demand shocks

Contribution of Aggregate supply shocks to house prices

——— Actual   - - - - Forecast   ·········· Agg. Supply shocks
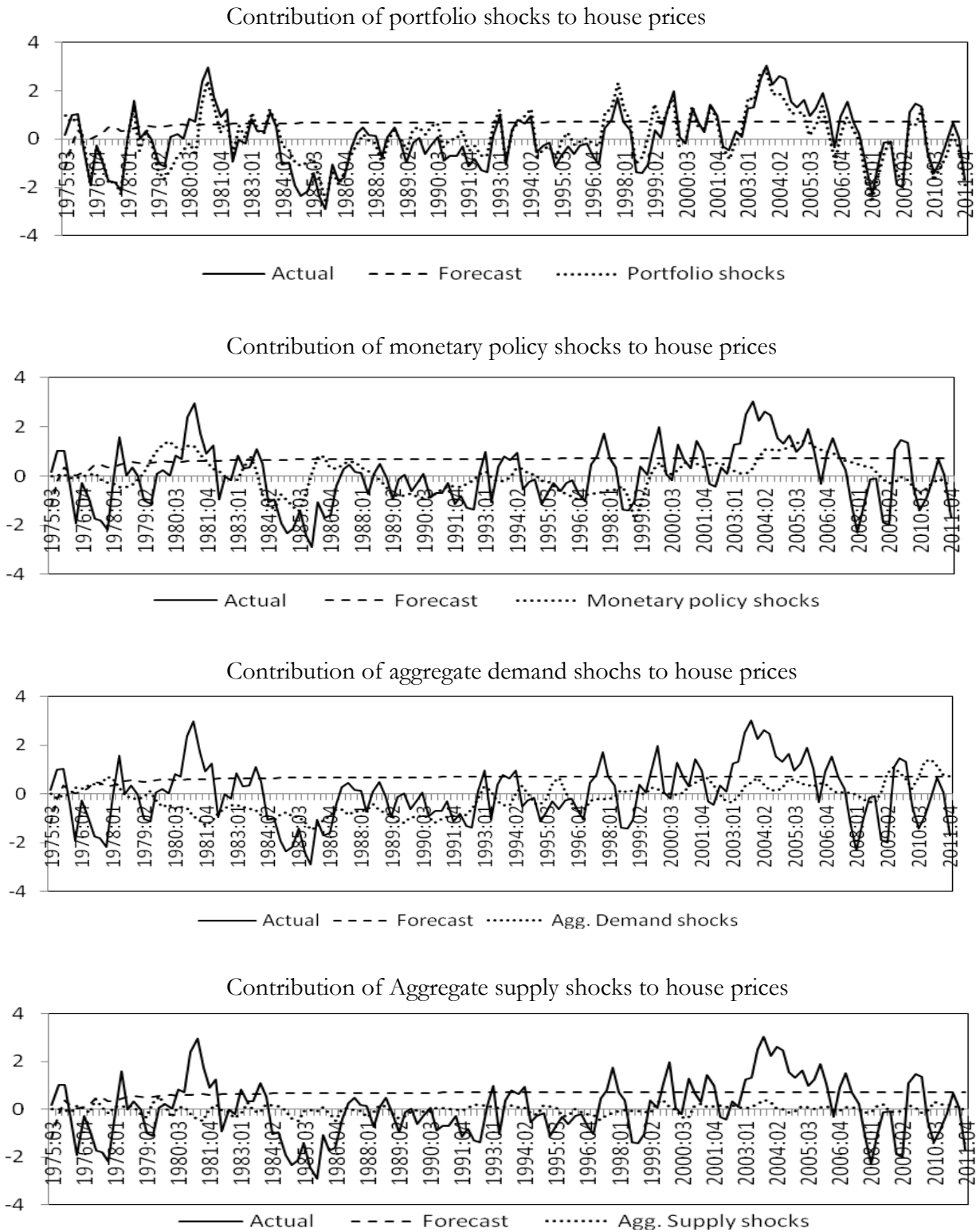
The potential explanation for this finding relates to the user-cost theory developed by Nakajima (2011) which emphasizes the importance of user costs- including interest rates and expectations- in driving house price dynamics. According to this theory, decreasing interest rate lowers the user cost of owning a house which in turn increases property prices. Likewise, user cost of housing falls with optimistic expectations about future house price movements, resulting in a decrease in equity risk premium which raises real house prices. Opposite effects are expected from the increasing interest rate or when people are pessimistic about future movements in house prices. Empirically, our result is consistent with Granziera and Kozicki (2012) and Piazzesi and Schneider (2009) who provide evidence that expectations of future increases in house prices have strengthened the recent US housing boom. It also conforms to the view that house prices play a key role in the monetary policy transmission mechanism (see for instance, Giuliodori, 2005; Mishkin, 2007; Bjørnland and Jacobsen, 2010 amongst others).

Overall, empirical results suggest that the common component of provincial house price movements is due to the combined effects of favourable and unfavourable structural shocks emanating from different sectors of the South African economy.

2.6. Conclusion

Given the recent debate on the comovement in house prices, this chapter estimates a dynamic factor model following Neely and Rapach (2011) to disentengle the relative importance of the common component in provincial house price movements from province- or region-specific shocks in South Africa. We apply Bayesian methods on quarterly house price data from 1974 to 2011 and find that house price dynamics have mainly been driven by local component (province- and region-specific) over the sample period. However, the national factor has been important in all provinces in the recent period (2001-2011); indicating that house price fluctuations are indeed a national phenomenon.

We then rely on theoretically motivated short-run restrictions in a VAR model to investigate the extent to which macroeconomic shocks are responsible for the common component in house price movements. The results indicate that all macro shocks have significant influence on real house prices with portfolio shocks having the largest fraction in the total variability in real house prices followed by monetary policy shocks. This finding substantiates the user-cost theory which emphasizes the importance of interest rates and expectations in driving house price

dynamics. Thus, there is evidence to suggest that during periods of high volatility in house prices, interest rates fall steadily and people expect strong growth in house prices, resulting in lower user cost of housing which in turn increases property prices.

Alternatively, the large contribution of portfolio shocks to the total variability of house prices indicates that non economic fundamentals appear to be a major factor in explaining extreme momentum of home price increases in almost all provinces in South Africa. This suggests that there may have been changes in home prices or housing activity that do not necessary emanate from the changes in traditional fundamentals. For instance, political transition in 1994 may have positively impacted on the decision to buy a house by restoring people's hope and confidence (Luüs, 2005). This line of reasoning corroborates the speculative psychology for which housing boom represents a feedback mechanism or social epidemic where housing is viewed as important investment opportunity (Shiller, 2007). The speculative psychology includes a wide variation of considerations such as emotion and institutional changes. Accordingly, there may have been changes in home prices or housing activity that do not necessary emanate from the changes in traditional fundamentals.

Chapter 3

The impact of house prices on consumption in South Africa: Evidence from provincial-level panel VARs♣

3.1. Introduction

Besides its leading role of providing shelter, houses can be used as collateral since they represent an important component of household's wealth. Due to these specific features of housing, house prices play an important role in formulating both consumption and investment decisions. Because consumption is a significant component of Gross Domestic Product (GDP), effect of house prices on consumption, serves as a key link between housing market and economic activity[12]. There seems to have been a consensus among a minority group of economists that house prices play an important role in fuelling consumption and growth of an economy (Iacoviello and Neri, 2010; Iacoviello, 2011). However, after the "Great Recession", this belief has strengthened amongst not only most economists, but also policy makers around the world. In addition to the fact that housing market spillover could be inflationary if it significantly affects aggregate demand through consumption (and residential investment), the recent financial crisis has once again rekindled the debate on whether central banks should conduct monetary policy in a more active manner to prevent the development of bubbles that can be costly in terms of future output and financial stability (Andre *et al.,* forthcoming; Peretti *et al.,* forthcoming). Further, some recent studies have also highlighted how fiscal policy affects house prices and the active role fiscal policy (tax and expenditure changes) can (and should) play in response to housing market movements (Agnello and Sousa, 2013; Afonso and Sousa 2011; Agnello *et al.,* 2012).

♣ Forthcoming in *Housing Studies*.

[12] For instance in South Africa, our country of concern in this paper, The evolution of house prices has been particularly remarkable, with annual changes in nominal house prices ranging from -0.13% to 27.92% between 1994 and 2011. This pattern has borne a relatively close resemblance to consumer spending with a strong growth in 2005 (5.74%) followed by a sharp decrease in 2009 (-0.02%).

When house prices fall, for example, the net wealth of the private sectors get eroded, and if this leads to a reduction in consumer expenditure, firms will respond by reducing industrial production and curtailing investment expenditure. This means that if there is a significant relationship between consumption and wealth, the change in the "wealth" bundle, i.e. the variation in the "price-quantity" set, can make economic agents more prone to adjust their demand patterns. More importantly, such adjustments also lead to substantial changes in future aggregate demand to which a policymaker could decide to react for stability purposes. On the other hand, a significant increase in housing prices can lead to a rise in housing wealth and, consequently, boost consumption, if a significant relationship holds. In the case of overheating of the economy, a (monetary and or fiscal) rule targeting asset prices would demand tightening of policy. However, the rise in housing prices may also trigger a rise in housing costs and generate a drop in housing wealth, whereby consumption spending would be reduced, again contingent on the significance of the wealth-consumption relationship. In this context, the policy response to the dynamics of housing prices would imply an expansionary policy. So unless known from the data, as to how consumption reacts to real house price movements, housing prices could provide an uncertain signal to the policy makers. Hence, understanding the implications of house price dynamics on consumption has become a question of paramount importance for developed and emerging market economies alike.

The relationship between real house prices and consumption is theoretically based on Friedman's (1957) permanent income hypothesis (PIH), which suggests that since home equity is an important component of homeowners' wealth, unexpected house price appreciation would increase the expected life time wealth of homeowners. Given that individuals smooth consumption over their life time, the increase in life time wealth would increase their desired consumption[13]. The collateral effect, on the other hand, refers to the phenomenon that house price changes may affect the actual consumption instead of the desired consumption. Under the conditions that house price changes are fully anticipated and households are financially constrained so that their actual consumption is lower than their desired consumption, and the assumption that housing wealth can be collateralized, house price increases can help relax homeowners' financial constraints and thus may increase their actual consumption (Aoki *et al.*, 2004; Buiter, 2008; Lustig and Van Nieuwerburg, 2010). In a series of papers, Iacoviello and

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[13] Recently, Morris (2006, working paper) presents a partial equilibrium model to analyze the wealth effect, and predicts that both age and expected mobility affect the wealth effect. His analysis based on data from the Panel Study of Income Dynamics (PSID) supports the predictions.

Minetti (2003), Iacoviello (2004, 2005), Iacoviello and Pavan (2008), Iacoviello and Neri (2010)[14], develop dynamic (stochastic) general equilibrium heterogenous agent models, that treat housing as both consumption and investment goods, show that house prices can affect consumption both via the wealth and collateral channels.

However, it must be pointed out that, some recent theoretical work suggests that house price changes do not necessarily have net aggregate effects on consumption in equilibrium. The intuition, based on a dynamic model of household consumption and investment, is that house price changes might only redistribute wealth between those who "long" housing and those who "short" housing, and thus there is no net wealth effect (Bajari *et al.*, 2005). Buiter (2008), using an overlapping generations model, suggests that, if the changes are in fundamental house values, there is no pure wealth effect on consumption from house price changes. However, house price-based wealth effects emerge from changes in the speculative bubble component of house prices. Also using a life-cycle model which treats housing as both a consumption good and an investment asset, Li and Yao (2007) find that house price changes have small aggregate effects, and the effects on the homeowners are different at different stages in the life cycle. Thus, overall, the theoretical effect of higher house prices on total consumption expenditure appears ambiguous; hence the dynamic relationship between house prices and consumption should be investigated empirically.

The purpose of this chapter is to provide an empirical analysis of the role of house prices in determining the dynamic behaviour of consumer spending in South Africa. It further investigates whether consumption exhibits symmetric responses to positive and negative house price shocks. Within a panel vector autoregressive (PVAR) framework, we make use of four variables namely, inflation, real consumption, real house prices and the nominal mortgage rate spanning the period 1996-2010 to address the dynamics of house price spillover on consumption in South Africa. This methodology exploits variations in the geographical distribution of housing wealth, as well as, differences in consumer behaviour among the South African provinces. The usual recursive (Cholesky) identification scheme is employed in order to isolate the dynamic responses of a particular shock. Although not structurally interpretable, the results from the Choleski

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[14] Open economy extensions of this model, highlighting the wealth and collateral effects of house prices on consumption, have been provided by Christensen *et al.* (2009), Vitola and Fadejeva (2010) and Vitola and Ajevskis (2011).

decomposition do not rely on strong assumptions that are necessary in more sophisticated models such as sign-restrictions or long-run and short-run restrictions models.

The empirical importance of housing wealth is yet to be widely explored in developing countries, especially at regional levels. This study contributes to the discussion by relying upon South African provincial data, which can be believed to be more informative. Besides the cross-regional heterogeneity of housing markets (Burger and van Rensburg, 2008), economic conditions prevailing during a house price shock are not necessarily the same across the regions. Additionally, economic situations in regions are likely to be non-aligned with national economic conditions (Ghent and Owyang, 2010), reflecting the fact that markets are not all relatively strong or weak at the same time. Given this, analysis needs to be carried out at a disaggregated (regional level), to correctly identify the role of house prices on consumption. South Africa comprises of nine provinces[15] which differ substantially in terms of economic development. Since housing market varies greatly with macroeconomic conditions including the structure of institutions, important unobserved differences exist among provincial housing markets and over time. Our methodology is able to capture the dynamic effects of shocks by allowing for these unobserved individual heterogeneities which might cause serious bias in the estimates. We find the following results: First, the aggregate effect of house price shock on consumption is positive and short-lived, and; second, once we distinguish between the positive and negative shocks, we find that consumption responds positively and significantly to increases in the positive house price growth rates. However, the negative response of consumption when there is an increase in the negative growth rate of house prices is found to be insignificant. This suggests that house prices exhibit an asymmetric effect on consumption.

The remainder of the chapter is structured as follows. The second section provides a review of the relevant literature. The third section presents the empirical methodology, while the fourth section discusses the data and results. Finally, the fifth section concludes.

3.2. Relevant literature

Numerous studies indicate a strong positive link between the housing market and economic activity, and in particular consumption, in the United States (Green, 1997; Belsky and Prakken,

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[15] The South African provinces are namely: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, North West and Western Cape.

2004; Carrol, 2004; Iacoviello, 2005, 2011; Case *et al.*, 2005; Leamer, 2007; Kishor, 2007; Jarocinski and Smets, 2008; Sousa, 2008; Vargas-Silva, 2008; Ghent, 2009; Mian and Sufi, 2009; Pavlidis *et al.*, 2009; Ghent and Owyang, 2010; Iacoviello and Neri, 2010, Shirvani *et al.,* 2012)[16]. Similar evidence is also available for the United Kingdom (Aoki *et al.,* 2002; Campbell and Cocco, 2007; Muellbauer and Murphy, 2008; Elbourne, 2008; Attanasio *et al.,* 2011). Following the "Great Recession", which had its root in the housing market, and even before the crisis for some other developed economies where worthwhile housing data was available, quite a large number of studies have analyzed the impact of house prices on consumption in other economies, such as Australia (Dvornak and Kohler, 2007), Canada (Christensen *et al.,* 2009), China (Chen *et al.,* 2009; Koivu, 2010), Taiwan (Chen *et al.*, 2010), Czech Republic (Sec and Zemčik, 2007), Hong Kong (Cheng and Fung, 2008; Gan, 2010), Italy (Paiella, 2007; Guiso *et al.,* 2005; Bassanetti and Zollino, 2010; Bulligan, 2010), Latvia (Vitola and Fadejeva, 2010; Vitola, and Ajevskis 2011), Portugal (de Castro, 2007; Farinha, 2008), Singapore (Edelstein and Lum, 2004; Phang, 2004), Spain (Aspachs-Bracons and Rabanal, 2011), Sweden (Chen, 2006) and Turkey (Akin, 2011). A few comprehensive international studies are also available, where a number of countries are studied concurrently (Boone *et al.,* 2001; Bertaut; 2002; Bayoumi and Edison, 2003; Byrne and Davis, 2003; Barrel and Davis, 2004; Catte *et al.,* 2004; Ludwig and Sløk, 2004; Case *et al.,* 2005; Aron *et al.*, 2006; Fung and Cheng, 2007; Goodhart and Hofman, 2008; Slacalek, 2009; Aron *et al.,* 2012; Demary, 2010; Musso *et al.*, 2011; Andre *et al.*, forthcoming; Ciarlone, 2011; Peltonen *et al.*, 2012; Šonje *et al.,* 2012)[17]. In general, barring Phang (2004), the evidence, based on a wide variety of econometric techniques covering simple linear regressions, structural and Bayesian vector autoregressive, (vector) error correction, panel data-based regressions, and estimated DSGE models, is in favour of significant housing market spillover on consumption or economic activity.

As far as South Africa, our country of interest in this chapter, is concerned, to the best of our knowledge, there exist four studies[18] analyzing the relationship between consumption and real house prices. They are Aron *et al* . (2006), Das *et al.* (2011), Ncube and Ndou (2011) and Peretti *et*

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[16] Some micro-level evidence for the US and the UK have been provided by Campbell and Cocco (2007), Bostic *et al.* (2009), Haurin and Rosenthal (2006), Sierminska and Takhtamanova (2012).

[17] Another strand of the literature focuses on international spillovers (see for example Otrok and Terrones, 2005; de Bandt *et al.,* 2010 and Vansteenkiste and Hiebert, 2011).

[18] South Africa was part of the panel of developed and developing economies considered by Fung and Cheng (2007) and also one of the fourteen emerging countries in the panel of Peltonen *et al.* (2012).

al. (forthcoming)[19]. Aron *et al.* (2006) indicated that much of the empirical literature assessing the wealth effect of house prices on consumption is marred by poor controls for the common drivers of both house prices and consumption. Given this, the authors suggested an empirical model for the United Kingdom and South Africa grounded in theory, and with more complete controls than generally used. The estimates suggested that in South Africa, unlike the UK, the marginal propensity to spend for housing wealth or collateral is slightly larger than for illiquid financial assets, though the difference is not statistically significant.

Das *et al.* (2011), first tested for house price bubbles in the South African housing market, based on the unit root test developed by Phillips *et al.* (2011). Next, the authors estimated an error correction model to investigate the existence of spillover effects from the housing sector onto consumption. Results indicated significant spillovers, though there was no evidence of the effect being higher during the bubble period. In an attempt to understand the indirect channels through which monetary policy influences real variables by focusing on transmission to consumption using a structural VAR (SVAR), Ncube and Ndou (2011) provided evidence of significant spillovers from real house prices onto consumption. Finally, Peretti *et al.* (forthcoming) investigated the existence of spillovers from the housing sector onto consumption using a time-varying vector autoregressive (TVP-VAR) model with stochastic volatility. The results suggested that, in general, consumption responded positively to a house price shock over the entire sample, with the effect being stronger post financial liberalization, and weaker during the financial crisis.

Thus, overall, irrespective of the methodology used, these four studies provided evidence of the existence of significant spillovers from the housing market onto consumption in South Africa at a national (aggregate)-level. These results are, perhaps, not surprising, given that in South Africa, housing, in general, accounts for 29.40 percent of household assets and 21.68 percent of total wealth (Das *et al.,* 2011). Although these numbers are not as large compared to the U.S. economy, which happens to be 37.78% and 47.92% respectively (Iacoviello, 2011), they most certainly cannot be ignored. However, for reasons of heterogeneity in the geographical distribution of housing wealth, spatial differences in consumer behaviour, different prevailing

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[19] Related to these studies, Simo-Kengne *et al.* (2012) empirically examined the effect of house price changes on economic growth across provinces in South Africa. The economic impact of house prices was estimated using a panel data set that covered all nine provinces in South Africa from 1996 to 2010. The authors found that when heterogeneity, endogeneity and spatial dependence are controlled for, house price changes exhibit a significant effect on regional economic growth in South Africa.

economic conditions across the South African provinces, which are possibly non-aligned with national economic conditions, one cannot assume the national level results to hold at the regional level without formally investigating the house price-consumption relationship.

Although the response of consumption to house price shocks has been extensively studied in developed countries, and more recently in developing countries as well, the corresponding analysis in terms of possible asymmetric effects of house price shocks has received virtually no attention. The three exceptions that we are aware of are the papers by Phang (2004), Das *et al.* (2011) and Guerrieri and Iacoviello (2012). Das *et al.* (2011) showed that consumption in South Africa responds significantly to the house price acceleration but not to deceleration, but being a single-equation error correction model, could not provide the dynamics of the behaviour of consumption following an unanticipated house price acceleration or deceleration. However, Phang (2004) showed that for Singapore, anticipated house price increases did not have a positive effect on aggregate consumption, in fact, it had a modest dampening effect, although this negative result was not statistically significant from zero. On the other hand, fall in expected house price growth was found to have a larger and marginally significant negative effect on consumption. This result is in line with Guerrieri and Iacoviello (2012) who report a much larger response of consumption to house prices decline than house prices increase in the US.

Given the general evidence on the procyclical behaviour of real estate prices and consumer expenditures, there are good reasons to conjecture that negative house prices shocks will lead to a decrease in consumption. In fact, another formulation of wealth effect is that, when a shock leads to decreasing housing prices, there will be a decline in household's net worth. The induced decrease in wealth will reduce the demand for consumption goods and thereby the household's consumption spending. In other words, consumption effect of housing wealth is expected to be symmetric, at least theoretically.

However, when we account for heterogeneity amongst agents in the economy, there could be asymmetric effects of house prices on consumption. For instance if the economy is divided between single home-owners, multiple home-owners (affluent agents who considers housing as an investment good as well) and renters (who are demanders of the multiple houses owned by the affluent agents), an increase in real house prices is likely to translate into higher consumption for the single and multiple home owners, and are unlikely to affect the renters, who are generally under nominal rental contracts, and are unlikely to change their consumption patterns. Hence,

the increase in the consumptions of single and multiple home owners are likely to raise consumption in aggregate. Note that, if there is an impact on the consumption of renters it is likely to be a delayed one and also possibly ambiguous. The inflationary effect following a real house price increase would reduce the real rental payments and could boost their consumption, but then again the general inflation in the economy is likely to reduce their consumption as well. Most likely the negative inflationary effect will dominate, and would add to the fall in aggregate consumption after the initial increase in consumption due to single home-owners and multiple home-owners.

On the other hand, when real house prices go down, single home owners are surely going to be negatively affected in terms of their consumption, however, the multiple home owners are likely to stay unaffected, since they, being the affluent section of the population, would be able to maintain their consumption from possibly other investments in their portfolio (Gupta *et al.,* 2010; Das *et al.,* 2011; Gupta and Inglesi-Lotz, forthcoming). As far as the renters are concerned, as in the case of a real house price increase, they should stay unaffected in terms of immediate changes to their consumption. A delayed rise in consumption could be a possiblity through the infaltion channel, thus causing aggregate consumption to recover quicker. Thus, consumption is likely to go down following a fall in house prices, but the fall might tend to be smaller in magnitude than the rise in consumption following a real house price increase, resulting in an asymmetric effect of real house price changes on consumption. Also as elaborated by Phang (2004), if households are liquidity constrained and if house price increases enhances the scope to borrow against the housing wealth by increasing the value of the collateral against which the loans are made then, the increase in consumption following a house price increase is likely to be more than the decrease in consumption resulting from a fall in house prices. This is called the collateral-enhancement effect[20]. It is therefore important to investigate whether positive and negative house price movements have asymmetric effect on consumption.

3.3. Methodology

Vector autoregression, though atheoretical, is a parsimonious and useful tool kit for economists. It is commonly applied in macroeconomics to assess dynamic relationships between time series. By treating all the variables in the system as endogenous, VAR approach does not require any a

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[20] The line of reasoning has been theoretically motivated in heterogenous-agent DSGE models by Iacoviello (2005), Luengo-Prado (2006), Chen *et al.,* (2010), Iacoviello and Neri (2010) and Vitola and Fadejeva (2010).

priori assumptions on the behaviour of variables in the model. This technique should equally apply to a panel framework. Unlike individual regression, the panel set up involves different cross-sections which are typically characterised by the individual heterogeneity. It is therefore inappropriate to apply the traditional VAR to panel data.

This study exploits the impulse response function using a panel-data vector autoregressive (PVAR) approach to analyze regional housing market spillovers on regional provincial consumption. In addition to the well known benefit of modelling the joint dynamics and causal relations among a set of variables, this technique has the advantage to account for unobserved individual heterogeneity which improves the consistency of the estimates. Therefore, the baseline model incorporates fixed effects designed to capture specifics of cross-sections.

Consider a first order panel VAR given by:

$$X_{it} = A_0 + A_1 X_{it-1} + f_i + d_{p,t} + \varepsilon_{it} \text{, i=1,..., N; t=1,..., T.} \tag{1}$$

where X_{it} is the vector of endogenous variables for province i and year t. It includes, in the following order, the annual changes of the log of consumer price index (inf), log of real consumption (cm), the nominal mortgage rate (mr) and log of real house prices (hp). The choice and ordering of the variables are in line with the recent studies dealing with wealth effect in time-series based VAR models for individual countries (see for example, Demary 2010; Musso *et al.,* 2011; Andre *et al.,* forthcoming and references cited therein). It must be emphasized that the VAR approach is essentially an atheoretical one, and hence, proper identification of the structural shocks continues to be an area of constant research in time-series econometrics. The most popular approach, and the one we follow here since it is the only available option in a PVAR framework, is the Choleski decomposition (recursive identification) of structural shocks, whereby all the possible shocks in the system are identified based on slow (ordered before)- and fast-moving (ordered after) variables relative to a specific shock. Inflation is ordered first and captures a supply-side shock (productivity or cost-push) shock, which tends to affect the other variables contemporaneously. Consumption is ordered second and relates to an aggregate demand shock, which affects inflation with a lag, but leads to simultaneous changes in the mortgage rate and the house prices. Since, we use inflation to identify an aggregate supply shock, we assume that consumption gets affected immediately following a supply shock, but the aggregate demand shock has a delayed effect on the inflation. The mortgage rate is ordered third,

and this shock affects house prices instantaneously by affecting the cost of borrowing, and this, in turn, affects consumption and inflation in the economy. The housing demand shock, originating from an exogenous change in house price shock ordered last, affects inflation, consumption and the mortgage rate with a lag. We are, however, here only interested in identifying the housing demand shock. In this regard, note that the equation for the real house price can be interpreted as a housing demand function, which, in turn, relates the real house price to inflation, consumption and the mortgage rate.

