RESEARCH REPORT: SOUTH AFRICAN COMMERCIAL REAL ESTATE AS AN INFLATION HEDGE

By

Marimo Taderera

Student Number: 383527

A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements of the degree of Master of Science in Building.

Supervisor: Dr. Kola Akinsomi

Johannesburg, June 2019

Declaration

I declare that this research report is my own unaided work. It has been submitted for the Degree of Master of Science in Building in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Signature of Candidate

11th Day of June Year 2019

Dedication

In memory of beloved late mother, your presence in my life is sorely missed. I hope we see each other again.

Hera Menas-Taderera

1960 - 2011

Abstract

One of the primary objectives of any investment manager is to protect investors' wealth against the negative effects of inflation. Real estate investments have traditionally been viewed as a good inflation hedge. Property has been included in mixed asset portfolios for two main reasons, the first being for diversification benefits, the second being for its alleged inflation hedging benefits. Escalation clauses in lease agreements and rent reviews are the mechanisms through which investors adjust rentals for inflation, and do not necessarily allow investors to adjust rentals for inflation instantaneously. The purpose of this study is to investigate the inflation hedging ability of South African Commercial Real Estate investments (CRE) and employs quantitative techniques to study the relationship between Inflation rates and CRE returns. The Vector Error Correction (VEC) model for cointegrated time series was used to investigate the long run relationship between property returns and inflation. This study finds that retail and industrial property hedge against inflation in the long-run, with retail property being the better inflation hedge of the two property types.

Acknowledgements

Having completed this research report, I have the privilege of looking back at the journey that has led me to this point. In this moment of reflection, it is clear that this work is not only mine, but rather the result of the collective effort of a lot of individuals and it is only right that I acknowledge these individuals.

I would like to begin by showing my gratitude to MSCI for providing me with the data necessary to conduct this research. In particular, I would like to thank Phil Barttram and Eileen Andrew for their assistance.

To Dr. Kola Akinsomi, I am grateful for your guidance which has been integral in completing my research.

To my father and brother, your constant support in all my endeavours is allows me to strive for more.

“

Contents

Table of Figures

Chapter 1

1.1 Introduction

Direct real estate is a term used to refer to investments held by direct ownership of title as opposed to ownership of shares in a listed or unlisted trust. The term Commercial Real Estate (CRE) will be used in this study to refer to direct real estate.

Investors purchase CRE for the sole purpose of leasing the space out to tenants. In a lease agreement, the tenant contractually undertakes to pay the property owner/investor rentals for a certain period of time into the future. The security of the investor's future income is dependent on the strength of the lease agreement. When investors purchase a property, they use their desired yield as a basis of determining rental rates that they should lease out their properties in order to make their investment financially viable. The desired yields are reviewed on a regular basis taking into consideration movements in the property market, the macro economy and the opportunity cost of capital. The negotiated terms of the lease agreement ultimately determine whether an investor can adjust the returns of CRE in order to protect their returns against inflation. The lease agreement is the key mechanism through which inflation rates transmit to property returns. In order to understand the effects of inflation on CRE returns in South Africa, the typical structure of lease agreements is an important factor that needs to be analysed.

In South Africa lease periods for retail space tend to range from three to five years. The anchor tenants who occupy larger premises and drive foot traffic to a retail centre tend to secure seven-year leases. Industrial and office space also follow a similar trend with lease periods typically being three to five years. With regards to strategic locations such as head offices and major distribution centres, the lease periods can range from seven to ten years.

The South African market tends to favour fixed annual rental escalation rates over the duration of the lease period. The property owners therefore often have to forecast their expectations of changes in the property market and the overall economy when deciding on the fixed escalation rates that will be applicable for the duration of the lease. Once a tenant has taken occupation of the leased premises, rental reviews tend to only occur upon renewal of the lease. For the longer lease periods (seven to ten years), fixed escalation rates are still applicable, except halfway through the leases provision is made for a rental review in order to align the lease with the prevailing market rates for the remaining period of the lease. An alternative to having fixed escalation rates is pegging the rental escalation rate to an index of choice and adding a margin to the index. In the South African rental market, the Consumer Price Index (CPI) tends to be the index of choice in such scenarios. Despite this option being available to property owners, it introduces administrative nightmares and is therefore not as popular as the fixed escalation rates.

With regards to anchor tenants in the retail property rental market, it is common for landlords to charge tenants a base rental with a fixed escalation rate and make a provision of charging rentals as a percentage of the tenant's gross turnover should this value exceed the base rental. Anchor tenants tend to sell large volumes of products with low profit margins and the intention behind charging rentals as a percentage of gross turnover is to share the success of a store between the tenant and the landlord which incentivises landlords to create a good tenant mix and market a retail centre in order to bring shoppers to the centre to the benefit of the tenants.

CRE rental returns are based on net operating income, the income that investors enjoy after having settled all operating expenses. Operating expenses include cleaning, security, insurance, managing agent fees, property rates and taxes, to name a few. CRE investors try to push the risk of increases in operating expenses onto the tenants. Lease agreements typically do so in one of two ways. Tenants are charged basic rentals in conjunction with operating expenses with fixed escalation rates. In such scenarios, the operating expense escalation rates are usually higher than the basic rental escalation rates. An alternative is to charge tenants a gross rental inclusive of operating expenses, making provision for the landlord to charge the tenant for any future increases in operating expenses. The operating expenses are therefore recovered from the tenants in arrears, typically one to three months after the landlord has incurred the cost. The CPI takes into consideration a basket of goods consumed by a typical family in South Africa and is not representative of increases in property operating expenses. The increase in operating costs of CRE is usually higher than the inflation rate reflected by the CPI. It is therefore important for investors to push the risk of operating expense increases onto the tenants to protect their returns against rising operating costs.

When investors are pricing CRE investments, they have to discount the net operating income that a property is capable of generating over the lifespan of the property. The discount rate used to price the CRE investments is based on an investor's required rate of return and takes into consideration an inflation risk premium. Capitalisation rates represent the ratio of net operating income to the value of CRE. The prevailing market capitalisation rates of property at any given time are an amalgamation of the required rate of return of investors, the perceived risk associated with a particular property type and location along with expected changes in the macro economy such as inflation. In South Africa, the common law principle of *huur gaat voor koop* protects the rights of tenants during the sale of property, ensuring that tenants can enforce the terms of their lease agreement on a new owner of a property (Delport, 2005). The previously negotiated rentals, escalation rates and renewal options are enforceable against a new owner. On the other hand, this common law principle also allows the new owners to enforce a lease agreement against the tenant, meaning that when an investor purchases a property, they also purchase the right to claim the rentals generated by all the lease agreements. Once again, the lease agreements and their structure are also an important factor when pricing property, and also affect the capital return that CRE investors will enjoy upon the sale of the property.

South Africa is defined as an emerging market, a phrase that has been used to describe markets that offer high short-term growth while high financial and political instability results in large fluctuations in macroeconomic indicators such as interest rates, inflation rates and an overall highly volatile market (Aguiar & Gopinath, 2007; Korotkov, Occhiocupo, & Simkin, 2013). The volatility of inflation rates in emerging markets would make it more difficult for investors to accurately predict/forecast inflation rates when compared to developed/advanced markets. This volatility has an impact on the inflation risk premium that CRE investors have to factor into their pricing, especially when forecasting over longer periods of time.

Real estate is commonly perceived as a good inflation-hedging asset. Real estate assets are very diverse in nature. They vary according to location, property type (industrial, office, residential and retail) and by the nature of the investment vehicle used to hold the asset (direct and indirect investments). The early research that helped create the notion that real estate is a good inflation hedge had not fully explored this diverse nature of real estate assets and the possible implications this would have on asssuming that all real estate investements could be considered good inflation hedges. With time, research in this field began to investigate the nature of the relationship between inflation and the various forms of real estate assets which produced results that challenged the notion that all real estate investments have the ability to hedge against inflation bringing to light the complexity of the relationship between real estate returns and inflation (see Chu & Sing, 2004; Fang, Wang, & Nguyen, 2008 ; Lee & Lee, 2014). As more research continued to produce empirical evidence indicating that real estate investments were not always capable of hedging against inflation and the that relationship varies from market to market, research on the topic began to spread internationally (see Chu & Sing, 2004; Fang, Wang, & Nguyen, 2008 ; Lee & Lee, 2014).

Despite there being numerous studies on the topic, most of the research has focused on the larger and more mature markets in developed nations. The topic has not been thoroughly investigated in a South African context. There are only two studies that have been conducted on the topic in South Africa. Erasmus (2015) focused on the inflation hedging ability of listed properties in comparison to other assets such as stocks in South Africa. Akinsomi, Mkhabela and Taderera (2018) studied the role of macroeconomic indicators in explaining the returns of South African CRE (industrial, office and retail), one of which was inflation. The study used a multivariate Ordinary Least Squares (OLS) regression model. As a consequence of the lumpy nature of CRE returns, the CRE market does not react instantaneously to macroeconomic shocks (Obereiner & Kurzrock, 2012). For lumpy CRE investments, the long term relationship between inflation and returns is more relevant and being able to isolate and focus on the long run relationship between CRE returns and inflation would be of value. This begs the question, how well do commercial real estate (CRE) investments in South Africa serve as a hedge against inflation in the long-run?

The model introduced by Fama and Schwert, 1977, was novel at the time because it compared the inflation hedging ability of various assets against expected and unexpected inflation. This model has subsequently been adopted by other researchers (see Fang, Wang, & Nguyen, 2008; Chu & Sing, 2004). The premise behind distinguishing between the expected and unexpected components of inflation is that although CRE leases allow investors to adjust rental for inflation, there is often a lag between changes in inflation and changes in rentals, especially when adjusting for unforeseen/unexpected inflation. Therefore, there is added value in studying the long run inflation hedging ability of CRE while separating inflation into the expected and unexpected components. Akinsomi, Mkhabela and Taderera (2018) did not distinguish between expected and unexpected components of inflation and the relationship between CRE returns, expected and unexpected inflation is yet to be studied in the South African context. Although in principle, the ability of investors to adjust rentals for inflation and factor in an inflation risk premium when pricing CRE investments, the long term lease agreements along with the fixed escalation rates require CRE investors to forecast changes in inflation three to five years into the future which can be a very difficult task in a market with volatile inflation rates such as South Africa. The accuracy of the investors' forecasts of future inflation rates and their ability to negotiate escalation rates in line with these forecasts will impact on the ability of CRE returns to hedge against inflation. This particular study aims to isolate the effects of inflation on CRE returns and investigate the relationship in much more detail, with the role unexpected inflation being a point of particular interest.

1.2 Motivation of Study

Emerging markets are becoming increasingly popular destinations for investors located abroad due to the higher returns they offer (Haran, et al., 2016), evidence of which can be seen in the increased flow in real estate from developed markets capital into sub-Saharan Africa (Anim-Odame, 2016). As mentioned, transactions in the South African commercial property market amounted to R18.5 billion in 2015 and R28 billion in 2017 (Jones Lang LaSalle, 2017), indicating that the South African commercial property market is vibrant and is of a substantial size. Although emerging markets offer higher returns, the high level of economic volatility in these markets when compared to developed markets exposes investors to higher levels of risk.

MSCI (2018) uses the criteria in Table 1 to classify countries into various market categories based on three main criteria, namely the level of economic development, number of companies in the country that meet certain size requirements and lastly the level of market accessibility. According to MSCI (2018) market classifications, South Africa is categorised as an emerging Market. Countries such as Brazil, Russia, Hungary, Poland, Malaysia, The Philippines and Taiwan, to name a few, also fall into the emerging market category. The category that a country falls into is an indication of the level of maturity of a market, the risk associated with investing in the market and an overall indication of the market’s behaviour.

Criteria	Developed	Emerging	Frontier
A: Economic Development			
A1 Sustainability of economic development	Country GNI per capita should be 25% above the World Bank high income threshold for three consecutive years	No requirement	No requirement
B: Size & Liquidity			
B1 Number of companies meeting the following requirements	5	3	2
Company Size (full market cap)	USD 2519 mm	USD 1260 mm	USD 630 mm
Security Size (float market cap)	USD 1260 mm	USD 630 mm	USD 49 mm
Security liquidity	20% ATVR	15% ATVR	2.5% ATVR
C: Market Accessibility			
C1 Openness to foreign ownership	Very High	Significant	At least some
C2 Ease of capital inflows	Very High	Significant	At least some
C3 Efficiency of operational framework	Very High	Good and tested	Modest
C4 Stability of institutional framework	Very High	Modest	Modest

Table 1: MSCI Criteria for Market classification (MSCI, 2018)

Table 2 shows the measures of central tendency (mean, standard deviation, minimum and maximum) calculated from inflation rates between 1996 and 2017 for advanced and developing markets along with those of South Africa, obtained from the International Monetary Fund. A comparison of the behaviour of South African inflation rates to that of developing, emerging and advanced/developed economies will allow the researcher to categorise the South African market purely based on the characteristics of its historic inflation rates and identify other markets that behave similar to South Africa. This in turn will allow us to determine which of the existing literature results we can expect the inflation hedging ability of South African CRE investments to be in line with thereby feeding into formulation of the hypotheses and also provide us with a basis for comparison of the results of this study to those of the existing body of literature after the South African data has been analysed.

Variable	Observations	Mean	Std. Dev.	Min	Max
Advanced Economies	22	1.7985	0.7571	.162	3.434
Emerging Markets	22	7.6700	3.8213	4.212	19.502
Emerging & developing Asia	22	4.4817	2.1502	1.474	10.644
Emerging & developing Europe	22	16.4130	17.9518	3.219	67.759
Sub-Saharan Africa	22	11.0465	5.7967	5.448	34.093
South Africa	22	6.2311	2.1726	1.3854	11.5365

Table 2: 1996 to 2017 Inflation Rates (International Monetary Fund, 2018)

It is clear that advanced economies have a lower mean inflation rate (1.799%) and a lower standard deviation (0.76) than emerging markets which have a mean and standard deviation of 7.67% and 3.82% respectively. This indicates that inflation rates in emerging markets are persistently higher than those of advanced economies and undergo much more extreme fluctuations, which is indicative of a more volatile market. Of the emerging markets, the European economies have experienced the highest and most volatile inflation rates, while emerging and developing Asia has experienced the lowest and most stable inflation rates. Sub-Saharan Africa's inflation rates are lower and less volatile than those of emerging Europe but higher and more volatile than those of emerging and developed Asia. The South African inflation rates appear to behave more similar to those of the emerging markets category than those of other sub-Saharan economies. Based on the available literature, results of studies conducted in China, Taiwan, Malaysia and Turkey will be of particular interest and will form the basis of this study's *a priori* expectations.

