Economic variables and their relationship to the returns of listed and unlisted commercial properties in South Africa

by

Che Wei Joey Lin
LNXCHE003

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Abstract

The purpose of this research is to investigate the relationship between unlisted and listed commercial property returns and the macroeconomic factors identified, which are the stock market, economic activity, inflation and interest rates, in South Africa for the period from 1995 to 2013 (for unlisted properties) and from 2002 to 2013 (for listed properties). It is commonly understood that relevant macroeconomic variables impact asset prices; it is therefore easy to see why it is important to examine the dynamic interactions between the macroeconomic variables and property returns.

Previous studies identified stock market performance, economic growth, interest rate and inflation as significant macroeconomic variables. The empirical research in this work is conducted using regression and vector autoregression (VAR) methodologies consistent with prior studies. Regression analysis considers the statistical dependence of the dependent variable on one or more explanatory variables. VAR analysis permits inferences to be drawn about how a particular variable helps to explain property returns and to see how a shock from the same variable affects that return.

The work concluded that unlisted property has insufficient historical data to perform the relevant statistical testing. It also established that unlisted property has shown a high correlation (69%) to listed property. Finally, for listed property it was determined that interest rates were found to be a significant negative variable. This result was consistent with the impulse response analysis conducted. Variance decomposition also showed that the interest rate variable explained almost 49% of the volatility of listed property. No other economic variables identified in this work were found to be statistically significant.

This research is the first of its kind relating to commercial property in South Africa. The findings of this research reaffirm the theoretical argument that the relationship between interest rates and returns of commercial property is negative. The findings of this research are of significance to investors, analysts and policymakers wishing to acquire a better understanding of this market.

Dedication

To my father, mother, wife and son for their support in my life and towards my dissertation.

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Abbreviations

AIC	Akaike's information criterion
ALBI	All-Bond Index
ALSI	All-Share Index
APT	arbitrage pricing theory
BER	Bureau of Economic Research
CAGR	compound annual growth rate
CAPM	capital asset pricing model
FDW	Fischer-DiPasquale-Wheaton (real estate model)
GDP	gross domestic product
INET BFA	a market data service provider
IPD	Investment Property Databank
JSE	Johannesburg Stock Exchange
NCREIF	National Council of Real Estate Investment Fiduciaries
PLS	property loan stock
PUT	property unit trust
REIT	real estate investment trust*
SA	South Africa
UK	United Kingdom
US	United States of America
VAR	vector autoregression

*This thesis refers only to Equity REIT.

1. Introduction

1.1 Introduction and purpose of this chapter

Property is an important real asset for investors because of its ability to diversify and provide an inflation hedge that is better than most financial assets (Ilmanen 2012, p. 106). The phrase 'to be as safe as houses' perpetuates the notion that property is among the least risky assets in the mind of investors, but as Niall Ferguson (2008, p. 229) points out, 'a bet on bricks and mortar is very far from being as safe as houses'.

According to research commissioned by the Property Sector Charter Council, the South African property sector is valued at approximately R4.9 trillion, with residential property estimated at R3 trillion, commercial property at R780 billion, undeveloped land at R520 billion and government property at R570 billion (Property Sector Charter Council 2012). As of 2011, the real estate sector contributed 6.0% towards South Africa's gross domestic product (GDP) (Bureau of Economic Research 2011). Thus, it is an important sector in the South African economy compared to agriculture at 2.2% and mining at 8.8%.

It is commonly believed that relevant economic variables impact asset prices (Chen, Roll & Ross 1986). Daily reports from financial media (newspapers, magazines, television and the internet) tend to support the view that asset prices are influenced by a variety of events, some of which seem to have more pervasive effects on asset prices than others.

There has been limited empirical research in South Africa on the linkages between property returns and economic variables. Prior research focused on residential properties (see Standish, Lowther, Morgan-Grenville & Quick 2005; Clark & Daniel 2006; Franken, Bloom & Erasmus 2011). This research will add to the body of knowledge and be of interest to investors, analysts and policymakers.

The remainder of this chapter provides an overview of property markets in South Africa. It also introduces the research problem statement and the research question; the aim, proposition,

and objectives of the study; and the proposed hypothesis, methodologies and justification for the research. The chapter concludes with an outline of the research report.

1.2 South African property market

In South Africa, an investor can access property investments through two main methods, namely:

1) via direct investment – whereby an investor purchases a physical property (such as an office, house or apartment) or
2) through securitised instruments such as listed property stocks (Ilmanen 2012, p. 106).

1.3 Listed property

The South African listed property sector currently has two main structures, namely property unit trusts (PUT) and property loan stocks (PLS). However, since 2013 the listed sector has switched to real estate investment trust (REIT), and a number of funds are being converted to this new structure. REIT provides tax certainty as it qualifies for the REIT tax dispensation as per Section 25BB of the Taxation Legislation Amendment Bill (South African Government 2013) and also provides investors with a similar structure to international standards.

The United States (US) is the leading market in securitised property. In 1961, the US introduced the REIT structure. There is an abundance of historical data on the US market, which has resulted in significant research in the US context. In South Africa, on the other hand, there has been limited research in this sector (Payne 2003).

There are three types of REIT structures, namely equity, mortgage and hybrid (Payne 2003). This research only discusses equity REITs, as none of the other products are available in South Africa.

As of November 2013, there were 41 REITs (*Business Day* 2013) listed on the Johannesburg Stock Exchange (JSE), with a market capitalisation of R236 billion (INET BFA[1] 2013).

The listed real estate sector has enjoyed tremendous growth over the last two decades. Market capitalisation has grown from R13 billion in 2002 to R236 billion in 2013 (INET BFA; see Figure 1). At R236 billion, the listed property sector accounts for less than 3% of the total market capitalisation of the JSE.

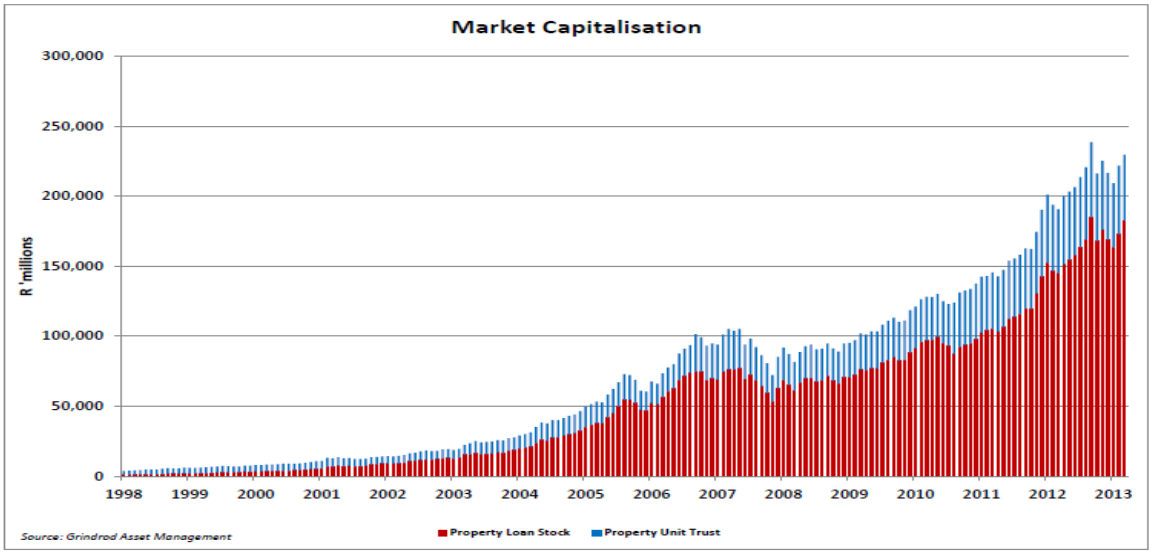


Figure 1: Market capitalisation of listed real estate chart book – October 2013 (SA REIT 2013c)

[1] INET BFA is a securities market data provider, created through the acquisition of Inet by McGregor BFA. http://www.inetbfa.com/

1.3.1 Returns on listed properties

Ilmanen (2012, pp. 102 and 111) noted that the long-run return of real estate in the US lies between that of bonds and stocks, and the real *ex ante* real estate risk premium over the ten-year treasury averaged 4% (from 1965 to 2006). Based on a review of prior research, Ilmanen (2012, p. 111) concluded that the long-run real return of real estate reflects mainly the cash yield, and real price growth is negligible; also it appears that the starting valuation matters for research, as real estate is subject to the significant impact of boom-bust cycles and mean-reverting valuations.

In South Africa, listed property outperformed both bonds and equities between August 2003 and August 2013 (see Table 1). The Property Loan Stock Index showed an annual return of 25.6% over a ten-year period. Over the same period, the JSE All-Share Index showed an annual return of 19.8%. Bonds over this period yielded an average 9.2% annual return according to the All-Bond Index.

Table 1 illustrates returns for the JSE's property loan stock, the JSE's All-Share Index (ALSI), and the JSE's All-Bond Index (ALBI):

Table 1: Return of listed property (INET BFA, calculated by author)

	Property Loan Stock (Total Returns)	ALSI Index (Total Returns)	ALBI (Total Returns)
2003 – 2013 CAGR Return p.a.	25.6%	19.8%	9.2%

As illustrated in Table 1, the listed property sector has provided excellent returns over the last ten years. Together with the steady increase in the number of listings and changes to the REIT structure, South African and foreign investors are giving increasing attention to the real estate sector (Smith 2013; Schnehage 2012).

1.3.2 Composition of listed properties

Commercial properties – consisting of office, retail and industrial properties – make up the majority of the underlying property in the listed real estate sector in South Africa. According to Stanlib (Anderson 2013a), South Africa's listed property sector has only 1% exposure by value to residential property, compared with about 11% in developed markets and 15% in emerging markets. However, recent trends indicate that listed properties are interested in increasing their investments in residential properties, for example, the recent acquisition by Arrowhead Properties of Jika Properties' residential portfolio for R406 million (Anderson 2013b). Thus, listed property indices provide a good benchmark for listed commercial properties in South Africa.

Currently, of the 41 REITs listed on the JSE, the top four dominate 46% of the market capitalisation of the listed property sector (see Table 2).

Table 2: Market capitalisation of top REITs on the JSE (INET BFA)

Market Capitalisation as of Nov 2013	**Billion ZAR**	**% of Total**
Growthpoint	46	20%
Redefine	28	12%
Hyprop	18	8%
Resilient	16	7%
Remainder	127	54%
SA REIT (J867)	**236**	**100%**

1.3.3 Regulation and structural change to REIT

Prior to the introduction of REIT, the listed real estate structure was comprised of property loan stock (PLS) and property unit trusts (PUT). The difference is in the corporate structure and tax structure.

A PUT is a collective investment scheme in property and is governed by the Collective Investment Schemes Act and the Financial Services Board. PUTs have tax certainty, and the income distributed to unitholders is not taxed in the PUT. It retains its nature and is taxed in the hands of the unitholder according to their tax status.

A PLS is a property loan stock company, which has a share linked to a variable rate debenture. PLSs have fewer restrictions than PUTs (for example, gearing is unlimited and they can invest in other companies), but they do not have tax certainty (SA Corporate Real Estate Fund n.d.).

The planning process commenced in August 2006 with a REIT conference, followed by three years of work between Property Loan Stock Association's REIT committee and the South African National Treasury. The result was the Taxation Legislation Amendment Bill released in February 2013. The bill contains the Section 25BB REIT tax dispensation, aligning the South Africa listed real estate market with the internationally recognised global standard (SA REIT Association 2013b).

The requirements for a JSE-listed South African REIT are as follows:

- own at least R300 million of property;
- keep its debt below 60% of its gross asset value;
- earn 75% of its income from rental or property owned or investment income from indirect property ownership;
- have a committee to monitor risk;
- not enter into derivative instruments that are not in the ordinary course of business;
- pay at least 75% of its taxable earnings available; and
- make a distribution to its investors each year.

The change of a listing structure to REIT may change its current relationship in terms of profitability. As pointed out by Graff (2001), investment companies can generate long-term per-share earning growth in two ways: by investing in assets with growing earnings and by financing investment portfolio expansion through reinvestment of retained earnings. Since real estate is not a growth asset, REITs can grow per-share earnings only by reinvesting retained earnings to expand underlying real estate portfolios. In the case of South Africa, as REITs are required to pay out 75% of taxable ordinary income to shareholders, REITs are not growth stocks, but cyclical income-generating assets with comparable investment characteristics to underlying investment portfolios.

The conversion to the REIT structure has no impact on this research, as the data used for this research were all pre-conversion structures.

1.4 Unlisted property

Although the market capitalisation of South African listed property is R236 billion (INET BFA), the unlisted sector remains substantial. Investment Property Databank (IPD) estimates that about 54% of the country's professionally managed investment property is listed (Hedley 2013), with the predominant players in the unlisted arena being either insurance companies or pension funds (such as, Liberty Properties, Old Mutual Property, Sanlam Properties, the PIC, Momentum Property Fund and Sasol).

Property economist Francois Viruly (as quoted in Hedley 2013) points out that some of the prime properties in South Africa are majority-owned by unlisted players such as Sandton City (by Liberties Properties), and Cavendish Square and Gateway (by Old Mutual). He believes that once the new REIT structure has 'bedded itself down', some of the unlisted funds could list in the next few years.

1.5 Research problem statement

The problem to be examined in this study is stated as:

International studies have suggested that there are relationships between macroeconomic variables and the performance of the commercial property sector (see Chen, Peng, Shyu & Zeng 2012; Downs, Fung, Patterson & Yua 2003; Payne 2003). This research considers whether the conclusions of these studies have relevance in the South African context. To date, no similar research has been comprehensively conducted in South Africa.

1.6 Research question

The research questions to be addressed are as follows:

a) Is there a significant relationship between macroeconomic variables and commercial property returns (listed and unlisted) in South Africa?

b) If such a relationship exists, what are the relationships between the chosen macroeconomic variables and commercial property returns?

1.7 Research aim

This research aims to determine whether the relationship between macroeconomic variables and commercial property returns, as found in international studies, is applicable to the South African property environment.

1.8 Research proposition

This study will test the following research proposition:

There is a significant relationship between the performance of commercial property and macroeconomic variables in South Africa.

1.9 Research objectives

This study aims to achieve the following research objectives:

a) establish the relevant economic variables;
b) determine whether there is significant linkage between economic variables and commercial properties returns;
c) determine the extent of the relationship between economic variables and commercial properties returns; and
d) assess the applicability of previous international studies.

1.10 Hypothesis

H_0: There is no statistically significant relationship between macroeconomic variables and commercial property (listed and unlisted) returns.

H_1: There is a statistically significant relationship between macroeconomic variables and commercial property (listed and unlisted) returns.

1.11 Methodology

This research builds on previous research providing the basis for testing both listed and unlisted property returns (see Ling & Naranjo 1997; Hoesli, Lizieri & MacGregor 2008). The application of vector autoregression (VAR) – employed by Downs et al. (2003), Payne (2003) and Laopodis (2009) – provided the basis for the research methodology. This study undertook a literature review on topics relevant to its field of study. The researcher then applied statistical methods (correlation, multiple regression and vector autoregression) to selected data to formulate the findings. Chapter 3 provides more details concerning the research methodology.

1.12 Justification of the research

Despite numerous international studies, no empirical research on the relationship between economic variables and commercial properties returns has been conducted for South Africa. The relationship between economic variables in this research is of significance to investors, analysts and policymakers; such findings may assist them with investment and related decision-making.

1.13 Limitations of this research

This study is subject to the following limitations:

a) The research focus is on commercial property only, due to data availability.
b) The research drew data from JSE and IPD, as the data are reliable and available to public.
c) This research did not test all economic variables; certain variables were excluded due to lack of available relevant data. The unavailability of data remains the major limitation to this study; other South African studies have confirmed this limitation (see Franken, Bloom & Erasmus 2011).

d) This research did not test firm specific variables – for example, gearing and market value to book value.
e) This research focuses on the commercial property sector as a whole and not on the influence of individual assets or companies.
f) The methodology adopted provides an understanding of historical experience and may not be a predictive model.
g) The research periods selected were from 1995 to 2013 for unlisted properties and from 2002 to 2013 for listed properties.
h) Some of the research in the area identified the asymmetrical effects of interest rates to asset prices (see Mueller & Pauley 1995; Simpson, Ramchander & Webb 2007; Chen et al. 2012). Since the period of the research falls in a period of decreasing interest rates, the results may be representative of a drop in interest rates and not throughout the cycle.

1.14 Outline of the research report

Chapter 1 introduced the research background, problem, questions, aim, objectives, hypothesis, methodologies and limitations. This concluding section presents an outline of the remaining chapters of this thesis.

Chapter 2 presents a review of international and South African literature in this field. This chapter addresses the question: 'What has previous research in this field revealed?'

Chapter 3 draws together methodologies used and the economic variables identified in previous research. It proposes the statistical research design to address the research questions.

Chapter 4 presents the results and interpretation of the statistical tests performed.

Chapter 5 concludes the discussion and recommends future areas of research.

This is followed by the full list of References and Appendices.

2. Literature Review

This chapter chronicles previous research undertaken in this field, focusing on both South African and international literature.

Property is a financial asset and thus presumably is sensitive to economic variables, as financial theory suggests that macroeconomic variables should systematically affect financial asset returns (Chen, Roll & Ross 1986).

The relationship between financial assets returns and economic variables forms the basis of finance theories (see section 2.1 for more details):

- The capital asset pricing model (CAPM) considers co-movement of the market *vis*-à-*vis* individual securities.
- Arbitrage pricing theory (APT) considers macroeconomic variables as significant variables in explaining financial asset returns.

The relationship between property returns and economic variables is well researched in developed countries but has received less attention in South Africa, as most prior research in South Africa focused on residential property. This identified gap presents a compelling research opportunity.

Research of this nature is often accomplished through various statistical methods, including:

- Correlation: This is a statistical method used to measure the strength or degree of linear association between two variables (Gujarati 2003). This research uses this method (see sections 3.1.1 and 3.1.2).
- Multiple regression: This is a popular statistical technique frequently used in econometrics and is concerned with the statistical dependence of dependent variable on independent variable(s) (Gujarati 2003). This research uses this technique (see section 3.1.1).

- Vector autoregression: This technique is frequently used in econometrics for the analysis of multivariate time series. Its main advantage is that researcher does not need to assume structural inferences (Brooks & Tsolacos 1999). See section 3.1.2 for more details.
- Cointegration: Economically speaking, two variables will be cointegrated if they have a long-term/equilibrium relationship (Gujarati 2003). This study did not apply this methodology, as it is often applied as a pre-test to detect spurious regression.

To date, there is no scholarly literature that addresses this research area in South Africa. Thus, this study and its findings are of significance to investors, analysts and policymakers.

Research by Chen, Roll and Ross (1986) provided the foundation for this area of research. They based their research on the proposition that the CAPM provided for only one factor (the market portfolio) as a determinant of financial markets and did not provide for 'macroeconomic variables' that may impact financial markets (see Formula 2.1 in section 2.1). Chen, Roll and Ross (1986) attempted to use macroeconomic variables to explain asset returns through the context of APT, and used macroeconomic variables as variables in the APT return generation process. The resulting empirical APT can be defined as the Macroeconomic Variable Model (Chen, Hsieh & Jordan 1997).

Chen, Roll and Ross (1986) identified industrial production, changes in risk premium and the term structure of interest rates[2] as significant variables for explaining stock returns. They argue that any economic variable that systematically affects either future cash flows and/or the discount factor will impact the prices and returns of financial assets. Chen, Hsieh and Jordan (1997) and Downs et al. (2003) support this view. They applied the methodology employed by Chen, Roll and Ross (1986) that commenced the determinants of real estate returns.

DiPasquale and Wheaton (1992) set out a conceptual framework that divides the real estate market into two underlying markets: the market for real estate space and the market for real

[2] Term structure of interest rates is defined as the difference between long-term government yield less the Treasury bill rate.

estate assets. The variables identified in the conceptual framework included economy, rent, supply, capitalisation rate, construction costs and replacements costs.

