THE IMPACT OF MACROECONOMIC AND FINANCIAL FACTORS ON THE PERFORMANCE OF THE HOUSING PROPERTY MARKET IN SOUTH AFRICA

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A thesis submitted in partial fulfilment of the requirements for the degree of

MASTER OF COMMERCE IN FINANCIAL MARKETS

DEPARTMENT OF ECONOMICS AND ECONOMIC HISTORY
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[1] The financial assistance of the Department of Labour (DST) and Andrew Mellon Foundation Scholarship towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at are those of the author and not necessarily to be attributed to the DST, Mellon Foundation or Rhodes University.

ABSTRACT

This study examines the impact of macroeconomic and financial variables on the performance of the housing property market in South Africa using monthly data for the period January 1996 to June 2008. Orthogonalised and non-orthogonalised house price returns and real estate returns are utilised as proxies for the housing property market in separate models.

Three main issues were empirically analysed in relation to the linkage between selected variables and the housing property market. The first aspect examined the relationship between selected macroeconomic and financial factors and property returns. Secondly, the study examined the influence that a unit shock to each variable has on property returns over a period of time. The third aspect focused on determining the proportion of property returns variation that results from changes in the macroeconomic and financial variables. VAR modelling was thus adopted to empirically analyse these three aspects.

The results reveal that house price returns are influenced by most of the macroeconomic and financial variables used in this study. Specifically, the real effective exchange rate, interest rate spread and manufacturing production positively impact on house price returns while the domestic interest rate, the dividend yield and expected inflation have a negative effect. Furthermore, manufacturing production has a lagged effect on house price returns while the real effective exchange rate and domestic interest rate have a contemporaneous effect. Real estate returns are not influenced by most of the variables except for the domestic interest rate and dividend yield which have a negative effect.

ACKNOWLEDGEMENTS

Firstly, I thank God, the Almighty for His grace and for giving me the strength and courage to do this work. Secondly, I would like to express my sincere gratitude to my supervisors Professor Meshach Aziakpono and Nicolette Cattaneo for the guidance, motivation and support they gave me in writing this paper. I say that you are really an inspiration to me given the commitment, patience and selfless effort that you put in the supervision role. You have contributed significantly towards the realisation of my dream of pursuing academic studies. May you continue doing this wonderful work.

Furthermore, I would like to thank my family for the unconditional love, moral support and care they have always given me. I say to my father, mother, sisters and brothers, this achievement is not mine but yours. I fully dedicate it to you as a sign of the fruits that you have reaped as a result of your support. I also want to thank my friends, Anthony, Solomon, Douglas and Godfrey for the moral support and encouragement that they gave me during the period I was doing this study. Additionally, I would like to say that you have contributed a lot to my achievement through being there for me in tough times and in good times, and for not letting me down as a friend. I will always remember you.

Lastly, I would like to thank Professor Snowball, Professor Faure, Professor Nel, Mr Seedat, Mr Chinzara and all the lecturing and administrative staff members of the Economics department for academic guidance and support. To my fellow Masters students, Economics tutors and my tutorial students, I am grateful for the moments that we spent together.

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LIST OF ABBREVIATIONS

OHPR... Orthogonalised house price returns
HPR ....Non-orthogonalised house price returns
ORER.. Orthogonalised real estate returns
ASR .... FTSE/JSE All Share index returns
RER .... Non-orthogonalised real estate returns
DIV .... Dividend yield
LMP .... Manufacturing production
IRUS ....Foreign interest rate
IRSA .... Domestic interest rate
ISP ....Interest rate spread
INF ....Actual inflation
EINF ....Expected inflation
UNINF ....Unexpected inflation
LRER ....Real effective exchange rate

CHAPTER 1

INTRODUCTION

1.3 CONTEXT OF THE RESEARCH

Globally, the housing property market has shown significant fluctuations since the 1960s. According to Du Toit (2005:1), the housing property market has been in a boom worldwide since the year 2000 and this is considered as the largest financial bubble experienced so far. This is attributed to the fact that property market indicators such as the real house price level, house prices as a ratio of income levels and rentals have reached their peak in the records, growing at double digit rates in many developed countries such as the USA, UK, Canada and Australia, and other developing countries especially South Africa.

Furthermore, Nel and Mbeleki (2005:12) assert that, internationally, housing property prices have probably been catching up with other asset prices since 2000. Two factors have been mentioned as the key drivers for this boom in the housing property market. These are traditionally low interest rates and the outstanding performance of property compared to other asset classes such as equities.

These changes in housing property markets have led to a growing interest in studying the influence of macroeconomic factors on property market returns especially in the USA (see Chan *et al.*, 1990; Liu and Mei, 1992; McCue and Kling, 1994; Ling and Naranjo, 1997) and the UK (see Lizieri and Satchell, 1997b and Brooks and Tsolacos, 1999). The common finding of these studies is that selected macroeconomic variables namely the real Treasury bill rate, nominal short-term interest rate, the term structure of interest rates and unexpected inflation have systematic influences on property market returns. However, Brooks and Tsolacos (1999) produce conflicting results, using UK data and a vector autoregressive (VAR) model. They conclude that the unemployment rate, nominal short-term interest rate, the interest rate spread, unanticipated inflation and dividend yield do not significantly influence the variation of the filtered property returns series. Such conflicting results were attributed to the sensitivity of the property returns series to methodologies used and the sample period (Brooks and Tsolacos, 1999:150). This forms the basis for investigating the influence of macroeconomic and financial factors on the housing property market in South Africa.

In line with global trends, the housing property market in South Africa has performed extremely well from 2000 to 2007. According to Nel and Mbeleki (2005:12-13) the South African housing property market, with a record of 21.4%, 32.1%, 23.3% annual nominal house price growth rates in 2003, 2004 and 2005 respectively has performed outstandingly above all housing property markets of selected developed countries[2]. ABSA (2007a:2) also affirms that between 2000 and 2006, the South African housing property market experienced strong average real price growth of about 14.5% per annum and approximately 20% per annum in nominal terms. However, according to ABSA (2008a:1), the average annual nominal house price growth rate was 6.4% during the first six months of 2008, compared with 15.6% in the first half of 2007.

Despite this outstanding performance of the South African housing property market, very limited research has been carried out on this market (Clark and Daniel, 2006: 27). The few studies mainly concentrated on the analysis of whether the South African housing property market is in a boom, its effects on the economy, whether the housing boom is sustainable or the likely effects on the economy if the bubble bursts (see Nel and Mbeleki, 2005; Du Toit, 2005; IMF, 2004; Funke *et al.*, 2006) without modelling the macroeconomic and financial factors that could have influenced the house price fluctuations.

However, Standish *et al.* (2005) undertook research aimed at determining whether a robust model(s) could be developed to forecast house prices in South Africa using a regression model. In this study, ten variables which include real interest rates, gross national income (GNI), household debt to income, net migration, crime, capitalisation of the JSE, the nominal exchange rate, tourism, the real effective exchange rate, and foreign direct investment were identified as possible key drivers of house prices based on a literature survey.

[2] UK, New Zealand, Australia, US, Sweden, Ireland, Norway and Denmark.

In addition, Clark and Daniel (2006) carried out a similar study aimed at forecasting South African house prices using a regression model and included the lagged values of the explanatory variables. It was concluded that the lagged stock market returns, real GDP, the interest rate, the Rand/Dollar exchange rate and transfer costs are the key drivers of the South African housing property market.

On the other hand, ABSA (2007a) merely outlines and explains the economic variables that have contributed to the performance of the South African housing property market and the effect of the housing market on the economy since 2000, without utilising any econometric model. Additionally, ABSA (2008a) briefly explains the factors that contributed to the trends in the housing property market in South Africa. Once again, no econometric model is utilised to analyse the influence of macroeconomic factors on the house price index. Therefore, with this background, this study seeks to close this gap by employing a VAR model to analyse the dynamic linkages between macroeconomic and financial variables and the South African housing property market.

Research in the housing property market is important because this market is considered as a component of the basic pillars among cash, bonds and equity of any well-diversified portfolio. This arises from the idea that investors may feel more comfortable with owning a tangible fixed asset rather than "paper" assets (Luus, 2003:156). Secondly, according to Brooks and Tsolacos (1999:150), it is important to establish empirically the linkages between property returns and the macroeconomic and financial environment to facilitate the prediction of property market returns.

1.2 OBJECTIVES OF THE STUDY

The aim of this research is to examine the impact of selected macroeconomic and financial variables on the performance of the housing property market in South Africa. In particular, the purpose of the research is:

1. To identify the relationship between the selected macroeconomic and financial variables and housing property returns[3] in South Africa.

2. To examine the influence that a shock to each variable has on property returns over a period of time in South Africa.

3. To determine what proportion of the changes in the housing property returns is due to innovations in the explanatory variables.

1.3 MOTIVATION FOR THE STUDY

In addition to contributing to the limited existing research on the housing property market of South Africa in particular and developing countries in general, this study also goes further in terms of the issues considered. In other words, the existing studies on the South African housing property market merely analyse the influence of macroeconomic variables on house prices (see Standish *et al.*, 2005; and Clark and Daniel, 2006) using regression models. On the other hand, this study uses a different and more advanced econometric technique and further examines the effect of shocks and innovations of each selected variable on property returns. Secondly, whilst the earlier studies on the South African housing property market use the house price index as a proxy, this study uses property returns[4] and orthogonalised property returns[5] as a proxy for the housing property market. Additionally, this study incorporates expected and unexpected inflation as macroeconomic variables.

Thirdly, unlike the previous studies on the South African housing property market which utilise quarterly and annual data, this study utilises relatively high frequency data (monthly). Furthermore, since a large number of previous studies on other countries[6] used monthly data, it is regarded as relevant to utilise data of similar frequency so that the findings of this research may be compared with the findings of existing studies. Fourthly, due to the

[3]The housing property returns are used in orthogonalised and non-orthogonalised form. Orthogonalised property returns are linearly independent and not contemporaneously related to stock market effects (Brooks and Tsolacos, 1999:143).

[4] The property returns are represented by (i) the house price returns which are calculated based on the house price index and (ii) the real estate returns which are calculated based on the real estate index.

[5] In the context of this study, orthogonalised property returns refer to house price returns and real estate returns filtered of the stock market effects.

[6]See for instance, Chan *et al.*, 1990; Lizieri and Satchell, 1997a, 1997b; Okunev *et al.*, 2000; Brooks and Tsolacos, 1999; Cho and Ma, 2006; Joshi, 2006.

developments that have occurred in the macroeconomy, the findings that have been obtained on the housing property market of South Africa by the earlier studies may be affected which necessitates this study as it is more up to date and in line with the developments in the economy.

The study focuses on the housing property market because this market is regarded as one of the most important asset classes for investors (Luus, 2003:156). Thus, understanding the relationship between macroeconomic and financial factors and the housing property market will help them in their investment decision-making given the turbulence of the macroeconomy. Nonetheless, this does not imply that studying the linkages of the macroeconomic and financial factors and other financial markets is not important.

This study concentrates on the South African housing property market because it has shown outstanding performance among other markets, even those in developed countries. Thus, it is crucial to determine which factors have contributed to that remarkable performance.

1.4 ORGANISATION OF THE STUDY

This study is organised as follows: Chapter 2 provides a review of the theoretical and empirical literature on the influence of macroeconomic and financial variables on the housing property market. Chapter 3 provides an overview of the South African housing property market in relation to the macroeconomic and financial environment.

Chapter 4 describes the econometric methodology employed in this study, namely autoregressive integrated moving average (ARIMA) (in relation to the generation of expected inflation), VAR, block exogeneity tests, impulse responses and variance decompositions. The results of the study are reported and discussed in Chapter 5. The presentation and discussion of the results is done chronologically according to each of the methodologies discussed in Chapter 4. Chapter 6 provides a summary of the findings, policy implications and recommendations made in this study as well as suggested areas for further research.

CHAPTER 2

REVIEW OF THE THEORETICAL AND EMPIRICAL LITERATURE

2.1 INTRODUCTION

This chapter reviews the theory of the housing property market based on the demand and supply framework and theoretical determinants of housing property prices and returns. Furthermore, the empirical literature on the impact of macroeconomic and financial factors on the performance of the housing property market is examined. In this study, the review of the empirical literature is categorised in three groups namely, developed countries, developing countries and South Africa in particular. This chapter is organised as follows: Section 2.2 discusses the theory underlying the housing property market. Section 2.3 provides an empirical review of the studies on the housing property market and Section 2.4 concludes the chapter.

2.2 THEORY UNDERLYING THE HOUSING PROPERTY MARKET

Housing demand and supply changes are usually used to model house price dynamics (see for instance, Naylor, 1967; Arcelus and Meltzer, 1973). Therefore, one can distinguish between changes in housing demand and supply when examining house price dynamics. The housing property market can be classified into four interrelated submarkets namely: (i) newly built houses not yet sold or occupied, (ii) new rental units, (iii) previously occupied units being offered for resale, and (iv) previously occupied units offered for rent (Naylor, 1967:384). Therefore, when discussing housing models one needs to distinguish carefully between the supply of existing units and that of new units. The focus of this study is the stock of existing units.

Égert and Mihaljek (2007:2) assert that the key determinants on the demand side of the housing property market generally consist of changes in house prices (P^H), household disposable income (Y), financial wealth (WE), housing expected rate of return (e), the real interest rate charged on housing loans (r), demographic factors and labour market determinants (D), and other demand determinants (X) such as the state of housing, age, location, and institutional factors for example financial development which affect individuals' access to loans for housing purposes. Thus, Égert and Mihaljek (2007:2) mathematically represent the demand function for the housing market as follows:

$$D^H = f(\overset{-}{P}^H, \overset{+}{Y}, \overset{-}{r}, \overset{+}{WE}, \overset{+/-}{D}, \overset{+}{e}, \overset{+/-}{X}) \quad (1.1)$$

where the sign represents the expected effect of the variable on housing demand.

In the short-run, housing supply is assumed to be fixed given the fact that land is fixed in supply and also that it is not feasible to increase the supply of housing in a short time (Hort, 1998:94). According to Seidel (1978) (in Windapo and Iyagba, 2007:2), house prices and rents tend to reflect at least over the long-term, the cost of producing that house. Thus, changes in housing supply imply changes in the long-term supply of housing. In addition, Égert and Mihaljek (2007:2) state that the long-run supply of housing generally depends on the construction business's profitability, which on the other hand, is considered to depend positively on house prices (P^H) and negatively on real construction costs (C). Real construction costs include wages and salaries of workers (W), the price of land (P^L), and costs of building material (M). Égert and Mihaljek (2007:2) mathematically represent this as follows:

$$S^H = f(\overset{+}{P}^H, \overset{-}{C}(P^L, W, M)) \quad (1.2)$$

As shown in Equation 1.2 above, the long-run supply of housing is positively related to the level of house prices. This is so because of the law of supply and the fact that since supply of land is fixed, land prices tend to rise with the size of the housing stock, that is, as land for development becomes more scarce (Hort, 1998:94-95).

Assuming an equilibrium condition in the housing property market, house prices can be mathematically represented as follows:

$$P^H = f(\overset{+}{Y}, \overset{-}{r}, \overset{+}{WE}, \overset{+/-}{D}, \overset{+}{e}, \overset{+/-}{X}, C(P^L, \overset{+}{W}, M)) \quad (1.3)$$

Therefore, Equation 1.3 tells us that equilibrium real house prices arise from the interaction between the forces of supply and demand for housing. However, this does not mean that there is no volatility in house prices. In several countries it is commonly discovered that volatility of house prices is extensively greater than the anticipated volatility as given by the changes in the key factors of demand and supply. Additionally, long-run dynamics of house prices may be influenced considerably by factors such as housing finance structure and tax management of owner occupation (Égert and Mihaljek, 2007:2-3). The discussion below explains the determinants of housing property prices and returns.

The global literature on the housing property market suggests that there are several key determinants that probably affect the performance of the housing property market by affecting house prices and returns. According to Standish *et al.* (2005:41) such variables include nominal and real interest rates, real GDP, the nominal and real exchange rate, the effect of the securities market as represented by the All share index and the cost of construction. Clarke and Daniel (2006) also add business confidence, motor vehicle sales, gold and oil prices, and transfer costs as determinants of house prices. Other important determinants include the rate of unemployment, the yield spread, actual inflation, unexpected inflation and the dividend yield (Brooks and Tsolacos, 1999:141). The expected influence of each of these variables on house prices and housing property returns is explained below.

i. Interest rates

Brooks and Tsolacos (1999:141) suggest that the interest rate (nominal or real) as a macroeconomic series usually reflects the state of the current and future business environment and investment opportunities. Generally, a rise in interest rates increases the cost of borrowing as loan repayments become more costly. In other words, it can be safely stated that high interest rates tend to increase the burden of debt settlement. Follain (1982) (in Wong *et al.,* 2003:9) states that high rates of interest cause financial problems for households which may lead to a decrease in the demand for housing. Thus, a high prime rate leads to high mortgage repayments, reducing the affordability and ultimately the demand for property. Therefore, interest rates and housing property prices (and returns) are inversely related (Clarke and Daniel, 2006:29). Many researchers share the above view and note that interest rate related variables are key drivers of real estate returns.

Windapo and Iyagba (2007:2-3) consider the supply side of housing by analysing the determinants of housing construction costs in Nigeria. They state that capital or finance is important in any housing development project and the ability of a developer to channel enough funds for the project determines its success. Thus, most developers are forced to look for funds from many sources including financial institutions which most of the time charge high interest rates. This will lead to a rise in housing construction costs and ultimately increases house prices, *ceteris paribus*. Thus, in summary either a positive or negative relationship between interest rates and house prices and returns can be expected.

ii. Interest rate spread

The interest rate spread (also referred to as the yield curve or term structure of interest rates) is the difference between the long-term government bond yield and the 30 days or 91 days Treasury bill rate (Brooks and Tsolacos, 1999:142). Estrella and Hardouvelis (1991) (in Brooks and Tsolacos, 1999:142) state that the term structure of interest rates has more predictive power concerning economic activity than short-term interest rates, hence it is usually used as a leading indicator of real GDP.

Furthermore, Goodhart (2007:1) states that a downward-sloping yield curve is a leading indicator of a future recession. A downward sloping yield curve would imply that investors expect interest rates to drop in the future. Generally this means that there is an expectation of low inflation in the future. Since interest rates and house prices may be inversely related, the expectation of a fall in interest rates which implies an expected fall in the cost of borrowing will lead to an increase in housing demand in the future. This will result in an increase in house prices (and housing property returns), assuming that all other things remain the same. Thus, a negative relationship between changes in interest rate spread and house prices and returns can be expected, *ceteris paribus*.

iii. Real GDP

GDP is a measure of overall economic activity. Thus, a change in real GDP implies a change in real economic growth which may directly impact on the housing property market. In addition, economic certainty that arises from a rise in real GDP results in high business confidence. Hence, it is argued that a rise in economic growth will lead to a rise in the demand for property. This will lead to a rise in house prices and thus housing property returns, *ceteris paribus*. Furthermore, real GDP growth means the level of occupants' willingness to pay increases, which further leads to a general increase of rental rates, *ceteris paribus* (Peng and Hudson-Wilson, 2002:9). Therefore, one can expect changes in real GDP and housing property returns to be positively related (Clarke and Daniel, 2006:29).

iv. Business Confidence

Business confidence is a major determinant of the demand for housing property. If business confidence is high, as a result of, for instance, political and economic certainty, this may attract more local and foreign investors to pursue other investment opportunities. In turn, this will positively influence consumer spending as people become more confident about the economy. Hence, business confidence positively affects consumer demand for property. On the other hand, a negative relationship may be expected given a decrease in business confidence (Clarke and Daniel, 2006:29).

v. Motor Vehicle sales

The number of motor vehicle sales is an indicator of the state of the economy. For instance, in a recession, business confidence and consumer spending is low. Therefore, when the number of motor vehicle sales is large this will indicate that real economic growth and business confidence is high, which, in turn, may lead to an increase in the demand for property. A rise in demand for housing property will then lead to an increase in house prices and returns, *ceteris paribus*. On the other hand, considering that motor vehicle purchase is a substitute for buying a house by an individual (given the individual's income constraint), a negative relationship may also be expected (Clarke and Daniel, 2006:29).

vi. Nominal and real exchange rates

The nominal or real exchange rate has a direct and indirect impact on the housing property market. For instance, a strong currency or an appreciation of the currency will discourage foreign investors from local property investment. In contrast, a depreciation of the currency will attract foreign investors to the local property market which results in a rise in the demand for local housing. Assuming that all other things remain constant, the increase in housing demand will result in the rise of local housing prices and returns. In addition, stability of the currency contributes to business confidence which also affects the demand for property as discussed earlier (Clarke and Daniel, 2006:30).

Windapo and Iyagba (2007:3) also argue that devaluation of a currency may lead to an increase in housing construction costs assuming that imported building materials, machinery and equipment are used. A rise in housing construction costs will then lead to an increase in house prices as the constructors and house owners want to compensate for the high building costs. Therefore, either a positive or negative relationship between house prices and the exchange rate is expected.

vii. Inflation

Wong *et al.* (2003:6) state that rental rates and the real value of assets are positively related. Furthermore, the real cost of housing occupancy is adjusted to include the real cost of holding housing capital, the gains from inflationary expectations and losses from deflationary expectations. Therefore, since the real cost of housing capital is included as a major determinant of housing demand, expected inflation or deflation is relevant for housing decisions.