Although South Africa shares a lot in common with other emerging markets, hence it has been categorised as an emerging market by the International Monetary Fund (IMF), United Nations and other international organisations, it does have its own unique characteristics that differentiate it from other markets. The main characteristic that differentiates South Africa from typical emerging markets is that it has a strong financial sector. South Africa owes this to a developed and well-regulated banking system, even when compared to industrialised countries attracting interest from foreign banks who have either established a presence in the country or acquired a stake in major banks. South Africa's financial market development was ranked 11th out of 138 economies (World Economic Forum, 2017). The strength of its currency, the South African Rand, relative to the United States dollar also places it in a unique position with regards to global trade as it allows SA to both import and export products easily. South Africa also boasts infrastructure that is far superior to that of other sub Saharan countries when considering both the quality and the value. However, a large portion of the South African population does not benefit from this infrastructure and still lives in poverty. Classifying South Africa as an emerging market acknowledges both the potential that the country has as a lucrative investment destination and risk that arises due to the volatility that the wealth inequality and lack of political maturity poses.

As investors seek to profit from the burgeoning South African market and its growing middle class, it is important to understand the fundamentals that drive the South African real estate market as it will allow for better informed decision making among investors and increase market efficiency. This study will explore the relationship between South African CRE returns and inflation, both expected and unexpected inflation, so as to uncover the idiosyncrasies of the South African market along with the characteristics it shares with other emerging markets. Furthermore, it will add to the body of literature on real estate as an inflation hedge in emerging markets, revealing the similarities and differences between the market fundamentals of emerging markets and serve as a stepping stone for future research.

A better understanding of the relationship between CRE returns and inflation in South Africa, a market with high and volatile inflation rates, would equip investors with the ability to make well-informed decisions. Investors and any agents who manage investments on behalf of another party stand to benefit from this study as it would aid them in their decision-making process with regards to protecting wealth against the negative effects of inflation, especially in an emerging market where markets tend to be less stable. Furthermore, this study would contribute to a better understanding of CRE investments in emerging markets, allowing a comparison between emerging markets and developed markets that can expose similarities and differences between the two types of markets.

1.3 Problem Statement

Inflation has the ability to erode the real value of wealth over time. One of the primary objectives of an investor is to guard wealth against the negative effects of inflation. The inclusion of real estate assets in mixed asset portfolios has been motivated by two main reasons, the first reason being the diversification benefits offered by real estate. Due to the nature of its correlation with other financial assets, real estate can enhance the returns of a mixed asset portfolio while reducing the risk that investors expose themselves to. The second reason for including real estate in a mixed asset portfolio is that real estate assets have traditionally been viewed as inflation hedges, in the sense that they have been believed to outperform inflation therefore safeguarding wealth against inflation (Liu, Hartze, & Hoesli, 1997).

Research on the inflation hedging characteristics of real estate has yielded a wide range of results, bringing into question the traditional view that real estate is a good inflation hedge (Newell, 1996). A close examination of the existing body of literature on real estate as an inflation hedge, shows that the inflation hedging ability of real estate varies from country to country (e.g. Gunasekarage, Power, & Zhou, 2008; Sing & Low, 2000; Park & Bang, 2012; Hamelink & Hoesli, 1996), by property type (e.g. Huang & Hudson-Wilson, 2007; Li & Ge, 2008; Le Moigne & Viveiros, 2008), the development level/maturity of the economy (e.g. Lee & Lee, 2014) and the nature of the investment vehicle used to invest in real estate (e.g. Lee & Lee, 2014; Bond & Webb, 199; Newell, 1996). This shows that research findings from one country cannot simply be inferred onto another country.

Emerging markets have become popular investment destinations as a result of the 2008 global financial crisis. Returns from investments in developed countries were extremely low in the aftermath of the financial crisis which left investors seeking opportunities for higher returns in emerging markets (Haran, et al., 2016). In 2015 alone, investors' spending on commercial real estate (Industrial, Office & Retail) in South Africa, amounted to R18.5 billion (Jones Land LaSalle, 2016)and in 2016 this increased to R28 billion (Jones Lang LaSalle, 2017). Emerging markets experience higher inflation rates than developed markets. Inflation rates in emerging markets are also significantly more volatile than those of advanced markets making it more difficult for investors to predict future inflation rates of emerging markets.

Typically, commercial property leases in South Africa include escalation clauses, which stipulate a rate at which rentals will increase over the term of the lease. Such increases in rental rates are designed to protect an investor's income return against inflation. The escalation rates can either be pegged to the previous year's Consumer Price Index (CPI) or be fixed at a specific rate, however, it is common practice to use fixed escalation rates. The typical lease periods for CRE range between three to five years. Rental reviews typically occur upon renewal of the lease agreements meaning that investors would have committed to a fixed escalation rate over a period of three to five years and cannot review the rentals or the escalation rates even if they realise that their initial assumptions were incorrect. Difficulties in predicting inflation rates would compromise the ability of investors to protect their income returns against inflation, especially the unexpected component of inflation.

Considering the value of investors' spending on real estate in South Africa along with the challenges of forecasting inflation rates in a typical emerging market, this emerging market warrants its own research into the ability of real estate to serve as an inflation hedge. The only way to determine whether the traditional view that real estate is a good inflation hedge holds true in South Africa, would be to conduct the study using South African data.

With regards to research on the topic of real estate as an inflation hedge in South Africa, there are only two studies that the author is aware of, which are by Erasmus (2015) and Akinsomi, Mkhabela & Taderera (2018). Erasmus (2015) only focused on listed South African property investments and only made use of correlations, a methodology that has been criticised for being weak when it comes to establishing long-term trends in time series (Lee, Lee, Lai, & Yang, 2011). The OLS regression model employed by Akinsomi, Mkhabela & Taderera (2018) leaves room for further investigation into the long run relationship between CRE returns and inflation. An in-depth analysis focusing on the returns of South African CRE, by property type, and their relative inflation hedging ability is yet to be seen. In addition, there is an opportunity to use a methodology which can specifically focus on the long run inflation hedging ability of CRE.

This report aims to quantify the inflation hedging ability of South African CRE in the short run and the long run, expanding the existing body of literature on the topic and contributing to a better understanding of key differences and similarities between the behaviour of real estate investments in emerging and developed markets. The findings of such a study would be beneficial to all real estate investors, and particularly to fund managers, with regards to how they allocate the various real estate asset classes within their portfolios to achieve one of their primary objectives, protecting wealth against the effects of inflation. Furthermore, the findings of this study will reveal the effectiveness of common industry practice with regards to the structure of lease agreements and their ability to allow CRE investors to adjust rentals for inflations. Should this study find that CRE in South Africa does not provide a good hedge against inflation, it would suggest that investors need to review the manner in which they structure lease agreements in order to adjust rentals for inflation or more effectively push the inflation risk onto the tenants.

1.4 Research Question

From a very simplistic point of view, CRE should be a good inflation hedge seeing as investors include an inflation risk premium when pricing CRE and setting rental rates in order to achieve their desired rate of return. The security of the income that CRE generates for an investor and the value of CRE is the dependent on the structure of the lease agreements between the investors and the tenants.

The lease agreement is the mechanism through which inflation rates influence the returns of CRE. Long term lease agreements that are typically associated with CRE are viewed as a source of stable income by investors. Within the South African market, the volatile the tendency of opting for fixed rental escalation rates over a period of four to five years requires investors to forecast future inflation rates when considering a suitable inflation risk premium. On the other hand, the volatile inflation rates, typical of merging markets, make it difficult for investors to forecast inflation rates.

The main question that this study will ask is whether the structure of lease agreements in South African allows investors/property owners to adjust their rentals for inflation? In answering this question, we will gain an understanding of how well CRE is capable of hedging investor’s wealth from the negative effects of inflation, given the constraints that investors face with regards to forecasting future inflation rates.

1.5 Research Objectives

Given that long term lease agreements that do not allow investors to adjust rentals for inflation instantaneously result in lags between changes in inflation and the adjustment of rentals, the long term relationship between inflation and CRE returns is a more relevant relationship to focus on. The first objective will be to determine how the inflation hedging ability of CRE in South Africa varies between the long run and short run.

The second objective of this study will be to determine to what degree CRE in South Africa offers a hedge against expected and unexpected inflation. The volatile South

African economy poses a challenge for investors that need to forecast future inflation rates. It will therefore be relevant to observe the influence that expected and unexpected inflation each have on CRE returns.

The third objective will be to determine how the inflation hedging ability of CRE in South Africa varies by property type. CRE comprises of industrial, office and retail properties. There is strong evidence from existing literature that the relationship between inflation and the returns of each property type within the same local market varies (Hamelink & Hoesli, 1996; Li & Ge, 2008; Le Moigne & Viveiros, 2008; & Huang & Hudson-Wilson, 2007). The terms of a lease agreement negotiated between the landlords and tenants are dependent on the intended use of the leased premises. For example, a tenant occupying industrial premises that house plant equipment that would cost large sums of money to relocate would be incentivised to enter into a longer term lease agreement than a tenant leasing office space that relocate their operations at a lower cost.

The fourth objective will be to determine to what degree appreciation and income returns of CRE in South Africa offer a hedge against Inflation. The total returns that CRE offer investors can be separated into two categories, income returns generated by rental income and capital returns generated by increases in property values. The relationship between income returns and inflation would be dependent on the ability of investors to adjust rentals through the lease agreement. On the other hand, the relationship between capital appreciation returns and inflation would be dependent the inflation risk premium that is incorporated into the capitalisation rates when valuing CRE investments.

1.6 Overview of Following Chapters

Chapter two of this report will analyse the existing body of literature devoted to the inflation hedging ability of real estate, highlighting progress that has been made to date in this field along with the gaps in the body of literature and where this study will fit into the body of literature. The theoretical framework and hypotheses of this study will also be stated in this chapter. Chapter 3 of this report will discuss the research design and methodology that will be used to answer the research questions mentioned in chapter 1 and test the hypotheses stated in chapter 2. The data collection and sampling processes will also be discussed in this chapter. Chapter 4 will discuss the analysis of the data and the results thereof. Lastly, Chapter 5 will conclude this report and recommendations for future topics of study will be made.

Chapter 2

2.1 Introduction

Chapter 2 of this report will focus on analysing the existing body of literature pertaining to real estate investments as an inflation hedge. The purpose of the literature review is to analyse the existing body of research literature pertaining to the inflation hedging ability of real estate. This review will discuss relevant peer-reviewed journal articles to gain a better understanding of the progress that has been made in this field of research over time along with the current state of affairs. In doing so, this study will be able to identify gaps in the existing body of literature that future research may be able to address and identify where this study will fit in within the context of the existing body of literature.

In addition to this, the theoretical framework of this study, drawn from the existing body of literature, will be discussed in detail. Furthermore, the hypotheses that will be tested in this study will be stated, these too will be based on the findings of previous research.

2.2Literature Review

The literature analysis will begin by introducing the concept of real estate as an inflation hedge along with the more traditional views on the subject. And then move on to discuss the two types of inflation and the relationship between inflation and real estate returns when considering the effects of location, maturity of the market, the investment vehicle used and property type. The last portion of the literature review will focus on the various methodologies that have been employed to measure the inflation hedging abilities of assets.

2.2.1 Real Estate as Inflation Hedge

One of the primary objectives of an investor is to protect wealth against the effects of inflation (Bond & Webb, 1995). An investment that can shield wealth against inflation through increased returns when inflation increases, to offset the effects of inflation, is referred to as an inflation hedge (Fang, Wang, & Nguyen, 2008). If an asset's returns diminish as inflation increases, it is referred to as a perverse hedge against inflation (Hoesli, 1994). Investors who wish to shield their wealth against the negative effects of inflation require an understanding of the inflation hedging abilities that various assets have and from there can ensure that a portfolio contains some inflation hedging assets.

Real estate was generally viewed as a good hedge against inflation in the United States (e.g. Fama & Schwert, 1977; Liu, Hartze, & Hoesli, 1997), which has been one of two main reasons for including real estate in a mixed asset portfolio. The second reason, being the diversification benefits offered by real estate due to the nature of its correlation with other financial assets. Of late, it appears that the traditional views may have exaggerated the ability of real estate to hedge against inflation. Further research on the topic of real estate as an inflation hedge around the world has produced contradicting results. Of the more recent studies, some have found that real estate is not a good inflation hedge (e.g. Chu & Sing, 2004; Fang, Wang, & Nguyen, 2008; Hamelink & Hoesli, 1996), others have found that it is indeed a good inflation hedge (e.g. Gunasekarage, Power, & Zhou, 2008; Huang & Hudson-Wilson, 2007), while some have found that real estate investments merely keep up with inflation but do not outperform it (e.g. Dokko, Edelstein, Pome, & Urdang, 1991). Looking at the existing body of literature in its entirety, it becomes clear that the older research may have portrayed the inflation-hedging abilities of real estate in an exaggerated manner (Huang & Hudson-Wilson, 2007). The more recent research has revealed that the relationship between real estate returns is more intricate than it was believed to be. The hedging abilities of real estate investments vary across many dimensions: country; property type and use; and the nature of the real estate investment itself (i.e. REITs or direct real estate purchases).

Reference	Country	Property Type	Findings on Inflation hedging
Mixed studies			
Lee & Lee, (2014)	UK France Germany Poland Czech Republic	REITs	Strong evidence of inflation hedging in developed markets Little evidence of inflation hedging in emerging markets
Developed Markets			
Le Moigne & Viveiros, (2008)	Canada	Office Industrial Residential Retail	All types hedge against expected and unexpected inflation in short run & long run
Huang & Hudson-Wilson, (2008)	USA	Office Industrial Retail	Good inflation hedge No significant hedging No significant hedging
Gunasekarage, Power, & Zhou, (2008)	New Zealand	Office Industrial Residential Retail	All types are good inflation hedge in long run
Hoesli, (1994)	Switzerland	REITs	REITs offer better hedge than stocks, but results vary by property type
Emerging markets			
Erasmus (2015)	South Africa	REITs	Better long-term inflation hedge than other asset classes.
Akinsomi, Mkhabela and Taderera (2018)	South Africa	Industrial Office Retail	Office income returns and retail total returns have a positive relationship with inflation.
Li & Ge, (2008)	Shanghai	Residential	No hedge in short run Partial hedge in long run
Fang, Wang, & Nguyen, (2008)	Taiwan	Residential	No hedging benefits
(Lee, Lee, Lai, & Yang, 2011)	Malaysia The Philippines Taiwan	REITs/Property stocks	No inflation hedging benefits
(Zhou & Clements, 2010)	China	All property types	No long run inflation hedging ability

Table 3: Summary of inflation hedging literature

Table 3, situated above, summarises the findings of various studies that have been conducted across the globe. Studies that analysed developed markets (e.g. Le Moigne & Viveiros, 2008; Huang & Hudson-Wilson, 2008; Gunasekarage, Power, & Zhou, 2008) and studies that compared developed markets to emerging markets (e.g. Lee & Lee,

2014) all suggest that commercial real estate is a better hedge against inflation in developed markets than in emerging markets. The unexpected component of inflation in the emerging markets of Malaysia, The Philippines and Taiwan has been found to have negative impact on commercial real estate returns (Lee M.-T. , Lee, Lai, & Yang, 2011). The high and volatile inflation rates in emerging markets, which make it difficult to forecast inflation rates in these markets may contribute towards explaining why commercial real estate in emerging markets tend to perform poorly as inflations hedges. The Chinese CRE market did not offer any inflation hedging benefit to its investors in the years between 2000 and 2008, a period in which Chinese inflation rates were rising (Zhou & Clements, 2010). Low and stable inflation rates in developed countries are also indicative of an overall stable economy, which means that factors such as interest rates, that have been found to be significantly related to property returns, are also more stable (Miles, 1996). Stable interest rates, among other macroeconomic variables, bode well for property returns, which could also lend to explaining why property is generally a good inflation hedge in developed markets.