Ilmanen (2012, p. 112) identified variables such as economic growth, inflation, demographics and population migration, as well as shorter-term supply-and-demand variables, as fundamental determinants of property returns. However, Ilmanen (2012) also argues that securitised properties, for instance, REITs are different in their behaviour and driven more by equity markets and interest rates. He observed that fluctuations in cap rates and rental yields are important drivers of real estate prices, often overwhelming the fundamental impact of income growth.

The Appraisal Institute (2008, p. 44) points out: 'To determine the influence of economic forces on value, appraisers analyse the fundamental relationships between current and anticipated supply and demand and the economic ability of the population to satisfy its wants, needs and demands through its purchase power.'

Many specific market characteristics are considered in analyses of economic forces:

- employment
- wage levels
- industrial expansion
- the economic base of the region and the community
- price level
- the cost and availability of the mortgage credit
- the stock of available vacant and improved properties
- new development under construction or in the planning stage
- occupancy rates
- the rental and price patterns of existing properties
- construction costs

Most prior studies have been on the securitised market, and the following variables were identified to have significant impact on property returns:

- Stock market (see Allen, Madura & Springer 2000; Okunev, Wilson & Zurbruegg 2000; Payne 2003; He, Webb & Myer 2003; Standish et al. 2005; Clark & Daniel 2006; Huang & Lee 2009; Franken, Bloom & Erasmus 2011; Chen et al. 2012; Yunus 2012).
- Economic growth (see Chen, Roll & Ross 1986; Ling & Naranjo 1997; Ewing & Payne 2005; Clark & Daniel 2006; Franken, Bloom & Erasmus 2011; Boshoff & Cloete 2012; Yunus 2012; Lieser & Groh 2013).
- Interest rate (see Ling & Naranjo 1997; Allen, Madura & Springer 2000; Swanson, Theis & Casey 2002; He, Webb & Myer 2003; Payne 2003; Clark & Daniel 2006; Huang & Lee 2009; Franken, Bloom & Erasmus 2011; Mangani 2011; Chen et al. 2012; Yunus 2012).
- Inflation (see Adrangi, Chatrath & Raffliee 2004; Ewing & Payne 2005; Hoesli, Lizieri & MacGregor 2008; Franken, Bloom & Erasmus 2011; Yunus 2012).

2.1 Stock market

The stock market is one of the most frequently used variables used to determine the performance of listed property. Ilmanen (2012, p. 112) suggested that listed properties are more driven by equity markets than market fundamental factors.

In terms of the CAPM theoretical framework, investors cannot diversify market risk away, but they can diversify specific risk, and as an asset, market risk is the only risk that should be rewarded (Hoesli & MacGregor 2000). Thus, the pricing of individual securities is expressed as a co-movement of the market (Beta, see Equation 1, [2.1]).

Equation 1: Capital Asset Pricing Model

$$\mathbf{E\,(R) = } \mathit{RFR} \mathbf{ + } \beta_1 \mathbf{\,R(Mkt)} \qquad \mathbf{[2.1]}$$

Where:

E (R)	Expected return of the portfolio
RFR	Risk Free Rate
β 1	Beta
R (Mkt)	Expected return on the market

In terms of APT, Chen, Roll and Ross (1986) acknowledged the need to consider multiple risk variables to price assets; however, a number of different variables have been identified (Hoesli & MacGregor 2000).

Irrespective of the CAPM or APT model, the stock market index is often used as proxy to assess market returns for research and valuation purposes. This thesis cites a number of studies that used stock market returns as a proxy for market return (see Chen, Hsieh & Jordan 1997; Ling & Naranjo 1997; Chen et al. 1998; Allen, Madura & Springer 2000; Swanson, Theis & Casey 2002; Downs et al. 2003; He, Webb & Myer 2003; Simpson, Ramchander & Webb 2007; Huang & Lee 2009; Chen et al. 2012; Nittayagasetwat & Buranasiri 2012; Yunus 2012).

Most previous research has found positive relationships between listed property returns and stock market returns (see Allen, Madura & Springer 2000; Okunev, Wilson & Zurbruegg 2000; Payne 2003; He, Webb & Myer 2003; Huang & Lee 2009; Chen et al. 2012; Yunus 2012). These observations are consistent with the study by Ilmanen (2012).

Liow (2010) studied 13 developed securitised real estate markets[3] from 1989 to 2009. The study determined that developed securitised real estate markets were more integrated with their local stock market and weakly integrated with the global stock market and global real estate markets over the past 20 years.

In South African literature, the ALSI is used as the proxy for market returns (see Standish et al. 2005; Clark & Daniel 2006; Franken, Bloom & Erasmus 2011).

According to a survey by PricewaterhouseCoopers (PwC 2012), the majority of corporate finance practitioners in South Africa use CAPM as the pre-eminent model[4] to determine cost of equity (for corporate valuation) and use the All-Share Indices as the proxy for market portfolio.

2.2 Economic growth and the property market

According to the Fischer-DiPasquale-Wheaton (FDW) real estate model (DiPasquale & Wheaton 1992), economic growth translates into an increase in a number of variables in the property market, thus affecting production, employment and household income (Du Toit & Cloete 2004). Considering that these factors influence the demand for space, one assumes that they would have a positive impact on the performance of the property market. Thus, in terms of economic theory the relationship should be positive.

Other theoretical considerations include studies by Ilmanen (2012) and The Appraisal Institute (2008), who considered economic growth as fundamental determinants of property returns.

The results from previous research on economic growth and property prices/returns were mixed. Most studies found significant positive relationships (Chen, Roll & Ross 1986; Ling & Naranjo 1997; Clark & Daniel 2006; Franken, Bloom & Erasmus 2011; Boshoff & Cloete 2012; Yunus 2012; Lieser & Groh 2013), which is consistent with economic theory. Some studies

[3] The author selected the countries as they were included in the S&P Global Property Index, namely: Australia, Hong Kong, Japan, Singapore, Belgium, France, Netherlands, Spain, Sweden, Switzerland, the United Kingdom, Canada and the United States.
[4] The other methods used included APT, dividend growth models and others.

found negative relationships (Ewing & Payne 2005), and others found that economic variables have no significant interaction with property returns (Brooks & Tsolacos 1999; Standish et al. 2005; Chang, Chen & Leung 2011).

The inconsistency in influence of the variables on property returns can be attributed to different periods, data sets, different types of proxies for economic growth and variety of methodologies used (see Table 3).

Table 4 summarises the relationships between economic growth and property returns.

Table 3: Summary of literature review (showing inconsistency between period, frequency of data, methodologies and results)

Studies	**Country, period of analysis, frequency of data**	**Data used (independent variable)**	**Methodologies**	**Results between economic growth and independent variable**
Chen, Roll & Ross (1986)	US, 1953 – 1983, monthly	NYSE listed stocks	Regression	Positive
Ling & Naranjo (1997)	US, 1978 – 1994, Quarterly	REIT and NCREIF[5] data	Regression	Positive
Brooks & Tsolacos (1999)	UK, 1985 – 1998, Monthly	REIT	VAR (Variance decomposition and Impulse Response)	No/inconclusive
Ewing & Payne (2005)	US, 1980 – 2000, Monthly	REIT	VAR (Impulse Response)	Negative
Standish et al. (2005)	SA, 1974 – 2003, Quarterly	ABSA Housing Index	Regression	No/inconclusive
Clark & Daniel (2006)	SA, 1980 – 2006, Quarterly	Residential house price	Regression	Positive
Chang, Chen & Leung (2011).	US, 1975 – 2008, Quarterly	REIT	VAR (Variance decomposition and Impulse Response)	No/inconclusive
Franken, Bloom & Erasmus	SA, 1974 – 2004, Quarterly	Residential house price	Regression	Positive

[5] The National Council of Real Estate Investment Fiduciaries (NCREIF) is a not-for-profit trade association that provides its members with commercial properties data, performance measurement and investment analysis. (http://www.ncreif.org)

(2011)				
Boshoff & Cloete (2012)	SA, 2000 – 2009, not disclosed	Used Share Price of PLS	Correlation	Positive
Yunus (2012)	US, Canada, Japan, Australia, Germany, France, Italy, Netherlands, Switzerland and UK, 1990 – 2007, Monthly and Quarterly	REIT	Cointegration and VAR (Granger Causality and Impulse Response)	Positive
Lieser & Groh (2013)	47 countries, 2000–2009, Annual	Commercial Real Estate Investment in USD million	Augmented Panel Regression Analysis	Positive

Table 4: Summary of relationships between economic growth and property returns

Relationship	**Studies**
Positive	Chen, Roll & Ross (1986); Ling & Naranjo (1997); Clark & Daniel (2006); Franken, Bloom & Erasmus (2011); Boshoff & Cloete (2012); Yunus (2012); Lieser & Groh (2013)
Negative	Ewing & Payne (2005)
No/inconclusive	Brooks & Tsolacos (1999); Standish et al. (2005); Chang, Chen & Leung (2011)

2.3 Interest rates

It is often assumed that property returns are linked to interest rates, because changes in interest rate impact return on property investment in two ways:

1. They impact the cash return of property, as most of the property investments have some form of financial gearing and interest rate changes will impact their bottom line. (Lynn 2007).
2. They impact the discount rate/capitalisation rate used to value the property investments (Chen, Roll & Ross 1986; Ilmanen 2012).

In terms of the FDW real estate model (DiPasquale & Wheaton 1992), 'The demand for real estate assets is determined by real estate yields in relation to the after tax yield of fixed income securities and other investments' (Du Toit & Cloete 2004). If the interest rate in the rest of the economy rises, then the existing 'yield' from the real estate becomes too low relative to fixed-income securities and investors will wish to shift their funds from the property sector. Thus the capitalisation rate will rise and depress property prices.

The International Valuation Standards Framework, paragraph 60, outlines the 'Income Approach' valuation methodology: 'This approach considers the income that an asset will generate over its useful life and indicates value through a capitalisation process. Capitalisation involves the conversion of income into a capital sum through the application of an appropriate discount rate' (International Valuation Standard Council 2011, p. 26). This method is consistent with the 'Income Capitalisation Approach' advanced by The Appraisal Institute in which 'a property's income and resale value upon reversion may be capitalised into a current, lump sum value' (The Appraisal Institute 2008, p. 142).

Therefore the theoretical argument is that the influence between property returns and the interest rate is negative, since an increase in the interest rate will increase the discount/capitalisation rate, or an increase in the interest rate will increase the interest repayments and reduce the bottom line of the property. Either way, an increase in the interest rate will reduce the value of the investment and returns on the property.

Past research has produced mixed results. The majority of prior studies have found significant negative relationships between property returns and the interest rate (see Allen, Madura & Springer 2000; He, Webb & Myer 2003; Payne 2003; Clark & Daniel 2006; Huang & Lee 2009; Mangani 2011; Chen et al. 2012; Yunus 2012). This is consistent with theoretical arguments. However, Chen et al. (2012) applied quantile regression testing, which further indicates that the impact of monetary policy (Fed Rate is used as a proxy) has a differential impact on the REIT market. The impact is significantly negative during bull markets and has no impact during bear/volatile markets.

Some prior studies have found significant positive relationships (see Ling & Naranjo 1997; Swanson, Theis & Casey 2002; Franken, Bloom & Erasmus 2011). This relationship between interest rates and equity REITs can be explained as, despite the proposition that lower interest rates reflect weak economic conditions and low inflationary expectations, an increase in interest rates may reflect stronger economic growth, higher inflationary expectations, and upward pressure on real estate prices. These effects may result in a positive relationship or negate the inverse relationship between interest-rate movements and real estate values. (See 2.3.1 for further discussion and empirical research.)

Research has also found that the interest rate has little impact on the performance of property returns (see Mueller & Pauley 1995; Chen et al. 1998; Nittayagasetwat & Buranasiri 2012).[6]

The inconsistency in influence of interest rate on property returns can be attributed to different periods, data sets and different proxies used for interest rates (see 2.3.1) deployed in prior studies (see Table 5).

[6] Most interest proxies not significant, with the exception of long-term US high-grade corporate bonds.

Table 5: Summary of literature reviewed above (showing inconsistency between period, frequency of data, methodologies and results

Studies	**Country, period of analysis, frequency of data**	**Data used (independent variable)**	**Methodologies**	**Results between interest rate and independent variable**
Mueller & Pauley (1995)	US, 1972 – 1993, monthly	REIT	Regression	No relationship
Ling & Naranjo (1997)	US, 1978 – 1994, Quarterly	REIT and NCREIF[7] data	Regression	Significant positive relationship to Treasury bill rate
Chen et al. (1998)	US, 1978 – 1994, Monthly	REIT	Regression	No relationship
Swanson, Theis & Casey (2002)	US, 1989 – 1998, Daily	REIT	Regression	Risk premium of 30 year Treasury bond has significant positive relationship REIT return
Franken, Bloom & Erasmus (2011)	SA, 1974 – 2004, Quarterly	Residential house price	Regression	Interest rate has positive relationship to residential property prices
Nittayagasetwat & Buranasiri (2012)	US, 2000 – 2011, Monthly	REIT	Regression	The monthly return on long-term US high-grade corporate bonds was the statistically significant interest rate proxy, which affected REIT's performance. All other interest proxies not significant.

[7] National Council of Real Estate Investment Fiduciaries (NCREIF) is a not-for-profit trade association that provides its members with commercial properties data, performance measurement and investment analysis. http://www.ncreif.org

2.3.1 Types of interest rate proxies

Previous research has suggested a number of proxies for the impact of interest rates:

- Brooks and Tsolacos (1999) and Huang and Lee (2009) used the nominal interest rate, defined as 'real interest rate plus a premium for expected inflation' (The Appraisal Institute 2008, p. 97).
- Other studies used the real interest rate, defined as the nominal Treasury bill rate less inflation (see Chen, Roll and Ross 1986; Standish et al. 2005).
- Other studies used the risk premium, defined as the Baa bond[8] yield less long-term government yield (see Chen, Roll & Ross 1986; Chen, Hsieh & Jordan 1997; Chen et al. 1998; Swanson, Theis & Casey 2002; He, Webb & Myer 2003; Payne 2003; Ewing & Payne 2005; Nittayagasetwat & Buranasiri 2012).
- Still other studies used the term structure, defined as the difference between long-term government yield less the Treasury bill rate (see Chen, Roll & Ross 1986; Ling & Naranjo 1997; Chen, Hsieh & Jordan 1997; Chen et al. 1998; Swanson, Theis & Casey 2002; He, Webb & Myer 2003; Payne 2003; Nittayagasetwat & Buranasiri 2012).

He, Webb & Myer (2003) found that overall the changes in yields on high-yield corporate bonds (Baa) have the strongest explanatory power for returns on REITs for most of the 27-year sample period (1972 – 1998).

Short-term vs long-term interest rates

South African proxies used for short-term interest rates are the South African 3-month Treasury bill rate (see Das, Gupta, Kanda, Tipoy & Zerihyn 2012) and the negotiable certificate of deposit (see Hassan & Biljon 2009).

[8] Bond rating by Moody's

Long-term interest rate proxies include: JSE Actuaries All-Bond Index used by Hassan and Biljon, (2009), the R186[9] bond used by majority of corporate financiers (PwC 2012) and the prime interest rate (Clark & Daniel 2006; Franken, Bloom & Erasmus 2011).

Investments rate vs borrowing rate

In the South African context, two major proxies are used as a benchmark for interest rates. The first is the 10-year government bond rate, which is considered as a risk-free interest rate benchmark, as it is the rate investors can obtain by investing in a long-term South African government bond. The other is the prime overdraft rate set by the Reserve Bank of South Africa, commonly known as the Prime Interest Rate. Most commercial bank interest rates in South Africa are linked to the Prime Interest Rate.

Listed properties are an asset class that is often compared to government bonds, since 'the long run return of real estate is between that of bonds and stocks' (Ilmanen 2012, p. 102). This can be observed from the opinions of numerous investment analysts and asset managers that listed properties are highly correlated to long-term government bonds or used as a benchmark to determine the attractiveness of listed property as an asset class (see Appendix 1).

According to PwC (2012), the proxies used by business valuation practitioners for the risk-free rate are predominantly South African government bonds (79% of respondents; in the 2010 Survey, 93% of the respondents used South African government bonds).

Based on the analysis of this thesis (see Figure 2), there is a high level of association between the ten-year yield and the Prime Interest Rate. The correlation between the ten-year yield and the Prime Interest Rate is 89% for the period from 1960 to 2013. Thus using either the ten-year yield or the Prime Interest Rate as proxy for the interest rate should yield similar results.

[9] R186 is a bond issued by South African government with a maturity date of 11/12/2026.

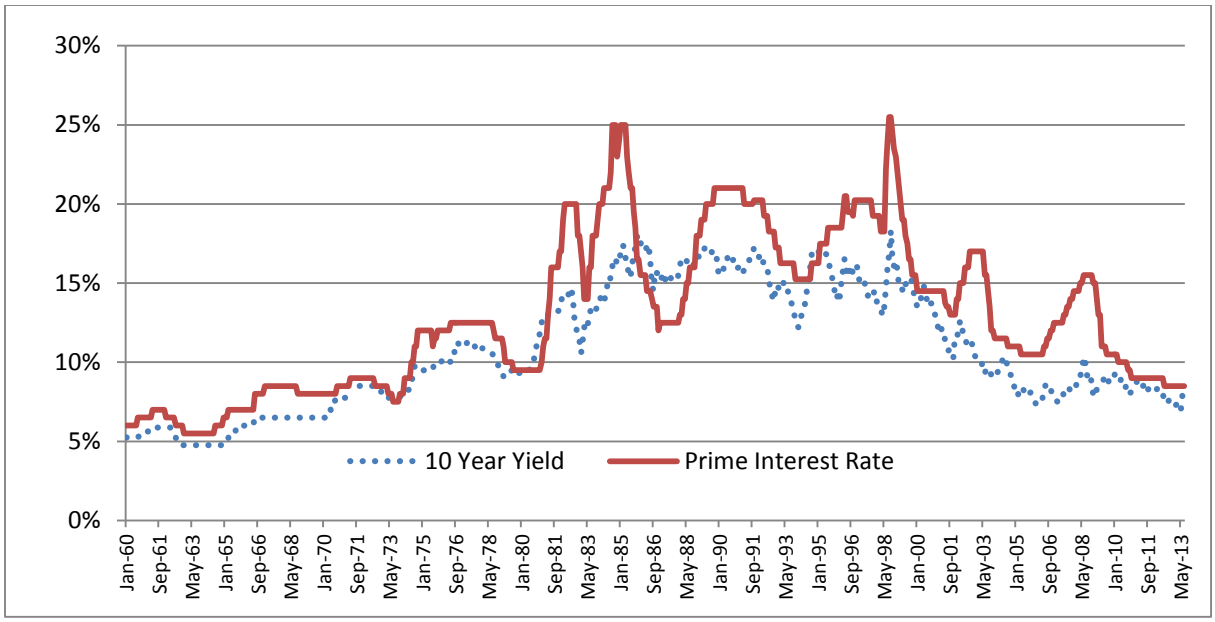


Figure 2: Investment rate vs borrowing rate (Bureau of Economic Research, University of Stellenbosch, prepared by author)

2.3.2 Non-academic empirical studies

Non-academic empirical studies performed by asset managers and consultants have produced various results.

Towers Watson (2012) found no relationship between gilt yield and property returns.

Blackrock Real Estate Equity Group (2005), CBRE Clarion Securities (2013), and JP Morgan Asset Management (2013) found that in a rising interest rate environment, returns actually increase, since rising interest rates are normally consistent with improving economic conditions.

Blackrock (2005) found that returns (income and capital) of commercial properties increase during periods of rising interest rates relative to periods when interest rates decline.

CBRE (2013) found that in the period of a rising interest rate in which REIT corrected more than 10%, REITs total returns underperformed equity market returns in the short term but thereafter delivered subsequent periods of strong absolute returns, and generally outperformed the broader equity market.