It is assumed that consumption does not react simultaneously to this shock, so that the shock cannot be dubbed a positive technology shock, including the ``positive news'' type shock. Also, the inflation is assumed to react with a lag to allow for the wealth effect to have had an impact on the consumption, and hence, the aggregate demand. The interest rate also responds with a lag on the assumption, and also recent evidence provided by Peretti *et al.* (forthcoming), that in South Africa interest rates respond more to the inflation effect of the house price shock, than to the house price directly. As it can be seen, the ordering of the variables, make a loose attempt to impose theory on the VAR. Ideally, one should be using restrictions on the parameters of the VAR or sign-restrictions on the impulse response functions generated from the VAR. However, such methods are yet to be developed in the context of PVARs. Also note that, the four variables are chosen to lend us a parsimonious model given the length of the time-series component of our data, but without making a compromise on the identification of the housing demand shock[21].

Because of its flexibility, panel-data approach also allows for unit-specific time dummies. Added to Equation (1), these dummies denoted by $d_{p,t}$ capture aggregated macroeconomic shocks that may affect provincial housing markets in the same way. It is useful to mention that our specification assumes ε_{it}, the vector of residuals to be independent and identically distributed (*iid*). However, this assumption is likely to be violated in practice; that is, the innovations may

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[21] Though the presence of real variables and inflation in a model could either capture the money illusion of wealth effect, our choice of variables are in line with the extant literature analyzing wealth effect of a real house price shock in time-series based VAR models, and is primarily in there to identify an aggregate supply shock, even though we are not concerned with this particular shock. Further, as seen from the GMM results reported in Appendix C, the effect of inflation on consumption is negative. In this case, the inflation effect is identified as a wealth effect provided that our result regarding the effect of inflation on consumption is consistent with theory. However, it must be realized that our objective was essentially to analyze the wealth effect arising from a real house price change. Finally, the decision to use inflation in the model is an attempt to capture whether the central bank responds to a house price shock directly by raising the interest rate, or does it only respond when the house price increase has raised consumption (aggregate demand), and hence, produced inflation.

still be contemporaneously correlated. To address this issue, Sims (1980) suggests a recursive causal ordering of variables in the VAR based on their degree of exogeneity. In this study, the ordering of variables reflects the framework provided by Demary (2010) and Andre *et al.* (forthcoming) in which housing market is set to react directly to all shocks. It is also in line with the literature on monetary policy transmission for which the business cycle variable is ordered after the inflation but before the interest rate. This procedure relies on Choleski decomposition which assumes the orthogonalisation of shocks in order to identify the shock of interest, which is the housing demand shock in our case.

The objective of this chapter was to analyze how consumption evolves following a housing demand shock, or in other words, we wanted to track the dynamic path of the wealth effect and in the process, its significance over time. And in this regard, we rely on the impulse response functions, which can only be obtained from VAR-type models, as it treats all the variables in an endogenous fashion[22]. Impulse responses generate the expected future path of variables following a particular shock. Further, it is also interesting to determine how important this particular shock is in explaining the fluctuations of variables in the PVAR system, which in turn is, achieved through variance decomposition. Given these objectives, we decided to rely on an atheoretical PVAR model, rather than a regression based panel data approach, which was likely to be more grounded in theory, but would come at a cost of its inability to track the dynamics of consumption over time following a housing demand shock.

Further, we distinguish between positive and negative shocks which are captured respectively by positive and negative values of house price changes (hpp, hpn). This is achieved by setting two dummies variables $d_{i,t}^{p}$ equal to one for the positive values of real house price changes and equal to zero for negatives values, while $d_{i,t}^{n}$ is specified conversely. We refer to the interaction terms $d_{i,t}^{p} \times hp$ as hpp and $d_{i,t}^{n} \times hp$ as hpn. Thus, X_{it} is either a four- variable vector in (inf, cm, mr, hp) or a five-variable vector in (inf, cm, mr, hpp, hpn).

We are aware of the fact that, with the chosen empirical set-up the dynamic responses delivered via the Cholesky decomposition are not structurally interpretable. This is due to the

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[22] One can also carry out future path projections of endogenous variables in structural models, but this would require obtaining information about the future path of the exogenous variables in the system from sources outside the economic model.

lack of a theoretical underpinning about the behaviour of the variables under consideration. For instance, a house price shock should be interpreted as an orthogonalized reduced-form shock for which it is not possible to determine whether the underlying structural driving force is a housing-demand or a housing-supply shock. Structural shocks may be identified via the use of more sophisticated identification scheme such as a combination of long-run and short-run restrictions or sign restrictions as in Andre *et al.* (forthcoming). The implementation of these identification schemes requires imposing some assumptions which would drive us away from our original objective which is to uncover the dynamic relationship between house prices and consumption.

3.4. Data and empirical results

3.4.1. Data

Since provincial level data on consumption is not available before 1996, this study makes use of four annual series from the period 1996 to 2010. The Allied Bank of South Africa (ABSA) compiles annual house prices, covering provincial areas. In the absence of data on provincial-level household consumption, annual retail sales series, which serves as a proxy for consumption following Zhou (2010) and Zhou and Carroll (2011, 2012), have been compiled at a regional level by the Regional Explorer database obtained from the Global Insight South Africa (GISA). Monthly mortgage rate data is sourced from the Statistics South Africa (SSA), which we use to derive annual series by taking an average over 12 months. Series have been deflated using the consumer price index which is drawn from the International Monetary Fund's International Financial Statistics (IFS). To allow for comparative analysis especially when analyzing asymmetric effects of house price changes, all the variables have been standardised by dividing with its respective standard deviations. Note that, our main variables are consumption and house prices. The model also includes the inflation (Meen, 1999) and the mortgage rate (Bhattacharya and Kim, 2011) to capture the affordability[23] of housing as a consumption and investment goods, respectively.

As indicated by Demary (2010), the rise in house prices is likely to increase household's consumption expenditure which in turn leads to inflationary pressures. This justifies the positive relation between house prices and inflation. However, consumption does not always increase as house prices rise (wealth effect). This could be due to the following reasons: (i) If households

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[23] At the micro level, however, housing affordability is often proxied by price-to-income ratio (Kim and Cho, 2010) and/or per capita income (Tipple *et al.*, 1997)

are not financially constrained, the increase in consumption due to the increase in the value of housing collateral will not take place; (ii) The increase in wealth might not affect consumption because of the precautionary savings; (iii) Changes in the preferences for old households (due to health restrictions, retirement saving) may also justify why the expected increase in consumption following a growth in house prices might not happen.

Furthermore, the increase in house prices is expected to drive up the mortgage payment. However, because growth in house prices raises the value of the collateral, homeowners have the possibility to access bank credits (especially those who were initially not qualified) allowing them to consume more. This increase in credit supply will reduce the mortgage rate (Demary, 2010). Thus, while conventional wisdom suggests a positive relationship between house prices and inflation, there are not clear cut sign-expectations about the effect of house prices on consumption and on mortgage rate.

We use the first-differences of the log values of the variables[24] rather than their log levels, except the interest rate for which we only take the first difference. As indicated in Panel A of Table 3.1, our variables in levels exhibit non-stationarity; justifying the transformation of the data in their first difference form[25]. The Fisher-type panel root test is employed[26]. Although the literature on time series offers a wide variety of panel unit root tests, the use of Fisher-type test has become popular for its simplicity, its power over the existing tests and the absence of restriction about the sample sizes (Maddala and Wu, 1999). Moreover, Fisher-type test is suitable for heterogeneous cross-sections as it relies on individual unit root processes. We represent the variables in levels in capital letters and the transformed ones in small letters.

Panel B of Table 3.1 substantiates the presence of heterogeneity with both F-test and Wald test for Fixed Effects (FE) and Random Coefficients (RC) models, respectively. Further, the

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[24] The variables are time demeaned after being differenced. Also known as within transformation, this procedure eases the estimation by allowing to get rid of the individual fixed effects (see appendix for details on the implementation of the PVAR).

[25] This transformation is considered on the premise of both the presence of unit root in the levels of variables and the absence of cointegration amongst variables. While Phillips and Moon (1999) pointed out that the spurious regression problem is less serious in panels (they show that estimates are consistent in both presence and absence of cointegration relation), the short length of our dataset (fifteen observations per province) could not allow conducting the panel cointegration test as the minimum of sixteen observations per cross-section is required.

[26] Fisher unitroot tests the null of "all panels contain a unit root" against the alternative that "at least one panel is stationary". This test consists of performing either a augmented Dickey Fuller (ADF) or a Phillips Perron (PP) unitroot on each panel series separately, then the p-values are combined to obtain an overall test of whether the panel series contain a unitroot (StataCorp, 2009).

Hausman test confirms that provincial-specific effects are adequately modelled by a FE representation; hence, providing us with a rationale for including fixed effect in the empirical methodology[27]. These tests are based on dynamic panel regressions reported in Appendix 3.2, using the contemporaneous values of inflation, mortgage rate and the real house prices (besides the first lag of consumption) , which all indicate a positive and significant effect of house price on consumption. FE and RC account for heterogeneity, while Feasible Generalised Least Squared (FGLS) controls for spatial effects. Though, the size of the wealth effect is smallest in this case, the effect continues to be statistically significant at the one percent level of significance.

The relevance of cross sectional dependence, as suggested by the Breuch-Pagan test, cannot be ignored. As pointed out Pesaran (2006) and Smith and Fuertes (2008), cross-sectional dependence in small panel time series is adequately modelled within the Seemingly Unrelated Regression (SUR) framework. In light of this, the SUR estimates are presented in Appendix B. The potential importance of cross-provincial dependence is inspected based on the Lagrange Multiplier tests for the diagonality of the cross-equation error covariance matrix developed by Breusch and Pagan (1980). This approach assumes one particular form of spatial dependence: the spatial error model (estimating a set of individual regressions by assuming their error terms are correlated). This estimator also helps to improve the efficiency of the individual regression estimates by allowing cross-equation residuals to be correlated. Panel I of the table containing the SUR estimates, provides strong evidence that house price changes affect consumption and that the effects vary across provinces. For instance, house price changes have a larger effect on consumption in Free State and Mpumalanga. Conversely, this causality appears negative and insignificant in Limpopo. The Breuch-Pagan test of independence ($\chi^2(36) = 96.103$) rejects the null hypothesis of independence, indicating the importance of cross-regional correlation.

Panel II of the table provides the test for spatial dependence based on correlation between house prices for each province: the higher the correlation coefficient, the stronger the spatial dependence. Again, this appears to confirm the spatial interactions in the South African provincial housing markets. Spatial dependence is omnipresent; the degree of dependence in the Western Cape is particularly noticeable, with higher correlation with almost all regions. For instance, the house price shock originating in Western Cape spreads in five out of nine provinces namely, Free State, KwaZulu-Natal, Gauteng, Mpumalanga and Limpopo. It is also important to

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[27] Details for the implementation are provided in Appendix 3.1.

highlight that practically all the correlations are positive, which, according to Meen (1996), indicate the absence of planning restrictions in some regions designed to force builders to migrate elsewhere.

Table 3.1

Unit root and diagnostic tests

Panel A: Fisher-type unit root test results				
	Variables			
	INF	HP	CM	MR
Statistic (Chi square)	8.339	2.593	2.513	10.612
P-value	1.000	1.000	1.000	0.910
Panel B: Diagnostic tests				
Fixed effects (FE) model	F-test (Pr>F=0.0003)			
Random Coefficients (RC) model	Wald test (Pr>Chi2=0.000)			
Fixed against Random model	Hausman test (Pr>Chi2=0.001)			
Breuch-Pagan test of independence	Chi-square(36)=96.103 (Pr=0.000)			

Notes: Panel A shows that all variables are non stationary (high probability means non stationarity). Panel B display the diagnostic tests.
(i) The heterogeneity tests (F-test and Wald test) suggest that the null hypothesis of coefficient equality across provinces is rejected in favour of the alternative that a least one coefficient is different from the remaining.
(ii) Similarly, the hypothesis that the individual-level effects are adequately modeled by a random effects model is resoundingly rejected by the Hausman test.
(iii) the Breuch pagan tests the null of cross section independence against the alternative of cross section dependence.

Given that our empirical set up assumes common causality among variables, we report in Table 3.2 the correlation matrix. The relatively high cross-correlations suggest similar trending behaviour of the series at the aggregated level. However, these correlations are subjected to econometric issues such as multicollinearity; justifying the need to analyse all the variables within an empirical set up based on a PVAR model, which we do in the following section.

Table 3.2

Cross- correlations

	House prices		
	hp	Hpp	Hpn
inf	-0.118*	-0.189***	0.109
cm	0.61***	0.555***	0.5071***
mr	-0.159*	-0.241***	0.11

Note: The table shows the cross regional average correlations among the variables.
*, ** and *** denotes significance at the 10%, 5% and 1% level respectively.

3.4.2. Empirical results

3.4.2.1. Spillover effects of house prices on consumption

As mentioned earlier, the impulse response functions (IRFs) represent a convenient tool for the analysis of spillover effects. An IRF captures the time profile of the effect of shocks at a given point in time on the expected future values of variables in a dynamic system. Appendix 3.3 displays the coefficients of the panel VAR estimation, which we use to construct the IRFs, as indicated in Figures 3.1 and 3.2, following a house price shock. The sign of the estimated coefficients are in line with our expectations, and, hence, produce IRFs that are theoretically consistent as well. In the Appendix C, looking at third column of both the panels corresponding to the 4- and 5-variables VAR, the signs of the coefficients of aggregate growth in real house price (*hp*) and the positive growth rates of real house price (*hpp*) are significant, at least at the 10 percent level, and have the expected positive signs. However, the coefficient of *hpn*, i.e., the negative growth in real house price is not significant despite having the expected negative sign. Both the mortgage rate and inflation rate have the expected signs, but are insignificant.

The responses of consumption, inflation and mortgage rate to a positive house price shock is portrayed in Figure 1 are compatible with theoretical expectations. We observe that a house price shock of one standard deviation results in a real house prices increase by 0.20% initially staying significant for about 2 and a half years. This is followed by a reversion to the baseline over three years. This pattern is in line with the strong autocorrelation in house prices that may result from predictive expectations.

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Figure 3.1: Impulse responses to orthogonalized one-unit house price shock
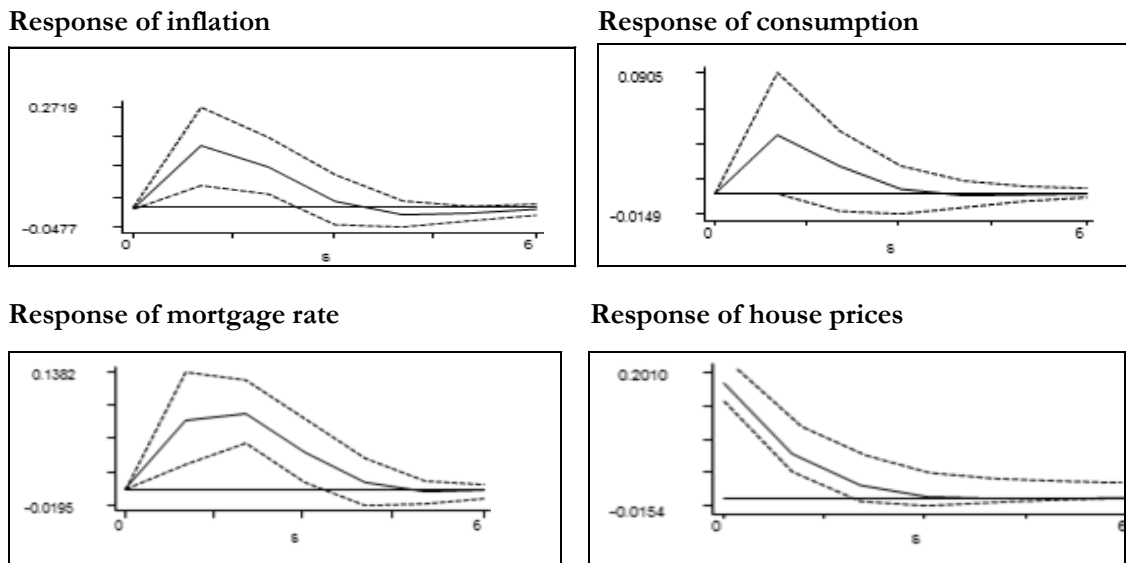
Response of inflation

Response of consumption

Response of mortgage rate

Response of house prices

Notes: Bold lines show the impulse response of a specific variable following a house price shock. The dotted lines represent % percent errors on both sides generated by 500 Monte-Carlo replications.

A delayed positive response to consumption take place following the positive house prices shock and peaks after slightly over a year. Although the reversion of the IRF to the baseline matches the one of the house price, this reaction is significant only at the 10% level initially, only to become insignificant after a year. The short-lived increase in consumption by about 0.09% indicates a small net housing wealth effect on consumption in South Africa.

The fact that we seem to have correctly identified a demand shock in housing leading to an increase in house prices is clear from the behaviour of the mortgage rate. The higher demand for housing, results in an increase in the mortgage rate initially. Then, the rise in real estate prices leads to an increase in household's wealth which translates into an increase in the demand for consumption goods. This increase in household's consumption expenditures lead to inflationary pressures, against which economic agents try to protect their wealth by investing in alternative assets including real estate. The induced demand for housing will ensure a persistent effect on real house prices. The Monetary authority might respond to increasing inflation by raising the money market rate, which in turn, will translate into higher mortgage rates. This line of thinking is vindicated by a second round increase in the mortgage rate, which peaks at about 2 years before starting to revert back to its original level and reaching the baseline around the fifth year

following the shock. The effect on the mortgage rate stays significant for about 4 years. The increase in inflation is quite sharp and peaks at about one year after the shock and stays significant for nearly three years and takes nearly six years to die down.

Disney *et al.* (2002) suggests that elderly homeowners tend to cut their consumption sharply after retirement; a number of possible reasons being shifts in preferences at retirement, precautionary savings against incapacity and disability, restrictions on consumption imposed by poor health. This has been known as "retirement savings puzzle" (Banks *et al.*, 1998). Moreover, since inflation increases by 0.27% which is more than the rise in the mortgage rate (0.13%), the real costs of financing real estate projects decrease so as to allow renters to save more to become owners. Overall, some of the increased consumption made by current young owners could be offset by the increased savings of both renters and old owners. This is one potential explanation why the consumption response is short-lived[28].

3.4.2.2. Asymmetric effects of house prices on consumption

As indicated earlier, Das *et al.* (2011) provided some evidence of a possible asymmetric effect of house prices on consumption at the national level for South Africa, with house price accelaration having a positive and significant effect on consumption, but the negative effect on consumption from house price deceleration was not significant. In light of this finding, and accounting for region specific effects, we compare the responses of consumption to a same-sized (one standard deviation) increase in positive and negative real house price growth rate shocks.

The IRFs displayed in Figure 3.2 confirm that house prices changes exhibit an asymmetric effect on consumption. An unexpected increase in positive real house price growth leads to a significant increase in consumption, while an increase in negative real house price growth tends to have no significant effect on consumption, although the sign of the response matches the theoretical expectations. Even though we only consider unexpected changes in positive and negative real house price growth rates, rather than real house price acceleration and deceleration, our results are in line with Das *et al.* (2011).

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[28] The impulse responses of the model following other shocks, namely aggregate demand (consumption), monetary (inflation) and the interest rate (mortgage rate) shocks, are in line with theory as vindicated by the coefficient estimates in Table 3. These results have been suppressed to save space, but are available upon request from the authors.

Figure 3.2: Impulse responses of consumption to positive vs negative real house price shock
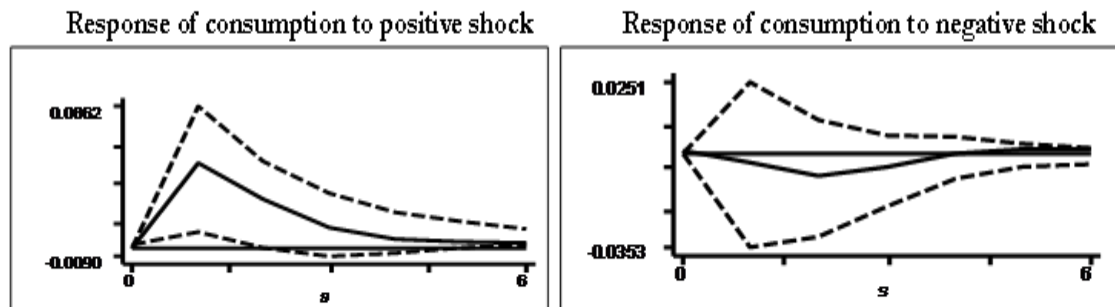
Notes: Bold lines show the impulse response of a specific variable following a house price shock. The dotted lines represent % percent errors on both sides generated by 500 Monte-Carlo replications.

However, in contrast to the single-equation error correction methodology of Das *et al.* (2011), our approach is able to identify the dynamic behavior of consumption over time, with our results indicating that the response of consumption to increases in positive growth in house price is short-lived. This highlights the importance of distinguishing between positive and negative house price shocks, since it provides an explanation as to why the dynamic effect on consumption following an overall house price shock fail to produce a significant impact.

Understandably, for the overall housing shock, which does not differentiate between the sign of the shocks, the average effect on consumption is a sum of both the positive and negative impact, and hence, tends to cancel out a bit as far as significance goes. However, given that consumption responds more strongly, in absolute value, following an increase in positive real house price shock in comparison to an increase in negative shock, the effect on consumption following an overall house price shock is still positive[29]. The asymmetric effect of house price changes on consumption is in line with our intuition put forth earlier. As discussed, with real house price changes likely to affect consumption of single home owners and unlikely to impact renters following house price changes, and owners of multiple houses only when there is a positive shock, the smaller negative impact on consumption is, perhaps, understandable. This could also be a reflection of the collateral enhancement effect as dicussed in Phang (2004).

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[29] The effect of the positive and negative house price shocks on inflation and mortgage rate, as captured by their respective IRFs, are theoretically consistent, which in turn, is expected given the signs of the coefficients in Table 3.3. These results have been suppressed to save space, but are available upon request from the authors.

Therefore, these findings from the provincial level data match the evidence of asymmetric effect found at the national level by Das *et al.*(2011).

3.4.2.3. The role of house prices in explaining consumption: Variance decomposition

This section investigates how much of the variation in consumption is attributable to variations in house prices. This is achieved via the variance decomposition analysis which relies on the forecast error variance to determine the relative importance of house prices shocks.

Table 3.3 reports the forecast error variance decomposition of house prices in the baseline model together with the two types of the house price shocks (*hpp* and *hpn*) in the alternative model. The variance decomposition presents an alternative way of summarizing the information depicted in the IRFs in Figures 3.1 and 3.2. The baseline model, which captures the joint shock, as indicated in the fourth column, suggests that the contribution of house price shock to the variance of consumption is about 2.9% at the 10-year horizon. Further, it shows that house prices shock accounts for 3.2% of the variation in the inflation rate compared to 2.5% in the mortgage rate. As also observed from Figure 2, the effect of the positive house price shock on consumption dominates the effect from the negative shock, with the former explaining 4.2% of the variation in consumption relative to only 0.1% of the same. The positive house price shock also outweighs the negative shock in explaining the variation in house prices itself (45.7% against 11.6%), the inflation rate (3.1% versus 0.4%) and the mortgage rate (3.7% versus 1.7%). Clearly, a positive house price shock affects the dynamics of our model economy much more than a negative house price shock.

Table 3.3

Variance decomposition

Impact from housing price shock on:	Shocks		Joint house price shocks
	Positive house price shock	Negative house price shock	
Inflation	0.031	0.004	0.032
Consumption	0.042	0.001	0.029
Mortgage rate	0.037	0.017	0.049
House prices	0.457	0.116	0.469

Note: The table reports the percentage of variation in the row variable explained by the column variables in the four- and five-variables VAR model. The variance decomposition is at a horizon of 10 years after the shock.

3.5. Conclusion

This chapter employs a Panel VAR approach on a provincial level data set for South Africa over the annual period of 1996-2010, to show that house prices have a short-lived effect on provincial level consumption in South Africa. However, when we differentiated the overall house price shock into its positive and negative components, we found that a positive house price shock tends to have a significant positive effect on consumption, which outweighs the size of the insignificant negative impact on consumption. This result highlighted that house prices changes exhibit an asymmetric effect on consumption. More generally, it also indicates that there is value in disaggregating shocks, since the overall shock could fail to capture the true effect on the variables of interest.

Finally, we found that real house price increases is inflationary, and it is likely that inflation-targeting South African Reserve Bank (SARB) responds significantly to curb such inflationary pressures,[30] as indicated by the increase in the long-term (mortgage rate), which in turn, tend to move in the same direction as the short-term policy rate, via the yield curve. But, it is also important to emphasize, that with positive house price shocks only affecting consumption significantly (as well as inflation positively and significantly, as seen from the GMM estimates in Appendix 3.3), the SARB needs to change its interest rate setting following a house price inflation. Since there is no significant negative wealth effect (deflation) following a decline in house prices, the SARB does not require to boost the aggregate demand by pursuing an expansionary monetary policy.

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[30] Similar observations were also made by Ncube and Ndou (2011) and Peretti *et al.* (forthcoming).

Appendix 3.1: PVAR implementation

The implementation of the PVAR[31] approach requires the underlying structure to be the same for all cross-sections; thereby imposing pooling restrictions across units. However, the introduction of the individual fixed effects denoted by f_i helps to relax these restrictions. Further, the "Helmert transformation" is applied so as to avoid bias due to mean-differencing procedure which is commonly used to purge fixed effects. The "Helmert procedure", known as forward mean-differencing, helps to preserve the orthogonality between transformed variables and lagged regressors which will be used as instruments in the estimation of VAR coefficients by system GMM (Love and Zicchino, 2006).

Within the recursive identification scheme, the impulse response functions are constructed from the estimated PVAR coefficients and their standard errors. Monte Carlo simulations are then used to generate 5% error bands for the impulse responses which correspond respectively to 5th and 95th percentiles of the 500 bootstraps. Because the impulse responses are being orthogonalised, dynamic responses to a particular shock can, therefore, be isolated.