According to Brooks and Tsolacos (1999:142) the effects of inflation rate are examined by using different elements of inflation, namely, the actual inflation rate and unexpected inflation. Unexpected inflation is the difference between actual inflation and anticipated inflation. When inflation is anticipated, house prices would increase, *ceteris paribus*. This is so because when inflation increases, the investment market for income-generating properties recognises the need to include an estimated growth rate in future yearly income (Wong *et al.*, 2003:8-9). In other words, changes in inflation and house prices are positively related, thus when inflation rises or is expected to increase, house prices (and ultimately nominal housing property returns) will also increase, all other things remaining constant. However, in the case of an inflation targeting framework, when inflation rises, interest rates will be increased to curb inflation. This will lead to a higher cost of borrowing which decreases housing demand and house prices, *ceteris paribus*.

viii. Transfer costs

Transfer costs directly influence the affordability of property as these costs increase the price of property. Hence, a decrease in transfer costs will imply a fall in house prices. This will lead to a rise in housing demand as the total purchase price decreases (Clarke and Daniel, 2006:30).

ix. Dividend yield

Stock returns are made up of two elements namely dividend payouts and capital gains. Therefore, a rise in the dividend yield will imply a rise in stock returns, *ceteris paribus*. Stock returns form part of stock wealth. Stock wealth may result in high house prices, since the real estate market acts as a safety valve for surplus capital (Baker, 2005:1). On the other hand, a negative relationship can be expected between the dividend yield and house prices. Harvey (1982) (in Lizieri and Satchell, 1997a:15) argues that a fall in profitability in the industrial production sector will lead to a fall in the dividend yield which in turn can result in capital switching into the real estate market in pursuit of higher profits.

x. Unemployment rate

Assume that the housing and labour markets are in equilibrium. Now, suppose that there is an unfavourable shock on the demand for labour which results in a decrease in wages and salaries and a rise in unemployment, *ceteris paribus*. The increase in unemployment will imply a decrease in disposable income for the affected workers and hence a fall in demand for housing. Durability of housing means that short-run supply of housing is fixed hence house prices will decrease in this case (Vermeulen and Ommeren, 2005:10). In short, house prices decrease as the unemployment rate increases, *ceteris paribus*. Zenou and Smith (1995) and Brueckner and Zenou (1999) indicate that unemployment and house prices have a negative relationship.

From the review of the theoretical literature on housing property markets above, it can be noted that there are mixed expectations about the relationship between the housing market and most of the macroeconomic and financial variables considered. However, having analysed the theory of the housing property market, the next section reviews the empirical literature on the housing property market and its macroeconomic determinants.

2.3 EMPIRICAL LITERATURE ON THE IMPACT OF MACROECONOMIC AND FINANCIAL VARIABLES ON THE HOUSING PROPERTY MARKET

As the pillar of this study, Sections 2.3.1 to 2.3.3 highlight and review the empirical literature on the impact of macroeconomic and financial variables on the housing property markets of developed and developing countries and South Africa, respectively. This will help to show the existing gaps in the literature that this current study seeks to cover especially with reference to South Africa, which by all standards is an important financial centre for Africa.

2.3.1 Empirical evidence from developed countries

A vast literature on housing property markets has focused on the linkage between the real estate market and the equity market instead of the linkages between the housing property market and the overall economy. Examples of such studies include Schnare and Struyk (1976), Goodman (1978, 1981), Miles *et al.* (1990), Liu *et al.* (1990), Geltner (1990), Ambrose *et al.* (1992), Okunev and Wilson (1997), Okunev *et al.* (2000) and Yang (2005).

The linkage between the real estate market and equity market arise from the twofold nature of property as a financial asset in capital markets and as a factor of production in the space or industrial markets (Hakfoort, 1994:12). Fisher (1992:6) also suggests that the rental income stream generated in the space market is a cashflow valued in the capital market. Corporate growth in profitability (expected or actual) results in business expansion as well as increasing rental levels given the inelastic short-run supply in the real estate market. An increase in rental rates result in high capital values in the capital market (both through increased income and reduced capitalisation rates). This ultimately increases net asset values and prices for property companies, property unit trusts, and real estate investment trusts (REITs) (Lizieri and Satchell, 1997a:14).

The real estate and equity markets and lagged values of these markets between peaks and troughs in the economy can also be expected to be inversely related. Harvey (1982, 1985) (in Lizieri and Satchell, 1997a:15) states that if profitability decreases in the industrial sector, investors will switch capital into the real estate market in pursuit of higher profits. In the equity market (and hence in the exchange-traded property company sector), the adjustments should be faster than in the direct, non-exchange traded market. For instance, a switch of capital into the real estate market will reduce capitalisation rates and hence increase capital values. Indication of this will only materialise after completion of sales. In turn, this will be shown in the published net asset value of property companies only after revaluation (which often occurs annually).

Conflicting results have been obtained from such research as some conclude that the real estate and stock markets are segmented and this implies that there is no co-movement between the two markets, while the other strand of studies finds that these two markets are integrated implying a significant positive contemporaneous co-movement (Gyourko and Keim, 1992:8). Examples of studies that support the notion that the real estate and stock markets are segmented include Schnare and Struyk (1976), Goodman (1978, 1981), Miles *et al.* (1990), Liu *et al.* (1990) and Geltner (1990). On the other hand, Ambrose *et al.* (1992), Okunev and Wilson (1997), Okunev *et al.* (2000) and Yang (2005), show that the real estate and stock markets are integrated by using both linear and nonlinear causality tests.

Another growing body of literature examines the link between real estate investment trust (REIT) and property share price movements, equity market returns, and returns to appraisal-based real estate indices. Such literature includes Mengden and Hartzell (1986), Giliberto (1990), Hoesli and Anderson (1991), Geltner (1991), Gyourko and Keim (1992) and Eichholtz and Hartzell (1996). Although the results differ, studies relating property shares to appraisal indices confirm strong correlations, with the share returns tending to act as leading indicators of changes in the appraisal-based real estate index. For instance, Gyourko and Keim (1992) indicate that important information about property market fundamentals is impounded in REIT returns, especially when these returns are adjusted to control for general market factors.

In contrast to the focus discussed thus far, other property market researchers have looked at the existence of house price bubbles as interpreted from market fundamentals. For example, Kim and Suh (1993) use an equilibrium price equation comprising of factors which include GDP, urban household consumption expenditure and the stock price index to test the existence of real estate bubbles in Korea and Japan. They find out that real estate bubbles existed more in Korea than in Japan.

Similar research was subsequently carried out using newer econometric methods such as the cointegration technique, Granger causality analysis and impulse response analysis. For example, Kim and Lee (2000) analyse the occurrence of real estate price bubbles in Korea using cointegration tests, and Bourassa *et al.* (2001) use the error correction model to test for bubbles in three New Zealand cities.

Later, Hui and Yue (2006) investigate whether a housing price bubble existed in 2003 in Shanghai and Beijing. The presence of the bubble was inferred from the irregular relationship between the selected key market factors and house prices. Granger causality tests, the reduced form of house price determinants and generalised impulse response analysis were the econometric techniques applied. The variables used as an input in the study are urban households' disposable income, GDP, stock price index and the stock of new vacant units for Beijing, Shanghai and Hong Kong. In relation to the influence of the selected market fundamentals on the housing market, the study concludes that house prices and the selected market determinants are integrated and that abnormal interactions exist (Hui and Yue, 2006:317). This conforms to the findings of the studies on the influence of macroeconomic variables on house prices.

However, as a result of the increased fluctuations in prices and returns in housing property markets worldwide, there has been a growing interest in studying the influence of macroeconomic factors on property market returns especially in the USA and UK property markets (Brooks and Tsolacos, 1999:139). Despite the different econometric methods used, the general finding of the studies supports the notion that macroeconomic factors positively or negatively influence the housing property market. In the discussion below, the studies done in relation to the linkages between the macroeconomic and financial variables and the housing property markets in developed countries are reviewed.

The empirical literature on the impact of macroeconomic and financial variables on the housing property market can generally be grouped into two categories: studies that use real estate returns index and studies that use house prices. Chan *et al.* (1990), McCue and Kling (1994), Lizieri and Satchell (1997a), Ling and Naranjo (1997), Brooks and Tsolacos (1999) fall in the first group. Abraham and Hendershott (1993,1996), Lizieri and Satchell (1997b), Hendershott and Weicher (2002), Kim (2004), Cho and Ma (2006), Edelstein and Tsang (2007) fall in the second category.

Chan *et al.* (1990), analyse the impact of selected pre-specified macroeconomic variables using a multifactor arbitrage pricing model[7] and USA data. The five variables used are changes in expected inflation and industrial production, the risk and term structure return factors, and unexpected inflation. The results obtained from regression analysis show that the equity REIT and NYSE indexes are significantly positively related to the risk and term structure return factors in a consistent way over the sub-periods 1973-1979 and 1980-1987. The indices are also systematically negatively, although not always statistically significantly, related to unexpected inflation. However, the impact of changes in expected inflation and industrial production are mixed and insignificant. Both REIT and NYSE indices are significantly positively related to changes in expected inflation in the 1980s, but unrelated (with negative coefficients) in the 1970s (Chan *et al.*, 1990:442-444). Although the findings from the study are mixed, they conform to *a priori* expectations.

However, since the study by Chan *et al.* (1990) excluded household consumption as a macroeconomic variable, the results stated above may be potentially biased by an 'omitted variables problem'. Furthermore, the study did not use real estate returns that exclude the effect of equity returns. In relation to this weakness, McCue and Kling (1994) further argue that very few studies make use of security-backed real estate indices to determine the relationship between housing property markets and the macroeconomy.

In an effort to rectify this, McCue and Kling (1994) utilise UK real estate investment trust (REIT) data as an input in a VAR model to analyse the linkage between real estate, inflation, interest rates, output, and investment. The two authors generated and utilised real estate returns that are filtered of equity market influence, technically known as orthogonalised real estate returns. Thus, these orthogonalised real estate returns make this research distinct from prior studies in the literature on property markets. McCue and Kling (1994) find that the

[7] "The Arbitrage Pricing Model (APM) shows that returns on N assets in the economy are assumed to be generated as follows: $r = E + Bf + \in$ where r is a N x 1 vector of returns, E is a N x 1 vector of expected returns, f is a Kx1 matrix of random factors with means equal to zero, B is a N x K matrix of factor sensitivities (loadings), and $\in$ is an Nx1 vector of residuals. The covariance matrix of r is given by V, and the covariance matrix of the $\in$ is given by Z" (Chan *et al.*, 1990:433). Furthermore, $E = ir_f + Bu$ where r_f is the return on a riskless asset if it exists, i is a vector of ones, and u is a K x 1 vector of risk premiums associated with each of the factors. Thus the multifactor arbitrage pricing model is given as $r - ir_f = Bu + Bf + \in$. Since the factors f *are* not identified by the APM, Chan *et al.*, (1990:434) pre-specify them to be a set of macroeconomic developments that capture the pervasive forces in the economy.

selected macroeconomic factors describe approximately 60% of the equity REITs variation. Nominal interest rates appear to have the most statistically significant influence. Similar to the findings of Chan *et al.* (1990) on industrial output, McCue and Kling (1994) demonstrate that industrial output explains very little of the variation of the equity REITs series.

Despite the available real estate literature, a gap still existed in terms of jointly examining the relationships between security-backed real estate and the underlying market, and focusing on the role of property in the overall economy. In order to close this gap in the literature, Lizieri and Satchell (1997a) utilise the UK stock market and property company share data to explore the linkage between real estate and the economy as a whole, using Granger causality tests. Secondly, the function and importance of commercial property in the wider economy is examined.

Furthermore, Lizieri and Satchell (1997a:18) argue that the use of orthogonalised data in the study by McCue and Kling (1994) can bias regression coefficients and alter the distribution of test statistics. This occurs especially if the orthogonalised variable replaces the original non-orthogonal variable thus leading to the problem of misspecification. Lizieri and Satchell (1997a:18) claim that their model is not misspecified in this sense since the true variable is orthogonal. They also point out the likelihood that a third (unspecified) variable may influence returns both on the property backed assets and on the overall stock market.

Ling and Naranjo (1997) examine the influence of selected macroeconomic variables on the performance of real estate returns and analyse whether variables that constantly affect asset returns bear a premium. The authors use nonlinear multivariate regression techniques to estimate jointly the risk factor sensitivities and return premium. The non-linear multivariate regression techniques are used mainly to overcome some of the econometric problems such as the generated regressors problems (Ling and Naranjo, 1997:284). Furthermore, Ling and Naranjo (1997) apply non-linear multivariate regression methods, in order to overcome the limitation evident in the literature that the fixed-coefficient model[8] may be highly restricted since risk sensitivities and risk premia are confined to be time invariant.

[8] A system of equations with cross-equation and within-equation restrictions estimated jointly (Ling and Naranjo, 1997:284).

The study concludes that the real Treasury bill rate, real per capita consumption growth rate, unexpected inflation and the term structure of interest rates have a systematic impact on real estate returns. This finding is contrary to that of Chan *et al.* (1990). Ling and Naranjo (1997) claim that their result of a constantly significant risk premium on consumption rectifies the omitted variables problem evident in the results of earlier research, such as Chan *et al.* (1990) that ignores consumption as a macroeconomic variable.

On the other hand, Brooks and Tsolacos (1999) produce conflicting results using UK data and a vector autoregressive model. They conclude that the unemployment rate, nominal short-term interest rate and dividend yield do not systematically influence the variation of orthogonalised property returns series. This conflicts with the result obtained by Ling and Naranjo (1997). However, the lagged real estate values have the highest significant impact on the real estate series, and this is in agreement with the result obtained by Lizieri and Satchell (1997a). However, interest rate spread and unanticipated inflation depict a contemporary influence on property returns.

Brooks and Tsolacos (1999:150) state that such conflicting results are attributed to the sensitivity of the property returns series to methodologies used and the sample period. Apart from obtaining conflicting results, a further characteristic that distinguishes the study by Brooks and Tsolacos (1999) from other studies such as Chan *et al.* (1990), McCue and Kling (1994), Lizieri and Satchell (1997a), Ling and Naranjo (1997), is the inclusion of the impact of a financial variable (dividend yield).

As can be noted from the literature that uses real estate returns as a proxy for the housing property market, mixed results have been obtained using different econometric methods. Of particular interest is the research by Brooks and Tsolacos (1999) which includes the dividend yield as a financial variable that affects property returns. Unlike other studies such as Chan *et al.* (1990), Lizieri and Satchell (1997a), and Ling and Naranjo (1997), Brooks and Tsolacos (1999) determine whether there is a lagged response in the orthogonalised property market returns to changes in the selected macroeconomic and financial variables using variance decomposition. Furthermore, impulse responses are employed to determine the influence of shocks in each selected variable on the property returns series over time. This gives a full analysis of the influence of macroeconomic and financial factors on the performance of the housing property market. Therefore, this motivates this study to investigate the influence of macroeconomic and financial factors on the housing property market in South Africa, following the approach by Brooks and Tsolacos (1999).

As noted earlier, the second category of literature on the influence of macroeconomic factors on the housing property market uses house prices as a proxy for the housing property market. In particular, Abraham and Hendershott (1993) analyse how real income growth, real construction cost inflation and variations in real interest rates after tax describe the changes in real house price inflation in thirty US metropolitan areas. Using the basic Copazza-Helsley (1989, 1990) urban model[9], the results show that the above-mentioned factors describe approximately 50% of the changes in real house price inflation. However, the model fails to explain the sharp, prolonged cycles in house prices of the other metropolitan areas.

This necessitated further research in an attempt to solve this weakness. Thus, Abraham and Hendershott (1996) carried out research in which the factors of real house price appreciation are classified into two sets. The first accounts for equilibrium price changes and this consists of real construction costs, changes in the real interest rate after tax and real income growth. The other group explains the changing deviations from the equilibrium price and is comprised of the difference between the equilibrium and actual house prices and real appreciation lagged values. The study concludes that each of the two groups of factors explain a little above 40% of the changes in real house price fluctuations in thirty metropolitan areas. When combined, the two groups explain about 60% of the variation.

Based on the argument that prior quantitative research such as Abraham and Hendershott (1993, 1996) has relied on linear models instead of using the non-linear, regime based models, Lizieri and Satchell (1997b) analyse the linkage between UK real rate of interest and property prices using a threshold autoregressive (TAR) model. The results show that real rate of interest has a non-linear impact on property share prices. Property share prices decreased sharply and were less volatile during periods of fairly high interest rates. However, during

[9] The model in which real land value is the sum of four elements that is, the real rent value of agricultural land , the cost of developing the land for urban use, the value of accessibility and the value of expected increases in real rent (Abraham and Hendershott, 1996:194).

times of reasonably lower rates of interest, price movements are more volatile. These results are consistent with a priori expectations.

However, in an attempt to examine how house prices are influenced by the macroeconomy as a whole, Hendershott and Weicher (2002) use forecasts made on US inflation, government policy and demographic forces to establish the influence and importance of these variables on forecasting prices of the housing property market. The study shows that changes in demographic factors become more significant as one progresses to long-run predictions, although predicting the influence of changes in demographic factors on housing markets may not be straightforward. The results also show that inflation and government policy have a significant impact on the housing property market. However, Hendershott and Weicher (2002) do not clearly specify whether government policy, demographic factors and inflation negatively or positively affect house prices.

In other research, Kim (2004) investigates the relationship between house prices, consumer spending and inflation using Korean data. The results from Granger causality tests suggest that the causality runs in both directions between house price increases and inflation. The linear model used shows that consumption co-integrates with house prices.

In a similar study, but using different econometric methods, Cho and Ma (2006) examine the dynamic relationship between Korean house prices and nominal interest rates in the long-term and short-term using the cointegration test, spectral analysis[10] and the transfer function model[11]. The Granger causality test for the short-term dynamic relationship between these

[10] The spectral analysis model is defined as $S_{x,y}(w)^2 = \dfrac{g_{x,y}(w)^2}{g_{x,x}(w)g_{y,y}(w)}$

where $S_{x,y}(w)^2$ = values of squared coherence, $g_{x,y}(w)$ = the cross-spectrum for series x and y, $g_{x,x}(w)$ = the spectrum of series x, $g_{y,y}(w)$ = the spectrum of series y (Cho and Ma, 2006:174).

[11] The transfer function model examines the dynamic relationship between the input time series and the output time series (Cho and Ma, 2006:174). It is represented as follows:

$$y_t = v_0\chi_t + v_1\chi_{t-1} + v_2\chi_{t-2} + \dots\dots\dots + n_t = v(B)x_t + n_t \text{ But } v(z) = \sum_{j=0}^{\infty}\left|v_j\right| < \infty$$

where y_t = output time series, x_t = input time series, B= backshift operator, $v(z)$ = transfer function (coefficient v_j of transfer function is impulse response weight in time lag j), n_t = noise term which satisfies the ARMA model (Cho and Ma, 2006:174-175).

variables depicts a one-way causality from the interest rate to the growth rate of house prices. Similar to Lizieri and Satchell (1997b), the results of the cointegration test depict a long-term negative equilibrium relationship between house prices and interest rates. The use of spectral analysis and a transfer function model to find the circulation cycle which exists internally and externally of the time series of the growth rate of housing prices and interest rates further advances and distinguishes Cho and Ma's (2006) study from the other studies such as Lizieri and Satchell (1997b), Kim (2004) and Edelstein and Tsang (2007).

Despite the fact that the majority of the earlier studies discussed above have analysed the influence of macroeconomic variables on house prices, many do not carefully integrate the theoretical framework and the econometric tests. The theoretical models concentrate either on the demand or the supply side of the housing market. Although the theoretical model may be accurate and well-constructed, it may provide incomplete representation of the housing market. Due to this weakness, many researchers use reduced-form single-equation models that relate house prices to determinants of the demand and supply of houses. However, these models produce empirical results associated with econometric problems of endogeneity and identification (Edelstein and Tsang, 2007:296).

To overcome these weaknesses of earlier studies, Edelstein and Tsang (2007) did research using data of four US cities on the significance of the influence of macroeconomic variables on housing market dynamics, and compared the impact of local and national fundamentals using an identified system of two equations. The first equation represents market demand relating rent, property values and capitalisation rates to demand fundamentals. The second equation is the market supply function and links housing investments and property values with the supply determinants (Edelstein and Tsang, 2007:296).The results show that local fundamentals, namely employment growth and unanticipated employment growth, have a stronger impact on residential housing markets than national fundamentals, namely state income growth and national changes in construction costs. Interest rates were found to be significant and positively related to housing supply (Edelstein and Tsang, 2007:312).

It can be noted that a wide range of research has been done on the housing property market in developed countries, especially in the US and UK. Although some of the studies focused on other areas like house price bubbles, the examination of the influence of macroeconomic variables on house prices was also incorporated. Furthermore, even though studies specifically on the analysis of the impact of macroeconomic variables on the housing property market used either real estate returns or house prices as a proxy of the housing property market, the common finding of these studies is that macroeconomic variables influence property prices and returns. However, other studies indicate conflicting results using real estate returns, especially the one done by Brooks and Tsolacos (1999). This highlights the need to examine whether this also applies in developing countries' housing markets and in South Africa in particular.

2.3.2 Empirical evidence from developing countries

Having analysed the different studies on the housing property markets of developed countries, it is important to review what has been done in relation to the influence of macroeconomic and financial factors on the housing property markets of developing countries. Such analysis will help to address some important questions. These include: have the studies done so far obtained comparable results to those attained from similar research in developed countries? What are the weaknesses of the research conducted so far? What has been done by later studies to overcome the drawbacks of earlier research?

Instead of analysing the link between the housing property market and the macroeconomy, several studies on housing property markets in developing countries focus on housing policy to ensure the provision of housing to people either in urban or rural areas. Examples of such studies include Kalabamu (1984), Ogu and Ogbuozobe (2001) and Huchzermeyer (2001). Pugh (1992) analyses international finance and housing policies in developing countries. On the other hand, other studies have looked at housing finance, such as Robinson (1976), Renaud (1987, 1999), Mutizwa-Mangiza (1991), Lee (1996), Datta and Jones (2001).

Another part of the literature focuses on the relevance of hedonic theory[12] to housing property markets. For example Grootaert and Dubois (1988) and Malpezzi (1998) apply hedonic indices to obtain measures of prices and quantities from information on dwelling value and

[12] Hedonic theory is based on the fact that housing property is considered as a differentiated product. The theory generally explains how the unique quality and quantity characteristics as well as the specific demand and supply conditions of the property interact to determine its price (Eftec, 2008:2).

rent. Megbolugbe (1989) constructs a hedonic index for the Nigerian housing market. In a similar study, Willis *et al.* (1990) develop a hedonic index to assess rent control in Ghana. Knight *et al.* (2004) also apply hedonic theory to the Ugandan housing market.

Very limited study has been done in relation to the impact of macroeconomic variables on the performance of housing property markets in developing countries in general. This is mainly attributed to the scarcity of information and data on such markets.