The two studies conducted in South Africa by Erasmus (2015) and Akinsomi, Mkhabela and Taderera (2018) do not conform to the trend of commercial real estate being a poor inflation hedge in emerging markets. When comparing various property types in Table 3, office space commonly provides a good hedge against inflation in developed markets. Research in emerging markets has not thoroughly compared the inflation hedging ability of different property types.

2.2.2 Expected and Unexpected Inflation

Fama & Schwert (1977) tested the inflation-hedging properties of various assets, using the concepts of expected and unexpected inflation that drew from the work of Fisher (1930). In their study, the United States (US) Treasury Bill (T-bill) rate was used as proxy for the expected inflation, while the unexpected inflation was defined as the difference between the actual inflation rate, reflected by the Consumer Price index (CPI), and the T-bill rate.

Despite Fama & Schwert (1977) having found that residential real estate serves as a good hedge against infaltion, Chu & Sing, (2004) found that real estate assets, in all four towns in China that were analysed, are poor hedges against both expected and unexpected Inflation at city level, the cities analysed being Chengdu, Beijing, Shanghai and Shenzhen. Furthermore, this was also found to be the case at country level. The study went on to find that real estate in one of the cities had negative hedging effects. Results from a study by Fang, Wang, & Nguyen, (2008) in Taiwan, echoed the same sentiment indicating that the asymetric nature in which real estate reacts to shocks induced by good news and bad news renders residential real estate incapable of proving a good hedge against expected inflation.

2.2.3 Real Estate Returns

The total return of real estate investments is comprised of two components, the income return and the capital (or appreciation) return. The income return is derived from the rental income generated by properties while the capital return is derived from the appreciation of the asset during the holding period and is only realised at the time of sale of the property. Although some researchers have only analysed total returns (e.g. Chu & Sing, 2004), others were more meticulous and chose to analyse total returns along with income and capital returns separately (e.g. Le Moigne & Viveiros, 2008; Huang & Hudson-Wilson, 2007). The main reason for making the distinction between income and capital returns is that real estate exists in two distinct markets, the asset market and the space market. Rental rates are determined in the space market, while property prices are determined in the asset market, and each of these asset markets are driven by different fundamentals (DiPasquale & Wheaton, 1992). To pinpoint the exact source of the inflation hedging qualities of real estate investments, if any, it is essential to make a distinction between the income and the capital returns. Huang & Hudson-Wilson (2007) found that in the US, the capital returns of appartments and offices were the main source of the inflation hedging abilities for these two property types while the income returns for offices had a negative relationship with inflation.

2.2.4 Inflation Hedging by Property Type

With regards to property type, some studies have focused specifically on non-residential real estate returns (e.g. Huang & Hudson-Wilson, 2007) some, some have focused solely on residential real estate (e.g. Hamelink & Hoesli, 1996; Li & Ge, 2008), while others have gone as far as disaggregating the real estate returns along property types and testing each property type: commercial, Industrial, Residential and Retail (e.g. Le Moigne & Viveiros, 2008). In addition, some studies have focused solely on REITs which are the most liquid form of real estate investments (e.g. Bond & Webb, 1995).

Huang & Hudson-Wilson, (2007) found that in the US, offices offered the best expected and unexpected inflation hedges followed by apartments and warehousing while retail propety returns showed no significant relationship with inflation. Gunasekarage, Power, & Zhou, (2008) found results similar to those of Huang & Hudson-Wilson, (2007) when studying the real estate markets in New Zealand. Their findings showed that all real estate types, Industrial, Office, Residential and Retail properties provide a good inflation hedge in the long rung. The only difference between their work and that of Huang & Hudson-Wilson, (2007) is that in their studies Retail properties also dispalyed inflation hedging abilities. Huang & Hudson-Wilson, (2007) went on to find that capital returns were the main source of inflation hedging of real estate. Income returns either showed no significant relationship with inflation or a perverse relationship, in the case of offices. This study highlights the fact that property type is an important factor that investors should consider when attempting to use real estate as an inflation hedge.

In Taiwan, reserach found that residential real esate does not offer any hedging benefits to investors due to the fact that the asset prices were more sensitive to negative shocks than to positive shocks when the returns of residential real estate were tested against both expected an unexpected inflation (Fang, Wang, & Nguyen, 2008).

2.2.5 Inflation Hedging by Country and Nature of Investment

Studies conducted on inflation hedging in the US have generally shown that REITs do not hedge investors against inflation in the short run, and in some cases, show a perverse relationship with inflation (Lee & Lee, 2014). Such studies are justified by the claims that real estate is a better hedge than financial assets such as stocks in the sense that REITs behave in a manner more similar to shares than direct real estate investments due to their higher liquidity. On the other hand, Bond & Webb, 1995 show that the inflation hedging abilities of REITs can be enhanced and exploited through switching between REITs and other financial assets, such as stocks and bonds, based on the predicted inflation rates as opposed to simply holding REITs over the same investment period. In Germany, evidence from studies indicated that various investment vehicles used for the purpose of indirect real estate investmnets were indipendent of inflation in the short run, however, they are inflation hedges in the long run (Obereiner & Kurzrock, 2012).

Studies on returns from direct ownership of real estate have yielded contradicting results with regards to real estate as an inflation hedge. Some studies claim that direct real estate investments are good inflation hedges, while others make a distinction between the various property types indicating that the various classes of properties, based on use, have different inflation hedging abilities. The inflation hedging ability of real estate also depends on the macroeconomic environment within which the real estate market operates, giving rise to contradictory results from country to country. For example, Swiss real estate does not provide a better hedge against inflation than any other financial assets (Hamelink & Hoesli, 1996), while in New Zealand real estate assets provide a better inflation hedge than all other financial assets (Gunasekarage, Power, & Zhou, 2008). In Singapore, Industrial properties were found to be a good hedge against both expected and unexpected inflation, Retail property was found to be a good hedge against unexpected inflation only while residential properties were found to be a good inflation hedge only during low inflation regimes (Sing & Low, 2000). In Korea, CRE investments hedge against inflation in the short-run and long run (Park & Bang, 2012). Newell (1996) revealed that commercial real estate investments in Australia show stronger inflation hedging than those in the United Kingdom (UK).

2.2.6 Inflation Hedging in Developed and developing markets

Lee & Lee, (2014), compared the degree of hedging against inflation that real estate offers in emerging markets (Poland and the Czech Republic), and in developed markets (France, Germany and The United Kingdom). They found that real estate in both emerging and developed markets does not offer a hedge against short-run inflation. However, when looking at the long-run inflation, they found that real estate investments in developed markets offered a greater degree of hedging against inflation than in emerging markets. The explaination for this difference between emerging markets and developed markets was attributed to institutional investors in developed markets having better access to information, which in turn allows them to anticipate inflation and manage the risk it brings better than investors in emerging markets. Investors therefore need to acklowledge that emerging markets behave differently to developed markets with regards to the ability of real esate to serve as an inflation hedge (Lee & Lee, 2014).

2.2.7 South African Property as an Inflation Hedge

To the knowledge of the author, there is only one study that has specifically focused on the ability of South African real estate to hedge investors' wealth against inflation. This study was conducted by Erasmus (2015) and only focused on the correlation between inflation and South African listed properties and found that listed real estate investments provided a better inflation hedge than other financial assets in the long term due to a negative correlation between listed property and inflation. Furthermore, listed properties were found to be more resilient than other financial assets during shocks to the market. A study by Akinsomi, Mkhabela & Taderera (2018) investigated the role that macroeconomic variables have in explaining CRE returns in South Africa. Although the study was not specifically aimed at investigating the inflation hedging ability of South African CRE, inflation was found to be a statistically significant determinant of rental growth, positively driving income returns.

2.3Hypotheses

The following hypotheses which are in line with the research question and objectives will be tested in this study. The hypotheses denoted by the subscript "0" represent the null hypotheses, while those denoted by the subscript "1" represent the alternative hypothesis.

The 1st hypothesis will draw from studies that have found that inflation rates do indeed have an influence on real estate returns. Akinsomi, Mkhabela & Taderera (2018) found that changes in inflation rates positively affect changes in CRE income returns in South Africa, however, they did not distinguish between expected and unexpected inflation. Seperating the expected and unexpected components of the inflation rate as done by Fama and Schwert, 1977, will allow this study to contribute to the existing literature on South African CRE as it will reveal the effects of a volatile inflation rate on the ability of CRE to hedge against inflation. This study will take the stance that the South African CRE returns respond to changes in unexpected inflation, based on the assumption that the assumption that the inclusion of escalation clauses in most commercial leases will allow investors the opportunity to ensure that their income returns outgrow inflation rates on an annual basis.

> **H$\boldsymbol{a_0}$:** Over time, changes in unexpected inflation, will result in changes in South African CRE returns.

> **H$\boldsymbol{a_1}$:** Over time, changes in unexpected inflation, will not result in changes in South African CRE returns.

The 2nd hypothesis that will be tested is based on the results of a study by Hamelink & Hoesli, (1996); Li & Ge, (2008); Le Moigne & Viveiros, (2008) & Huang & Hudson-Wilson, (2007) whose studies all found that the inflation hedging ability of industrial, office, residential and retail properties varies. Although these studies provide conflicting results with regards to whether inflation has a pervasive or positive effect on real estate returns, they all support this hypothesis in the sense that they present evidence that inflation influences real estate returns. The lease terms will vary according to the property type and the intended use of the premsies. The lease period, method of rental escalation and the recovery of operating expenses all have an impcat on the   The expenses asociated with relocating plant equipment and the unique specifications that tenants in industrial properties require for their opertaions are likely incentivise tenants to secure longer term leases in order to avoid having to relocate regularly. This will in turn require landlords to forecast inflation rates over a longer period of time. This study expects retail and office property to be more responsive to changes in expected and unexpected inflation than industrial property, which in in line with the findings of Akinsomi, Mkhabela & Taderera (2018) whose found that inflation is among the macroeconomic variables that influence CRE returns of Retail and Office property.

Hb_0: The predictive power of inflation over CRE returns over time will vary by property type.

Hb_1: The predictive power of inflation over CRE returns over time will not vary by property type

Huang & Hudson-Wilson, (2007) found that capital appreciation returns, in the United States, accounted for the inflation hedging ability of real estate, as opposed to income returns which did not show ay significant inflation hedging. In South Africa, the findings of Akinsomi, Mkhabela & Taderera (2018) indicate that the income return of CRE is significantly influenced by inflation, showing a positive relationship between income returns and inflation. Their study, however, did not distinguish between expected and unexpected inflation. Erasmus (2015), who focused on South African Listed properties, as opposed to CRE, found that the Listed Properties provided a hedge against expected and unexpected inflation. The ability of invetsors to increase their rental rates on an annual basis, allows them to incorporate their expectations of future changes in inlfation into the escalation rates, giving them an opportunity to protect their income returns agianst inflation. Intuitively, the volatile inflation rates in South Africa increases the margin of error with regards to predictions of future inflation rates. This will result in larger unexpected inflation rates and decrease the chances of CRE hedging against unexpected inflation. This study expects CRE income returns to hedge against expected inflation, but not unexpected inflation.

> **Hc_0** The income returns of South African CRE are the source of the inflation hedging ability of South African real estate.

> **Hc_1:** The income returns of South African CRE are not the source of the inflation hedging ability of South African real estate.

For the 4th hypothesis Lee & Lee, (2014); Li & Ge, (2008); Gunasekarage, Power, & Zhou, 2008; and Obereiner & Kurzrock, (2012) all found that real estate provides a better inflation hedge in the long run that in the short run. These studies all cite CRE investments as being highly illiquid long term investments and that do not react instantly to changes in inflation rates. Lease periods are typically 3 years or 5 years long, which and property owners are usually only get to adjust the escalation rates and rentals upon renewal of the leases. Property owners have the ability to adjust rentals for previous movements in unexpected inflation, however they are only able to do so in hindsight. This study therefore expects unexpected inflation to have predictive power for CRE returns over time.

> **Hd_0:** Unexpected inflation has predictive power for commercial real estate over time.

> **Hd_1:** Unexpected inflation does not have predictive power for commercial real estate over time.

Chapter 3

3.1Introduction

Chapter 3 of this report will be concerned with the research design and strategy. This entails devising how the research questions will be answered and how the hypotheses will be tested, thereby achieving the research objectives outlined in chapter 1. This chapter will go on to define the population that will form the focus of this research and discuss the sample that will be used to study the population along with the manner in which data will be collected and analysed.

3.2 Research Design

Research design is the framework for collecting/gathering and analysing data with the objective of answering the research questions and testing hypotheses. This study will employ a quantitative research strategy and make use of panel data which is a combination of cross sectional and time-series data.

The use of a quantitative research strategy will allow the researcher to test hypotheses based on theory from the existing body of literature to answer the research questions posed in chapter 1 of this report. The use of secondary data will save the researcher precious time that would otherwise be spent collecting data, allowing the researcher to dedicate the saved time towards the processing and analysis of a large amount of data. This in turn will ensure that the results obtained will have greater statistical power contributing to the integrity of the study.

3.3 Research Philosophy

The research philosophy of this study is rooted in Positivism. This study will be an empirical study, of which observation and scientific measurement will lie at the heart of the research process. Testable hypotheses will be produced, based on existing knowledge, to arrive at findings. The research will be conducted in an objective manner and adhere to making scientific statements rather than normative ones, distinguishing “what is” from “what ought to be”.