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[31] We make use of the program written by Inessa Love from the World Bank, Research Department Finance Group, 1818 Hst, NW, MC3-300, Washington, DC 20433, United States.

Appendix 3.2: Panel regression results

Fixed Effects (FE), Random Coefficients (RC) and Feasible Generalised Least Squares (FGLS) Estimates

Cm	FE	RC	FGLS
Hp	0.111***	0.396***	0.019***
Test	Pr>F=0.000	Pr>Chi2=0.000	Pr>Chi2=0.000

Breuch-Pagan test of independence: $\chi^2(36) = 96.103$ (Pr=0.000)

SUR Estimates

Panel I: Provincial regression of consumption

cm	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo
hp	0.198**	0.074**	0.272**	0.346**	0.212**	0.226**	0.231**	0.319**	-0.006

Breuch-Pagan test of independence: $\chi^2(36) = 96.103$ (Pr=0.000)

Test	Pr>F=0.000		Pr>Chi2=0.000			Pr>Chi2=0.000

panel II: Correlation matrix

	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo
Western Cape	1.000								
Eastern Cape	-0.201	1.000							
Northern Cape	0.113	0.173	1.000						
Free State	0.623	0.128	-0.244	1.000					
KwaZulu-Natal	0.705	-0.017	-0.104	0.646	1.000				
North West	0.071	0.461	0.233	0.469	0.005	1.000			
Gauteng	0.634	0.179	-0.345	0.505	0.435	0.160	1.000		
Mpumalanga	0.789	-0.391	0.367	0.534	0.428	0.150	0.138	1.000	
Limpopo	0.529	-0.247	0.465	0.122	0.308	0.219	0.148	0.447	1.000

Notes: FE and RC account for heterogeneity while FGLS controls for spatial effects. SUR estimates show provincial estimates after controlling for spatial effect, providing the significance of spatial effects across provinces confirmed by Breuch-Pagan test. Further, the correlation matrix indicates how house price shock in one province spills over other provinces.

Appendix 3.3: Dynamics results

Panel A: 4-VAR	GMM estimates			
	inf(t)	cm(t)	mr(t)	hp(t)
inf(t-1)	0.444(4.07)**	-0.015(-0.46)	0.245(4.05)**	-0.070(-2.07)**
cm(t-1)	0.603(1.49)	0.231(1.49)	0.444(2.10)**	0.165(1.57)
mr(t-1)	-0.681(-3.16)**	-0.054(-0.82)	-0.023(-0.25)	-0.013(-0.22)
hp(t-1)	0.912(2.44)**	0.244(1.67)*	0.455(2.43)**	0.391(4.02)**

	GMM estimates				
Panel B: 5-VAR	inf(t)	cm(t)	mr(t)	hpp(t)	hpn(t)
inf(t-1)	0.441(4.02)**	-0.009(-0.27)	0.233(3.64)**	-0068(-2.54)**	0.0024(0.29)
cm(t-1)	0.589(1.44)	0.251(1.64)*	0.397(1.90)*	0.177(2.04)**	0.005(0.15)
mr(t-1)	-0.689(-3.20)**	-0.041(-0.64)	-0.053(-0.53)	0.060(1.26)	-0.062(-4.36)**
hpp(t-1)	0.839(1.79)*	0.356(2. 21)**	0.194(0.81)	0.436(4.27)**	0.047(1.43)
hnn(t-1)	1.117(1.22)	-0.740(-0.22)	1.193(-2.19)**	-0.143(-.085)	0.269(2.70)**

Notes: VAR is estimated by GMM, unit-specific and fixed effects are removed prior to estimation. Each of the regressors (inf(t-1), cm(t-1), mr(t-1) and hp(t-1))are being instrumented by its own lags. Reported numbers show the coefficients of regressing the column variables on lags of the row variables. Heteroskedasticity adjusted t-statistics are in parentheses. * and ** denote significance at the 10% and 5% level respectively.

Chapter 4

House prices and economic growth in South Africa:

Evidence from provincial-level data♣

4.1. Introduction

Disparities in growth rates have been widening among South Africa's provinces, which account for significant inequality in the spatial distribution of economic activity (Naude and Krugell, 2006). The four fastest growing provinces averaged an annual per capita growth rate of 2.62% over the past five years. In contrast, the two slowest growing provinces registered 1.62% growth rate on average over the same period. The high growth regions differ in terms of population densities, building constructions, personal income, as well as job market conditions. Gauteng and Western Cape are examples of densely populated regions with high house prices that have grown faster over the past five years. Free State is less densely populated and has grown tremendously over the same period, but the house prices are lower with moderate unemployment rate. Conversely, Northern Cape, the slowest growing province has recorded the highest house prices inflation over the past few years (see Table 4.1).

Holly *et al.* (2010) state that changes in housing prices have major implications for output and credit market. Also, job market conditions are sensitive to house prices fluctuations through the affordability of housing and relocation costs (Holmes, 2007). It follows that housing market may stimulate the economy or may trigger economic recession as vindicated by the recent global financial turmoil which had its roots in the subprime crisis in the US. However, from the differences in average house prices inflation across the regions, it is not clear whether regions experiencing high increases in house prices grow faster than those experiencing slow increases in house prices. In effect, house prices may simply keep pace with inflation such that house prices in the relatively poorer regions may not be below the cross-regional average as expected. Understanding how economic growth is related to house prices is therefore of considerable value.

Table 4.1

Characteristics of the fastest and slowest growing provinces in South Africa, 2006-2010

Provinces	Real Per capita Growth rate (%)	Population growth (%)	House prices changes (%)	Unemployment rate changes (%)
Fastest Growers				
Gauteng	2.871	0.666	7.958	3.336
KwaZulu-Natal	2.753	0.521	6.865	-8.978
Eastern cape	2.724	0.496	7.654	-1.644
Free State	2.485	-0.022	9.632	-0.594
Western Cape	2.302	1.094	7.086	4.547
Average	**2.627**	**0.551**	**7.839**	**-0.666**
Slowest Growers				
Northern Cape	1.366	0.981	12.352	-1.078
Mpumalanga	1.620	0.77	10.708	1.205
Limpopo	1.741	0.955	11.289	-3.843
North West	1.743	0.568	9.545	-2.117
Average	**1.617**	**0.818**	**10.973**	**-1.458**

In South Africa, housing accounts for 29.40 percent of household assets and 21.68 percent of total wealth (Das *et al.*, 2011). The permanent income hypothesis asserts that house prices inflation increases the expected lifetime wealth of homeowners and hence their desired consumption. This is known as the wealth effect. The collateral effect, on the other hand, postulates that fluctuations in house prices relax homeowners' financial constraints which may in turn affect their actual consumption. While the wealth effect is immediate, the collateral effect assumes households to be financially constrained. Consequently, distinguishing between the wealth effect and the collateral effect of house prices may contribute to understanding which policy measures will be effective in raising growth. For instance, easing borrowing constraints to stimulate the economy may not be efficient if the recession is due to the wealth effect; meaning that "... households voluntarily reduce consumption because they feel poorer" (Miller *et al.,* 2011).

Against this backdrop, this study investigates the effect of house prices on provincial Gross Domestic Product (GDP) in South Africa over the period of 1996 to 2010. South Africa comprises of nine provinces namely: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, North West and Western Cape. We provide a provincial map of South Africa in the Appendix 4.1 to assist the reader in understanding the geographical structure of the country and its provinces. The methodology employed is able to address diverse econometric issues in analyzing house prices within a panel data context. Specifically, we apply Fixed Effect and Random Coefficient models to account for heterogeneity and Generalised Method of Moments to control for endogeneity. Spatial dependence, on the other hand, is addressed within an error component framework in which Seemingly Unrelated Regression (SUR) is considered to allow for cross-provincial comparison.

The estimation results from this study provides strong evidence that house prices changes significantly and positively affect provincial-level per capita GDP growth, both across and within provinces. The importance of cross-correlation between regions is also established, indicating that economic growth in a province is not only affected by the local house price changes but also by the fluctuations in house prices in other provinces. Further, we distinguish between collateral effect and wealth effect. As in Campbell and Cocco (2007), collateral effect is captured by the predictable component of house price changes and wealth effect by the unpredictable component of house price changes. Whilst the wealth effect is relevant at the aggregate level, the evidence from cross-sectional variation is mixed. The economic effect of the predictable component of house price changes dominates in five out of nine provinces whereas the economic effect of the unpredictable component rules four provinces. These variations substantiate the heterogeneity of regional housing markets within the South African economy; indicating thereby the existence of socio-economic imbalances among provinces.

The rest of the chapter is organised as follows: the second section provides theoretical motivations for the economic impact of house prices and reviews thereafter the limited evidence of the effect of housing price fluctuations on economic growth. The third section describes the data with respect to the measures and transformation of the variables included in the regression. The fourth section discusses the empirical methodology. The fifth section presents the estimation results, and the last section concludes.

4.2. Literature review

Although the economic impact of house prices may be channelled through a variety of transmission mechanisms (Demary, 2010), the literature on housing mainly focuses on the wealth effect and the collateral effect.

Derived from Friedman's Permanent Income Hypothesis, the wealth effect suggests that unexpected house prices appreciation is likely to increase the expected life time wealth of homeowners and thereby their desired consumption. Since housing accounts for a substantial share of household assets and wealth, house prices inflation would increase the expected life time wealth of homeowners. Based on the assumption that homeowners are willing to smooth consumption over their life time, the increase in life time wealth would increase their desired consumption (Miller *et al.,* 2011).

Furthermore it has recently been argued that a link between house prices and consumption may arise via the collateral effect (Ortalo-Magne and Rady, 2004). When households are financially constrained, house prices increase can help relax homeowners' financial constraints which translate into an increase in credit supply. Since housing wealth can be collateralised, higher house prices enhance the borrowing capacity of homeowners and enable them to borrow and spend more. The rise in credit supply will lower interest rates which may affect the actual consumption instead of desired consumption. Therefore, the consumption effect of house price changes relies on the assumption that the actual consumption of constrained households is lower than their desired consumption.

An increasing body of empirical literature on housing now exists, particularly in developed countries, and offer mixed conclusions about the economic impact of house price changes. While many studies (see for example Benjamin *et al* (2004), Case *et al* (2005), *Carrol et al* (2006), Kishor (2007), Campbell and Cocco (2007), Bostic *et al.* (2009)) subtantiate the consumption effect of house price changes, there are some evidence that house prices inflation is not favourable to consumer optimism. These studies include Phang (2004), Koivu (2010) and Song (2010). According to Phang (2004), the liquidity constraints of homeowners, might be the reason why house price inflation in Singapore do not affect consumption. Housing being a risky asset with uncertain value, households are not willing to use housing equity to finance consumption. This interpretation is in line with the findings by Song (2010) that the existence of transaction

costs halts the conventional comovement between housing and consumption. Additionally, the positive link between asset price and household consumption in China is not robust due to the high volatility of the stock market (Koivu, 2010). Although these studies focus on consumption, their different results suggest that housing effect is country specific.

Furthermore, the link between house prices and the macroeconomy is well- established (Sutton, 2002; Tsatsaronis and Zhu, 2004; Stepanyan *et al.*, 2010). However, with notable exceptions most of these studies are based on national data and ignore the issue of spatial dependence which might cause severe bias in the estimates. In effect, the work of Meen (1996) on the UK housing market has confirmed the high degree of parameter variation across the regions; invalidating thereby parameter homogeneity-based approaches such as aggregate national equations and panel estimations.

Given the dual causality between house prices and macroeconomic variables (Goodhart and Hofmann, 2008), one can conjecture that the impact and transmission mechanism of housing wealth also depend on business cycle trends. Demary (2010), therefore, highlights the need to consider the output rather than consumption when assessing the effect of house price changes. This is because output summarises the information such as investment and wages that may affect the transmission channel of house price variations. In fact, consumption being the main component of output, the rise in the demand for consumption goods following unexpected changes in house prices will push the gross domestic product above its long term steady state, *ceteris paribus*.

A more recent study by Holly *et al.* (2010) has investigated the link between house prices and output, using U.S. state-level panel data. They exploit newly developed techniques for the analysis of heterogeneous dynamic panels and show that house prices and per capita income converge in the long run. More interestingly, they find evidence that spatial dependence matters in the U.S. housing market; and that the borrowing cost negatively affects the real house prices. The state level population growth, however, is found to be positively related to changes in real house prices. Similar results are provided by Miller *et al.* (2011) who rather exploit U.S. metropolitan statistics. But, they find the collateral effect to be stronger than the wealth effect; suggesting that financially constrained households are more likely to borrow against sustainable house price changes. Both studies apply the Common Correlated Effects (CCE) estimator which controls for heterogeneity and spatial dependence. Similar results are provided by Miller *et al.*

(2011) who rather exploit metropolitan statistics in USA. But, they find the collateral effect to be stronger than the wealth effect; suggesting that more financially constrained households are more likely to borrow against sustainable house price changes. Both studies apply the Common Correlated Effects (CCE) estimator which controls for heterogeneity and spatial dependence.

However, these findings cannot be generalised to the developing countries since housing is country specific and crucially depends on the level of development. Moreover, the choice of the appropriate method depends on purpose and characteristics of the data generating process (Smith and Fuertes, 2008). For instance, the CCE estimator is not appropriate for short panels (Pesaran, 2006) and does not allow cross-sectional comparison since the estimation focuses on the average value of the parameter vector of the slope coefficients. On the other hand, Podesta (2002) points out that Seemingly Unrelated Regression (SUR) represents an appropriate tool for comparative studies. Suitable for panel time series, this framework offers the possibility to link the causal effect within cross-sections to characteristics that vary across units.

Therefore, this study makes the following contributions to the literature. Firstly, it carries out a case study in a developing country on the basis of regional data which provide more informative results. To the best of our knowledge, this is the first such attempt for South Africa. Secondly, the methodology employed allows for cross-provincial comparison by taking into account not only the heterogeneity, but also the spatial dependence. Considering the housing market as a series of interconnected provincial markets rather than a national aggregate amounts to capturing spatial structure as well as provincial adjustment mechanism such as wages and migration (Meen, 1996).

In contrast to previous studies, this chapter offers a comparative analysis in terms of cross-provincial variations, using SUR which better fits relative thin panels. In fact, these studies make important contributions by analysing housing within a framework that addresses the issues of common factors including spatial dependence in large panels. However, these studies do not answer the question whether the impact and transmission mechanism of house price changes differ across cross-sections, whereas the present study tries to answer this question.

4.3. Preliminary data analysis

This study compiles regional data for nine provinces in South Africa during the period 1996 and 2010 (that is, T=15 and N=9). The choice of the data set is constrained by the availability of regional data which only start in 1996. Although there seems to be consensus among growth economists that annual data might not be ideal for statistical inference, Bond *et al.* (2010) provide meaningful conclusions on growth analysis using annual variables. Based on available data, we follow Bond *et al.* (2010) and make use of six annual time series: Per capita GDP, house prices (HP), personal income (PI), population (POP), the unemployment rate (UR) and the number of buildings plans passed (BP) used as a proxy for the number of construction permits. Apart from house prices[32], obtained from Allied Bank of South Africa (ABSA)[33], and buildings plans passed, derived from Statistics South Africa, the remaining four variables are provided by the Regional Explorer data base maintained by Global Insight South Africa. Data on Consumer Price Index (CPI) is extracted from the International Monetary Fund's database is used to obtain real terms for per capita GDP, house prices and personal income.

Personal income, population, the unemployment rate and number of buildings plans passed are included in our analysis as control variables in order to alleviate the reverse causation from economic growth to house prices. It is reasonable to argue that the impact of gdp on household income involve housing demand through its effect on local demographic conditions, such as migration and population changes (Ortalo-Magne and Rady, 2004). Therefore, personal income and population are used to capture this effect of gdp. Similarly, the impact of gdp on regional labour market conditions might affect both the demand and supply of housing due to the resulting labour force migrations. Therefore, labour market conditions are proxied by unemployment rate (Clayton *et al.*, 2010). Furthermore, it is standard to control for housing construction as changes in economic performance contribute to house price changes prompted by the volume of housing transactions. As a result, the number of building plans passed is

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[32] Note, ABSA categorizes housing into three price segments, namely luxury (ZAR 3.5 million – ZAR 12.8 million), middle (ZAR 480,000 – ZAR 3.5 million) and affordable (below ZAR 480,000 and area between 40 square metres - 79 square metres). The middle segment is further categorized into three more segments based on sizes, namely large-middle (221 square metres – 400 square metres), medium-middle (141 square metres – 220 square metres) and small-middle (80 square meters – 140 square meters). Additionally, house prices are also available for the entire middle-segment. However, no house price data is available at the provincial level for the luxury and affordable sections. Hence, for provincial level house price data, we use the house prices corresponding to the entire middle-segment. This is understandable since the other provincial-level macro variables are not categorized based on the alternative sizes of the middle-segment.

[33] ABSA is one of the leading private banks in South Africa.

included in the regression. Accounting for all these control variables is likely to isolate the effect of the exogenous component of house prices caused by gdp.

The initial inspection of the data shows a strong comovement between per capita GDP and House prices, suggesting that they are positively related (see Figure 4.2). However, in order to draw efficient conclusions, such relation needs to be assessed based on an econometric modelling. Since the asymptotic properties of standard panel estimators rely on whether time series are stationary or not, determining the order of integration of variables becomes important. The Im, Pesaran and Shin (2003) (IPS)[34] unit root test is therefore conducted. Unlike other panel unit root tests (including Levin, Lin and Chu (2002), Maddala and Wu (1999), among others), IPS test is consistent in the presence of both heterogeneity and serial correlation. As mentioned earlier, provided that regions in the sample share some similar features, cross-section dependence is more likely to be present.

For a particular variable y, the starting point for the IPS test is a set of Augmented Dickey Fuller (ADF) regressions of the following form:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{k} \phi_{ij} \Delta y_{i,t-j} + \lambda_i t + u_{it}, \quad i=1,\ldots,N; \ t=1,\ldots,T. \tag{1}$$

where α_i and β_i are respectively panel-specific intercept and slope, t is the time trend and u_{it} the residuals assumed to be normal independently distributed for all cross-section i with heterogeneous variances across panels.

The average t-statistic of these regressions is thereafter used to compute the IPS test as follow:

$$IPS = \frac{\sqrt{N}\left(\bar{t} - E(\bar{t})\right)}{\sqrt{var(\bar{t})}} \tag{2}$$

---

[34] The size of the panel (N=8) could not allow us to consider other alternatives such as cross-section IPS (CIPS) which has been shown to encounter under-size distortion (Hashiguchi and Hamori, 2010).

Table 4.2

IPS unit root test results

	Variables					
	GDP	HP	PI	POP	UR	BP
With trend	-2.06	-1.40	-1.69	-0.12	-2.39	-2.28
Without trend	-1.30	-0.47	0.29	-15.9	-1.97	-1.91

Notes: Under the null hypothesis that all panels contain a unit root, we have $\alpha_i = 0$ for all i. The alternative is that the fraction of panels that follow stationary processes is nonzero; i.e., as N tends to infinity, the fraction N1=N converges to a nonzero value, where N1 is the number of panels that are stationary. Critical values with trend are: -2.88, -2.66 and -2.54 at 1%, 5% and 10% respectively. Critical values without trend are: -2.24, -2.02 and -1.90 at 1%, 5% and 10% respectively.

Table 4.3

Data summary

	gdp	hp	pi	Pop	Ur	bp
Panel I: Means, medians, and standard deviations						
Mean	-0.042*	0.062*	0.018*	0.011*	0.023*	-0.016
Median	-0.040*	0.049*	0.010*	0.011*	0.010	-0.011
Std. Dev.	0.036*	0.117*	0.034*	0.005*	0.087*	0.42*
Panel II: Correlation Matrix						
Gdp	1					
hp	0.681*	1				
pi	0.819*	0.518*	1			
pop	-0.153	0.034	-0.345*	1		
ur	-0.412*	-0.2176*	-0.428*	0.323*	1	
bp	0.186*	0.2435*	0.161	0.112	0.098	1

Notes: Panel I shows the cross regional averages of the means, medians and standard deviations of the six variables (in log differences form). Panel II displays the cross regional average correlations among all the variables. * denotes significance at the 5% level.

Figure 4.1: Per Capita GDP and House Prices.
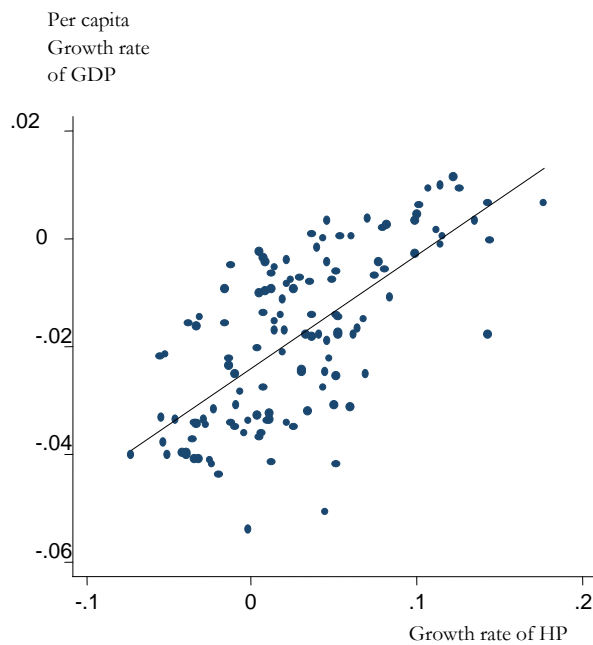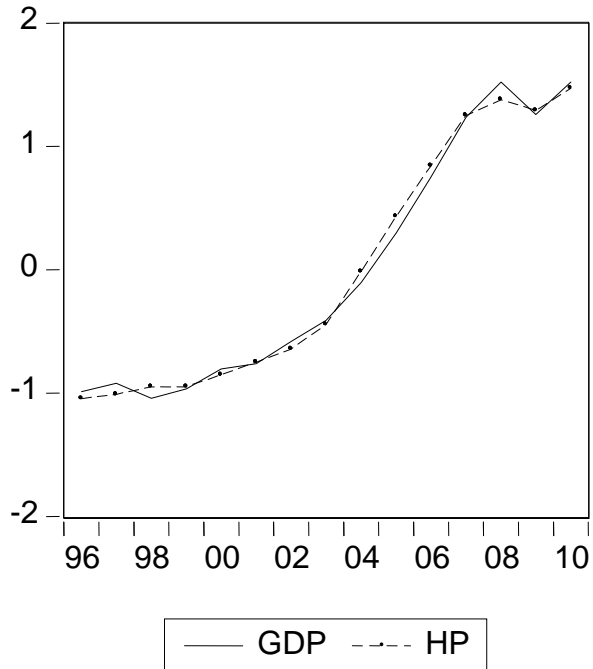
Notes: Upper panel shows normalised (transformed to same scale) real per capita GDP and real HP across regions. Lower panel shows OLS regression line between the per capita growth rate of GDP and the growth rate of HP across regions.

Unit root test results in Table 4.2 indicate that all variables in levels exhibit non-stationarity. Only the variable POP is stationary without trend. However, it becomes non stationary when allowing for a time trend. This is plausible as the demographic boom is one of the major characteristics of developing nations. These results indicate that the null hypothesis of a panel unit root cannot be rejected, justifying the need to transform the data. We, therefore, use the first differences of the log values of the variables rather than their log levels, except the unemployment rate, for which we used only first difference of the variable. The transformed data are denoted as: gdp, hp, pi, pop, bp and ur which respectively stand for the growth rates of GDP, HP, PI, POP, BP and the changes in UR.

Table 4.3 summarises the six time series across regions. Although the correlation between gdp and hp is positive and significant, it is worth noting that, both gdp and hp are significantly correlated to the regional control variables (personal income, population, total residential buildings and the unemployment rate.). This justifies the importance of controlling for these variables in order to alleviate the reverse causation from gdp to hp.

4.4. Empirical methodology

The empirical analysis is based on panel time series modelling since the time dimension is dominant. Besides the wide benefits of panel data[35], panel time series has the advantage to address the issues of heterogeneity and endogeneity in relatively thin panels. In addition, it is usual to assume the absence of cross-section dependence in panels but Smith and Fuertes (2008) assert that such assumption appears restrictive for many applications in macroeconomics and finance. Spatial econometrics suggest a natural way to characterise dependence in terms of distance. However, for most economic problems there is no obvious distance measure (Baltagi, 2008). Panel time series on the other hand, offer a variety of tools designed to deal with cross-sectional dependence; the choice of the method depending on purpose and characteristics of the data generating process.

Recall that, although all the provinces in South Africa are subject to the same monetary and fiscal policies, political and legal environments, as well as financial market conditions, it is worth noting that the effects of macroeconomic shocks on the housing market might be of different

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[35] The advantages of panel data include: (i) efficiency gains and the possibility of estimating more complex dynamic models, (ii) identifying unobserved effects such as differences in adjustment over units, (iii) mitigating multicollinearity problems.

magnitude across provinces. Furthermore, labour mobility and lower house prices in certain provinces may provide an incentive to migrate. In addition, there are notable differences among provinces in the country as far as the housing market is concerned. These differences include population density, human capital and land availability among others. Given the importance of heterogeneity in spatially distributed housing markets, we hypothesise that real income differs among provinces because of variations in real house prices.

The issue of heterogeneity is common in dynamic time series panels. It arises because of misspecification when assuming homogeneity across units. As a result, the regressors are correlated to the lagged dependent variable since the disturbance term is serially correlated. Two solutions are frequently suggested to deal with this problem. One can either use the Fixed Effect (FE) model or the Random Coefficient (RC) model. Although both models allow for cross-section individual effects, the FE estimates might not be appropriate as slope coefficients are assumed to be homogeneous. The RC estimator, which considers heterogeneity of both intercepts and slopes, is designed to address this inconsistency. More specifically the baseline model is given by:

$$\mathbf{gdp_{it} = \alpha_i + \beta hp_{it} + \delta' x_{it} + \lambda gdp_{i(t-1)} + \varepsilon_{it}} \, , \qquad i = 1,...,N; \, t = 1,...,T. \qquad (3)$$

Where α_i is a the regional fixed effect; gdp_{it} and hp_{it} are respectively the log differences of the regional GDP and house prices; x_{it} is a vector of control variables including log differences of personal income, population, the unemployment rate and the log difference of the number of building plans passed; and ε_{it} is the error term.