JP Morgan (2013) found that in the short term, rising interest rates have a limited impact on capitalisation rates, as a rising interest rate is normally consistent with improving economic conditions. In the long term, the current core unleveraged yield on property is the main determinant of whether rising interest rates will impact property prices.

Cohen and Steers Capital Management (2013) found that during periods of rising inflation, REIT returns outperformed equity markets. Capitalisation rates (cap rates) also do not move in tandem with interest rates but with economic growth expectations and credit spreads.

Table 6 summarises the above non-academic research by country, period of analysis, used data, methodologies, and the relationship between property returns and the interest rate.

Table 6: Summary of literature review (non-academic research)

Author	Country, period of analysis, frequency of data	Data Used (independent variable)	Methodologies	Relationship between property returns and the interest rate
Towers Watson (2012)	UK 1987 – 2010, Annually	IPD	Correlation Scatterplot	No significant relationship.
Blackrock (2005)	US 1978 – 2004, Quarterly	NCREIF		Found returns income and capital) of commercial properties increase during period of rising interest rates.
CBRE (2013)	US 1994 – 2013, Daily	REIT	Event study and charts	In the period of rising interest rate REIT corrected more than 10%. In the short term, REIT total returns underperformed equity market returns, thereafter, delivered subsequent periods of strong absolute returns, and generally outperformed equity market.
JP Morgan (2013)	US, 1983 – 2013, Quarterly	REIT	Line chart and Scatter plot	In the short term, rising interest rates have limited impact on capitalisation rates.
Cohen & Steers (2013)	US 1979 – 2012, Monthly	REIT	Event study and charts	During period of rising inflation, REIT returns outperformed equity markets, capitalisation rate do not move in tandem with interest rates and that REITs can be an effective inflation hedge

2.4 Inflation

The Proxy Effect Hypothesis, initially developed by Fama (1965 cited in Adrangi, Chatrath & Raffliee 2004), describes the negative relationship between equity returns and inflation. The hypothesis predicts that rising inflation rates reduce real economic activity and demand for money. The decline in economic activity should subsequently negatively affect employment and stock returns (Adrangi, Chatrath & Raffliee 2004).

Non-academic empirical research conducted by Cohen and Steers (2013) found the contrary: US REITs can be effective as a hedge against inflation, since US REITs have outperformed stocks and bonds in periods of both rising and moderating inflation through dividend growth at a pace faster than inflation.

The relationship between asset returns and inflation has been extensively researched, particularly in terms of the effectiveness of REIT in hedging inflation. The studies are often divided into two types of proxies – actual inflation and expected/unexpected inflation.

Yobaccio, Rubens and Ketcham (1995) studied the inflation-hedging property of REIT from 1972 to 1992 and found that REIT acts as poor hedge against any measure of inflation actual, expected or unexpected).

2.4.1 Actual inflation

The proxy predominantly used by researchers for actual inflation is the consumer price index (CPI) (see Chen, Roll & Ross 1986; Yobaccio, Rubens & Ketcham 1995; Chen, Hsieh & Jordan 1997; Chatrath & Liang 1998; Chen et al. 1998; Glascock, Lu & So 2002; Payne 2003; Adrangi, Chatrath & Raffliee 2004; Ewing & Payne 2005; Franken, Bloom & Erasmus 2011; Yunus 2012).

The results of the research are not consistent, with the majority of the studies finding no relationship/response or a negative relationship/response.

Despite the different time periods, most studies found no relationship (see Chen, Hsieh & Jordan 1997; Chatrath & Liang 1998; Chen et al. 1998; Glascock, Lu & So[10] 2002).

Some studies found a negative relationship (see Adrangi, Chatrath & Raffliee 2004; Ewing & Payne 2005). However, a few studies found a positive relationship/response (see Franken, Bloom & Erasmus 2011; Yunus 2012).

Table 7: Summary of literature reviews above (showing inconsistency between period, frequency of data, methodologies and results

Studies	**Country, period of analysis, frequency of data**	**Data used (independent variable)**	**Methodologies**	**Results between actual inflation and independent variable**
Chen, Hsieh & Jordan (1997)	US, 1974 – 1991, Monthly	REIT	Regression	None
Chatrath & Liang (1998)	US, 1972 –1995, Monthly	REIT	Regression and Cointegration tests	No relationship between inflation and REIT.
Chen et al. (1998)	US, 1978 – 1994, Monthly	REIT	Regression	None
Glascock, Lu & So (2002)	US, 1972 – 1995, Monthly	REIT	VECM, VAR (Variance decomposition and Impulse Response)	REIT returns anticipate changes in inflation (expected and unexpected).
Adrangi, Chatrath & Raffliee (2004)	US, 1972 – 1999, Monthly	REIT	Regression and Cointegration tests	Real REIT returns are negatively correlated with inflation.
Ewing & Payne (2005)	US, 1980 – 2000, Monthly	REIT	VAR (Generalised impulse response)	Shocks to monetary policy lead to lower than expected returns
Chang, Chen & Leung (2011)	SA, 1974 – 2004, Quarterly	Residential house price	Regression	Inflation has positive relationship to residential house price.
Yunus (2012)	US, Canada, Japan,	REIT	Cointegration and	'shocks to inflation

[10] Glascock, Lu and So (2002) concluded that the observed negative relationship between REITs and inflation is spurious, and this is explained once the monetary policy effects on the respective variables are specifically taken into account.

	Australia, Germany, France, Italy, Netherlands, Switzerland and UK, 1990 – 2007, Monthly and Quarterly		VAR (Granger Causality and Impulse Response)	induce a positive response in international securitised property returns'

2.4.2 Expected/unexpected inflation

Expected and unexpected inflation are derived and calculated variables:

- Expected inflation is defined as the Treasury bill rate less ex post real rate of interest (see Fama and Gibbons 1984 cited in Chen, Roll and Ross 1986).
- Unexpected inflation is defined as the difference between the realised inflation rate during period *t* and the expected inflation rate at the beginning of the same period *t*. The realised inflation rate is the first-order log relative of the CPI for all urban consumers. Unexpected inflation is calculated by the Fama and Gibbons (1984 cited in Chen, Roll and Ross 1986) method (see Equation 2, [2.2]), which uses the Fisher equation and time-series analysis to derive unexpected inflation.

Equation 2: Fisher theorem on deriving unexpected inflation

$$UI(t) = I(t) - E[I(t) \mid t-1] \qquad [2.2]$$

UI(*t*) is unexpected inflation.

I(*t*) is the realised monthly first difference in the logarithm of CPI for period *t.*

E[I(*t*) | *t*–1] is expected inflation defined as Treasury bill rate less ex post real rate of interest.

Most studies found expected inflation insignificant by (see Chen, Hsieh & Jordan 1997; Ling & Naranjo 1997; Chen et al. 1998).

Hoesli, Lizieri and MacGregor (2008) is the only study that found expected inflation positively linked to asset returns.

Most researchers found no significant relationship between unexpected inflation and real estate returns (see Ling & Naranjo 1997; Chen, Hsieh & Jordan 1997[11]; Chen et al. 1998; Brooks & Tsolacos 1999).

However, Simpson, Ramchander and Webb (2007) found previous studies to be flawed. Their study documented an asymmetrical response of REIT return to inflation. During expansionary periods, REIT returns go up with both increases and decreases in inflation. However, during a restrictive monetary policy period, the asymmetric framework cannot explain the perverse relationship between REIT return and inflation.

2.5 Summary of the literature review

Table 8 summarises the relevant international academic literature by country, data used, methodologies and variables found to be significant in the research. The table is sorted in the order of the research studies quoted in the literature review.

Table 8: Summary of academic literature review (in alphabetical order)

Author	Country, period of analysis, frequency of data	Data Used	Methodologies	Variables found to be significant
Adrangi, Chatrath & Raffliee (2004)	US, 1972 – 1999, Monthly	REIT	Regression and Cointegration tests	Real REIT returns are negatively correlated with inflation.
Allen, Madura & Springer (2000)	US, 1993 – 1997, Monthly	REIT	Regression	REITs are sensitive to long- or short-term interest-rates.
Boudry, Coulson,	US, 1984 – 2009,	REIT	VECM	REITs and the underlying real estate markets are related. Furthermore, the

[11] for two of the three periods tested (January 1980 to December 1985 and January 1986 to December 1991)

Kallberg & Liu (2012)	Quarterly and Annually			relation appears to be stronger in particular in annual rather than quarterly data.
Brooks & Tsolacos (1999)	UK, 1985 – 1998, Monthly	REIT	VAR (Variance decomposition and Impulse Response)	The conclusion from the VAR methodology adopted in this paper is that the overall, UK real estate returns purged of general stock market influences are difficult to explain on the basis of the information contained in the macroeconomic variables tested.
Chatrath & Liang (1998)	US, 1972 – 1995, Monthly	REIT	Regression and Cointegration tests	This study concludes that there is no relationship between inflation and REIT.
Chen (1997)	US, 1974 – 1991, Monthly	REIT	Regression	None
Chen et al. (1998)	US, 1978 – 1994, Monthly	REIT	Regression	None
Chen et al. (2012)	US, 1972 – 2008, Monthly	REIT	Regression	The results of this study show that stock market returns had a positive impact on EREIT returns in the period from 1972 to 2008.
Downs et al. (2003)	US, 1972 – 1999, Monthly	REIT	VAR (Variance decomposition and Impulse Response)	The relationship between income-return variance and each variable is statistically significant; construction accounts for about 10%; industrial production, 4%; T-bill yield, 5%; mortgage rate, 7%; and market portfolios, 2%. Only the past price return is consistently significant in price-return variance.
Ewing & Payne (2005)	US, 1980 – 2000, Monthly	REIT	VAR (Generalised impulse response)	The research examined data from 1980 to 2000. This research found that shocks to monetary policy, economic growth and inflation all lead to lower than expected returns, while a shock to default risk premium is associated with higher return.
Glascock, Lu & So (2002)	US, 1972 – 1995,	REIT	VECM, VAR (Variance	Fed Fund Rate provided partial explanation to the relationship

	Monthly		decomposition and Impulse Response)	between REIT returns and REIT returns anticipate changes in inflation (expected and unexpected).
Huang & Lee (2009)	US, 1994 – 2007, Daily	REIT	Autoregressive Integrated Moving Average (ARIMA)	Huang and Lee (2009) investigated asset returns from 1994 to 2007. They found the changes the REIT is negatively sensitive to interest rates and demonstrate that REIT returns are more sensitive in the long term than in the short term.
He, Webb & Myer (2003)	US, 1972 – 1998, Monthly	REIT	Flexible Least Square	This study found changes in yields on high-yield corporate bonds (Baa).
Hoesli, Lizieri & MacGregor (2008)	US and UK, 1977 – 2003, Quarterly	REIT, NCREIF (US) and IPD (UK)	Error Correction Model	Hoesli, Lizieri & MacGregor (2008) found that anticipated inflation was positively linked to asset return. The ECM approach clearly demonstrates that asset return adjustment to changes in inflation does not occur in period but rather through an error correcting adjustment process to the long run relationship that is gradual. The results were similar between the UK and the US.
Laopodis (2009)	US, 1971 – 2007, Monthly	REIT	VAR (Variance decomposition and Impulse Response)	Laopodis (2009) found that REITs display reciprocal linkage between the general stock market and industrial production movements.
Lieser & Groh (2013)	47 countries, 2000–2009, Annual	Commercial Real Estate Investment (USD million)	Augmented Panel Regression Analysis	GDP per capita and inflation
Ling & Naranjo (1997)	US, 1978 – 1994, Quarterly	REIT and NCREIF[12] data	Regression	Real per capita consumption growth
Liow (2010)	13 developed countries,	REIT	Cointegration test	The developed securitised real estate markets are more integrated with their

[12] National Council of Real Estate Investment Fiduciaries (NCREIF) is a not-for-profit trade association that provides its members with commercial properties data, performance measurement and investment analysis. http://www.ncreif.org

	1989 – 2009, Weekly			local stock market.
Mueller & Pauley (1995)	US, 1972 – 1993, Monthly	REIT	Regression	The result indicated that the price movement has a low correlation with changes in interest rate and a lower correlation of interest rate than with movement in the stock market as a whole.
Nittayagasetwat & Buranasiri (2012)	US, 2000 – 2011, Monthly	REIT	Regression	The monthly return on long-term US high-grade corporate bonds was the statistically significant interest rate proxy, which affected REIT performance.
Okunev, Wilson & Zurbruegg (2000)	US, 1972 – 1998, Monthly	REIT	VAR Granger (Causality)	Strong unidirectional non-linear relationship running from the stock market to REIT was found.
Payne (2003)	US, 1982 – 2003, Monthly	REIT	VAR (Impulse Response)	Unexpected shocks in the broad stock market index have a positive impact on REITs. An unexpected shock to the term structure has an adverse effect on REITs.
Simpson, Ramchander & Webb (2007)	US, 1981 – 2002 and 1990 – 2002, Monthly	REIT	Regression	During expansionary periods, REIT returns go up with both increases and decreases in inflation. However, during restrictive monetary policy periods, the asymmetric framework cannot explain the perverse relationship between REIT returns and inflation.
Swanson, Theis & Casey (2002)	US,1989 – 1998, Daily	REIT	Regression	They found that value weighted stock index and risk premium of a 30-year Treasury bond appears to explain REIT return better than other interest rate proxy used.
Yunus (2012)	US, Canada, Japan, Australia, Germany, France, Italy, Netherlands, Switzerland and U.K. 1990 – 2007,	REIT	Cointegration and VAR (Granger Causality and Impulse Response)	Property markets co-integrated with its respective stock markets in the long run. In the majority of the countries investigated, property returns positively responded to shocks to the stock market.

	Monthly and Quarterly			

2.6 Other variables

Previous studies have identified other economic variables that are not considered in this study:

- demographics (Lynn 2007)
- employment/unemployment levels (Brooks & Tsolacos 1999)
- the cost and availability of mortgage credit (Downs et al. 2003)
- new development under construction or in the planning stage (Clark & Daniel 2006; Franken, Bloom & Erasmus 2011)
- construction costs (Downs et al. 2003; Franken, Bloom & Erasmus 2011)
- oil (Chen, Roll & Ross 1986; Clark & Daniel 2006; Hoesli, Lizieri & MacGregor 2008, Huang & Lee 2009)
- motor vehicle sales (Clark & Daniel 2006)
- debt/household income (Standish et al. 2005; Clark & Daniel 2006; Franken, Bloom & Erasmus 2011)
- liquidity (Ilmanen 2012)
- dividend yield (Downs et al. 2003; Brooks & Tsolacos 1999)

The variables above were not considered for this study as they are not frequently tested, lack reliable data, were not necessary economic variables and were not found to be significant variables in prior studies.

2.7 South African literature

Currently, research into the South African property market is limited, with the majority of the focus placed on performance in the residential sector.

Standish et al. (2005) focused on isolating the determinants of residential property in South Africa and developed two national models. One model covers the period from 1974 to 2003 and another model covers the period from 1994 to 2003. For the 1974 to 2003 model, significant variables were net immigration (positive relationship), real capitalisation of JSE (negative relationship), foreign direct investment (positive relationship), the real Rand gold price (positive relationship) and the Rand dollar exchange rate (negative relationship). For the 1994 to 2003, significant variables were the ratio of household debt to income (negative relationship), foreign direct investment (positive relationship) and the real Rand gold price (positive relationship).

Clark and Daniel (2006) developed a forecast model for South Africa's residential housing market. They identified the following variables to forecast South African residential housing prices: All-Share Index (positive relationship), GDP (positive relationship), Prime Interest Rate (negative relationship), Rand/US Dollar exchange rates (negative relationship) and transfer costs (positive relationship).

In their research, Franken, Bloom and Erasmus (2011) identified eight indicators that could be utilised as predictors of future residential estate price cycles. The variables were: construction costs, consumption, the debt to income ratio, GDP, inflation, interest rate, the JSE ALSI and affordability. All the variables are positively related to residential properties prices.

Simo-Kengne, Bittencourt and Gupta (2012) investigated the economic impact of house prices in South Africa using a panel data set that covered all nine provinces from 1996 to 2010. They found strong evidence that economic growth affects house prices.

Further, a working paper by Simo-Kengne, Bittencourt and Gupta (2013) found that in South Africa house price changes exhibit a significant effect on regional economic growth. The paper

applied a VAR model to investigate the extent to which macroeconomic shocks are responsible for the common component in house price movements. The results indicate that all macro shocks have significant influences on real house prices with portfolio shocks having the largest fraction in the total variability in real house prices followed by monetary policy shocks. This finding substantiates the user-cost theory, which emphasises the importance of interest rates and expectations in driving house price dynamics. Thus, there is evidence to suggest that during periods of high volatility in house prices, interest rates fall steadily and people expect strong growth in house prices, resulting in lower user costs of housing, which in turn increases property prices.

Du Toit and Cloete (2004) provided one of few commercial property studies that considered the development of an integrated property and asset market model for South African property markets, utilising the Pretoria office market as case study. They apply the FDW real estate model (DiPasquale & Wheaton 1992) to simulate the interrelationships between property and asset markets in a diagrammatic quadrant model configuration.

Mangani (2011) applied the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model to investigate monetary policy on the JSE portfolio for the period from 1990 to 2009. The analysis showed that repo rates changes are important for describing mean return and return volatilities. The repo rate has a significant negative coefficient; this indicates that contractionary monetary policy tended to lower stock returns as theoretically postulated. However, the effect of repo rate changes were found to be asymmetrical, i.e., the impact of the repo rate changes differs for positive rate changes versus a negative rate changes. The results suggest that JSE returns are more responsive to contractionary monetary policy than to expansionary policy

Boshoff and Cloete (2012) applied a correlation to determine the relationship between property share price and economic variables. They found that the share price of PLS is correlated to employment (in private, public and non-agriculture sector), disposal income, national government revenue and expenditure, GDP (at market prices) and gross value added at basic prices of construction (a measure of construction industry activity used in calculation of

GDP) and repo rates. However, they pointed out that there are limitations to their research, as they applied a simple linear correlation and thus excluded the combined effect of more than one variable.

Table 9 summarises South African academic literature reviewed by period, frequency, data used, methodologies and variables found to be of significance.

Table 9: Summary of South African academic literature review

Author	Country, period of analysis, frequency of data	Data Used	Methodologies	Variables found to be significant
Standish et al. (2005)	SA, 1974 – 2003, Quarterly	ABSA Housing Index	Regression	They found that net immigration (positive relationship), real capitalisation of JSE (negative relationship), foreign direct investment (positive relationship), real Rand gold price (positive relationship), and rand dollar exchange rate (negative relationship) to be significant variables.
Clark & Daniel (2006)	SA, 1980 – 2006, Quarterly	Residential house price	Regression	All-Share Index (positive relationship), GDP (positive relationship), Prime Interest Rate (negative relationship), Rand/US Dollar exchange rates (negative relationship), and transfer costs (positive relationship)
Franken, Bloom & Erasmus (2011)	SA, 1974 – 2004, Quarterly	Residential house price	Regression	constructions cost, consumption, the debt to income ratio, GDP, inflation, interest rate, the JSE ALSI, and affordability (all positive relationship)
Boshoff and Cloete (2012)	SA, 2000 – 2009, not disclosed	Used Share Price of PLS	Correlation	Repo interest rate (negative relationship) GDP (positive relationship)

2.8 Summary and conclusion

This chapter chronicles existing literature in this field both in South Africa and internationally and is summarised as follows:

Property is a financial asset, and as financial theory suggests should be sensitive to economic variables (Chen, Roll & Ross 1986). Theoretical frameworks such as DiPasquale and Wheaton (1992), Ilmanen (2012) and prior empirical research summarised earlier have identified the following variables as being of critical importance:

- The performance of the stock market (section 2.1) is considered as one of the most frequently used variables in prior research, and the majority of the research found a positive relationship between property returns and stock market performance.
- Economic growth (section 2.2) was identified in the various theoretical frameworks (DiPasquale & Wheaton 1992; The Appraisal Institute 2008); prior empirical research yielded mixed results. (The majority of studies found a positive relationship, which is consistent with economic theory.)
- Interest rates (section 2.3) influence property returns through the impact on cash return of the property and/or capitalisation rate. The results of empirical research are mixed, but the majority found a negative relationship between property returns and the interest rate; this negative relationship is consistent with theoretical arguments. Non-academic research found a mostly positive relationship between property returns and interest rates. The inconsistency can be attributed to different period, data, proxies[13] and methodologies deployed.
- Inflation (section 2.4) is an extensively researched variable. The often used proxies are actual inflation (section 2.4.1), expected inflation (section 2.4.2) and unexpected inflation (section 2.4.2). Most past studies found no significant relationship between inflation (actual, expected and unexpected) and property returns.

