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Report Title: South African listed real estate as protection against inflation

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Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Abstract

This research aims to shed light on the relationship between the South African CPI inflation and JSE-listed property index returns. Furthermore, the relationship between the South African CPI inflation and JSE-all share index returns was modelled with the intent of comparing the relationship to that of JSE-listed property index (versus South African CPI). The short-term relationship between CPI inflation and JSE-listed property index returns was discovered to be negative for the period starting from Jan 2005 to Jun 2015, in the other hand, the relationship between the JSE-all share index returns and CPI inflation was seen to be positive over the same period.

The study also tests for the consistency of the relationships between the JSE-listed property and JSE-all share returns (against CPI inflation) to changes in the South Africa repo rate cycles (over the period starting from Jan 2005 to Jun 2015). The results show that a change in the repo rate cycle changes the sign of the CPI inflation coefficients of the short-term relationships, which indicates that the relationships are unstable (for the short-term case). Moreover, cointegration models were fitted to determine the existence of a long-term relationship between the JSE-all share and JSE-listed property indices (against the South Africa CPI index). The results of the long-term relationships indicate a meaningful economic relationship between the JSE-listed property index and the CPI – the Hansen instability test proved the relationship to be stable. On the other hand, the relationship between the CPI and the JSE-all share index was not meaningful (it failed both the Hansen instability as well as the Engle and Granger tests).

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Chapter 1: Problem Definition

1.1. Introduction

An article written by the South African REITs association comparing the performance of listed real estate to other asset classes grabbed the attention of the author and the idea to conduct a test to assess the effectiveness of JSE listed real estate as an inflation hedge was born.

The Research purpose and scope (RPS) section of the paper attempts to provides an overview as to why inflation is an issue in any economy, more especially in South Africa (which is one of the emerging markets that are most affected by inflation due to Quantitative Easying). Moreover, the author outlines the objectives of the research in this section as well.

Quantitative Easing (QE) and its effects are also discussed in the research motivation section, as this makes inflation - hedging topical in South Africa. This is owing to inflation fears that were created as a result of QE in most emerging markets.

The abovementioned section (the research motivation section) goes a step further to touch on some of the potential benefits of introducing Real Estate Investment Trusts (REITs) into the Johannesburg Stock Exchange (JSE). The introduction of REITs not only presents an opportunity to assess the effectiveness of South African listed real estate returns against hedging inflation but most importantly presents an opportunity to compare the results to the insights discovered in other countries. REITs are easier to compare between countries as they are a commonly used form of listed real estate asset class in most countries.

Although the author will focus on testing the relationship between South African listed real estate returns against inflation, however, the literature touches on a lot of research that was done in both the direct and indirect real estate markets - indirect real estate investment encompasses the purchase of listed real estate, where the investor may own a share of a diversified portfolio of properties, that is, the investor does not own the entire physical real estate portfolio, but rather a percentage of the real estate portfolio in conjunction with other investors (previously in South Africa,

the indirect real estate investment vehicles that were used were property unit trusts (PUTs) and property loan stocks (PLSs)) (Bauer, 2012). The aim of this approach was to draw from the knowledge of other scholars on how test the relationship between inflation and real estate returns. Moreover, the author wishes to compare the findings from the research to the common thread that is derived from the expansive literature on both direct and indirect real estate markets.

The approach that the author follows segments the literature by the state of economic development for direct investment into real estate and broader split between listed against direct investments. The purpose of such an approach (perusing the literature) is to ensure that the literature is scrutinized sufficiently, and to allow the literature to reveal a pattern in the findings from the different segments. Therefore, the segmentation is not meant to presuppose the difference in the findings from the various segments.

The listed equities section that contains literature on South African and international research will be crucial in enhancing the analysis of the findings from the current study on the relationship between South African listed real estate and inflation. Most importantly, the research on listed equities will also focus on the inflation-hedging ability for JSE listed real estate compared to JSE listed equities (based on the literature gathered).

1.2. Research Problem

The unexpected increase in inflation in South Africa presents the need to protect assets from inflation; listed real estate can protect investors from the negative effects of inflation (Hardin, Jiang, & Wu, 2012).

1.3. Research Purpose and scope

Quantitative easing presents a potential challenge to institutional investors in South African investment environment as inflation fears on the back of the policy have increased. To add to the problem, the South African CPI future and CPI-Linked Bond market is not large enough to absorb the potential demand resulting from the need to hedge against inflation (Roache & Attie, 2009).

This research sets out to explore the relationship between JSE listed real estate returns with inflation for the period 2004 to 2014. The research objectives are as follows:

I. Determine if there is a positive relationship between CPI inflation and JSE listed REIT returns.
II. Analyse the degree to which JSE listed real estate can protect the wealth of investors against CPI inflation.
III. Compare the effectiveness of general equities against listed real estate (both listed JSE indices) with respect to protecting investor value against CPI inflation.

1.4. Research motivation

1.4.1 Practical interest

The risk of inflation is more pronounced in emerging markets than developed markets(inflation in emerging markets tends to be higher relatively) (Lee M. T., Lee, Lai, & Yang, 2011); as a result, investors in emerging markets must make inflation-hedging part of their long-term investment policy, more especially due to the monetary policy mechanisms that the US has been using to re-ignite its economy over the last 5 to 10 years (Lee M. T., Lee, Lai, & Yang, 2011) and (Grelck, Prigge, Tegtmeier, Topalov, & Torpan, 2011).

The implementation of QE (Quantitative Easing) by the US Federal Reserve Bank saw the rise of inflation in most emerging markets as a result of increasing commodity and asset prices (Peng, 2011). This sudden rise in inflation reinvigorated the need to understand the relationship between most asset classes and inflation – as this will enable investors to hedge inflation.

Tapering started in December 2013 where the Federal Reserve Bank (which will be referred to as the FED from this point going forward) reduced its bond purchasing program from $85 billion to $75 billion per month (Zumbrun, 2013). This sparked the biggest sell-off of emerging market assets since 2009 in January 2014 (Xie & Detrixhe, 2014), where (Koester, 2014):

- Argentinean peso lost 23% in January 2014, which was the highest depreciation since 2002.

- Turkish lira lost 6%, this was followed by an initiative by the Turkish central bank to increase its lending rate for banks from 4.5% percent to 10%.
- The Rand lost 7.5%, its lowest level since 2008. The currency continued to fall even after the central bank raised its repo interest rate to 5.5% from 5.0% – the first rate hike in almost six years.
- Russian ruble lost 7%, hitting a five-year low. But Russia's central bank kept rates unchanged.

In South Africa this meant that inflation fears we re-ignited since the country's reliance on oil and other imports as production inputs (also referred to as inflation-pass through) implies that the prices for final goods could increase as result of the depreciation of the rand against major currencies (Marcus, 2014).

Inflation can be a huge risk to the South African economy as a result of the following:

- Inflation destroys the value of money over time, that is, the higher the inflation rate the more value it destroys.
- Inflation rates that are unpredictable make planning difficult for the investment community and policy makers
- The problem of negative real interest rates (that occurs when interest rates are lower than inflation) negatively affects those who rely on interest from their savings to meet livings expenses
- A country's global competitiveness is severely hampered as result of higher costs of borrowing; expensive exports; reduced inflow from foreign investors and higher labour costs as a result of high inflation in a country

All of the above affect the valuation of assets in an economy, thus investors have to pay special attention to changes in inflation in an economy in order to achieve positive real returns.

The introduction of REITs provides an opportunity for an assessment to be made on whether South African listed real estate does provide an adequate hedge against inflation; from which the findings can be compared to others studies conducted on REITs internationally.

Property unit trusts (PUTs) and property loan stocks (PLSs) dominated the listed real estate market before REITs were introduced in the South listed real estate market.

However, this presented many challenges to foreign institutional investors as PUTs and PLSs did not conform to global best practice (as listed real estate securities). The introduction of REITs into the Johannesburg Stock Exchange is expected to address some of the issues and will bring with the following benefits:

- Tax advantages (as a result of the removal of capital gains tax on the sale of properties) of the new structure will make the listed real estate sector more attractive to foreign investors (Lamprecht, 2013) – this will enhance institutional involvement
- Reduced transactions costs to local investors as there's no securities transfer tax payable on listed REITs (Lamprecht, 2013)
- Alignment to global best practice, which enhances transparency to investors (Lamprecht, 2013)

The current perception is that the move by PUTs and PLSs to a REITs structure will revive the South African listed real estate sector as REITs tend to have lesser gearing, which makes banks more comfortable to fund real estate developments and will also facilitate consolidation in the listed real estate market (Hedley, 2013).

1.4.2 Academic interest

The literature seems to highlight inconclusive results on how well listed equities hedge inflation in comparison to listed real estate. For example Arjoon *et al*. (2012) arrived to the conclusion that the relationship was only positive in the long-term while Bonga-Bonga (2011) established a weak relationship between inflation and listed equity returns. Moreover, most of the research covers REITs as an inflation hedge from an international perspective; however, the South African REITs case still needs be tested.

It is also important to note that there are other factors that influence the relationship between inflation and listed real estate returns in South Africa (as all countries have their own economic and institutional peculiarities), therefore to fully understand the relationship between inflation and listed real estate returns the author needs to also understand and take into account all the other factors (which seem to have a significant influence on the relationship based on the perused literature) that operate in the background. The factors are listed below:

- Context – whether the level of inflation is high or low (Tien-Foo & Swee-Hiang, 2000); markets are turbulent or normal
- State of economic development – emerging versus developed markets (Moazzami, 2010).
- Institutional involvement (Ling & Naranjo, 2015) and the variety of securities in the market to meet the demand to hedge inflation (Roache & Attie, 2009).
- The inflation range, that is, inflation is higher in South Africa than in the US. This means certain real estate assets may be better at protecting investors against unexpected inflation (which is common in South Africa) (Park & Bang, 2012).

Chapter 2: Literature Review

2.1 Direct Real estate and Inflation

2.1.1 Direct real estate investment in emerging markets

The concept of hedging is a process in which an investment is made with an intension of neutralizing the risk of adverse price movements of an asset or portfolio – the intention of the investment is to protect the returns of an asset or portfolio from market risk (Investopedia, 2015). Inflation-hedging in particular, means protecting an asset or portfolio returns from inflation risk through an investment into a security in the market that will move in an opposite direction to inflation. Inflation is measured as the growth in consumer price index (CPI index) over a specified period of time for the purposes of this study – the all urban area index is used. The CPI index is composed of a weighted basket of goods that Statistics South Africa deems to be representation of the average consumer shopping basket.

Inflation has always been a pressing issue to all organs of the South African economy (affecting both private and institutional investors). So far, the long-term relationship between house prices and inflation in South Africa has indicated that household ownership does provide sufficient protection against inflation (the derived Fisher coefficients were bigger than one for the luxury segment, equivalent to one for the middle-segment and below one for the large and medium middle-segments, as well as the affordable segments) (Inglesi-Lotz & Gupta, 2013) – a fisher coefficient of 1 implies that the property price percentage change is equal to the inflation rate, and where it is greater than 1 the property price percentage change is higher than the inflation rate (Inglesi-Lotz & Gupta, 2013). The evidence seems to conform to intuition as the ownership of residential property implies that the owner is most likely to pay an instalment and mortgages' the outstanding loan balance with a bank; both these amounts are eroded by inflation as they are not adjusted upwards for inflation over the life of the mortgage (Inglesi-Lotz & Gupta, 2013).

A technique similar to that used by Gupta (2013) was used to analyse the relationship between inflation and residential property in Hong-Kong where the evidence suggested that residential property was the only real estate type that had the ability to protect against actual, expected and unexpected inflation (which is the difference between actual and expected inflation) over a given period of time (Lee, 2013). Furthermore, the study indicated that there is a one way relationship between inflation and real estate returns where within this relationship inflation seemed to be the leading indicator (Lee, 2013) – inflation adjusts and real estate returns follow at a later stage.