The major attraction of the FE estimator is its ability to control for all regional specific characteristics and thereby alleviating potentially sources of bias. This method consists of differencing out the individual variability across regions; the intuition being that within-variation can eliminate much of the error variance. Thus, the FE estimator results in a pooled Ordinary Least Square (OLS) estimator on the differenced (demeaned) equation and provides unbiased estimates under strict exogeneity assumption. However, disregarding between-variation can yield biased standard errors that may in turn lead to wrong inference. Differently from the FE model which assumes random intercepts $\mathbf{\alpha_i}$ and homogeneous slopes $\mathbf{\beta}$, the RC model treats all parameters as random. Since it uses both within and between- variations, RC has less sampling

variability than FE (Baltagi, 2008). RC estimator proposed by Swamy and Tavlas (1995) can be interpreted as a Generalised Least Square (GLS) estimator which is a weighted average of the time series $\hat{\beta}_i$ estimates of different regions.

Specifically, the above equation takes the form:

$$\mathbf{gdp_{it}} = \boldsymbol{\alpha_i} + \boldsymbol{\beta_i}\mathbf{hp_{it}} + \boldsymbol{\delta}'\mathbf{x_{it}} + \boldsymbol{\lambda}\mathbf{gdp_{i(t-1)}} + \boldsymbol{\varepsilon_{it}}, \qquad i = 1,...,N; \; t = 1,...,T. \qquad (4)$$

Note that both FE and RC estimators provide consistent estimates under the assumption of orthogonality of the error term which, however, seems unrealistic for several reasons. First, some omitted variables included in the disturbances may be correlated with house prices. Second, Stepanyan *et al* (2010) argue that dynamics of fundamentals such as GDP, remittances and external financing lead house price fluctuations. Hence, the independent variable (house prices) in our model appears to be determined simultaneously along with growth. Third, measurement errors are frequent in most empirical studies. These reasons raise the issue of endogeneity and the Hausman test[36] (P>|t|=0.000) could not reject this assumption.

The SYSTEM-Generalised Method of Moments (SYS-GMM) estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998) is popular in addressing the problem of endogeneity. This method consists of controlling for a number of instruments in order to improve the efficiency of the estimates. To account for the existence of weak instruments, SYS-GMM makes available a large set of instruments that include the moment conditions for the first-difference GMM as well as the extra moment conditions for the model in levels. However, this estimator is consistent for large sample and can be inconsistent if all the available instruments are being used (Hayakawa, 2006). We, therefore, make use of the small-sample adjustment provided by Windmeijer (2005). Furthermore, in order to avoid overfitting, we carefully control for the number of instruments and use "internal" instruments that only include lags of the instrumented variable (hp).

Formally, the following specification is estimated:

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[36] The test is conducted in two steps: we first regress the potential endogenous variable (HP) on its instruments (its own lags and the other control variables). The residuals from this regression are then added in the main regression as an additional independent variable. Under the null hypothesis of exogeneity, the coefficient of this extra explanatory variable is expected not to be significant at the conventional level of significance.

$$\Delta\mathbf{gdp_{it}} = \alpha\Delta\mathbf{hp_{it}} + \boldsymbol{\delta'}\Delta\mathbf{x_{it}} + \lambda\Delta\mathbf{gdp_{i(t-1)}} + \Delta\boldsymbol{\epsilon_{it}}, \qquad i = 1,...,N; \ t = 1,...,T. \qquad (5)$$

Although SYS-GMM might help to mitigate the issue of endogeneity, it is unable to alleviate the bias due to the spatial effect and its implications for parameters consistency. In fact, despite regional variations in economic development, GDP in one region can be affected by not only local house price changes but also house prices changes in other regions. Moreover, house prices might be correlated across regions and thus have spatial effect. This justifies the need to consider an error component based-approach.

The Feasible Generalised Least Squares (FGLS) does not impose any restrictions on the error structure. This procedure allows for autocorrelation within panels, cross-sectional correlation and/or heterocedasticity across units. It is similar to a random effects model in which the regression disturbances comprise three dimensions: one component associated with time, the other associated with space and the third associated with both time and space (Podesta, 2002). Furthermore, we consider a Seemingly Unrelated Regression (SUR) in order to link the differences in the economic impact of house prices within regions to characteristics that vary across regions. It is a system of individual regressions in which cross-equation errors are allowed to be correlated. Thus, FGLS can be interpreted as a pooled SUR in which estimates rather represent the average value of the regional coefficients since they vary across regions.

More precisely, by stacking the observations in the t dimension,

let $GDP_t = [gdp_{1t}, ..., gdp_{Nt}]'$, $HP_t = [hp_{1t}, ..., hp_{Nt}]'$, $X_t = $ *block-diagonal matrix with* $x_{1t}, ..., x_{Nt}$ on its diagonal, $U_t = [\varepsilon_{1t}, ..., \varepsilon_{Nt}]'$, our model has the following SUR representation:

$$\mathbf{GDP_t} = \boldsymbol{\alpha_t} + \boldsymbol{\beta}\mathbf{HP_t} + \boldsymbol{\delta'}\mathbf{X_t} + \lambda\mathbf{GDP_{(t-1)}} + \mathbf{U_t} \qquad (6)$$

Where $\mathbf{U_t}$ represents the contemporaneous cross-equation errors.

4.5. Estimation results

This section first starts off with aggregated results. Four models, namely, the FE, RC, SYS-GMM, and FGLS estimators are employed to estimate the economic effect of house price fluctuations. Based on a series of assessments on model diagnostics, the model with cross-section dependence appears the most appropriate. Cross-regional analysis is then proceeded in order to present parameter estimates that vary across regions. The second interest consists of disaggregating the economic effect of the different components of house price changes.

4.5.1. Aggregate effect of house price changes on economic growth

Table 4.4 reports the results of four different estimators. In all the regressions, estimates for the coefficient of house price changes are positive and significant, which is consistent with the theoretical effect of house prices on economic growth. Nevertheless, there are noticeable differences among these estimators and it is useful to understand the source of these differences. The first regression, FE, which ignores heterogeneity of slopes, finds no significant relation between GDP growth rate and three of the four control variables, notably population growth rate, unemployment rate and changes in building plans passed. Although the RC regression accounts for the heterogeneity of slopes, its results do not really differ from the FE estimates. This is not surprising since both FE and RC are subject to the well known Nickell bias when applied to short panel time series. However, the F-test (Pr>F=0.0362) and Wald test (Pr>χ^2=0.000) illustrate some evidence of country fixed effects, and heterogeneity of intercepts and slopes, which rationalises the use of FE and RC estimators as benchmark in this instance.

Table 4.4

FE, RC, SYS-GMM, and FGLS estimates of house prices on economic growth

gdp	FE	RC	SYS-GMM	FGLS
hp	0.086***	0.082**	0.105*	0.827***
pi	0.727***	0.747***	0.489	0.383***
pop	0.784	1.275	-3.42**	-3.677***
ur	-0.021	-0.015	0.042	-0.014
bp	0.002	0.001	0.012**	0.005***
gdp$_{-1}$	-0.137*	-0.216*	-0.24*	-0.352***
F test	(Pr>F=0.036)			
Wald test		(Pr>chi2=0.000)		(Pr>chi2=0.000)
Sargan test			(Pr>chi2=1.000)	
Arellano-Bond test			(Pr>Z=0.46)	

Notes: This table shows regressions of per capita gdp on the house prices appreciation (hp) controlled by regional variables: personal income (pi), population (pop), unemployment rate (ur), and building plans passed (bp), including the lag dependent variable gdp$_{-1}$ to account for dynamics. The SYS-GMM estimates are corrected for small sample bias as in Windmeijer (2005). *, ** and *** denote significance at 10%, 5% and 1% level respectively.

In view of the above arguments, the FGLS estimators are consistent regardless of house price changes being endogenous. This substantiates the importance of allowing for cross-sectional dependence. The coefficient of house price changes is now significantly larger since the residual has been purged with the contemporaneous cross-equation error correlations. We conclude that a positive shock in the housing market is likely to increase the economic growth in South Africa. Note that the lag dependent variable is found to be significant and negative, suggesting a conditional convergence across regions. In other words poorer regions are expected to catch up with richer ones. Regional level population growth has a significant and negative effect on per capita gdp growth which is unsurprising given the high level of unemployment in developing countries.

4.5.2. Cross-regional dependence analysis

The potential importance of regional dependence is inspected based on the Lagrange Multiplier tests for the diagonality of the cross-equation error covariance matrix developed by Breusch and Pagan (1980). This approach assumes one particular form of spatial dependence: the spatial error model which is well addressed in the SUR framework. This estimator further helps to improve the efficiency of the individual regression estimates by allowing cross-equation residuals to be correlated. The results are reported in Table 4.5. Panel I provides strong evidence that house price changes affect economic growth and that the effects vary across provinces. For instance, the effect of house price changes in North West is about three times stronger than in Western Cape and KwaZulu-Natal. Similarly this causality in Free State, Limpopo, Gauteng and Northern Cape is, respectively, about 2.3, 2, 1.5 and 1.3 times stronger than Western Cape and KwaZulu-Natal.

The Breuch-Pagan test of independence (Pr= 0.000) rejects the null hypothesis of independence, indicating the importance of cross-provincial correlation. The second part of the table provides the appropriate test for each province: the higher the correlation coefficient, the stronger the spatial dependence. In no province, does spatial errors independence hold on the basis of correlation matrix residuals. Again, this appears to confirm the spatial interactions in the South African regional housing markets. Spatial dependence is omnipresent; the degree of dependence in the Western Cape is particularly noticeable, with higher correlation with almost all provinces.

Table 4.5

Seemingly unrelated regression estimates

	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo
panel I: regional regressions of the growth rate of gdp									
hp	0.087**	0.129***	0.153***	0.195***	0.084**	0.258***	0.157***	0.123***	0.162***
pi	0.379**	0.302*	0.625***	-0.021	0.779***	0.247**	0.194*	0.045	0.089
pop	-2.354***	-7.97***	-6.56***	-6.331***	0.412	-6.22***	-2.444***	-2.93***	-3.59***
ur	-0.137**	-0.035	0.047*	-0.208**	-0.044	-0.129**	-0.073*	-0.138***	0.118**
bp	-0.0003	-0.022**	-0.005**	0.004	0.007	0.034***	0.018*	0.037***	0.0123
gdp$_{-1}$	-0.127	-0.024	-0.12514	-0.974***	-0.0908	-0.95***	-0.357**	-0.864***	-0.36**

Breuch-Pagan test of independence: $\chi^2(36) = 96.103$ (Pr=0.000)

Panel II: Correlation Matrix of residuals									
Western Cape	1								
Eastern Cape	0.6845	1							
Northern Cape	0.5343	0.4682	1						
Free State	0.6015	0.4145	0.2786	1					
KwaZulu-Natal	0.6925	0.2877	0.5244	0.4234	1				
North West	-0.3248	0.0144	0.387	0.171	-0.1207	1			
Gauteng	0.6927	0.7481	0.3505	0.4876	0.5671	-0.0923	1		
Mpumalanga	0.1544	0.3825	0.05772	0.1784	0.2655	0.679	0.4349	1	
Limpopo	0.3693	0.2721	0.6367	-0.1738	0.4659	0.0046	0.2815	0.1892	1

Notes: Panel I reports the SUR estimates for each region. *, ** and *** denotes significance at 10%, 5% and 1% level respectively. Panel II shows the cross-regional correlation matrix.

For instance, the house price shock originating in Western Cape spreads in six out of nine regions. Note that it is not consistently the case that dependence is related only to neighbouring locations. For example, Limpopo has links with the Eastern Cape, whereas Gauteng is related to Western Cape, Eastern Cape and KwaZulu Natal. This raises the inadequacy of the simple binary spatial weights matrices and matrices based on distance decay. It is also important to highlight that practically all the correlations residuals are positive, suggesting the absence of planning restrictions which might force builders to migrate elsewhere (Meen, 1996).

Spatial dependence is related to spatial convergence which implies a stable long-run relationship between house prices in the regions. Although not shown, if house price changes in one region affect the economy in other regions, there is also the possibility of spatial convergence in house prices. In effect, the growth convergence hypothesis cannot be rejected in

this instance; the average coefficient of the gdp$_{-1}$ being negative and significant (-0.352). Given the reverse causation from growth, migration and job market conditions may act as regional equilibrium mechanisms leading to house prices convergence. This interpretation is in line with the evidence of "ripple effects" found by Das *et al.,* (2010) and Balcilar *et al.,* (forthcoming) in the housing market of metropolitan areas of South Africa.

4.5.3. Economic effect of the different components of house prices

Recall that there are two main mechanisms which drive the economic effect of house price changes. A better understanding of these mechanisms requires us to distinguish between the predictable component which captures the collateral effect (hpc)[37] and the unpredictable component which denotes the wealth effect (hpw). The predictable and unpredictable components are proxied respectively by the fitted values and the residuals of the regression of house price changes on an intercept term and the instrumental variables. These instruments include twice lagged gdp, hp, pop and pi. Note that the regression is conducted for each region separately. The descriptive statistics are summarised in Table 4.6. While the wealth effect appears to be of negligible importance, the collateral effect seems to validate the hypothesis that households are expected to borrow more against house prices inflation. The reason is because the wealth effect corresponds to regression residuals which sum up to zero. Adequate econometric tools are therefore required to examine the true causality.

Having established the distinction between collateral and wealth effects, the interest is now focused on the economic magnitude of each component of house price changes. We first compute estimates for the average economic effect across regions. Thereafter, we consider SUR estimators to account for cross-section variation of the economic effect. The results are reported in Table 4.7. As observed from this Table, predictable and unpredictable components of house price changes are positive[38] although not all significant. The pooled estimators show that the wealth effect of house price changes across regions is stronger than the collateral effect; the coefficients of the two effects being respectively, 0.149 and 0.101 in the preferred model (FGLS).

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[37] Readers should be cautious that precautionary savings or myopic behaviour might also be part of the predictable component of house price changes (Campbell and Cocco, 2007).

[38] The coefficient of the collateral effect is negative in North West but not significant.

Table 4.6

House price changes disintegration

	hp	hpc	Hpw
Panel I: Means, medians, and standard deviations			
Mean	0.062*	0.072*	0.000
Median	0.049*	0.069*	0.009
Std. Dev.	0.117*	0.079*	0.091*
Panel II: Correlation Matrix			
hp	1		
hpc	0.656*	1	
hpw	0.755*	-0.000	1

Notes: This table reports summary statistics for different components of house price inflation. Panel I reports the cross-regional averages of means, the medians, and the standard deviations. Panel B reports the cross-regional average correlations among the components. T-tests are conducted for zero-means and * denotes significance at the 5% level.

Table 4.7

Economic impact of different components of house prices

	hpc	Hpw
Panel I: Average impact across regions		
FE	0.088***	0.110***
RC	0.056	0.094**
SYS-GMM	0.423	0.489
FGLS	0.101***	0.149***
Panel II: regional impact		
Western Cape	0.291***	0.183***
Eastern Cape	0.163***	0.089*
Northern Cape	0.121***	0.221***
Free State	0.106	0.097*
KwaZulu-Natal	0.106**	0.042
North West	-0.055	0.134***
Gauteng	0.184**	0.234***
Mpumalanga	0.174***	0.055**
Limpopo	0.269**	0.357***

Breuch-Pagan test of independence: $\chi(36) = 102.44$ (Pr=0.000)

Notes: Panel I reports the pooled effect of each component of house price changes. Panel II displays the effect of each component of house price changes for different regions. *, ** and *** denotes significance at 10%, 5% and 1% level respectively.

This suggests that the aggregate borrowing facility is not the relevant variable in South Africa. In effect, the collateral effect is based on the intuition that housing wealth is an important borrowing collateral and hence, the economic impact of house prices is expected to relate to the borrowing constraints of homeowners. In other words, the collateral effect is stronger when households are more constrained and the wealth effect is higher when households are less constrained[39].

For the cross-regional variation analysis, the results are mixed. In terms of magnitude, the wealth effect is dominant in Northern Cape, North West, Gauteng and Limpopo; indicating that households are not affected by the collateral value of their houses since they are less constrained. Also, as indicated by Campbell and Cocco (2007), the collateral and wealth effects are not mutually exclusive except in Free State, KwaZulu-Natal and North West.

On the other hand, the collateral effect dominates in Western Cape, Eastern Cape, KwaZulu-Natal and Mpumalanga; substantiating the hypothesis that at the regional level, households more likely borrow against house prices inflation (Miller *et al*, 2011). Besides the inability for South African households to save (Luüs, 2005), these provinces are dominated by low income households who are more exposed to financial constraints. While Eastern Cape is the poorest province in South Africa (Baiyegunhi *et al*, 2010), the presence of poor households in KwaZulu-Natal is not surprising since the local economic development is essentially driven by the small, mediums and micro enterprises that are also subjected to financial constraints (Rankhumise and Rugimbana, 2010).

Moreover, although Western Cape and Mpumalanga inherits socio-economic benefits, their increasing level of inequality (Bhorat and Van der Westhuizen, 2005) favourable to poverty might be the reason why constrained households are more prominent in these provinces than unconstrained households. We, therefore conclude that regional variations are due to the existence of socio-economic imbalances among provinces.

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[39] The empirical test was also conducted using the housing ratio proposed by Lustig and Van Nieuwerburg (2010). To the previous regressions, we add an additional regressor (interaction between house price changes and housing collateral ratio); a negative sign being expected for the coefficient of the interaction term as households are less constrained when the housing collateral ratio is larger. However, the coefficient was found positive, substantiating the importance of the wealth effect. The estimation results are available upon request from the authors.

4.6. Conclusion

This chapter investigates the economic impact of house prices in a panel made up of nine South African provinces over fifteen years where there is a significant spatial dependence. Different estimation techniques are applied to account for heterogeneity, endogeneity and spatial dependence in analysing house prices within a panel data context. After addressing these econometric issues, our results provide strong evidence that house price changes affect regional economic growth and that the effects vary across regions.

The causation from house price changes to economic growth channels through the collateral effect and the wealth effect. We find that the wealth effect of house prices is stronger than the collateral effect at the aggregated level; indicating that homeowners are more likely to raise their desired consumption as house prices increase. Conversely, at the regional level, the collateral effect dominates in four provinces namely Western Cape, Eastern Cape, KwaZulu-Natal and Mpumalanga. We conclude that in these regions, homeowners are more likely to borrow against house prices appreciation, in order to increase their actual consumption. From a policy perspective, these findings suggest that the monetary authority might want to stimulate the economy by relaxing borrowing constraints in regions where the collateral effect is dominant (Miller *et al.*, 2011). On the other hand, this policy might not be efficient at the aggregated level since a fall in house prices is more likely to lead to an economic recession due to the wealth effect. However, as mentioned earlier, the two effects are not clearly separated in a way that provides sufficient evidence that the economic impact of house prices is due to wealth effect or collateral effect. This result is in line with Campbell and Cocco (2007) who assert that the two effects are not mutually exclusive.

In general, we find overwhelming evidence of a positive impact of house prices on provincial-level growth in South Africa. Given the dual nature of the causal relationship between housing market and the real economy which is, however, not empirically supported by the analysis of this chapter, this finding can be further improved by the mean of a more rigorous empirical methodology. For instance, modelling housing dynamics within a multivariate framework could possibly provide further insights on the economic impact of house prices in South Africa.

Appendix 4.1: The Nine Provinces and Map of South Africa
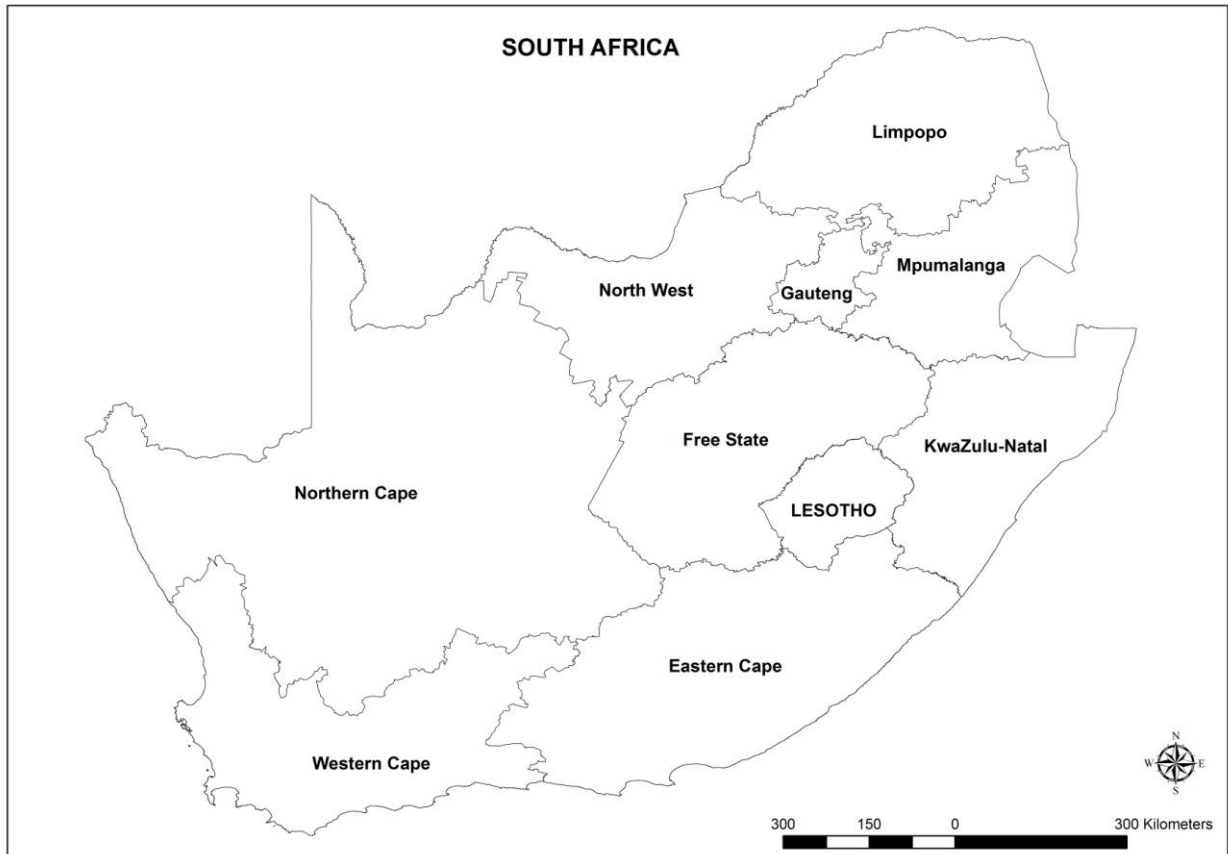
Source: Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa.

Chapter 5

Asymmetry between house prices and monetary policy in South Africa[♣]

5.1. Introduction

The recent global economic downturn attributed to the sub-prime crisis in the US with rapid contagion worldwide has attracted the attention of academics and policymakers of both developed and developing countries, and South Africa is no exception. As observed during the "Great Recession", the bursting of the house price bubble is generally followed by significant contractions in the real economy.[40] Over the last two decades, South Africa has witnessed a rapid appreciation in home values which has been shown to have affected the real economy, through consumption, at both aggregate and provincial levels (Das *et al.*, 2011; Ncube and Ndou, 2011; Peretti *et al.*, forthcoming; Simo-Kengne *et al.*, 2012 and forthcoming).[41] Furthermore, Gupta and Hartley (forthcoming) point out that house price in South Africa, is a leading indicator for output and inflation, and hence, can provide important information as to where the real economy is heading. Given this, it is crucial for central banks to analyze thoroughly the effects of monetary policy on asset prices in general and real estate in particular, which in turn, would lead to the understanding of the effects of monetary policy on the economy at large[42].

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[40] Recently, Leamer (2007) strongly argues that housing *is* the business cycle, indicating "any attempt to control the business cycle needs to focus especially on residential investment." (p. 150). His main point relates to the dynamics of the construction of homes. To wit, a building boom over one time interval pushes the stock of new homes above trend and that necessitates with some lag another time interval with a building slump. Thus, monetary policy should focus on preventing booms from occurring to head off the eventual slump. Smets (2007) provides commentary on Leamer's (2007) paper and argues that interest rates (and monetary policy) crucially determine the linkages between the housing cycle and the business cycle. Leamer (2007) responds that "in the context of my paper, the interest rate spread has its impact though housing, though it surely operates through other channels." (p. 249).

[41] For a detailed international literature review on the impact of house prices on the real economy, the reader is referred to André *et al.* (forthcoming), Peretti *et al.* (forthcoming), and Simo-Kengne *et al.* (2012 and forthcoming).

[42] For a detailed international literature review on the impact of interest rate on house prices, the reader is referred to Vargas-Silva (2008), Gupta and Kabundi (2010), Gupta et al. (2012a, b).

Against this backdrop, the main objective of this chapter is not only to analyze the impact of interest rate on South African house prices, but also, to check if the effect is asymmetric depending on whether the housing market is in a bull or bear regime. To this end, we use a Markov-switching vector autoregressive (MS-VAR) model in which parameters change according to the phase of the housing cycle. This methodology allows us to examine asymmetries in the relationship between monetary policy and the middle segment of the South African housing market from 1966:M2 to 2011:M12.

South African housing market is categorized into luxury, middle and affordable segments based on the price of the properties, with the middle-segment being further divided into, large, medium and small based on sizes of the houses.[43] In this chapter, besides analyzing the entire middle-segment, we also look at the different size category of this segment, to capture possible heterogeneity in the relationship between house prices and interest rate. Given that a MS-VAR is parameter intensive, we use the maximum possible span of monthly data covering the period of 1966:1-2011:12, which is a departure from the quarterly data-based earlier studies related to house prices and interest rate in South Africa. In this regard, note that, with house price being identified as a leading indicator, Gupta (forthcoming) emphasizes that one should carry out the analysis on housing markets at the highest possible frequency. Due to this, we had to rule out the luxury and affordable sections of the housing market, since data on these two segments are only available at quarterly frequency. However, with Gupta *et al.* (2010), Das *et al.* (2011) and Gupta and Inglesi-Lotz (forthcoming) indicating that policies do not significantly affect these two extreme ends of the market, we believe, that the compromise in the form of losing information on the luxury and affordable segments by using monthly frequency, is not a serious one. As in the existing literature on housing markets and interest rate in South Africa, the monetary policy instrument is chosen to be the three months Treasury bill rate[44]. Ultimately, we look at four sets

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[43] See data section for further details.