With the objective of filling this void, Joshi (2006) applies a structural VAR model to examine specifically the impact of permanent shocks to monetary variables and income growth on housing prices in India. In particular, the results from the forecast error variance decomposition of housing prices indicate that the variation in housing prices is described by innovations in the rate of interest; hence interest rates are a major determinant of housing prices. However, the forecast error variance decomposition results also show that interest rate and credit growth account for about 72.3% of the year-on-year variation in housing prices (Joshi, 2006:85). Therefore, it is concluded that permanent shocks to the interest rate more significantly influence housing prices than credit growth shocks. The result of this study by Joshi (2006) is consistent with the results of the research done in developed countries which shows the importance of interest rates in determining house prices, such as McCue and Kling (1994), Brooks and Tsolacos (1999), Ling and Naranjo (1997), Lizieri and Satchell (1997b).

In summary, despite the growing number of studies on housing property markets in developing countries, very few studies have focused on the relationship between macroeconomic factors, let alone financial variables, and the performance of housing property markets. This is a gap that needs immediate attention in order to provide substantial answers to those questions posed at the beginning of this review. From the literature reviewed above, it can be noted that for it to be possible to compare and contrast the research literature on developing countries with the developed countries adequately, there is still a lot of work that needs to be done to boost the empirical literature on developing countries' housing property markets, especially in terms of examining the relationship between the housing market and the macroeconomy.

2.3.3 Empirical evidence: The case of South Africa

Unlike the studies on the housing property markets in other developing countries, research that has been done so far in relation to the South African housing property market mainly focuses on whether the market is in a boom, its effects on the economy, whether the housing boom is sustainable or the likely effects on the economy if the bubble bursts, without modelling the macroeconomic and financial factors that could have caused the house price changes (see Nel and Mbeleki, 2005; Du Toit, 2005; Funke *et al.*, 2006).

One exception is the study by Standish *et al.* (2005) that examined whether a robust model could be developed to forecast residential house prices in South Africa. The study also aimed at identifying the major determinants of the South African housing property market using a regression model. They identify ten variables as possible key drivers of house prices based on a survey of the literature. These are real interest rates, gross national income (GNI), household debt to income, net migration, crime, capitalisation of the JSE, the nominal exchange rate, tourism, the real effective exchange rate, and foreign direct investment.

The results show that foreign direct investment and the real price of gold are positively correlated with house prices. The ratio of household debt to disposable income, the nominal and real exchange rate show a negative relationship with house prices. The real capitalisation on the JSE indicates a negative relationship with house prices. This is in agreement with Catella (2002:1) and Donnell (2003:1) who state that decreasing share prices lead people to invest in property and when share returns rise people invest more in equity. However, the regression model employed by Standish *et al.* (2005) did not include the impact of past values of the explanatory variables on house prices. Examining the impact of past values of the explanatory factors on house prices is deemed necessary to obtain a full analysis of the influence of macroeconomic variables on the property market.

In order to rectify this, Clark and Daniel (2006) conducted a similar study including the lagged values of the explanatory variables and employing a regression technique. They use quarterly data and eleven economic and financial variables. These are the JSE All Share index, the prime rate of interest, real GDP, household debt to disposable income, the Rand/Dollar exchange rate, gold and oil prices, business plans, business confidence, motor vehicle sales and real transfer costs. The results show that lagged values of real GDP, the interest rate, the lagged stock market returns, the Rand/Dollar exchange rate and real transfer costs are the key determinants of the South African housing property market (Clark and Daniel, 2006:32). This supports the general finding that macroeconomic variables and the stock market impact on the housing property market obtained from studies done on developed countries.

Conversely, the papers by ABSA (2007a, 2008a) employ no econometric technique in analysing the trends in the housing property market in South Africa and the factors that could have contributed to those trends.

As the majority of the studies on the South African housing market are mainly focused on forecasting house prices, a gap still needs to be filled in terms of analysing the impact of macroeconomic and financial variables on the performance of the housing market using advanced econometric techniques. Furthermore, the studies by Standish *et al.* (2005) and Clark and Daniel (2006) utilise house prices only and not returns. By contrast, this study uses house price returns and real estate returns. Moreover, the fact that the stock market and housing property markets may be contemporaneously correlated is accounted for in the present study by orthogonalising the property returns, a procedure that was not done in the earlier studies on South Africa.

As can also be noted, both Standish *et al.* (2005) and Clark and Daniel (2006) use the regression model in their research. However, it can be argued that the use of regression models is associated with the problems of multicollinearity and many biased estimators which may impact negatively on the accuracy of results (Brooks, 2002:190-191). Thus, this research utilises the VAR model instead.

2.4 CONCLUSION

This chapter provided a theoretical and empirical review of the housing property market. The theoretical analysis mainly focused on the demand and supply framework and determinants of the housing property market. A number of factors are suggested to influence the housing market. These include short-term interest rates, the interest rate spread, inflation, real GDP, business confidence, motor vehicles, nominal and real exchange rates, transfer costs, dividend yield and the unemployment rate. From this theoretical review, it can be concluded that there are mixed expectations on the relationship between the macroeconomic and financial variables and the housing property market.

The empirical literature regarding the influence of the selected variables on the housing market was reviewed based on the following categories: developed countries, developing countries and South Africa in particular. In the case of developed countries, the studies were grouped into those that used real estate returns as a proxy for the housing property market and those that used house prices. By contrast, despite the growing number of existing studies on housing property markets in developing countries, very few studies have focused on the relationship between macroeconomic factors, let alone financial variables, and the performance of housing property markets. This makes it difficult to compare the findings of the influence of macroeconomic factors on the housing markets in developed countries with those in developing countries. Furthermore, it has been noted that research on the South African housing property market is extremely scanty especially with respect to the relationship between selected variables and the housing market.

The next chapter analyses the macroeconomic and financial environment and the housing property market of South Africa. This is done with a view to establishing whether the housing property market is linked to macroeconomic and financial variables. Together with this chapter, the next chapter lays the foundation for the empirical analysis that will follow.

CHAPTER 3

OVERVIEW OF THE SOUTH AFRICAN HOUSING PROPERTY MARKET AND MACROECONOMIC ENVIRONMENT

3.1 INTRODUCTION

This chapter provides an overview of the macroeconomic environment and housing property market of South Africa since 1996 with a view to determining if there are any implications for a relationship between the macroeconomic fluctuations and house price returns. The chapter is organised as follows: Section 3.2 discusses the changes in the macroeconomic and financial environment and the housing property market. Section 3.3 concludes the chapter. By and large, this chapter and Chapter 2 form the basis of the empirical analysis in later chapters.

3.2 ANALYSIS OF THE MACROECONOMY AND HOUSING PROPERTY MARKET OF SOUTH AFRICA

The South African economy has experienced uneven growth since the 1980s due to factors such as changes in monetary policy, exchange rate policy, the political environment, and the turbulence of the global economy. Furthermore, the housing property market shows fluctuations in its behavior as given by changes in the nominal year-on-year house price growth rate (see Figure 3.1). Are the fluctuations in the housing property market a result of the changes in the South African macroeconomic and financial environment? If so, which are the variables that could have influenced the housing market? This section seeks to provide answers to these questions by analysing the macroeconomic developments and the housing property market, respectively. It is important to note that the analysis in this chapter focuses only on the period from January 1996 to June 2008.

3.2.1 Macroeconomic developments

In terms of the monetary policy of South Africa, it can be noted that the eclectic approach[13] was still in use during 1996 and until 1997, after its adoption in 1990 (Aron and Muellbauer,

[13]This is whereby the monetary targets were complemented by an eclectic set of indicators which include asset prices, the exchange rate, the balance of payments, the output gap, wage settlements, the fiscal position and credit growth (Aron and Muellbauer, 2007:709).

2007:709). According to Gelb (2005:376), high rates of interest were utilised to reduce inflation as well as the gradual depreciation of the nominal exchange rate in order to boost the competitiveness of exports. Nonetheless, monetary policy became very opaque in this period and this reduced the South African Reserve Bank's accountability (Aron and Muellbauer, 2007:709). This led to the introduction of the repurchase (repo) rate system in March 1998 in order to improve the flexibility of financial instruments so that interest rates would react more quickly and sensitively to the periodic changes in underlying financial market conditions. From 1998 to 1999, it is stated that the Reserve Bank implemented informal inflation targeting since the emphasis was on reducing inflation as part of the primary objective of monetary policy (Smal and de Jager, 2001:3).

Following the elimination of the financial rand system in March 1995, the gradual exchange control liberalisation proceeded smoothly including relaxations for private individuals, corporates and investors. The relaxations for residential institutional investors (namely unit trusts, pension funds and insurers) allowed them to diversify part of their assets in foreign countries (Farrell and Todani, 2004:24).

However, in February 1996, and again in May 1998, with the expectation of a depreciation of the Rand, foreign portfolio investors attempted to circumvent losses in own currency value by quickly selling Rand-denominated assets. This actually led to the depreciation of the Rand. In both instances, the Reserve Bank tried to control the outflow by selling US dollars into the market in order to absorb exchange-rate risk from both foreign investors and importers. On the other hand, in an attempt to attract foreign portfolio flows back, real interest rates were increased significantly by about 2.5% in 1996 and 7% in 1998. In these crises, the rand ultimately re-stabilised at levels of nearly 20% lower than the level before the crises, and net inflows increased once more (Gelb, 2005: 380).

Late in the 1996 crisis, the Growth, Employment and Redistribution (GEAR) macroeconomic strategy was issued to achieve the growth targets for the economy (Schoombee, 2003:34). The policy explicitly stated the commitment to three objectives, namely: (i) consistent monetary policy to avoid a resumption of inflation ...(ii) nominal exchange rate policy to maintain a stable and competitive real effective exchange rate ... and (iii) an open capital market through regular exchange control relaxations (Department of Finance, 1996). Following the crisis of 1998, the costs of maintaining the three goals ignoring the problems of simultaneously pursuing these objectives were exposed which led to the shifting of exchange rate and monetary policy stance (Gelb, 2005: 381). Thus, in February 2000, the South African Reserve Bank formally adopted inflation targeting as the monetary policy framework while exchange control relaxation continued smoothly up to date (2008)[14].

Therefore, in light of the above-mentioned changes in monetary policy regimes and exchange rate policy between 1996 and mid-1999, the South African economy experienced (in average terms) relatively high levels of inflation, low economic growth, high nominal short-term interest rates and high levels of nominal currency depreciation (Aron and Muellbauer, 2007:707).

From the third quarter of 1999 to the fourth quarter of 2004, the average annual nominal short-term interest rate was 14.2%, inflation as given by the CPI was 5.3% and 6.9% as given by CPIX[15], the average annual growth rate was 3.6% and the annual percentage change in the nominal exchange rate was -1.5%. Thus, it can be stated that from 2000, the economy showed a noticeable improvement in terms of growth[16], regardless of the nominal exchange rate shock in the fourth quarter of 2001 which, together with regional grain price increases, raised inflation in 2002–2003 (Aron and Muellbauer, 2007:707).

However, the economic situation became unfavorable from late 2006 in terms of inflation rising above the target band, reduced economic growth and increased interest rates. According to Investec (2008:1) annual CPIX inflation increased from 7.9% in November 2007 to 8.6% in December 2007. Inflation has been increasing continuously and in June 2008 it was at 12.2% as measured by CPI[17]. The major contributors to the rising inflation were food and fuel price increases due to rising global oil[18] and food prices. In an attempt to ease

[14] For a detailed explanation of exchange control liberalisation in South Africa since 1995, see Farrell and Todani (2004).

[15] The CPIX for metropolitan and urban areas contains no interest rate component (Aron and Muellbauer, 2007:707).

[16] Real GDP growth averaged 4,1% per annum since 2000 and was driven by domestic demand to a larger extent (ABSA, 2007a:2).

[17] 10,9% as given by CPIX.

[18] Brent crude oil was trading at about US$145 per barrel.

inflation, the SARB adopted a tight monetary policy stance which led to an increase in the repo rate by a total of 400 basis points since June 2006 (ABSA, 2008a:1).

The financial markets of South Africa have also shown some developments following financial liberalisation, exchange control relaxations and globalisation. This has further implications for the performance of different asset classes. Focusing on the equity market, it can be stated that the listed companies on the JSE performed differently according to their sectoral influences. This affected important indicators such as dividend yield, earnings per share and dividend growth. For instance, considering the first quarter of 2007, resources and mining sector shares outperformed other shares due to commodity price increases, particularly the price of precious metals such as gold. Financial share prices were also highly volatile compared to other share prices. Dividend yield on the All Share index constantly decreased from 2.9% to 2.6% and to 2.3% in 2004, 2005 and 2006 respectively (ABSA, 2007b:2).

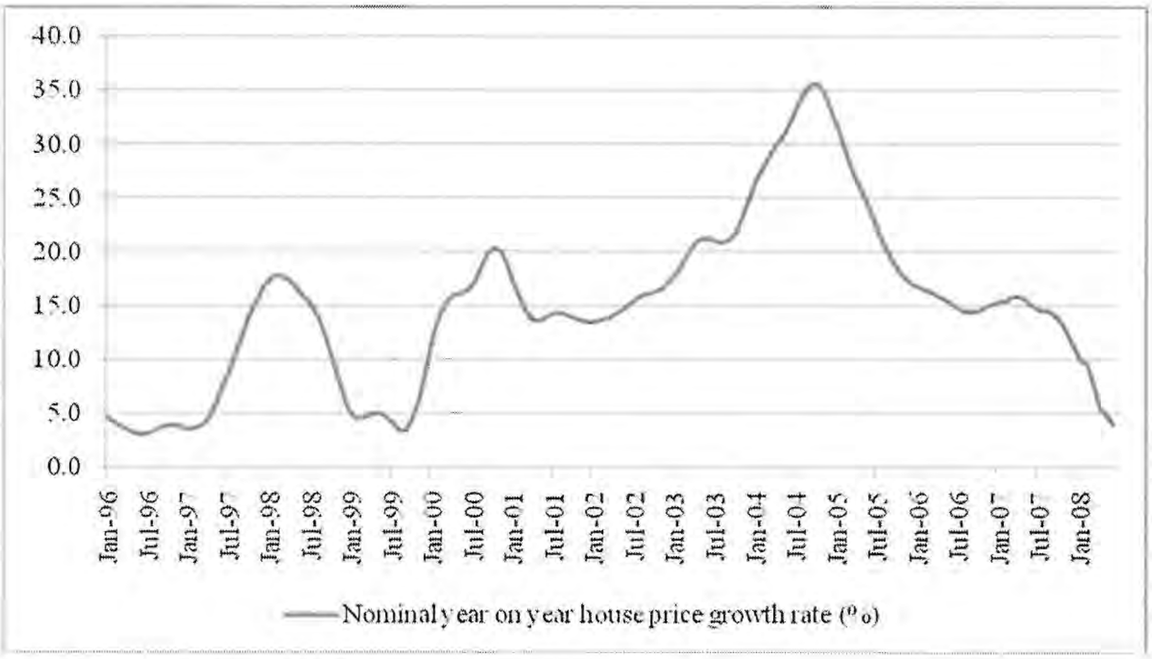
Furthermore, a credit crisis began in the US subprime mortgage industry[19] in 2007. The subprime lending crisis resulted from the spread of real estate loans throughout the US financial system in the form of collaterised debt obligations and other derivatives in order to diversify risk. However, when house prices stopped increasing and house owners failed to make their payments, banks were compelled to accept massive write-offs and write-downs on these financial products. Therefore, several financial institutions became insolvent with many of them being forced to increase their capital or become bankrupt and this led to the global financial crisis in 2008. Lehman Brothers Fin SA, Merrill Lynch, Citigroup and UBS AG are examples of companies that were significantly adversely affected by the subprime lending crisis which contributed to the 2008 global financial crisis. Therefore, the 2007 credit crunch negatively affected the US residential real estate market, the US economy and global financial markets in general (IMF, 2008:6-7). This implies that the financial markets and environment in South Africa have also been affected by the 2007 credit crunch and 2008 global financial crisis.

[19] Subprime lending refers to the provision of loans to borrowers with poor credit ratings or loan repayment histories.

3.2.2 The housing property market: January 1996-June 2008

Figure 3.1 below shows the trends in the nominal year-on-year house price growth rate from January 1996 to June 2008. The trends are analysed in the subsequent discussion.

Figure 3.1: Graphical presentation of nominal year-on-year house price growth rate



Data Source: ABSA (2008c)[20].

During 1996 and 1997, South Africa was still in its early stages of independence with the beginning of the new democratic era in April 1994. Business confidence was restored and nominal house prices recovered to some extent during 1996 and 1997 (see Figure 3.1 above) even though average real house prices and annual percentage change in real house prices were still very low. Furthermore, the property market was kept under pressure due to the ongoing exodus of skilled managers and professionals during the 1990s (Luus, 2003:155-156).

According to Luus (2003:156) the housing market started to recover in mid-1997 on the back of an improved fiscal situation, economic growth, lower inflation and interest rates. Nonetheless, contagion effects from the Asian crisis resulted in a massive depreciation of the

[20] Data for January 1996 to December 2007 was obtained from ABSA upon request. I would like to thank Jacques Du Toit for assisting me with this data.

Rand, which once again caused interest rates to rise by seven percentage points during mid-1998 and this caused a fall in the house price growth rate in nominal terms (see Figure 3.1) and real terms. By late 1999, the house price boom resumed as the economy stabilised from the crisis and house prices began to rise as shown by the upward trend in the nominal year-on-year growth rate shown in Figure 3.1 above.

From 2000 to 2005, the housing market seemed to be performing outstandingly as evidenced by an ascending trend in nominal and real house prices. By mid-2003, house prices had almost doubled in nominal terms from their early 1998 values (Luus, 2003:155-156). Figure 3.1 above shows the upward trend in the growth rate of nominal year-on-year house prices from 2000 to early 2005. According to Nel and Mbeleki (2005:12-13), the South African housing property market performed exceptionally well above all the housing property markets of selected developed countries[21]. This coincides with prudent monetary policy introduced by the SARB in 2000 as well as a strong domestic currency during this period (IMF, 2004:19).

However, the rate of growth of house prices slowed down since early 2005 (see Figure 3.1 above). For instance, ABSA (2008b:1) shows that nominal annual growth in house prices decreased from 12.5% in November 2007 to 11.2% in December 2007 which brought the average nominal house price to approximately R964 000 at the end of the year. This was the minimum recorded growth in house prices after December 1999.

According to ABSA (2008a:1), nominal house prices remained practically unchanged for the period January to June 2008, which implies that no growth was recorded on a month-on-month basis over this period and that house prices were falling in real terms. This coincides with the unfavorable movements of the exchange rate, oil and food prices, rising inflation above the 6% upper limit of the inflation target range, the impact of the National Credit Act[22] and the tight monetary policy in an effort to curb inflation. This suggests that a relationship

[21] UK, New Zealand, Australia, US, Sweden, Ireland, Norway and Denmark.

[22] The National Credit Act was implemented on 1 June 2007 and it requires all lenders and financial institutions to register as credit providers, and aims to protect consumers by regulating the country's credit-granting practices so that consumers can benefit from a credit environment that is transparent, fair and responsible (ABSA, 2008d:1).

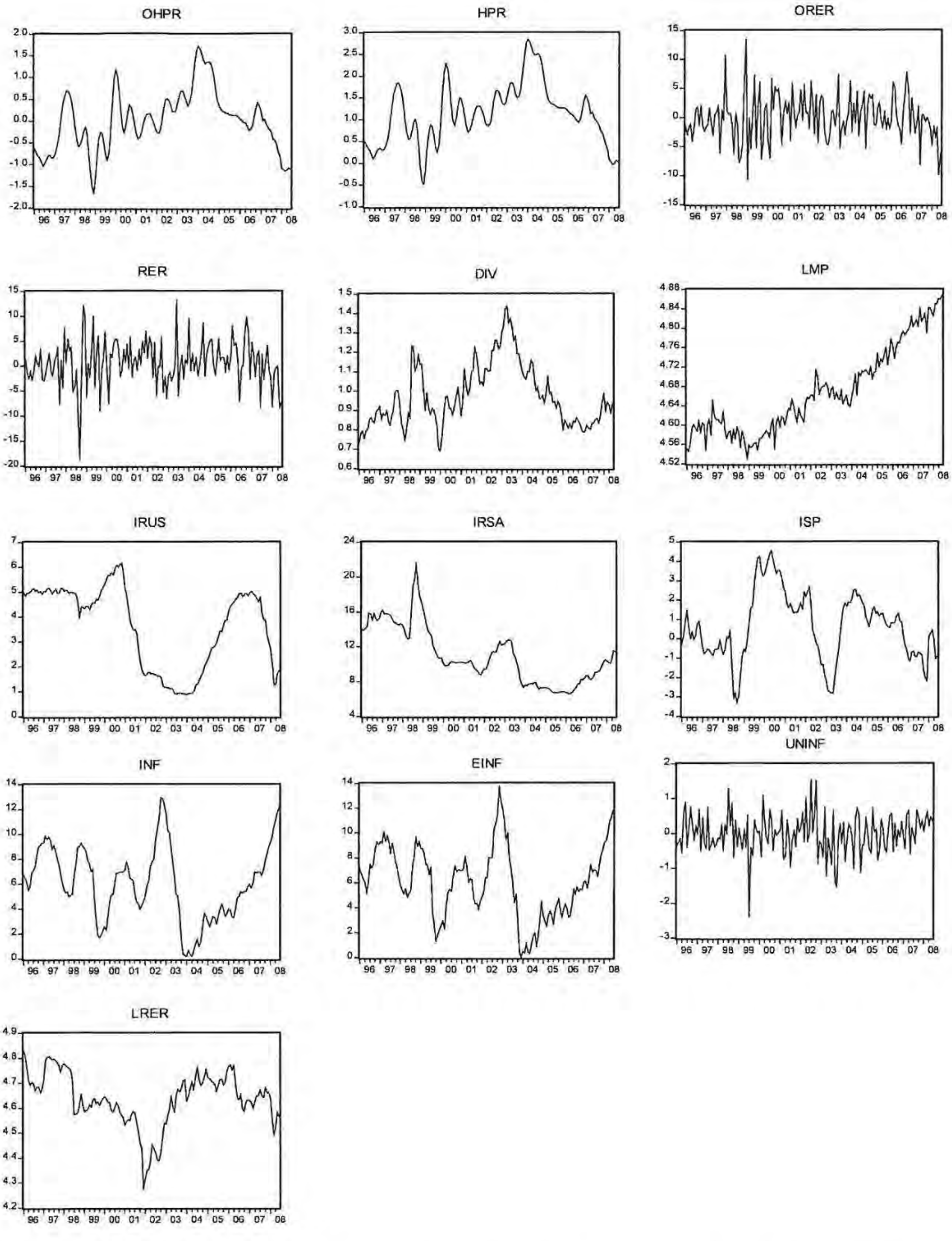
exists between changes in the macroeconomy and the performance of the housing property market.