The data collected during the period from 2000 to 2008 in China in which the autoregressive distributive lag (ARDL) cointegration technique was applied seemed to suggest that there was no relationship between inflation and real estate returns irrespective of the term (Zhou & Clements, 2010). The result seems to differ from the other literature perused thus far in this paper where some form of link between inflation and real estate was established – more especially in the long-term.

In the Korean market it was found that the relationship between inflation and direct commercial real estate (CRE) had a positive relationship for both the long and short-term. What made this finding more interesting is the fact that this type of real estate showed a positive relationship with both expected and unexpected inflation for the short-term case (Park & Bang, 2012). Similar findings were uncovered by Lee (2013), where residential property in Hong-Kong demonstrated the ability to provide sufficient protection against both unexpected and expected inflation, however, Lee (2013) did not go further to distinguish between short-term unexpected versus expected inflation as is the case in the study conducted by Park and Bang (2012).

2.1.2. Direct real estate investment in developed markets

Real estate from the perspective of direct investment into infrastructure was introduced in a study in the US, where the results indicated that the asset class provided partial protection against inflation in the short-term but seemed to grant adequate protection against inflation in the long-term (Wurstbauer & Schafers, 2015). The study also revealed that infrastructure provided the best protection against inflation amongst the real estate asset classes that were tested in the study (Wurstbauer & Schafers, 2015).

In 2002, the relationship between residential property and inflation in the US was also tested using the fisher relationship. The results lead to the conclusion that residential real estate made a stable hedge against inflation in the long-term (Anari &

Kolari, 2002). Interestingly though, this result somewhat differed to most of the literature that the researcher perused thus far, as residential property in the study conducted by Anari and Kolari (2002) was not presented as a comprehensive hedge against inflation, whereas it was presented to be a comprehensive hedge against inflation in most papers.

In the UK, it is noted that although direct real estate yields positive real returns, it provides partial protection (hedge) against inflation than a full hedge. In fact, it is mentioned that there are other asset classes in the country that are more effective in hedging against inflation than direct real estate (Is commercial property a hedge against inflation?, 2011).

The study conducted in Singapore showed that context was essential as the derived evidence indicated that residential real estate was a better hedge of expected inflation where inflation levels were low while direct industrial real estate was a better hedge for both unexpected and expected inflation where inflation levels were high (Tien-Foo & Swee-Hiang, 2000). What stands out from the research that Foo and Swee-Hiang (2000) conducted is the fact that it makes mention of the importance of context (where the extent of inflation determines how effective a particular type of real estate investment is in hedging inflation).

2.1.3. Direct real estate investment in general

Listed property (real estate) returns seems to correlate with those of direct investment properties in long-term only. In the short-term listed properties are also affected by short-term fluctuations (most of which are random by nature) – a quality that is seen with equities trading on a stock market. Therefore, direct real estate investment is able shed light on the long-term behaviour of listed properties, and therefore it is essential to peruse literature on it.

2.2 Listed Securities against Inflation

2.2.1 Inflation and Stock Returns

In the early 2000s, the relationship between inflation and that of stock price returns was tested; under the fisher relationship it was noted that stock price returns seemed to have the ability to hedge against inflation only in the long-term and not in the short-term (Anari & Kolari, 2001). Ahmed and Cardinale (2005) also found that in the US stock returns have been effective hedges against inflation strictly for periods longer than five years, whereas in the UK and Germany the results were inconclusive. The findings from Anari and Kolari (2001) were further confirmed in another study where it was demonstrated that the relationship between stock returns and inflation is weak (Kumari, 2011). However, Kumari (2011) did not go as far as classifying inflation into short and long-term as it is the case in the study conducted by Anari and kolari (2001).

The findings from Anari and Kolari (2001) were also confirmed in a study where a combination of 12 developed and emerging countries were tested for the positive relationship between inflation and stock returns (Moazzami, 2010). In a similar approach, Moazzami (2010) also performed tests on both short and long-term inflation to check if the relationship with stock returns was consistent for both cases.

In the South African context the vector autoregressive (VAR) approach was used to understand the relationship between inflation and stocks returns (Arjoon, Botes, Chesang, & Gupta, 2012). What is interesting from the derived insights is the fact that the relationship between inflation and stock returns was positive in the long-term (Arjoon *et al.*, 2012). Furthermore, in the short-term the results seemed to suggest that there was a negative relationship between inflation and stock returns (Arjoon *et al.*, 2012). Both pieces of research by Arjoon *et al.* (2012) and Anari and kolari (2001) came to the same conclusion despite using different approaches – Anari and Kolani (2001) used a fisher relation approach.

Another study in South Africa analysed the effectiveness of stock returns as a hedge of inflation, the results from the study revealed that there was a positive relationship between inflation and stock market returns (Eita, 2012); meaning that stock returns could be an effective hedge against inflation in the South African market. Although both Arjoon *et al.* (2012) and Eita (2012) studies used the same technique (namely, the vector autoregressive technique), their conclusions are similar but also differ to some extent since the study conducted by Eita (2012) indicates that the relationship is positive irrespective of duration. Interestingly the study conducted by Arjoon *et al.*

(2012) makes mention of the difference between short and long-term inflation relationship.

Eita (2012) also demonstrates that the relationship between stock returns and inflation is bidirectional (meaning that stock returns can cause inflation and *vice versa*). In a similar quest to demonstrate the causal relationship between equities and inflation in the South African context, it was revealed that the relationship between expected inflation and equity returns was weak (Bonga-Bonga, 2011); this finding goes against that of Eita (2012).

In Singapore a distinction between expected and unexpected inflation was made where it was indicated that direct real estate hedged inflation more effectively than equities and securitized real estate stocks (Tien-Foo & Swee-Hiang, 2000).

This section of the literature review is essential to the topic, as it is widely accepted that the behaviour of listed properties is very similar to that of equities in the short-term. Therefore, it is crucial to source evidence (or lack thereof) that seems to suggest that equities are able to protect investors from inflation risk (irrespective of context and duration), as this will only serve to strengthen the case (or shed light) for listed properties as a shield against inflation.

2.2.2 Inflation and Listed Real Estate Returns

In a study conducted in the US the results indicated that inflation does not cause REIT returns, however from the same findings it appears that REIT returns may be a signal for a change in monetary policy (Lu & So, 2001). Another study on REITs in the US revealed a negative relationship between returns and expected inflation in the short-term (Hardin, Jiang, & Wu, 2012), the study also suggested that the short-term negative relationship is as a result of the market's inability to accurately account for the short-term effects of inflation, which culminates in the mispricing of stock prices in the short-term (this phenomenon is defined to be inflation illusion).

To understand the short-term movements in listed real estate the link between direct real estate and listed real estate has to be understood due to the fact that direct real estate has been demonstrated in many studies to be highly effective in hedging inflation both in the short and long-term, thus the short-term misalignment from direct real estate renders listed real estate ineffective against hedging inflation in the short-term. The mispricing in the short-term may be as result of either irrational investor behaviour(which includes inflation illusion), changes in the fundamentals of the real estate market and institutional involvement, either of which may affect listed real estate stock movements in the short-term.

The fundamentals that affect the real estate market can in effect create a mismatch in the returns of direct real estate versus those of listed real estate (Ling & Naranjo, 2015) and this can be of particular interest. Some of the literature perused below touches on the usefulness of the fluctuations as result of the changes in the fundamentals that govern the real estate market (Boshoff & cloete, 2012). The literature also mentions that there is lag before information on the changes in fundamentals filters through to the direct real estate market – due to the time it takes to develop real estate.

Institutional involvement on the one side may act as a double edge sword, where in some instances it may bring with waves of unfounded investor sentiments while on the other hand it may introduce rigorous analysis to validate transactions in the market place (Ling & Naranjo, 2015); later in the literature the latter case is explored with the intention of adding to the broader discussion on the misalignment between direct and listed real estate investments.

2.2.2.1 Inflation illusion

Inflation illusion was defined by Modligliani and Cohn (1979) to be as result of two incorrect calculations in the determination of the value of a stock price, namely:

- In an inflationary environment, the market tends to capitalize equity earnings at the nominal rate rather use the nominal rate less the inflation premium (instead of using the real rate) because of the inability to accurately calculate the inflation premium.
- As inflation increases the outstanding balance of any loans that the company has in the balance sheet will be eroded by inflation over time, thus the gains in real terms to shareholders should be recognised, however, in reality this is not

the case as a result of the fact that most accounting practices fail to make the recognition.

The errors result in the undervaluation of a stock price in the short-term (Modligliani & Cohn, 1979). Modligliani and Cohn (1979) went further to state that by the end of 1977 investors had undervalued the stock market by fifty percent(50%).

The study conducted by Modligliani and Cohn (1979) is very important as it brings to light some of the mistakes that investment analysts make when pricing listed securities (more especially entities that have balance sheets loaded with debt). In the case that the findings holds, listed properties will be affected the most as the majority use a lot of debt (in conjunction with equity investment) to fund projects, therefore, the prices that most listed properties would trade on in the short-term will be more often than not be affected – this makes the findings of Modligliani and Cohn (1979) to be relevant in this paper (as it may explain some of the short-term random fluactuations in listed properties and equities in general).

However, recently studies conducted in the US revealed that inflation illusion is no longer responsible for the negative relationship between REIT returns and inflation; instead behavioural factors such as consumer sentiments contribute to REIT mispricing, which may create the negative relationship with inflation (Hong & Lee, 2013). It is interesting to note that the study conducted by Hardin *et al.* (2012) had a different conclusion to that of Hong and Lee (2013), this is despite the fact that both studies were conducted during similar periods with the similar objectives.

2.2.2.2 Listed real estate leads direct real estate

A study conducted in South Africa alluded to how listed real estate share prices can be viewed to provide pertinent information about the economic activity in the direct real estate market and the nature of the actual real estate assets that real estate companies own (Boshoff & cloete, 2012). However, the study cautions against interpreting the movements in the share price of listed real estate companies in the short-term, as these could be as result of irrational investor behaviour (Boshoff & cloete, 2012). The findings from Boshoff and Cloete (2012) suggests that reading into listed real estate trends as a means of gaining knowledge on the direct real estate market only makes sense in the long-term. The differences between the studies conducted by Modligliani and Cohn (1979) and Boshoff and Cloete (2012) stem from the fact that the latter does not necessarily allocate the mispricing in the short-term to inflation illusion, but rather to irrational investor behaviour, which is a broader classification (that includes inflation illusion).

An extension on the study conducted by Boshoff and Cloete (2012) was done in the US where it was demonstrated that some of the movements in listed real estate stock prices were as result of a shift in fundamental variables, and thus listed real estate stock price movements were critical information transmission channels to the direct real estate market (Ling & Naranjo, 2015). Ling and Naranjo (2012) insights seemed to suggest that listed real estate market leads the direct real estate market. Using the vector-error correction model the findings from Ling and Naranjo (2015) were affirmed for office, retail, and apartment sectors, but not in the industrial sector (Hoesli & Serrano, 2013).

2.2.2.3 Institutional involvement

In Europe a study revealed that institutional involvement is related to the inflation-hedging effectiveness of real estate stocks (Lee & Lee, 2014). Lee and Lee (2014) results were inconclusive in emerging markets. However, in the developed markets the findings seem to suggest that there is a long-term relationship between inflation and real estate stocks. In a similar study, analysis on data from the US, UK and Australia suggested that REITs and direct real estate investments can be direct substitutes in the long-term (Hoesli & Oikarinen, 2012). Hoesli and Oikarinen (2012) results seem to confirm the outcome from the study conducted by Lee and Lee (2014), in the case of developed markets.

Before the study conducted by Lee and Lee (2014) an earlier research noted that the involvement of institutional investors helps to facilitate the flow of information into the REITs market in the US, this in turn according to the study helps to align the performance of REITs to that of the underlying real estate assets which improves the security's ability to hedge against inflation (Lee & Lee, 2012). Perhaps the involvement of institutional investors is accompanied by the ability to correctly account for inflation and a lot of other factors in the valuation of listed real estate securities as noted by Hardin *et al*. (2012), which then creates alignment between the returns of direct and indirect investments into real estate – this enables listed real estate to hedge inflation effectively.