[44] It is believed that the housing market is unlikely to respond to policy actions that were already anticipated. Therefore, we utilized a measure of monetary policy surprise for our case, originally developed by Gupta and Reid (forthcoming) to analyze its impact on stock returns in South Africa. The monetary policy surprise was constructed using the change in the three month Banker's Acceptance rate on the day after the Monetary Policy Committee announces the official repurchase rate decision. Monthly values for the surprises were obtained by taking averages of the event-based data if there were multiple Monetary Policy Committee meetings in a month, and when there was no such meetings held in a particular month, the value of the surprise for that specific month was set to zero.

of bivariate MS-VAR models[45] comprising real house price of the entire, large, medium and small middle-segments considered individually, along with the three months Treasury bill rate.

The rest of the chapter is structured as follow: the second section reviews the existent literature; the third section briefly presents the Markov switching framework and discusses the estimation and identification procedures while the fourth section describes the data used. The fifth section reports the empirical results with regard to the potential asymmetric effects of monetary policy on house prices and vice versa. Finally, the last section concludes.

5.2. Literature review

In general, housing literature is favourable to a bidirectional relationship between housing market and monetary policy. Demary (2010) argues that an increase in the interest rates tends to increase the user cost of capital which translates into a decrease in housing activity and consequently a fall in real estate prices. On the other hand, an increase in house price may either increase or decrease the interest rates. The first scenario refers to the situation where central bank is likely to raise the interest rates in response to house price increase in order to prevent the inflationary pressure due to the subsequent wealth effect on consumption. The second scenario is related to the collateral effect. An increase in house prices raises the value of collateral against which homeowners are expected to borrow more. The resulting increase in credit supply leads to decrease the lending rate and hence the interest rates.

A number of studies have analysed the relationship between house prices and the interest rates in developed countries and recently in developing economies. A detailed international literature on this relationship is provided by Vargas-Silva (2008), Gupta and Kabundi (2010) and Gupta *et al.,* (2012a, b). However, most of these studies use linear (structural and factor-augmented)VAR models, and hence, could not account for possible non-linearities in the relationship between interest rate and house prices that could exist under different states of the housing market. In effect, the class of models developed by Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), in which there exist agency costs of financial intermediation (finance constraint) assert that when there is information asymmetry in the financial market, agents may

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[45] The reason for not including all the house prices together in a MS-VAR is to avoid the possible multicollinearity between the house price index for the entire middle segment and the house price indices of its three sub-categories. Besides, it is not advisable to go beyond three-variable MS-VARs due to the problem of overparameterization leading to imprecise inferences (Perlin, 2011).

behave as if they were constrained financially. Moreover, the financial constraint is more likely to bind in bear markets. As a result, monetary policy may have greater effects in bear than in bull markets; hence suggesting asymmetric effects across different market states.

In South Africa, few studies, namely, Gupta and Ndahiriwe (2010), Gupta *et al.* (2010) and Ncube and Ndou (2011), indicate a negative impact of monetary policy on house prices. Further, studies, such as Naraidoo and Ndahiriwe (forthcoming) and Naraidoo and Raputsoane (2010), Peretti *et al.* (forthcoming), Simo-Kengne *et al.* (forthcoming) which analyse the plausibility of a feedback from housing prices onto interest rate[46] did not investigate the possible asymmetry in this effect. Unlike other studies, Peretti *et al.* (forthcoming) used a time-varying parameter VAR model, which accounted for non-linearities in the relationship between consumption, interest rate and house prices, and was able to depict the changes in the nature of this relationship over time. However, this paper did not discuss how monetary policy reacted to house price movements during bear and bull markets, though it could have, having identified the regimes. Given the possibility of a feedback of house prices onto the interest rate setting behavior of the SARB, we use a Markov-switching vector autoregressive (MS-VAR) model comprising the interest rate and house prices, rather than the standard Markov switching regressions popularly used when analyzing the impact of monetary policy on asset returns (mainly stock returns),[47] which in turn, assumes exogeneity of the monetary policy instrument.[48] On one hand, the MS structure allows us to characterize the time series dynamics in different states, and on the other hand, the VAR structure allows for possible endogeneity in the relationship between monetary policy and house prices.

To the best of our knowledge, the study by Chang *et al.* (2011) is the only other existing study that has utilised the MS-VAR approach to analyse the impact of monetary policy on housing returns (besides equity real estate investment trusts and stock returns) for the US. Though this paper does not provide a clear identification of the housing cycle in terms of bull and bear markets, the authors indicate that, following an innovation in Federal Funds rate, housing

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[46] For a detailed international literature review on the response of monetary policy to asset prices the reader is referred to André *et al.* (2011) and Peretti *et al.* (forthcoming).

[47] The reader is referred to Napolitano (2009) for a detailed literature review.

[48] As far as the housing market is concerned, studies such as Garino and Sarno (2004), Xiao and Tan (2006) and Feng and Li (2011) have used univariate Markov-switching unit root tests to detect house price bubbles in the UK, Hong Kong and Seoul, and Beijing, respectively. Prior to that Hall *et al.* (1997) had used a univariate Markov-switching error correction approach to model the housing cycle in the UK.

returns decline substantially more in low-volatility regime than in high-volatility regime. However, this paper did not analyze the possible feedback from housing returns to interest rate. More importantly, with no confidence intervals provided for the impulse response functions generated from the MS-VAR model, one cannot gauge whether the effects were significant or not. The present chapter addresses these shortcomings by investigating the case of South Africa.

5.3. Methodology: Markov-Switching Vector Autoregressive Model

The use of the Markov-switching approach has become popular for determining asymmetries. This methodology initially appeared in the form of switching regressions in Golfeld and Quandt (1973), and underwent a number of extensions and refinements. Hamilton (1989) and Krolzig (1998) made important contributions by combining switching models with vector autoregression to develop a MS-VAR which is well equipped to characterise macroeconomic fluctuations in the presence of structural breaks or shifts. Applied to the housing market, the Markov-switching framework offers the possibility to model booms and contractions as switching regimes of the stochastic process that generates the growth rate of the housing prices. As discussed above, given our interest in studying the possible feedback from house prices to the interest rate behaviour of the SARB, besides analyzing the effect of the monetary policy on house prices, we look at a MS-VAR. The MS-VAR also allows us to analyze impulse response functions to tract the dynamic of the variables of concern following shocks to the system.

A special case of the MS-VAR framework is the MSIAH[49](m)-VAR(p) model, in which all parameters of the autoregression including the intercept term and the variance are allowed to switch between regimes. Let Y_t be a bivariate VAR in monetary instrument (Tbill) and real house price growth (ghp) of either the entire middle-segment or its respective size categories, used individually. Based on all the standard unit root tests, namely, Augmented Dickey-Fuller[50] (1981) (ADF), Phillips-Perron (1988) (PP), Dickey-Fuller test with generalized least squares detrending (DF-GLS), the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992) test; the Elliot, Rothenberg, and Stock (ERS) (1996) point optimal test, the Ng-Perron (2001) modified versions of the PP (NP-MZt) test and the ERS point optimal (NP-MPT) test, all the real house prices were found to be non-stationary, so the real house price measures were converted to their

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[49]MSIAH(m)-VAR(p) refers to Markov switching mean (M), intercept (I), autoregressive parameters (A) and heteroskedasticity (H) where m is the number of regimes and p is the lag length of the vector autoregression (VAR).
[50] The ADF test was initially proposed Fuller (1976) and Dickey and Fuller (1979).

corresponding growth rates, and denoted *ghp*. The nominal interest rate was found to be stationary at the 10 percent level of significance using ADF, DF-GLS, ERS, NP-MZ$_t$ and NP-MP$_T$ tests, and hence, was used in levels, and denoted as *Tbill*[51]. As in Ehrmann, Ellison and Valla (2003), the joint dynamics of (*Tbill*, *ghp*) are given by the following MSIAH-VAR specification:

$$
Y_t = \begin{cases} \mu_1 + B_{11}Y_{t-1} + ... + B_{p1}Y_{t-p} + A_1\varepsilon_t & \text{if } s_t = 1 \\ \\ \mu_2 + B_{12}Y_{t-1} + ... + B_{p2}Y_{t-p} + A_2\varepsilon_t & \text{if } s_t = 2 \end{cases} \tag{1}
$$

We identify the housing demand and the monetary policy shocks using a recursive or Choleski identification scheme. We order the variables as follows: *Tbill and ghp* following Musso *et al.* (2011) and André *et al.* (forthcoming). Note that the latent variable s_t which indicates bull or bear markets conventionally corresponds to "the high mean growth rate of house prices and stable state" and "low mean growth rate of house prices and volatile state" respectively. The fundamental residuals (ε_t) are assumed to be uncorrected at all leads and lags and their variance is set to unity so as to ensure the identity variance-covariance matrix. However, as each fundamental residual is pre-multiplied by a switching matrix A_i, the variance-covariance matrix $\sum_i$ of the structural disturbances $A_i\varepsilon_t$ is regime-dependent as indicated by the following transformation:

$$
\sum_i = E(A_i u_t u'_t A'_i) = A_i E(u_t u'_t)A'_i = A_i I_2 A'_i = A_i A'_i , \tag{2}
$$

The main characteristic of MS-VAR is that the dynamics of the variables are conditioned on the unobserved Markov process followed under the regime. Because the Markov chain is unobservable, Ehrmann *et al.* (2003) emphasise that the recursive nature of the likelihood function prevents standard estimation techniques from providing the maximised likelihood. One alternative suggested by Krolzig (1997) is the iterative maximum likelihood estimation technique known as *Expectation-Maximisation* (EM) algorithm which is designed for a general class of

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[51] These results are available upon request from the authors.

models where the observed time series depends on some hidden stochastic variables. This estimation technique consists of two steps whereby the *Expectation* step infers the hidden Markov chain conditioned on a given set of parameters and the *Maximisation* step re-estimates the parameters based on the inferred unobserved Markov process. These steps are repeated until convergence.

One major attraction of the MS-VAR is the possibility of regime-dependent Impulse Response Functions (IRFs), which helps determine the cyclical variation in the responses of variables to a particular shock. Equation (3) gives the mathematical definition of the regime-dependent IRFs for regime *i*. It traces the expected path of the endogenous variables at time *t+h* following a one standard deviation shock to the *k*-th initial disturbance at time *t*, conditional on regime *i* (Ehrmann *et al.*, 2003).

$$\theta_{ki,h} = \frac{\partial E_t Y_{t+h}}{\partial u_{k,t}} \Bigg|_{s_t=...=s_{t+h}=i} \qquad \text{for } h \geq 0 \qquad (3)$$

Recall that EM algorithm only provides estimates of the variance-covariance matrix $\sum_i$ and not the matrices A_i. To make structural inferences from the data, the structural disturbances and hence $A_i B^{-1}$ must be identified. In other words, sufficient restrictions are imposed on the parameter estimates in order to derive a separate structural form for each regime, from which regime-dependent IRFs are then computed. As in a standard VAR measuring the housing effect of monetary policy, the house prices index is ordered last with the assumption that housing market reacts directly to changes in monetary policy. This is known as recursive identification scheme based on which the estimated variance-covariance matrix $\hat{\Sigma}_i$ obtained by Choleski decomposition is used to identify the matrix $\hat{A}_i$. Through the standard bootstrapping technique, $\hat{A}_i$ are combined with the parameter estimates of the Markov-switching unrestricted VAR[52] to derive the response vectors. The bootstrapping procedure consists of creating artificial histories for the variables based on which the distribution of the estimated parameters is approximated. This distribution shapes the confidence bands required for the impulse response analysis; the

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[52] Refer to Ehrmann *et al.* (2003) for details on characteristics and computation of the regime-dependent impulse responses.

crucial step being the simulation of the hidden regime s_t. As in Chib (1996), the states are simulated using Forward Filter-Backwards Sampling (FFBS) known as Multi-Move algorithm. The confidence bands are obtained by Markov Chain Monte Carlo (MCMC) simulation with Gibbs sampling of 5000 draws with a burn-in of 2000.

5.4. Data

The data sample covers the monthly house price indexes for the period of 1966:01 until 2011:12. Though the three-month Treasury bill rate data is available since 1957, we were constrained by the availability of the house price data, which in turn, determined the starting point of the analysis. The three-month seasonally adjusted Treasury bill rate data and the Consumer Price Index (CPI) data (used to convert nominal house prices into its real counterpart) are derived from the International Financial Statistics of the International Monetary Fund. Amalgamated Bank of South Africa (ABSA), one of the major private banks in South Africa, provides the seasonally adjusted house price index. As discussed earlier, ABSA categorizes housing into three price segments, namely luxury (ZAR 3.5 million – ZAR 12.8 million), middle (ZAR 480,000 – ZAR 3.5 million) and affordable (below ZAR 480,000 and area between 40 square metres - 79 square metres). The middle-segment is further categorized into three more segments based on sizes, namely large-middle (221 square metres – 400 square metres), medium-middle (141 square metres – 220 square metres) and small-middle (80 square meters – 140 square meters). The stable MS-VAR is estimated based on two lags, as was unanimously suggested by all the popular lag-length tests, namely, the sequential modified LR test statistic, the Akaike information criterion, the Schwarz information criterion, applied to a constant parameter VAR[53]. Accounting for lags, our effective sample period start from 1966:04.

5.5. Empirical results

The MSIAH-VAR[54] type of MS-VAR model is considered and the estimated coefficients are used to compute the IRFs. The choice of MSIAH type is motivated by the specification tests in Table 5.1 which clearly indicate a strong evidence of non-linearity, non-normality and heteroskedasticity for the four models corresponding to the entire middle segment and each of its sub-segments. Given these properties, regime dependent IRFs are meaningfully applied with a

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[53] The linear VAR is found to be stable as all roots were found to lie within the unit circle. The details of the lag-length test along with the results indicating the stability of the VAR, is available upon request from the authors.
[54] MSIAH is also known as the heteroskedastic intercept switch model.

small number of regimes. We set two regimes prior to the estimation of the model to identify bear and bull markets. As noted earlier, states are differentiated not only by their average growth rate but also by their variances. The results presented in Table 5.3 support the presence of two regimes. The growth rate of house prices is more volatile in regime 1 than in regime 2, and the intercept is also lower in regime 1 than regime 2. Thus, regime 1 is identified as a bear market and regime 2 corresponds to a bull market.

The sample properties of the data for each of the individual market segment are summarised in the first panel of Table 5.1. The appropriateness of the Markov switching model for the sample data is judged on the basis of the linearity tests. The LR tests the presence of two separate regimes in a linear system (Quandt, 1960) while Davies tests the presence of structural break under nuisance parameter (Davies, 1977).

Table 5.1

Specification Tests and Regime Properties

Specification tests	Linearity		Normality		Heteroskedasticity			
					StdResid		VAR Error	
	LR	Davies	StdResid	VAR Error	Hetero	Hetero-X	Hetero	Hetero-X
All segments	545.28**	0.00**	139.44**	787.44**	5.44**	4.35**	7.04**	5.56**
Large segment	578.9**	0.00**	124.28**	7.44.97**	7.31**	5.20**	11.85**	7.86**
Medium segment	519.53**	0.00**	107.92**	724.17**	4.85**	3.76**	7.34**	5.99**
Small segment	524.96**	0.00**	127.67**	723.85**	5.28**	3.85**	7.11**	5.02**
Regime properties	Transition probabilities		Duration		Observations			
	Bear regime	Bull regime	Bear regime	Bull regime	Bear regime	Bull regime		
All Segments	0.880	0.878	8.33	8.22	276.1	272.9		
Large segment	0.875	0.879	8.00	8.28	269.4	279.7		
Medium segment	0.877	0.868	8.13	7.60	283.3	265.7		
Small segment	0.886	0.887	8.83	8.88	273.3	275.7		

Notes: the first panel shows the specification tests; ** indicates significance at the conventional level (5%) of significance. The second panel displays the regime properties.

For all market segments, the Markov switching model turns out to be the preferred specification relative to the linear alternative. We also report the normality tests which test whether the skewness and kurtosis of the residuals correspond to that of the normal distribution (Doornik and Hansen, 2008). Under the null of normality, these tests give appropriate rejection frequencies based on chi-square critical values. Finally, following White (1980), the hetero test and hetero-x test for heteroskedasticity are conducted under the null of unconditional homoskedasticity. The hetero test relies on an auxiliary regression of the squared residuals on the

original explanatory variables and their squares while the hetero-x test is based on a similar design, but accounts for the cross-products of the original regressors as arguments in the auxiliary regression. The evidence of heteroskedasticity is confirmed for all market segments by means of Chi-square critical values.

5.5.1. Regime properties

The second panel of Table 5.1 displays the regime properties for each of the individual housing market. In general, the regimes are persistent with the transition probabilities lying between 0.87 and 0.89. For instance, the probability of being in bear market in time t when the state of market was bear in t-1 is 0.88. In other words, market stays in bear regime for about 8 months on average which is quite persistent for a financial market. The timing of the change is similar across regimes with an average expected duration of about 8 months for the first three models (All, Large and Medium segments) and 9 months for the fourth model (Small segment). As indicated by the sum of observations per regime, the number of months for which the housing markets were under the two regimes, are very similar as well. Inferences regarding the turning points can be obtained from the smoothed probabilities of regime 2 (bull market), as depicted in Figure 5.1. It seems that the bear market is the prevailing regime between periods of 1966 to 1970, 1976 to 1979 and 2001 to 2011 in the middle sector of South African housing market. These periods coincide with some important economic features and socio-political conditions that prevailed in South Africa.

The first downswing period matches the residential segregation reinforced by the Group Areas Act 36 of 1966 which forced people of different races to live in separate residential areas (Prinsloo and Cloete, 2002) with huge consequences on property prices (Koetze, 1999). The second period coincides with the 1976 Soweto student uprising which had an adverse effect on confidence and economic performance, leading to a decline in real house prices by 22.4 percent between 1976 and 1979 (Luüs, 2005). The last downswing is partly attributed to the effectiveness of the monetary policy in stabilizing financial markets, especially given that the SARB moved to an inflation targeting regime starting in the February of 2000.

Figure 5.1: MSIAH-VAR- Smooth Probabilities of Regime 2 (Bull Market)

All segments

Large segment

Medium segment

Small segment
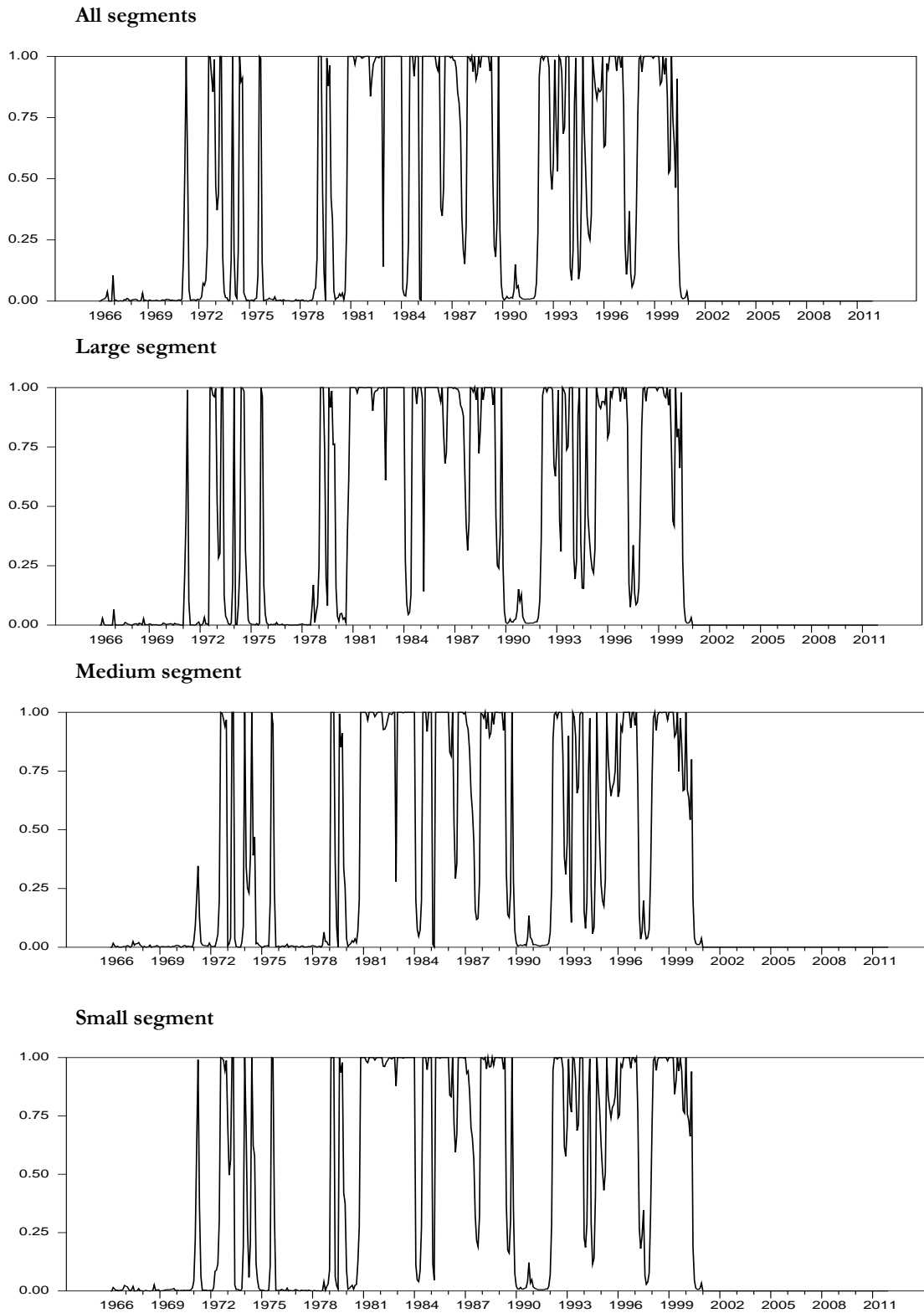
Moreover as depicted by Naraidoo and Ndahiriwe (forthcoming) and Naraidoo and Raputsoane (2010) using linear and non-linear Taylor rules, the SARB had systematically been reacting to a financial conditions index, which included real house prices, during this period. It is also likely that the recent economic turmoil coupled with the Euro crisis, towards the end of the sample, has contributed to depressing real house prices through the slowdown of the South African economy in general.

On the other hand, Figure 5.1 indicates two periods of bull markets (regime 2) in the housing market, namely 1970 to 1976 and 1980 to 2000. While the first period of housing boom can be associated with the global inflation due to oil price shock resulting in a hike of construction costs, we can infer that loose monetary policy contributed to the substantial run-up in house prices between 1980 and 2000[55]. As discussed in Luüs (2005), the upward trend of the property prices in the early 1980s was mainly due to the gold price boom and a reduction in tax rates which boosted the household net wealth and facilitated a reduction in the mortgage lending rate.

However, the increasing political pressure and the decrease in gold price resulted in higher interest rates, and depressed the property market from 1984; but the effect was restrained by financial liberalisation which took place in 1985 following the recommendations of the De Kock Commission. The easy availability of credit following the liberalization led to a consumption boom (housing and non housing goods), which, in turn, translated into sizable real estate appreciations[56]. This trend slowed down in 1991 with the political uncertainty about the future of the country. However, with the confidence restored in 1994 with democracy, a recovery in the housing market was observed mainly due to higher economic growth and lower inflation and interest rates. However, the contagion effect from the Asian crisis in 1996-1997 led to the fall in the value of the rand with significant rise in interest rates, and thus discouraging housing activities but by late 1999, the house price boom resumed.

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[55] Housing may also have been seen as a hedge against inflation, leading to a higher housing demand and hence real estate prices.
[56] The causality may also run the other way round: financial liberalisation led more credit translated into more housing demand, higher house prices and hence more consumption through the wealth and collateral effects

5.5.2. "Housing markets Synchronisation"

The similar pattern observed with smooth probabilities across segments raises the issue of potential synchronisation of the different market segments. Synchronisation tests[57] developed by Harding and Pagan (2006) could not reject this hypothesis. In contrast of Harding and Pagan (2006) who used regime classification from a non-parametric NBER type rule, our regime classification or dating is based on smooth probability statistics[58], which is 1 for regime j if its probability is the maximum[59]. Focusing on the first panel of Table 2, the concordance indices (upper diagonal) are reported to capture the degree of synchronisation of cycles, that is, the fraction of time housing cycles are in the same regime. Reported values are large, suggesting that housing cycle in the three selected market segments spends much of the time in the same regime (Bull in this case). Moreover, the pairwise correlations (lower diagonal) are typically high, indicating a strong correlation between states in different market segments.

There is also evidence of serial correlation in the states across segments[60]. For instance the first order serial correlation coefficient in the regime dummy series is around 0.94; highlighting the need to use robust variance matrix in the tests. We, therefore, use Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors with Barlett weights to perform the tests in Panel C. Robust t-statistics in the second panel (lower diagonal) of Table 2 show that the evidence for the null hypothesis of no market synchronisation is strongly rejected. Giving this, we first test for the necessary condition for perfect synchronisation. Results from panel C in Table 2 show a high p-value (0.991), suggesting that the null hypothesis that necessary condition holds (that is, the mean of regime dummy variable is equal across segments) cannot be rejected.

Second, we perform the test of strong multivariate non-synchronisation based on the null of no synchronisation. Again, results are favourable to strong multivariate synchronisation as p-value is apparently very small (0.000). Third, with a high p-value of 0.995, the test for strong perfect positive synchronisation could not reject the null hypothesis of perfect positive synchronisation.

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[57] As aggregate series, "All segment" was excluded in the test since it is most likely to lead the synchronisation result. Furthermore, we did not test for negative synchronisation as this is not applicable in our case.

[58] We provide the results for Bull market since probability of Bear market=1-probability of bull market; leading to similar results.

[59] The reader is referred to Harding and Pagan (2006) for technical details.

[60] We did not report the multivariate ACF, but results are available from the authors upon request.