Generally, it can be noted from the above discussion that as the economic variables changed over time, so did the house prices. In most instances, it can be noted that the better the economy performs, the better the housing property market is in terms of performance. This therefore, suggests a notable link between the macroeconomy and the performance of the housing property market. Further evidence of the possibility of a relationship between the changes in the macroeconomy and the housing property market can be obtained from the graphical presentation of property returns and selected variables in Figure 3.2 below.

The variables shown in Figure 3.2 are defined as follows: OHPR represents orthogonalised house price returns, HPR is non-orthogonalised house price returns, ORER represents orthogonalised real estate returns, RER is non-orthogonalised real estate returns, DIV is the dividend yield, LMP is manufacturing production, IRUS is the foreign interest rate, IRSA is the domestic interest rate, ISP is the interest rate spread, INF is actual inflation, EINF is expected inflation, UNINF represents unexpected inflation and LRER is the real effective exchange rate.

Analysis of the graphs below shows that property returns (represented by OHPR, HPR, ORER and RER) are inversely and positively related to the macroeconomic and financial variables. This implies that the fluctuations in the housing property market may be as a result of the changes in the South African macroeconomic and financial environment. However, what is the nature of the relationship between the macroeconomic and financial variables and property returns? What magnitude of the variation in property returns is due to changes in the selected variables? Empirical analysis is required to determine how property returns are impacted by macroeconomic and financial variables.

Figure 3.2: Graphical presentation of property returns and selected variables



Note: OHPR and HPR series were generated based on house price index data obtained from ABSA upon request. ORER and RER series were generated based on real estate index data obtained from Thomson DataStream. Dividend yield data was obtained from the JSE upon request. Data for other variables shown in the graphs plotted above was obtained from IMF-IFS (2008), South African Reserve Bank (2008), Federal Reserve Bank (2008) and Statistics South Africa (2008).

3.3 CONCLUSION

This chapter provided an overview of the macroeconomic environment and the housing property market of South Africa. This chapter thus forms the foundation of this study. It was revealed that there may be a link between the changes in the macroeconomic conditions and the housing property market. Further evidence of the possibility of such a relationship was shown in the graphical presentation of the selected variables and property returns. From the graphical analysis, it has been noted that each of the variables show either a positive and/or negative relationship with property returns. Thus, there is need for empirical analysis in order to determine the relationship between the selected variables and property returns, as well as the influence of shocks and innovations to the macroeconomic and financial variables on the property market in South Africa. This leads to the next chapter on the methodology used to answer these research objectives.

CHAPTER 4

METHODOLOGY AND ANALYTICAL FRAMEWORK

4.1 INTRODUCTION

As noted in Chapter 1, this study seeks to determine: (i) the relationship between selected macroeconomic and financial variables and the housing property returns, (ii) the influence of a shock to each variable on property returns over a period of time in South Africa, and (iii) the proportion of changes in housing property returns that result from changes in the explanatory variables. As a result, the objective of this chapter is to adopt an appropriate analytical framework that will help to address the three stated objectives of the study. Following Brooks and Tsolacos (1999), this study uses a vector autoregressive (VAR) model, block exogeneity tests, impulse responses and variance decompositions to answer the goals of this study. The chapter is organised as follows: Section 4.2 discusses the data and measurement issues. Section 4.3 discusses the econometric procedure and Section 4.4 concludes the chapter.

4.2 DATA AND MEASUREMENT ISSUES

4.2.1 Data source and sample period

Data for the model estimation covers the period January 1996 to June 2008, thereby making a total of 150 monthly observations for each series. The January 1996 to June 2008 period has been selected for the analysis because of data limitations, particularly regarding the data used to measure housing property returns[23] on a monthly basis. Given the importance of property returns in this study and to enable comparability across the models, the analysis in this chapter and the subsequent chapters has been restricted to this time frame.

This study uses monthly data, following most of the previous studies[24] that utilise the same data frequency to examine property return variations. Therefore, the results of this study may be compared with the findings presented in the existing literature.

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[23] This specifically refers to real estate returns.

[24] For instance, Chan *et al.*, 1990; Lizieri and Satchell, 1997a, 1997b; Okunev *et al.*, 2000; Brooks and Tsolacos, 1999; Cho and Ma, 2006; Joshi, 2006.

All the variables used for the models are expressed in natural logarithms except for actual, expected and unexpected inflation, domestic and foreign interest rates and interest rate spread. The data for the FTSE/JSE real estate price index and the FTSE/JSE All Share index are obtained from the *Thomson DataStream* while that of the house price index is from *ABSA*[25]. The USA interest rate data is obtained from the *Federal Reserve Bank*, while the manufacturing production and inflation data are obtained from *Statistics South Africa.* Dividend yield data was obtained from the *JSE* upon request[26], while the data for the domestic short-term interest rate and interest rate spread are obtained from *IMF- IFS*. The data for the real effective exchange rate is obtained from the *South African Reserve Bank.* The following section discusses the explanatory variables used in the subsequent analysis.

4.2.2 Explanatory variables

A review of the earlier studies on the housing property market suggests the following explanatory variables: stock returns as a measure of macroeconomic and business conditions, the rate of unemployment as an indicator of general economic conditions, aggregate consumption expenditure, real *per capita* consumption growth, industrial production, real GDP, inflation rate, nominal short-term interest rate, interest rate spread, nominal and real exchange rate (see for instance Chan *et al.*, 1990; Liu and Mei, 1992; McCue and Kling, 1994; Zenou and Smith, 1995; Ling and Naranjo, 1997; Lizieri and Satchell, 1997a, 1997b; Brooks and Tsolacos, 1999; Standish *et al.*, 2005; Clarke and Daniel, 2006).

Given the purpose of this study and the availability of data, the following nine explanatory variables are used in addition to the computed property returns: expected inflation rate, unexpected inflation, actual inflation rate, manufacturing production, domestic short-term interest rate, foreign interest rate, the interest rate spread, real effective exchange rate and dividend yield. These explanatory variables have been selected in order to conform to the variables that are commonly used in many previous studies. The following presents a brief discussion of the anticipated effects of each of the explanatory variables used in this study and their measurement.

[25] The data was provided by ABSA upon request. I would like to thank Jacques Du Toit for assisting me with this data.
[26] I would like to thank Helwick Makola for helping me with the data.

i. Actual Inflation

According to Wong *et al.* (2003:8-9) nominal house prices and returns would increase when inflation rises, *ceteris paribus*. This is so because when inflation increases, the investment market for income-generating properties would account for an assumed growth rate in the future annual income. Thus, a positive relationship is expected between changes in inflation and house prices and returns in nominal terms, all other things remaining constant.

However, there are mixed findings for the influence of inflation on house prices and /or returns. For instance, some studies find no evidence of any relationship between inflation and property market returns (see for instance Chan *et al.*, 1990; Ling and Naranjo, 1997). On the other hand, Wong *et al.* (2003) find that inflation changes and house prices are positively related. In this study, actual inflation is represented by the percentage change of the year-on-year consumer price index (CPI) on all items including interest on mortgage bonds.

ii. Expected inflation

An expected increase in inflation would imply a rise in the expected inflation rate, *ceteris paribus*. This may lead to an increase in nominal house prices and returns assuming that changes in expected inflation and nominal house prices and returns are positively related (Wong *et al.*, 2003:8). However, a negative relationship between expected inflation and house prices and returns can also be expected especially in real terms. Mixed results have been obtained on the influence of expected inflation on house prices and/or returns, for instance Pozdena (1980) and Wong *et al.* (2003) found a positive relationship, while Chan *et al.* (1990) and Ling and Naranjo (1997) found no significant relationship. The expected inflation series used in this study was generated using an ARIMA (2,0,0) model. A detailed explanation of the computation of expected inflation is given in the subsequent section on measurement issues.

iii. Unexpected inflation

As explained earlier in Chapter 2, unexpected inflation is defined as actual inflation rate minus the expected inflation rate (Brooks and Tsolacos, 1999:142). Thus, an expected increase in inflation would imply a rise in the expected inflation rate, which subsequently leads to a fall in unexpected inflation, *ceteris paribus*. This may lead to a decrease in nominal house prices and/returns assuming that inflation changes (whether it be actual or expected) and house prices are positively related, *ceteris paribus* (Wong *et al.*, 2003:8). However, a negative relationship can also be expected in the case of real house prices and returns.

Some empirical studies find a negative relationship between unexpected inflation and property returns (see for instance Chan *et al.*, 1990; and Brooks and Tsolacos, 1999:147). In this study, the unexpected inflation variable is measured as the difference between the actual inflation rate represented by the percentage change of the year-on-year CPI and an estimated series of expected inflation.

iv. Manufacturing production

Typically, real GDP is used to represent general economic activity. However, due to lack of high frequency data for real GDP, manufacturing production is used as a proxy for general economic conditions. An increase in manufacturing production would imply a rise in real GDP and economic growth. An increase in economic growth will lead to an increase in the demand for property. This will lead to a rise in house prices and thus housing property returns, *ceteris paribus* (Brooks and Tsolacos, 1999:141). However, despite the anticipated theoretical positive relationship between industrial production and property returns, Ling and Naranjo (1997), McCue and Kling (1994) and Chan *et al.* (1990) find no effect of industrial production on property returns. In this study, manufacturing production is represented by the seasonally adjusted index of the physical volume of manufacturing production.

v. Domestic interest rate

Interest rates and housing property prices (and returns) are expected to have a negative relationship following the argument that high interest rates lead to high mortgage repayments, which in turn reduce the affordability and ultimately the demand for property, holding all other factors constant (Follain, 1982:20; Clarke and Daniel, 2006:29).

Empirical studies show mixed results regarding the relationship between the interest rate and property returns. For instance, McCue and Kling (1994) and Brooks and Tsolacos (1999:149) obtain a negative relationship. Other studies find no evidence of any relationship between the interest rate and property returns (see for instance Mueller and Pauley, 1995), while Wong *et* *al.* (2003) obtain a positive relationship. In this study, the interest rate is defined by the three-month Treasury bill rate.

vi. Foreign interest rate

A positive relationship is expected between the foreign interest rate and house prices and returns in the sense that a rise in the foreign interest rate would mean a rise in foreign mortgage repayments. This would reduce the affordability and ultimately the demand for property in that foreign property market, *ceteris paribus*. Alternatively, these foreign investors would buy property in other markets with relatively lower interest rates, thus increasing the demand for property in those markets and ultimately the property prices and returns will increase, holding all other factors constant (Rao and Whillans, 1980:156-157). In this study, the foreign interest rate is represented by the USA three-month Treasury bill rate annualised utilising bank interest or a 360-day year on a discount basis.

vii. Interest rate spread

A downward sloping yield curve would imply that investors expect short-term interest rates to drop in the future. Given that interest rates and house prices/returns are negatively related, the expectation of a fall in interest rates which implies an expected fall in the cost of borrowing will lead to a rise in demand for housing in future. This will result in an increase in house prices and returns, assuming that all other things remain the same (Goodhart, 2007:5). Following Brooks and Tsolacos (1999), this study defines interest rate spread (or yield spread) as the difference between the yield on the 10 year government bond and the three-month Treasury bill rate.

viii. Real exchange rate

According to Clarke and Daniel (2006:30) an appreciation of the currency will discourage foreign investors from local property investment while a depreciation of the currency will attract foreign investors to the local property market which results in a rise in the demand for local housing. Assuming that all other things remain constant, the rise in housing demand will then lead to an increase in local house prices and returns. In addition, stability of the currency contributes to business confidence which also affects the demand for property as discussed in Chapter 2. However, a positive relationship can also be expected, as explained in Chapter 2.

In this study, the real exchange rate is represented by the real effective exchange rate of the Rand against the most important currencies.

ix. Dividend yield

As discussed in Chapter 2, the dividend yield and property returns may be positively related. This is so because the dividend yield is a component of the stock of wealth (Baker, 2005:1). On the other hand, a negative relationship can also be expected in the sense that a fall in the dividend yield can result in capital switching into the housing property market in pursuit of higher profits (Harvey 1982 in Lizieri and Satchell, 1997a:15). This will mean a rise in the demand for housing which will ultimately increase house prices and returns, *ceteris paribus*. Dividend yield in this study is the dividend yield earned on the FTSE/JSE All Share index. As in Brooks and Tsolacos (1999), the dividend yield is considered as a financial variable.

4.2.3 Measurement issues

This section explains how the property returns used in this study were computed. Furthermore, an explanation of how the expected and unexpected inflation series were computed is given.

4.2.3.1 Calculation of orthogonalised house price returns and real estate returns

The orthogonalised house price returns and real estate returns used in this study were calculated based on the house price index and real estate index, respectively. The first step in computing the orthogonalised house price returns was the calculation of the house price index returns and All Share index returns using the logged values of the house price index and FTSE/JSE All Share index, respectively. Mathematically, the returns R_t were calculated using the following continuously compounded return formula (Brooks, 2002:7):

$$R_t = \ln(P_t / P_{t-1}) \times 100 \qquad (4.1)$$

In the case of calculating house price returns, P_t represents the value of the house price index for the period t; and t is the time period in months. P_{t-1} is the house price index for the period $t-1$; $ln\ (.)$ is the natural logarithm operator. The house price returns are denoted as HPR[27]. For

[27] Since real estate returns were also used as a proxy for the housing market, the real estate returns were computed using the same procedure except for the fact that the FTSE/JSE real estate index was used as an input

the calculation of the FTSE/JSE All Share index returns which are denoted as ASR, P_t represents the value of the FTSE/JSE All Share price index for the period t; and P_{t-1} is the FTSE/JSE All Share price index for the period $t-1$.

Due to the existence of common factors (for example, interest rates, expected inflation and economic growth expectations) in determining prices, it may be argued that house price returns and real estate returns obtained from Equation 4.1 above are linearly dependent on stock market effects (Lizieri and Satchell, 1997a:12; Brooks and Tsolacos, 1999:143). Furthermore, in this study these contemporaneous general market influences are examined based on the selected macroeconomic and financial variables discussed in Section 4.2.2 above. This results in the need for orthogonalisation in order to separate house price returns and real estate returns from the broad equity market effects. This step is essential since the rationale of this study is to model the housing property market itself excluding the general market changes that affect all financial assets.

The orthogonalised house price returns were obtained by firstly regressing HPR on ASR as follows:

$$HPR_t = \alpha + \beta ASR_t + \mu_t \qquad (4.2)$$

The estimation results of Equation 4.2 reported in Table A2 in the appendix show that the β coefficient is negative (-0.002815) which implies that house price returns are negatively related to stock market returns although the β coefficient is statistically insignificant. The second step was then to obtain the orthogonalised house price returns as follows:

$$OHPR = HPR_t - \hat{\alpha} - \hat{\beta} ASR_t \qquad (4.3)$$

In the same manner, the orthogonalised real estate returns were computed by first regressing RER on ASR as shown in Equation 4.4 below:

$$RER_t = \alpha + \beta ASR_t + \mu_t \qquad (4.4)$$

Table A3 in the appendix shows that the β coefficient in Equation 4.4 is positive (0.397308) and statistically significant which implies that the real estate returns and stock market returns

to the continuously compounded return formula shown in Equation 4.1. The real estate property returns are denoted as RER.

are positively correlated. Therefore, South Africa's real estate and stock markets are integrated. This finding of integration of real estate and stock markets is consistent with that of Gyourko and Keim (1992:6-7) for USA and Okunev *et al.* (2000:254) for USA. The orthogonalised real estate returns were then obtained as follows:

$$ORER = RER - \hat{\alpha} - \hat{\beta} ASR_t \qquad (4.5)$$

For computation of orthogonalised house price returns (OHPR) and orthogonalised real estate returns (ORER), the non-recursive coefficient estimates were used which assume that the β coefficient is constant over time[28].

4.2.3.2 Computation of expected and unexpected inflation

As mentioned earlier in this study, to obtain unexpected inflation, we need to subtract expected inflation from actual inflation. In order to compute the expected inflation series, this study utilised the autoregressive integrated moving average (ARIMA) model following studies such as Meyler *et al.* (1998); Kenny *et al.* (1998); and Brooks and Tsolacos (1999). Furthermore, Meyler *et al.* (1998:5) state that ARIMA models have been proved to produce more robust results in terms of generating short-run inflation forecasts, and outperform other models (see also, Litterman, 1986 and Stockton and Glassman, 1987).

According to Meyler *et al.* (1998:2), ARIMA modelling is a particular type of univariate modelling, whereby a time series is represented by its own lagged values (the autoregressive component) and the present and past values of a 'white noise' error term (the moving average component). Thus, ARIMA models are expressed as ARIMA (p,d,q), where p is the number of autoregressive terms, q the number of moving average terms and d the number of times the series has to be differenced to make it stationary (Meyler *et al.*, 1998: 5). Equation 4.4 below shows the mathematical representation of the ARIMA models[29].

$$\phi(B)\Phi(B)\nabla^d\nabla_s^D Y_t = \theta(B)\Theta(B)a \qquad (4.4)$$

where a stationary series $X_t = \nabla^d\nabla_s^D Y_t$, and the number of seasonal differences needed to make Y_t stationary is represented by $\nabla^D = (1-B)^D$ (Meyler *et al.*, 1998: 5). ARIMA models

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[28] The recursive coefficient estimates which assume that the β coefficient varies over time were also used. However, the results were not satisfactory.

[29] See Meyer *et al.* (1998:5) for a description of ARIMA models and some of their theoretical properties.

are *atheoretical*, that is they are not explained by or do not assume any knowledge of economic theory or structural relationships. In addition, ARIMA models only require data of the time series in question[30] (Meyler *et al.*, 1998:4). Following the steps involved in ARIMA modelling, the subsequent discussion explains how the expected inflation series was generated.

Step 1: Data collection and analysis

Data collection and graphical analysis was done in order to identify any outliers or structural breaks. In this case the data for INF (the percentage change of year-on-year CPI) from August 1995 to June 2008 was used since a lengthy time series of data of at least 50 observations is required for univariate time series forecasting (McGough and Tsolacos, 1995: 8). The analysis of the graph for INF shown as Figure A1 in the appendix shows that there seem to be no structural breaks or outliers, hence the data was suitable to be used for modelling purposes.

Step 2: Model identification and estimation

Model identification and estimation involves the use of the autocorrelation coefficient (ACF) and partial autocorrelation coefficient (PACF) to determine the order of the ARMA model (p,q) (Brooks, 2002: 256). The correlograms reported in Table A4 in the appendix suggests that the right model to be specified would possibly be an AR(1) model as the PACF dies off immediately after one lag and the ACF declines gradually. Since there is no sound theoretical guideline for choosing the maximum order of ARIMA models to consider (Meyler *et al.*, 1998: 23), modelling was started from ARIMA (1,0,0) until ARIMA (5,0,0). Furthermore, using information criteria, the top two models which minimise the value of the information criteria were selected for the next step. The Akaike information criterion (AIC), the Schwarz Bayesian information criterion (SIC) and the Hannan-Quinn criterion (HQIC) were used. The results are shown in Table A5 in the appendix. ARIMA models (2,0,0) and (3,0,0) were selected as the best models and these two models were used to proceed to Steps 3 and 4.

[30] For more advantages and disadvantages of ARIMA , see Meyer *et al.* (1998:4-5).

Step 3: Diagnostic checking

The third step involves diagnostic checking of the selected best models from Step 2. According to Meyler *et al.* (1998:23) this can be done by way of plotting the autocorrelogram of the residuals in level terms which should die out immediately from one lag on. If the model has been correctly specified the residuals will be "white noise". Accordingly, stationarity testing was done on these residuals and the results reported in Table A6 in the appendix show that the residuals are stationary at 1% level in level terms. The autocorrelograms of the residuals in level terms for ARIMA (2,0,0) and ARIMA (3,0,0) models died out immediately from lag one.

The unit root circles were then plotted for ARIMA (2,0,0) and ARIMA (3,0,0) models in order to choose the best model. The basic interpretation is that the closer the AR and MA roots are to zero (i.e. the centre) the better the model is. The unit root circles are shown in the appendix in Figures A2 and A3 for ARIMA models (2,0,0) and (3,0,0) respectively. ARIMA (2,0,0) has its AR and MA roots closer to the centre than those of ARIMA (3,0,0).

Step 4: Forecasting and forecast evaluation

This step involves trying to determine the value of the model within the period estimated known as the in-sample forecast and outside the period estimated known as out-of-sample forecast (Brooks, 2002:279-280). Thus, the two selected ARIMA models (2,0,0) and (3,0,0) were tested based on the mean squared forecast error which can be decomposed into a bias proportion, a variance proportion and a covariance proportion. Accurate forecasts would be unbiased and have a small variance proportion, so that most of the forecast error should be based on the covariance component[31] (Brooks, 2002:293). Furthermore, the Theil statistic was also considered since it compares the root mean square error of the selected model to that of the forecast model and also allows a quick comparison with the 'naive' forecast model. In this case, the Theil statistic must be less than one in order to accept the model (Meyler *et al.*, 1998:27). The results for the in-sample forecast and out-of sample forecast for the two models led to the selection of ARIMA (2,0,0) as the best model[32]. Therefore, the expected inflation series was generated using an ARIMA (2,0,0) model. The graphical presentation of

[31] For a detailed explanation see Brooks (2002:293).

[32] The results are not shown in this study due to space constraints.

the results for expected and unexpected inflation is shown as Figure A4 in the appendix[33]. The next section discusses the econometric procedure used in the subsequent analysis.

4.3 ECONOMETRIC PROCEDURE

As mentioned earlier in this chapter, the three objectives of this study will be pursued by employing the vector autoregressive (VAR) model, block exogeneity tests, impulse responses and variance decompositions. Therefore, this subsection provides a detailed explanation of how the above econometric techniques are employed in this study.