[13] See section 2.3.1: nominal nterest rate, real interest rate, risk premium, term structure, change in expected inflation, short-term interest rates, long-term interest rates, investment rate, and borrowing rate

- South African literature (section 2.7) is limited, with the majority of studies focused on residential house price. The stock market and GDP were found to have a positive relationship (Clark & Daniel 2006; Franken, Bloom & Erasmus 2011; Boshoff & Cloete 2012) to residential property prices. The interest rate was found to have both positive (Clark & Daniel 2006) and negative relationships (Franken, Bloom & Erasmus 2011; Boshoff & Cloete 2012).

Chapter 4 will test the selected variables.

3. Research Methodology

This research is based on a deductive approach and brings together the theoretical framework, relevant statistical methodologies and economic variables identified in previous studies as presented in Chapter 2. This chapter provides further details on how proxies for the chosen economic variables were selected and how the data was collected.

Based on economic theories and a review of previous international and local studies, it seems reasonable to suggest that there are statistically significant economic variables that influence commercial property returns.

3.1 Statistical methodology

The objective of this study is to investigate and identify the macroeconomic variables that systematically affect commercial properties returns. There are two methodologies applied in this study, namely: cross-sectional regression and vector autoregression (VAR). These two statistical approaches were the most frequently used[14] in prior research and were chosen for this research. As discussed in the previous chapters, previous research applied either regression or VAR models. This study applies both regression and VAR methodologies.

In order to assess the robustness of this research, this study considered both listed and unlisted commercial properties. IPD data is the proxy used for listed commercial properties are listed property indices and proxy for unlisted commercial properties. This approach of testing both listed and unlisted data is similar to the approach of prior studies (see Ling & Naranjo 1997; Hoesli, Lizieri & MacGregor 2008). Table 10 summarises the statistical methodologies applied for this research.

[14] Seventeen prior literatures cited in this research used regression (see 3.1.1 for the references) and ten prior literatures used VAR (see section 3.1.2 for details).

Table 10: Summary of statistical methodologies to be applied

Type of commercial properties	Methodologies
Unlisted	Cross-sectional regression
Unlisted	VAR, variance decomposition and impulse response
Listed	Cross-sectional regression
Listed	VAR, variance decomposition and impulse response

Most prior research focused narrowly on one or two macroeconomic variables only and applied either one of the statistical methodologies mentioned above (see Table 11).

Table 11: Summary of academic literature review (in alphabetical order)

Author	Methodologies	Variables considered in the research
Adrangi, Chatrath & Raffliee (2004)	Regression and cointegration tests	Inflation
Allen, Madura & Springer (2000)	Regression	Interest rate and stock market
Boudry, Coulson, Kallberg & Liu (2012)	VECM	Stock market (various proxies)
Brooks & Tsolacos (1999)	VAR (variance decomposition and impulse response)	Rate of unemployment, interest rates (various proxies), inflation and the dividend yield
Chatrath & Liang (1998)	Regression and cointegration tests	Inflation
Chen, Hsieh & Jordan (1997)	Regression	Inflation (various proxies), interest rate (various proxies), stock market
Chen et al. (1998)	Regression	Inflation (various proxies), interest rate (various proxies), stock market
Chen et al. (2012)	Regression	Interest rate
Downs et al. (2003)	VAR (Variance decomposition and impulse response)	Stock market, interest rate (various proxies), other variables (construction, industrial production, dividend yield)
Ewing & Payne (2005)	VAR (generalised impulse response)	Interest rate (federal funds rate, the default risk premium) the index of coincident indicators, inflation
Glascock, Lu & So (2002)	VECM, VAR (variance decomposition and impulse response)	Interest rate (federal fund rate), inflation (CPI, unexpected, expected), other variables (industrial production)
Huang & Lee (2009)	Autoregressive Integrated Moving	Oil, stock market, interest rate (short

	Average (ARIMA)	term and long term).
He, Webb & Myer (2003)	Flexible least square	Interest rate (various)
Hoesli, Lizieri & MacGregor (2008)	Error correction model	Inflation (various)
Laopodis (2009)	VAR (variance decomposition and Impulse Response)	Stock market, other variables (industrial production)
Lieser & Groh (2013)	Augmented panel regression analysis	Other variables (economic activities, real estate investment opportunities, depth and sophistication of capital markets, investor protection and legal framework, admin burden and regulatory limitation, socio-cultural and political environment)
Ling & Naranjo (1997)	Regression	Inflation, interest rate (treasury bill, term structure), other variables (consumption expenditures)
Liow (2010)	Cointegration test	Stock market
Mueller & Pauley (1995)	Regression	Stock market, interest rate (various)
Nittayagasetwat & Buranasiri (2012)	Regression	Interest rate (various)
Okunev, Wilson & Zurbruegg (2000)	VAR granger (causality)	Stock market
Payne (2003)	VAR (impulse response)	Stock market, inflation, interest rate (various), other variables (industrial production), inflation
Simpson, Ramchander & Webb (2007)	Regression	Inflation (various)
Swanson, Theis & Casey (2002)	Regression	Interest rate (various)
Yunus (2012)	Cointegration and VAR (Granger causality and impulse response)	Stock, economic growth, inflation, interest rate, other variable (money supply)

3.1.1 Regression analysis

Regression analysis is the main tool of econometrics and concerned with the statistical dependence of the dependent variable on one or more explanatory variables (Gujarati 2003). This method and its modified approaches are a popular method known as cross-sectional regression, as the explanatory variables are associated with one period or point in time. The regression is subject to normal distribution of the data, and thus the Jarque–Bera test was applied to test stationarity (Clark & Daniel 2006).

This method were used in a number of prior studies (see Chen, Roll & Ross 1986; Mueller & Pauley 1995; Chen, Hsieh & Jordan 1997; Ling & Naranjo 1997; Chatrath & Liang 1998; Chen et al. 1998; Clayton & MacKinnon 2001; Swanson, Theis & Casey 2002; He, Webb & Myer 2003; Standish et al. 2005; Clark & Daniel 2006; Simpson, Ramchander & Webb 2007; Franken, Bloom & Erasmus 2011; Adrangi, Chatrath & Raffliee 2004; Chen et al. 2012; Nittayagasetwat & Buranasiri 2012; Simo-Kengne, Bittencourt & Gupta 2012).

The modified regression approaches, such as flexible least square (He, Webb & Myer 2003), seemingly unrelated regression (Simo-Kengne, Bittencourt & Gupta 2013), augmented panel regression analysis (Lieser & Groh 2013), were not frequently used and are not applicable to this research; thus, they were not applied.

The assumptions of the multiple regression models are (Pindyck & Rubinfeld 1998):

1. The relationship between the independent (X) and the dependent (Y) variables is linear.
2. The independent variable (X) has no exact linear relationships between two or more independent variables, i.e., the independent variables are independent.
3. The error has zero expected value for all observations.
4. The error terms have constant variance for all observations. If not, it is called heteroskedasticity.
5. Errors terms corresponding to different observations are independent and therefore uncorrelated.
6. The error term is normally distributed.

The formula for regression will be as follows:

Equation 3: Regression

$$\mathbf{Y} = \alpha + \beta_1 \mathbf{X}_1 + \beta_2 \mathbf{X}_2 + \ldots \beta_n \mathbf{X}_n + \varepsilon \quad \textbf{[3.1]}$$

Where:

Y is the dependent variable, α is a constant, $\beta_{1, 2, n}$ are coefficient of independent variables, $\mathbf{X}_{1, 2, n}$ are independent variables and ε is error term.

More specifically, the regression equation would be:

Equation 4: Regression of Unlisted Property

$$\mathbf{IPD} = \alpha + \beta_1 \mathbf{ALSI} + \beta_2 \mathbf{CPI} + \beta_3 \mathbf{GDP} + \beta_4 \mathbf{LB} + \varepsilon \quad \textbf{[3.2]}$$

Where:

IPD	IPD total return (annual)
ALSI	Changes in JSE/FTSE All-Share Index total return (i.e., include dividends, annual)
CPI	Changes in Consumer Price Index (annual)
GDP	Changes in Gross Domestic Product (annual)
LB	Changes in 10-Year Government Yield (annual)

Equation 5: Regression of Listed Property

$$\mathbf{J256T} = \alpha + \beta_1 \mathbf{ALSI} + \beta_2 \mathbf{CPI} + \beta_3 \mathbf{GDP} + \beta_4 \mathbf{LB} + \varepsilon$$

[3.3]

Where:

J256T The changes in total returns indices of Property Loan Stock (include all distribution, quarterly)

ALSI Changes in JSE/FTSE All-Share Index total return (i.e., include dividends, quarterly)

CPI Changes in Consumer Price Index (quarterly)

GDP Changes in Gross Domestic Product (quarterly)

LB Changes in 10-Year Government Yield (quarterly)

3.1.2 Vector autoregression (VAR)

Vector autoregression was introduced as an alternative approach to multi-equation modelling through the work of Christopher Sims (Pindyck & Rubinfeld 1998), who was awarded Nobel Memorial Prize in Economics in 2011 for his 'empirical research on cause and effect in the macroeconomy'.[15]

Sims (1980) formulated the VAR model to assume all variables to be endogenous. The application of VAR model requires only two specifications:

1. The variables (endogenous and exogenous) are believed to interact and hence are included as part of the economic system.

[15] Nobel Prize Website – http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2011/sims-facts.html

2. The largest number of lags needed must capture most of the effects that the variables have on each other (Pindyck & Rubinfeld 1998).

The VAR methodology has the following advantages over other methods:

1. It has few theoretical restrictions (Laopodis 2009).
2. It enables the researcher to determine the adjustment time required for REIT to incorporate information from change within these economic variables (Downs et al. 2003).
3. It provides information on the magnitude of the shocks.
4. It is suitable when variables within the model are highly autocorrelated.

Numerous prior studies in this field have applied this methodology and its derivatives (see Brooks & Tsolacos 1999; Glascock, Lu & So 2002; Downs et al. 2003; Payne 2003; Ewing & Payne 2005; Laopodis 2009; Chang, Chen & Leung 2011; Boudry, Coulson, Kallberg & Liu 2012; Yunus 2012; Simo-Kengne, Bittencourt & Gupta 2013).

There are three forms of VAR model, namely: reduced, structured, and recursive (Stock & Watson 2001).

- A reduced form of VAR expresses each variable as a linear function of its own past values, the past values of all other variables being considered and a serially uncorrelated error term.
- A structural VAR uses economic theory to sort out the contemporaneous links among the variables. Structural VARs require 'identifying assumptions' that allow correlations to be interpreted causally. These identifying assumptions can involve the entire VAR, so that all of the causal links in the model are spelled out, or just a single equation, so that only a specific causal link is identified.
- A recursive VAR constructs the error terms in each regression equation to be uncorrelated with the error in the preceding equations. This is done by judiciously including some contemporaneous values as regressors.

This research applies the reduced form, as the study assumes no structural inferences of the variables (i.e., does not impose any restrictions about which of the variables affect the others, as would be the case in a regression model). It is assumed that variables are related to their own lagged values and the lagged values of the other variables over time (Brooks & Tsolacos 1999).

The general form of a VAR model is given by the following unrestricted reduced-form) system:

Equation 6: General form of VAR

$$\boldsymbol{Y_t = \alpha + \beta\ (L)\ Z_t + v_t} \qquad \textbf{[3.4]}$$

Where:

$\boldsymbol{Y_t}$ is a vector of the *n* stationary endogenous variable, α is an *n* X 1 vector of constants, β ***(L)*** is an *n X n* matrix of (lagged) polynomial coefficients, and $\boldsymbol{v_t}$ is an *n* X 1 vector of white noise innovation terms with $E(v_{tk}) = 0$ and $E(v_{tk}, v_{sk}) = 0$ for $t \neq s$. The disturbance term $\boldsymbol{v_t}$, also has a covariance matrix, $E(v_t, v_t) = \Sigma$.

Finally, the lag operator is defined as: $\beta\ (L) = \beta_1 + \beta_2 + \ldots + \beta_k L^{k-1}$ of degree *k* -1 and β_j, for *j =1, …k.* Laopodis (2009)

Specifically, the general four-equation VAR system can be expressed as follows:

Equation 7: VAR of Unlisted Property

$$\textbf{IPD}_t = \alpha + \sum_{i=1}^{n} a1,i\ \textbf{IPD}_{t-i} + \sum_{i=1}^{n} b1,i\ \textbf{ALSI}_{t-i} + \sum_{i=1}^{n} c1,i\ \textbf{CPI}_{t-i} + \sum_{i=1}^{n} d1,i\ \textbf{GDP}_{t-i} + \sum_{i=1}^{n} e1,i\ \textbf{LB}_{t-i} + \varepsilon$$

[Formula 3.4.1]

$$\textbf{ALSI}_t = \alpha + \sum_{i=1}^{n} a2,i\ \textbf{IPD}_{t-i} + \sum_{i=1}^{n} b2,i\ \textbf{ALSI}_{t-i} + \sum_{i=1}^{n} c2,i\ \textbf{CPI}_{t-i} + \sum_{i=1}^{n} d2,i\ \textbf{GDP}_{t-i} + \sum_{i=1}^{n} e2,i\ \textbf{LB}_{t-i} + \varepsilon$$

[Formula 3.4.2]

$$\textbf{CPI}_t = \alpha + \sum_{i=1}^{n} a3,i\ \textbf{IPD}_{t-i} + \sum_{i=1}^{n} b3,i\ \textbf{ALSI}_{t-i} + \sum_{i=1}^{n} c3,i\ \textbf{CPI}_{t-i} + \sum_{i=1}^{n} d3,i\ \textbf{GDP}_{t-i} + \sum_{i=1}^{n} e3,i\ \textbf{LB}_{t-i} + \varepsilon$$

[Formula 3.4.3]

$$\mathbf{GDP}_t = \alpha + \sum_{i=1}^{n} a4,i\ \mathbf{IPD}_{t-i} + \sum_{i=1}^{n} b4,i\ \mathbf{ALSI}_{t-i} + \sum_{i=1}^{n} c4,i\ \mathbf{CPI}_{t-i} + \sum_{i=1}^{n} d4,i\ \mathbf{GDP}_{t-i} + \sum_{i=1}^{n} e4,i\ \mathbf{LB}_{t-i} + \varepsilon$$

[Formula 3.4.4]

$$\mathbf{LB}_t = \alpha + \sum_{i=1}^{n} a5,i\ \mathbf{IPD}_{t-i} + \sum_{i=1}^{n} b5,i\ \mathbf{ALSI}_{t-i} + \sum_{i=1}^{n} c5,i\ \mathbf{CPI}_{t-i} + \sum_{i=1}^{n} d5,i\ \mathbf{GDP}_{t-i} + \sum_{i=1}^{n} e5,i\ \mathbf{LB}_{t-i} + \varepsilon$$

[Formula 3.4.5]

Where:

IPD	IPD total return (annual)
ALSI	Changes in JSE/FTSE All-Share Index total return (i.e., include dividends, annual)
CPI	Changes in Consumer Price Index (annual)
GDP	Changes in Gross Domestic Product (annual)
LB	Changes in 10-Year Government Yield (annual)

Equation 8: VAR of Listed Property

$$\mathbf{J256T}_t = \alpha + \sum_{i=1}^{n} a1,i\ \mathbf{J256T}_{t-i} + \sum_{i=1}^{n} b1,i\ \mathbf{ALSI}_{t-i} + \sum_{i=1}^{n} c1,i\ \mathbf{CPI}_{t-i} + \sum_{i=1}^{n} d1,i\ \mathbf{GDP}_{t-i} + \sum_{i=1}^{n} e1,i\ \mathbf{LB}_{t-i} + \varepsilon$$

[Formula 3.5.1]

$$\mathbf{ALSI}_t = \alpha + \sum_{i=1}^{n} a2,i\ \mathbf{J256T}_{t-i} + \sum_{i=1}^{n} b2,i\ \mathbf{ALSI}_{t-i} + \sum_{i=1}^{n} c2,i\ \mathbf{CPI}_{t-i} + \sum_{i=1}^{n} d2,i\ \mathbf{GDP}_{t-i} + \sum_{i=1}^{n} e2,i\ \mathbf{LB}_{t-i} + \varepsilon$$

[Formula 3.5.2]

$$\mathbf{CPI}_t = \alpha + \sum_{i=1}^{n} a3,i\ \mathbf{J256T}_{t-i} + \sum_{i=1}^{n} b3,i\ \mathbf{ALSI}_{t-i} + \sum_{i=1}^{n} c3,i\ \mathbf{CPI}_{t-i} + \sum_{i=1}^{n} d3,i\ \mathbf{GDP}_{t-i} + \sum_{i=1}^{n} e3,i\ \mathbf{LB}_{t-i} + \varepsilon$$

[Formula 3.5.3]

$$\mathbf{GDP}_t = \alpha + \sum_{i=1}^{n} a4,i\ \mathbf{J256T}_{t-i} + \sum_{i=1}^{n} b4,i\ \mathbf{ALSI}_{t-i} + \sum_{i=1}^{n} c4,i\ \mathbf{CPI}_{t-i} + \sum_{i=1}^{n} d4,i\ \mathbf{GDP}_{t-i} + \sum_{i=1}^{n} e4,i\ \mathbf{LB}_{t-i} + \varepsilon$$

[Formula 3.5.4]

$$\mathbf{LB}_t = \alpha + \sum_{i=1}^{n} a5,i\ \mathbf{J256T}_{t-i} + \sum_{i=1}^{n} b5,i\ \mathbf{ALSI}_{t-i} + \sum_{i=1}^{n} c5,i\ \mathbf{CPI}_{t-i} + \sum_{i=1}^{n} d5,i\ \mathbf{GDP}_{t-i} + \sum_{i=1}^{n} e5,i\ \mathbf{LB}_{t-i} + \varepsilon$$

[Formula 3.5.5]

Where:

J256T Changes in total returns indices of Property Loan Stock (include all distribution, quarterly)

ALSI Changes in JSE/FTSE All-Share Index total return (i.e., include dividends, quarterly)

CPI Changes in Consumer Price Index (quarterly)

GDP Changes in Gross Domestic Product (quarterly)

LB Changes in 10-year Government Yield (quarterly)

The VAR tests included in this study are vector autoregression, variance decomposition and impulse response functions.

The variance decomposition expresses each variable mathematically as a linear combination of its and other variables' current and past forecast errors (residual terms) (Downs et al. 2003).

The impulse response function of the VAR analysis provides insight on the speed of information transmission among the commercial property returns and the economic variables. Also its analysis identifies changes over time in the dependent variables.

All variables included in the VAR tests need to be stationary in order to carry out the significance test. Thus, all variables were subjected to augmented Dickey–Fuller tests. Also, in order for a VAR to be unrestricted, it is required that the same number of lags of all of the variables is used in all equations. Therefore, Akaike's information criterion (AIC) was used.

3.2 Data and proxy selection

Macroeconomic variables relevant to this study were selected from prior research (see Chapter 2). In addition to identifying potential macroeconomic variables that influence property returns, relevant proxies for each of the variables were identified.

3.2.1 Unlisted properties

The commercial properties returns data used as the proxy of **unlisted commercial properties** were collected from Investment Property Databank (IPD). IPD published the first index in 1997. As of the end of 2011, the IPD databank in South Africa includes over 2000 properties with a value of over R205 billion[16]. IPD returns show the return of direct property without any gearing or market impacts. The observation of the data is on an annual basis, as the IPD data is available annually.