Chapter 3: Research Propositions

3.1 Take away from literature review

Given the above literature review and research problem, the author will make the following research propositions:

1. Returns from the JSE listed real estate index have a positive relationship with the South African CPI inflation rate.
2. The JSE listed real estate index returns are better at protecting investors from the South African CPI inflation than JSE All share index returns.

The conclusion that the author will make from testing the above research propositions will be useful to asset managers, pension funds and investors that have the desire to hedge inflation risk given the nature of their liabilities (Armec, Martellini, & Ziemann, 2009).

Chapter 4: Research methodology

4.1 Research Approach and Design

The paper will use a hypothetical deductive approach as the method of research, the approach provides the researcher with two outcomes (in this case the presence of a relationship or no relationship between South African CPI inflation and JSE listed real estate returns). The hypothetical deductive approach begins with a theory which is used to create a hypothesis (namely, JSE listed real estate has a positive relationship with CPI inflation rate), the hypothesis is then tested. The approach makes assumptions of phenomena that are observable in the economy and market place, from which concise statements are formulated. Data is gathered and used to test the hypotheses formed as a result of the observed phenomena, the test will either suggest that the hypothesis is supported or rebutted (Field, 2013).

The researcher will adopt a descriptive research approach, and the process used to gather data for the aforementioned research approach helps in defining and suggesting hypothesis to real world problems (Saunders & Lews, 2012). Moreover, this research approach also has the ability to determine the relative influence of an independent variable on a dependent variable – this may help to focus the research on those independent variables that have the greatest influence on the dependent variable (Field, 2013). Thus the research approach is highly effective in guiding further studies on a topic.

The author chooses a descriptive instead of an exploratory research approach due to the fact that some work has already been done to test for a relationship between CPI inflation and JSE listed security returns in the South African context. In the other hand, the research has not conclusively proven that CPI inflation has a positive relationship with JSE listed real estate returns. Therefore, the body of knowledge is not sufficient to support a research into the causal relationship between the abovementioned variables at this point in time (CPI inflation rate and JSE listed real estate returns) (Saunders & Lews, 2012).

4.2. Research method

The researcher will adopt a quantitative research method. The said method is based on the premise that observable phenomena in the economy and market place can be quantified, thus can be expressed as numerical values, which can then be analysed through the use of statistical models. The research method requires that observation units be identified; in this case these will be a monthly data set of JSE listed real estate returns (which will be the dependent variable) and these are related to macroeconomic variables (one of which will be the CPI index amongst other variables).

The quantitative research approach is best suited for research that aims to establish patterns and relationships between numerical observations (in this case, the relationship between JSE listed real estate and CPI inflation rate) (Saunders & Lews, 2012).

4.3 Sample Population

The population universe (which is also the population of interest) in this study will be the returns of All JSE listed properties (Saunders & Lews, 2012). The JSE listed property index will be a proxy for this population, which is a free float market capitalisation value weighted index. The index comprises of the top 20 liquid property companies, where at least 15% of the issued shares trade in the JSE, and is reviewed every three months to ensure that the definition is preserved (this also caters for survivorship bias, as the index is updated and rebalanced with new information on a quarterly basis) – the index represents more than 70% of the listed property population (Johannesburg Stock Exchange, 2015).

A sample is defined as a subgroup from a population (Saunders & Lews, 2012). Therefore, the sample of interest in this study will be the period from 2004 to 2014(from the JSE listed property index), so as to capture the inflationary effects of QE and the accompanying returns from listed properties during the period.

4.4 Unit of analysis

The research method requires as a first port of call that observation units be identified; in this case these will be a monthly data set of the JSE listed property returns (which will be the dependent variable) calculated from the JSE listed property index. The observation units (the monthly JSE listed property index returns) which the researcher will study form the unit of analysis (Saunders & Lews, 2012).

4.5 Sample Size

For this study the researcher will not physically collect data through the use of surveys and interviews; however, the data for the study will be collected from the following databases:

1. I-Net Bridge
2. The South African Reserve Bank website
3. The Statistics South Africa website

The data will be collected for the period ranging from 2004 to 2014 (to ensure that the inflationary effects of QE and accompanying listed property returns are captured) – the represents 126 monthly data points. The period will ensure that the researcher limits regime changes and that the data is sufficient. Moreover, the large sample size will make certain that the manner in which that data is manipulated does not significantly distort the supposed underlying statistical output.

4.6 Sample Method and Period

Sampling methods can be broadly defined into two groups namely: probability and non-probability methods (Saunders & Lews, 2012). To create valid probability statistical models judgemental sampling method (judgement on the time period had to be made so as to capture the inflationary effects of QE) needs to be adopted for this research – a judgemental sampling method is part of non-probability sampling. A subset (which is the period from 2004 to 2015) of the universe of JSE listed property returns data was selected from I-Net Bridge to create statistical models. These returns are then related to the South African Reserve Bank and the Statistics South Africa data sets through the use of time series regression models.

4.7 Data Collection Tools

The websites of the South African Reserve Bank and Statistics South Africa have databases that allow for the filtering of monthly data. I-Net Bridge which has the JSE listed real estate returns will also have monthly returns data, which can be filtered based on need as well.

Due to the fact that the South African government owns a major part of the South African Reserve Bank and Statistics South Africa databases, this ensures that the data are accurate and reliable(data sources) – this explains the researches decision for choosing these databases.

4.8 Data Analysis procedures

The researcher will create statistical models and analysis for JSE - listed real estate (or JSE - all share index) returns through the use of EViews software. Through the use of the said tools a time series regression model will be created, where the JSE - listed property (or JSE-all share index) returns will be explained by the South African CPI inflation rate amongst other economic variables; a cointegration model may be fitted in the event that a strong positive relationship between CPI inflation and JSE - listed real estate (or JSE - all share index) returns is noted. Time series regression models were also fitted by Lee (2013) and Arjoon *et al*. (2012) to explore the relationship between real estate returns and inflation. Moreover, Lee (2013) and Arjoon *et al*. (2012) also tested for causality.

A regression time series model is chosen specifically for its ability to determine relationships between continues variables (in this case CPI Inflation and listed real estate returns). From the model, the researcher will also draw conclusions and statistical computations to aid the discussion around the findings of the study. The researcher chose Eviews as a statistical package for ease of use and the fact that it is readily available.

4.8.1 Data analysis procedures – introduction into ARIMA models

Before the researcher explains ARIMA models, the following concepts are introduced:

- Stochastic process

- Stationary process
- Differencing
- Unit root definition

4.8.1.1 Introduction to Unit Roots and stationary processes

A stochastic process is a collection of random values over time that represents an evolution of a system (the random values are driven in the background by a system of probabilities) - the probabilities may be time dependent (karlin, 2014).

A stochastic process is considered stationary (or strictly stationary) if its probability distribution is the same for all times or positions – the distribution does not change with time (Parzen, 1957). For such a distribution the mean and variance parameters do not change over time. The white noise process is a good example of a stationary process (both the mean and variance do not change with time).

Strict Stationarity in the context of a stochastic process means that the distribution of the observation y_t *at* time t is the same for all its moments as the distribution for the observation y_{t-s} which arises at time $t-s$ for $s = 1,\ldots, t-1$ (Parzen, 1957). Time series analysis hinges upon the stationarity condition as without understanding this condition for any given time series no meaningful models can be fitted. Moreover, if stationarity is not satisfied then the results from the fitted models can be misleading.

In this paper the (Augmented Dickey-Fuller) ADF tests (which will be defined in the next section) are conducted to determine stationarity of the explanatory variables (and all other variables used in the study) – all these variables were observed to be non-stationary. However, after the first difference four out of 13 explanatory variables appeared to be non-stationary; this means that all the nine variables that became stationary after the first difference have a single unit root. The remaining four had at most two unit roots.

A time series in which the first two moments do not change with time is said to be *weakly stationary* of order 1; this implies that the mean and variance are constant throughout time (Parzen, 1957).

From equation (1.1) below the term (1 − B) must follow the log-levels to ensure stationarity in the model. Tests for stationarity normally aim to find out whether a process can be factorised to produce equation (1.2) below.

$$(1\text{-}B).\ln y_t = \ln y_t - \ln y_{t-1} \text{.........} \quad (1.1)$$

$$(1-B)^d y_t = a_t \text{........} \quad (1.2)$$

In equation (1.1) above the time series may be transformed into a stationary series by first-order differencing. More so, valid statistical analyses can be conducted (usually) where log transformations are used on times series data as log transformation reduces the rate of change of a time series.

In the same way, where a times series has two unit roots, it is necessary to apply second-order differencing prior to analysis – the same logic can be applied to a times series that has *n* unit roots where n-order differencing would need to be applied before analysis is conducted (Dickey & Fuller, 1979).

Fortunately, most financial, commodity and economic time series data usually have a single unit root. This is because it is rare to find growth rates for the abovementioned time series data that increase or decrease over time, it is therefore not necessary to perform a second order difference to get the series stationary – as these series tend to have growth rates that are mean reverting over time.

4.8.1.2 Identification, Estimation and forecasting of Box-Jenkins models

The Autoregressive Integrated Moving Average (ARIMA) time series model is represented as an **ARIMA(p, d, q)** – the model is also referred to as the Box-Jenkins**.** The model uses a combination of a AR(p) and an MA(q) process to describe a series Y_t (Pindyck & Rubinfeld, 1998). The *d* represents the order of integration of the series, the *p* refers to the number of lags that it takes for the partial autocorrelations to fade and the *q* is the lag period that it takes for the autocorrelations to fade (Pindyck & Rubinfeld, 1998).

4.8.1.2.1 Autoregressive Process

An autogressive process is represented as follows:

$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + ... + \phi_p Y_{t-p} + \varepsilon_t$ which can be transformed into the following equation

$$(1 - \phi_1 B - \phi_2 B^2 - ... - \phi_p B^p) Y_t = \varepsilon_t \text{ .... (1.3)}$$

where ε_t ~iid rv(0,σ²) and *B* is the back shift operator, which is used to relate a time series observation Y_t to a time series observation Y_{t-1} (which was observed from the same distribution one time period prior to the most recent observation at time t) with the formula outlined below:

$$B.Y_t = Y_{t-1}$$

Equation 1.3 above represents an AR(*p*) model with partial autocorrelation coefficients $\varnothing_1, \varnothing_2, \ldots, \varnothing_p$.

Theoretically an AR(*p*) model will have partial autocorrelations of zero for lags greater than *p* (EViews users guide, n.d.).

4.8.1.2.2 Moving Average Process

Suppose we have a process Y_t, this process can be represented as follows:

$$Y_t = \varepsilon_t - \theta_1.(\varepsilon_{t-1}) - \theta_2.(\varepsilon_{t-2}) - \ldots - \theta_r.(\varepsilon_{t-q}) \text{.........(1.4)}$$

For instance we consider an MA(1) to be as follows:

$$Y_t = \varepsilon_t - \theta_1.\varepsilon_{t-1}$$

where ε_t ~iid rv(0,σ²)

An MA(*q*) model will have autocorrelations of zero for lags greater than *q.*

The moving average (represented as MA(q) – referring to a process depicted by equation 1.4 above) process is a linear combination of error terms and therefore the moving average process is *always stationary* as each error term is stationary by definition (EViews users guide, n.d.).

4.8.1.2.3 Order of Integration

The order of integration of a series refers to the number of times the series needs to be differenced in order to turn it into a stationary process (Dickey & Fuller, 1979). Simply put a given stationary series Y_t that is integrated of order 0, denoted as Y_t ~ I(0) it also follows that if Y_t ~ I(1), then (1 − B). Y_t ~ I(0) which is a stationary process - this series has a single unit root (Dickey & Fuller, 1979). In general, if Y_t ~ I(d), then the series contains *d* unit roots – which means it needs to be differenced *d* times in order to make it stationary so that it is adequate for modelling purposes (Dickey & Fuller, 1979).

4.8.1.2.4 Explaining the ARIMA(p, d, q)

The first step to fitting an ARIMA model is to determine the necessary order of integration – as this determines the number of times the series needs to differenced in order to render it stationary. The Augmented Dickey-Fuller tests conducted in chapter 5 in section 5.3 determined the presence of unit roots, and thus we are now able to gauge the order of integration of the time series of interest.