3.4 Theoretical Framework

There are three measures of asset returns, these being the income return, appreciation return and total return. The income return represents the return gained form the cash flows paid out to an investor/owner of an asset. In the case of real estate investments, the income return is derived from the rental income less operating expenses. The appreciation return represents the return to an investor that arises from a change in the market value of an asset. The total return is the sum of the income return and the appreciation return as shown in Equation 1.

Equation 1

$$R_t = \frac{Cf_t}{V_{t-1}} + \frac{V_t - V_{t-1}}{V_{t-1}}$$

Where:

R_t	Is the total return of the asset during period t;
Cf_t	Is the net cash flow paid out to the investor during period t;
V_t	Is the value of the asset during period t
V_{t-1}	Is the market value of the capital asset as of the end of period t;
$\frac{Cf_t}{V_{t-1}}$	Is the income return of the asset during period t;
$\frac{V_t - V_{t-1}}{V_{t-1}}$	Is the appreciation return of the asset during period t;

The ability of an asset to serve as an inflation hedge can be determined using the regression model in Equation 2. If an asset is a perfect hedge against inflation, the coefficient β_j will have a value equal to 1 meaning that a unit change in inflation will result in a unit change in the return of the asset thereby perfectly shielding the investor from the negative effects of inflation.

Equation 2

$$R_{jt} = \alpha_j + \beta_j \Delta_t + \varepsilon_{jt}$$

Where:

R_{jt}	Is the nominal return of asset j during period t;
α_j	Is the intercept term of asset j, which can be interpreted as the real rate of return of asset j;
β_j	Is the coefficient of inflation of asset j;
Δ_t	Is the actual inflation rate during period t;
ε_{jt}	Is the error term of asset j;

Fisher (1930) proposed that inflation consists of two components, these being expected inflation and the unexpected inflation. Autoregressive Integrated Moving Average (ARIMA) models can and have been employed to estimate the expected inflation, while the unexpected inflation rate is the difference between the observed ex-post inflation rate less the expected inflation rate.

Equation 3

$$I_{unexpected} = \Delta_t - E\left(\hat{\Delta}_t \middle| \emptyset_{t-1} \right)$$

Where:

$I_{unexpected}$	Is the unexpected inflation rate
Δ_t	Is the true observed ex-post inflation rate
$E\left(\hat{\Delta}_t \middle| \emptyset_{t-1} \right)$	Is the estimate of expected inflation rate $\hat{\Delta}_t$ based on information $\emptyset_{t-1}$ available at period t -1;

The regression model proposed by Fama and Schwert (1977), indicated in Equation 4, tests the ability of an asset to hedge against expected and unexpected inflation.

Equation 4

$$R_{jt} = \alpha_{jt} + \beta_j E(\hat{\Delta}_t | \emptyset_{t-1}) + \gamma_j [\Delta_t - E(\hat{\Delta}_t | \emptyset_{t-1})] + \varepsilon_{jt}$$

Where:

R_{jt}	is the nominal return of asset type j from period t -1 to t;
α_{jt}	is the intercept term;
β_j	Is the slope coefficient for the expected inflation for asset j;
γ_j	Is the slope coefficient for unexpected inflation for asset j;
$E(\hat{\Delta}_t \| \emptyset_{t-1})$	Is the estimate of expected inflation, $\hat{\Delta}_t$, based on information available $\emptyset_{t-1}$, at period t – 1;
Δ_t	Is the true ex-post inflation rate from t – 1 to t;
ε_{jt}	Is the error term of asset j, from t – 1 to t;

The method proposed by Fama and Schwert (1977) has been by far the most popular and accepted method of testing the relationship between inflation and returns in real estate research (Huang & Hudson-Wilson, 2007). The Fama and Schwert (1977) method makes a distinction between the expected and unexpected components of inflation and tests the inflation-return relationship for both components of inflation. This model for testing the inflation-hedging abilities of assets has been incorporated into the work of numerous authors in the real estate field (e.g. Chu & Sing, 2004; (Dokko, Edelstein, Pome, & Urdang, 1991; Fang, Wang, & Nguyen, 2008 and Hamelink & Hoesli, 1996 to name a few). Furthermore, very little changes have been made to the method. A key adaptation of the Fama & Schwert (1977) method is the inclusion of cointegration into the model. This technique is used to examine the relationship between non-stationary variables by integrating the variables simultaneously (Le Moigne & Viveiros, 2008). Cointegration has been useful in establishing the long-term relationship between real estate returns and inflation considering criticism against the Fama & Schwert (1977) model's weak ability to establish relationships between long run inflation and real estate return.

Granger causality tests: The Granger causality test has been a common choice in the research of real estate as an inflation hedge. The reason for performing the test is to determine whether inflation influences real estate returns or whether real estate returns influence inflation. In New Zealand, the results from the causality test indicated that with regards to commercial, Industrial and Residential properties, the relationship between inflation and returns is better explained with the use of the lagged inflation (Gunasekarage, Power, & Zhou, 2008). Such findings suggest that inflation shocks do not affect the real estate markets instantaneously probably due to the lumpiness of Real estate.

Correlations between real estate returns and inflation have also been used to investigate the ability of real estate investments to provide a hedge against inflation. An example of such is the case of Le Moigne & Viveiros, (2008) who were studying Canadian real estate. The use of correlations to study long term relationships has received criticism for being a weak methodology (Lee , Lee, Lai, & Yang, 2011).

3.5 Methodology

The actual observed inflation rate for each year of the period of analysis will be deconstructed into an expected inflation component and an unexpected inflation component. An Autoregressive Integrated Moving Average (ARIMA) model will be used to predict the expected inflation rates. The difference between the actual inflation rate and the estimate of the expected inflation will provide us with the unexpected inflation component.

Using the calculated expected and unexpected inflation rates, the short run relationship between CRE returns and the two components of inflation will be tested using the model proposed by Fama & Schwert (1977).

The long run relationship between CRE returns and expected and unexpected inflation will be analysed using a Vector Error Correction (VEC) model. The VEC model is the preferred choice for this study due to the fact that it is best suited for testing the long run relationship between non-stationary variables and measures the velocity at which a system of equations reverts to a long run equilibrium.

3.5.1 Expected and unexpected inflation

Fama & Schwert (1977) used US Treasury Bill yields as a proxy for expected inflation, however, this method of estimating expected inflation rates has been criticised for its inability to distinguish between changes in the real yield of the Treasury Bills and changes in expected inflation (Le Moigne & Viveiros, 2008; Sing & Low, 2000). The Autoregressive Integrated Moving Average (ARIMA) model has been used to predict expected inflation in several studies (e.g. Sing & Low, 2000; Obereiner & Kurzrock, 2012).

An integrated series (I), is one that requires differencing to be made stationary. The lags of the stationary variable are referred to as Auto Regressive (AR) terms. The moving average (MA) refers to the number of lags in the forecast errors. An ARIMA model can be summarised with the following three variables; p, the number of auto regressive terms (AR); d, the number of differences; and lastly q, the number of lags of the error forecast (MA). The standard representation of the ARIMA model is denoted as ARIMA (p, d, q) and this notation will be used from this point onwards in this report. The application of the ARIMA model for predicting expected inflation requires certain conditions to be met, and Equation 5 will be used to evaluate whether these conditions are met.

Equation 5

$$\Delta = \alpha + \beta E(\Delta_t) + \varepsilon_t$$

Where Δ is the actual inflation observed ex post and E(Δt) is the expected inflation. The most suitable model will be one whereby α is not significantly different from zero and β is as close to 1 as possible.

The ARIMA model is only applicable to non-stationary variables. Time series data variables such as the CPI are typically non stationary and the average moves over time.

The non-stationary variables require differencing in order to be made stationery. The Augmented Dickey-Fuller (ADF) test will be used to examine the stationarity of differenced CPI variable that has been used in the ARIMA model.

3.5.2 Short run inflation hedging

This study will make use of the model proposed by Fama and Schwert (1977) to test the short-run inflation hedging ability of industrial, office and retail property. Equation 6, below, shows the regression model that will be used to quantify the extent to which South African direct real estate investments hedge against inflation.

Equation 6

$$R_{jt} = \alpha_{jt} + \beta_j E\left(\hat{\Delta}_t \middle| \emptyset_{t-1} \right) + \gamma_j \left[\Delta_t - E\left(\hat{\Delta}_t \middle| \emptyset_{t-1} \right) \right] + \varepsilon_{jt}$$

Where:

R_{jt} is the nominal return of asset type j from period t -1 to t;

α_{jt} is the intercept term;

β_j Is the slope coefficient for the expected inflation for asset j;

γ_j is the slope coefficient for unexpected inflation for asset j;

$E\left(\hat{\Delta}_t \middle| \emptyset_{t-1} \right)$ is the estimate of expected inflation, $\hat{\Delta}_t$, based on information available $\emptyset_{t-1}$, at period t – 1;

Δ_t is the true ex-post inflation rate from t – 1 to t;

ε_{jt} is the error term of asset j, from t – 1 to t;

The following logic will be used to interpret the regression coefficients:

- If $\beta_j < 0$, asset class j is a pervasive hedge against expected inflation
- If $0 < \beta_j < 1$, asset class j is a partial hedge against expected inflation
- If $\beta_j > 0$, asset class j is a positive hedge against expected inflation
- If $\gamma_j < 0$, asset class j is a pervasive hedge against expected inflation
- If $0 < \gamma_j < 1$, asset class j is a partial hedge against expected inflation

- If $\gamma_j > 0$, asset class j is a positive hedge against expected inflation

3.5.3 Long run inflation hedging

The Vector Error Correction (VEC) model was developed to determine the long run relationship between cointegrated time series variables, (Gujarati & Porter, 2010). The model treats time series variables of interest as exogenous, thereby creating a system of equations in which the effect of each variable on the rest of the variables is measured. The VEC model is used to test the long run relationship between non-stationary variables.

Equation 7

$$\Delta y_t = \Pi y_{t-1} \sum_{k=1}^{p-1} \Gamma_i \, y_{t-i} \Delta y_{t-1} + \quad Bx_t + \quad \varepsilon_t$$

Where:

$$\Pi = \sum_{l=1}^{p} A_i - 1$$

$$\Gamma = \sum_{j=i+1}^{p} A_j$$

k is the number of endogenous variables included in the VEC model

y_t is the k-dimensional vector of non-stationary variables.

x_t. d-dimensional vector of exogenous variables.

ε_t. k-dimensional vector of random components.

p is the rank order of the VEC model.

The VEC model works on the premise that if a long-term relationship between the non-stationary time series exists, they would tend towards a long run equilibrium. The correction error term, denoted by Π in Equation 7, represents the velocity at which the system of equations returns to equilibrium. A negative correction error term would indicate that the system naturally reverts to a long run equilibrium. This is what we will be looking for with regards to the relationship between the various property returns that will be analysed.

Using the above, the hypotheses will be tested, and the research questions will be answered which is in line with the theoretical framework presented in chapter 3.4 shedding light on the degree to which income, capital appreciation and total returns of industrial, office and retail property that fall under the definition of South African CRE investments hedge against expected and unexpected inflation in the short-run and long-run.

3.6 Population

The population that will constitute the focus of this study is the South African CRE investment population. This includes all commercial properties, (Industrial, Office and Retail) in South Africa that are typically acquired with the intention of generating income and capital appreciation returns for the investors.

3.7 Data

Seeing as this study made use of secondary data, the difficulties associated with collecting data were circumvented ensuring that the process of acquiring the data was swift.

3.7.1 Inflation

Using annual CPI data obtained from Quantec Database for the period from December 1960 to December 2016, consisting of 57 observations, an ARIMA model will be constructed to predict the expected inflation. Before an ARIMA model can be fit to the data, the orders of integrated difference, the autoregression and the moving average will need to be specified.

Table 4 shows the annual recorded CPI from December 1958 to December 2016. The historical CPI values are calculated using the cost of a basket of goods consumed by a typical South African family using the year 2010 as a basis. From 1958 to 2016, the CPI has increased by an order of 2. In 1958, the basket of goods cost 100 times less than it did in 2010. Granted, the basket of goods has changed over the years with technological advancements which would cause an increase in the CPI, however, prices have increased. The line Plot of the CPI displayed in Figure 1 indicates that the CPI has been increasing at an exponential rate over the period of analysis.

The ARIMA model will be fit to the CPI values in this table to predict the expected CPI. Thereafter the actual CPI and the expected CPI values will be converted into inflation by calculating the year on year difference as a percentage of the preceding year's CPI value.

Year	CPI	Year	CPI	Year	CPI	Year	CPI
1958	1,644	**1973**	2,728	**1988**	18,106	**2003**	68,3258
1959	1,664	**1974**	3,046	**1989**	20,773	**2004**	69,2724
1960	1,686	**1975**	3,427	**1990**	23,748	**2005**	71,6271
1961	1,721	**1976**	3,805	**1991**	27,390	**2006**	74,9518
1962	1,743	**1977**	4,229	**1992**	31,190	**2007**	80,2722
1963	1,766	**1978**	4,700	**1993**	34,221	**2008**	89,5328
1964	1,811	**1979**	5,325	**1994**	37,280	**2009**	95,9164
1965	1,884	**1980**	6,052	**1995**	40,516	**2010**	100
1966	1,950	**1981**	6,976	**1996**	43,496	**2011**	105
1967	2,019	**1982**	7,997	**1997**	47,235	**2012**	110,937
1968	2,059	**1983**	8,981	**1998**	50,485	**2013**	117,317
1969	2,126	**1984**	10,016	**1999**	53,101	**2014**	124,435
1970	2,212	**1985**	11,648	**2000**	55,936	**2015**	130,145
1971	2,338	**1986**	13,821	**2001**	59,126	**2016**	138,378
1972	2,490	**1987**	16,054	**2002**	64,544		

Table 4: South African Annual CPI (Source: Quantec Database)

Figure 1 shows a line plot of the annual CPI, as observed ex post, over the period of analysis. There is an upward trend that appears to be exponential nature. The CPI observations will need to be transformed into a stationary variable. In Figure 2, the CPI variable has undergone a natural log-transformation and has been differenced to the 1st order making it more stationary over time.

The line plot in Figure 4 shows the CPI variable differenced to the 2nd order. Although it more stationary that the plot of the natural logarithm of the CPI variable in Figure 2, the variance increases with time.