Earlier studies by Hoesli, Lizieri and MacGregor (2008), Boudry et al. (2012) and Towers Watson (2012) used IPD data.

The other proxies identified for analysis were: stock market, economic growth, inflation and interest rates.

Stock market: The proxy chosen is the annual percentage change FTSE/JSE All-Share Index (J203T), which is the total returns index (includes dividends distribution). The data was obtained from INET BFA[17]. The use of J203T is a consistent with prior local research such as Clark and Daniel (2006) and Franken, Bloom and Erasmus (2011). However, this research uses total returns are used instead of price only, as most prior research locally and internationally uses price indices only.

Economic growth: The proxy chosen was the annual percentage change in GDP. The data was obtained from Bureau of Economic Research (BER). GDP was used as a proxy in several studies

[16] www.ipd.co.za
[17] www.inetbfa.com

(see Standish et al. 2005; Clark & Daniel 2006; Chang, Cheng & Leung 2011; Franken, Bloom & Erasmus 2011; Boshoff & Cloete 2012; Yunus 2012; Lieser & Groh 2013).

Inflation: The proxy chosen is the annual percentage change of the annual CPI. The data was calculated by Statistics South Africa and obtained from BER. CPI is a consistent proxy for inflation as per previous international studies (see Chen, Roll & Ross 1986; Yobaccio, Rubens & Ketcham 1995; Chen, Hsieh & Jordan 1997; Chatrath & Liang 1998; Chen et al. 1998; Glascock, Lu & So 2002; Payne 2003; Adrangi, Chatrath & Raffliee 2004; Ewing & Payne 2005; Yunus 2012). In South African literature, Firer and McLeod (1999), Hassan and Biljon (2009) and Franken, Bloom and Erasmus (2011) use CPI.

Interest rate: The proxy chosen is the annual movement of ten-year government bond yield. The interest rate proxy is nominal, i.e., not adjusted with inflation (see Brooks & Tsolacos 1999). The data was maintained by South African Reserve Bank and obtained from BER.

The ten-year government bond yield is chosen over the Prime Interest Rate for the following reasons:

1. Prime Interest Rate is a borrowing interest rate for investors (i.e., investors cannot invest in the Prime Interest Rate). Thus in terms of a theoretical framework, it is not relevant for the estimation of cost of capital and capitalisation rate.
2. The government bond yield is considered as an investable risk-free return. As listed properties as an asset class are often compared to government bond, this can be observed from the publications from numerous investment analysts and asset managers (see Appendix 1).
3. Prior research in South Africa used the Prime Interest Rate as an interest rate proxy, as the studies all dealt with residential properties, and borrowing costs in residential properties are generally linked; thus Prime Interest Rate is a relevant proxy for residential (see Clark & Daniel 2006; Franken, Bloom & Erasmus 2011)
4. According to PwC (2012), the proxies used by business valuation practitioners for risk free rate are predominantly South African government bonds (79% of respondents in

2012, and in the 2010 survey, 93% of the respondent used South African government bonds).

Table 12 summarises the variables and proxies used for the unlisted properties.

Table 12: The variables and proxies used

Variables	Proxy (Code)	Data period	Frequency	Source
Unlisted commercial property returns	Total return of IPD databank (IPD)	1995 – 2012	Yearly	IPD
Stock market	Percentage changes of All-Share Index Total Returns (ALSI)	1995 – 2012	Yearly	INET BFA
Economic growth	Percentage changes in GDP (% GDP)	1995 – 2012	Yearly	BER
Inflation	Percentage changes in Consumer Price Index (CPI)	1995 – 2012	Yearly	BER
Interest rates	Percentage changes in 10-Year Government Yield (LB)	1995 – 2012	Yearly	BER

3.2.2 Listed properties

For **securitised commercial properties**, the proxy used is the quarterly changes of total return indices of PLS (J256T). PUT was not included in this study, as it accounted for only a small percentage of the listed property sector (see Figure 1 in Chapter 1, PUT is in blue and PLS in red).

The total return index is used, as this index captures the income return as well as the capital return of listed property. Income is an important part of securitised commercial properties return and thus must be incorporated. Figure 3 shows the historical total quarterly returns for PLS Income return (in red) and price appreciation (in blue). Several studies used total return indices: Brooks and Tsolacos (1999); Glascock, Lu and So (2002); Okunev, Wilson and Zurbruegg (2000); Laopodis (2009); and Nittayagasetwat and Buranasiri (2012). The other prior studies cited did not specify whether total return indices were used.

The data is quarterly, as the GDP data is available quarterly.

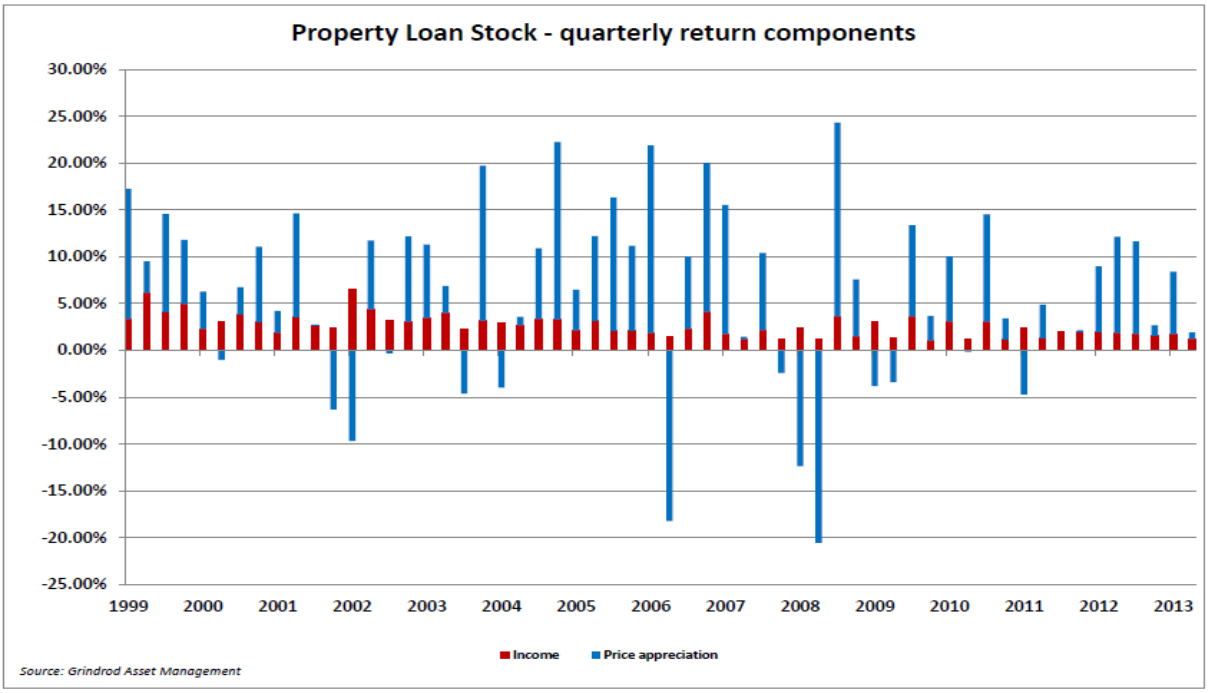


Figure 3: Quarterly Return of PLS – August 2013 (SA Reit Association 2013a)

The following proxies were identified for analyses:

- Quarterly percentage change FTSE/JSE All-Share Index (for stock market)
- Quarterly percentage change in the Gross Domestic Product (for economic growth)
- Quarterly percentage change in Consumer Price Index (for inflation)
- Quarterly percentages movement of averages of monthly ten-year government bond yield (for interest rates)

The proxies were the same as the proxies used for IPD, except the period is from 2002 to 2013, and the frequency is quarterly. This is due to the fact that J256T was started in 2002, as in that year the FTSE Group and the JSE entered into a partnership to create the FTSE/JSE Africa index Series. These new indices, which apply the FTSE global classification system (Mangani 2011), replaced the old indices and brought about a change in calculation methodologies[18]; limited

[18] See http://www.jse.co.za/Libraries/JSE_Magazine_educational_pullouts/Indices_for_Beginners.sflb.ashx

data were available prior to 2002. Table 13 summarises the variables and proxies used for the listed properties.

Table 13: Summary of variables, proxies, period and source of data

Variables	Proxy	Data period	Frequency	Source
Listed Commercial Property Returns	Total return of FTSE/JSE Listed Property Loan Stock (J256T)	Sept 2002 to Sept 2013	Quarterly	INET BFA
Stock Market	All-Share Index total returns (ALSI)	Sept 2002 to Sept 2013	Quarterly	INET BFA
Economic Growth	Percentage changes in GDP (% GDP)	Sept 2002 to Sept 2013	Quarterly	BER
Inflation	Percentage changes in Consumer Price Index (CPI)	Sept 2002 to Sept 2013	Quarterly	BER
Interest rates	Percentage changes in 10-Year Government Yield (LB)	Sept 2002 to Sept 2013	Quarterly	BER

3.2.3 Comparison between the proxy of listed and unlisted properties

According to Stan Garrun of IPD, IPD covers 65% of professionally managed unlisted properties and 80% of the listed property sector. The effect of the overlap is evident from Figure 4, which graphs the movement of ALSI, IPD and J256T from 2002 to 2012. Table 14 demonstrates correlation between the three variables ranges from 62% to 77%. The IPD is 69% correlated to J256T.

Table 14: Summary of variables, proxies, period and source of data

	J256T	ALSI	IPD
J256T	100%		
ALSI	77%	100%	
IPD	69%	62%	100%

The differences can be attributed to three variables:

1. Difference in population: not all listed property funds report to IPD, and IPD covers some unlisted property fund as well.
2. Gearing effects: IPD reports asset returns of underlying property; however, PLS companies in J256 are allowed to borrow and thus may be able to generate higher returns through gearing.
3. Difference in capital returns: IPD is an appraisal-based index and is not transaction-based. However, capital returns are based on the appreciation of the linked unit and do not necessarily correlate to the performance of the underlying assets. (For instance Growthpoint's trading price may exceed the Net Asset Value of the stock, due to the nature of the market.)

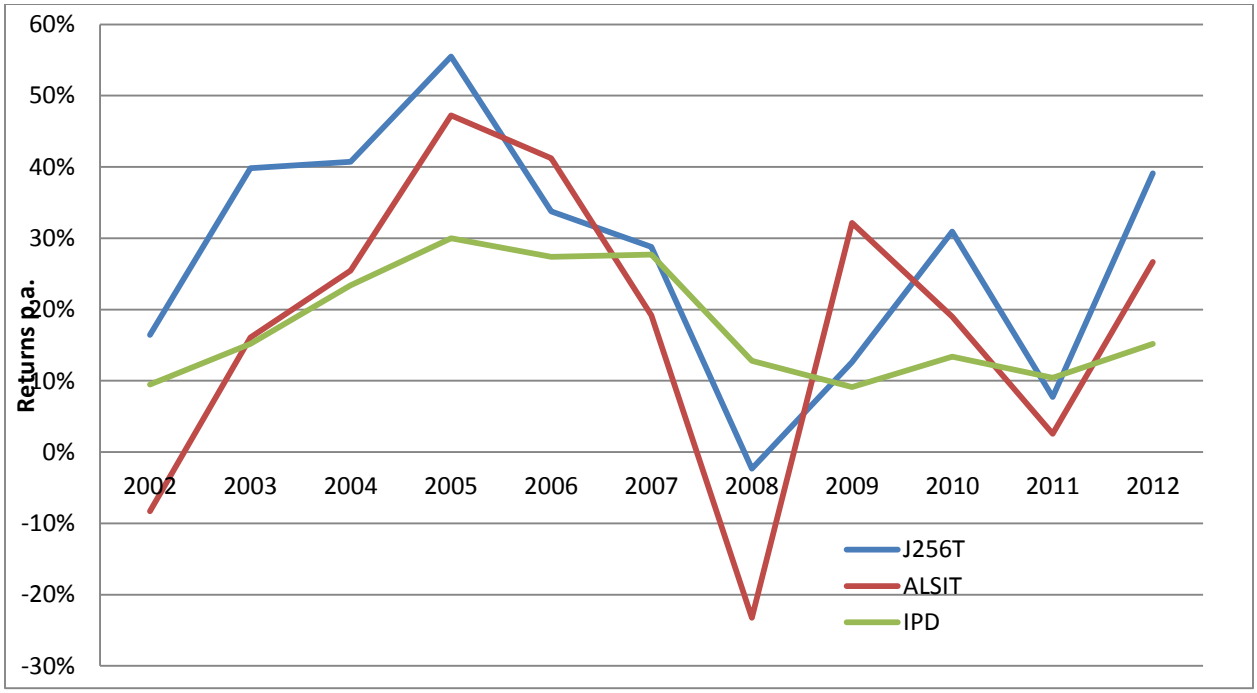


Figure 4: Returns of PLS, IPD and ALSI

This result is consistent with prior research by Boshoff and Cloete (2012) and Boudry et al. (2012), which found listed property relating to the underlying property market and activities.

3.2.4 Other proxies considerations

The variables used in this research are basic series and not derived series. Some examples of derived series used in prior research include:

- Real returns, i.e., nominal returns less inflation (Adrangi, Chatrath & Raffliee 2004).
- Excess return (Chen, Roll & Ross 1986; Ling & Naranjo 1997; Payne 2003; Laopodis 2009; Chen et al. 2012; Nittayagasetwat & Buranasiri 2012).
- Expected inflation (Chen, Roll & Ross 1986; Chen, Hsieh & Jordan 1997; Ling & Naranjo 1997; Chen et al. 1998; Simpson, Ramchander & Webb 2007; Hoesli, Lizieri & MacGregor 2008)
- Unexpected inflation, defined as the difference between the realised inflation rate (as measured by the Consumer Price Index) and the expected inflation rate (Chen, Roll & Ross 1986; Ling & Naranjo 1997; Brooks & Tsolacos 1999; Simpson, Ramchander & Webb 2007; Hoesli, Lizieri & MacGregor 2008)
- Real interest, defined as nominal treasury bill rate less inflation (Chen, Roll & Ross 1986; Standish et al. 2005)
- Risk premium, defined as Baa bond yield less long-term government yield (Chen, Roll & Ross 1986; Payne 2003; Chen et al. 2012; Nittayagasetwat & Buranasiri 2012)
- Term structure, defined as difference between long-term government yield less the Treasury bill rate (Chen, Roll & Ross 1986; Ling & Naranjo 1997; Chen, Hsieh & Jordan 1997; Chen et al. 1998; Swanson, Theis & Casey 2002; He, Webb & Myer 2003; Payne 2003; Nittayagasetwat & Buranasiri 2012)
- Property returns residual (employed by Brooks & Tsolacos 1999); the property returns were regressed on the stock market index and residuals saved.

This research avoided using the derived series, as the purpose of this research is to test the direct relationships between returns and identified economic variables. Clark and Daniel (2006), Laopodis (2009), Franken, Bloom and Erasmus (2011), and Yunus (2012) applied the methodology of using the basic series.

Industrial production is another indicator of economic growth (used by Chen, Roll & Ross 1986; Adrangi, Chatrath & Raffliee 2004; Ling & Naranjo 1997; Glascock, Lu & So 2002; Downs et al. 2003; Payne 2003; Laopodis 2009; Chen et al. 2012). Ewing and Payne (2005) used a coincidental index.

3.3 Application of statistical methodology

Eview[19] software was used to perform the statistical analysis. The process of statistical analysis was as follows:

1. Collect raw data described in section 3.2
2. Process data – as some data collected are in index form and thus need to be converted into 'changes in' the relevant proxies[20].
3. Data analysis
    a. Sample period analysis – to consider the business cycle and interest rate cycle of the sample period
    b. Descriptive statistics
        i. Histogram – use to detect outliers
        ii. Descriptive statistics – brief summary of the data
        iii. Jarque–Bera test - ensure the data is normally distributed
        iv. Correlation matrix – to identify the relationships between the variables
    c. Regression analysis
        i. Results
        ii. Assumptions – ensuring the assumptions for multiple regression are met
    d. Vector autoregression
        i. Histogram – used to detect outliers

[19] Version 7, a statistical package for Windows, used mainly for time-series oriented econometric analysis, http://www.eviews.com/

[20] During this process, the author detected that some of the data provided by INET BFA was incorrect. INET BFA was informed and data was subsequently corrected.

ii. Dickey–Fuller test – ensure the statistical process is stationary
iii. Vector autoregression
iv. Variance decomposition – The variance decomposition expresses each variable mathematically as a linear combination of its and other variables' current and past forecast errors.
v. Impulse response – The impulse response function of the VAR analysis provides insight on the speed of information transmission among the commercial property returns and the economic variables.

3.4 Summary

This chapter presented the two main statistical methodologies:

- Regression analysis and its underlying assumptions
- Vector autoregression and its underlying assumptions

Further, the chapter discussed the detail, source and justification for each of the proxies used. Moreover, it considered the data that would be appropriate in a South African context, including proxies for that could be applied for both listed and unlisted properties. The chapter tested a comparison between the performance of listed and unlisted property for the period 2002 to 2012. It found that the performance of listed and unlisted property was highly correlated. In addition, this chapter listed proxies used in previous studies that were excluded from this study. Finally, this section concluded the chapter with a description of each of the steps of the statistical methodology to be applied in the following chapter.

4. Results and Discussion

This chapter presents the results of the statistical analysis performed, the interpretations and the discussion of the results.

4.1 Unlisted properties (IPD)

4.1.1 Sample period analysis

Figure 5 shows the sample size of the data set is from 1995 to 2012 (18 annual data points per series). This period is characterised by a declining interest rate from 16% to 8%, thus not one full interest rate cycle. However, over the same period, there is at least one and a half business cycles (Composite Business Cycle – leading indicator[21] is used as a proxy for business cycles). Business and interest rate cycles were considered, as the period of research may affect the outcome of the results. For instance, Chen et al. (2012) found that monetary policy (the fed rate is used as a proxy) has a differential impact on the REIT market, and that the impact is significantly negative during bull markets and has no impact during bear/volatile markets.