Next, one needs to examine the autocorrelation and partial autocorrelations (which are included in chapter 5 in section 5.2) structure of the time series (in this case the JSE-listed property index or the JSE – all share index) - this is called the *identification* phase of the ARIMA modelling procedure (EViews users guide, n.d.). The appropriate ARIMA specifications depend on the correlations between current value of residuals and their past values (the residuals are a by-product of the fitted model against the JSE listed property index or the JSE – all share index).

The AR(p) term should only be included when the partial autocorrelations fade away after *p* lags. Similarly, an MA(q) term should be incorporated only when the autocorrelations fade away after *q* lags. However, under normal circumstances it is ideal to proceed in a stepwise fashion, starting with either an AR(1) or MA(1) term or a combination of both (whichever is most appropriate) and observing the autocorrelations (and Durbin Watson statistics in the resulting model) of the residual terms in the model. It is recommended that the econometrician should continue fitting successively higher-order autoregressive and moving average terms until all autocorrelations are accounted for in the model (the Durbin Watson statistic is pulled closer to 2).

4.8.2 Data analysis procedures – preliminary tests

In order to create reliable models, the following tests have to be conducted (the researcher will be able to paint a picture on the weaknesses and strengths of the collected data):

- Test for unit roots (Augmented Dickey-Fuller test) – conducted in chapter 5 presented in table 5.3
- Test for autocorrelation
    - Correlogram of residuals (conducted in chapter 5 represented by table 5.2)
    - Durbin-Watson test (conducted in chapter 5 represented by table 5.4)
- Tests for heteroscedasticity
    - Park test (conducted in chapter 5 represented by table 5.4)
    - Residual plots (conducted in chapter 5 represented by figure 5.1)
- Multicollinearity tests – correlation matrix (in chapter 5 represented by table 5.7)

The computations (or procedures that need to be followed) of the abovementioned tests are outlined in the sections that follow in this chapter.

4.8.2.1 The Augmented Dickey-Fuller (ADF) Test

Suppose we are given the following time series model for $y_{t,}$, where

$$\ln y_t = \phi . \ln y_{t-1} + \theta + a_t$$

deducting $\ln y_{t-1}$ from both sides of the above equation yields the following

$$\ln y_t - \ln y_{t-1} = \phi . \ln y_{t-1} - \ln y_{t-1} + \theta + a_t$$

$$(1 - B).\ln y_t = (\phi - 1).\ln y_{t-1} + \theta + a_t$$

$$(1 - B).\ln y_t = \phi' . \ln y_{t-1} + \theta + a_t$$

Where $\ln y_{t-1} = B.\ln y_t$ *(B is the back shift operator*)

It therefore follows that to perform the ADF test one needs to conduct the following hypothesis:

$$H_0 : \phi' = 0$$

$$H_1 : \phi' < 0$$

In the event that the alternative hypothesis is rejected then most probably the series is stationary (Dickey & Fuller, 1979).

The financial and commodity data collected for this paper will be checked for stationarity by means of the ADF test for unit roots – the tests are conducted in chapter 5 (table 5.3 shows the results).

4.8.2.2 Detecting Autocorrelation

The presence of autocorrelation (in regression analysis) in the residual terms means that the OLS (ordinary least squares) estimators are not best (implying the variance is not minimised), non-linear and biased (this is also referred to as the BLUE criterion) (Tiao, et al., 1990) – one of these problems is usually present where there's evidence of autocorrelation.

Similary, heteroskedasticity introduces a situation where the OLS estimators are non-BLUE – this is due to the fact that the OLS method is unable to minimise the variance in the presence of heteroskedasticity (Engle, 1982). However, even though heteroskedasticity may be present the estimators can remain linear and unbiased.

4.8.2.2.1 Heteroskedasticity and Autocorrelation

The OLS estimator ($\hat{\beta}_{ols}$) that forms part of a model defined by the equation: $y = x\hat{\beta} + \mu$ is said to be BLUE: Best (implying minimum variance), Linear, Unbiased, Estimator where the constant variance of the residuals assumption holds (Engle, 1982). In the event that this assumption is violated the interpretations of results from the model could lead to wrong inferences (the violation of this assumption leads to heteroskedasticity which can result in autocorrelation).

CPI inflation levels in the South African economy should have a significant impact on the property market (both listed and direct investment) – as it affects rental income. Therefore, as CPI inflation increases property owners are expected to take advantage of the increase to negotiate further increases in rental income.

In the other hand, where CPI inflation is increasing interest rates (the repo rate being the case in point) levels tend to be low (this is as a result of inflation targeting by the SARB). Prolonged low interest rate environments result in an increase in the number of property developments (due to the low cost of capital) – both supply and demand of properties expands (as affordability improves), as a result the whole property market becomes vibrant. The expansion in demand is expected to be at a faster rate than that of supply – this leads to higher property prices (and therefore higher property returns).

The economic activity explained in the above paragraph suggests that the variance of listed property returns increases as the repo rate decreases (or as CPI inflation increases), this is referred to as heteroskedasticity (where the variance of an observation increases as the magnitude of an explanatory variable changes) (Engle, 1982) – this means there's a good chance that the constant variance assumption may be violated. Therefore, tests for heteroskedasticity are essential.

4.8.3 Data analysis procedures - formal tests for heteroskedasticity

A formal approach to detecting heteroskedasticity is to conduct formal statistical tests, and a variety of tests exist. In this study we use the Park test (also referred as the Canonical Cointegrating Regression (CCR)) to test for the relationship between Log(ListedPropertyIndex) and Log(CPI) (EViews users guide, n.d.) - table 5.4 in chapter 5 presents the results.

4.8.3.1 Model specification of heteroskedasticity

The aim is to demonstrate the presence of heteroscedasticity in the residuals of the fitted equation below, where Ln(ListedPropertyIndex) is the dependent variable.

$$Ln(\mathbf{LP_t}) = \alpha + \beta * Ln(CPI_t) + u_t \text{ for all } t \quad ......(1.4)$$

Where LP_t = listed property index at time t, CPI_t = consumer price index at time t and u_t = error term and u_t ~iid rv$(0,\sigma^2)$.

4.8.3.2 The Park test for heteroskedasticity

As mentioned above this paper will use the park test amongst others to check for heteroskedasticity. The null hypothesis of the park test says there's no relationship between the residuals (of listed property returns) and CPI inflation (which means $\beta = 0$) in equation 1.4 above.

4.8.3.3 Model specification for the Park test

To conduct the test the equation: $Ln(\boldsymbol{u_t^2}) = \alpha + \beta.dLn(\boldsymbol{CPI_t}) + v_t$ *for all t,* where u_t^2 represents the estimated residuals from equation (1.4) and $dLn(\boldsymbol{CPI_t})$ as the first difference of the log of CPI time series. The hypothesis is as follows:

$$H_0 : \beta = 0 \text{ (Homoskedasticity)}$$

$$H_1 : \beta \neq 0 \text{ (Heteroskedasticity)}$$

In the event that β is statistically different from zero, H_0 is rejected and it can be concluded that Heteroskedasticity is present – this means that there's a relation between the residuals and the size of inflation (EViews users guide, n.d.).

4.8.3.4 Durbin-Watson test statistic

The Durbin-Watson statistic is calculated with the following formula:

$$DW = 2.(1-r)$$

, where the null hypothesis states that there's no autocorrelation in a times series, and that r in the above equation is the autocorrelation.

A DW test statistic of less than one indicates the presence of positive first-order autocorrelation, and a test statistic of two indicates the absence of first-order autocorrelation in the residual series. In the other hand, in the event that the DW test statistic is greater than two, this suggests that there's negative first-order autocorrelation in the residual series - table 5.4 in chapter 5 presents the results.

4.8.4 Data analysis procedures - multicollinearity

Multicollinearity is observed where two or more independent (or a subset thereof) variables in a regression are strongly correlated to one another; this makes it difficult to ascribe the effects of the independent variables on the dependent variable (Greene, 2008). Economic variables tend to exhibit the multicollinearity condition, and it is crucial to check for the condition before building any econometric models.

To identify multicollinearity, a correlation matrix (which is included in table 5.7 in chapter 5) can be used – a correlation coefficient of more than 0.9 in absolute terms is suspicious (EViews users guide, n.d.). Moreover, other tests do exist – some of these may not necessarily yield more value for the purposes of this paper, and therefore a correlation matrix will suffice for this analysis.

To conduct the ordinary least square (OLS) method for estimating regressions, one of the key assumptions is that no linear relationships should exist between the regressor variables (Greene, 2008). If this assumption is violated then the coefficients derived may be unstable – this may lead to unexpected signs with high standard deviations (and the F test and t-statistics will conflict).

The rule of thumb amongst statisticians is that one should only worry about multicollinearity where the correlation between two explanatory variables squared is greater than the R^2 (for the fitted model) – this means that in the case where two explanatory variables have a stronger relationship with each other than the relationship between all the independent variables (including the explanatory variables of interest) combined in a multivariate regression against the dependent variable then multicollinearity exists.

Other symptoms:

i.) R^2 for the regression based on both explanatory variables is greater than the correlation between each explanatory variable against the response variable.

ii.) The coefficients of the explanatory variables in a multivariate regression context differ markedly to those derived in a simple regression context for the individual regressors – this is as a result of each regressor doing the work of at least two regressors in a simple regression context.

iii.) Drastic increase in variances of the estimated regression coefficients as one moves from simple to a multiple regression model.

The correlation matrix is included in chapter 5 (in section 5.7) shows the relationships between the variables used in this study.

4.8.5 Data analysis Procedures – developing cointegration models

The main issue with cointegration tests is that they require that two variables be regressed against each other, and often than not one finds that the regression between the two variables has a high R^2. However, the resulting R^2 (even though high) does not necessarily indicate a meaningful economic relationship between the variables – which is referred to as spurious regression (Kao, 1999).

To avoid spurious regression statistician usually resort to differencing time series data. However, this creates another problem as differencing destroys long-term information in times series data (leaving short-term information only) – this means that differencing is not the appropriate solution when conducting cointegration tests.

In plain English, cointegration means that two times series have similar long-term trend lines – this means that the two series' drift together over time. However, from a statistics point of view Harris (1995) says that in the event that two time series' y_t and x_t are integrated of order d (meaning that they both need to be differenced d times before rendering them stationary), then a weighted combination of y_t and x_t will typically be of order d as well.

In the other hand Engle and Granger (1987) say that where a vector β exists such that the disturbance time series variable ε_t (which is derived from the equation $\varepsilon_t = y_t - \beta.x_t$) and the resulting order of integration for ε_t is d-b (where both d and b are greater than zero) then y_t and x_t are defined as being cointegrated of order (d,b). For instance, suppose y_t and x_t are both integrated of order 1, and the resulting ε_t series is integrated of order 0, then y_t and x_t are cointegrated of order (1,1) - this means that the long-term relationship between y_t and x_t can be approximated by conducting the following regression: $y_t = \beta.x_t + \varepsilon_t$.

4.8.5.1 Using Engle-Granger and Hansen Instability tests to prove Cointegration

Using the single equation approach to test for cointegration has its own drawbacks, more especially where the underlying time series has more than one cointegration relationship with other time series'. To avoid this problem the Engle-Granger Cointegration approach (in conjunction with the Hansen instability test) is used in this paper in order to establish if the long-term relationship between variables results in stationary residuals (or result in stable parameters).