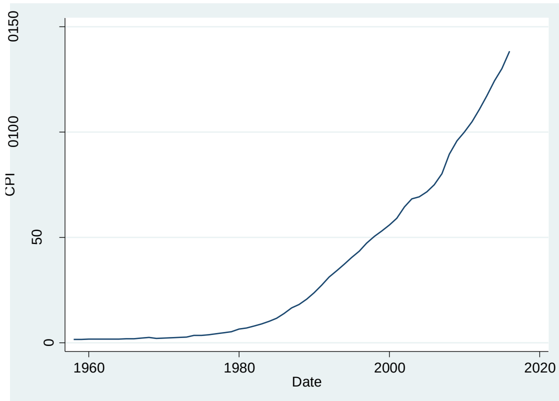

Figure 1:Line Plot of CPI

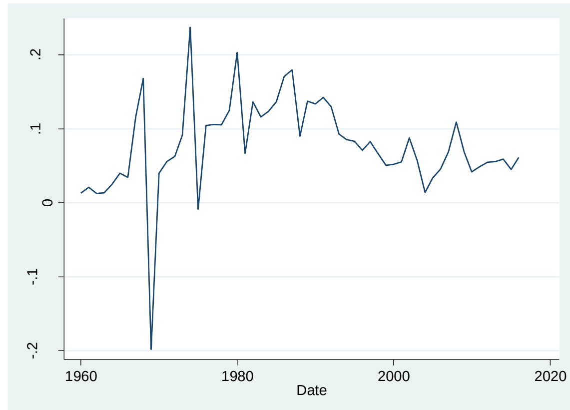

Figure 2: Line Plot of ln(CPI)

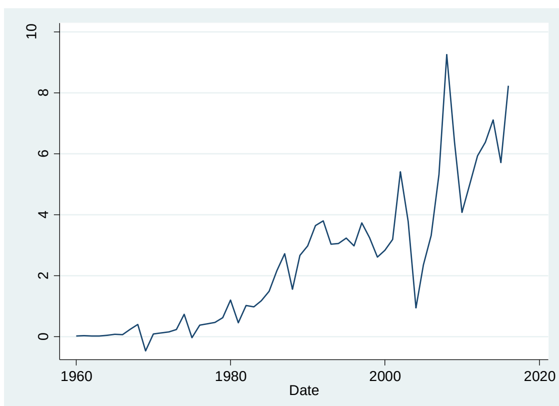

Figure 3: Line plot of difference in ln(CPI)

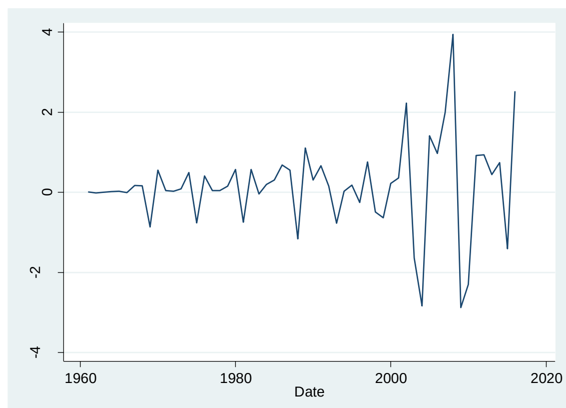

Figure 4: Line plot of 2nd order difference of CPI

A correlogram of the natural logarithm of the CPI differenced to the first order, displayed in Figure 5, shows the relationship between the CPI recorded in each year has with the previous year's CPI. Most of the autocorrelations lie within the confidence band denoted by the grey area of the graph, however, the 6th lag is quite strong and lies outside of the confidence interval. This suggests there is evidence of autocorrelation.

The partial correlogram in Figure 6 shows the relationship between ln(CPI) of each year and the previous year's residual term. Once again, majority of the observations are comfortably within the confidence band save for the 6th lag suggesting that there is evidence of a moving average. The correlogram of the 2nd order differenced CPI variable in Figure 7 shows that most of the lags are within the confidence interval, with the exception of the 2nd and the 6th lags. The partial correlogram in Figure 8 shows that the majority of the lags lie outside of the confidence interval with a couple of very strong lags.

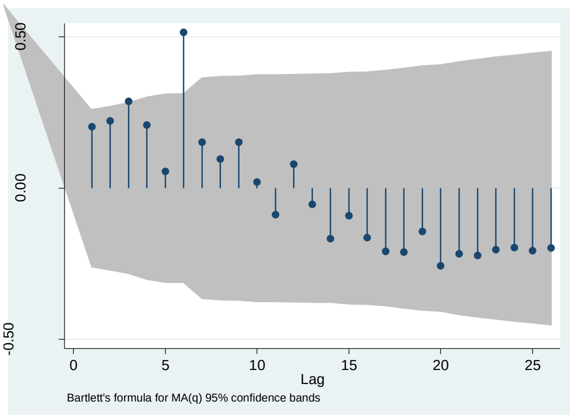

Figure 5: Autocorrelation of 1st order difference of ln(CPI)

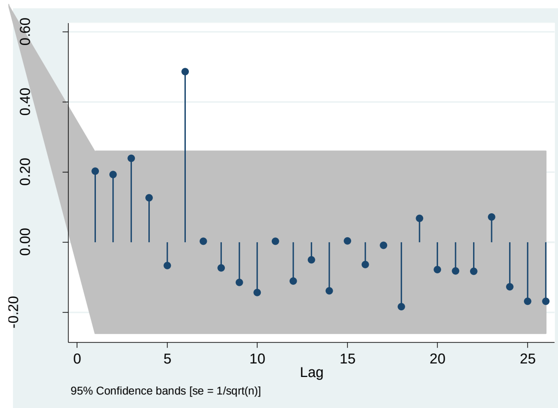

Figure 6: Partial autocorrelation of 1st order difference of ln(CPI)

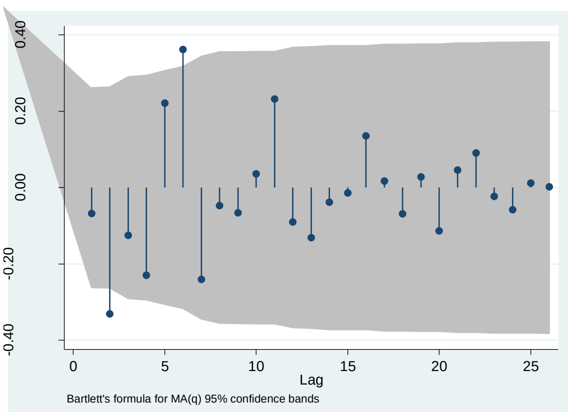

Figure 7: Autocorrelation of 2nd order difference of CPI

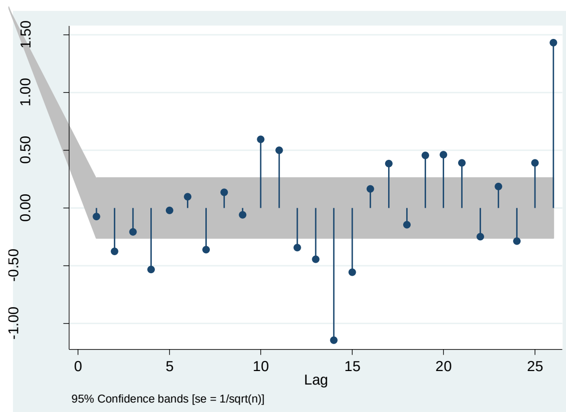

Figure 8: partial autocorrelation of 2nd order difference of CPI

The Augmented Dickey-Fuller (ADF) test was used to examine the stationarity of the 2nd order differenced CPI variable. In this exercise, three models, shown in Table 5, will be tested and all three of these models should be unanimous with regards to the stationarity of the variable.

Model	Equation	Assumptions
1	$\Delta CPI_t = \alpha + \Upsilon CPI_{t-1} + \varepsilon_t$	Intercept only
2	$\Delta CPI_t = \alpha + \beta t + \Upsilon CPI_{t-1} + \varepsilon_t$	Intercept and trend
3	$\Delta CPI_t = + \Upsilon_1 CPI_{t-1} + \varepsilon_t$	No intercept and no trend

Table 5: Augmented Dickey-Fuller Models to be tested

Where: t is the time index; ΔCPI is the change in the 2nd order differenced CPI variable; α is the intercept terms, also referred to as the drift term; β is the coefficient time trend; ϒ the focus of the test, the coefficient representing the process root; and lastly, e_t is the evenly distributed residual term. The following hypotheses will be tested for each of the three models to make a judgement on the stationarity of the 2nd order differenced CPI variable. The null hypothesis (H_0) being that the variable is not stationary, (ϒ = 0) and the alternative hypothesis (H_1) being that the variable is stationary (ϒ < 0). When the absolute value of the test statistic is greater than the critical value (at 5% a significance level), then the null hypothesis will be rejected (Gujarati & Porter, 2010).

ADF Model	**1**	**2**	**3**
ϒ	-1.073986***	-1.077443***	-1.0604***
β		.0070204	
α	.1566982	-.0395164	
Test statistic	-7.514	-7.499	-7.452
5% Critical value	-2.926	-3.495	-1.950
Interpretation	reject H_0	reject H_0	reject H_0

*denotes a 10% significance level, **denotes a 5% significance level and *** denotes a 1% significance level

Table 6: Dickey-Fuller Test Results

Table 6 indicates that all three models are in accord and indicate that the 2nd difference of the CPI variable is stationary. The significance levels of the trend term and constant term indicate that the 2nd differenced CPI variable is best explained by the 3rd model which does not include a trend and a constant (α = β = 0).

3.7.2 CRE returns

The sample data for annual income, capital growth and total returns of South African CRE were obtained from the Investment Property Databank (IPD) which contains 67% of all professionally managed property funds in South Africa, (MCSI, 2015). This ensures that it will be safe to infer the inflation hedging ability of South African CRE from the results of such a large sample group. Only annual returns of CRE Investments in South Africa were available for this study. It would have been ideal to have the opportunity to analyse annual and quarterly data, however quarterly data was not available. The annual South African inflation rates will be obtained from Quantec Database. Quantec database sourced its inflation data from the South African Reserve Bank (SARB). Table 7 shows the capital growth, income and total returns as percentages for CRE investments in South Africa by property type. There are 22 observations for each property type and each type of return.

Year	Industrial ZAR Capital Growth	Industrial ZAR Income Return	Industrial ZAR Total Return	Office ZAR Capital Growth	Office ZAR Income Return	Office ZAR Total Return	Retail ZAR Capital Growth	Retail ZAR Income Return	Retail ZAR Total Return
1995	2,62	10,52	13,39	5,83	7,91	14,16	7,80	8,78	17,21
1996	6,26	10,77	17,65	1,43	8,47	10,02	7,16	9,33	17,09
1997	5,56	10,27	16,35	3,39	8,91	12,58	11,23	9,86	22,09
1998	-7,75	10,67	2,16	-7,39	9,44	1,41	0,12	9,20	9,33
1999	-2,79	11,52	8,44	-1,46	10,99	9,38	7,19	9,36	17,16
2000	-3,86	11,65	7,38	1,26	11,19	12,57	1,07	9,33	10,50
2001	-4,11	12,24	7,66	-4,12	10,64	6,12	4,31	9,73	14,42
2002	-3,61	12,06	8,05	-5,02	10,07	4,59	1,98	8,99	11,13
2003	4,37	13,44	18,34	-1,75	10,90	8,97	6,59	9,74	16,92
2004	9,62	13,42	24,22	5,20	10,67	16,37	14,72	9,94	25,99
2005	18,20	12,49	32,75	12,86	10,96	25,10	22,23	9,57	33,72
2006	20,95	10,59	33,55	14,21	10,21	25,73	17,99	8,44	27,81
2007	23,88	9,89	35,90	19,35	9,61	30,64	16,66	8,00	25,87
2008	8,71	9,13	18,57	5,13	9,13	14,69	2,69	7,96	10,85
2009	-0,18	9,53	9,33	-1,48	9,26	7,65	1,24	8,10	9,43
2010	3,37	9,96	13,64	4,29	9,76	14,43	5,64	8,28	14,35
2011	1,57	10,27	11,99	1,14	9,62	10,86	2,17	8,16	10,50
2012	4,97	10,54	15,99	2,01	9,82	12,01	7,92	8,24	16,76
2013	6,49	10,00	17,08	3,65	9,43	13,39	9,35	7,86	17,87
2014	3,35	9,60	13,24	2,15	9,40	11,74	5,10	7,95	13,43
2015	3,57	9,37	13,25	2,45	9,08	11,73	5,96	7,60	13,98
2016	4,16	9,12	13,63	-1,13	8,87	7,65	4,54	7,69	12,55

Table 7: Annual Returns by Property Type (Source: MSCI)

Table 8 shows the mean, variance and standard deviation of South African CRE by property type for the period between 1995 and 2016. For all property types, the average annual income returns are greater than the annual capital growth returns. Furthermore, the income returns of all property types have the lower standard deviation and variance than capital returns. CRE annual capital growth returns are more volatile than income returns. The annual total returns of each property type are the most volatile, with the capital growth component being the source of this volatility. The retail CRE has enjoyed the highest total returns compared to industrial and office properties and the lowest variance. The retail market is the least volatile amongst the three property types. On average, the retail capital growth returns contribute more towards total retail returns than office and industrial capital returns contribute towards their respective total returns.

	Industrial Capital Growth	Industrial Income Return	Industrial Total Return	Office Capital Growth	Office Income Return	Office Total Return	Retail Capital Growth	Retail Income Return	Retail Total Return
Mean	4,788	10,775	16,025	2,818	9,742	12,808	7,439	8,732	16,770
Median	3,865	10,53	13,635	2,08	9,615	11,875	6,275	8,61	15,59
Variance	63,571	1,677	77,034	39,171	0,775	47,312	34,721	0,617	43,324
Standard deviation	7,973	1,295	8,776	6,258	0,880	6,878	5,892	0,785	6,582
No. of observations	22	22	22	22	22	22	22	22	22

Table 8: Descriptive statistics for annual CRE returns

Table 9 shows the results of the ADF tests whereby the test statistic is compared to the critical value at 5% significance. None of the variables are stationary, except for the unexpected inflation variable. The variables will therefore require differencing to introduce stationarity. Because of the non-stationary variables, the VEC model will have to be used as opposed to a VAR model which is more suited for stationary variables.

		Augmented Dickey Fuller Test Statistic		
	Variable	**Drift term**	**Drift term and trend term**	**No drift & no trend terms**
Inflation	Expected Inflation	-3.212***	-3.199	-1.327
	Unexpected Inflation	-4.641***	-4.507**	-4.757***
Industrial	Capital Growth	-1.761**	-1.723	-1.478
	Income Return	-0.871	-1.532	-0.525
	Total Return	-1.785**	-1.710	-0.811
Office	Capital Growth	-2.187**	-2.171	-2.122**
	Income Return	-2.270**	-2.388	0.188
	Total Return	-2.178**	-2.116	-1.152
Retail	Capital Growth	-2.400**	-2.336	-1.483
	Income Return	-0.983	-3.122	-0.601
	Total Return	-2.414**	-2.403	-0.939
*, **, *** denote 1%,5% and 10% level of significance				

Table 9: ADF test statistics

The number of lags in the VEC model will be specified according to the Akaike Information Criterion (AIC). The Johansen Test for cointegration will be used to test the level of cointegration between real estate returns and inflation (both expected and unexpected). The null hypotheses (H_0) is that there is no cointegration, while the alternative hypothesis of the test (H_1) is that there is cointegration. If trace statistic is greater than the critical statistic, we will reject the null hypothesis, and assume that there is cointegration. If the variables are not cointegrated, we can use the unrestricted VAR model. The LaGrange Multiplier Test will be used to test for level of autocorrelation in the variables included in the models. The Jarque-Bera Test will be used to determine whether the error term of the VEC Model is normally distributed. Ideally, there should be no autocorrelation and the error terms should be normally distributed.