4.3.1 Vector autoregressive (VAR) model

For the purpose of determining the relationship between the selected variables and housing property returns, the empirical analysis employs a VAR model framework following Brooks and Tsolacos (1999). Since the VAR approach does not have any structural restrictions, it enables the estimation of correctly specified reduced form equations whose actual economic structure may be unknown. This is an essential characteristic in empirical analysis of data since structural models are usually misspecified. According to Brooks (2002:332), unlike in a regression model, an unrestricted VAR approach does not restrict the influence of variables on each other. It is basically presumed that variables are related to their own past values and the past values of the other variables over time. Therefore, VAR models are more flexible than regression models and univariate autoregressive (AR) models and are able to capture more features of the data. Furthermore, all variables in the VAR model are considered as endogenous, hence there is no need to specify which variables are endogenous or exogenous (Brooks, 2002:332).

Specifically, the empirical analysis of this study employs a reduced form VAR model framework[34] as in Brooks and Tsolacos (1999). The analysis adopts a multivariate time-series analysis to circumvent the problem of omitted variable bias associated with a bivariate model that could further result in erroneous causal implications (Luintel and Khan, 1999:385). In this study, the VAR model is specified as follows:

[33] Actual refers to actual inflation, fitted refers to expected inflation and the residual represents unexpected inflation which is the difference between actual and expected inflation.

[34] That is, only lagged values of the variables on the right-hand side are used, hence there is no simultaneity in the system (Brooks, 2002:332).

$$X_t = \beta + \sum_{k=1}^{m} A_k X_{t-k} + \varepsilon_t \tag{4.5}$$

where X_t represents a vector of the variables used in this study, X_{t-k} represents the past values of all the variables in the equation, β is the deterministic component comprised of a constant, k represents the number of lags and ε_t is a set of error terms (or innovations) which are assumed to be serially and contemporaneously uncorrelated to the variables in the system (Brooks and Tsolacos, 1999:143). The variables used as inputs in Equation 4.5 above are orthogonalised house price returns (OHPR), the log of the dividend yield (DIV), the log of manufacturing production (LMP), the log of the real effective exchange rate (LRER), expected inflation (EINF), the domestic short-term interest rate (IRSA), foreign interest rate (IRUS), interest rate spread (ISP) and unexpected inflation (UNINF) [35].

Prior to estimation of the VAR models, the tests for stationarity of the series were carried out using four tests: Augmented Dickey and Fuller (ADF), Dickey and Fuller (DF-GLS), Phillips and Perron, and Ng and Perron tests. This is important because most macroeconomic time series are non-stationary. The tests were used in order to ensure that we have the best results in determining the order of integration of each variable. This is so because the weakness of each test will be counterbalanced by the strengths of the other tests (see Brooks, 2002:381-382).

The next important step in VAR modelling is determination of the appropriate lag length. The importance of determining the appropriate lag length is confirmed by Braun and Mittnik (1993) who demonstrate that estimates of a VAR whose lag length is different from the true lag length are inconsistent as are the impulse responses and variance decompositions derived from the estimated VAR. There are various arguments on determining the lag length. Bala and Premaratne (2003:18) state that the use of information criteria will ensure that the model is kept parsimonious. Furthermore, Friedman and Shachmurove (1997) advocate a higher lag order to ensure that an analysis will capture all the dynamics in the data. However, Lütkepohl

[35] Other models were estimated using each of the following returns as a proxy for the housing property market; non-orthogonalised house price returns (HPR), orthogonalised real estate returns (ORER) or real estate returns (RER). Furthermore, in the case where actual inflation (INF) was included, expected and unexpected inflation would be excluded.

(1993:23) indicates that selecting a higher lag order than the true lag length causes an increase in the mean-square forecast errors of the VAR while the selection of a lower lag order than the true lag length frequently produces autocorrelated errors.

Since the majority of previous studies use information criteria and since there is no specific theory that guides the speed at which the influence of variables are transmitted to the housing property market and to each other, this study utilises the information criteria. However, according to Brooks (2002:335-336) it is important to note that different information criteria tend to select different lag lengths. Another problem is that some of the information criteria tend to be sensitive to the optimum lag length which is selected. In this study, the specification of the lag length of the VAR is sequentially tested using the Akaike information criterion (AIC), Schwarz Bayesian information criterion (SIC) and Hannan-Quinn information criterion (HQIC).

Although VAR analysis is a useful econometric technique for determining the relationship between the housing market and the selected variables, econometric literature generally shows that one primary limitation of the VAR method is that of its *atheoretical* characteristic and the large number of parameters involved that make the estimated models difficult to interpret. In other words, some lagged variables may have coefficients that change signs across the lags, and this, combined with the interconnectivity of the equations, makes it difficult to establish the effect of a given change in a variable on the future values of the variables in the system. In order to solve this problem, block significance tests, impulse responses and variance decompositions are utilised (Brooks, 2002:338).

4.3.2 Block exogeneity tests

Generally, the block exogeneity tests distinguish between the variables that have significant influences on each of the dependent variables and those that do not. This is done by restricting all the lags of variables included in the system to zero and then testing for the significance of purging these variables. According to Brooks (2002:339), this joint significance test follows an F-distribution and is similar to the Granger causality test. In this study, the block exogeneity tests are applied to the parameters specified in Equation 4.5 in order to determine which variables have significant explanatory power on property returns.

However, since the block exogeneity test does not give us the sign, magnitude and persistence of response of housing property returns to shocks in other variables, impulse responses are employed.

4.3.3 Impulse responses

Brooks (2002:341) defines impulse responses as the tests that show the responsiveness of the dependent variables in the VAR to shocks in each variable in the model. In this study, impulse response analysis will help to examine the influence of a shock to each explanatory variable upon the property returns over time. In addition, the sign, magnitude and persistence of responses of the housing property market to shocks in the selected variables are captured.

According to Lütkepohl and Saikkonen (1997:130), if the VAR process represented by Equation 4.5 is white noise, it can then be inverted into a moving average representation whose coefficients are forecast error impulse responses. The moving average will then be represented as:

$$X_t = \beta + \sum_{k=0}^{m} B_k \varepsilon_{t-k} \tag{4.6}$$

where X_t represents the dependent variables. In this study, the coefficient B_k is the response of each of the variables to a one unit shock in any of the variables in the system k periods ago and ε_t represents error terms which are serially uncorrelated even though they may be contemporaneously correlated.

Generally, impulse responses are estimated using the Cholesky decomposition proposed by Sims (1980) and the generalised impulse response advocated by Koop, Pesaran and Potter (1996) and Pesaran and Shin (1998). However, the generalised impulse response has an advantage over the Cholesky decomposition in that it requires innovations to be orthogonalised and does not vary with the ordering of variables in the VAR system (Pesaran and Shin, 1998:17). Thus, this study uses the generalised impulse response estimation criterion. Since impulse response functions do not tell us the proportion of variations in the dependent variable that are due to its own shocks and to shocks in other variables, variance decompositions are applied to achieve this.

4.3.4 Variance decompositions

As mentioned earlier, variance decompositions will help to establish the proportions of property return variations that are due to changes in the explanatory variables. This will also help to determine which of the variables have the greatest influence on property returns. Therefore, in technical terms, a shock to the *i*th variable directly affects that variable, but the shock will also be transmitted to all the other variables in the system due to the dynamic nature of the VAR. Hence variance decompositions determine how much of the z-step-ahead forecast error variance of a given variable is explained by innovations to each selected variable for $z = 1, 2\ldots$ (Brooks, 2002:342). Empirical literature generally supports that own series innovations tend to explain most of the forecast error variance of the series in the VAR (see for instance, Lamba and Otchere, 2001:18; Brooks, 2002:342).

4.4 CONCLUSION

This chapter provided a chronological explanation of the analytical framework that will be employed in order to achieve the goals of this study. Firstly, the data and measurement issues were discussed whereby the explanatory variables to be used in the empirical analysis were defined and the *a priori* expectations were given for each variable. This was followed by a detailed explanation of the computation of orthogonalised property returns as well as the generation of the expected inflation series based on an ARIMA (2,0,0) model. The econometric procedure for analysing the relationship between selected variables and property returns was then described. In line with this, the VAR model, block exogeneity tests, impulse response and variance decomposition techniques were discussed and how these techniques are employed in this study. Having described the analytical framework in this chapter, the study now proceeds to the application of the analytical framework so as to achieve the objectives as set out in Chapter 1.

CHAPTER 5

EMPIRICAL RESULTS

5.1 INTRODUCTION

This chapter focuses on addressing the objectives of this study by providing the interpretation of the results obtained from the econometric modelling. In the light of the goals of this research and as can be recalled from Chapter 4, VAR modelling is applied.

Based on the majority of previous studies that used house prices[36] and real estate returns[37] as the proxies for the housing property market, the estimations for this study were done using house price returns and real estate returns. These returns were used both in orthogonalised and non-orthogonalised form. In addition, the models were estimated based on the following options: (i) excluding actual inflation and (ii) including actual inflation but excluding expected and unexpected inflation. Thus, there are four alternative options in each of the two broad categories of house price returns and real estate returns. Table 5.1 below gives a summary of the total number of models estimated.

The results for block exogeneity tests, impulse responses and variance decompositions are reported based on the two categories of property returns used as proxies for the housing property market, namely house price returns and real estate returns.

This chapter is organised as follows: Section 5.2 provides the results of the unit root tests and the lag length selection. Section 5.3 provides the interpretation of the results of the block exogeneity tests, impulse responses and variance decompositions and Section 5.4 concludes the chapter.

[36]These include Abraham and Hendershott (1993,1996), Lizieri and Satchell (1997b), Hendershott and Weicher (2002), Kim (2004), Standish *et al.* (2005), Cho and Ma (2006), Clarke and Daniel (2006), Joshi (2006), Edelstein and Tsang (2007).

[37] See for instance Chan *et al.* (1990), McCue and Kling (1994), Lizieri and Satchell (1997a), Ling and Naranjo (1997), Brooks and Tsolacos (1999).

Table 5.1 Summary of estimated models

Name of Model	Proxy for housing property market (dependent variable)	Excluded variables
Model A	Orthogonalised house price returns (OHPR)	Actual inflation
Model B	Orthogonalised house price returns (OHPR)	Expected and unexpected inflation
Model C	House price returns (HPR)	Actual inflation
Model D	House price returns (HPR)	Expected and unexpected inflation
Model E	Orthogonalised real estate returns (ORER)	Actual inflation
Model F	Orthogonalised real estate returns (ORER)	Expected and unexpected inflation
Model G	Real estate returns (RER)	Actual inflation
Model H	Real estate returns (RER)	Expected and unexpected inflation

Source: Table formulated by the author

5.2 UNIT ROOT TESTS AND LAG LENGTH SELECTION RESULTS

The first step in VAR modelling is ensuring that the series used as inputs in the models are stationary. Therefore, the determination of the order of integration of each variable was done using four tests, namely the Augmented Dicky Fuller (ADF) test, DF-GLS test, Phillips and Perron (1988) test and Ng and Perron (2001) test. For each of these tests, the null hypothesis which states that the variable is non-stationary (has a unit root) is tested against the alternative hypothesis that the variable is stationary. In order to establish the data generating process of each series, the unit root tests were done at level and first difference with an intercept and intercept and trend. The unit root test results are reported in Table A7 in the appendix.

The criterion used for determining whether the series is stationary in level terms or at first difference is that if at least two tests show that the series is stationary in level terms, that series would be considered as level stationary. The cut off significance level used was 5%. Following this criterion, the hypothesis of a unit root is rejected in level terms for orthogonalised house price returns (OHPR), orthogonalised real estate returns (ORER), non-orthogonalised real estate returns (RER), unexpected inflation (UNINF), interest rate spread (ISP) and manufacturing production (LMP) hence these variables were not differenced. On the other hand, non-orthogonalised house price returns (HPR), actual inflation (INF), expected inflation (EINF), dividend yield (DIV), real effective exchange rate (LRER), domestic interest rate (IRSA) and foreign interest rate (IRUS) were stationary at first difference. Thus, the VAR analysis proceeded using the above mentioned variables with each variable differenced according to its respective order of integration.

The next important step in VAR modelling is to determine the lag length. The specification of the lag length was done using the Akaike (AIC), Schwarz (SIC) and Hannan-Quinn (HQIC) Information Criteria and the lag that minimises the information criteria was selected. The results for the selected lag length for each model are shown in Table A8 in the appendix. This was then followed by the serial correlation diagnostic test since the presence of serial correlation would suggest misspecification of the underlying model. The serial correlation test was done sequentially whereby the minimum lag length selected by information criteria is subsequently increased until serial correlation is eliminated.

For instance, in the case of Model A the serial correlation test started at Lag 3 and the lag length was subsequently increased until serial correlation was eliminated at Lag 4, hence Lag 4 is used for this model. Following the same procedure as in the case of lag order selection for Model A, the lag order of 5 was used for Models B and D, Lag 4 for Models C, G and H, and Lag 3 for Models E and F. The results for the serial correlation tests are presented in Table 5.2 below.

Table 5.2: Serial correlation test results

	Model							
Lag	A	B	C	D	E	F	G	H
1		238.82 [0.00]		209.99 [0.00]		119.03 [0.00]		114.17 [0.00]
2		128.85 [0.00]		124.97 [0.00]		106.67 [0.00]		103.02 [0.00]
3	111.87 [0.01]	80.22 [0.08]	106.17 [0.03]	84.22 [0.05]	91.3* [0.20]	78.32* [0.11]	100.36 [0.07]	79.9 [0.09]
4	95.9* [0.12]	84.08 [0.05]	90.8* [0.21]	87.34 [0.03]			83.3* [0.41]	76.07* [0.14]
5		65.02* [0.44]		64.53* [0.46]				

Note: [ ] is the probability value; * shows the selected lag which shows no evidence of serial correlation. The null hypothesis for the serial correlation test is that there is no serial correlation among the residuals and thus rejection of the null implies that the residuals are serially correlated.
Source: Based on estimations by the author.

5.3 BLOCK EXOGENEITY TESTS, IMPULSE RESPONSES AND VARIANCE DECOMPOSITION RESULTS

The present subsection attempts to address the goals of this research by considering the block exogeneity tests, impulse responses and variance decomposition analyses. Table 5.3 presents the block exogeneity test results. Impulse response results are shown in Figure A5 and Figure A6 in the appendix. Table 5.4 shows the t-statistics for the impulse responses of house price returns to shocks to each of the explanatory variables. Variance decomposition results are presented in Table 5.5 and Table A10 in the appendix.

Overall, the results using house price returns performed better than those using real estate returns. The results show that house price returns are influenced by more of the variables used in this study than real estate returns. This finding suggests that real estate returns are largely exogenous while house price returns are endogenous. The insignificant influence of variables used in this study on real estate returns is consistent with the findings of Brooks and Tsolacos (1999) who find that the orthogonalised real estate returns are not influenced by the macroeconomic and financial variables used in their study. Therefore, in line with Brooks and Tsolacos (1999:145), real estate returns are influenced by other property market-related factors such as rents and capitalisation rates which are not employed in this study due to data limitations.

However, it is important to note that, firstly, although most of the macroeconomic and financial variables used in this study do not affect real estate returns, exceptions are IRSA and DIV that have a slightly statistically significant and negative effect on real estate returns. The finding of a negative impact of IRSA on real estate returns is consistent with the results of McCue and Kling (1994) for the UK and Ling and Naranjo (1997) for the USA. Similar to the findings of Ling and Naranjo (1997), McCue and Kling (1994) and Chan *et al.* (1990) who find no effect of industrial production on property returns, this study find no impact of LMP on real estate returns. Secondly, the results for non-orthogonalised and orthogonalised real estate returns imply that the stock market has a significant influence on real estate returns. Given that the real estate returns did not significantly respond to the macroeconomic and financial variables used in this study, the subsequent analysis of the results focuses on house price returns.

By and large, the results for orthogonalised and non-orthogonalised house price returns are similar. As discussed in Chapter 4, although VAR analysis is a vital tool that can be used to test for linkages between variables, the fact that there are so many coefficients and that the signs of the coefficients of variables may vary with different lags raises issues regarding interpretation. Furthermore, the VAR estimates do not allow us to determine the sign of the relationship between house price returns and selected variables or the proportion of the variation in house price returns that is due to shocks in the explanatory variables. Hence, the results of the VAR model are not discussed here. The summary of the significant VAR parameters are reported in Table A9 in the appendix.

5.3.1 Block exogeneity test results

The results for the block exogeneity tests reported in Table 5.3 below show that DIV only explains OHPR at the 10% level in Model A which excludes actual inflation. LMP has explanatory power for house price returns at the 10% level in the models where actual inflation is included. EINF explains OHPR at the 10% significance level and HPR at the 5% level. ISP also has explanatory power for house price returns at the 1% level in the case where actual inflation is excluded from the models. However, ISP explains HPR at the 10% level in the case where actual inflation is included in Model D. UNINF has explanatory power at the 5% significance level for HPR only. Therefore, based on the block exogeneity tests, the preliminary conclusion is that DIV, LMP, EINF, ISP and UNINF have explanatory power for house price returns while LRER, IRSA, IRUS and INF have no explanatory power.

Table 5.3: Block exogeneity test results

Dependent variable	OHPR		D(HPR)		ORER		RER	
Model	A	B	C	D	E	F	G	H
D(DIV)	8.11* [0.09]	7.67 [0.18]	4.91 [0.30]	7.94 [0.16]	4.61 [0.20]	4.02 [0.26]	12.72* [0.01]	12.87* [0.01]
LMP	4.39 [0.36]	9.29* [0.10]	6.28 [0.18]	10.66* [0.06]	1.42 [0.70]	1.24 [0.74]	2.01 [0.73]	3.51 [0.48]
D(LRER)	4.94 [0.29]	8.07 [0.15]	4.79 [0.31]	3.46 [0.63]	0.83 [0.84]	0.56 [0.91]	1.94 [0.75]	1.86 [0.76]
D(EINF)	8.53* [0.07]		9.26* [0.05]		4.92 [0.18]		3.06 [0.55]	
D(IRSA)	4.5 [0.34]	4.08 [0.54]	4.42 [0.35]	7.8 [0.17]	7.35* [0.06]	7.5* [0.06]	7.36 [0.12]	7.1 [0.13]
D(IRUS)	4 [0.41]	2.01 [0.85]	2.35 [0.67]	1.33 [0.93]	1.47 [0.69]	2.63 [0.45]	1.39 [0.85]	3.35 [0.50]
ISP	13.86* [0.01]	8.65 [0.12]	14.77* [0.01]	10.42* [0.06]	2.83 [0.42]	7.79* [0.05]	3.48 [0.48]	8.97* [0.06]
UNINF	7.02 [0.13]		10.05* [0.04]		4.01 [0.26]		3.68 [0.45]	
D(INF)		3.89 [0.57]		3.35 [0.65]		1.07 [0.78]		1.76 [0.78]
All	**66.3 [0.00]**	**68.68 [0.00]**	**48.51 [0.03]**	**48.95 [0.06]**	**36.73 [0.05]**	**31.46 [0.07]**	**62.36 [0.00]**	**60.04 [0.00]**

Note: [ ] is the probability value. The null hypothesis for the block exogeneity test states that all the lags of a particular variable have no explanatory power for the dependent variable and hence rejection of the null implies that all the lags of a variable have explanatory power for the dependent variable. * shows that the null hypothesis of no explanatory power for the dependent variable is rejected.

5.3.2 Impulse response and variance decomposition results

Impulse responses seek to determine the effect of a one-unit shock to each explanatory variable on the property returns over time. Furthermore, impulse response results show the sign (positive or negative) of the relationship between property returns and the explanatory variables. The impulse responses were estimated using the generalised impulse response approach which does not vary with the ordering of variables in the VAR system.

Variance decomposition helps to determine the percentage or proportion of the movements in the property market returns that are due to its 'own' innovations, against those that are due to shocks in the selected variables. Brooks and Tsolacos (1999:146) and Mills and Mills (1991) emphasise the importance of ordering variables in variance decomposition by pointing out that it is as important as putting restrictions on the primitive form of the VAR. Following Mills and Mills (1991) and Brooks and Tsolacos (1999:146), two orderings were adopted, which are exactly the opposite of each other. For instance, in the case of OHPR, the orderings are as follows:

Order I: OHPR, D(DIV), LMP, D(LRER), D(EINF), D(IRSA), D(IRUS), ISP, UNINF
Order II: UNINF, ISP, D(IRUS), D(IRSA), D(EINF), D(LRER), LMP, D(DIV), OHPR

As is the case with the findings by Mills and Mills (1991:277), results from the two orderings were very similar especially in the case of impulse responses, hence only the results of ORDER I are reported for both impulse responses and variance decompositions[38]. The results for impulse responses of house price returns are reported in Figure A5 in the appendix. The level of significance of the impact of a shock to each variable on house price returns was determined by calculating the t-statistics at each period where the influence was at its peak. The t-statistics are reported in Table 5.4 below. The summary of the variance decomposition results for Model A to D are presented in Table 5.5 below.

[38] In the case of variance decompositions, only ORDER I results are reported for consistency reasons with impulse responses and to avoid unnecessary duplication in interpretation although the proportions differ slightly between the two orderings. Furthermore, the aim is to determine the proportion of the variation in property returns that result from the shocks to each variable and not how the proportions change between the two orderings.

Table 5.4: Computed t-statistics for impulse response of house price returns

	DIV	LMP	LRER	EINF	IRSA	IRUS	ISP	UNINF	INF
Model A	-1.44 [7]	1.49 [3]	1.97^{b} [6]	-1.69^{c} [6]	-2.57^{a} [6]	1.14 [6]	2.55^{b} [7]	0.99 [16]	
Model B	-0.45 [5]	2.27^{b} [5]	2.81^{a} [6]		-2.37^{b} [6]	0.80 [8]	1.17 [7]		-1.05 [6]
Model C	-1.80^{c} [4]	1.67^{c} [2]	1.80^{c} [5]	-1.40 [3]	-3.03^{a} [4]	0.95 [3]	2.60^{a} [4]	1.20 [13]	
Model D	-1.31 [4]	2.17^{b} [3]	1.69^{c} [4]		-1.95^{c} [5]	-0.90 [11]	1.92^{c} [5]		-1.54 [2]

Note: Model A shows the response of OHPR to a shock to each of the explanatory variables excluding INF. Model B represents the response of OHPR to a unit shock to each variable excluding EINF and UNINF. Model C shows the response of HPR to each variable excluding INF. Model D represents the response of HPR to shocks to each variable excluding EINF and UNINF. The t-statistics were obtained by dividing the generalised impulse response by its standard error. [ ] represents the period at which the highest impact of the variable on house price returns is shown. ^{a} denotes significance at 1% level, ^{b} denotes significance at 5% level and ^{c} denotes significance at 10% level. The critical values used are: 1%=2.576, 5%=1.960 and 10%=1.645.
Source: Based on estimations by the author.