In this paper a four step process was followed to determine the existence of a long-term relationship between the variables of interest. The steps are outlined below:

Step 1: An Augmented Dickey-Fuller (ADF) test is conducted to determine the order of integration. These tests are conducted in chapter 5 (the results are presented in table 5.3)

Step 2: All subsets regression techniques are used to select the most significant variables in terms of explaining the long-term relationship between JSE-all share index (or JSE-listed property index) against the universe of variables collected for this study. The table below shows the resulting variable selection for the *JSE - listed property index* and the *JSE - all share index models*:

Variable type	Equities long term model	Listed property long term model
dependent	*JSE All Share Index*	*JSE listed property Index*
Independent	*House price Index*	*Rand dollar exchange rate*
Independent	*JSE All Bond Index*	*Gold price*
Independent	*Consumer Price Index*	*Consumer Price Index*

Step 3: A regression is performed between JSE-listed property Index returns, JSE-All bond index returns, change in gold prices, and CPI inflation (for the listed property vs. CPI cointegration model). Similary, another regression model is performed to determine the relationship between the JSE-all share index, house price index, JSE-all bond index and Consumer price index – all the models are selected through a stepwise selection procedure (as mentioned in step 2 above).

Step 4: Through elimination the independent variables (from the list of variables resulting from the stepwise selection procedures – stated in step 2 above) with the most influence on the dependent variables (JSE-listed property index or JSE-all share index) remain.

Step 5: The Cointegration Regression Durbin-Watson (DW) and Engle and Granger tests are conducted (on the resulting models from step 4 above) to determine whether the residuals from the resulting regression residuals are stationary – this indicates if there's a long-term relationship between the variables of interest.

Step 6: Hansen instability test is also conducted (on the resulting models from step 4 above) to determine the stability of parameters of the fitted long-term relationships between the dependent and independent variables.

4.9 Limitations

Reliability means that results are at a satisfactory level of accuracy in order for a user to make good decisions (Saunders & Lews, 2012), in this case using the JSE-listed property index would enable users to make an informed judgement from the results acquired from the research on whether JSE-listed real estate returns do protect the wealth of investors from inflation. Validity means precision (Saunders & Lews, 2012), thus in this case the JSE-listed property index represents more than 70% of the listed property sector, and this means that the conclusion derived on the back of the index can be applied to the general JSE-listed property sector in the country (which implies that the results are externally valid) – in this context internal validity means that the results from the study can only be applicable to listed property companies included in the index.

In order to ensure that the statistical models and analysis are valid and reliable, the researcher will follow the steps below as an additional line of defence (the above paragraph outlines the first line of defence):

1. Gather data from reliable sources such as the South African Reserve Bank and Statistics South Africa, which are partly state-owned – this will ensure that the data is sufficiently accurate.

2. Scatter plots will be created to check for linearity, influential points and outliers within the data.

3. Tests will be conducted to check for the accuracy of the fitted models

The reason for the above tests is to ensure that the results are reliable as reliability plays a big role in quantitative research - the models fitted will be used to aid the discussion on the study and future research by other scholars (Saunders & Lews, 2012).

CHAPTER 5: Data analysis

5.1 Variable selection

It is known that all markets function within the context of an economy, therefore economic activity influences markets (which includes properties).Markets influence each other (for instance, the foreign exchange market does affect equity and property markets). It is for this reasons that the researcher chose the following variables for this paper:

- JSE-All bond index – which functions as a potential substitute to JSE-listed property index.
- JSE-All share index – acts as an indicator of economic activity and public company performance (which includes JSE-listed property). It may serves as a potential substitute to the JSE-listed property index.
- Consumer price index (CPI) – it is used as the measure of consumer price inflation by most organs of the economy, it therefore facilitates the measurement of the rate at which cash losses value (in the hands of a consumer) as result of inflation risk.
- Gross domestic product – it is used to measure economic performance, it is critical to include as it drives all markets in an economy
- Gold price – used by the investment community as an indicator of market risk aversion (most investors believe that gold is a safe investment where markets are volatile) (Qadan & Yagil, 2012).
- House price index – measures the performance of the residential property market.
- Rand dollar exchange rate – also used to measure risk aversion in the market (the dollar is considered to be a safe haven currency when markets are jittery). A strong rand against the dollar puts South African investors at an advantage when investing abroad (when buying dollar denominated assets)
- Repo rate – indicates the state of liquidity in the economy (when interest rates are high credit extension slows which is followed by a decrease in money supply in the economy and vice versa)
- South African gross capital formation – indicates the commitment of capital into long-term projects (this also shows that the country is gearing up to boost

productivity in the long-term). Gross capital formation tends to be followed by investments into property and other asset classes.

- South African business confidence index – provides information on production, orders and stock piles of enterprises (serves as an early signal to the direction of the economy).
- South African gross savings – it is an indicator of the potential change to the demand for investments in the future (an increases in savings increases the investment rate into long-term projects and property)
- South African unemployment – measures the economic productivity of the population (where unemployment decreases demand for consumption products increases which is followed by demand for retail property)

The researcher included the above variables in order to best capture the movements in the JSE-listed property index (or the JSE-all share index). The movements in the JSE-listed property index (or the JSE-all share index) are explained by the changes in the market (for instance changes in demand for the rand surges unexpectedly) and economic performance (where enterprises and general organs of the economy change production).

State organs such as the SARB (South African reserve bank) have an influence on the performance of the economy and markets (such as the JSE-listed property market) – this is through repo rate changes in the economy.

Economic data (such as the business confidence, gross national savings and unemployment statistics) in the list above will serves to explain the movements (as result of changes in expectations) in the JSE-listed property and JSE-all share indices – these variables serve as indicators of future economic production (and capacity).

The **table 5.1** below provides the descriptive statistics of the selected variables

Variable	Min	Max	Average	Standard deviation	Number of observations
Repo Rate	5	12	7	2	126
GDP (in mil)	1 539 250	3 951 760	2 686 090	729 818	42
Gold Price (in US dollar)	2 527	15 267	9 127	4 062	126
Listed Property Index	180	659	379	116	126
Alsi Index	12 556	54 440	31 284	10 686	126
Rand Dollar Exchange	6	12	8	2	126
SA Capital Formation (in mil)	257 751	800 639	534 819	154 128	42
SA Gross Saving (in mil)	236 031	640 916	431 468	111 547	42
House Price Index	241	490	371	61	124
SA Unemploy (in %)	22	26	16	12	126
CPI	62	114	87	16	126
SA Business Confidence Index	87	122	103	11	126
ALBI index	147	183	168	8	126

Linear interpolation was used to estimate the observations of quarterly data such as the SA gross national savings, SA capital formation and gross domestic product (GDP).

5.2 Economic and Market data

The tables below show the autocorrelations, the partial autocorrelations, Q statistic and p-values for the first difference of the natural log of all the time series data that was used in this paper (the variables are outlined in table 5.2). The same statistics are calculated for special cases where a second difference was required, namely for the gross national savings, gross capital formation, ALBI trend and house price index (the descriptions to all the time series data used in this study are given in appendix 1).

Determining the autocorrelations and partial autocorrelations helps to inform the statistician as to whether underlying time series data is increasing (or decreasing) over time – this suggests that the increments from one data point to the next are not random (or otherwise). In the event that the underlying time series data is increasing (or decreasing) over time a first difference is calculated followed by autocorrelation (together with partial autocorrelations) computations to check the effectiveness (in terms of removing autocorrelation) of a first difference procedure. It is essential to remove autocorrelation as it prevents statistical procedures from minimizing the variance of the resulting models – which implies that the models estimates cannot be relied upon.

The computation of autocorrelations also enables the statisticians to get a feel of the data before creating models.

Table 5.2: Q statistic, Autocorrelations and *partial* autocorrelations for the first six lags

Variable	Lags	AC	PAC	Q-Stat	Prob
dLn(ALBI)	1	-0.04	-0.04	0.25	0.62
	2	0.01	0.01	0.25	0.88
	3	0.06	0.07	0.79	0.85
	4	-0.22	-0.21	6.84	0.14
	5	0.08	0.07	7.68	0.18
	6	-0.18	-0.19	12.00	0.06
dLn(ALSI)	1	-0.07	-0.07	0.56	0.46
	2	0.12	0.12	2.53	0.28
	3	0.10	0.11	3.70	0.30
	4	0.16	0.16	6.89	0.14
	5	-0.05	-0.05	7.17	0.21
	6	-0.02	-0.08	7.22	0.30
dLn(CPI)	1	0.32	0.32	13.13	0.00
	2	-0.01	-0.13	13.15	0.00
	3	-0.06	-0.02	13.62	0.00
	4	0.03	0.06	13.74	0.01
	5	0.05	0.02	14.10	0.02
	6	0.15	0.14	16.91	0.01
dLn(GDP_Trend)	1	0.31	0.31	12.30	0.00
	2	-0.16	-0.28	15.43	0.00
	3	-0.01	0.17	15.44	0.00
	4	0.09	-0.02	16.42	0.00
	5	0.10	0.12	17.71	0.00
	6	0.09	0.04	18.81	0.01
dLn(GDP)	1	0.68	0.68	59.44	0.00
	2	0.36	-0.19	76.44	0.00
	3	0.06	-0.20	76.92	0.00
	4	0.05	0.31	77.28	0.00
	5	0.04	-0.11	77.53	0.00
	6	0.05	-0.06	77.85	0.00

Variable	Lags	AC	PAC	Q-Stat	Prob
dLn(RepoRate)	1	0.06	0.06	0.39	0.53
	2	0.36	0.36	16.90	0.00
	3	0.27	0.27	26.38	0.00
	4	0.09	-0.04	27.54	0.00
	5	0.11	-0.10	29.06	0.00
	6	0.18	0.11	33.42	0.00
d(Ln(SA_CapForm),2)	1	0.00	0.00	0.00	0.97
	2	0.00	0.00	0.00	1.00
	3	0.04	0.04	0.17	0.98
	4	0.01	0.01	0.19	1.00
	5	0.01	0.01	0.21	1.00
	6	-0.22	-0.22	6.41	0.38
dLn(SA_BusConIndex)	1	-0.43	-0.43	23.19	0.00
	2	0.16	-0.03	26.37	0.00
	3	0.04	0.12	26.58	0.00
	4	-0.11	-0.06	28.29	0.00
	5	0.11	0.02	29.76	0.00
	6	-0.06	0.00	30.22	0.00
d(Ln(SA_GrossSav),2)	1	0.00	0.00	0.00	0.98
	2	0.00	0.00	0.00	1.00
	3	-0.51	-0.51	33.63	0.00
	4	0.00	-0.01	33.63	0.00
	5	0.00	0.00	33.63	0.00
	6	-0.14	-0.54	36.01	0.00
dLn(SA_Unemploy)	1	0.45	0.45	26.07	0.00
	2	0.08	-0.15	26.91	0.00
	3	-0.29	-0.33	37.57	0.00
	4	-0.18	0.14	42.02	0.00
	5	-0.08	-0.03	42.96	0.00
	6	0.01	-0.09	42.98	0.00

Variable	Lags	AC	PAC	Q-Stat	Prob
dLn(GoldPrice)	1	-0.07	-0.07	0.70	0.40
	2	0.02	0.01	0.73	0.69
	3	-0.06	-0.06	1.16	0.76
	4	-0.01	-0.02	1.17	0.88
	5	-0.06	-0.06	1.71	0.89
	6	0.01	0.00	1.73	0.94
d(Ln(HouseIndex),2)	1	0.79	0.79	78.61	0.00
	2	0.32	-0.83	91.60	0.00
	3	-0.15	0.35	94.51	0.00
	4	-0.41	0.03	116.24	0.00
	5	-0.38	0.18	134.79	0.00
	6	-0.16	-0.31	137.97	0.00
dLn(ListedPropIndex)	1	0.11	0.11	1.61	0.20
	2	-0.13	-0.14	3.67	0.16
	3	0.02	0.06	3.74	0.29
	4	-0.06	-0.09	4.17	0.38
	5	0.06	0.09	4.61	0.47
	6	-0.09	-0.14	5.61	0.47
dLn(RandDollarExchange)	1	0.30	0.30	11.25	0.00
	2	-0.11	-0.22	12.81	0.00
	3	-0.01	0.11	12.83	0.01
	4	0.04	-0.02	13.06	0.01
	5	-0.08	-0.10	13.98	0.02
	6	-0.20	-0.14	19.05	0.00

Variable	Lags	AC	PAC	Q-Stat	Prob
d(Ln(ALSI),2)	1	-0.46	-0.46	26.56	0.00
	2	0.22	0.02	32.89	0.00
	3	-0.03	0.10	32.98	0.00
	4	-0.10	-0.10	34.28	0.00
	5	0.06	-0.05	34.74	0.00
	6	-0.06	-0.03	35.19	0.00
d(Ln(ALBI_Trend),2)	1	-0.59	-0.59	44.58	0.00
	2	0.17	-0.28	48.37	0.00
	3	0.02	-0.02	48.43	0.00
	4	-0.01	0.07	48.44	0.00
	5	0.00	0.05	48.44	0.00
	6	0.00	0.00	48.44	0.00
dLn(RandDollarExchange_Trend)	1	0.30	0.30	11.25	0.00
	2	-0.11	-0.22	12.81	0.00
	3	-0.01	0.11	12.83	0.01
	4	0.04	-0.02	13.06	0.01
	5	-0.08	-0.10	13.98	0.02
	6	-0.20	-0.14	19.05	0.00

The autocorrelations and partial autocorrelations for the first difference of the natural log of the gold price, JSE-listed property and all share indices all had a clean pass – the autocorrelations (and partial autocorrelations) are small in absolute terms (the cut off is 2/(N)^0.5 = 0.18, where N = 126 observations from the history collected in the time series data). The first difference of the natural log of the CPI also tended to have small autocorrelations. However, there were cases where the second difference had to be applied to some of the time series data, namely for the SA gross national savings, SA capital formation, ALBI trend and house price index – the variables seem to indicate that as the time series changes the rate of change also varied in a consistent fashion over time.