3.8 Data Analysis

The data analysis stage begins by preparing the data and performing descriptive statistics to identify the distribution of the data and the extent of its dispersion. The historic inflation rates were then deconstructed into their expected and unexpected components. The dependent variables, CRE returns, were regressed against expected and unexpected inflation to quantify the extent to which inflation drives returns and the results were tabulated and displayed for interpretation. STATA, a statistical analysis software package, was used for the entire data analysis process.

3.9 Ethical Considerations

With regards to the ethical considerations for this research, the majority of the issues pertaining to the collection of data were avoided seeing as this study utilised secondary data. The burden of collecting data in an ethical manner would have been borne by IPD during the data collection process, and it is safe to assume that an institution of their calibre would have adhered to these ethical considerations. The researcher will source data from MSCI in a legal manner and ask for permission to access and use the data.

Chapter 4

In this chapter, the data will be analysed, and the results will be visually presented with the use of visual statistics and interpreted thereafter. The ability of South African direct real estate investments to provide a hedge against inflation will be assessed both in the short run and in the long run. The aim of this exercise is to test the hypotheses presented in chapter 3 and answer the research questions posed.

4.1 Expected Inflation and unexpected inflation

As explained in the methodology section of this report, the inflation rates obtained from the annual CPI data obtained from Quantec Database for the period from December 1960 to December 2016 have to be separated into expected and unexpected inflation.

4.1.1 Selection of the ARIMA Model

Table 10 shows the regression results of four ARIMA models were fit to the CPI variable with the intention of selecting the model with the best fit. The ARIMA (0,2,2) and ARIMA (0,2,1) appear to fit the data best. Furthermore, the constant term is significantly close to zero while the sigma value is significantly close to one. The better of these two would be the ARIMA (0,2,1) model as it is more parsimonious than the ARIMA (0,2,2) model, achieving good explanatory power of the data with fewer variables.

	ARIMA (0,2,2)	ARIMA (0,2,1)	ARIMA (1,2,0)	ARIMA (1,2,1)
Constant	.1298044	.12892	.1437824	.1277552
	(4.06)***	(2.48)***	(1.02)	(10.56)***
AR(1)			-.0727058	.498898
			(-0.94)	(3.16)***
MA(1)	-.2846142	-.7003819		-1
	(-2.00)**	(-6.94)***		
MA(2)	-.5374339			
	(-5.52)***			
Sigma	.9627268	1.085052	1.121226	.9817753
	(12.88)***	(21.01)***	(15.61)***	(18.35)***
Log likelihood	-77.91206	-84.36887	-85.87386	-79.92135
Wald Chi^2	41.26	48.21	0.88	9.98
Prob > Chi^2	0.0000	0.0000	0.3471	0.0016

The z statistics are in parenthesis
*denotes a 10% significance level, ** denotes a 5% significance level, *** denotes a 1% significance level

Table 10: ARIMA models for Expected inflation

4.1.2 Predicted expected and unexpected inflation

The ARIMA (0,2,1) model can be used to predict the expected inflation rates between 1995 and 2016. The difference between the actual observed inflation and the predicted expected inflation (using the ARIMA model) for the same period will represent the unexpected inflation.

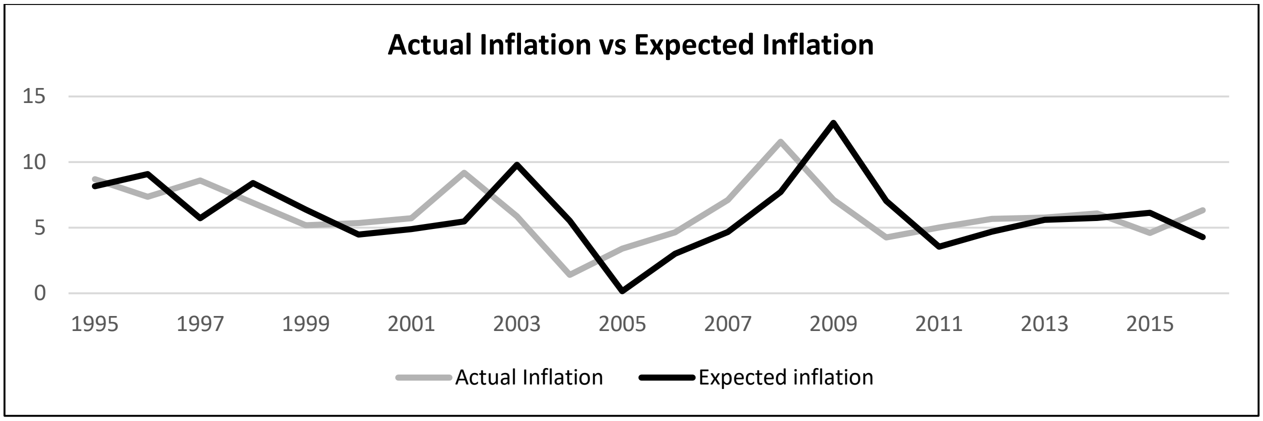

Figure 9: Line Plot of Actual inflation and Expected inflation

Figure 9 shows line plots of the actual inflation rate from December 1995 to December 2016, calculated for the CPI data obtained from Quantec Database, along with the expected inflation rate that has been derived from the predicted CPI values using the ARIMA (0,2,1) model.

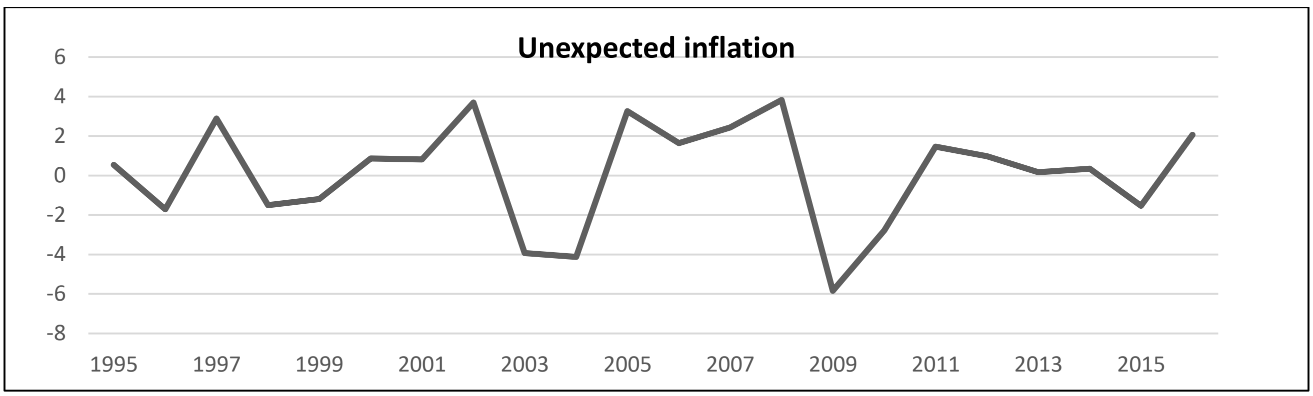

Figure 10: Line plot of Unexpected inflation

Figure 10 shows a line plot of unexpected inflation, which is the difference between the actual observed inflation and the estimated expected inflation generated by the ARIMA (0,2,1) model.

4.2 Short-term Inflation Hedging ability of Real estate

Equation 8, was be used to test the individual and combined short term inflation hedging ability of Industrial, Office and Retail property. The magnitude of the coefficients α and β will indicate the degree to which each property type hedges against expected and unexpected inflation, respectively. The level of significance of each of these coefficients will be taken into consideration.

Equation 8

$$R_{jt} = \alpha_{jt} + \beta_j E(\hat{\Delta}_t | \emptyset_{t-1}) + \gamma_j [\Delta_t - E(\hat{\Delta}_t | \emptyset_{t-1})] + \varepsilon_{jt}$$

An Ordinary Least Squares regression analysis was performed to estimate the values of the β and ϒ coefficients. Table 11 shows the results of the OLS regressions.

Dependent Variable	Constant α	Expected Inflation β	Unexpected Inflation ϒ	R^2	Adjusted R^2
INDUSTRIAL RETURNS					
Capital Growth	11.4443***	-1.0831	.07087	0.1427	0.0524
Income Return	12.4424***	-0.2558**	-0.2535**	0.1722	0.0850
Total Return	25.2323***	-1.4871	-0.2026	0.1691	0.0816
OFFICE RETURNS					
Capital Growth	8.6453**	-.9511652	.0681546	0.1792	0.0928
Income Return	11.4551***	-0.2650***	-.1989296**	0.3446	0.2756
Total Return	20.8798***	-1.3102*	-0.1349	0.2227	0.1409
RETAIL RETURNS					
Capital Growth	17.1427***	-1.5637**	-0.6096	0.3120	0.2396
Income Return	9.1229***	-0.0618	-.08223	0.0427	-0.0580
Total Return	27.4321***	-1.7101**	-0.7158	0.2852	0.2099

*denotes a 10% significance level, **denotes a 5% significance level and *** denotes a 1% significance level

Table 11: OLS Regression Results

Industrial capital growth returns do not have a significant relationship with both the expected and unexpected inflation rates. The income return of industrial property has a negative relationship with both expected and unexpected inflation as denoted by the negative β and ϒ coefficients. The extremely low R^2 and adjusted R^2 values indicate that the model has low explanatory power with regards to movements in unexpected and expected inflation influencing changes in capital growth, income and total returns of industrial properties.

For the office properties, there is no statistically significant relationship between capital growth and the expected and unexpected inflation rates. The β and ϒ coefficients of the income return are both negative (-0.2650 and -0.1989296 respectively) and statistically significant at 1% and 5% significance levels respectively, indicating that office property returns are a pervasive hedge against expected and unexpected inflation. The total return of office property, which is a combination of the income return and capital growth, has a negative relationship with expected inflation that is statistically significant at a 10% level. The R^2 and adjusted R^2 values, ranging between 9% and 34%, for the OLS models for office returns are considerably larger than those of industrial property.

Retail property returns appear to be most sensitive to expected and unexpected inflation rates based on the magnitude of the statistically significant β and ϒ coefficients along with the R^2 and adjusted R^2 values of all three OLS models. Retail property capital growth is a pervasive hedge against expected inflation as indicated by the α coefficient which has a value of -1.5637 and is statically significant at the 5% level. The OLS model for the retail capital growth has an R^2 value of 31% and an adjusted R^2 value of 24%. The income returns of retail property do not have a statistically significant relationship with both expected and unexpected inflation. As for the total returns, the β coefficient has a value of -1.7 and is statistically significant at the 5% level.

The results of the OLS model confirm the notion that CRE investments offer a poor hedge against inflation in the short run. The lease agreements do not allow investors to adjust rentals in response to changes in inflation rates quickly enough to protect their returns in the short run.

The industrial and office property income returns are very sensitive to both expected and unexpected inflation, unlike the retail property returns. The retail returns have a lower mean and are less volatile than both office and industrial property returns. Furthermore, retail property capital growth returns contribute a much higher percentage towards the total retail returns than office and industrial property returns do to their respective total returns.

4.3 Long Term Inflation Hedging

The Fama and Schwert (1977) model utilised to determine the short-term inflation hedging ability has been criticised for its inability to determine the long-term relationships between real estate returns, expected and unexpected inflation. Even more so when analysing direct real estate, which responds very slowly to macroeconomic changes due to its lumpy nature (Obereiner & Kurzrock, 2012).

VEC models are used to test the long run relationship between non-stationary variables and work on the premise that the variables require differencing to transform them into stationary variables. The first step will be to test whether the expected inflation and unexpected inflation variables are stationary, to ascertain which of the two models can be used to analyse the data. This will be achieved by using the ADF test.

4.3.1 Industrial Property

Table 12 displays the results of the Johansen test for the capital growth, Income return and total return of industrial property. For all three types of returns, a comparison of the trace statistics and their respective critical values at a 5% significance level shows capital growth, income returns, and the total returns of industrial property have a long run cointegrated relationship with expected and unexpected inflation.

The Johansen test results displayed in Table 12 suggest a rank order of 2 will have to be specified for the VEC models for capital growth, income and total returns. A rank order of 2 indicates that at least two of the three variables included in the VEC model are cointegrated and therefore linearly related, meaning that the system of three independent equations can be reduced to a system of two equations.

	Maximum rank	Parameters	Eigenvalue	Trace statistic	5% critical value
Capital Growth	0,0	21,0	.	49.5732	29.68
	1,0	26,0	0.80667	18.3493	15.41
	2,0	29,0	0.53639	3.7438*	3.76
	3,0	30,0	0.17884		
Income Return	0,0	21,0	.	57.0617	29.68
	1,0	26,0	0.87943	16.8671	15.41
	2,0	29,0	0.54164	2.0451*	3.76
	3,0	30,0	0.10204		
Total Return	0,0	21,0	.	47.8065	29.68
	1,0	26,0	0.79898	17.3242	15.41
	2,0	29,0	0.51592	3.5394*	3.76
	3,0	30,0	0.16996		

*denotes the rank at which the trace statistic is smaller than the 5% critical value

Table 12: Industrial Property Johansen Test Results

Table 13 shows the results of the three VEC models that have been analysed for capital growth, income return and total return in their respective panels. In Panel A, we have the VEC model with 3 lags and a rank order of 1 for capital growth returns. The negative error correction term suggests that the system of equations returns to a long run equilibrium, however this correction error term is not statistically significant. The coefficient of the lagged 1st difference for expected inflation (3.195) indicates a positive short run relationship between expected inflation and capital returns, while the coefficient of the 2nd lagged difference is negative (-5.459). Both of these coefficients are statistically significant at a 5% level indicating that there is indeed a short run relationship between industrial property capital growth and expected inflation, as suggested by the OLS model. The lagged 2nd difference of the unexpected inflation variable is statistically significant at the 1% level and has a negative coefficient (-4.494) suggesting that capital growth has a negative relationship with unexpected inflation.

In Panel B of Table 13, the coefficients of the industrial property income return VEC model is displayed. Both error correction terms are positive, with the 2nd correction error term being the only statistically significant of the two. This suggests that there is no long run relationship between the system of equations since there is no evidence that the system has self-correcting properties to restore itself to a point of equilibrium.