By and large, the impulse response results for house price returns show that actual inflation, foreign interest rate and unexpected inflation do not significantly impact on house price returns although their respective variance decompositions suggest that the proportion of variation in house price returns attributed to a shock in each of these variables gradually increased over time. This result confirms the block exogeneity test results in the case of INF and IRUS. The result of insignificant influence of actual and unexpected inflation on property returns is consistent with the finding of Chan *et al.* (1990), Ling and Naranjo (1997) and Brooks and Tsolacos (1999). The following discussion focuses on the interpretation of the results for the variables that show a significant effect on house price returns.

The impulse responses in Figure A5 and the t-statistics in Table 5.4 above show that the domestic interest rate has a negative and significant impact on house price returns at least at the 10% level. Cho and Ma (2006:183) also find a negative relationship between the nominal interest rate and house prices in Korea using cointegration tests and spectral analysis. Furthermore, Lizieri and Satchell (1997b) found a negative relationship between interest rate and UK property prices using a Threshold autoregressive (TAR) model. Clarke and Daniel (2006:31) also find that interest rates negatively influence house price growth rates in South Africa using a regression model.

Table 5.5: Variance decomposition results for house price returns

Variance decompositions for OHPR: Model A										
	SE	OHPR	D(DIV)	LMP	D(LRER)	D(EINF)	D(IRSA)	D(IRUS)	ISP	UNINF
Period:1	0.08	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.50	67.39	2.87	0.04	6.02	0.04	8.11	1.43	14.04	0.05
12	0.62	52.68	4.13	0.06	6.12	0.08	13.57	4.33	18.66	0.37
18	0.71	53.02	3.91	0.13	5.13	0.06	11.47	4.05	19.45	2.78
20	0.71	52.44	3.81	0.15	5.17	0.06	11.21	4.01	19.39	3.76
24	0.74	52.16	3.58	0.22	5.05	0.06	10.54	3.76	18.69	5.95
Variance decompositions for OHPR: Model B										
	SE	OHPR	D(DIV)	LMP	D(LRER)	D(INF)	D(IRSA)	D(IRUS)	ISP	
Period:1	0.08	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6	0.52	73.26	0.31	1.99	11.66	0.92	4.21	0.28	7.36	
12	0.63	61.40	0.55	1.97	16.72	3.19	6.17	1.48	8.52	
18	0.72	62.59	0.57	1.55	18.69	3.48	5.18	1.36	6.60	
20	0.74	62.20	0.60	1.69	18.27	3.37	5.78	1.67	6.42	
24	0.77	62.05	0.54	1.98	16.81	3.07	6.93	2.69	5.93	
Variance decompositions for D(HPR): Model C										
	SE	D(HPR)	D(DIV)	LMP	D(LRER)	D(EINF)	D(IRSA)	D(IRUS)	ISP	UNINF
Period:1	0.07	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.17	66.99	4.38	0.31	3.75	0.27	7.17	2.58	14.44	0.11
12	0.20	65.94	4.75	0.24	5.62	0.29	6.18	2.73	12.90	1.35
18	0.21	63.16	5.16	0.25	6.71	0.27	6.17	2.66	12.90	2.72
20	0.21	62.52	5.16	0.25	6.89	0.27	6.28	2.91	12.88	2.83
24	0.22	62.46	5.16	0.26	6.78	0.27	6.20	2.92	12.89	3.07
Variance decompositions for D(HPR): Model D										
	SE	D(HPR)	D(DIV)	LMP	D(LRER)	D(INF)	D(IRSA)	D(IRUS)	ISP	
Period:1	0.07	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6	0.16	74.17	3.00	1.44	5.53	0.93	4.61	0.24	10.09	
12	0.20	67.68	5.39	1.87	6.14	1.07	5.50	1.34	11.02	
18	0.21	64.33	5.90	1.76	7.90	1.38	6.88	1.31	10.54	
20	0.22	63.41	5.82	1.93	7.89	1.36	7.37	1.59	10.63	
24	0.22	63.34	6.01	1.97	7.89	1.39	7.23	1.67	10.49	

Note: See note to Table 5.4 above for a description of models estimated.
Source: Based on estimations done by the author.

The variance decompositions show that shocks to IRSA contribute a relatively larger proportion of the variation in house price returns than other variables. For example, Table 5.5-Model A shows that IRSA explains about 14% of the variation in OHPR after 12 months and about 11% after 24 months. However, the block exogeneity test results show that all the lagged values of IRSA have no explanatory power for house price returns, while variance decompositions show that shocks to IRSA significantly explain the variation in house price returns. This implies that IRSA has a contemporaneous effect on house price returns. This finding is consistent with Joshi (2006:85) who finds that the interest rate explains a larger proportion of the variation of house prices in India using a structural VAR model.

The finding of a negative effect of domestic interest rate on house price returns implies that rising domestic interest rates encourage postponement of durable purchases, which includes purchasing of houses since housing is a durable asset. An increase in the domestic interest rates also leads to high mortgage repayments, which in turn, reduces the affordability and the demand for property. This ultimately results in the decrease in house prices and returns. Furthermore, the results may imply that, as with other assets, house prices are responsive to the return on other financial assets. For instance, if interest rates increase, the return on investing in the money market rises and asset holders will reallocate their portfolios by investing more in this market than in the housing property market given the illiquid nature of property. This will lead to a fall in house prices and returns. Another implication is that tight monetary policy reduces house prices and returns by increasing the burden of variable interest rates to such an extent that many people sell the houses in order to pay back the principal. Therefore, it is evident that the tight monetary policy that has been applied by the South African Reserve Bank since June 2006 may contribute significantly to the downward pressure on the housing property market in South Africa. In other words, it can be concluded that rising interest rates may result in the underdevelopment of the housing property market in South Africa as investors may not be attracted to the market due to increased mortgage repayments.

House price returns appear to respond positively and significantly, at least at the 10% level of significance, to shocks in the real effective exchange rate. This is shown in the impulse response results in Figure A5 in the appendix and Table 5.4 above. The variance decomposition results suggest that shocks to LRER explain a relatively large proportion of changes in house price returns, especially in Model B in which LRER has its highest impact (for instance, after 6 months it was nearly 12% and it rose to about 19% in the eighteenth month). The difference between these variance decomposition results and the block exogeneity tests, which show that all the lagged values of LRER do not significantly explain house price returns, suggests that LRER has a contemporaneous effect on house price returns (Brooks and Tsolacos, 1999:147). This result of a positive influence of real effective exchange rate on the housing property market conflicts with Standish *et al.* (2005:44) and

Clarke and Daniel (2006:31) who find a negative relationship between real exchange rate and house prices in South Africa. Standish *et al.* (2005:44) state that this result suggests that investors hedged the inflationary consequence arising from the depreciation of the Rand by investing in the housing property market.

The results of this study suggest that a positive shock to LRER (an appreciation of the Rand) leads to local investors becoming more attracted to the buying of houses. Furthermore, an appreciation of the Rand may imply a fall in housing construction costs, inflation and interest rates, which may boosts domestic demand for property, *ceteris paribus*. On the other hand, foreign investors may be discouraged from buying houses in South Africa due to appreciation of the Rand. Therefore, the net effect will be a rise in house prices and returns assuming that the increase in domestic demand for property outweighs the decrease in foreign demand for houses. Thus, the positive effect of the real effective exchange rate on the house price returns might have arisen from the relatively strong Rand, on average, over most of the period covered in this study. However, the weakening of the Rand over time and the consequent rise in inflation and interest rates during recent years, especially between June 2006 and June 2008, may dampen the demand for property. This may lead to underdevelopment of the property market in the future.

Interest rate spread has a significant positive impact (at least at the 10% level, except in Model B where it was insignificant) on house price returns and this is shown by the impulse response results in Figure A5-Model A to D in the appendix and Table 5.4. The variance decomposition results reported in Table 5.5 show that ISP explains the largest proportion of the variation in house price returns (except in Model B). For instance, ISP explains a minimum of 10% of the variation in house price returns even after two years (24 months), as shown in Models A, C and D. The result of the significant positive influence of ISP on house price returns is consistent with Chan *et al.* (1990) who find a positive and significant effect of term structure return on equity REIT in USA.

The findings imply that an increase in interest rate spread (an upward sloping yield curve) leads to investors expecting an expansion in the economy. This may boost business confidence which will positively influence consumer spending on goods (including durable goods such as housing) and services as well as causing an increase in the level of occupants' willingness to pay as people become more confident about the economy. In addition, more local and foreign investors will be attracted to pursue more investment opportunities including purchasing houses. This will ultimately increase the demand for housing which increases house prices and returns. However, given the direct relationship between house price returns and ISP, the continuous rise in short-term interest rates since June 2006 (which may cause the yield curve to invert) may lead to an opposite effect on the housing property market.

Manufacturing production impacts positively and significantly (at the 5% level) on house price returns when the actual inflation variable is included in the models (see Figure A5-Model B and D in the appendix and Table 5.4). This result conflict with Ling and Naranjo (1997), McCue and Kling (1994) and Chan *et al.* (1990) who find no significant effect of industrial production on property returns. However, the associated variance decompositions reported in Table 5.5 indicate that LMP explains a very low proportion (nearly 2%) of the variation in house price returns. The insignificant variance decomposition vis-à-vis the block exogeneity test, which is significant, suggests that LMP has a lagged effect on house price returns. A lagged effect of LMP on price return is not unexpected given that a growth in output may not manifest instantly on the demand for housing. However, in the long-run an increase in manufacturing production will cause an increase in economic growth and demand for property which ultimately will increase house prices and returns, *ceteris paribus*. This is evident in South Africa where the housing property market performed very well from 2000 to 2005, a period coinciding with rising manufacturing production and economic growth. However, the housing property market has experienced decreasing real house price growth since 2006, a period coinciding with generally falling manufacturing production and reduced economic growth.

The shocks to expected inflation negatively and significantly affect OHPR at the 10% level but not HPR. The related variance decompositions show that EINF explains less than 1% of the variation in OHPR. This suggests that relative to the other variables in the model, EINF has a relatively weaker effect on house price returns. However, the significance of impulse response and the block exogeneity do suggest that a rise in inflation expectations will lead to investors expecting interest rates to increase, especially in an economy like South Africa where inflation is targeted. This will lead to investors being discouraged from buying houses; hence house prices and returns will fall in the future, *ceteris paribus*.

Dividend yield also has a significant negative effect relationship with HPR and not OHPR at the 10% level (see Figure A5-Model C in the appendix and Table 5.4). The associated variance decomposition results shown in Table 5.5-Model C show that DIV explains about 5% of the variation in HPR and the proportion of the influence remains constant after 18 months. These findings imply that a decrease in the dividend yield leads to capital switching into the housing property market in pursuit of higher profits. This will mean a rise in the demand for housing which will ultimately increase house prices and returns, *ceteris paribus*. Therefore, investors substitute investment in other asset classes with investment in the property market.

In general, the impulse response and variance decomposition results show that house price returns are influenced more significantly by their own shocks than by shocks to other variables. When house price returns respond positively and significantly to their own shocks, this may imply that investors are buying and re-selling property based on the expectation of higher prices and returns. On the other hand, a negative response of house price returns to their own shocks implies that people are buying and holding property. Another possible explanation in line with Brooks and Tsolacos (1999:146) is that house price returns are influenced more significantly by their own shocks suggesting that new information is gradually revealed in house prices and that current house price returns may have predictive power for future returns. Although Brooks and Tsolacos (1999:146) used this explanation in relation to orthogonalised real estate returns, it could be possible that the explanation also applies in this case.

5.4 CONCLUSION

This chapter reported and discussed the results of the influence of selected macroeconomic and financial variables on property returns. The first part of the chapter reported and discussed the unit root test results as a preliminary step for VAR analysis. This was then followed by the discussion of lag length selection which was done based on information criteria and diagnostic serial correlation tests. A total of eight models were estimated, namely four based on house price returns and the other four on real estate returns.

By and large, most of the explanatory variables used in this study do not influence real estate returns; the exceptions are the domestic interest rate and dividend yield which have a negative effect on real estate returns. The weak explanatory power of the variables could be because of the strong effect of the stock market on real estate returns. Other possible factors could be capitalisation rates and rents which were not explored in this study due to data limitation.

House price returns respond more to the macroeconomic and financial variables used in this study. The real effective exchange rate, interest rate spread and manufacturing production positively impact on house price returns while the domestic interest rate, dividend yield and expected inflation have a negative effect. Furthermore, manufacturing production has a lagged effect on house price returns while the real effective exchange rate and domestic interest rate have a contemporaneous effect. Lastly, it is important to note that the domestic interest rate and dividend yield affect both real estate returns and house price returns and the effects are negative. The implications of these findings are highlighted in the concluding chapter.

CHAPTER 6

SUMMARY OF FINDINGS, RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH

6.1 SUMMARY OF MAJOR FINDINGS

This study examined the impact of macroeconomic and financial variables on the performance of the housing property market in South Africa using monthly data for the period January 1996 to June 2008. Three main issues were empirically analysed in relation to the linkages between selected variables and the housing property market. The first aspect examined the relationship between selected macroeconomic and financial factors and property returns. Secondly, the study examined the influence that a unit shock to each variable has on property returns over a period of time. The third aspect focused on determining the proportion of property returns variation that results from changes in the macroeconomic and financial variables. VAR modelling was thus adopted to analyse the three stated aspects empirically.

The results using house price returns performed better than those using real estate returns. The results show that most of the macroeconomic and financial variables used in this study do not influence the real estate returns except for the domestic interest rate and dividend yield which have a negative effect. The weak explanatory power of the variables suggests that real estate returns may be explained by property market-related factors such as capitalisation rates and rents which were not explored in this study and that the stock market has a strong influence on real estate returns.

The results relating to house price returns reveal that house price returns are influenced by most of the macroeconomic and financial variables used in this study. Specifically, the domestic interest rate, dividend yield and expected inflation negatively affect house price returns while the real effective exchange rate, interest rate spread and manufacturing production have a positive effect. Furthermore, the real effective exchange rate and domestic interest rate have a contemporaneous effect on house price returns while manufacturing production has a lagged effect. Lastly, the results reveal that the domestic interest rate and dividend yield are the two factors that affect real estate returns and house price returns and the effect is negative in both cases.

6.2 POLICY IMPLICATIONS AND RECOMMENDATIONS

From the discussion in this study, certain policy implications arise. The first implication of the study is that changes in macroeconomic and financial variables affect the general performance of the housing property market in South Africa. Therefore, trends and developments in the macroeconomic environment must be continuously and closely monitored to determine how such developments affect the property market in terms of property prices and returns. For instance, changes in the domestic interest rate, expected inflation and dividend yield impact negatively on house price returns while the real effective exchange rate, interest rate spread and manufacturing production have a positive influence. Therefore, the knowledge of this underlying relationship between the macroeconomic variables and the housing market will help investors to monitor effectively the developments in the macroeconomic environment and the implications thereof for property prices and returns. This will further assist investors in investment decision-making.

Secondly, the result that the domestic interest rate significantly and negatively impacts on the housing property market implies that monetary policy stance (expansionary or contractionary) will impact significantly on the housing market. It is therefore recommended that an appropriate level of interest rates is called for since interest rates that are too high will not be favourable for the development of the housing property market while interest rates that are too low may lead to house prices rising to levels that may cause a bubble in the housing market which could have a negative impact on the property market and the economy if it bursts. Furthermore, maintaining an appropriate balance of the interest rates is necessary as this will cause the interest rate spread to be positive which will contribute to the development of the housing property market. Thirdly, exchange rate stability must be ensured as this will attract more investors into the property market which will lead to its continued and sustainable development. Finally, managing inflation so that expectations are not high is important. Therefore, efforts of the Monetary Policy Committee to keep inflation expectations in check are a step in the right direction.

6.3 LIMITATIONS OF THE STUDY AND AREAS FOR FURTHER RESEARCH

This study was limited by the unavailability of monthly data for property market-related variables such as capitalisation rates and rental rates that might have a significant influence on the housing property market, especially the real estate returns. The inclusion of these variables may possibly improve the findings of this study. Therefore, future research could be done using property market-related factors rather than macroeconomic or financial factors. This may call for lower frequency time series as opposed to the monthly series.

Furthermore, the time frame and frequency of data used in this study limited the macroeconomic variables considered to have impacted on the housing property market. Such macroeconomic variables include unemployment series and measures of aggregate economic activity, such as GDP. The use of such low frequency series will require the scope of the analysis to cover a longer period than the current study has done. An implication of using longer time frame will be the possibility of structural breaks which the current study tried to minimise.

While this study focused on the South African housing property market, similar studies could be undertaken focusing on other developing countries and the results compared with those of the present study, since there is very limited research of this nature in the case of developing countries. In addition, research could be done on what causes property returns to respond to their own shocks. Further, since this may have implications for information efficiency in the housing property market, more research could be done using the Efficient Market Hypothesis to determine how efficient the housing property market is.

The limitations stated above do not however nullify the importance of this study but only reveal other important issues that can be considered in future studies on the property market of South Africa.

APPENDIX

Table A1: Summary of studies on the relationship between the macroeconomic and financial variables and the housing property market

Author and Year	Country cover	Period	Method used	Measure of housing property market used	Macroeconomic and financial variables used	Summary of findings
Chan *et al.* (1990)	USA	1973-1987	Multifactor Arbitrage Model	Thirty equity REITs traded on the NYSE, AMEX and NASDAQ indexes	Changes in expected inflation and industrial production, the risk and term structure return factors, and unexpected inflation.	Mixed: The equity REIT and NYSE indexes are significantly positively related to the risk and term structure return factors. The indexes are also systematically negatively (although not always statistically significantly) related to unexpected inflation. Both REIT and NYSE indexes are significantly positively related to changes in expected inflation in the 1980s, but unrelated (with negative coefficients) in the 1970s.
McCue and Kling (1994)	UK		Vector autoregressive model (VAR)	Equity REITs	Inflation, interest rates, output, and investment.	Mixed: The selected macroeconomic factors explained about 60% of the variation in the equity REITs series. Nominal interest rates are negatively related to equity REITs and have the most statistically significant influence. Industrial output explained very little of the variation of the equity REITs series.
Lizieri and Satchell (1997a)	UK	June 1972 - May 1992.	Granger causality tests and two sector analytic model	Financial Times Property Sector Index	Financial Times All Share index	Positive and negative coefficients: the All share index index positively and negatively affects the property sector index.
Ling and Naranjo (1997)	USA	1978Q1-1994Q4	Multi-factor asset pricing model	Commercial real estate returns	The growth rate in real per capita consumption, the real Treasury Bill rate, the term structure of interest rates and unexpected inflation.	The selected macroeconomic variables systematically impact on real estate returns.

Brooks and Tsolacos (1999)	UK	December 1985-January 1998	Vector autoregressive model (VAR)	Real estate returns	Interest rate spread, unanticipated inflation, unemployment rate, nominal short-term interest rate and the dividend yield	Mixed: interest rate spread and unanticipated inflation depict a contemporaneous effect on property returns. Unemployment rate, nominal short-term interest rate and the dividend yield do not have a systematic influence on the variation of the orthogonalised property returns series.
Abraham and Hendershott (1993)	30 US metropolitan areas	1977-1992	Copazza-Helsley (1989, 1990) urban model	Annual house price indices	Real income growth, real construction cost inflation and changes in real after tax interest rates	The selected variables explain about 50% of the variation in real house price inflation.
Abraham and Hendershott (1996)	30 US metropolitan areas	1977-1992	Copazza-Helsley (1989, 1990) urban model	Annual house price indices	The growth in real income, real construction costs and changes in the real after-tax interest rate, lagged real house price appreciation and the difference between the actual and equilibrium real house price levels.	Each of the two groups of factors explain a little above 40% of the variation in real house price movements in thirty metropolitan areas. When combined, the two groups explain about 60% of the variation.
Lizieri and Satchell (1997b)	UK	1975-1995	Threshold autoregressive (TAR) model	Property company returns	Real interest rates	Positive and negative: During periods of relatively high interest rates, property share prices fall sharply and reveal little volatility. However, during periods of relatively low interest rates, price movements are more volatile.
Kim (2004)	Korea	1970-2002	Granger causality tests	House prices	Consumer spending and inflation	Causality runs in both directions between house price increases and inflation
Cho and Ma (2006)	Korea	1991-2002	Granger causality tests, spectral analysis and transfer function model	House prices	Nominal interest rates	One-way causality from the interest rate to the growth rate of house prices.

Edelstein and Tsang (2007)	4 US cities	1988–2003	Two equation system	House prices	Employment growth, unanticipated employment growth, state income growth, interest rates and national changes in construction costs.	Positive: employment growth and unanticipated employment growth have a stronger impact on residential housing markets state income growth and national changes in construction costs. Interest rates were found to be significant and positively related to housing supply.
Joshi (2006)	India	April 2001 - June 2005	Structural VAR model	House price index	Interest rates, credit growth and income growth	House prices are significantly much more sensitive to permanent interest rate shocks than shocks to credit growth.
Standish *et al.* (2005)	South Africa	1974- 2003	National house price model	House price index	real interest rates, gross national income (GNI), household debt to income, net migration, crime, capitalisation of the JSE, the nominal exchange rate, tourism, the real effective exchange rate, and foreign direct investment.	Negative coefficients: nominal and real exchange rate, ratio of household debt to disposable income and real capitalisation on the JSE. Positive coefficients: foreign direct investment and real price of gold.
Clark and Daniel (2006)	South Africa	1980Q1-2006Q4	Linear regression model	House price index	JSE All-Share Index, the prime rate of interest, real GDP, building plans, business confidence, motor vehicle sales, household debt to disposable income, the Rand/Dollar exchange rate, gold and oil prices, and transfer costs	Lagged stock market returns, real GDP, the interest rate, the Rand/Dollar exchange rate and transfer costs are the key drivers of the South African housing property market.