The Q statistic for the rand dollar exchange rate, the repo rate, consumer price index, GDP, unemployment rate, business confidence index and house price index (for the first difference of the natural log series) tended to be significant at the 5% significant level. In the other hand, the Q statistic for the natural log of gold prices, JSE-listed property index, gross capital formation (GCF) and the all share index (for the first difference of the natural log series) are insignificant at the 5% significance level. From these results the researcher demonstrates that the autocorrelations observed in the first six lags are by and large insignificant (more especially for the first difference of the natural log of gold prices, JSE-listed property index, and the JSE-all share index time series data), hence it follows that the time series data used in this study is largely random – with the exception of the house price index. This serves to aid the model building process as the reliability of the output is enhanced.

5.3 Augmented Dickey-Fuller (ADF) results

Another way of proving that times series data is increasing (or decreasing) overtime – which indicates that the increments from one data point to the next are not random; is to prove that a times series has a unit root. To prove the presence of a unit root the augmented dickey fuller (ADF) test has to be conducted (Chapter 4 explains the ADF test).

Table 5.3: ADF tests

	First Unit root test		Second Unit root test		Third Unit root test	
Variable	ADF stat	Unit root present	ADF stat	Unit root present	ADF stat	Unit root present
Ln(ALBI)	-2.75	Yes	-11.53	No	n/a	No
Ln(ALSI)	-1.78	Yes	-11.83	No	n/a	No
Ln(CPI)	-1.04	Yes	-7.87	No	n/a	No
Ln(GDP)	-2.46	Yes	-2.04	Yes	-8.93	No
Ln(GoldPrice)	-2.14	Yes	-11.89	No	n/a	No
Ln(HouseIndex)	-1.04	Yes	-2.67	Yes	-5.76	No
Ln(RanddollarExchange)	-1.08	Yes	-8.13	No	n/a	No
Ln(RepoRate)	-1.37	Yes	-3.57	No	n/a	No
Ln(SA_BusConIndex)	-0.47	Yes	-17.43	No	n/a	No
Ln(SA_GrossSav)	-1.87	Yes	-2.69	Yes	-8.09	No
Ln(SA_Unemploy)	-1.15	Yes	-8.08	No	n/a	No
Ln(ListedPropIndex)	-1.55	Yes	-9.91	No	n/a	No
Ln(SA_Capform)	-2.11	Yes	-2.64	Yes	-10.97	No

*First Unit root test includes term

**Second unit root test includes term and trend

***Third unit root test includes term and trend

The ADF tests results for a *single unit root* are given in the above table. The natural log levels of the underlying time series data were used to conduct the analysis. In the event that the ADF test statistic is less than the critical value of -2.883 (for the single unit root test) it is considered to be significant at the 5% level of significance, and this serves to indicate the absence of a unit root (for the log level of the time series). Therefore, it can be seen in the above table that all variables have at least 1 unit root.

The above table also shows that only GDP, the Absa House Price Index, South Africa gross national savings and capital formation have at least two unit roots. For these variables the researcher conducted further tests to confirm if the unit roots do exceed more than two. The critical value for the ADF test at a 5% significance level is -3.45 (where a trend term is included) – most of the ADF test statistics in the above table are less than -3.45, indicating the absence of unit roots after the second difference (covered by the second unit root test in table 5.3 above). Furthermore, from the table above it can be noted that no third unit root is present in GDP, House price index, SA Gross national savings and capital formation – the third unit root test in table 5.3 above shows the results.

In conclusion, it can be seen that all variables (with the exception of GDP, House price index, South African gross national savings and capital formation) can be considered stationary after a second difference – the results coincide with the results in section 5.1.

5.4 Fitting Box-Jenkins Models

The partial autocorrelation and autocorrelation lags of JSE-Listed property and JSE-all share index returns (the first difference of the natural log of the JSE-listed property and JSE-all share index time series') are all insignificant – these are presented in table 5.2 above. This means that both time series' cannot be modelled as an ARMA(*p,q*). It therefore follows that both the JSE-listed property and JSE-all share index time series' are ARIMA(0,1,0) processes. In the sections that follow a search for econometric models to fit to both the JSE-listed property and JSE-all share index return time series data is conducted – a pure ARIMA(p,d,q) model would be difficult to fit without the incorporation of macroeconomic variables in both cases (JSE-listed property index and JSE-all share index models).

5.5 Detecting heteroskedasticity and autocorrelations

It is important to investigate the presence of heteroskedasticity as it tends to work against statistical procedures that are meant to minimize the variance of a model. In the event that heteroskedasticity is discovered further statistical procedures need to be used to minimize its presence.

In the sections that follow the writer uses the Durbin-Watson statistic to indicate the presence of autocorrelations from the model derived from equation (1.4) below. Moreover, figure 5.2 below makes a graphical depiction of the autocorrelation that remains once the model represented by equation (1.4) below is fitted.

5.5.1 Formal test for heteroskedasticity

Table 5.4 below shows that the relationship between Log(CPI) and Log(ListedPropIndex) is strong – the equation that explains the relationship between the two variables is outlined below. The t-statistic is significant, which supports the rejection of the null hypothesis (which means that heteroskedasticity may be present). Furthermore, figure 5.1 below also shows that there's evidence of heteroskedasticity from the resulting residuals – as dLog(CPI) increases (which is the inflation rate), the squared residuals increase as well.

Dependent Variable: LOG(LISTEDPROPINDEX)				
Method: Canonical Cointegrating Regression (CCR)				
Date: 09/05/15 Time: 12:17				
Sample (adjusted): 2005M02 2015M06				
Included observations: 125 after adjustments				
Cointegrating equation deterministics: C				
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth				
= 5.0000)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CPI)	1.4808	0.1280	11.5685	0.0000
C	-0.7000	0.5688	-1.2306	0.2208
R-squared	0.8186	Mean dependent var		5.8981
Adjusted R-squared	0.8171	S.D. dependent var		0.3005
S.E. of regression	0.1285	Sum squared resid		2.0310
Durbin-Watson stat	0.1464	Long-run variance		0.0697

The above output aims is to demonstrate the presence of heteroskedasticity in the residuals after fitting equation (1.4) below, where Ln(ListedPropertyIndex) is the dependent variable.

$$Ln(\mathbf{LP}_t) = \alpha + \beta * Ln(CPI_t) + u_t \text{ for all } t \quad ...... (1.4)$$

where $Ln(\mathbf{LP}_t)$ = natural log of the JSE-listed property index at time t, CPI_t = consumer price index at time t and u_t = error term and u_t ~iid rv(0,σ²). Note: Ln(x) refers to the natural log of x.

The model specification for a formal heteroskedasticity test is outline below:

$$Ln(\mathbf{u}_t^2) = \alpha + \beta.dLn(\mathbf{CPI}_t) + v_t \text{ for all } t,$$

where u_t^2 represents the estimated residuals from equation (1.4) and $dLn(\mathbf{CPI}_t)$ as the first difference of the natural log of the CPI time series. The hypothesis is as follows:

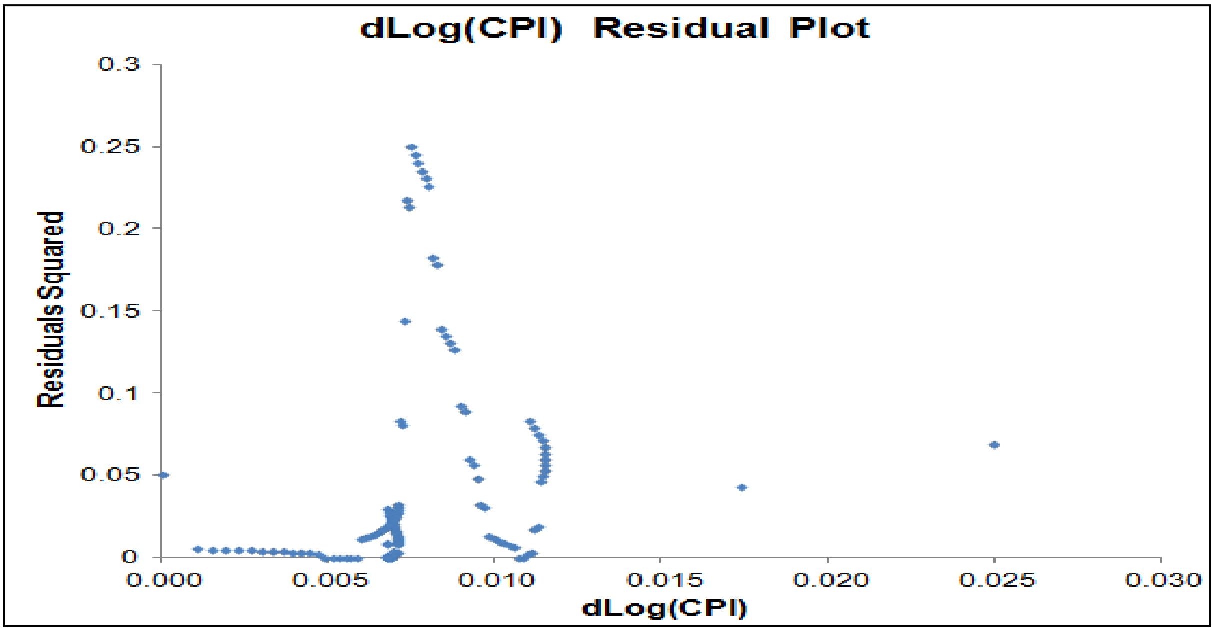
$$H_0 : \beta = 0 \text{ (Homoskedasticity)}$$

$$H_1 : \beta \neq 0 \text{ (Heteroskedasticity)}$$

In the event that β is statistically different from zero, H_0 is rejected and it can be concluded that Heteroskedasticity is present – this means that there's a relationship between the residuals and the size of inflation (EViews users guide, n.d.).

Note: the above equations are also stated in chapter 4.