Panel C of Table 13 indicates that the negative coefficient of the error correction term (-0.0264) for industrial property total returns is statistically significant at the 10% level, indicative of a long run relationship between industrial total returns and inflation. The magnitude of the error correction term coefficient tells us that every time the system of equations deviates from equilibrium in the short-run, 2.6% of the deviation will be restored in the next year, which is relatively low. Industrial property total returns have a negative short-run relationship with the 2nd lagged difference of both expected and unexpected inflation as indicated by the negative coefficients of -5.758 and -4.63 respectively which are both statistically significant.

Panel A: Capital Growth								
Error Correction Term		**Capital Growth**		**Expected Inflation**		**Unexpected Inflation**		
CE_{t-1}	**CE_{t-2}**	**CG_{t-1}**	**CG_{t-2}**	**EI_{t-1}**	**EI_{t-2}**	**UI_{t-1}**	**UI_{t-2}**	**Constant**
-.0325		.5067	.2080	3.195	-5.459	.5290	-4.494	-.2764
(-1.43)		(1.80)*	(0.87)	(2.02)**	(-3.65)***	(0.40)	(-2.83)***	(-0.26)
Panel B: Income Return								
Error Correction Term		**Income Return**		**Expected Inflation**		**Unexpected Inflation**		
CE_{t-1}	**CE_{t-2}**	**IR_{t-1}**	**IR_{t-2}**	**EI_{t-1}**	**EI_{t-2}**	**UI_{t-1}**	**UI_{t-2}**	**Constant**
.03612	.4038	.2197	.0615	-.1408	-.2052	-.1418	-.1168	-.1229
(1.76)*	(3.17)***	(0.85)	(0.25)	(-0.51)	(-0.79)	(-0.32)	(-0.40)	(-0.81)
Panel C: Total Return								
Error Correction Term		**Total Return**		**Expected Inflation**		**Unexpected Inflation**		
CE_{t-1}	**CE_{t-2}**	**TR_{t-1}**	**TR_{t-2}**	**EI_{t-1}**	**EI_{t-2}**	**UI_{t-1}**	**UI_{t-2}**	**Constant**
-.0264		.4671	.2227	3.5110	-5.758	.8469	-4.63	-.2778
(-1.63)*		(1.72)*	(0.94)	(1.97)**	(-3.44)***	(0.57)	(-2.58)***	(-0.23)

Z statistic values are in parentheses; *, **, *** denote 1%,5% and 10% level of significance; CE denotes the error correction term, CG denotes Capital Growth, IR denotes Income Return and TR denotes Total Return.

Table 13: Industrial Property VECM Analysis Results

Table 14 shows the results of the LaGrange Multiplier tests conducted on each of the three industrial property return VEC models to test for autocorrelation. There is no evidence of autocorrelation in all three models.

	lag	Chi^2	df	Prob > Chi^2
Capital Growth	1	7.7897	9	0.55547
	2	3.6818	9	0.93108
Income Return	1	5.0882	9	0.82655
	2	10.1442	9	0.33894
Total Return	1	8.491	9	0.48552
	2	3.6598	9	0.93234

Note: df denotes degrees of freedom.

Table 14: Industrial Property LaGrange Multiplier Test results

The Jarque-Bera test results are displayed in Table 15. Indicate that for the most part the error terms of the models that were fit to the data are randomly distributed at the 5% significance level.

	Equation	Chi^2	df	Prob > Chi^2
Capital Growth	**ΔCapital Growth**	6.966	2	0.03072
	ΔExpected Inflation	3.559	2	0.16873
	ΔUnexpected Inflation	0.617	2	0.73449
	All	11.142	6	0.08408
Income Return	**ΔIncome Return**	4.449	2	0.10814
	ΔExpected Inflation	1.609	2	0.44727
	ΔUnexpected Inflation	3.363	2	0.18612
	All	9.421	6	0.15127
Total Return	**ΔTotal Return**	8.973	2	0.01126
	ΔExpected Inflation	6.130	2	0.04665
	ΔUnexpected Inflation	0.614	2	0.73574
	All	15.717	6	0.01536

Table 15: Industrial Property Jarque-Bera Test results

4.3.2 Office Property

From Table 16 we observe that there is cointegration in all three systems of equations for the analysis of office property return.

	Maximum rank	**No. of parameters**	**Eigenvalue**	**Trace statistic**	**5% critical value**
Capital Growth	0,0	21,0	.	49.405	29.68
	1,0	26,0	0.84854	13.5434*	15.41
	2,0	29,0	0.45155	2.1310	3.76
	3,0	30,0	0.10610		
Income Return	0,0	36,0	.	99.4791	47.21
	1,0	43,0	0.95494	40.5837	29.68
	2,0	48,0	0.77351	12.3673*	15.41
	3,0	51,0	0.47464	0.1377	3.76
	4,0	52,0	0.00722		
Total Return	0,0	21,0	.	52.3980	29.68
	1,0	26,0	0.87414	13.0184*	15.41
	2,0	29,0	0.44952	1.6762	3.76
	3,0	30,0	0.08444		

*denotes the rank at which the trace statistic is smaller than the 5% critical value

Table 16: Office Property Johansen Test Results

A rank order of 1 will have to be specified for the capital growth and total return VEC models. On the other hand, a rank order of 2 will be specified for the income returns.

The coefficients of the three VEC models for capital growth, income and total returns of office space are displayed in Table 17. In panel A we observe that the system of equations for office property capital returns does not have a long-term equilibrium. This suggests that in the long run office property does not provide an inflation hedge. The statistically significant coefficients (at a 5% level) of the 2nd lagged differences of expected and unexpected inflation indicate that in the short run, capital growth has a negative relationship with both expected and unexpected inflation. The two coefficients are -4.640 and -3.841 respectively.

Panel B suggests that the system of equations for the income returns of office property does not have a long run equilibrium as indicated by the positive and statistically significant error correction term coefficient (.385). The 1st and second lagged differences of the expected and unexpected inflation are all negative and statistically significant at the 5% level indicating that in the short run, office income returns have a negative relationship with expected and unexpected inflation. This is in line with the results of the OLS model.

Lastly, Panel C shows us that the negative error correction term of office property capital growth is not statistically significant and that there is no long run equilibrium between capital growth and expected and unexpected inflation. Once again, the 2nd lagged differences of expected and unexpected inflation are negative, and that office property is a pervasive hedge against inflation in the short run.

Panel A: Capital Growth								
Error Correction Term		**Capital Growth**		**Expected Inflation**		**Unexpected Inflation**		
CE_{t-1}	**CE_{t-2}**	**CG_{t-1}**	**CG_{t-2}**	**EI_{t-1}**	**EI_{t-2}**	**UI_{t-1}**	**UI_{t-2}**	**Constant**
-.0256		.3054	-.1427	2.3266	-4.640	-.6817	-3.841	-.524363
(-0.42)		(0.78)	(-0.48)	(1.48)	(-3.06)***	(-0.54)	(-2.44)**	(-0.51)
Panel B: Income Return								
Error Correction Term		**Income Return**		**Expected Inflation**		**Unexpected Inflation**		
CE_{t-1}	**CE_{t-2}**	**IR_{t-1}**	**IR_{t-2}**	**EI_{t-1}**	**EI_{t-2}**	**UI_{t-1}**	**UI_{t-2}**	**Constant**
.00958	.385	-.4536	-.3411	-.7301	-.7057	-1.226	-.6988	-.081578
(0.33)	(4.34)***	(-1.97)**	(-1.52)	(-3.55)***	(-3.74)***	(-3.89)***	(-3.40)***	(-0.92)
Panel C: Total Return								
Error Correction Term		**Total Return**		**Expected Inflation**		**Unexpected Inflation**		
CE_{t-1}	**CE_{t-2}**	**TR_{t-1}**	**TR_{t-2}**	**EI_{t-1}**	**EI_{t-2}**	**UI_{t-1}**	**UI_{t-2}**	**Constant**
-.02951		.21731	-.1735	2.4153	-4.915	-.6873	-4.043	-.582754
(-0.40)		(0.57)	(-0.57)	(1.30)	(-2.91)***	(-0.39)	(-2.23)**	(-0.50)

Z statistic values are in parentheses; *, **, *** denote 1%,5% and 10% level of significance; CE denotes the error correction term, CG denotes Capital Growth, IR denotes Income Return and TR denotes Total Return.

Table 17: Office Property VECM Analysis Results

The results of the LaGrange Multiplier tests are displayed in Table 18 and indicate that there is no autocorrelation present in the office property data that was analysed.

	lag	Chi^2	df	Prob > Chi^2
Capital Growth	1	7.5453	9	0.58053
	2	10.7170	9	0.29560
Income Return	1	17.1161	9	0.04693
	2	21.2036	9	0.01178
Total Return	1	6.9254	9	0.64489
	2	11.7975	9	0.22496

Table 18: Office Property LaGrange Multiplier

The Jarque-Bera test results displayed in Table 19 indicate that the error terms of the systems of equations that were analysed for capital growth, income and total returns were all normally distributed.

	Equation	Chi^2	df	Prob > Chi^2
Capital Growth	**ΔCapital Growth**	0.136	2	0.93435
	ΔExpected Inflation	1.817	2	0.40309
	ΔUnexpected Inflation	0.227	2	0.89274
	All	2.180	6	0.90243
Income Return	**ΔIncome Growth**	2.002	2	0.36755
	ΔExpected Inflation	1.323	2	0.51600
	ΔUnexpected Inflation	0.093	2	0.95447
	All	3.418	6	0.75481
Total Return	**ΔIncome Growth**	0.225	2	0.89339
	ΔExpected Inflation	2.324	2	0.31291
	ΔUnexpected Inflation	0.446	2	0.79992
	All	2.996	6	0.80940

Table 19: Office Property Jarque-Bera

4.3.3 Retail Property

Specification of the retail property VEC models introduced several challenges. Firstly, the Johansen Test performed on the capital growth, expected and unexpected inflation variables failed to provide any indication as to the rank order of the system of equation, from 1 lag right through to 11 lags. Seeing as there are only three variables in this system of equations, the maximum possible rank order is 3, however, the Johansen test results suggest that the rank order of this system of equations exceeds 3, which is not possible. The system of equations for the income return of retail property had a rank order of 0, indicating that there is no evidence of cointegration. In the absence of cointegration, a VAR model should be used. For the total returns, the Johansen test suggested a rank order of 2 as indicated in Table 20.

	Maximum rank	Parms	Eigenvalue	Trace statistic	5% critical value
Capital Growth	0,0	21,0	.	51.3234	29.68
	1,0	26,0	0.78797	21.8536	15.41
	2,0	29,0	0.60464	4.2224	3.76
	3,0	30,0	0.19927		
Income Return	0,0	21,0	.	25.0257*	29.68
	1,0	26,0	0.49781	11.9389	15.41
	2,0	29,0	0.44085	0.8934	3.76
	3,0	30,0	0.04593		
Total Return	0,0	12,0	.	42.2655	29.68
	1,0	17,0	0.6921	18.7037	15.41
	2,0	20,0	0.5269	3.7328*	3.76
	3,0	21,0	0.1702		

*denotes the rank at which the trace statistic is smaller than the 5% critical value

Table 20: Retail Property Johansen Test

Panel A of Table 21 shows the results of the VEC model for the retail property capital returns. Bearing in mind the challenges encountered while trying to determine the rank order of this system of equations, a rank order of 2 was. The first and second lagged error correction terms (CE_{t-1} and CE_{t-2}) are both statistically significant at a 1% and 5% level of significance respectively, with the 1st having a coefficient of -0.777 and the 2nd having a coefficient of 5.06 suggesting that there is no long run equilibrium. The coefficients of the 1st, 2nd and 3rd lagged differences of the expected inflation are all statistically significant and negative. The coefficient of the 1st lagged difference of unexpected inflation is negative and statistically significant. In the short run, capital growth has a negative relationship with expected and unexpected inflation.

Panel B displays the coefficients of the VAR (1) model for retail income returns. The income return of retail property has a statistically significant relationship with the lagged values of itself. Although the coefficients of expected and unexpected inflation are both positive, they are not statistically significant at the 5% level, therefore the short-term relationship between income return, expected and unexpected inflation cannot be determined.

Panel A: Capital Growth											
Error Correction Term		**Capital Growth**			**Expected Inflation**			**Unexpected Inflation**			
CE_{t-1}	**CE_{t-2}**	**CG_{t-1}**	**CG_{t-2}**	**CG_{t-3}**	**EI_{t-1}**	**EI_{t-2}**	**EI_{t-3}**	**UI_{t-1}**	**UI_{t-2}**	**UI_{t-3}**	**Const**
-.777	5.06	4.747	1.706	.766	-10.2	-2.89	1.94	-13.19	-2.77	1.2	-.0027
(-6.6)***	(2.3)**	(2.5)**	(6.6)***	(2.2)**	(-4.9)***	(-1.81)*	(1.59)	(-5.1)***	(-1.66)*	(0.69)	(-0.01)
Panel B: Income Return (VAR model)											
Error Correction Term		**Income Return**			**Expected Inflation**			**Unexpected Inflation**			
CE_{t-1}	**CE_{t-2}**	**IR_{t-1}**	**IR_{t-2}**	**IR_{t-3}**	**EI_{t-1}**	**EI_{t-2}**	**EI_{t-3}**	**UI_{t-1}**	**UI_{t-2}**	**UI_{t-3}**	**Const**
		.9018			.130			.052			
		(33)***			(3.6)***			(1.42)			
Panel C: Total Return											
Error Correction Term		**Total Return**			**Expected Inflation**			**Unexpected Inflation**			
CE_{t-1}	**CE_{t-2}**	**TR_{t-1}**	**TR_{t-2}**	**TR_{t-3}**	**EI_{t-1}**	**EI_{t-2}**	**EI_{t-3}**	**UI_{t-1}**	**UI_{t-2}**	**UI_{t-3}**	**Const**
-.22	1.20	.207	.515		3.91	-1.44		4.028	-.447		-.0015
(-1.7)*	(0.97)	(0.73)	(2.1)**		(1.86)*	(-0.64)		(1.40)	(-0.19)		(-0.00)

Z statistic values are in parentheses; *, **, *** denote 1%,5% and 10% level of significance; CE denotes the error correction term, CG denotes Capital Growth, IR denotes Income Return and TR denotes Total Return.