[21] compiled by the South African Reserve Bank since 1983

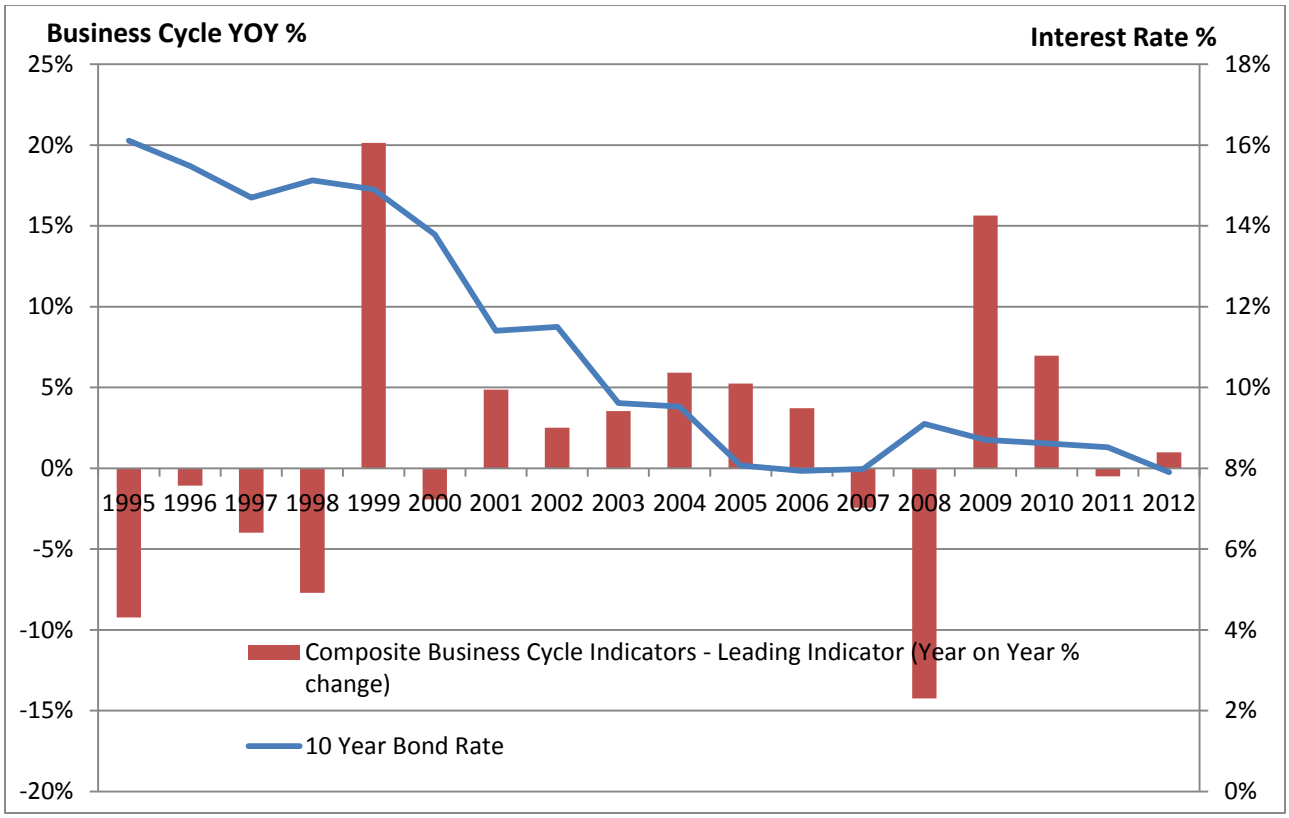


Figure 5: Business cycle and ten-year bond rate over the sample period

4.1.2 Descriptive statistics

Histogram

Histograms are used in Figure 6 to detect outliers (defined as extreme values that are very far removed from the rest of the data set) in the data set (Gujarati 2003). After reviewing the histograms, no outliers were detected at the either end of the histogram and none were removed from the data set.

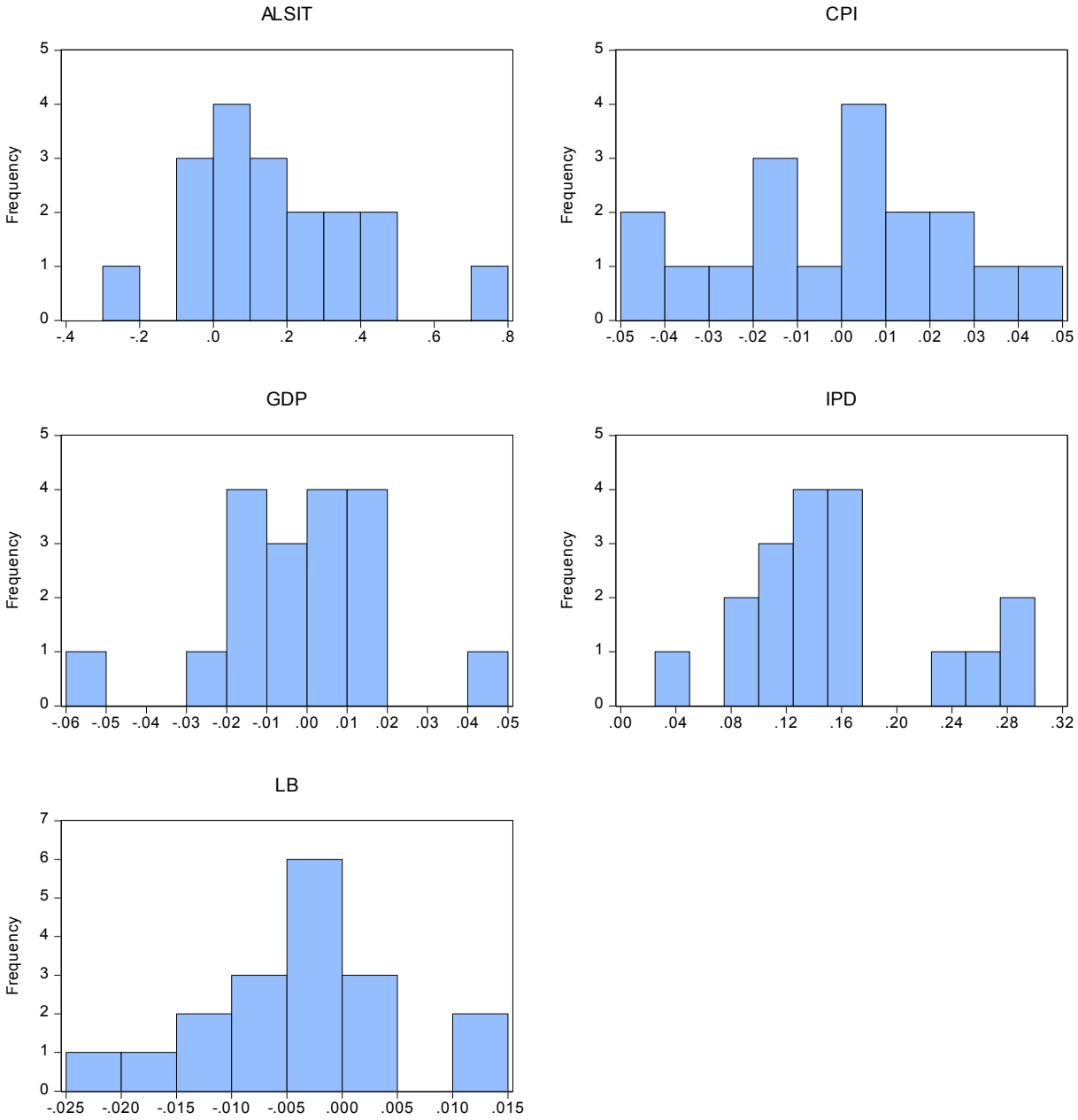


Figure 6: Data of variables

Descriptive statistics

Table 15 summarises the descriptive statistics used.

Table 15: Descriptive statistics

	IPD	ALSI	CPI	GDP	LB
Mean	0.16	0.17	0.00	0.00	0.00
Median	0.14	0.18	0.00	0.00	0.00
Maximum	0.30	0.71	0.04	0.05	0.01
Minimum	0.05	-0.23	-0.04	-0.05	-0.02
Std. Dev.	0.07	0.23	0.03	0.02	0.01
Skewness	0.82	0.44	-0.11	-0.21	-0.32
Kurtosis	2.66	2.97	2.21	3.86	3.01
Observations	18	18	18	18	18

Mean: Also known as average (Gujarati 2003), the mean is the weighted average of the data. The annual average total return for IPD during this period is 16% and ALSI is 17%.

Median: This is the number located in the middle of the data set (UCT 2011). The annual median total return for IPD during this period is 14% and ALSI is 18%; they are very close to the mean.

Maximum: This is the highest value in the data set; the highest annual return for IPD was 30% and ALSI is 71%[22].

Minimum: This is the lowest value in the data set. The lowest annual return for IPD was 5% and for ALSI is -23%.

Standard deviation: This is the square root of variance and is the most commonly employed measure of spread (UCT 2011). Higher numbers indicate a higher spread from the mean.

Skewness: This is a statistic that provides useful information about a symmetry probability distribution. For all symmetric distribution skewness should be zero. For non-symmetric distribution, it is positive when upper tail is thicker than lower tail and vice versa (Pindyck & Rubinfeld 1998). In the results, IPD and ALSI are marginally positive, and CPI, GDP, and LB are marginally negative.

[22] This number was verified against other data sources and is correct.

Kurtosis: This is a measure of 'thickness' of the tail distribution; for a normal distribution it is three. If the results are greater than three, it is thicker and vice versa (Pindyck & Rubinfeld 1998). IPD, ALSI and CPI are just below three; GDP and LB are above three.

Observation: This is the sample size of the data set. In this case, it is annually from 1995 to 2012 (18 data points per series).

Jarque–Bera test

Regression is a parametric test; thus, the data must be tested using the Jarque–Bera test to ensure the data is normally distributed. Jarque-Bera measures the difference of the skewness and kurtosis of the series with those from the normal distribution. Under the null hypothesis of a normal distribution, the Jarque–Bera statistic is distributed X^2 as with two degrees of freedom (Pindyck & Rubinfeld 1998).

Table 16: Jarque–Bera test

	IPD	ALSI	CPI	GDP	LB
Jarque–Bera	2.13	0.59	0.50	0.68	0.30
Probability	0.35	0.74	0.78	0.71	0.86
Reject Null hypothesis at 5%	No	No	No	No	No

Based on the results of Jarque–Bera test in Table 16, the data series can be assumed to be normally distributed.

Correlation matrix

Table 17: Correlation matrix

	IPD	ALSI	CPI	GDP	LB
IPD	1.00	0.42	0.20	0.24	-0.08
ALSI	0.42	1.00	-0.34	0.17	-0.36
CPI	0.20	-0.34	1.00	-0.04	0.18
GDP	0.24	0.17	-0.04	1.00	0.03
LB	-0.08	-0.36	0.18	0.03	1.00

In the correlation matrix (Table 17) above, IPD returns are positively correlated to ALSI, CPI and GDP, and are negatively related to the ten-year bond rate. None of the independent variables are correlated for greater than 0.7 or less than -0.7; thus there is no concern with multicollinearity (a statistical phenomenon in which two or more independent variables in a multiple regression model are highly correlated).

4.1.3 Regression analysis and vector autoregression

Due to the limited sample size of IPD data (18 data points), the results of the statistical analysis such as regression and the VAR model do not have any statistical significance.

There is no general description on what the minimum sample size should be, as it is dependent on sample distribution and a number of independent variables. Some economists think 30 is sufficient (Wooldridge 2012, p. 176)

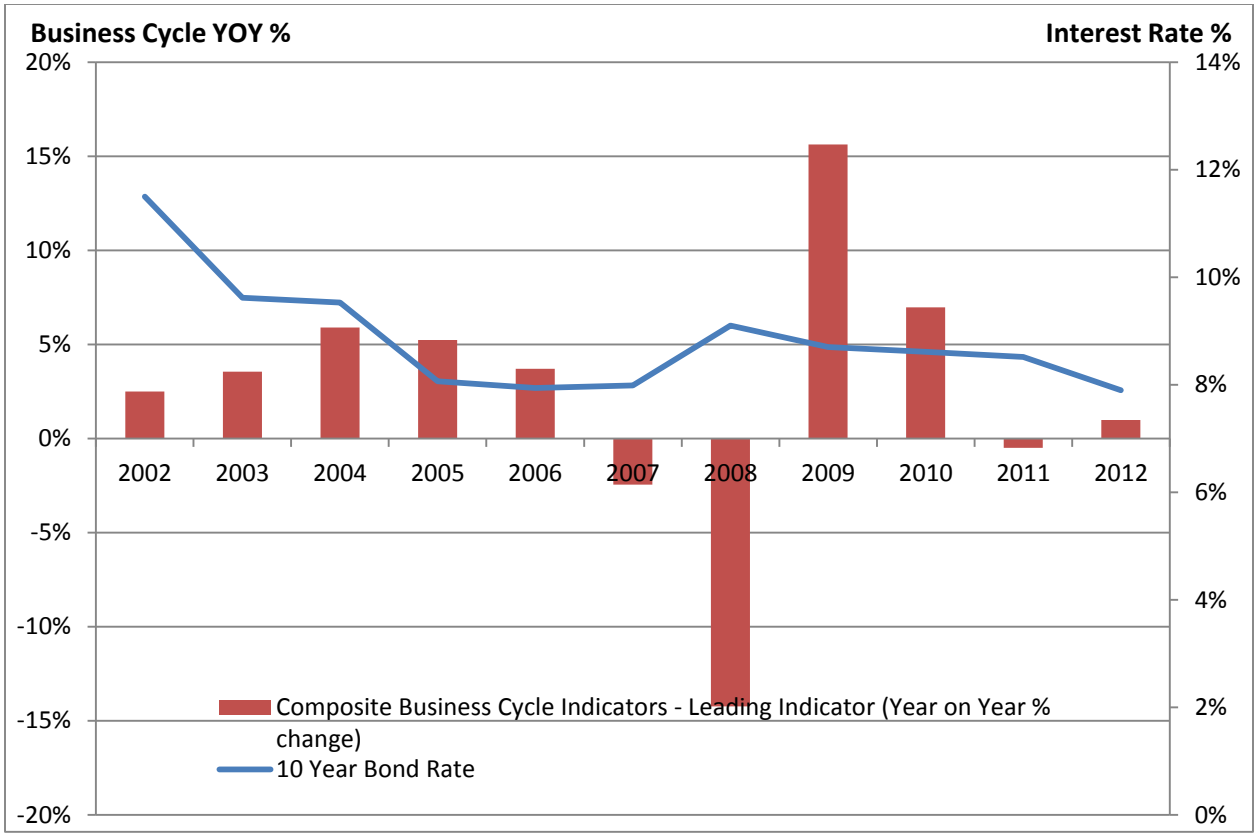
4.2 Listed (J256T, Property Loan Stocks)

4.2.1 Sample period analysis

Figure 7 shows the data set is quarterly from 2002 to 2013 (46 data points per series). This period is essentially not one full interest-rate cycle but half a cycle of declining interest rates

(from 12% to 8%). However, over the same period, there is at least one business cycle (the Composite Business Cycle – leading indicator[23] is used as a proxy for business cycles).

Figure 7: Business cycle and ten-year bond rate over the sample period



[23] Compiled by South African Reserve Bank since 1983

4.2.2 Descriptive statistics

Histogram

As shown in Figure 8, no outliers (defined as extreme values that are very far removed from the rest of the data set) were detected from the histograms earlier, and none were removed from the data set (Gujarati 2003). All the variables appear to be stationary.

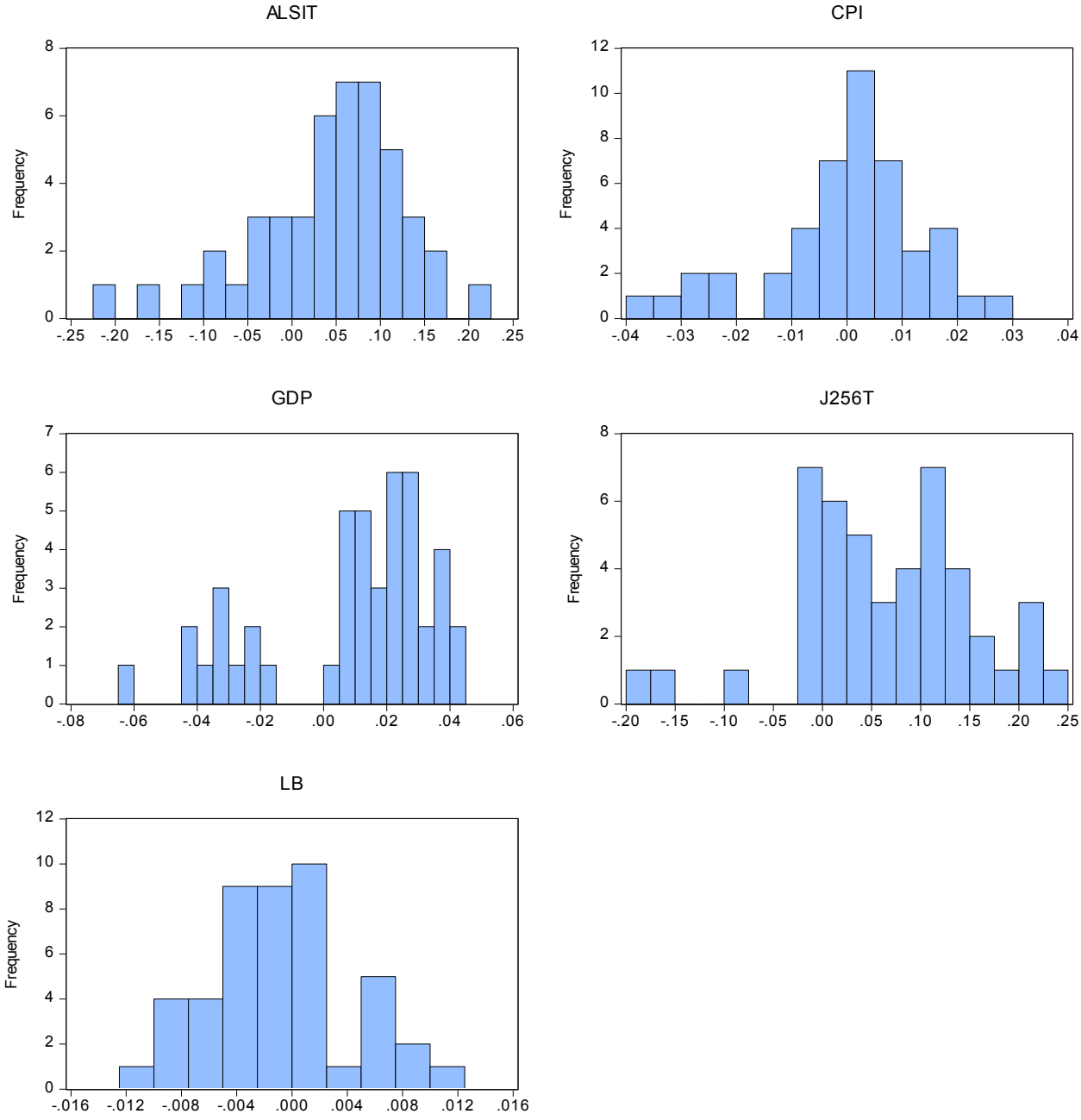


Figure 8: Data of Variables

Descriptive statistics

Table 18 summarises the descriptive statistics data set.

Table 18: Descriptive statistics

	J256T	ALSI	CPI	GDP	LB
Mean	0.06	0.04	<0.001	0.01	<0.001
Median	0.06	0.06	0.001	0.02	0.00
Maximum	0.25	0.20	0.03	0.04	0.01
Minimum	-0.20	-0.21	-0.04	-0.06	-0.01
Std. Dev.	0.09	0.08	0.01	0.03	0.01
Skewness	-0.46	-0.82	-0.71	-0.92	0.30
Kurtosis	3.59	3.72	3.57	2.81	2.55
Observations	46	46	46	46	46

Mean: Also known as the average (Gujarati 2003), the mean is the weighted average of the data. The quarterly average return for J256T during this period is 6% and ALSI is 4%.

Median: This is the number located in the middle of the data set (UCT 2011). The annual median total return for J256T during this period is 6% and ALSI is 6%; thus they are very close to the mean.

Maximum: This is the highest value in the data set. The highest quarterly return for J256T was 25% and ALSI was 20%.

Minimum: This is the lowest value in the data set. The lowest annual return for J256T was -20% and for ALSI is -21%.

Standard deviation: This is the square root of variance and is the most commonly employed measure of spread (UCT 2011). Higher numbers indicate a higher spread from the mean.

Skewness: This is a statistic that provides useful information about symmetry of probability distribution. For all symmetric distribution skewness should be zero. For non-symmetric distribution, it is positive when the upper tail is thicker than the lower tail and vice versa (Pindyck & Rubinfeld 1998). In this case, J256T, ALSI, CPI and GDP's lower tails are slightly thicker than their upper tails.

Kurtosis: This is a measure of 'thickness' of the tail distribution; for normal distribution it is three. If the results are greater than three, it is thicker and vice versa (Pindyck & Rubinfeld 1998). IPD, ALSI and CPI are all just above three; GDP and LB are just below three.

Observation: This is the sample size of the data set. In this case it is quarterly from 2002 to 2013 (46 data point per series).

Jarque–Bera test

Based on the results of Jarque–Bera test in Table 19 the data series can be assumed to be normally distributed.