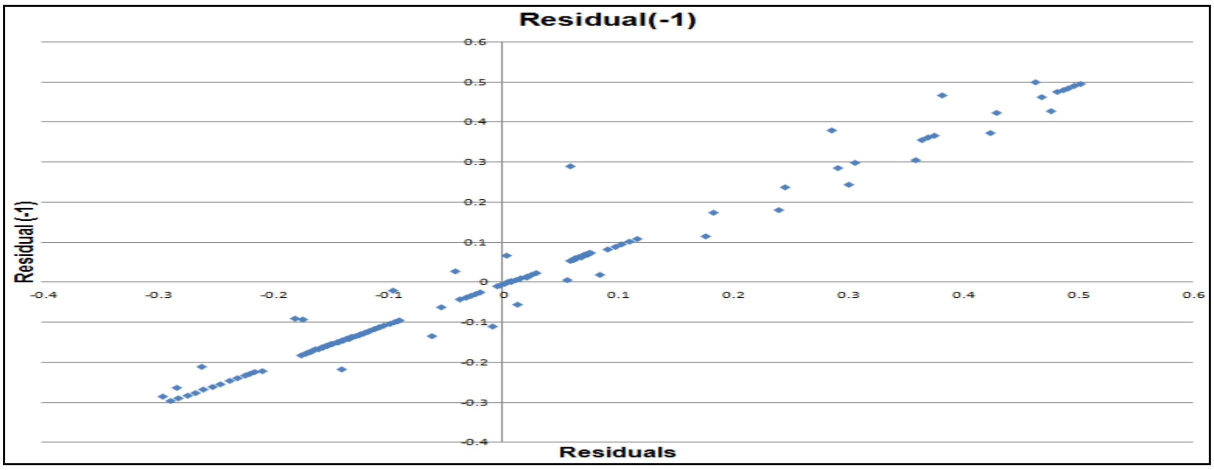
Figure 5.1



5.5.2 Durbin-Watson test for first-order autocorrelation (in Park test)

From table 5.4 above it can be seen that the Durbin-Watson (DW) test statistic is 0.146 < 1. Therefore, the null hypothesis of no positive autocorrelation is rejected and we conclude that there is positive autocorrelation in the residuals derived from equation (1.4) above. Moreover, the figure below (figure 5.2) shows that there's a positive relationship between the residuals and the one month lag of the residuals.

Figure 5.2



Given that there's presence of autocorrelation and heteroskedasticity in the residuals of the model represented by equation (1.4) above, it follows that techniques such as differencing or adding first order autoregressive terms need to be used to remove autocorrelation (which may or may not be caused by heteroskedasticity) - the next section demonstrates the effectiveness of differencing and the use of first order autoregressive terms in removing the effects of autocorrelation and heteroskedasticity.

5.6 Removing Autocorrelation

Table 5.5 below shows results of differencing both the Log(ListedPropertyIndex) and Log(CPI) and plugging them into a cointegration model (See the effect on the DW test statistic).

Table 5.5:

Dependent Variable: DLOG(LISTEDPROPINDEX)				
Method: Canonical Cointegrating Regression (CCR)				
Date: 09/05/15 Time: 15:32				
Sample (adjusted): 2005M03 2015M06				
Included observations: 124 after adjustments				
Cointegrating equation deterministics: C				
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth				
= 5.0000)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CPI)	-2.8003	1.1538	-2.4270	0.0167
C	0.0231	0.0069	3.3330	0.0011
R-squared	0.0057	Mean dependent var		0.0094
Adjusted R-squared	-0.0024	S.D. dependent var		0.0479
S.E. of regression	0.0480	Sum squared resid		0.2806
Durbin-Watson stat	1.8504	Long-run variance		0.0020

In the above table it can be seen that the DW test statistic has increased to 1.85 (from 0.146 in table 5.4). Therefore, we cannot reject the null hypothesis of no serial autocorrelation in residual series (derived in equation (1.4) above) for the new model in table 5.5 – this means the differencing procedure is effective in removing autocorrelation from the residual series.

Alternatively, one could use generalised least squares method with an AR(1) term as a means for removing autocorrelation in the residual series. The table below shows the results of the procedure.

Table 5.6:

Dependent Variable: LOG(LISTEDPROPINDEX)				
Method: Least Squares				
Date: 09/05/15 Time: 15:57				
Sample (adjusted): 2005M02 2015M06				
Included observations: 125 after adjustments				
Convergence achieved after 15 iterations				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CPI)	-1.505	1.036	-1.453	0.149
C	14.425	5.872	2.457	0.015
AR(1)	0.991	0.008	124.547	0.000
R-squared	0.975	Mean dependent var		5.898
Adjusted R-squared	0.975	S.D. dependent var		0.300
S.E. of regression	0.048	Akaike info criterion		-3.230
Sum squared resid	0.276	Schwarz criterion		-3.162
Log likelihood	204.847	Hannan-Quinn criter.		-3.202
F-statistic	2412.982	Durbin-Watson stat		1.821
Prob(F-statistic)	0.000			
Inverted AR Roots	0.990			

In tables 5.4 (where the first procedure was conducted before differencing Log(CPI) and Log(ListedPropIndex)), 5.5 and 5.6 above it can be seen that the coefficients of Log(CPI) were 1.48, -2.8 and -1.51 respectively. The DW test statistics were 0.146, 1.85 and 1.82 respectively. From the results it can be concluded that both procedures (represented in tables 5.5 and 5.6) are able to remove first-order autocorrelation.

5.7 Multicollinearity

Table 5.7: Correlation Matrix

	D(LN_ALBI_)	D(LN_ALSI_INDEX_)	D(LN_CPI_)	D(LN_GDP_)	D(LN_GOLDPRICE_)	D(LN_HOUSEPRICEINDEX_)	D(LN_LISTEDPROPINDEX_)	D(LN_RANDDOLLAREXCHANGE_)	D(LN_REPO_RATE_)	D(LN_SA__CAPFORM_)	D(LN_SA_BUSCONINDEX_)	D(LN_SA_GROSSSAVING_)	D(LN_SA_UNEMPLOY_)
D(LN_ALBI_)	1.00	-0.06	-0.03	0.03	-0.06	-0.02	0.52	-0.07	-0.07	0.01	0.07	-0.12	-0.03
D(LN_ALSI_INDEX_)	-0.06	1.00	-0.08	-0.03	-0.08	0.25	0.29	-0.31	-0.12	-0.10	0.09	0.02	0.06
D(LN_CPI_)	-0.03	-0.08	1.00	0.01	-0.04	-0.09	-0.15	-0.07	0.07	0.03	-0.13	0.09	0.31
D(LN_GDP_)	0.03	-0.03	0.01	1.00	0.10	0.12	-0.02	0.16	0.28	0.50	0.04	0.45	-0.20
D(LN_GOLDPRICE_)	-0.06	-0.08	-0.04	0.10	1.00	0.03	-0.24	0.28	0.10	0.15	-0.02	0.03	-0.13
D(LN_HOUSEPRICEINDEX_)	-0.02	0.25	-0.09	0.12	0.03	1.00	0.14	-0.03	0.15	0.15	0.07	-0.08	0.05
D(LN_LISTEDPROPINDEX_)	0.52	0.29	-0.15	-0.02	-0.24	0.14	1.00	-0.33	-0.13	0.00	0.19	-0.07	-0.01
D(LN_RANDDOLLAREXCHANGE_)	-0.07	-0.31	-0.07	0.16	0.28	-0.03	-0.33	1.00	0.22	0.32	-0.31	0.13	-0.14
D(LN_REPO_RATE_)	-0.07	-0.12	0.07	0.28	0.10	0.15	-0.13	0.22	1.00	0.43	0.03	0.03	-0.12
D(LN_SA__CAPFORM_)	0.01	-0.10	0.03	0.50	0.15	0.15	0.00	0.32	0.43	1.00	-0.09	0.24	-0.36
D(LN_SA_BUSCONINDEX_)	0.07	0.09	-0.13	0.04	-0.02	0.07	0.19	-0.31	0.03	-0.09	1.00	0.09	0.02
D(LN_SA_GROSSSAVING_)	-0.12	0.02	0.09	0.45	0.03	-0.08	-0.07	0.13	0.03	0.24	0.09	1.00	-0.21
D(LN_SA_UNEMPLOY_)	-0.03	0.06	0.31	-0.20	-0.13	0.05	-0.01	-0.14	-0.12	-0.36	0.02	-0.21	1.00

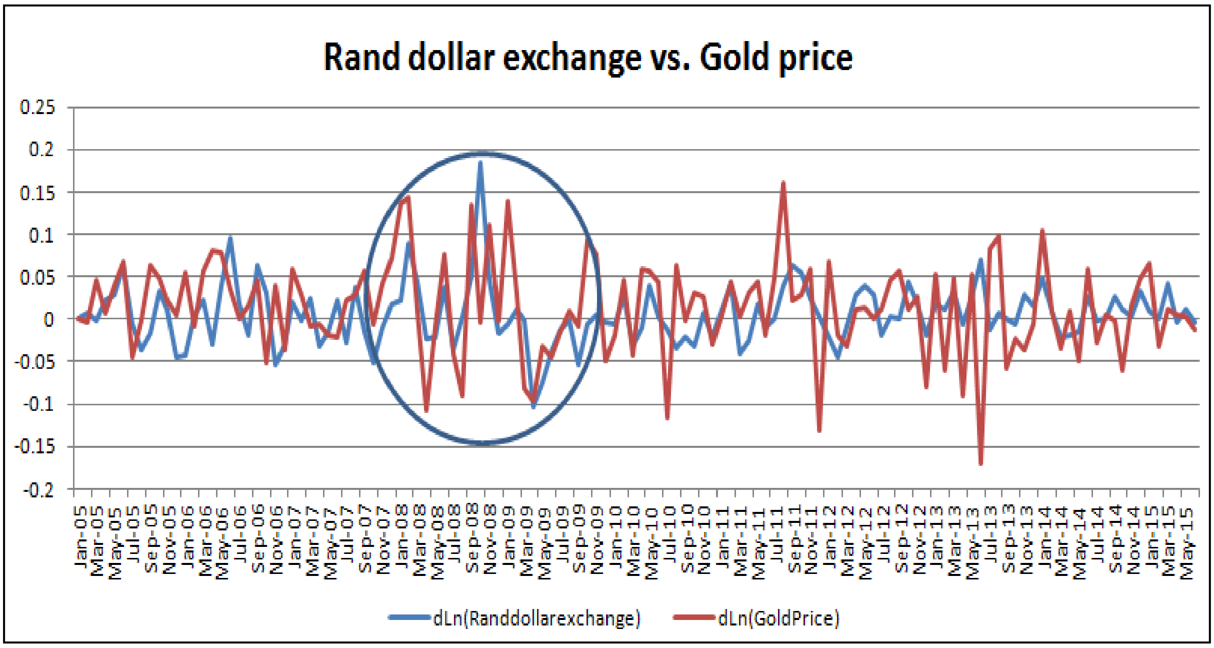
From the above correlation matrix it appears that the change in SA gross capital formation (D(LN_SA__CAPFORM_)), SA gross national saving rate (D(LN_SA_GROSSSAVING_)) and SA GDP (D(LN_GDP_)) are correlated to some extent (they exhibit correlation coefficients of more than 0.4). This means that national savings, gross capital formation and GDP growth take place at the same time.

The relationship between the change in gold price (D(LN_GOLDPRICE)) and the change in rand dollar exchange rate (D(LN_RANDDOLLAR_EXCHANGE_)) appears to be positive (with a coefficient of 0.28). This is due to a flexible exchange rate system; an increase in demand for gold globally increases the demand for the dollars (therefore demand for rand against the dollar drops), and results in the appreciation in the dollar against the rand.

Interestingly, the CPI (D(LN_CPI_)) appears to have a relationship with unemployment (D(LN_SA_UNEMPLOY_)), with a correlation coefficient of 0.31 – this can be as a result of the fact that high inflation is followed by interest rate increases (due to the South African reserve bank's inflation targeting policy). High interest rates make it expensive for employers to expand operations (as a result of higher cost of capital), which can result in lay-offs as well – unemployment increases as result.

In the other hand, the relationship between CPI inflation and unemployment could also be explained by the CPI inflation and salary increase relationship – which creates lay-offs due to employers minimizing costs (or constrains job creation).

Figure 5.3



It can also be seen in the above diagram that in the event that there's substantial movement in the exchange rate market the gold price reacts in a similar manner – therefore it makes sense for the two to be related – this explains the 0.28 correlation coefficient between the gold price and rand dollar exchange rate.

From the above findings, it is clear that no correlation between any two variables exceeds 0.5 (in absolute terms). Therefore, multicollinearity poses minimal risks to model integrity.