Note: REITs means real estate investment trusts and NYSE denotes New York Stock Exchange.

Table A2: Results for regressing HPR on ASR

Dependent Variable: HPR
Method: Least Squares
Date: 09/03/08 Time: 15:21
Sample: 1996M01 2008M06
Included observations: 150

	Coefficient	Std. Error	t-Statistic	Prob.
C	1.142580	0.057192	19.97792	0.0000
ASR	-0.002815	0.009243	-0.304510	0.7612

R-squared	0.000626	Mean dependent var	1.139364
Adjusted R-squared	-0.006126	S.D. dependent var	0.686311
S.E. of regression	0.688410	Akaike info criterion	2.104379
Sum squared resid	70.13842	Schwarz criterion	2.144521
Log likelihood	-155.8284	Hannan-Quinn criter.	2.120688
F-statistic	0.092726	Durbin-Watson stat	0.076814
Prob(F-statistic)	0.761167		

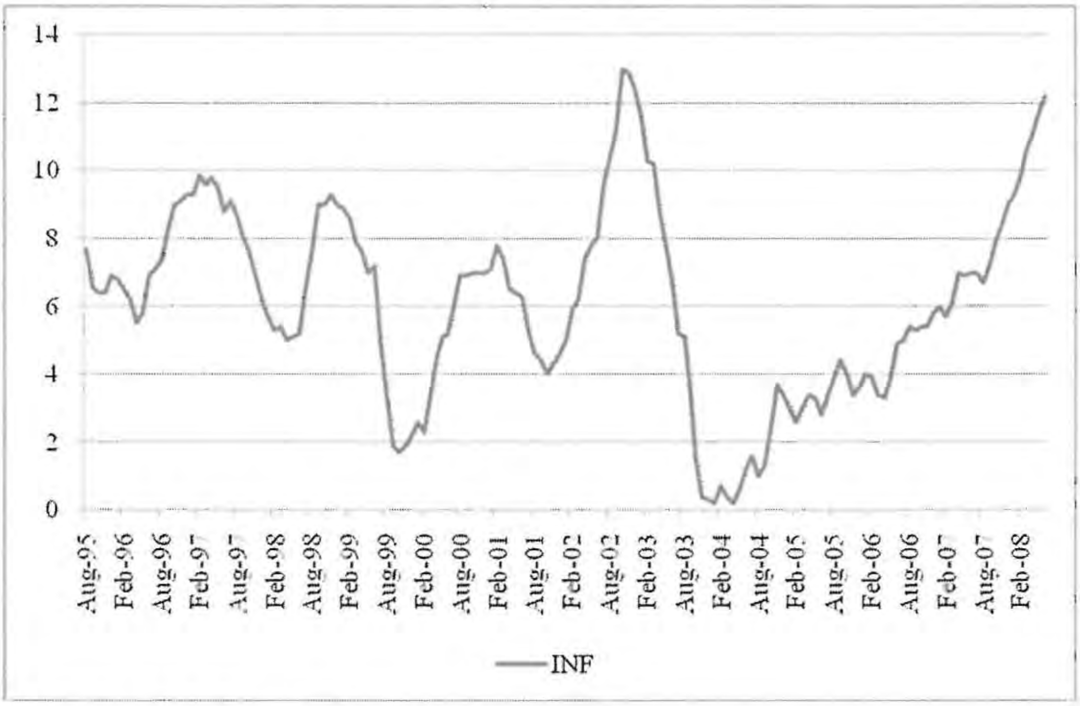
Table A3: Results for regressing RER on ASR

Dependent Variable: RER
Method: Least Squares
Date: 09/03/08 Time: 15:29
Sample: 1996M01 2008M06
Included observations: 150

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.249910	0.326247	0.766012	0.4449
ASR	0.397308	0.052728	7.534992	0.0000

R-squared	0.277259	Mean dependent var	0.703882
Adjusted R-squared	0.272376	S.D. dependent var	4.603674
S.E. of regression	3.926975	Akaike info criterion	5.586859
Sum squared resid	2282.327	Schwarz criterion	5.627001
Log likelihood	-417.0144	Hannan-Quinn criter.	5.603168
F-statistic	56.77611	Durbin-Watson stat	1.877744
Prob(F-statistic)	0.000000		

Figure A1: Graphical plot of INF



Data Source: Statistics South Africa (2008)

Table A4: Correlogram of INF in level terms

Date: 08/28/08 Time: 17:03
Sample: 1995M08 2008M06
Included observations: 155

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|*******</td><td>.|*******</td><td>1</td><td>0.956</td><td>0.956</td><td>144.41</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>**|. |</td><td>2</td><td>0.886</td><td>-0.327</td><td>269.18</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>*|. |</td><td>3</td><td>0.799</td><td>-0.150</td><td>371.47</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>*|. |</td><td>4</td><td>0.700</td><td>-0.135</td><td>450.47</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>*|. |</td><td>5</td><td>0.591</td><td>-0.120</td><td>507.07</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>*|. |</td><td>6</td><td>0.470</td><td>-0.156</td><td>543.14</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>7</td><td>0.347</td><td>-0.041</td><td>562.97</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>8</td><td>0.235</td><td>0.071</td><td>572.09</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>9</td><td>0.136</td><td>0.055</td><td>575.17</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>10</td><td>0.050</td><td>-0.001</td><td>575.59</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>11</td><td>-0.026</td><td>-0.036</td><td>575.71</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>12</td><td>-0.087</td><td>0.027</td><td>576.99</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|** |</td><td>13</td><td>-0.115</td><td>0.239</td><td>579.26</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>14</td><td>-0.123</td><td>-0.005</td><td>581.88</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>15</td><td>-0.121</td><td>-0.068</td><td>584.40</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|* |</td><td>16</td><td>-0.103</td><td>0.078</td><td>586.26</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>17</td><td>-0.076</td><td>-0.012</td><td>587.27</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>18</td><td>-0.042</td><td>-0.054</td><td>587.59</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>19</td><td>-0.006</td><td>-0.046</td><td>587.60</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>20</td><td>0.024</td><td>-0.036</td><td>587.70</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>21</td><td>0.042</td><td>-0.110</td><td>588.02</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>22</td><td>0.049</td><td>-0.058</td><td>588.47</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>23</td><td>0.049</td><td>-0.018</td><td>588.90</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>24</td><td>0.036</td><td>-0.058</td><td>589.15</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>25</td><td>0.009</td><td>-0.040</td><td>589.16</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>26</td><td>-0.029</td><td>-0.004</td><td>589.33</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>27</td><td>-0.074</td><td>-0.047</td><td>590.38</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>28</td><td>-0.127</td><td>-0.045</td><td>593.46</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>29</td><td>-0.183</td><td>-0.040</td><td>599.95</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>30</td><td>-0.240</td><td>-0.019</td><td>611.18</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>31</td><td>-0.294</td><td>-0.015</td><td>628.20</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>32</td><td>-0.341</td><td>0.000</td><td>651.22</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>*|. |</td><td>33</td><td>-0.380</td><td>-0.067</td><td>679.95</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>34</td><td>-0.409</td><td>-0.038</td><td>713.57</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|* |</td><td>35</td><td>-0.423</td><td>0.086</td><td>749.82</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>36</td><td>-0.422</td><td>-0.015</td><td>786.26</td><td>0.000</td></tr>
</table>

Table A5: Ranking of models using information criteria

Rank	AIC	SIC	HQIC
1	5, 0, 0	2, 0, 0	2, 0, 0
2	4, 0, 0	3, 0, 0	3, 0, 0
3	2, 0, 0	4, 0, 0	5, 0, 0
4	3, 0, 0	5, 0, 0	4, 0, 0
5	1, 0, 0	1, 0, 0	1, 0, 0

Table A6: Stationarity test in level terms on residuals of ARIMA models (2,0,0) and (3,0,0)

Residual series	KPSS test (critical value at 1% = 0.739)
ARIMA (2,0,0)	0.112697*
ARIMA (3,0,0)	0.107574*

Note:* shows that the residuals are stationary at 1% level.

Figure A2: Unit root circle for ARIMA (2,0,0)

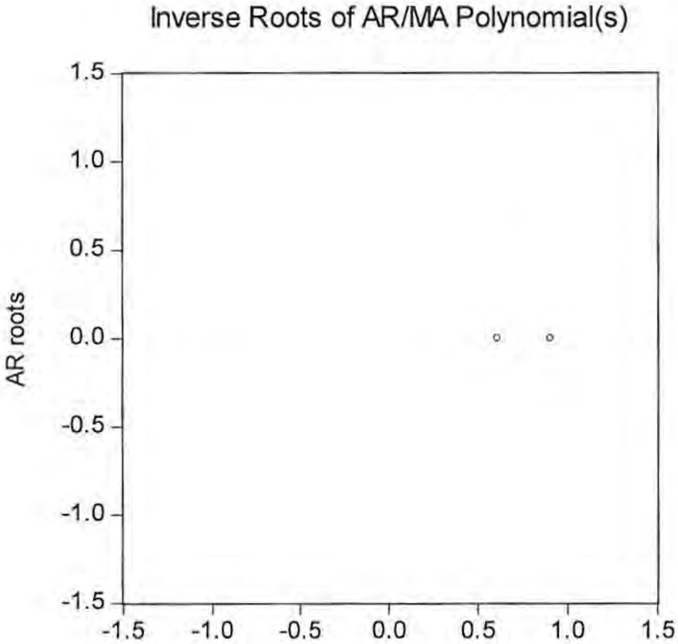


Figure A3: Unit root circle for ARIMA (3,0,0)

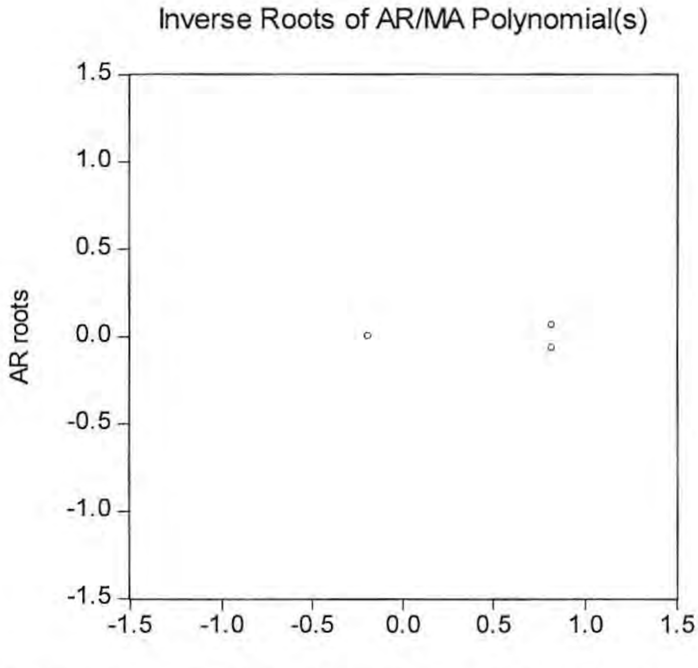


Figure A4: Graphical presentation of actual, expected and unexpected inflation

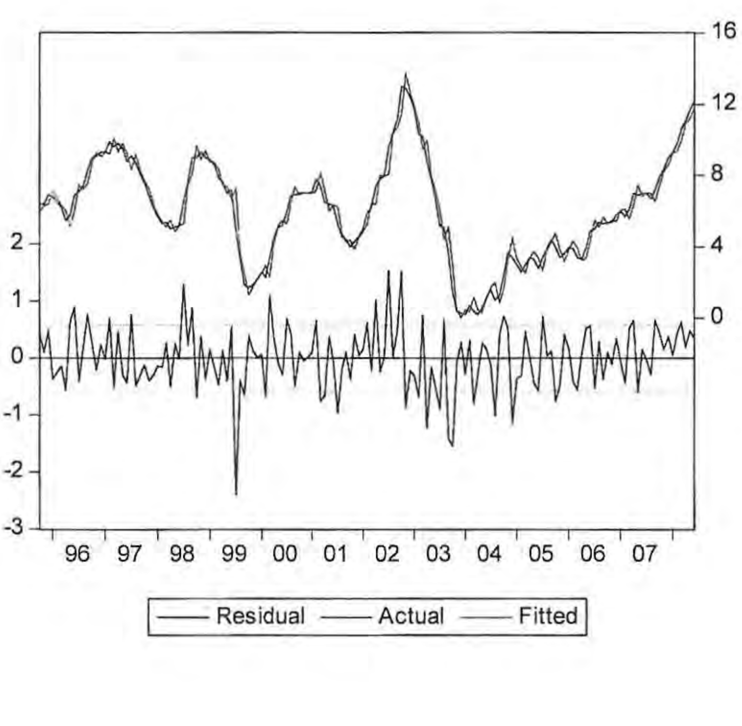


Table A7: Unit root test results

	OHPR	HPR	ORER	RER	INF	EINF	UNINF	ISP	DIV	LMP	LRER	IRSA	IRUS
ADF													
Level: Intercept	-2.58	-2.36	-11.40[a]	-10.54[a]	-1.4	-1.32	-5.01[a]	-2.61[c]	-2.68[c]	0.69	-2.37	-1.89	-2
Intercept & trend	-2.27	-1.91	-11.36[a]	-10.52[a]	-0.62	-0.67	-4.97[a]	-2.62	-2.62	-1.32	-2.31	-2.49	-2.18
First difference: Intercept	-3.53[a]	-4.53[a]	-10.91[a]	-10.75[a]	-4.70[a]	-6.45[a]	-4.51[a]	-8.48[a]	-12.08[a]	-15.90[a]	-10.14[a]	-7.50[a]	-3.72[a]
Intercept & trend	-10.70[a]	-4.81[a]	-10.93[a]	-10.75[a]	-5.04[a]	-6.67[a]	-4.57[a]	-8.46[a]	-12.06[a]	-15.99[a]	-10.11[a]	-7.49[a]	-3.69[b]
DF-GLS													
Level: Intercept	-2.01[b]	-1.76[c]	-10.46[a]	-10.55[a]	-1.35	-1.26	-2.78[a]	-2.47[b]	-1.57	2.29[b]	-0.93	-1.45	-1.58
Intercept & trend	-2.31	-1.95	-11.00[a]	-10.21[a]	-1.38	-1.27	-4.34[a]	-2.56	-2.11	-1.3	-1.75	-2.51	-2.18
First difference: Intercept	-2.81[a]	-3.67[a]	-12.67[a]	-16.36[a]	-3.63[a]	-4.56[a]	-1.64[c]	-6.81[a]	-9.09[a]	-2.77[a]	-8.84[a]	-7.46[a]	-3.06[a]
Intercept & trend	-3.16[b]	-4.05[a]	-10.55[a]	-9.77[a]	-5.00[a]	-6.31[a]	-2.26	-8.04[a]	-11.24[a]	-15.24[a]	-9.85[a]	-7.53[a]	-3.55[a]
PP													
Level: Intercept	-2.09	-2.1	-11.38[a]	-10.47[a]	-2.24	-2.38	-12.91[a]	-2.22	-2.65[c]	-0.06	-2.52	-1.66	-1.39
Intercept & trend	-1.85	-1.87	-11.33[a]	-10.45[a]	-2.09	-2.24	-12.88[a]	-2.25	-2.55	-3.52[b]	-2.47	-1.92	-1.63
First difference: Intercept	-2.91[b]	-2.67[c]	-59.59[a]	-52.89[a]	-6.67[a]	-10.76[a]	-73.20[a]	-8.37[a]	-12.46[a]	-23.16[a]	-10.06[a]	-7.25[a]	-8.25[a]
Intercept & trend	-2.85	-2.65	-73.93[a]	-58.23[a]	-6.71[a]	-10.78[a]	-73.46[a]	-8.35[a]	-12.48[a]	-24.66[a]	-10.04[a]	-7.19[a]	-8.23[a]
NP													
Level: Intercept	-12.6[b]	-7.2[c]	-72.9[a]	-73.2[a]	-4.1	-2.8	-55.5[a]	-12.3[b]	-4.9	2.4	-2.2	-4.4	-6.4[c]
Intercept & trend	-26.9[a]	-12.2	-73.8[a]	-72.4[a]	-4.3	-3	-54.6[a]	-13.4	-8.6	-3.9	-5.8	-14.1	-11.5
First difference: Intercept	-8.6[b]	-18.1[a]	-97.5[a]	-57.3[a]	-177.7[a]	-14.6[a]	-0.1	-59.7[a]	-55.1[a]	-1.4	-81.3[a]	-60.7[a]	-15.4[a]
Intercept & trend	-11.2	-22.6[b]	-2716.0[a]	-8074.5[a]	-8	-3.2	-0.3	-66.7[a]	-69.4[a]	-102.4[a]	-78.4[a]	-60.6[a]	-19.4[b]

Note: [a] denotes the rejection of a hypothesis of a unit root at 1% significance level; [b] denotes rejection of a hypothesis of a unit root at 5% significance level while [c] denotes rejection of the hypothesis of a unit root at 10% level. However, the 10% level was not considered in the criterion used in this study.
Source: Based on estimations by the author.

Table A8: Lag length selection using information criteria

Information criterion	Model A	Model B	Model C	Model D	Model E	Model F	Model G	Model H
AIC	Lag 12	Lag 12	Lag 12	Lag 12	Lag 12	Lag 12	Lag 12	Lag 12
SIC	Lag 3	Lag 1	Lag 3	Lag 1	Lag 3	Lag 1	Lag 3	Lag 1
HQIC	Lag 12	Lag 2	Lag 3	Lag 2	Lag 3	Lag 1	Lag 3	Lag 1

Table A9: VAR results

Model	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
	OHPR	OHPR	HPR	HPR	ORER	ORER	RER	RER
OHPR(-1)	1.958^{a}	1.940^{a}						
OHPR(-2)	-1.090^{a}	-1.007^{a}						
OHPR(-3)		-0.454^{b}						
OHPR(-4)	0.395^{a}	0.603^{a}						
D(HPR)(-1)			1.082^{a}	1.052^{a}				
D(HPR)(-3)			-0.542^{a}	-0.538^{a}				
D(HPR)(-5)				0.193^{b}				
D(DIV(-1))							-18.666^{b}	-19.360^{a}
D(DIV(-2))			-0.221^{c}	-0.279^{b}				
D(DIV(-3))	-0.368^{a}	-0.277^{a}			11.370^{c}			
LMP(-2)	-0.725^{c}		-0.856^{b}					
LMP(-5)		-0.924^{b}		-0.647^{a}				
D(LRER(-2))		0.547^{b}						
D(LRER(-3))			0.393^{c}					
D(IRSA(-1))					-2.390^{b}	-2.263^{b}	-2.585^{b}	-2.456^{b}
D(IRSA(-4))	0.030^{c}							
D(IRSA(-5))				0.036^{b}				
D(IRUS(-2))	0.083^{c}							
ISP(-1)	0.063^{a}		0.058^{a}	0.049^{b}				
D(INF)(-1))				-0.022^{a}				
C	0.169	0.625	0.132	0.777^{a}	7.121	-7.168	-18.378	-28.579

Note: ^{a} denotes significance at 1% level, ^{b} denotes significance at 5% level and ^{c} denotes significance at 10% level.

Source: Based on estimations by the author.