Table 5.2

Synchronisation tests

Panel A: Concordance indices (Upper) and Correlation (Lower) of housing cycles for selected market segments

	Large segment	Medium segment	Small segment
Large segment	....	0.974	0.967
Medium segment	0.948	....	0.970
All segment	0.934	0.942	....
Mean	**0.498**	**0.487**	**0.517**

Panel B: Standard (upper) and Robust t-statistics (Lower) for the null hypothesis of no correlation of classical housing cycle states for selected market segments

	Large segment	Medium segment	Small segment
Large segment	....	69.4	60.7
Medium segment	63.8	....	65.4
All segment	42.4	50.0	....

Panel C: Non parametric tests of synchronisation

	Statistic	P-Value
Test for the necessary conditions for perfect synchronisation across three housing market segments	0.018	0.991
Test for strong multivariate non-synchronisation	$1.17 \cdot 10^{14}$	0.000
Test for strong perfect positive synchronisation	$2.75 \cdot 10^{-2}$	0.995

Notes: Panel A displays the concordance indices constructed upon phase states for binary housing cycles and analogue of Pr ($S_{xt}=S_{yt}$) advocated in Harding and Pagan (2006). These indices have a maximum value of unity when $S_{xt}=S_{yt}$ and zero when $S_{xt} =(1-S_{yt})$. Panel B shows standard and robust t-statistics which account for both heteroskedasticity and autocorrelation. Panel C reports three synchronisation tests computed based on regime dummy variable using smooth probability of Bear market.

Consequently, there is strong evidence in favour of perfect positive synchronisation in these market segments. They move simultaneously; indicating that regime of one market cannot be used in advance to predict the regime of others. We conclude that there is no leading market.

5.5.3. Regime dependent impulse responses

The empirical analysis focuses on IRFs as economic inference from the autoregressive coefficients might be difficult, if not misleading, given that the model is essentially an *atheoretical* representation of the dynamics between interest rate and house prices. As is obvious from Table 5.3, we, however, find that almost all the autoregressive coefficients are statistically significant, and the simple Wald test of asymmetry indicates that these coefficients are significantly different across regimes, except for the entire middle segment. Furthermore, the coefficients on the two lags of the growth rate of house prices in the first equation (Tbill equation) of the system add up to 0.499, 0.571, 0.613, 0.635 (regime 1) and 0.811, 0.744, 0.799, 0.805 (regime 2) for the four models respectively. This suggests considerable interest rate smoothing by the SARB.

Figure 5.2 displays the IRFs of real house price inflation of the different models with the 16 percent and 84 percent quantiles for the impulse responses resulting from a 100 basis point shock to the Treasury bill rate over a period of thirty-six months. Regardless of the category, the Tbill rate reaches a peak of 1.5 percent (1.8 percent) in the bear regime (bull regime) and stays significant throughout the three-year period. The resulting response of the real house price growth rates, following a contractionary monetary policy, is negative in general for all four categories. However, a few remarks are worth mentioning: First, in terms of magnitude and persistence, the responses of real house price inflation to a contractionary monetary policy differ considerably across regimes, hence, justifying the need of generating regime dependent impulse responses; Second, the initial rise of all and medium segment house prices observed in the bear regime following a monetary shock reflects the so-called *house price puzzle* often observed in the monetary policy and housing market literature that employs limited information sets contained in small-scale VARs based on a Choleski (recursive) decomposition for the identification of shocks.[61] However, the puzzling effect of a rise in real house price growth rates following a contractionary monetary policy is marginal and/or short-lived, as it lasts about two months; Finally, the impact of monetary policy appears stronger, but with short-lived significance in the

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[61] The interested reader is referred to the paper by Vargas-Silva (2008), Gupta *et al.* (2010, 2012a, b) for a detailed literature review.

bear regime, compared to the bull regime, in which the effect is of smaller magnitude but more persistent, with significance holding for the entire period of 3 years following the shock. The results are indicative of asymmetric effects across regimes for both the interest rate and house prices emanating from a monetary policy shock[62].

As argued by the theoretical models developed by Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), economic agents are more likely to be optimistic (pessimistic) about future house price movements during the bear (bull) market[63]. Although the prominence of financial constraints reinforces the impact of a contractionary monetary policy in the bear market, as suggested by Chen (2007) when analyzing stock markets, the response of house price inflation is likely to be short-lived due to the optimistic behaviour of economic agents which progressively outweighs the negative effect of a positive shock in the interest rate. On the other hand, the distinctive pessimistic behaviour of the bull regime tends to make the reaction of real house price growth rate prolonged but weaker to a positive monetary shock, since households are less financially constrained in this regime.

Figure 5.3 displays the feedback from a house prices shock to monetary policy based on the IRFs following a 100 basis point shock to real house price growth. The reaction of house prices, following a positive shock in real house prices, dies out within a year in the bear market, while in the bull regime, the reaction lasts for about 15 months. The effects are similar within regimes, and across the different housing categories. The effect also remains consistently significant before reverting back to its equilibrium value.

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[62] These results are consistent with the monetary surprise results. Since, this measure is exogenous, we applied a Markov-switching regression framework on monthly data covering the period of 2000:1-2011:12 instead of a MS-VAR model. The results indicate that sudden adjustments occur contemporaneously in the dynamics of house prices due to unanticipated changes in monetary policy. House prices decrease with the increase in the monetary surprise, with a significant effect being reported in the bear regime. Moreover, the asymmetric effect of monetary policy emerges in all market segments; the coefficients being different in size and or signs across the states. Additionally, the bear market appears to be the most affected for all categories except the small segment, which shows a significant effect in the bull regime. In the same vein, we carried out our analysis treating the three month Treasury bill rate as exogenous using Markov-switching regressions. However, given that the fit of the MS-VAR models were consistently better than the Markov-switching regressions, indicative of, perhaps, the endogeneity of the three months Treasury bill rate, these results were suppressed to save space. Moreover, the MS-VAR approach offers the possibility to analyze joint dynamics, which in turn, better characterizes the behavior of financial time series. The details of all these results are available upon request from the authors.

[63] Backward looking, expectations would bring the opposite effect. This also suggests mean reversion, hence no bubbles.

Table 5.3

EM Estimation for the MSIAH(2)-VAR(2), 1966:02-2011:12

	All Segments		Large segment		Medium segment		Small segment	
	Tbill	ghp	Tbill	ghp	Tbill	ghp	Tbill	ghp
Regime dependent intercept								
μ_1	0.02*	0.11*	0.03**	0.02	0.02*	0.08	0.03**	0.04
	(0.013)	(0.064)	(0.013)	(0.077)	(0.014)	(0.060)	(0.013)	(0.067)
μ_2	0.20	0.18**	0.22*	0.29***	0.20	0.19**	0.19	0.15**
	(0.121)	(0.062)	(0.113)	(0.062)	(0.056)	(0.064)	(0.119)	(0.072)
Standards errors								
σ_1	0.09	0.46	0.08	0.57	0.09	0.44	0.09	0.5
σ_2	0.61	0.28	0.60	0.30	0.61	0.28	0.60	0.31
Regime 1: Parameter estimates								
$\beta_{1,1}$	1.36**	-0.49**	1.40**	-0.19	1.35**	-0.36**	1.34**	-0.44*
	(0.043)	(0.164)	(0.038)	(0.192)	(0.053)	(0.163)	(0.123)	(0.253)
$\beta_{1,2}$	-0.36**	0.48**	-0.40**	0.18	-0.35**	0.35**	-0.35**	0.44*
	(0.044)	(0.164)	(0.037)	(0.192)	(0.053)	(0.163)	(0.123)	(0.251)
$\beta_{2,1}$	0.02	0.21**	0.01	0.66**	0.02*	0.25**	0.02	0.44**
	(0.012)	(0.061)	(0.010)	(0.064)	(0.013)	(0.060)	(0.012)	(0.062)
$\beta_{2,2}$	0.01	0.29**	-0.02**	-0.09	-0.002	0.37**	-0.01	0.19**
	(0.012)	(0.061)	(0.010)	(0.065)	(0.013)	(0.060)	(0.013)	(0.063)
Regime 2: Parameter estimates								
$\beta_{1,1}$	1.48**	-0.08**	1.48**	-0.09**	1.48**	-0.1**	1.49**	-0.08**
	(0.055)	(0.026)	(0.054)	(0.028)	(0.056)	(0.027)	(0.055)	(0.030)
$\beta_{1,2}$	-0.50**	0.07**	-0.50**	0.07**	-0.5**	0.08**	-0.50**	0.07**
	(0.055)	(0.026)	(0.054)	(0.028)	(0.056)	(0.027)	(0.055)	(0.030)
$\beta_{2,1}$	0.16	0.47**	0.14	0.48**	0.14	0.46**	0.16	0.59**
	(0.109)	(0.054)	(0.101)	(0.057)	(0.112)	(0.057)	(0.107)	(0.060)
$\beta_{2,2}$	-0.07	0.35**	-0.08	0.26**	-0.04	0.34**	-0.08	0.21**
	(0.108)	(0.052)	(0.097)	(0.054)	(0.111)	(0.056)	(0.105)	(0.058)
ω_{12_Tbill}	0.015	1.8×10^{-5}	0.023	0.006	0.012	5.5×10^{-4}	0.003	2.4×10^{-4}
ω_{12_ghp}	0.167	7.54	0.219	2.065	0.262	2.601	0.265	1.954

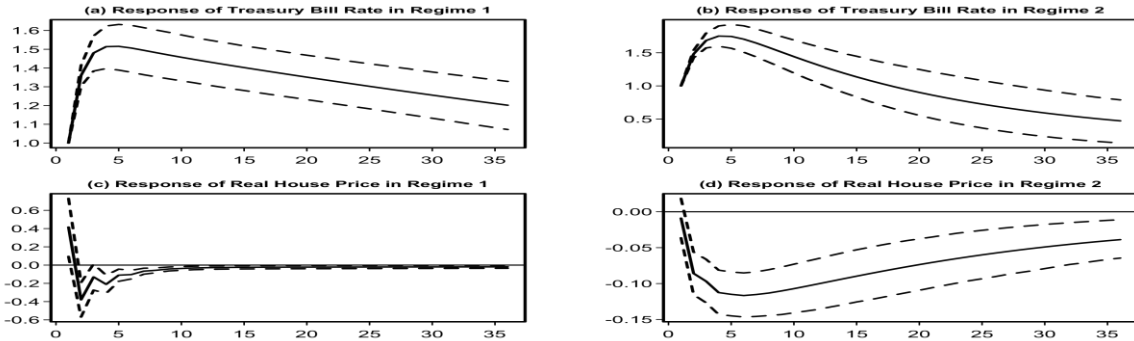|	All segments		Large segment		Medium segment		Small segment	
Fitting								
	MSIAH-VAR	Linear VAR	MSIAH-VAR	Linear VAR	MSIAH-VAR	Linear VAR	MSIAH-VAR	Linear VAR
LogLik	-315.14	-587.78	-393.62	-683.07	-307.51	-567.28	-369.20	-631.68
AIC	1.25	2.18	1.54	2.54	1.22	2.11	1.45	2.35
HQ	1.33	2.23	1.62	2.58	1.31	2.15	1.53	2.39
SC	1.47	2.29	1.76	2.64	1.44	2.21	1.67	2.45

Notes: Standard errors are in brackets. ***, ** and * indicate significance at 1%, 5% and 10% level of significance respectively. Terms ω_{12_Tbill} and ω_{12_ghp} are the Wald statistics for asymmetric effect (Equality of coefficients within regime 1 and regime 2):

$\beta_{1,j}$(regime1) = $\beta_{1,j}$(regime2) and $\beta_{2,j}$(regime1) = $\beta_{2,j}$(regime2) for asymmetric effect of monetary policy and asymmetric feedback from

house price shock, respectively. The test statistic is χ^2 with one degree of freedom under the null of symmetry. The critical values are 6.635 and 3.841 at 1%, 5% respectively. AIC, SC and HQ are Akaike, Schwartzand Hannan-Quinn information criterion, respectively.

Figure 5.2: IRFs following a contractionary monetary policy shock across bull and bear markets
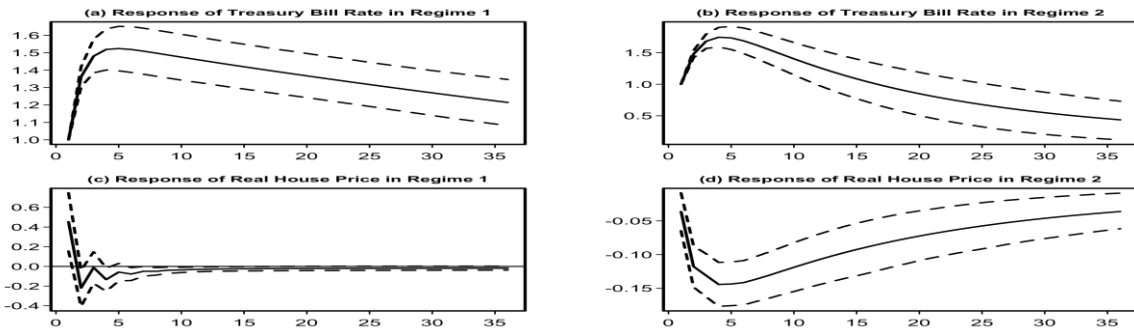
Response to Tbill rate shock: All Segments

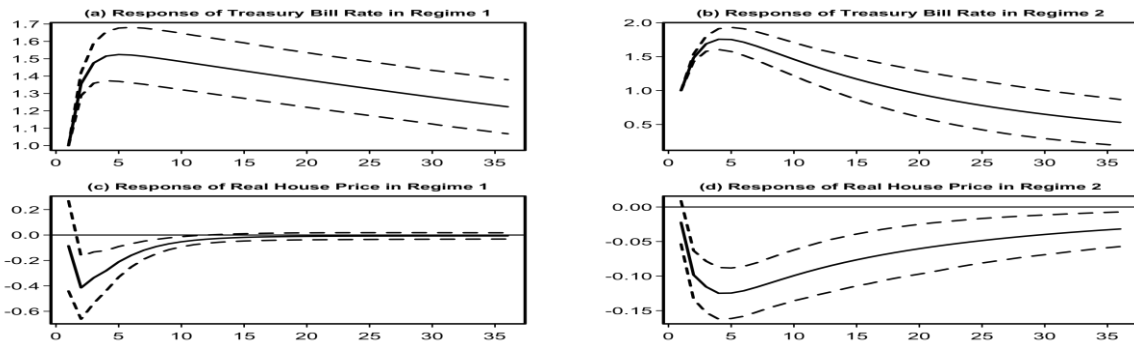**Response to Tbill rate shock: Large Segment**
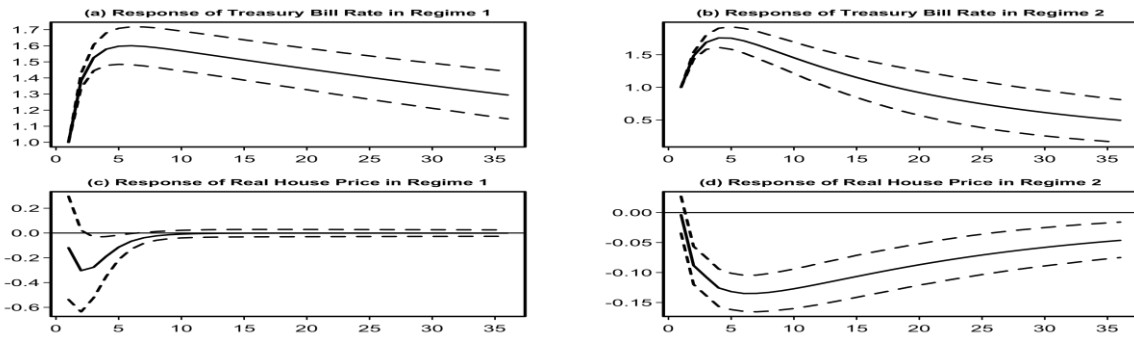
Response to Tbill rate shock: Medium Segment

Response to Tbill rate shock: Small Segment

Note: on the left, IRFs in bear market (Regime 1). On the right, IRFs in bull market (Regime 2).

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Figure 5.3: Responses of interest rate to a positive house price shock across bull and bear markets

Reponses to House Price Shock: All segments

Reponses to House Price Shock: Large segment

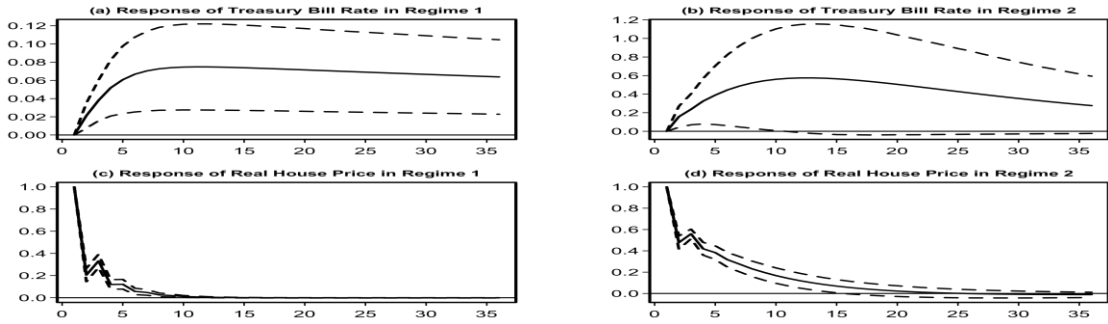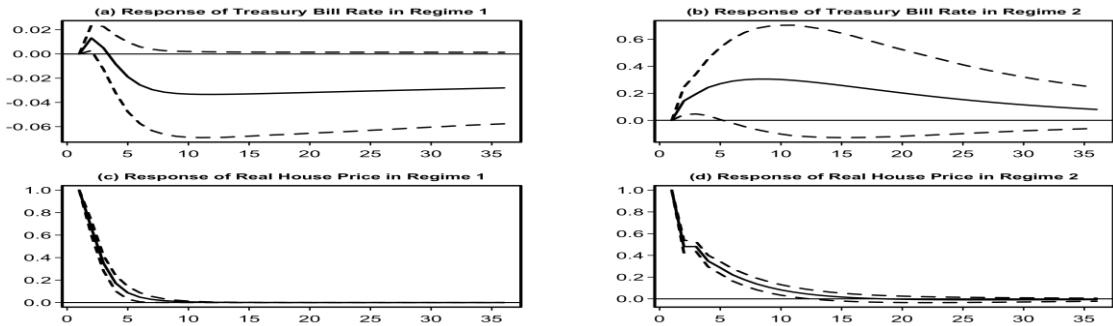
Reponses to House Price Shock: Medium segment

Reponses to House Price Shock: Small segment

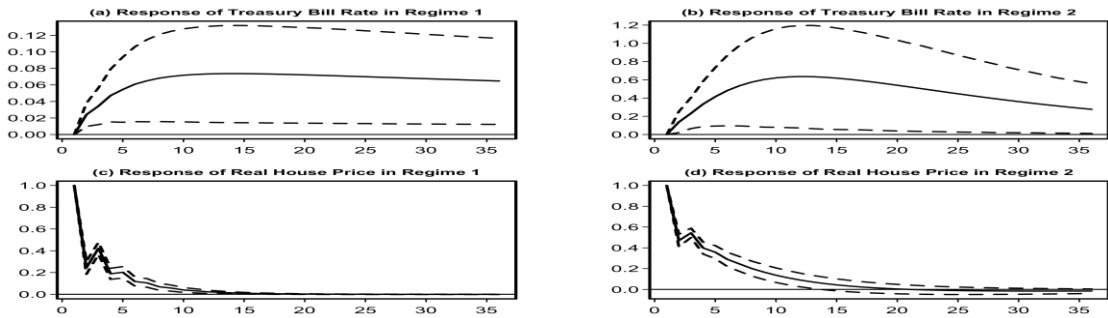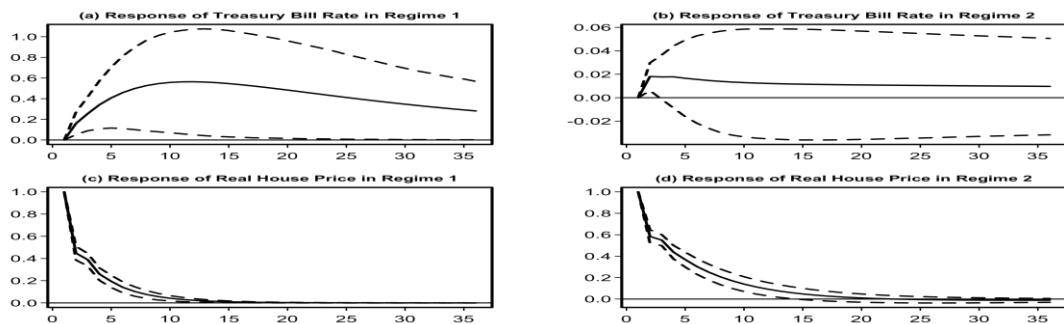**Note**: on the left, IRFs in bear market (Regime 1). On the right, IRFs in bull market (Regime 2).

Though the effects might seem asymmetric visually, the Wald tests carried out in Table 2 on the autocorrelation coefficient tend to suggest that the impact on house prices, following a house price shock, are not statistically different across the regimes within the individual housing categories. In general the results indicate a positive response of monetary policy to a house price shock across the two states. The responses of interest rate following a shock in the entire (All) middle segment indicate that the reaction of monetary policy is stronger in the bull market, but the effect is significant for only a short period. This is not surprising, since the bull market tends to associated with house price bubbles (Helbling, 2005), and in order to prevent potential crisis related to the subsequent bust, the monetary authority might have a stronger reaction in this regime. Moreover, as economic agents are already pessimistic about future expectations in house price movements, the monetary policy reaction is likely to be big but quick one. Besides this, given that the movement in the house prices in South Africa is found to have a positive impact on the prices of non-housing goods and services (Gupta and Inglesi-Lotz, forthcoming), and which is likely to be bigger in magnitude during the bull market, the relatively stronger reaction of monetary policy to house price shock is justified in this regime to prevent inflationary pressures. Furthermore, when the housing market is in the bear regime, causing the economy to be in recession via the wealth effect (Ncube and Ndou, 2011; Peretti *et al.,* forthcoming; Simo-Kengne *et al.*, forthcoming), the central bank is likely to be more conservative but more persistent in its response to house price increases.

However, diverse patterns emerge with respect to different models. In terms of magnitude, the reaction of monetary policy is stronger in the bull regime, relative to the bear regime, for the large and medium middle-segments, with the positive effect for the large segment under the bull regime lasts for a way shorter period when compared to the medium segment. These results, especially for the medium segment, are in line with the findings for the entire middle-segment, but contrast with the small segment, in which a stronger and more persistent reaction of monetary policy is obtained in the bear regime. The observed difference could be possibly attributed to the dual feature of housing as being both a consumption and investment good simultaneously[64]. In effect, small segment houses are believed to act as an investment good for relatively richer households who reside in mainly the luxury segment of the market or the large middle-segment (Gupta and Inglesi-Lotz, forthcoming). Bear markets are more a buyer's market,

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[64] Alternatively, since investors need to be leveraged, credit quality concerns might be higher in the lower segment for owner-occupiers during busts, as fall in income and unemployment risks are higher.

in light of this, richer homeowners might want to spend some of their wealth to acquire property in the small segment as investment. The resulting increase in housing demand coupled with the typical optimism of the bear regime might lead to increase inflation or financial stability risks in a low interest environment, causing the monetary authority to respond more to a positive house price shock in the bear regime of small-segment housing. At this stage, it is perhaps worth noting that even though the SARB is likely to monitor house prices of all the segments of the housing market, it is most likely that it would want to respond to an average price of the housing sector[65], which in our case happens to be the house price of the aggregate middle segment. Given this, the response of the monetary authority following a house price shock to the entire middle segment, could be depicting its typical response. However, having said this, our results do provide evidence that the interest rate responds significantly to the house price movements of the different segments of the market.

5.6. Conclusion

This chapter investigates whether the impact of monetary policy shock on the entire middle-segment of the South African housing market, and its three categories based on sizes, is asymmetric using a MS-VAR approach spanning the period of 1966:M2 to 2011:M12. We find that monetary policy is non-neutral, as a contractionary monetary policy significantly depresses real house prices irrespective of house sizes. Furthermore, important asymmetries are found in the dynamics of house prices following a monetary policy shock in the bull and bear regimes identified for the housing market. Monetary policy is found to have larger effect on real house price inflation during the bear market-regime, thus supporting theoretical models that suggest the role of information asymmetry in reinforcing financial constraints of economic agents during this regime. This finding is robust to the aggregate and the various house sizes within the middle-segment.

Given that we used a MS-VAR to account for a possible feedback effect of house price movements on monetary policy setting, we also analyzed the impact on the interest rate following a house price shock. We found evidence of positive feedbacks from housing prices to the interest rate, which, in turn, confirmed that monetary policy in South Africa reacts to house price shocks, with the SARB found to respond more to a positive house price shock in the bull

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[65] Alternatively, credit profiles may vary across segments, implying different risks for the economy and for financial stability.

regime. This is not surprising, given that a bull market is possibly associated with house price bubbles, thus leading the monetary authority to react stronger in this regime in an attempt to prevent economic recession due the subsequent bust. Also, house price increases are likely to be more inflationary in the bull-regime than the bear regime, due to a bigger impact on the aggregate demand via the wealth effect of real house price increases. Finally, while the effect of monetary policy is consistent across house sizes in general, the reaction of the central banker to a house price shock in the small sized middle segment contrasts the remaining categories. In this segment, the reaction of monetary policy is found to be stronger in the bear regime; suggesting that houses in the small-segment are more likely to be investment goods and hence, are more attractive in the bear regime given the optimism of economic agents which, in turn, motivates a stronger response from the monetary authority to prevent possible inflationary pressures.

On the other hand, there is also some evidence that house price expectations are, at least to some extent, backward-looking. This is reflected by the fact that house prices show inertia and follow long cycles, plausibly displaying bubbles. Monetary authorities may, therefore, respond more in a bear market because they are concerned with credit quality and financial stability, more than by inflation prospects, which would be benign in a bear market (unless the housing market is disconnected from the rest of the economy). It is also possible that the lower segment of the market is more representative of wider economic conditions than higher segments, where buyers might be less credit constrained and where there may be more support for prices (for example because of better locations, foreign buyers). Hence a pick-up in lower segment prices may provide a stronger signal for normalising interest rates when those are low in a bust.