Table 19: Jarque–Bera test

	J256T	ALSI	CPI	GDP	LB
Jarque–Bera	2.29	6.13	4.45	6.45	1.07
Probability	0.32	0.05	0.11	0.04	0.59
Reject Null hypothesis at 5%	No	No	No	No	No

Correlation matrix

Table 20: Correlation matrix

	J256T	ALSI	CPI	GDP	LB
J256T	1.00	0.14	-0.07	-0.07	-0.56
ALSI	0.14	1.00	-0.14	0.13	0.04
CPI	-0.07	-0.14	1.00	0.17	0.22
GDP	-0.07	0.13	0.17	1.00	0.34
LB	-0.56	0.04	0.22	0.34	1.00

The correlation matrix above (Table 20) demonstrated that J256T returns are positively correlated to ALSI and negatively related to GDP, CPI and ten-year bond rate. None of the independent variables are correlated for greater than 0.7 or less than -0.7; thus there is no

concern with multicollinearity (a statistical phenomenon in which two or more independent variables in a multiple regression model are highly correlated). The correlation results for ALSI and ten-year bond are consistent with unlisted property returns.

4.2.3 Regression analysis

Regressions results (all variables): Initially without any adjustments, the Durbin–Watson (DW) test for the regression had a result of 2.68, indicating a negative serial correlation. This means that errors corresponding to different observations are not independent and are therefore correlated (Pindyck & Rubinfeld 1998), and thus violated an assumption required for multiple regression. Thus, autoregressive function, ar (1) was subsequently incorporated into the regression to adjust for the negative serial correlation, after the incorporation of ar (1); the DW stat is around two (see Table 21).

Table 21: Regression results after incorporation of autoregressive function (all variables)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.04	0.01	3.80	<0.001
ALSI	**0.21**	0.12	1.81	**0.08**
CPI	0.55	0.67	0.82	0.42
GDP	0.78	0.51	1.53	0.13
LB	**-13.19**	2.21	-5.97	**<0.001**
AR (1)	-0.42	0.16	-2.71	0.01

R-squared	**0.46**
Adjusted R-squared	0.39
S.E. of regression	0.07
Sum squared resid	0.21
Log likelihood	55.10
F-statistic	6.55
Prob (F-statistic)	**<0.001**
Mean dependent var	0.07
S.D. dependent var	0.10
Akaike info criterion	-2.23

Schwarz criterion	-1.99
Hannan-Quinn criter.	-2.14
Durbin-Watson stat	**2.08**
Inverted AR Roots	0.07

This regression model (after incorporating an autoregressive function) can explain 46% (see R-squared in Table 21) of the J256T's returns. The ten-year bond was significant at 0% level (see probability) and ALSI was significant at 8% level (see Table 21). CPI and GDP were not found to be statistically significant. The coefficient of ALSI was positive, indicating a positive relationship between ALSI and J256T. The negative coefficient of LB indicated a negative relationship between LB and J256T. The results are consistent with correlation matrix in section 4.2.2.

The F-statistical probability indicates this regression model is statistically significant at less than 0.1%.

Stepwise regression

Researchers often use stepwise regression to determine the best explanatory variables for a regression model (Gujarati 2003). By using stepwise regression, the ten-year government bond (probability at less than 0.1%) and the All-Share Index (probability at 2%) were identified as significant variables at 5% level (see Table 22). The coefficient was negative for LB and positive for ALSI, consistent with previous regressions.

Table 22: Stepwise regression results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LB	**-13.01**	2.63	-4.94	**<0.001**
ALSI	**0.35**	0.14	2.44	**0.02**
GDP	0.83	0.51	1.65	0.11
R-squared	0.19	Mean dependent var		0.06
Adjusted R-squared	0.15	S.D. dependent var		0.09
S.E. of regression	0.09	Akaike info criterion		-1.98
Sum squared resid	0.32	Schwarz criterion		-1.86
Log likelihood	47.48	Hannan-Quinn criter.		-1.93
Durbin–Watson stat	2.41			

Regressions results (two variables)

Based on the results of the stepwise regression, only two variables were found to be statistically significant (with ALSI and LB); thus a two-variable model was created.

Initially without any adjustments, the Durbin–Watson test for the regression indicated a negative serial correlation (with DW statistics of 2.60). The researcher then incorporated an autoregressive function, ar (1), into the regression. Table 23 presents the results:

Table 23: Regression results after incorporation of autoregressive function (two variables)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.05	0.01	3.74	0.00
ALSI	0.22	0.14	1.55	0.13
LB	**-11.67**	2.67	-4.37	**0.00**
AR (1)	-0.33	0.17	-1.93	0.06

R-squared	**0.41**
Adjusted R-squared	0.37
S.E. of regression	0.08
Sum squared resid	0.23
Log likelihood	54.69
F-statistic	9.54
Prob (F-statistic)	**<0.001**
Mean dependent var	0.06
S.D. dependent var	0.09
Akaike info criterion	-2.25
Schwarz criterion	-2.09
Hannan–Quinn criter.	-2.19
Durbin–Watson stat	**2.08**

This regression model with ALSI and LB as explanatory variables (after incorporating an autoregressive function) can explain 41% of the J256T's returns, and the model is statistically significant (F-statistical probability at less than 0.1%). The statistically significant (at 0% level) negative coefficient of LB indicates a negative relationship between LB and J256T, which is consistent with the correlation matrix, regression model (all variables) and stepwise regression.

The assumptions for this regression model were considered and accounted for (especially regarding the error terms and explanatory variables). This was to ensure the validity of the statistical outcome. Based on the relevant test results, the regression model is valid. Table 24 summarises the relevant tests and results.

Table 24: Assumptions for multiple regression

Assumptions of Multiple Regression Models	**Relevant Tests**	**Test Results**
The relationship between independent (X) and dependent (Y) is linear.	Examine residual plot	Residual plot appears to be linear.
The independent (X) variables have no exact linear relationships between two or more independent variables. If there are, it is called multicollinearity.	Correlation Matrix and VIF	None of the independent variables are correlated for greater than 0.7 or less than -0.7.
The error has zero expected value for all observations.		If the error terms do not have zero mean values, the intercept in the regression equation cannot be estimated. However, in reality, the intercept is not important. In addition, the slope coefficients remain unaffected if this assumption is violated. Thus, this assumption is not of concern

		here (Gujarati 2003).
The error terms have constant variance for all observations.		Heteroscedasticity is adjusted in the equation by applying the white heteroscedasticity-consistent covariance matrix in the Eview Software.
Errors corresponding to different observations are independent and therefore uncorrelated.	The Durbin–Watson test is the most popular test for testing serial correlation between independent variables.	Autoregressive term is included in the equation.
The error term is normally distributed.	The Jarque–Bera test was tested on the residuals (Jarque–Bera = 0.23, Probability = 0.89).	Cannot reject the hypothesis that the residual is of a normal distribution. Gujarati (2003) contends that the central limit theorem can be relied upon, if the sample size is large enough (30 or more observations). The usual test procedures, namely the t- and F- tests, are still valid even if the error terms are not normally distributed.

4.2.4 Vector autoregression

Histogram

As the data set is the same as in section 4.2.2, we do not have to reperform the analysis.

Dickey–Fuller test

The Augmented Dickey–Fuller is used to test the unit root, if there is a unit root and the statistical process is non-stationary. Thus, a more sophisticated model may need to be adopted. Table 25 presents the results.

Table 25: Dickey–Fuller test

Variables	**Probabilities**	**Results**
J256T	<0.001	Reject hypothesis of unit root
ALSI	<0.001	Reject hypothesis of unit root
GDP	0.17	Accept hypothesis of unit root
CPI	<0.01	Reject hypothesis of unit root
LB	<0.001	Reject hypothesis of unit root

All the series except for GDP did not have a unit root. Thus, the unit root null hypothesis was rejected, suggesting that the data series can be examined further in this format. The GDP variables had to be removed from the variables.

Vector autoregression

Two issues are very important when performing VAR analysis: firstly, the ordering of the variables, and secondly, the appropriate lags must be applied to the model (Laopodis 2009).

There are various ways the variables can be ordered. One method is to rely on economic theory, and another method is to use statistical techniques. In this study, the results from the regressions were applied to the ordering of the variables.

In order to determine appropriate lag orders, *VAR Lag Order Selection Criteria* in Eviews was used to determine the lag order. Based on the test, the optimal lag is determined to be two.

Vector autoregression of the economic variables was performed based on the orders and lag derived earlier. Table 26 shows the results of the vector autoregression.

Table 26: VAR results

	Coefficient	**Std. Error**	**T-Statistic**
LB (-1)	1.12	-4.63	0.24
LB (-2)	0.92	-3.85	0.24
ALSI (-1)	0.16	-0.21	0.76
ALSI (-2)	0.26	-0.21	1.21
CPI (-1)	-1.13	-1.62	-0.69
CPI (-2)	1.81	-1.59	1.14
J256T (-1)	-0.10	-0.22	-0.44
J256T (-2)	-0.17	-0.25	-0.67
C	0.06	-0.03	2.55

R-squared	0.30
Adj. R-squared	0.14
Sum sq. resids	0.00
S.E. equation	0.00
F-statistic	1.87
Log likelihood	177.52
Akaike AIC	-7.66
Schwarz SC	-7.30
Mean dependent	0.00
S.D. dependent	0.01

None of the variables or lags of variables appear to be statistically significant.

The following tests were performed to ensure the fundamental assumptions of VAR met:

1. Testing the unit root of VAR (Figure 9)
2. VAR Residual (Figure 10)
3. VAR Residual Portmanteau Tests for Autocorrelations (Table 27)

The results are as follows:

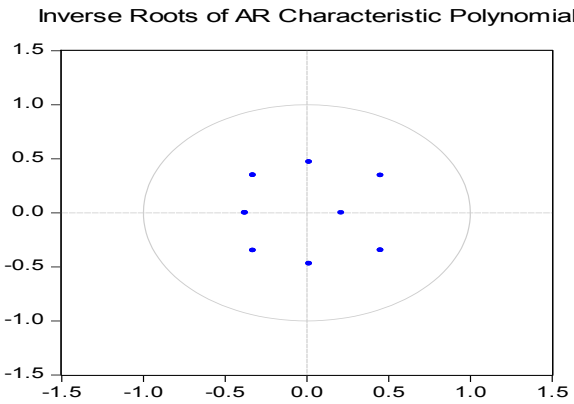


Figure 9: Testing the unit root of VAR

No root lies outside the unit circle. Thus, VAR satisfies the stability condition.

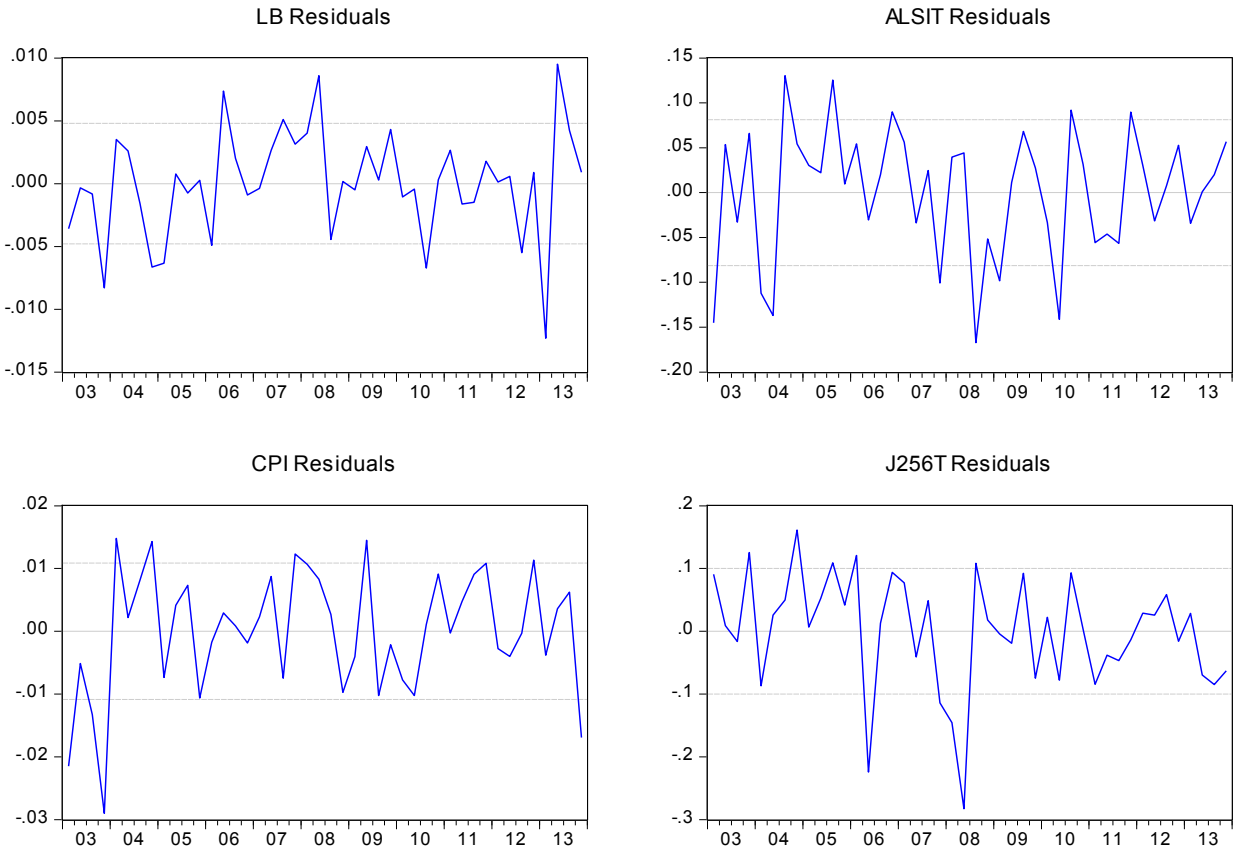


Figure 10: VAR residual

Based on the charts in Figure 10, it can be observed that the residuals are normally distributed.

The VAR residual portmanteau tests for autocorrelations were perforformed to test whether there was residual autocorrelation. Based on the results presented in Table 27, there is no residual autocorrelation.

Table 27: VAR residual portmanteau tests for autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	3.08	NA*	3.15	NA*	NA*
2	9.88	NA*	10.27	NA*	NA*
3	23.61	0.10	25.01	0.07	16.00
4	38.39	0.20	41.26	0.13	32.00
5	49.61	0.41	53.93	0.26	48.00
6	56.09	0.75	61.42	0.57	64.00
7	73.27	0.69	81.86	0.42	80.00
8	82.61	0.83	93.27	0.56	96.00
9	91.34	0.92	104.26	0.69	112.00
10	93.18	0.99	106.63	0.92	128.00
11	108.83	0.99	127.50	0.83	144.00
12	117.34	1.00	139.20	0.88	160.00

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

Based on the tests performed above, the fundamental assumptions of VAR are met and the results are valid.

4.2.4.1 Variance decomposition

Variance decomposition seeks to determine what proportions of the changes in the listed property return series can be attributed to changes in the lagged explanatory variables (Brooks & Tsolacos 1999).

Table 28 shows how the economic variables interact with the listed properties index (J256T). The table presents the percentages of quarterly return variance explained by own volatility and by the macroeconomic variables.

In the short run (two quarters), the shock to interest rate accounted for 47.4% of the variation of the fluctuation in the returns of listed properties. Listed property accounted for 46.7% of the variation of the fluctuation in the returns of listed properties (own shock). The shock to stock market accounted for 4% and shock to CPI accounted for 1.9% of the variation of the fluctuation in the returns of listed properties.

In the long run (ten quarters), the shock to interest rate accounted for 46% of the variation of the fluctuation in the returns of listed properties. Listed property accounted for 43.9% of the variation of the fluctuation in the returns of listed properties (own shock). The shock to stock market accounted for 6.1% and shock to CPI accounted for 3.6% of the variation of the fluctuation in the returns of listed properties.

The results indicated that the volatility of total returns of listed properties is influenced by interest rates, its own volatility, the stock market and inflation. Interest rates are the greatest source of volatility. The interest rate variable explained almost 49%, and its own volatility was almost 48%. The stock market and inflation were not significant contributors to the volatility of listed properties returns. The significant own shock is similar with the results found by Brooks and Tsolacos (1999), Downs et al. (2003) and Laopodis (2009); however, in prior studies, own shock was the largest contributor to variance. In this study, own shock was the second largest contributor to variance, second to interest rates.

The information content of the economic variables seems to produce effects on the returns long enough so the quarterly data still expose their influence.

Table 28: Variance decomposition

Period	S.E.	LB	ALSI	CPI	J256T
1	0.00	48.36	3.13	0.81	47.70
2	0.01	47.43	4.00	1.86	46.71
3	0.01	46.43	6.06	3.32	44.19
4	0.01	46.36	6.15	3.35	44.14
5	0.01	46.40	6.11	3.54	43.95
6	0.01	46.39	6.11	3.60	43.91
7	0.01	46.39	6.11	3.60	43.91
8	0.01	46.38	6.11	3.60	43.91
9	0.01	46.38	6.11	3.60	43.91
10	0.01	46.38	6.11	3.60	43.91

Cholesky Ordering: ALSI CPI J256T LB

4.2.4.2 Impulse response

This study conducted an impulse response analysis on the total return volatilities of the listed properties indices to observe the dynamic interaction between these returns and the economic variables. This analysis enables researchers to identify if the listed property indices returns respond positively or negatively to one unit of information shocks from economic variables (Downs et al. 2003; Brooks & Tsolacos 1999).

This test also reveals how quickly the returns absorb the information from changes in economic indicator. The impacts of economic variables are the most significant in the first quarter enduring for three quarters.

See Table 29 and Figure 11 for the results.

Table 29: Impulse response (Table format)

Period	LB	ALSI	CPI	J256T
1	-0.07	0.02	-0.01	0.07
2	0.01	0.01	-0.01	-0.01
3	0.02	0.02	0.01	-0.01
4	0.00	0.00	0.00	0.00
5	-0.01	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00

The shock to interest rate had a largely negative response on listed properties returns for the first two quarters; this was followed by three quarters of a slightly positive response. Then beyond that it seems to work the shock appears to have worked its way out of the system. This result is consistent with the findings of Ewing and Payne (2005)[24], and similar to those of Glascock, Lu & So (2002)[25] and Payne (2003)[26]. The shock to stock market has a positive response on properties returns; this result is in line with the findings of Payne (2003)[27] and Yunus (2012)[28].

[24] Ewing and Payne (2005) showed the shock was negative for first six months and positive subsequently.
[25] Glascock, Lu and So (2002) found that the shock results in initially two months of negative effects and five months of positive effects.
[26] Payne (2003) showed that the effect is negative and last six months.
[27] Payne (2003) established that the impact is positive and last five months.
[28] Yunus (2012) indicated that the impact is positive and last 15 months for the US market.

The shock to CPI had initially two quarters of negative response then in the third quarter it had positive response. This result is similar to the findings of Glascock, Lu & So (2002)[29], Payne (2003)[30] and Ewing and Payne (2005)[31].

The shock to properties return (own shock) had the largest positive response for all variables tested in the first quarter, followed by two quarters of negative response. The response is similar to the findings by Glascock, Lu & So (2002)[32] and Laopodis (2009)[33].

Other than the CPI, the results from impulse response are consistent with regression analysis.

The longevity of the shock is similar to Brooks and Tsolacos (1999), where they found the shock persists past 24 months (in the UK market). Glascock, Lu & So (2002)'s results showed the shock persists after 15 months.

[29]Glascock, Lu and So (2002) found that the shock in the first month is zero and then positive for the next 14 months.
[30] Payne (2003) found that the shock is negative for first six months and then reverts to zero.
[31] Ewing and Payne (2005) found that the shock is negative for first six months and then reverts to zero.
[32] Glascock, Lu and So (2002) indicated that the own shock is mostly positive and has the biggest impact relative to other variables.
[33] Laopodis (2009) found that the own shock is positive and has the biggest impact relative to other variables tested.