Table 21: Retail Property VECM analysis results

The coefficients of the retail total returns VEC model are displayed in Panel C. The coefficient of 1st error correction (CE_{t-1}) is statistically significant at the 10% level and is also negative (-0.22) demonstrating that there is long run relationship between total returns, expected and unexpected inflation. The error correction term also informs us that 22% of any short-run deviation from the long run equilibrium is restored in the following year, which is a much faster rate than that of the industrial space total returns. The coefficient 1st lagged difference of the expected inflation variable is positive, suggesting that total returns of retail property react positively to changes in expected inflation in the short run. This is contrary to the findings from the OLS model which suggests a statistically significant negative relationship between total returns and expected inflation.

The LaGrange Multiplier along with the Jarque-Bera test results for the retail total returns are shown in Table 22. There is no evidence of autocorrelation in the system of equations of the total return VEC model. Furthermore, the error terms of the model are normally distributed.

LaGrange Multiplier Test				
	Lag	Chi^2	df	$Prob>Chi^2$
Total Return	1,0	7.2102	9,00	0.61524
	2,0	11.9417	9,00	0.21661
Jarque-Bera Test				
Dependent Variable	**Excluded Variables**	Chi^2	df	$Prob>Chi^2$
Total Return	**ΔIncome Growth**	0.005	2	0.99742
	ΔExpected Inflation	5.566	2	0.06184
	ΔUnexpected Inflation	0.858	2	0.65109
	All	6.430	6	0.37680

Table 22: Retail Property Total Return LaGrange Multiplier & Jarque-Bera Tests

5. Conclusion

This study set out to investigate how well office, industrial and retail property investments in South Africa hedge against expected and unexpected inflation in the long-run and short-run. Observed inflation over the period from January 1995 to December 2016 were deconstructed into their expected and unexpected inflation components.

An ARIMA model was used to predict the expected inflation rate over the period of analysis based on the observed *ex post* annual CPI. The difference between the actual observed inflation and the expected inflation provided estimates of the unexpected inflation rate over the analysis period.

Thereafter, the short run inflation-hedging ability of industrial, office and retail property were individually analysed using the Ordinary Least Squares (OLS) regression models.

The capital growth, income and total returns of each property type were individually regressed against expected and unexpected inflation.

In the case of the long run inflation-hedging, the capital growth, income and total returns of each property type were individually incorporated into Vector Error Correction (VEC) models. The VEC models treat the property returns along with expected and unexpected inflation variables as endogenous, with each variable having an influence on the others. The long run relationship between the exogenous variables is revealed by the error correction term. A negative error correction term is evidence that the variables under analysis self-correct, in the sense that after a shock, they naturally revert towards a long run equilibrium. A positive error correction term indicates that the model has no long run equilibrium.

5.1 Short Run Inflation hedging

The study finds that, in the short run, the income returns of industrial and office properties are pervasive hedges against both expected and unexpected inflation while the income return of retail properties does not have a statistically significant relationship with expected and unexpected inflation rates. The capital growth and total returns of industrial and office properties do not have a statistically significant relationship with expected and unexpected inflation, while retail property capital growth and total returns are a pervasive hedge against expected inflation. Although total return of office and retail property is a pervasive hedge against expected inflation, the source of this negative relationship differs between the two property types. For office property, the income return is the source of the negative relationship between total returns and expected inflation, while capital growth is the source of the negative relationship between retail total returns and expected inflation. With regards to industrial property, there is no significant relationship between the total returns, expected and unexpected inflation. Industrial property is neither a positive inflation hedge, nor a pervasive hedge. Despite having the ability to decide the rate at which rental rates escalate on an annual basis, it appears that the long-term nature of the leases restricts commercial property investors from adapting to changes in inflation rates in the short run. This study in conjunction with that of Erasmus (2015) shows that

South African CRE investments do not hedge against inflation in the short run, whereas Listed Properties have the ability to do so.

The low explanatory power of the OLS models, based on the Fama & Schwert (1977) model in Table 11, reveal that there are other variables at play that influence property returns in South Africa, and the combined effect of these variables that have been omitted from this particular study accounts for a large share of changes in the capital growth, income and total returns for industrial, office and retail property. In that sense, they reaffirm the decision by Akinsomi, Mkhabela, & Taderera (2018) to include additional variables such as unemployment, Gross Domestic Product and interest rates, in their analysis of CRE returns in South Africa. Furthermore, the low explanatory power of the OLS models, represent by the low adjusted R^2 values, indicates that generally, south African property does not respond much to changes in expected and unexpected inflation in the short-run. This is not surprising considering the fact that direct real estate investments are illiquid and as a result the market does not react instantly to macroeconomic shocks. This is consistent with findings by Obereiner & Kurzrock, (2012) who investigated the ability of German Listed properties and CRE to hedge against inflation and found that listed properties are a much better inflation hedge in the short-run than CRE.

It is interesting ot note that, in the short run, the income returns were the main reason why office and industrial properties are pervasive hedges against inflation. On the other hand, the capital growth return of retail property is the reason retail property is a pervasive hedge against inflation in the short run.

5.2 Long-Run Inflation Hedging

The results of the VEC models indicate that the total returns of Industrial and retail properties have a long run relationship with inflation, with retail property being the better inflation hedge of the two property types. No statistically significant relationship was found between office space total returns and inflation, whereas the income returns of office and industrial properties were found to be a pervasive hedge against inflation. Findings by Erasmus (2015) proved that listed properties in South Africa hedge against inflation in the short run. Whereas, this study shows that CRE investments in South Africa only hedge against inflation in the long run, further proving that CRE investments do not react instantaneously to changes in inflation, but rather require time to adjust to these changes in inflation. These results are in line with those of Park & Bang, (2012) who found that Korean listed property stocks only hedge against inflation in the short run while direct CRE investments are pervasive hedges against inflation in the short run, and positive hedges against inflation in the long run.

The income returns of office space and industrial space are both pervasive hedges against inflation in the short-run and long-run, suggesting that the rental escalations do not allow rental returns to outgrow inflation in the short-run and long-run. This may be due to investor's inability to negotiate escalation rates that enable the rental returns to outgrow inflation due to other macroeconomic variables such as interest rates and GDP (Akinsomi, Mkhabela, & Taderera, 2018). This further suggests that despite there being no statistically significant long-run relationship between the capital returns of office and industrial properties, it is very likely that source of the inflation hedging ability of CRE in the long run is due to capital growth. This is open for further research in the future.

This study failed to construct a stable VEC model for retail property income returns due to the combination of having a limited number of data points that were available for the study and the fact that the VEC models consume a large number of degrees of freedom and work best when data is abundant. With larger data sets, more robust and reliable models can be constructed, shedding more light on the relationship between direct real estate returns.

5.3 Relevance of Findings

With regards to the significance of this study in aiding investors in their decisions regarding shielding their wealth against inflation, we find that CRE is suitable for investors who are seeking a long-term inflation hedge. Investors looking to hedge their wealth against inflation in the short-run would be better off looking into the listed properties market. Of the three CRE property types tested in this study, Industrial and Retail properties hedge against inflation in the long run, with retail property being the better inflation hedge of the two property types. This may be of particular interest to pension fund managers seeking long term investments that could potentially be severely affected by inflation. Investors should also take note of the fact that the very same long term leases with fixed escalation rates that give them the comfort of a secure and predictable future income also prevent them from adjusting their rentals to unforeseen changes in inflation. Perhaps introducing rent reviews more regularly during the lease periods would protect their returns and push the inflation risk onto consumers.

Furthermore, the addition of this study to the existing body of literature on emerging markets (see Erasmus, 2015; Park & Bang, 2012; and Lee M.-T., Lee, Lai, & Yang, 2011) and , highlights the fact that emerging markets such as Korea, Taiwan, Malaysia, The Philippines and South Africa all use an inflationary targeting monetary policy and also share the characteristic of having listed properties hedging against inflation in the short-run and CRE hedging against inflation in the long-run.

5.4 Topics for Future Research

This study was limited by the amount of data points that were available. Conducting this study with a longer period of analysis or quarterly data may reveal more interesting findings. Erasmus (2015) investigated the inflation hedging ability of listed property in South Africa, and this study has assessed the inflation hedging ability direct real estate investments. A comparison of the inflation hedging ability of the two assets, direct and indirect real estate, would be welcomed as an addition to the existing body of knowledge.

Furthermore, it would be of great interest to study the effects of inflation targeting monetary policy in South Africa on the ability of CRE and listed properties to hedge against inflation.

References

Aguiar, M., & Gopinath, G. (2007). Emerging Market Business Cycles: The Cycle Is the Trend. *Journal of Political Economy, 115*(1), 69-102.

Akinsomi, O., Mkhabela, N., & Taderera, M. (2018). The Role of macro-economic indicators in explaining real estate returns: evidence form South Africa. *Journal of Property Research, 35*(1), 28-52.

Anim-Odame, W. K. (2016, Summer). Developing Real Estate Markets in Sub-Sahara Africa: The Fundamentals. *Real Estate Finance, 33*(1), 26-32.

Bond, M. T., & Webb, J. R. (1995). Real Estate versus Financial Asset Returns and Inflation Can a P* Trading Strategy Improve REIT Investment Performance? *The Journal of Real Estate Research, 10*(3), 327-334.

Chu, Y., & Sing, T. F. (2004). Inflation Hedging Characteristics of the Chinese Real Estate Market. *Journal of Real Estate Portfolio Management, 10*(2), 145-154.

Delport, H. J. (2005). *South African Property Practice and the Law* (Vol. Service 12). Pretoria: Juta & Co Ltd.

DiPasquale, D., & Wheaton, W. C. (1992). The Markets for Real Estate Assets and Space: A Conceptual Framework. *Journal of the American Real E.state and Urban Economics Association, 20*(1), 181-197.

Dokko, Y., Edelstein, R. H., Pome, M., & Urdang, S. E. (1991). Determinants of the Rate of Return for Nonresidential Real Estate: Inflation Expectations and Market Adjustment Lags. *AREUEA Journal, 19*(1), 52-69.

Erasmus, W. (2015). Analysis of South African listed real estate to serve as an inflation hedge versus other asset classes. *Unpublished Master's Thesis University of Cape Town*.

Fama, E. E., & Schwert, G. W. (1977). Asset Returns and Inflation. *Journal of Financial Economics, 5*(2), 115-46.

Fang, W.-S., Wang, K.-M., & Nguyen, T.-B. T. (2008). Is Real Estate Really an Inflation Hedge? Evidence from Taiwan. *Asian Economic Journal, 22*(2), 209–224.

Fisher, I. (1930). *The Theory of Interest.* New York: MacMillan.

Gujarati, D. N., & Porter, D. C. (2010). *Essentials of Econometrics* (4 ed.). Ney York: McGraw Hill.

Gunasekarage, A., Power, D. M., & Zhou, T. T. (2008). The long-term inflation hedging effectiveness of real estate and financial assets: A New Zealand investigation. *Studies in Economics and Finance, 25*(4), 267-278.

Hamelink, F., & Hoesli, M. (1996). Swiss real estate as a hedge against inflation: New evidence using hedonic and autoregressive models. *Journal of Property Finance, 7*(1), 33-49.

Haran, M., McCord, M., Davis, P., McCord, J., Lauder, C., & Newell, G. (2016). Re-examining investment attributes and framing opportunities. *Journal of Property Investment & Finance, 34*(1), 27 - 50.

Hoesli, M. (1994). Real Estate as a Hedge against Inflation: Learning from the Swiss Case. *Journal of Property Valuation and Investment, 12*(3), 51-59.

Huang, H., & Hudson-Wilson, S. (2007). Private Commercial Real Estate Equity Returns and Inflation. *The Journal of Portfolio Management*(Special Issue), 63-73.

International Monetary Fund. (2018, March 20). *Data: Global Data*. Retrieved from IMF Web site: http://www.imf.org/external/pubs/ft/weo/2017/02/weodata/weorept.aspx?

Jones Land LaSalle. (2016). *Commercial Real Estate Transaction Review: South Africa.* Capital Markets. Johannesburg: Jones Land LaSalle.

Jones Lang LaSalle. (2017). *Investments Review.* Johannesburg: Jone Lang LaSalle.

Korotkov, N., Occhiocupo, N., & Simkin, L. (2013). Simulated test marketing in emerging markets: the need to re-think. *Marketing Intelligence & Planning, 31*(7), 807 - 822.

Le Moigne, C., & Viveiros, É. (2008). Prívate Real Estate as an Inflation Hedge: An Updated Look with a Global Perspective. *Journal of Real Estate Portfolio Management, 14*(4), 263-285.

Le Moigne, C., & Viveiros, E. (2008). The Inflation-Hedging Ability of Canadian Direct Reai Estate Return and its Components, Income, and Appreciation. *Journal of Real Estate Portfolio Management, 14*(2), 141-154.

Lee, C. L., & Lee, M.-L. (2014). Do European real estate stocks hedge inflation? Evidence from developed and emerging markets. *International Journal of Strategic Property Management, 18*(2), 178-197.

Lee, M.-T., Lee, M.-L., Lai, F.-T., & Yang, T.-H. (2011). Do Real Estate Stocks Hedge Inflation In The Long Run? Evidence From Three East Asian Emerging Markets. *Journal of Real Estate Literature, 19*(2), 345-372.

Li, L. H., & Ge, C. L. (2008). Inflation and housing market in Shanghai. *Property Management, 26*(4), 273-288.

Liu, C. H., Hartze, D. J., & Hoesli, M. E. (1997). "International Evidence on Real Estate Securities as an Inflation Hedge. *Real Estate Economics, 25*(2), 193-221.

MCSI. (2015). *IPD Global Annual Property Index.* New York: MCSI.

Miles, D. (1996). Property and inflation. *Journal of Property Finance, 7*(1), 21-32.

MSCI. (2018, March 14). *Home/Our Solutions/Indexes/Idex Resources/Market Classification*. Retrieved from MSCI Web site: https://www.msci.com/market-classification

Newell, G. (1996). The inflation-hedging characteristics of Australian commercial property: 1984-1995. *Journal of Property Finance, 7*(1), 6-20.

Obereiner, D., & Kurzrock, B.-M. (2012). Inflation-hedging properties of indirect real estate investments in Germany. *Journal of Property Investment & Finance, 30*(3), 218-240.

Park, Y. W., & Bang, D. W. (2012). Direct Commercial Real Estate as an Inflation Hedge: Korean Evidence. *Journal of Real Estate Portfolio Management, 18*(2), 187-203.

Sing, T.-F., & Low, S.-H. Y. (2000). The Inflation-Hedging Characteristics of Real Estate and Financial Assets in Sinagapore. *Journal of Real Estate Portfolio Management, 6*(4), 373-385.

World Economic Forum. (2017). *The Global Competitiveness Report 2016–2017.* Geneva: World Economic Forum.

Zhou, X., & Clements, S. (2010). The Inflation Hedging Ability of Real Estate in China. *Journal of Real Esatate Portfolio Management, 16*(3), 267-279.