Chapter 6

House prices and balance of trade dynamics in South Africa: Evidence from an agnostic identification procedure♣

6.1. Introduction

For countries with small foreign assets such as South Africa, the balance of trade is typically the most important component of the current account, and thus, fluctuations in the patterns of trade are key drivers of the current account dynamics. As economies integrate and liberalize, the national current account dynamics remain a policy-relevant issue for both developed and developing countries. Current account dynamics may provide useful information about the supply and demand for domestic currency in the foreign exchange markets and the performance of the domestic economy. In addition, large dispersions of trade deficits trigger worries that a current account reversal could cause a contraction of the real economy as vindicated by the "disorderly correction hypothesis", especially when current account is mainly driven by consumption. Since trade imbalances predict macroeconomic instability which is not conducive to sustainable economic growth, it is crucial to understand the sources of these imbalances and their likely adjustment mechanism. Particularly, the role of house prices is of interest and is thus, the focus of this chapter.

Over the last decade, South Africa's current account deficit has increased sharply from 1.65 percent of Gross Domestic Product (GDP) in 1995 to 7.15 percent of GDP in 2008. This pattern has borne a relatively close resemblance to the housing market developments, with annual changes in nominal house prices ranging from -0.13 percent to 27.92 percent between 1994 and 2011. Smit (2006) points out that the decline in the trade balance is the primary cause of current account deficit in South Africa; hence, indicating the role of consumption in driving

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♣ Forthcoming in the *Journal of Housing Research*.

current account deficits. This argument is consistent with Kandiero (2007) who emphasized that investment and more importantly consumption goods play a key role in determining South African trade imbalances. Given the strong link between housing wealth and consumption spending (Aron *et al.*, 2006; Ncube and Ndou, 2011; Das *et al.*, 2011; Peretti *et al.*, forthcoming; Simo-Kengne *et al.*, forthcoming), we hypothesize and test if house price appreciation could have possibly amplified the vulnerabilities of the trade deficit in South Africa through its effect on consumption.

The current period of trade deficits began in 2004. Over the 33-year sample plotted in Figure 6.1, the trade deficits peak in the early 1982 at 4.9 percent of GDP. The next larger peak was about seven eighths as large (4.23 percent of GDP) in the latter 2006. While South Africa ran enormous trade deficits, real house prices were high. This suggests a co-movement between real house prices and the trade deficits which is consistent with the negative correlation coefficient (-0.54) between the two variables over the sample period. However, in order to derive efficient inference, such relationship needs to be investigated based on an econometric model.

Figure 6.1: House prices and South Africa's trade balance
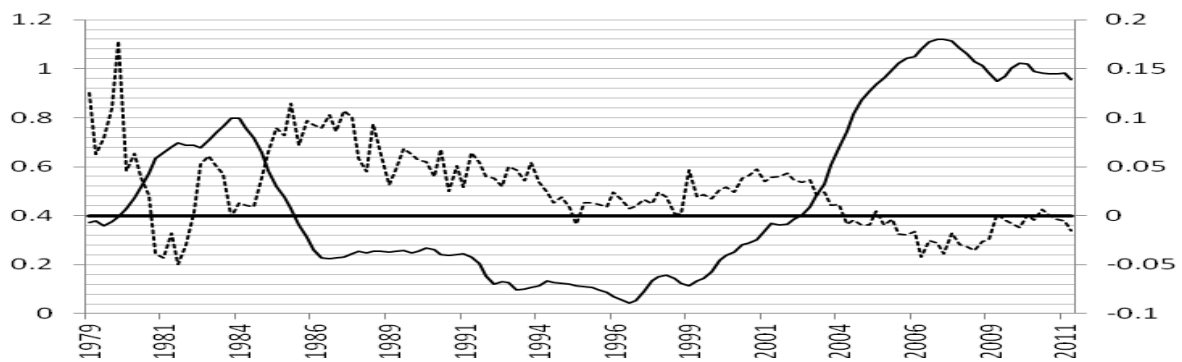
Notes: Real house prices (solid line, scale on the left axis), the ratio of trade balance to GDP (dotted line, scale on the right axis). A zero horizontal line is added from the right axis to indicate the trade deficit.

As a leading indicator for the real economy (Gupta and Hartley, forthcoming), real estate prices facilitate the propagation of boom-bust cycles which exacerbate the distortions of economic activities (Aizenman and Jinjarak, 2009; Schiller, 2007; Finicelli, 2007). Despite the important implications that house price shocks may have on external imbalances, to the best of our knowledge, there is no empirical study that has examined this link in South Africa where housing accounts for 29.40% of households' assets and 21.68% of total wealth (Das *et al.,* 2011).

Besides the strong housing cycles which have been an overriding feature of the South African housing market since the second half of 1990s, emerging economies such as South Africa are subject to both domestic and foreign shocks[66]. This may result in large capital movements, interest and exchange rates fluctuations with sizeable effects on asset (including housing) prices which, in turn, can affect the current account positions through the wealth and/or balance sheet effects on consumption and investment, respectively.

This chapter analyses the relationship between house prices and the trade balance in South Africa over the period from 1979:Q1 to 2011:Q4 using an agnostic identification procedure. This method allows a housing demand shock to be identified by imposing sign restrictions on the impulse response functions of all other variables barring the variables of interest. Besides standard variables such as private consumption, price level, short term interest rate and real effective exchange rate, our VAR includes key variables of interest, namely real house prices and the ratio of trade balance to Gross Domestic Product (GDP). Given that housing is not only a consumption good but represents also an alternative to investment in stocks, we further add mortgage loans and residential investment in order to control for balance sheet effects on investment over the relevant time horizon. In addition to carrying out impulse response analysis following a housing demand shock, we also analyze the historical decomposition of the impulse responses, which, in turn, adds a dynamic, medium-term oriented perspective to the ongoing policy driven debate of current account imbalances.

The rest of the chapter is organised as follows. The second section reviews the relevant literature; the third section presents the empirical methodologies. The fourth section describes the data and discusses the results with respect to both recursive and sign-restriction approaches; highlighting the ability of the sign restriction procedure to alleviate the "price puzzle" observed with the recursive identification scheme. The fifth section concludes.

6.2. Literature review

Conventionally, house price shocks may affect net exports through the wealth effect and/or collateral effect, and the exchange rate channel (Fratzscher *et al.*, 2010; Laibson and Mollerstrom, 2010; Gete, 2010; Bergin, 2011). The wealth effect implies that house prices fluctuations induce

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[66]Recent studies document that financial liberalisation has led to a rapid development in housing market translated into large capital inflows, exchange rate appreciation, credit and consumption booms (Aron and Muellbauer, 2007; Fedderke and Liu, 2002; Gupta and Ndahiriwe, 2010).

an adjustment of consumption and investment decisions which will be reflected as a trade surplus or deficit. Based on the Permanent Income Hypothesis, an increase in house prices raises expected income of households and thus consumption, while also serving as collateral, making it easier for firms to finance investment opportunities. These might lead to increases in import, thus inducing a deterioration of the country's trade balance.

On the other hand, real exchange rate determines net exports through relative prices and, plausibly, a wealth effect, the sign of which would depend upon the currency denomination of assets held by domestic investors relative to the weight of foreign goods in the consumption basket (Gavin, 1989). Under the assumption that exchange rate policies can be separated from monetary policies, the increase in house prices may be favourable to the exchange rate appreciation which affects international competitiveness, resulting in a deterioration of the trade balance. However, exchange rate might not be an efficient tool to adjust trade balance in open economies (McKinnon, 1990; McKinnon and Ohno, 1997)[67]. Further, Yang and Zhiqiang (2012) find that the impact of higher house prices on the exchange rate is negative in the short run and positive in the long run; resulting in an ambiguous link between housing wealth and the exchange rate.

Though a number of studies have attempted to analyse the determinants of the current account fluctuations[68], only few authors assessed the contribution of house prices shocks to the emergence of external imbalances. Notable and recent exceptions include Punzi (2007), Aizenman and Jinjarak (2009), Kole and Martin (2009), Fratzscher *et al.* (2010), Laibson and Mollerstrom (2010), Gete (2010), Adam and Kuang (2011) and Bergin (2011). The common

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[67] Recently, Quiao (2007) strongly argues that the exchange rate channel of the wealth effect increases the complexity of forecasting current account movement. His main point relates to the interdependencies between nations via international trade, which make exchanges rates endogenous to monetary policies; invalidating elasticity-type models in predicting the effects of exchange rate fluctuations. With a strictly limited capital movement and a less prevalent trade, exchange rate policies can be separated from monetary policies so that when an exogenous exchange rate change takes place, the domestic price level can remain unaffected because the money supply is unaltered. In such conditions, exchange rate depreciation may restore the trade balance and appreciation may increase the trade deficit. But, as economies integrate and liberalize, exchange rate can be considered as a forward-looking variable and thus reflects people's beliefs about the relative tightness of monetary policy in a country compared to others. In this case, depreciation may or may not lead to a reduction in trade deficit.

[68] Some authors identify the savings glut hypothesis (Bernanke, 2005, 2007), fiscal policy (*Erceg et al.*, 2005, Corsetti and Muller, 2006; Kim and Roubini, 2008; Batdelger and Kandil, 2012), productivity shocks (Bems *et al.*, 2007; Corsetti *et al.*, 2008; Bussiere *et al.*, 2010) as well as stock prices shocks (Berg, 2011, Fratzscher and Straub, 2009; Fratzscher *et al.*, 2010; Laibson and Mollerstrom, 2010) as the main drivers of the current account imbalances. Others focus on the adjustment mechanism and emphasize that exchange rate depreciation helps to restore current account balance for countries with large external deficits (Krugman, 2007).

result from these studies points to the positive effect of house prices appreciation on the current account deficits. However, the magnitude of the effect varies depending upon the methodology used. Thus, the observed differences in the response of current account to house price shock may be due to the methodological flaws. Further, most of these studies focus on cross-country analysis which admittedly offer more degrees of freedom but do not provide a structural identification of house price shocks. Additionally, the cross-country heterogeneities in the housing markets, trade openness and financial market depth with possibly different structures of the current account, require country specific analysis of the relationship between house prices and current account dynamics.

We, therefore, extend the literature by investigating the effect of house price shocks on trade balance in South Africa using Bayesian Vector Autoregressive approach with sign restrictions on the impulse response functions. This methodology has been applied by Fratzscher and Straub (2009) and Fratzscher *et al.* (2010) in the context of the identification of stock and house prices shocks based on Uhlig (2005)'s pure sign restrictions. Alternatively, the restrictions may also be derived from a structural model as in Adam and Kuan (2011)[69]. To identify all the shocks properly, structural models require many restrictions. For instance, the identification of eight structural shocks in an eight-variable VAR, as we use, requires as many as *(8×7) / 2 = 28* restrictions. Since, in this study we want to identify a housing demand shock only, we rely upon the sign restriction scheme, which helps us achieve our objective without requiring us to identify the other shocks in the system.

The identification of a housing demand shock, using the sign restriction procedure offers several advantages (Andre *et al.*, forthcoming; Busch *et al.*, 2010): First, it has the advantage of distinguishing housing demand shock from other types of shocks including aggregate demand, monetary policy and fiscal policy shocks, which could yield similar behaviour of the variables in the system. Second, it prevents theoretically inconsistent behaviour of the impulse responses commonly observed in the popular recursive (i.e. Cholesky) identification scheme[70]. Third, given

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[69]Adam and Kuan (2011) develop a simple open economy asset pricing model that accounts for the house price and the current account dynamics for the G7 economies and find that the model-implied correlation is greater than the data-generating correlation between the total accumulated current account deficit and the house price growth over the same period. Thus, as reported by Bergin and Sheffrin (2000); Nason and Rogers (2006),structural models of current account tend to be invalid empirically.

[70]To empirically test the theoretical superiority of the sign restriction over the recursive ordering, we also include results from the later.

that the structural identification is based on orthogonalized matrices drawn randomly within a Bayesian framework, the ordering of the variables in the VAR does not affect the impulse responses. Indeed, it allows immediate responses to the relevant shock, thus mitigating the issue of delayed effects.

The existing literature builds on two specific assumptions regarding the structural interpretation of the asset price shocks, and so does the present study. The first hypothesis is consistent with Engle and Rogers (2006) in that house prices are considered to be forward looking and thus reflect people's expectations about the future outcomes, such as economic fundamentals. For instance, a positive house price shock may be understood as being an increase in expected future productivity which leads to rise in house prices. The second hypothesis associates the sharp increase in house prices to some extent with rational bubbles as in Kraay and Ventura (2005). Consistent with rational expectations, shifts in people's expectations and/or rational bubbles which are directly reflected in higher house prices would thus, be favourable to current account deficits.

6.3. Empirical methodology

In line with Uhlig (2005), this chapter implements the sign restrictions approach in a Bayesian VAR framework for estimation and inference of the following reduced-form VAR:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + u_t, \qquad t=1,\dots, T. \tag{1}$$

$$u_t \sim N(0, \Sigma),$$

where Y_t is an $n \times 1$ vector of endogenous variables at time $t=1,\dots,T$; including consumer price level (p), private consumption (c), residential investment (ri), the interest rate (i), real house prices (hp), mortgage loan (l), the real effective exchange rate ($reer$) and trade balance (tb). Thus,

$$Y = [p, c, ri, i, hp, l, reer, tb]. \tag{2}$$

A_i are coefficient matrices of size $n \times n$ and u_t is an $n \times 1$ vector of residuals, with variance-covariance matrix $E[u_t u_t'] = \Sigma$. The reduced-form residuals u_t have no structural interpretation. To make structural inferences from the data, sufficient restrictions need to be provided in order to identify the VAR in equation (1). The identification of the VAR in (1) requires a matrix B

such that $B\varepsilon_t = u_t$, where the coefficient b_{ij} captures the contemporaneous response of the ith endogenous variable in the system to the jth structural shock of one standard deviation.

Conventionally, the identification is achieved by orthogonalizing the reduced-form disturbances using the Choleski decomposition. Accordingly, a recursive structure is imposed on B so that B is restricted to be lower triangular. However, without *a priori* theorizing, this method always leads to counter-intuitive behaviour of some variables under consideration; the commonly reported being the "price puzzle". Thus, our empirical investigation relies on pure-sign restriction procedure developed by Uhlig (2005) which basically imposes theoretically consistent restrictions on some variables for a specific period of time, and hence, ensures expected behaviour of variables with respect to the theory.

This chapter seeks to identify housing demand shocks[71]. For this purpose, we first analysed the impulse response functions from a recursive causal ordering of variables as indicated in equation (2). As in Musso *et al.* (2011), equation (2) is interpreted as a housing demand function since it relates real house prices to consumption and residential investment. On the other hand, the ordering of variables is in line with Jarocinski and Smets (2008), Iacoviello and Neri (2010) and Musso *et al.* (2011) who associate a positive non-monetary housing demand shock with an increase in house prices which leads to a rise in residential investment without causing a fall in the monetary policy instrument. Further, consumption is assumed not to react simultaneously to this shock. Hence, residential investment, interest rate and real house prices are ordered after consumer price level and private consumption. Finally, under the assumption that trade balance responds to changes in all other variables, trade balance is ordered last, after mortgage loan and the real effective exchange rate respectively. However, Although, these features might help to identify a housing demand shock, it is widely recognised that one cannot separate a housing demand shock from macroeconomic shocks (such as technology, monetary and fiscal policy shocks) based on a standard VAR (See Musso *et al.*, 2011; Aspachs-Bracons and Rabanal, 2011). Further, as indicated in Berg (2011), the ordering of financial variables is unclear, although his findings appear to be robust to different ordering schemes. Moreover, as will be seen below, the results from this identification scheme are inconsistent with theoretical considerations; thus motivating the use of an alternative identification procedure.

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[71] Details on the implementation is provided in the Appendix 6.1.

Table 6.1 summarises our identification sign restrictions. To ensure that house price shock is a housing demand shock, we make use of an agnostic identification scheme by imposing sign restrictions on the responses of all variables in the VAR except tb (our variable of interest) and reer (given the uncertainty in the exchange rate- house price relationship). Albeit the wealth effect has been investigated empirically in South Africa[72], there is no study that relates house prices and exchange rate in this specific context. Additionally, the exchange rate channel might not be significant for a small open economy such as South Africa, since exchange rate movements are related to the degree of trade openness of an economy (Hau, 2002). In this respect, we keep the reer unrestricted; allowing "the data to speak" and impose non-negative sign restrictions on *c, i, p, l, hp and ri* for 4 quarters.

These reactions of the macroeconomic variables are fundamentally different from the responses that could originate from an aggregate demand, aggregate supply, monetary policy and credit shocks. A standard aggregate demand disturbance can either originate from an exogenous shock to consumption, residential investment or the trade balance itself. The shock to the real effective exchange rate could also be viewed as an aggregate demand shock, since it will affect the aggregate demand via the net exports (trade balance). While a positive housing demand shock induces an increase in house prices (see sign restrictions Table), a positive demand shock results in inflationary pressure to which monetary authority reacts by raising the interest rate. As interest rate increases, the cost of financing real estate project increases, leading to a fall in housing demand and hence a decline in real house prices. Theoretically, the monetary policy shock is different from the aggregate demand shock, as well as the housing demand shock, since we would expect inflation to fall following a contractionary monetary policy shock. An exogenous positive shock to the mortgage loans, characterizing a credit shock, is likely to originate from a fall in the mortgage rate, which is only possible if the interest rate declines, causing house price, consumption and residential investment to rise with possible inflationary effects. Again, the movement of the interest rate distinguishes this shock from the aggregate demand and housing demand shock.

Finally, with no measure of output in the model, the CPI shock captures the aggregate supply side of the model. A positive shock to the CPI, is likely to lead to an increase interest rate, but most likely will be associated with fall in consumption, investment, house price (and hence

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[72] See for instance Aron and Muellbauer (2007), Ncube and Ndou (2011), Das *et al.* (2011), Peretti *et al.* (forthcoming), and Simo-Kengne *et al.* (forthcoming).

mortgage loans), since the economy in general is costlier. Note that, there could be a hedging effect of inflation on house prices (Gupta and Inglesi-Lotz, forthcoming), which could lead to an increase in house price and which in turn, can have a positive impact on consumption. However, it is likely that the direct effect of higher general prices is likely to reduce consumption more than the increase in the same through the hedging effect[73]. Clearly, our identification of the housing demand shock in this framework is unique[74].

Table 6.1

Identifying Sign Restrictions

Shock	p	c	ri	I	hp	l	reer	tb
Housing demand	+	+	+	+	+	+		

Note: This table shows the sign restrictions on the impulse responses for a housing demand shock. "+" means that the response of the variable is restricted to be positive for the first four quarters following a housing demand shock. A blank entry indicates no restrictions.

As mentioned earlier, one major attraction of the sign restrictions-based identification procedure is the possibility to distinguish one particular shock from the others. Paustian (2007) pointed out that the effectiveness of this identification procedure in delivering unambiguous and correct sign of unconstrained impulse responses depends on the number of shocks identified; the larger the number of structural shocks identified, the closer to the true impulse responses of the shock of interest However, he admitted that since the evaluation was based on the numerical analysis of calibrated DSGE model, the result depends on the underlying model structure and therefore cannot be generalised to other models. The objective of this chapter is to analyse how trade balance evolves following a housing demand shock, that is, to tract the dynamic path of the wealth and balance sheet effects in the process and their significance over time. We, thus identify only one shock (housing demand shock) at the expense of a greater share of the structural shock remaining unexplained (Uhlig, 2005). Without making a compromise on the identification of the housing demand shock, the focus on the shock of interest is in line with recent studies on wealth

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[73] This line of thinking was verified based on the BVAR estimates under the Choleski decomposition. Details of these results are available upon request from the authors.

[74] These reactions of the macroeconomic variables are also fundamentally different from the responses following technology and fiscal policy shocks. As argued in Fratzscher and Straub (2009), a positive technology shock induces an increase in consumption associated with a fall in inflation. On the other hand a fiscal policy shock (fall in government spending) results in a positive reaction of private consumption and inflation.

effects based VAR models with sign restriction identification procedure (see for example, Fratzscher and Straub, 2009; Fratzscher *et al.*, 2010, Andre *et al.*, forthcoming).

As well documented in the recent literature (see for instance Fry and Pagan, 2011), the sign restriction scheme will not yield unique identification. Explicitly, although this identification procedure solves the structural identification problem by providing adequate information to identify the structural parameters, many models with identified parameters might provide the same fit to the data. As a result, the estimated impulse response functions characterise the responses to shocks from different models, suggesting that the structural shocks may not be orthogonal (Aastveit *et al.,* 2012). In our case, however, we identify only one shock and not multiple shocks. In addition, as discussed above, theoretically all the different shocks are expected to have different effects on the variables of the economy (and hence sign restrictions), which in turn, explicitly allows us to distinguish the housing demand shock from the other shocks, since impulse responses that do not conform with our theory are discarded in any case.[75] So in our case, the median response is unique. But note, more importantly, we allow the sign-restrictions to hold for four quarters and not just one quarter. Hence, as discussed in Fry and Pagan (2011), the introduction of extra information this way enables us to discriminate between the multiple models. It is believed in the literature that adding on sign restrictions for longer impulse responses provides stronger identifying information, as depicted by the Monte Carlo study in Paustian (2007).

6.4. Data and results

6.4.1. Data

Included in this sample study are private consumption, consumer price index, money market rate, residential investment, mortgage loan, real house price index, real effective exchange rate and trade balance relative to GDP. The data sample covers quarterly series for the period of 1979:01 to 2011:04. Though other variables are available prior to 1979, the choice of the dataset is constrained by the availability of the mortgage loan data, which in turn, determines the starting point of the empirical investigation. Barring money market rate and consumer price index which are derived from the International Financial Statistics of the International Monetary Fund, and seasonally adjusted house price index obtained from Amalgamated Bank of South Africa

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[75] The reader is referred to the Appendix of the chapter for further details.

(ABSA), the remaining variables are obtained from the Quarterly Bulletin of the South African Reserve Bank (SARB). We took three-months averages for monthly variables to get to quarterly frequency.

In South Africa, banks are responsible for more than 90% of mortgage lending; making the banking sector the most important provider of mortgage finance for housing[76]. ABSA, one of the major private banks in South Africa, plays a leading role in the mortgage finance market and represents one of the most well known sources of residential property market data in the country. It categorises South African housing market into three price segments, namely luxury (ZAR 3.5 million – ZAR 12.8 million), middle (ZAR 480,000 – ZAR 3.5 million) and affordable (below ZAR 480,000 and area between 40 square metres - 79 square metres). The middle-segment is further categorized into three more segments based on sizes, namely large-middle (221 square metres – 400 square metres), medium-middle (141 square metres – 220 square metres) and small-middle (80 square meters – 140 square meters). Since we are concerned about the entire economy in general, we decided to use the house price of the entire middle-segment in our analysis, as it is likely to be the house price that applies to most households in the economy. Note that, to compile these indices, ABSA follows a specific process: Firstly, data are extracted from applications for mortgage finance that were approved by the bank. Then these data including purchase prices, building and land area and building and land value among others are generated and filtered for the different size categories. Cut –off prices for affordable, middle and luxury segments are determined once a year based on various trends such as the CPI inflation and growth in housing prices. These series are then seasonally adjusted and smoothed and the average house price data series are compiled for each segment. For the sub-segments (small, medium and large) the weighted average is lastly combined based on the sample sizes of each of the segments.[77]

The variables are used in levels as it is standard that Bayesian analysis does not require stationarity of the data. As indicated Sims *et al.* (1990), Bayesian approach relies on the likelihood

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[76] In the second half of 2003, mortgage loans comprised 32% of the total loans and advances on the bank's balance sheets (Luüs, 2005)

[77] Though there are other house price indices available for South Africa, none of them report data starting in 1979:Q1, except for ABSA house price indices, which starts in 1966:Q1. Given that we have an eight variable VAR with two lags, which in turn, requires a relatively long data span to ensure significant parameter estimates, we decided to use the ABSA database to obtain reliable results. , Note that, in this regard (i.e. the choice of the house price data), we follow the existing literature that analyzes the housing market of South Africa.

function which keeps the same Gaussian distribution irrespective of the presence of unit roots. The estimation is based on two lags as suggested by the Schwartz information criterion. We use natural logarithms of all variables, barring the interest rate, real effective exchange rate and the trade balance as a percentage of GDP. We start off discussing the results from the recursive identification procedure which provides theoretically inconsistent responses of some variables; thus motivating the decision to rely on the results from the sign-restriction methodology.

6.4.2. Impulse responses using a recursive identification scheme

A perusal of Figure 6.1 reveals that a housing demand shock of one standard deviation generally shows the expected behaviour for all variables except the consumer price index. Real house prices increases to a maximum of 0.05 percent (which implies an increase of 1.05 percent accounting for the fact that house prices are in logs), staying significant for about 20 quarters with a very slow reversion to the baseline. This pattern is consistent with significant autocorrelation in house prices that may result from extrapolative expectations (Andre *et al.,* forthcoming). Higher housing demand leads to long lasting increases in residential investment and mortgage loan associated with significantly positive reactions of private consumption and interest rate, which last about 9 and 6 quarters respectively. The response of the trade balance looks conventional (significant decline) and the timing of the response matches that of nominal interest rate and private consumption. However, real effective exchange rate increases significantly initially, which is however, short-lived. Further, a long lasting decrease in the level of consumer prices which is hardly compatible with a housing demand shock confirms the possibility of puzzling results often observed with the Choleski decomposition. The fact that this puzzling effect is significant for 14 quarters makes the case against using a recursive identification stronger.

Despite the inability of the Choleski decomposition to properly identify the housing demand shock, one can infer that a housing shock may affect the trade balance through several mechanisms. First, the significant rise in residential investment generates multiplier effects on employment and income which result in a deterioration of the trade balance. Second, as mortgage loan increases, the wealth and/or collateral effects justify the increase in private consumption which in turn induces an increase in trade deficits. Third, increases in interest rates and real effective exchange rate could offset part of investment and wealth effects; leading to the observed short-lived reaction of the trade balance.