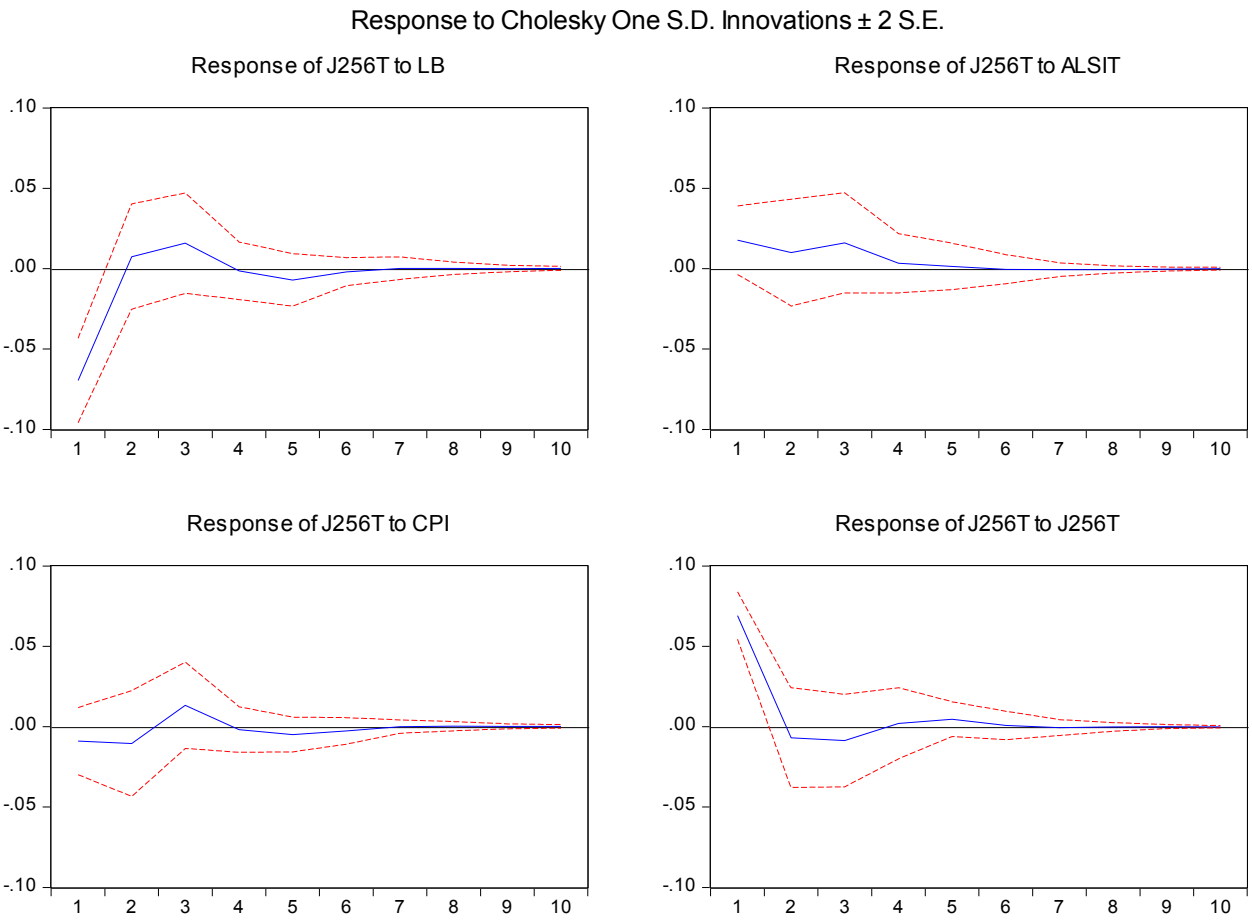


Figure 11: Impulse response (Graph format)

The horizon axis is measured in quarters; the vertical axis measures the magnitude of the response, scaled such that 1.0 equals 1 Standard Deviation. Confidence bands, used to determine statistical significance, are shown as red dashed (——) lines and represent 2 Standard Errors.

4.3 Summary and discussion

Table 30 summarises the statistical tests conducted and the significant results from the tests.

Table 30: Summary of results

	Unlisted Properties	Listed Properties
Data – Sample period analysis	18 annual data points (1995 to 2012) cover one and half business cycle but not one full interest rate cycle	46 quarterly data points (2002 – 2013) cover one and half business cycle but not one full interest rate cycle
Data – Histogram	No outlier was detected and none were removed from the data set	No outlier was detected and none were removed from the data set
Data – Descriptive statistics	No unusual data identified in the descriptive statistics	No unusual data identified in the descriptive statistics
Data – Jarque–Bera test	The data is normally distributed	The data is normally distributed
Data – Correlation matrix	IPD returns are positively correlated to ALSI, CPI, and GDP and negatively related to the ten-year bond rate. No concern with multicollinearity.	J256T returns are positively correlated to ALSI and negatively related to GDP, CPI and ten-year bond rate. No concern with multicollinearity.
Regression – Results	Unable to perform test due to limited size of sample	ten-year bond rate was the only variable to be found to be statistically significant, with negative coefficient.
Regression – Assumptions	Unable to perform test due to limited size of sample	All assumptions for multiple regression met.
VAR – Histogram	Unable to perform test due to limited size of sample	No outlier was detected and none were removed from the data set
VAR – Dickey–Fuller test	Unable to perform test due to limited size of sample	GDP had to be removed from the data set as it had unit root.
VAR	Unable to perform test due to limited size of sample	No statistically significant variable. All assumptions for VAR are met, thus results are

		valid.
VAR – Variance decomposition	Unable to perform test due to limited size of sample	Volatility of listed property returns is most influenced by interest rate and its own volatility.
VAR – Impulse Response	Unable to perform test due to limited size of sample	The shock to interest rate has large negative response to listed property returns.

Unlisted properties

IPD returns are positively correlated to ALSI, CPI, and GDP and negatively related to the ten-year bond rate. However, due to the limited data available for unlisted properties, detailed statistical analysis (regression and VAR) was not performed on unlisted properties. Thus the null hypothesis as stated in section 1.10 cannot be rejected.

Listed properties

Interest rate was the only statistically significant variable identified via regression model; all other variables were not statistically significant.

Stock market (see section 4.2.3, Table 21) was significant at 8% level, just above the 5% significance level. Thus, it can be concluded that the stock market is close to being considered but is not statistically significant. Despite not being considered statistically significant, the positive co-efficient (regression) and effect (impulse response) is compatible with most of the previous research (see Allen, Madura & Springer 2000; Okunev, Wilson & Zurbruegg 2000; Payne 2003; He, Webb & Myer 2003; Huang & Lee 2009; Chen et al. 2012; Yunus 2012).

Economic growth (see section 4.2.3, Table 21) was found not to be a significant variable. This is similar with previous literature by Brooks and Tsolacos (1999), Standish et al. (2005) and Chang, Chen & Leung (2011).

Inflation (see section 4.2.3, Table 21) was not a significant macroeconomic variable to property returns. This is comparable with the majority of prior research cited in this study (Chen, Hsieh & Jordan 1997; Chatrath & Liang 1998; Chen et al. 1998; Glascock, Lu & So 2002).

Interest rate (see section 4.2.3, Table 21, Table 22 and Table 23) was statistically significant and was negatively related to property returns. This result is consistent with the theoretical arguments and prior research (see Allen, Madura & Springer 2000; He, Webb & Myer 2003; Clark & Daniel 2006; Huang & Lee 2009; Mangani 2011; Boshoff & Cloete 2012; Chen et al. 2012; Nittayagasetwat & Buranasiri 2012).

Variance decomposition (see section 4.2.4.1, Table 28) indicated that interest rates are the greatest source of volatility. The interest rate variable explained almost 49% of the volatility of property returns. The second largest contributor is own shock accounting for 48% of the volatility of property returns, similar to results from Brooks and Tsolacos (1999), Downs et al. (2003) and Laopodis (2009).

The impulse response result (see section 4.2.4.2, Table 29) is consistent with that of Ewing and Payne (2005) that the shock to interest rate leads to negative returns. The impulse response analysis on the stock market is in line with the findings of Payne (2003), Laopodis (2009) and Yunus (2012) that property negatively responds to a shock to the stock market. The shock to CPI had initially two quarters of negative response then in the third quarter it had a positive response. This result is similar to the findings of Glascock, Lu and So (2002), Payne (2003), and Ewing and Payne (2005). The shock to properties return (own shock) has the largest positive response for all variables tested in the first quarter, then followed by two quarters of negative response. The response is similar to the findings by Glascock, Lu and So (2002), and Laopodis (2009). The results from impulse response are consistent with regression analysis.

Despite the lack of data for unlisted property, the strong correlation of 69% (see section 3.2.3) between unlisted property (IPD) and listed property (J256T), can infer similar results for the period studied.

Thus, based on statistical methods applied by this research, interest rate is a noteworthy macroeconomic variable (and negatively related) to listed and unlisted properties for the period studied. All other macroeconomic variables studied such as stock market, economic growth and inflation were not found to be statistically significant; thus, no relationship between the macroeconomic variables and commercial property returns can be concluded. Thus, the null hypothesis as stated in section 1.10 can be rejected for interest rate. There is a statistically significant relationship between interest rate and commercial properties returns (listed and unlisted) returns.

5. Conclusion and Suggested Future Research

This research attempted to answer two questions (as stated in section 1.6):

a) Is there a significant relationship between macroeconomic variables and commercial property returns (listed and unlisted) in South Africa?
b) If such a relationship exists, what are the relationships between the chosen macroeconomic variables and commercial property returns?

In order to answer the two questions, this study reviewed and summarised previous local and international literature on this subject matter. Four macroeconomic variables were considered critical, namely: stock market performance (the majority of the studies found a positive relationship between property returns and stock market performance); economic growth (despite mixed results, most found a positive relationship consistent with economic theory); interest rate (the majority of the studies found a negative relationship consistent with theoretical argument); and inflation (most past studies found no significant relationship between inflation and property returns).

Further, statistical methodologies – namely, cross-sectional regression and vector autoregression (VAR) – were adopted from prior studies for this research. Relevant proxies for the four variables were identified from prior literature and consideration was given to the South African context. Data for the relevant proxies were collected and statistical analysis was performed.

The statistical test result on unlisted property was found to be inconclusive due to insufficient data.

The statistical tests on listed property demonstrated that interest rate is significantly negatively related to listed property returns (using cross-sectional regression). The negative relationship was further confirmed using impulse response analysis (VAR); the interest rate was also found to be the largest contributor (almost 49%) to volatility of listed property returns (using variance

decomposition of VAR). The result of a negative relationship between the interest rate and listed property returns is consistent with the majority of prior studies cited (see Allen, Madura & Springer 2000; He, Webb & Myer 2003; Clark & Daniel 2006; Huang & Lee 2009; Mangani 2011; Boshoff & Cloete 2012; Chen et al. 2012; Nittayagasetwat & Buranasiri 2012).

The stock market was found to be close to being significant and positively related to property, compatible with prior studies. Economic growth and inflation were not found to be significant variables similar to prior international studies.

Thus, the null hypothesis (in section 1.10) for unlisted commercial property cannot be rejected due to lack of data, and this study concludes that there is no statistically significant relationship between macroeconomic variables and unlisted commercial properties for the period studied.

For listed commercial property, the null hypothesis (in section 1.10) can be rejected, and this study concludes that there is a negative statistical significant relationship between interest rate and listed property returns for the period studied.

The major obstacle to this research was the lack of available data (the lack of data resulted in inconclusive result for unlisted properties). Thus, one area for future research is to repeat this research using a larger dataset, especially covering more than one full interest-rate cycle. Other potential research areas would be to perform this analysis by splitting the returns into income returns and price returns individually, as conducted by Downs et al. (2003).

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Appendices Cover Page

Appendix 1: Investment analysts' views on listed property

Appendix 2: Data used

Appendix 1: Investment analysts' views on listed property

Table 31 summarises a brief survey of investment analysts indicates that listed property is highly correlated to long-term government bonds or used as a benchmark to determine the attractiveness of listed property as an asset class (see section 2.3.1, under investments rate vs borrowing rate).

Table 31: Summary of survey of analysts

Asset Manager	**View**	**Date and Source**
Sanlam (Rafiq Taylor)	'The volatility can largely be attributed to movements in bond yields and the rand. We expect listed property to remain volatile in the short term due to its strong correlation with the bond market.' '…the current interest rate cycle, as bond yields and property yields are highly correlated.'	18 July 2013 https://www.sanlam.co.za/wps/wcm/connect/sanlam_en/sanlam/media+centre/media+releases/volatility+supports+a+wait-and-see+approach+to+listed+property
Catalyst	'…With the listed property sector's yields having rerated relative to the government bond index by 0.63%, "the listed property historic rolled yield is now trading at a premium spread to the long-term government bond index yield of 1.25%, compared with the five-year average of 0.18%..."'	10 July 2013 http://www.bdlive.co.za/business/property/2013/07/10/correlation-between-bonds-and-listed-property-weakening
Grindrod (Ian Anderson)	'…the South African listed property sector was trading on a forward yield of 6.9% — about 90 basis points above the yield on a ten-year government bond. This leaves the sector vulnerable to further weakness in global and local bond markets and is likely to result in significant price volatility in the short term…'	10 July 2013 http://www.bdlive.co.za/business/property/2013/07/10/correlation-between-bonds-and-listed-property-weakening

Plexus Asset Management (Paul Stewart)	'...correlations between the bond (ALBI) and real estate (SAPI) markets proved to be much greater than those witnessed between equities and real estate...' 'Between 49% to 94%'	11 August 2011 http://www.moneyweb.co.za/moneyweb-property/is-listed-property-correlated-more-with-bonds-or-e
Coronation (Anton De Goede)	'…over the past ten years, the local listed property sector has really benefitted from ... the subsequent rerating in the local bond market in general.' '…the derating in the property market following the spike in bond yields is related to the sector's perceived yield prospects.'	10 December 2013 http://www.moneyweb.co.za/moneyweb-property/listed-property-in-2014
Old Mutual Properties (Peter Levett)	'While property and bond yields generally trend together over the long term…' 'long-term correlation of 89%'	http://www.oldmutual.co.za/documents/Insights/PropMktStrat.pdf
Erwin Rode	Erwin Rode, property valuer and economist at Rode and Associates, says, 'the correlation between long bond yields and listed property yields is strange, since property's income stream grows with about 6% on average while that of bonds is fixed. It is therefore odd that the market acts on the perceived similarities between the asset classes. However, one cannot argue with the market and has to accept its behaviour.'	10 December 2013 http://www.moneyweb.co.za/moneyweb-property/listed-property-in-2014
ABSA (Mariette Warner)	'From 2003 to 2005, the SAPY increased by 113% (28.7% p.a.) because of falling long bond yields – from 10% to 7.5%.'	http://www.bondstreet.co.za/pdfs/desk/Listed%20Property%20Historical%20Perspective.pdf
Prudential	'…property yields are still out of line with bond yields, having sold off less than bonds so far this	20 October 2013

	year…’	http://www.iol.co.za/business/personal-finance/financial-planning/investments/bad-quarter-for-listed-property-1.1594309#.UrskKfQW2So

Appendix 2: Data used

The raw data used in this research are in the tables below. (A softcopy of the data is included in an USB flash drive as part of the final submission.)

Data set for section 4.1

	Annual	Stock Market	Economic	Inflation	Interest Rate
	IPDT	ALSI	GDP	CPI	LB
1994			0.0320	0.0896	0.1483
1995	0.1530	0.0819	0.0310	0.0869	0.1611
1996	0.1400	0.0953	0.0430	0.0735	0.1548
1997	0.1740	(0.0691)	0.0260	0.0860	0.1470
1998	0.0500	(0.0591)	0.0050	0.0687	0.1512
1999	0.1360	0.7082	0.0240	0.0520	0.1490
2000	0.1100	0.0035	0.0420	0.0533	0.1379
2001	0.1040	0.3261	0.0270	0.0571	0.1141
2002	0.0950	(0.0831)	0.0370	0.0915	0.1150
2003	0.1520	0.1608	0.0290	0.0588	0.0962
2004	0.2340	0.2544	0.0460	0.0138	0.0953
2005	0.3000	0.4725	0.0530	0.0340	0.0807
2006	0.2740	0.4123	0.0560	0.0464	0.0794
2007	0.2770	0.1919	0.0550	0.0710	0.0799
2008	0.1280	(0.2323)	0.0360	0.1153	0.0910
2009	0.0910	0.3213	(0.0150)	0.0712	0.0870
2010	0.1340	0.1898	0.0310	0.0427	0.0862
2011	0.1040	0.0257	0.0350	0.0500	0.0852
2012	0.1520	0.2668	0.0250	0.0565	0.0790

Data set for section 4.2

	Listed Properties	Stock Market	Economic	Inflation	Interest Rate
	J256T	ALSI	GDP	CPI	LB
30-Sep-02	0.03266	-0.10111	-0.0040	0.0268	-0.0041
31-Dec-02	0.12736	-0.01350	-0.0015	0.0240	-0.0034
31-Mar-03	0.12260	-0.16275	0.0028	-0.0210	-0.0082
30-Jun-03	0.06479	0.09684	-0.0045	-0.0290	-0.0039

30-Sep-03	-0.02280	0.07932	0.0005	-0.0310	-0.0006
31-Dec-03	0.19727	0.17118	0.0002	-0.0400	-0.0040
31-Mar-04	-0.00635	0.03676	0.0098	-0.0030	0.0024
30-Jun-04	0.03757	-0.04723	-0.0013	0.0030	0.0073
30-Sep-04	0.11509	0.17433	0.0025	0.0060	-0.0046
31-Dec-04	0.22415	0.08139	-0.0060	0.0190	-0.0086
31-Mar-05	0.06305	0.05949	-0.0005	-0.0030	-0.0075
30-Jun-05	0.12530	0.07243	0.0083	0.0030	0.0022
30-Sep-05	0.16421	0.20286	-0.0045	0.0070	-0.0029
31-Dec-05	0.11638	0.07740	-0.0073	-0.0020	-0.0017
31-Mar-06	0.22128	0.13252	0.0088	0.0010	-0.0052
30-Jun-06	-0.17217	0.04866	0.0013	0.0020	0.0046
30-Sep-06	0.09932	0.06334	-0.0023	0.0120	0.0081
31-Dec-06	0.20344	0.11834	0.0015	0.0030	-0.0058
31-Mar-07	0.15951	0.10381	0.0003	0.0040	-0.0044
30-Jun-07	0.01157	0.04288	-0.0085	0.0110	0.0019
30-Sep-07	0.11171	0.06713	0.0048	0.0000	0.0061
31-Dec-07	-0.01242	-0.02969	0.0025	0.0140	-0.0019
31-Mar-08	-0.09836	0.02918	-0.0075	0.0150	0.0054
30-Jun-08	-0.19679	0.03361	0.0035	0.0170	0.0093
30-Sep-08	0.24529	-0.20555	-0.0065	0.0180	-0.0022
31-Dec-08	0.08302	-0.09166	-0.0088	-0.0230	-0.0090
31-Mar-09	-0.01096	-0.04194	-0.0115	-0.0270	-0.0037
30-Jun-09	-0.02168	0.08650	0.0090	-0.0070	0.0054
30-Sep-09	0.12538	0.13906	0.0110	-0.0130	0.0015
31-Dec-09	0.03412	0.11441	0.0045	-0.0040	0.0018
31-Mar-10	0.10089	0.04479	0.0023	-0.0030	0.0004
30-Jun-10	0.00562	-0.08173	-0.0033	-0.0120	-0.0019
30-Sep-10	0.14455	0.13291	0.0013	-0.0100	-0.0061
31-Dec-10	0.03344	0.09470	0.0020	0.0000	-0.0011
31-Mar-11	-0.02311	0.01116	0.0010	0.0030	0.0054
30-Jun-11	0.05072	-0.00608	-0.0073	0.0080	-0.0012
30-Sep-11	0.01840	-0.05836	0.0000	0.0080	-0.0030
31-Dec-11	0.03058	0.08380	0.0035	0.0070	0.0016
31-Mar-12	0.09117	0.06005	-0.0020	0.0000	-0.0013
30-Jun-12	0.12001	0.00979	0.0023	-0.0040	-0.0009
30-Sep-12	0.11491	0.07257	-0.0055	-0.0060	-0.0077
31-Dec-12	0.02100	0.10338	0.0023	0.0050	0.0009