Figure A5: Impulse response results for house price returns

Figure A5-Model A

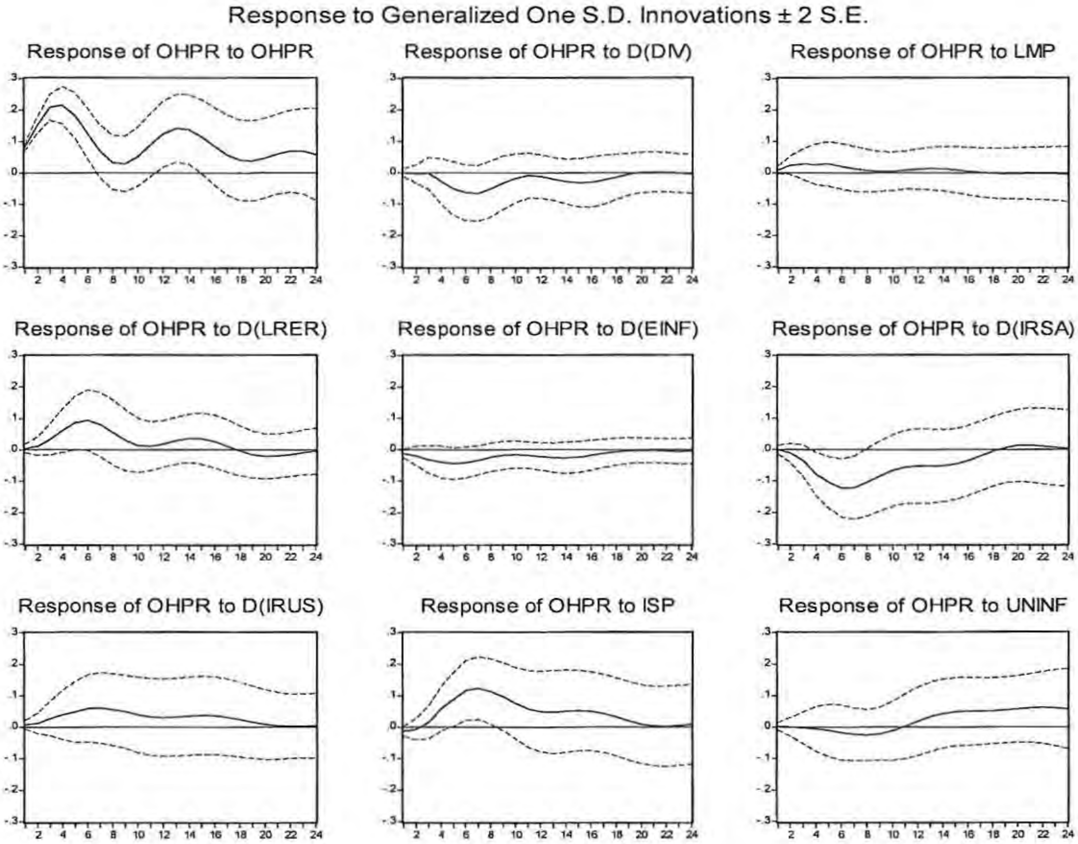


Figure A5-Model B

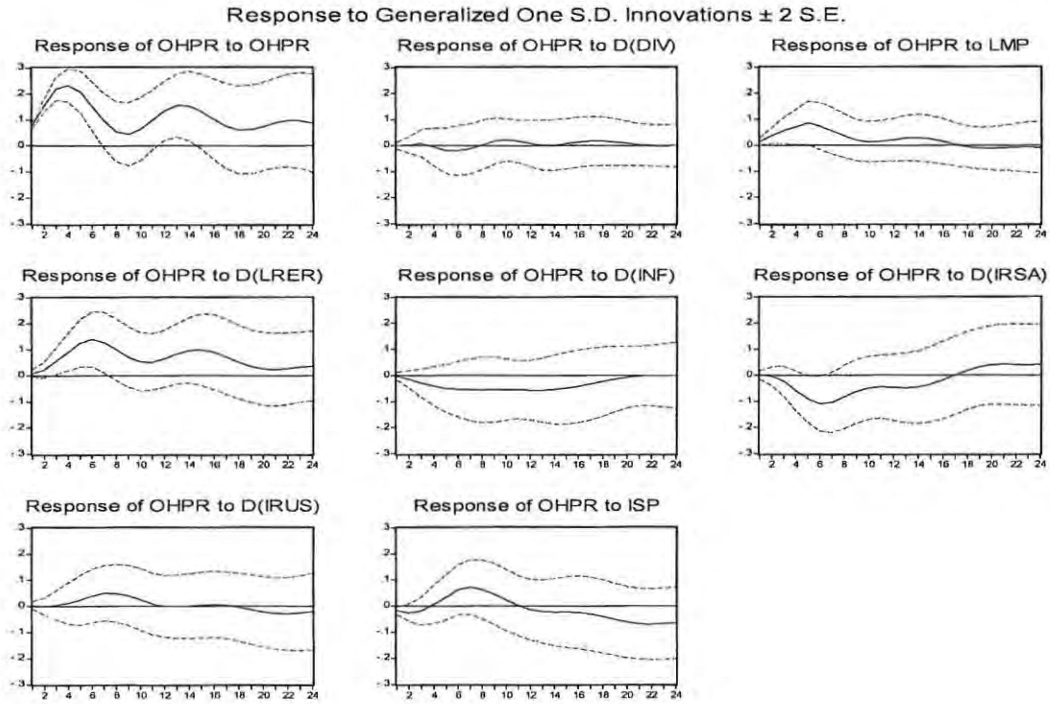


Figure A5-Model C

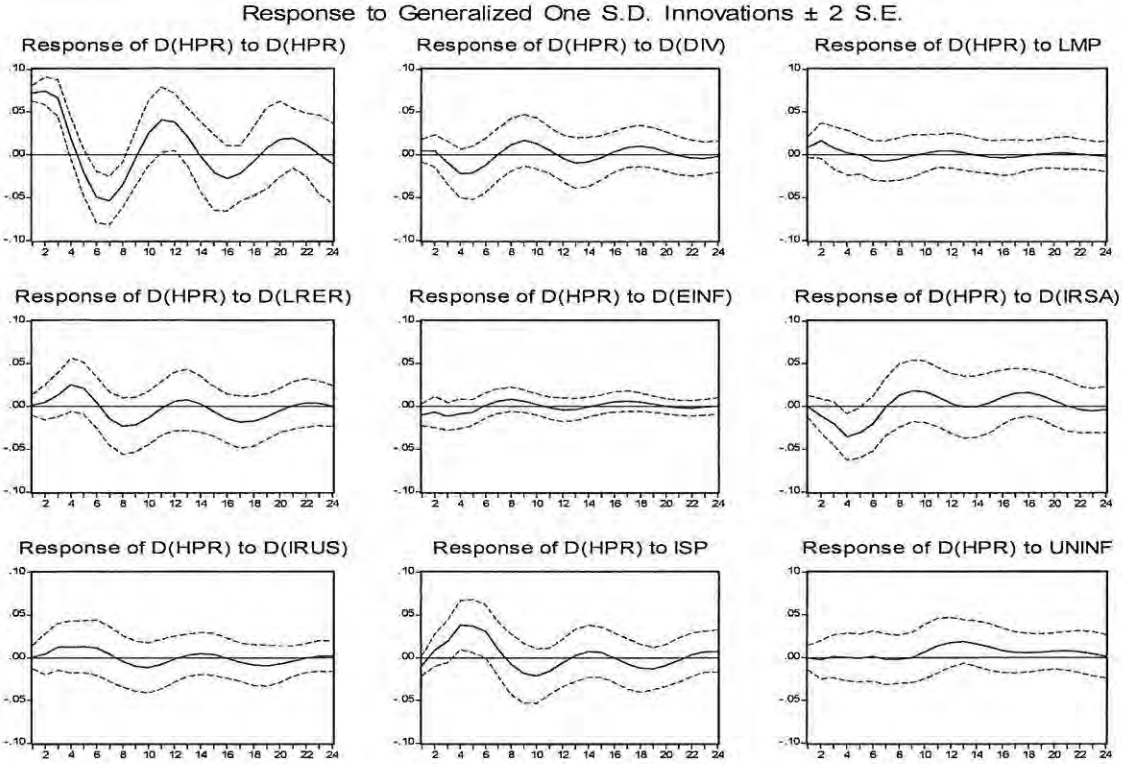


Figure A5-Model D

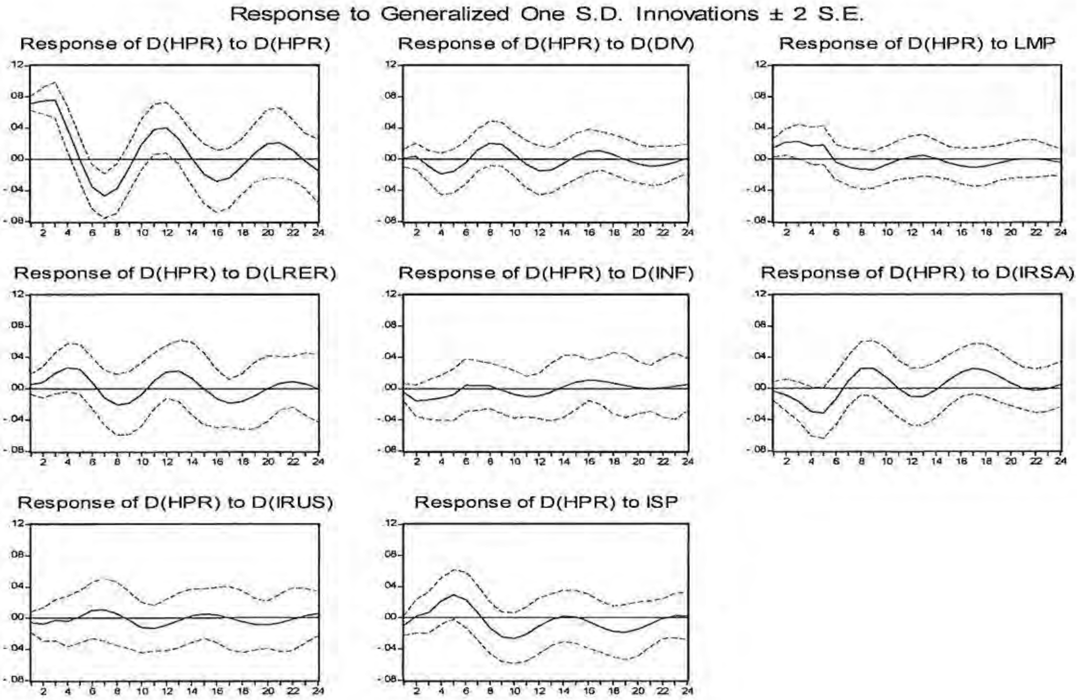


Figure A6: Impulse response results for real estate returns

Figure A6-Model E

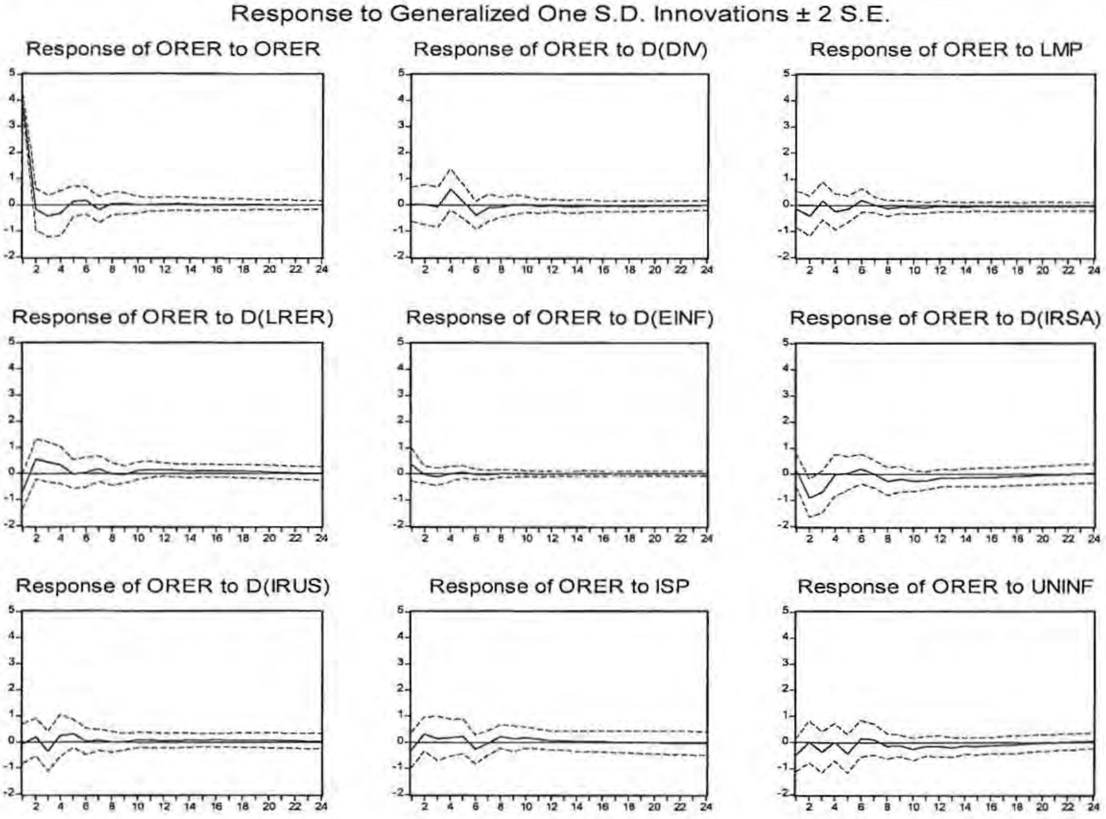


Figure A6-Model F

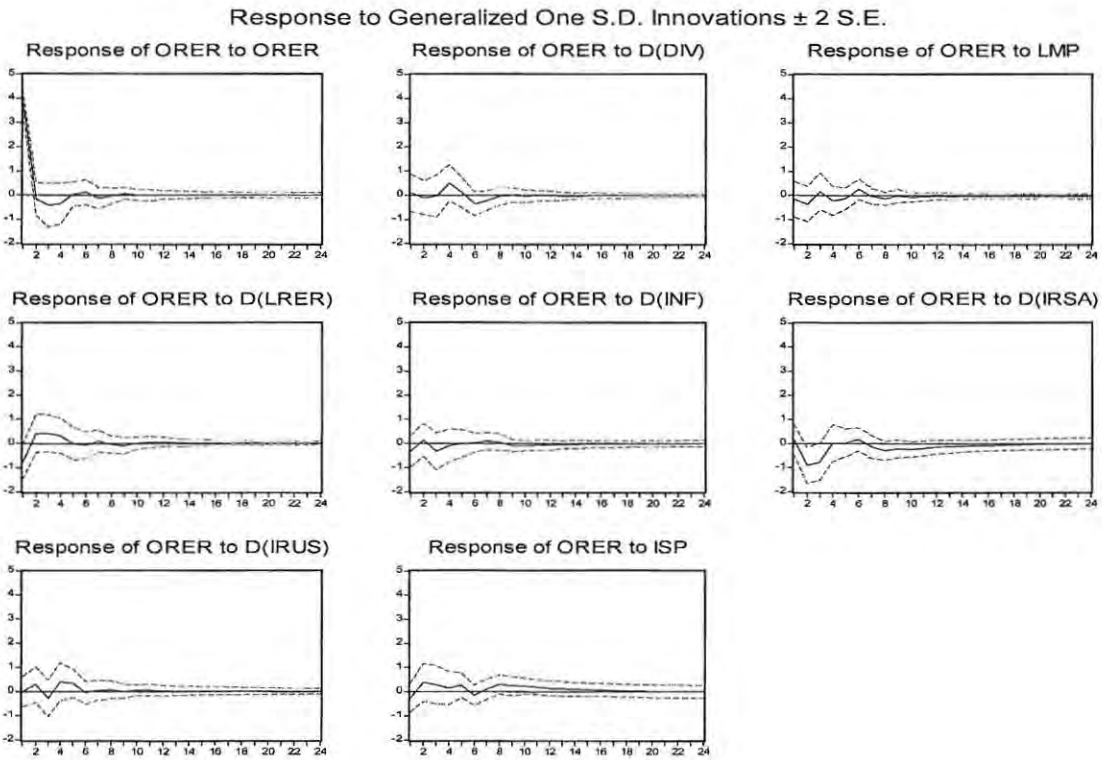


Figure A6-Model G

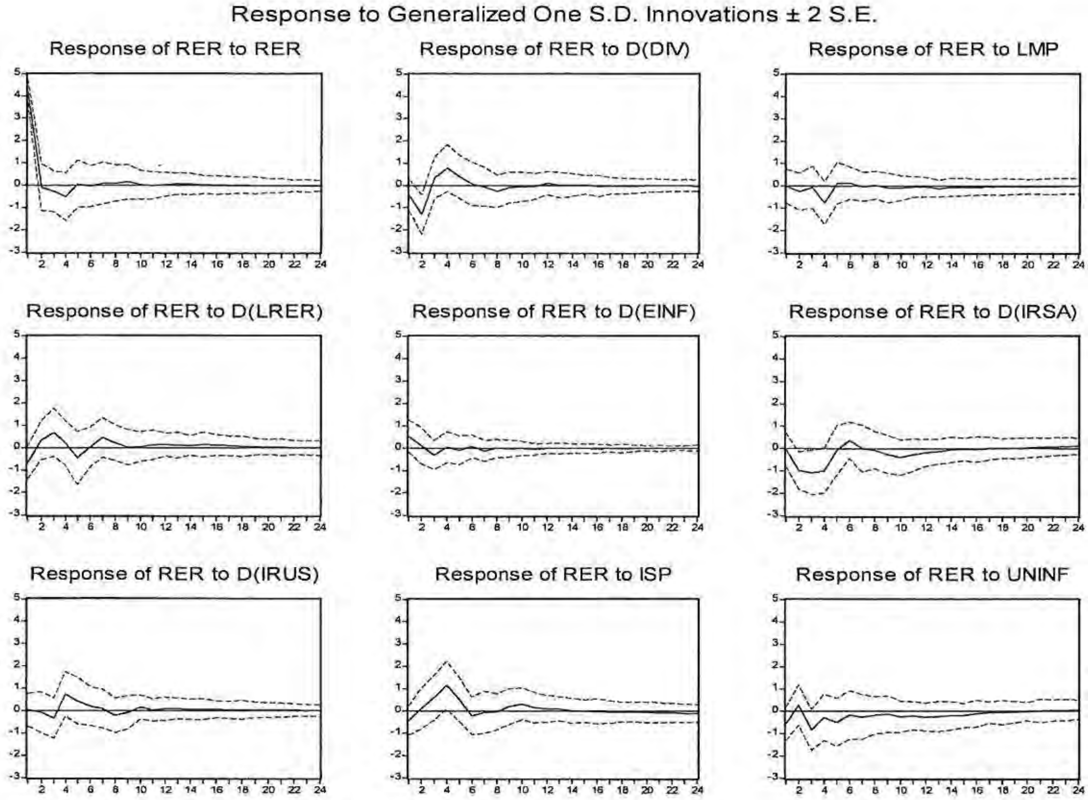


Figure A6-Model H

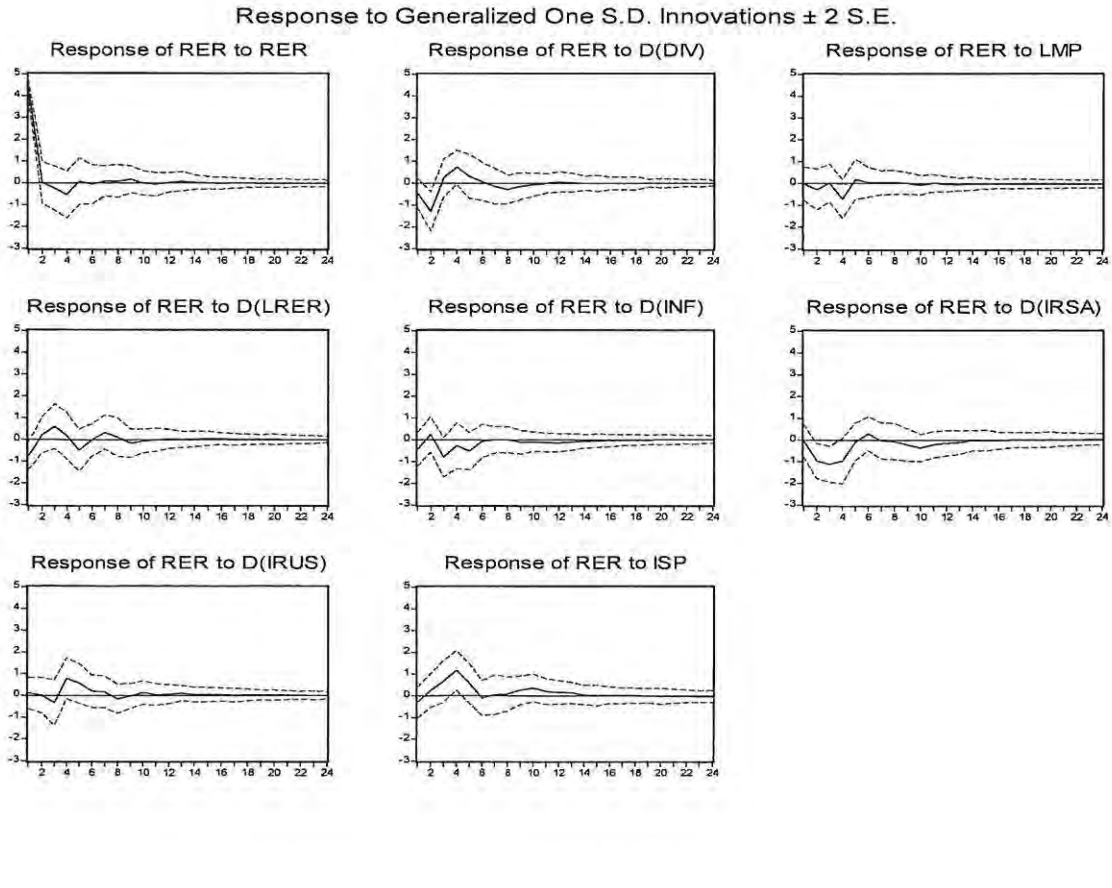


Table A10: Variance decomposition results for real estate returns

Variance decompositions for ORER: Model E											
		SE	ORER	D(DIV)	LMP	D(LRER)	D(EINF)	D(IRSA)	D(IRUS)	ISP	UNINF
Period:	1	3.81	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	4.26	81.89	2.94	1.42	2.99	0.02	5.77	1.66	1.59	1.72
	12	4.33	79.78	2.98	1.58	3.35	0.02	6.80	1.71	1.58	2.20
	18	4.36	78.73	3.02	1.67	3.70	0.02	6.91	1.78	1.57	2.60
	20	4.36	78.60	3.03	1.70	3.75	0.02	6.91	1.81	1.57	2.62
	24	4.36	78.48	3.04	1.74	3.76	0.02	6.91	1.83	1.58	2.62
Variance decompositions for ORER: Model F											
		SE	ORER	D(DIV)	LMP	D(LRER)	D(INF)	D(IRSA)	D(IRUS)	ISP	
Period:	1	3.84	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	6	4.25	83.60	2.29	1.39	2.08	0.78	6.49	2.14	1.22	
	12	4.31	81.43	2.52	1.58	2.14	0.96	7.70	2.29	1.38	
	18	4.31	81.10	2.54	1.65	2.15	1.00	7.83	2.32	1.41	
	20	4.32	81.07	2.54	1.67	2.15	1.00	7.83	2.32	1.41	
	24	4.32	81.04	2.54	1.70	2.16	1.00	7.83	2.32	1.41	
Variance decompositions for RER: Model G											
		SE	RER	D(DIV)	LMP	D(LRER)	D(EINF)	D(IRSA)	D(IRUS)	ISP	UNINF
Period:	1	4.23	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	5.22	66.85	9.21	2.56	2.59	0.49	10.51	4.26	1.13	2.40
	12	5.33	64.26	9.12	2.56	3.65	0.50	11.18	4.52	1.26	2.95
	18	5.36	63.62	9.12	2.64	3.95	0.50	11.11	4.51	1.26	3.37
	20	5.36	63.58	9.04	2.66	3.97	0.50	11.11	4.51	1.27	3.38
	24	5.37	63.47	9.02	2.67	3.97	0.50	11.21	4.51	1.29	3.38
Variance decompositions for RER: Model H											
		SE	RER	D(DIV)	LMP	D(LRER)	D(INF)	D(IRSA)	D(IRUS)	ISP	
Period:	1	4.21	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	6	5.19	67.00	8.48	2.48	2.18	3.71	9.61	5.43	1.11	
	12	5.28	65.04	8.65	2.44	2.72	3.82	10.20	5.61	1.53	
	18	5.28	64.89	8.63	2.45	2.74	3.87	10.21	5.67	1.54	
	20	5.28	64.89	8.63	2.45	2.74	3.87	10.21	5.67	1.54	
	24	5.28	64.87	8.63	2.46	2.74	3.87	10.22	5.67	1.55	

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