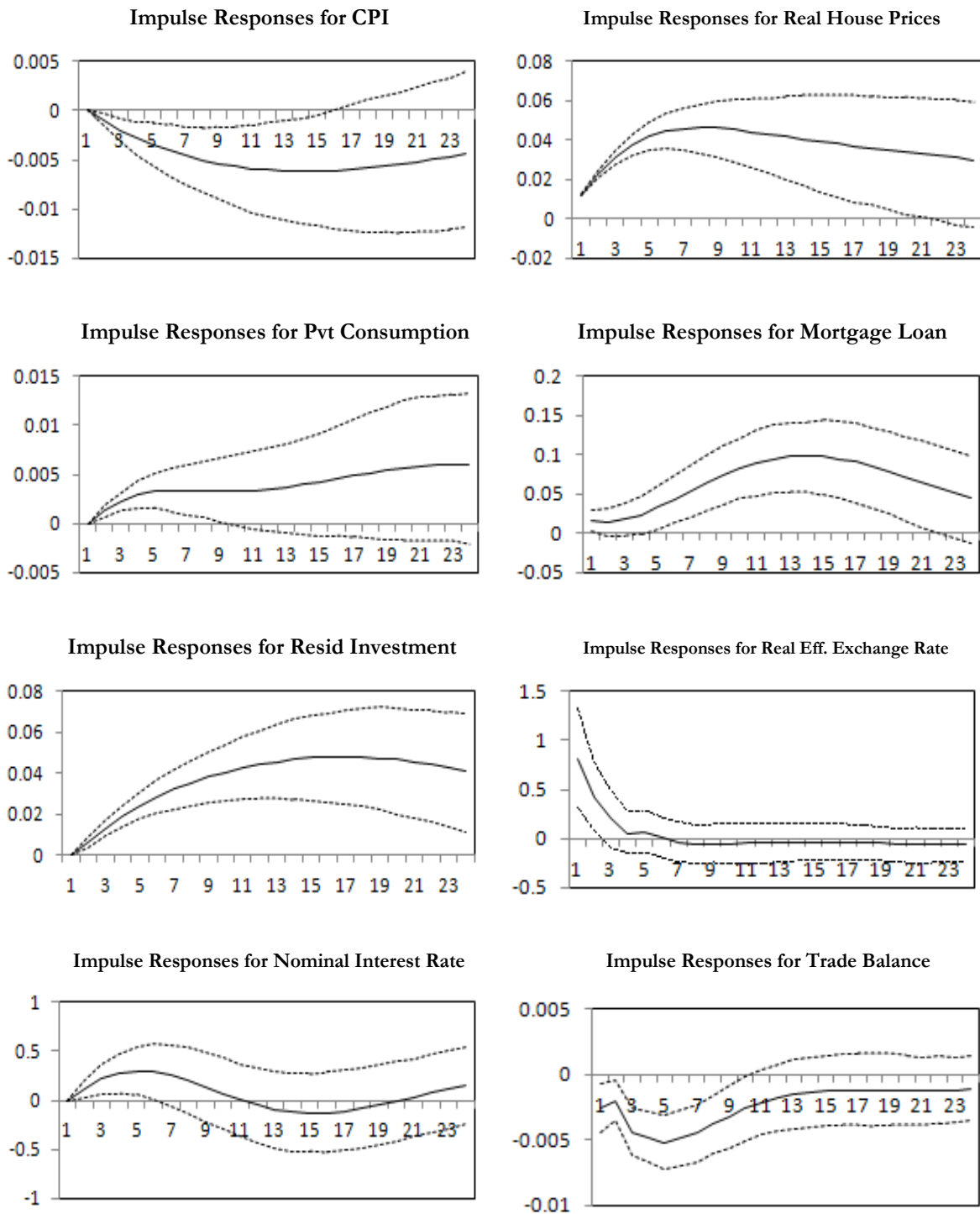### 6.4.3. Impulse responses using an agnostic identification procedure

Because of the theoretically inconsistent decrease in the consumer price level within a recursive identification framework, we have used an alternative approach to better identify a housing demand shock. This procedure is called agnostic in that we impose sign restrictions to some variables, allowing impulse response functions to be theoretically consistent.

Figure 6.3 displays the responses to one standard deviation increase in real house prices and the corresponding 16 percent and 84 percent quantiles. The rise in house prices is followed by a significant increase (from 5 to 14 quarters) in mortgage loan, consumption, residential investment and consumer prices, suggesting the presence of wealth/collateral and balance sheet effects on consumption and investment, respectively. The puzzling effect reported above is avoided by construction. Moreover, besides the significant and immediate response of mortgage loan which satisfies a necessary condition to identify a housing demand shock (Andre et al., 2011), one can distinguish between housing demand shock and aggregate demand shock since the former induces a positive correlation between consumption and consumer price level while the latter is typically associated with a negative correlation between the two variables.

Further, in response to the increase in consumption and consumer prices, the monetary policy is found to be contractionary. Short-term interest rates show a significant and long lasting increase, consistent with Taylor-type feedback rule in the reaction of the South African Reserve Bank to financial condition index which included real house prices as depicted Naraidoo and Ndahiriwe (forthcoming) and Naraidoo and Raputsoane (2010). This result is also in line with Simo-Kengne *et al.* (2013) who document the existence of positive feedbacks from housing sector to interest rate; confirming that monetary policy does react to house price shock in South Africa.

We observe an initial depreciation of the real effective exchange rate followed by a noticeable appreciation up to 2 quarters and a near to zero effect thereafter. The effect is however not significant. This again substantiates the uncertainty surrounding the effect of housing wealth on domestic currency. Finally, in response to house price growth, the trade account worsens immediately and reaches a trough around 3 quarters. Thereafter, the trade deficit improves gradually and trade balance is restored after around 4 years.

Figure 6.2: Impulse Responses with Recursive (Choleski) Identification Scheme

Impulse Responses for CPI

Impulse Responses for Real House Prices

Impulse Responses for Pvt Consumption

Impulse Responses for Mortgage Loan

Impulse Responses for Resid Investment

Impulse Responses for Real Eff. Exchange Rate

Impulse Responses for Nominal Interest Rate

Impulse Responses for Trade Balance

Notes: The Solid line represents the median, while the dotted lines indicate the 16 % and the 84 % quantiles for the sample of impulse responses.

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Figure 6.3: Impulse Responses with Sign Restrictions
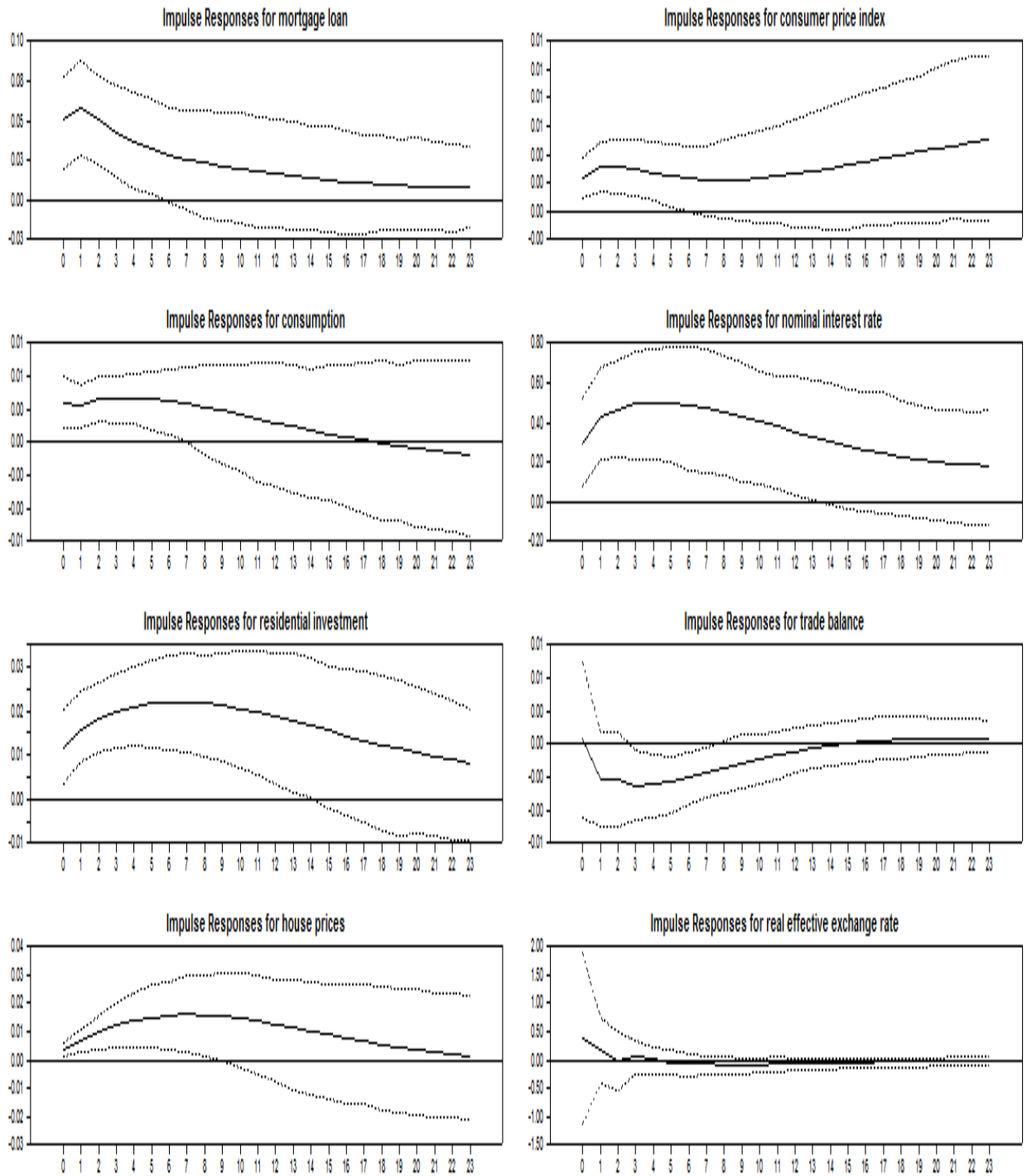
Notes: The Solid line represents the median, while the dotted lines indicate the 16 % and the 84 % quantiles for the sample of impulse responses.

However, the effect is only significant between the 3 and 8 quarters. The maximum impact of one standard deviation house price shock resulting in a corresponding to 1.23 percent increase in house prices (once we account for the fact that house prices have been expressed in logarithms, but not trade balance) deteriorates the trade balance by -0.249 percent. It can therefore be economically inferred that a 10 percent increase in house prices corresponds to the deterioration of the trade balance by 2.02 percent. This result is in line with Fratzscher *et al.* (2010) who associate a 1.6 percent deterioration of the US trade balance with 10 percent increase in house prices after 11 quarters.

Without *a priori* theorizing, it appears difficult to properly identify a housing demand shock. The pure-sign restriction impulse responses have mitigated the evidence of puzzling effect observed with the consumer price level in the benchmark recursive identification scheme.

6.4.4. How much variation in the trade balance do house price shocks explain?

The importance of the house price shocks in explaining fluctuations in the trade balance is evaluated by examining both variance decomposition and historical decomposition[78]. The variance decomposition shows the fraction of forecast error variance for the trade balance that is attributable to innovations in house prices. It captures both direct and indirect effects and can be interpreted, according to Sims (1982), as a Granger-causal relation. Figure 6.4 displays the variance decomposition of the relevant variables (unrestricted variables). The plots indicate that housing demand shocks account for 8 percent (7 percent) in the total variation in trade balance (real effective exchange rate) after one quarter. As the horizon increases, these proportions increase and reach about 10 percent and 8 percent respectively after 20 quarters. However, this econometric tool provides only the overall effect and does not allow analysing the relative importance of house price shocks across different sub-periods. We, therefore, conduct a historical decomposition in order to appreciate how such effect has evolved over time.

The historical decomposition depicts the cumulative effect of a particular shock for a given date. Figure 6.5 plots the contribution of housing demand shocks to the historical path of the trade balance and real effective exchange rate over the sample period.

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[78] See Doan (2009) for computation details.

Figure 6.4: Forecast Error Variance Decomposition under Pure-Sign Restriction Approach

Fraction of trade balance due to a house price shock

Fraction of real effective exchange rate due to a house price shock
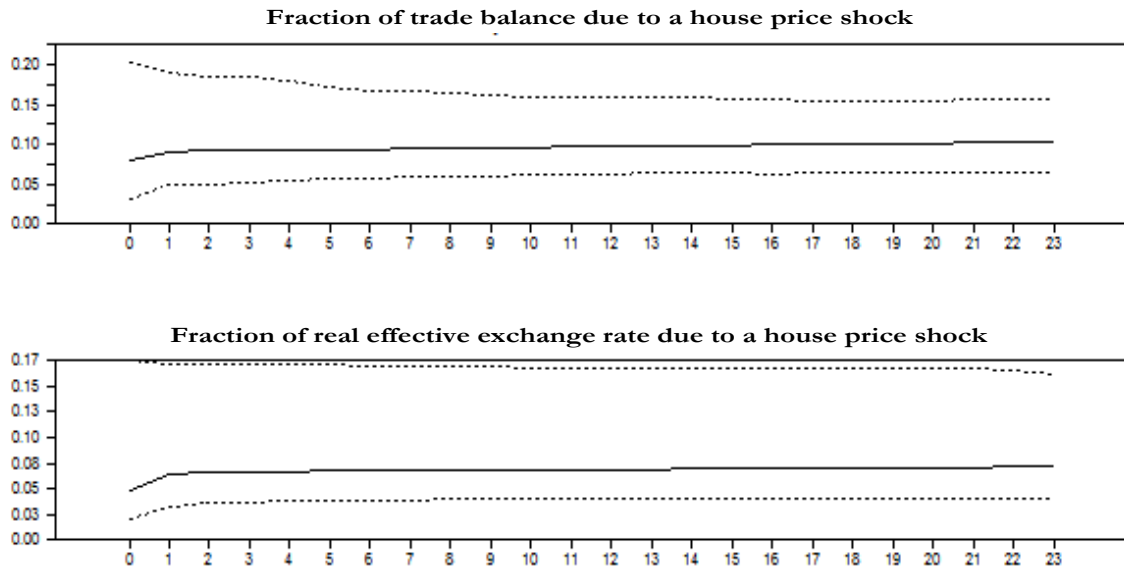
Figure 6.5: Historical Decomposition with Pure-Sign Restriction Approach

Contribution of house price shock to trade balance

Contribution of house price shock to real effective exchange rate
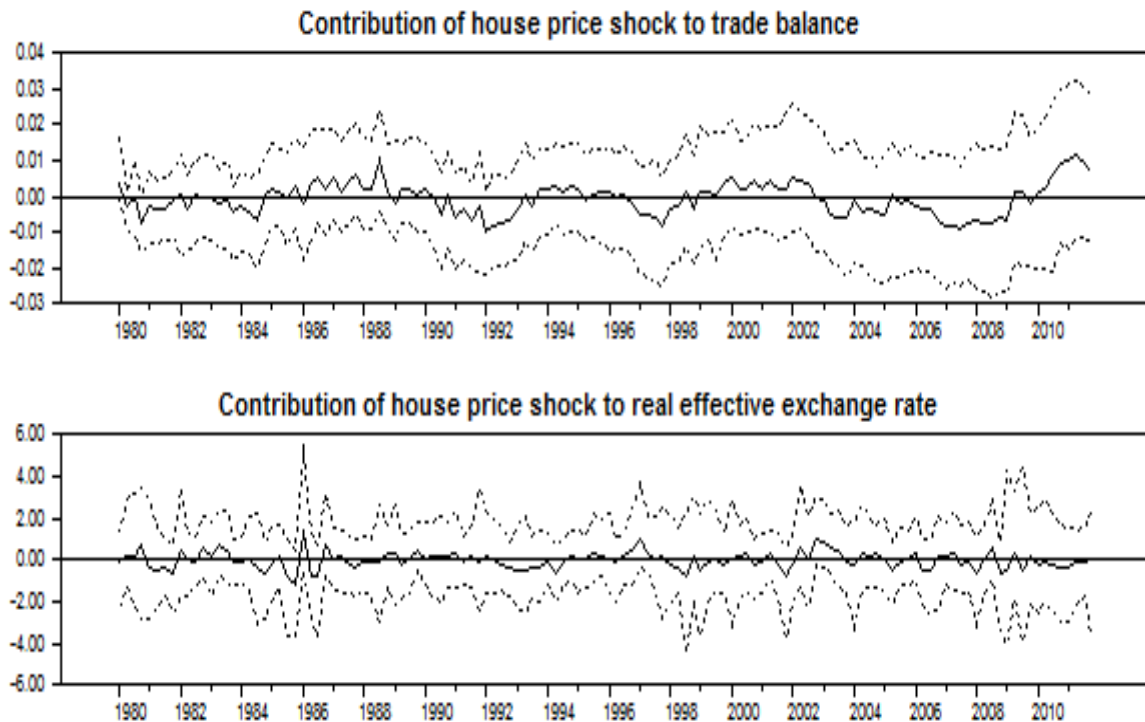
While the evolution of the role of house price shocks on the real effective exchange rate seems constant over time, trade balance appears to have been subject to several shocks of different magnitude throughout the relevant period, most notably in 1980s, 1990s and 2000s. These three sub-periods coincide with some important domestic and foreign shocks which may have affected housing activities. As shown in Figure 6.5, the gap between the forecast (dashed lines) and the true effect (solid line) is particularly large in the third sub-period; indicating a smaller incidence of house price shock on trade deficit than could have predicted from the model during that period.

The 1980s sub-period coincides with the gold price boom and the beginning of financial liberalization which may have contributed to the run-up in house prices. The resulting wealth and collateral effects led to consumption boom which, in turn, translated into trade deficit. The subsequent recovery of the trade balance observed between 1985 and 1989 can be attributed to the slowdown in house prices due to political pressures and the uncertainty about the future of the country with negative effect on people's confidence. The sub-period of 1990s shows substantial troughs and slower recoveries in the trade balance compared to the 1980s sub-period. This could be ascribed to the combined effects of a positive domestic shock (political transition, higher economic growth, low inflation and interest rate) and a negative world shock (Asian crisis). The last decade indicates a smaller proportion of trade deficit attributable to house price shocks compared to the 1990s sub-period. However, a substantial improvement is observed from 2010. This is quite understandable since monetary transmission mechanism in the last decade has shifted somewhat to the housing sector; thus, enabling monetary authorities to restrain the unexpected effects of housing wealth on the macroeconomic stability. Moreover, the 2007/2008 global financial crisis and its contagion worldwide may have hit the housing sector, leading to the slowdown of the general economy which in turn, resulted in the trade balance appreciation.

In summary, high house prices growth induced by financial liberalization, loose monetary policy and to some extent world shocks turns out to have played an important role in driving South African trade deficits. More specifically, the increase in house prices has encouraged lenders to extend loans to borrowers, allowing households to increase their investment expenditure and consumption spending on both domestic and foreign goods; resulting in the trade balance deterioration. According to the reported numbers above, a housing market underperformance of 10% improves the trade balance by about 2.02% and the adjustment happens gradually, taking around 4 years. From a policy perspective, this result suggests that

house price movements are a potential driver of the adjustment process of the trade balance and henceforth, making house prices an additional tool for current account-adjustment in South Africa. Since the decline in house prices is favourable to trade balance appreciation, it is likely that South African Reserve Bank (SARB) responds significantly to house price inflation to limit the consumption spending and/or borrowing capacity of households which in turn, improve the national saving and hence the trade balance. This policy relevance of house price channel is further demonstrated by the common observation that SAR does react to house price shocks (Ncube and Ndou, 2011; Peretti *et al.,* forthcoming; and Simo-Kengne *et al.*, 2013).

6.5. Conclusion

Given the on-going global debate on the causes of global current account imbalances, this chapter provides empirical evidence of the effect of house price shocks on the current account in South Africa. In order to clearly identify a housing demand shock and also to avoid possible puzzling results frequently observed when shocks are identified using a Choleski (recursive) identification scheme, housing demand shock was identified using sign-restrictions in a Bayesian VAR comprising of eight variables namely, consumer price index, private consumption, residential investment, nominal interest rate, real house prices, mortgage loan, trade balance and the real effective exchange rate. As in Uhlig (2005), we impose theoretically consistent non negative sign-restrictions on the responses of real house prices, private consumption, consumer price index, nominal interest rate, residential investment and mortgage loan and keep unrestricted the variables of interest namely trade balance and the real effective exchange rate.

The results show that higher housing demand tends to deteriorate the trade balance. 1.23 percent increase in house prices, following a one standard deviation increase in real house prices, worsens the trade balance by 0.249 percent at a horizon of three quarters. However, the effect on the real effective exchange rate is short-lived and insignificant. This suggests that wealth and/or collateral and balance sheet effects on private consumption and investment, respectively, represent the main channel through which South African housing market spills over onto current account. Further, the relative contribution of housing demand shocks to trade deficit is found to vary over time. As expected, the smaller fraction is reported in 2000s, reflecting the effectiveness in the conduct of South African monetary policy which is now encompassing housing price movements.

Appendix 6.1: Implementation of the BVARs (Choleski Decomposition and Sign-Restriction Approach)

The Choleski factorization is applied within a Bayesian framework by imposing a diffuse (Jeffrey's) prior on the VAR (ie $F(A, \Sigma) a |\Sigma|^{-(n+1)/2}$; the posterior being essentially the Ordinary Least Squares estimates. The impulse responses are thus generated from Monte Carlo simulation with 1000 keeping draws. Specifically, we use antithetic acceleration which consists of drawing new values of Σ and A on the odd draws and then flipping A around the mean of the posterior on the even draws.

Differently from the Choleski decomposition where different orderings of the variables lead to different impulse responses, by imposing sign restrictions on the impulse responses of a set of variables, Uhlig (2005) showed that any orthogonal matrix Q with $QQ' = I_n$ and $\Sigma = BQQ'B'$ is an admissible decomposition for Σ, in which case $u_t = BQ\tilde{\varepsilon}_t$, $E[\tilde{\varepsilon}_t \tilde{\varepsilon}_t'] = I_n$. Although different Q-matrices produce different signs and magnitudes of the impulse responses, it is not possible to discriminate among them on the basis of data, as they imply identical VAR specifications. Thus, for any impulse vector $b \in \mathbb{R}^n$ such that $b = \tilde{B}q$ and $\tilde{B}\tilde{B}' = \Sigma$, $\tilde{B}$ is the lower triangular Choleski factor of Σ. For a given structural vector b_j, the impulse responses of n variables up to K horizons can be computed using the estimated coefficients A_i as follows:

$$IR_k = [I - A]^{-1} b_j$$

where IR_k is the matrix of impulse responses at horizon k. Sign restrictions are imposed on m variables ($m<n$) over the horizon $0, ..., K$ so that b_j identifies the shock of interest. Empirically, given the estimated reduced form VAR, we take n_1 draws from the posterior of the Normal-Wishart for (A, Σ) and n_2 draws from an independent uniform prior to compute the impulse vector b_j and the associated impulse responses as described above. To ensure that the retained draws generate all the IRs which satisfy the sign restrictions, each draw for which the IRs do not comply with the sign restrictions is discarded. This procedure is repeated n_3 times and the error bands are calculated based on the favourable draws. We use $n_1 = n_2 = 200$; $n_3 = 1000$ and $K = 3$ for the estimation.

Chapter 7

Conclusion

This thesis has examined the dynamic interaction between housing market and the real economy in South Africa. Using a variety of macroeconometric tools that account for unobservable issues in housing analysis, empirical investigation supports evidence of bidirectional relationship between South Africa housing sector and the macroeconomy. Specifically, the following are reported.

In the second chapter, the determinants of house price dynamics are estimated using a structural VAR with short run restrictions. Based on a dynamic factor model, fluctuations in provincial house prices are found to be mainly driven by a common component associated to a national factor. Then, VAR results attribute this co-movement in house prices to the combined effects of favourable and unfavourable structural shocks emanating from different sectors of the economy. Monetary policy shocks are reported to be an important contribution to the historical path of house price dynamics besides portfolio shocks while aggregate supply shocks have had less influence.

The third chapter employs a panel VAR approach to establish the role of house prices in explaining the dynamic behaviour of consumption in South Africa. A positive shock to house prices is found to impact positively and significantly on consumption whereas a negative shock causes an insignificant decline in consumption; suggesting an asymmetric comovement between house prices and consumption. This confirms the evidence of both wealth and collateral effects of house price appreciation on household expenditure.

The fourth chapter makes use of a set of panel methods to assess the economic impact of house price changes on provincial economic growth. Results indicate that when heterogeneity, endogeneity and spatial dependence are controlled for, house price changes exhibit a significant effect on provincial economic growth; the magnitude of the effect varying across provinces. Further, we distinguish between wealth and collateral effects and find that the wealth effect is dominant at the aggregate level which contrasts the dominance of the collateral effect at the provincial level.

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The fifth chapter identifies two different regimes (bull and bear markets) in the South African housing market based on a Markov-Switching VAR and shows significant asymmetries in the dynamics of house prices in relation to monetary policy. While the impact of a contractionary monetary policy on house prices is larger in bear regime, monetary policy reaction to a positive house price shock is found to be stronger in the bull regime. On the other hand, monetary authorities are more concerned about bull regime characterized by the prominence of house price bubbles and hence their subsequent burst which has been shown to always lead to economic recession. These results are consistent with Aron and Muellbauer (2007) that housing market plays a noteworthy role in the South African monetary transmission mechanism.

In an attempt to understand the sources of external imbalances, the sixth chapter provides empirical evidence of the effects of house price shocks on the trade balance using a Bayesian VAR with sign restrictions. The result shows that 1 percent decrease in house prices is found to improve the trade balance by 0.2 percent; the effect being channelled mainly through the wealth and balance sheet effects on consumption and investment, respectively. This finding suggests that house price can serve as an additional instrument for trade balance adjustment besides the conventional exchange rate channel.

In summary, housing development is favourable to economic growth but requires effective policies to restrain negative externalities such as house price bubbles busts, unexpected effects on macroeconomic and financial stability. This study has considered only the effect of monetary policy and results can further be improved by analysing the effect of fiscal policy. Another direction of extension relates to the issue of volatility which is characteristic of asset markets. For instance, it is possible to consider the link between housing market volatility and economic fundamentals. Finally, as an asset, housing is related to other types of assets and hence requires to be analysed conjointly. This research can therefore be extended to the asset market so as to capture the interdependencies between different types of assets which, in our view, could provide more efficient results.

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