5.8 JSE-listed property models

5.8.1 JSE-listed property short-term models

In this section of the research an attempt is made to fit an econometric model for DLn(ListedPropIndex) (which are JSE-listed property index returns) - the model is based on differenced variables. The model description and output are presented below:

First JSE-listed property Short-term model:

$$dLn(LP_t)=-1.63*dLn(CPI_t)+1.25*dLn(ALBI_t)+0.23*dLn(ALSI_t)-0.79*dLn(GDP_t)-0.12*dLn(GP_t)+0.46*dLn(HP_t)-0.27*dLn(RD_t)-0.08*dLn(R_t)+0.73*dLn(CapF_t)+0.15*dLn(BusC_t)+0.06*dLn(GroS_t)+0.16*dLn(Unemp_t)+0.02...(a)$$

The above model has an R^2 of 0.48, which means the model explains 48% of the total variation of the JSE-listed property returns. The DW statistic is 2.18, which implies autocorrelation is being accounted for in the model. When one takes a closer look into the model, most of the independent variables have insignificant coefficients; however, the following independent variables were significant at 5% level (the output can be seen in appendix 1 a.):

- *JSE-all Bond Index returns*
- *JSE-all share index returns*
- *Gold price change*
- *Rand dollar exchange rate change*

Second JSE-listed property Short-term model: Output after excluding *South African Gross national savings* and *unemployment*

Appendix 1 b.) shows the results of the regression after excluding the following independent variables:

- *South African Gross national savings growth rate*
- *change in South African unemployment rate*

From the resulting model, it can be seen that excluding the above variables has not benefitted the R^2 (which is still 0.48) and overall regression model as the DW statistic remained at 2.18.

Third JSE-listed property Short-term model: Output of the "best" model

After several attempts, a regression model that minimizes the Schwarz criterion (also referred to as the Bayesian Information criterion (BIC)) was determined – the BIC is seen to be -3.57. This number is lower than that observed in first two short-term JSE-listed property models above. This indicates that the model (described below as equation (A)) makes a better attempt to minimising overall variance.

From the output in appendix 1 c.) it can be noted that the R^2 is 0.38, which means only 38% of the variation in JSE-listed property returns are explained by the model. The DW statistic (which is 2.21) shows that autocorrelation is being catered for in the model. In addition, all the independent variables included are significant. The equation of the model is presented below:

$$dLn(LP_t) = 0.021 - 1.66 * dLn(CPI_t) - 0.4 * dLn(RD_t) + 1.24 * dLn(ALBI_t) \ldots\ldots\ldots\ldots (A)$$

Where: $dLn(LP_t)$ = *JSE-listed property returns from time t-1 to t,* $dLn(CPI_t)$ = *CPI inflation from time t-1 to t,* $dLn(RD_t)$= *change in Rand dollar exchange rate from time t-1 to t,* $dLn(ALBI_t)$ = *listed bond index returns from time t-1 to t*

5.8.2 Using all subsets regression models to fit JSE-listed property short-term models

In reality, one needs to keep in mind that a regression model which has too few independent variables could lead to biased predictions (Derksen & Keselman, 1992). In the other hand, a regression model that has too many independent variables may have a high prediction variance – which is also not good. On the back of these facts, it therefore follows that either a backward or forward procedure should be used to derive the best regression models (Derksen & Keselman, 1992). Below are some of the techniques that can be adopted in order to select a subset of independent variables – for creating the best regression model:

- The *forward selection procedure*, which starts with a constant variable and adds (as it goes through the available independent variables) explanatory variables that result in a better fit (Derksen & Keselman, 1992).

- The *backward selection procedure* begins with all the available independent variables and at each step eliminates a variable that contributes the least to the overall fit of the regression model (Derksen & Keselman, 1992).
- The *stepwise selection procedure* is similar to a forward selection in that it starts with no explanatory variables, and at each step independent variables are added and removed. In the event that there are existing independent variables in the model, these are subjected to an F-test to assess if they are worth retaining in the model. Where there are no variables to be removed, then the procedure checks from the independent variables outside the model to see if these can be added – the variables a subjected to a tests that assess whether the overall predictive model improves as a result of adding the independent variable. When all the variables in the resultant model pass the test for remaining in the model and all other variables excluded from the model fail the test for being added the stepwise procedure stops (Derksen & Keselman, 1992).

In this paper the *stepwise selection procedure* was used in Eviews to derive the best predictive model from the set of available independent variables. Correlograms were used (as models were fitted) to assess if the models had unexpected autocorrelations (and partial autocorrelations) – this helps to inform the researcher as to whether AR and MA terms should be included into the model to remove autocorrelations (which brings the Durbin-Watson (DW) statistic closer to 2). This also improves the model's predictive ability.

The results (for the short-term relationships) from the stepwise procedures are displayed in the sections that follow – the same techniques will also be used to determine the JSE- all share index models.

5.8.2.1 First stepwise short-term model for JSE-listed property returns

Appendix 1 d.) shows that all independent variables used were significant at the 5% level. The R^2 (which is 0.63) is significantly higher when compared to the results in first three models above. This means that the model (in appendix 1 d.)) explains 63% of the total variation in JSE-listed property returns. The equation of the resulting model is outlined below:

$$dLn(LP_t) = -0.44*AR(5)+0.94*MA(5)_t + 2.4*dLn(GDP'_t) + 0.54*dLn(ALBI_{t-2}) + 0.22*dLn(R_{t-3}) - 0.16*dLn(GP_{t-3}) + 0.33*dLn(ALSI_t) - 0.25*dLn(GP_t) - 1.45*dLn(CPI_{t-3}) + 1.33*dLn(ALBI_t) ....(B)$$

Where: $dLn(LP_t)$ = *JSE-listed property returns at time t,* $dLn(GDP'_t)$ = *% GDP trend change at time t ,* $dLn(ALBI_{t-2})$ = *change in all bond index from time t-3 to t-2,* $dLn(ALBI_t)$ = *All bond index returns from time t-1 to t,* $dLn(R_{t-3})$ = *change in repo rate from time t-4 to t-3,* $dLn(GP_t)$= *% change in gold price from time t-1 to t,* $dLn(ALSI_t)$ = *JSE-all share index returns from time t-1 to t,* $dLn(CPI_{t-3})$ = *change in CPI index from time t-4 to t-3,* **AR(5)** = *autoregressive term of order 5,* **MA(5)** = *moving average for the 5 months prior to time t,* $dLn(GP_{t-3})$ = *change in gold price from time t-4 to t-3,* $dLn(ALBI_{t-2})$ = *All bond index returns from time t-3 to t-2*

In the following table, the correlogram indicates a minor presence of autocorrelation and partial autocorrelation in the first 2 lags after fitting the above model.

Date: 09/07/15 Time: 23:53
Sample: 2005M01 2014M06
Included observations: 105
Q-statistic probabilities adjusted for 2 ARMA terms and 8 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.291	-0.291	9.1510	
		2	-0.158	-0.265	11.880	
		3	0.190	0.064	15.851	0.000
		4	-0.191	-0.170	19.899	0.000
		5	-0.006	-0.080	19.903	0.000
		6	0.056	-0.062	20.258	0.000

*Probabilities may not be valid for this equation specification.

The above correlogram shows that none of the lag ACs and PACs are higher than the cut-off of 0.2 (the cut off is 2/(N)^0.5 = 0.2, where N = 105 observations used by the above model) – this means lag ACs and PACs are not affecting the overall fit of the model.

5.8.2.2 Second stepwise short-term model for JSE-listed property returns

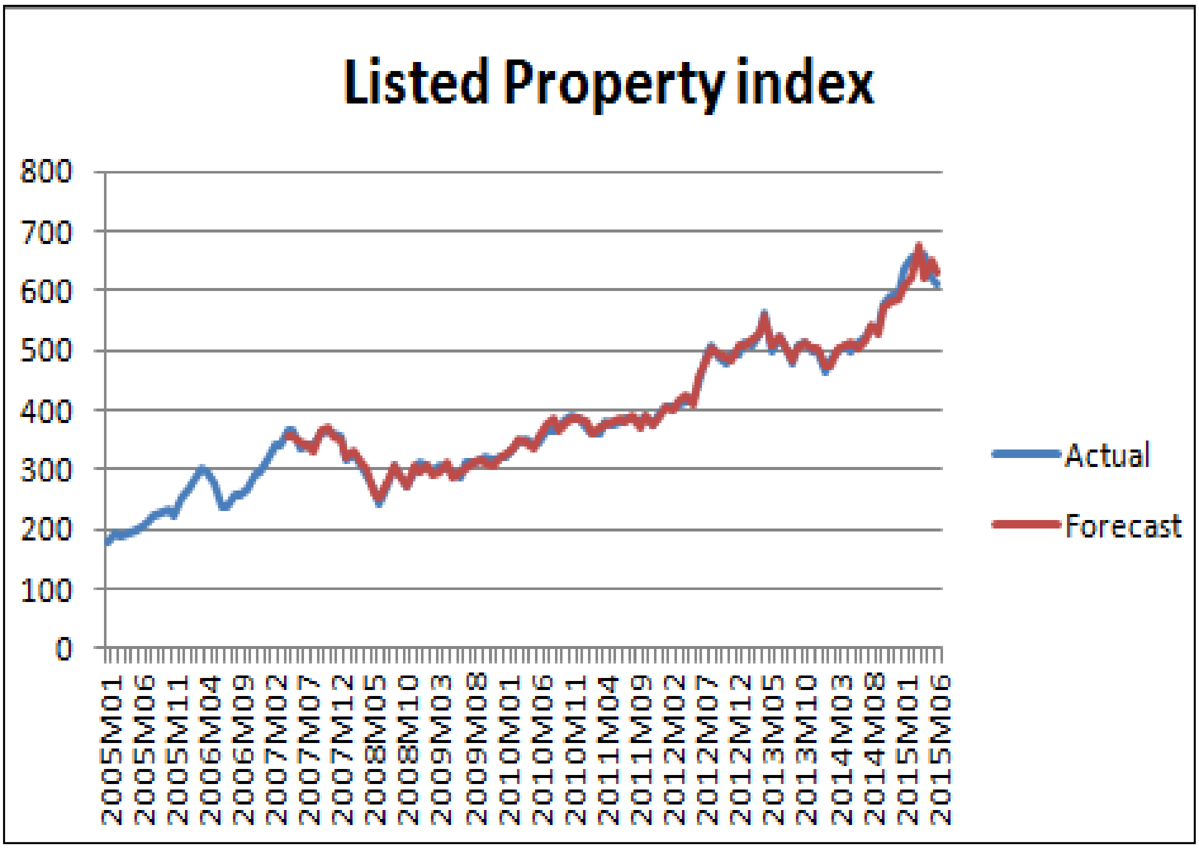
For the second stepwise result the R^2 is increased (at 0.82), which means 82% of JSE-listed property returns are explained by the model (the model output can be seen in appendix 2.). All independent variables are significant at a 5% level. The DW statistic is 2.52, very similar to the first stepwise result above .The correlogram which can be seen appendix 2, shows that majority of the PACs and ACs are less than 0.21 (where the cut off is 2/(N)^0.5 = 0.21, where N = 87 observations are used by the above model from the collected history) – only the first lag seems to be concerning. The equation of the model (derived from the 2nd stepwise procedure) is as follows:

$dLn(LP_t) = 0.195*AR(24)_t - 0.92*MA(24)_t + 1.6*dLn(GDP'_t) + 0.095*dLn(GP_{t-2}) - 0.26*dLn(GP_t) + 1.41*dLn(ALBI_t)$.....(C)

Where: ***$dLn(LP_t)$*** = *JSE-listed property returns at time t,* ***$dLn(GDP'_t)$*** *= % change in GDP trend from time t-1 to t,* ***$dLn(ALBI_t)$*** *= All bond index returns from time t-1 to t,* ***$dLn(GP_{t-2})$*** *= % change in gold price from t-3 to t-2,* ***$AR(24)_t$*** *= autoregressive term of order 24 at time t,* ***$MA(24)_t$*** *= moving average for the last 24 months prior to time t,* ***$dLn(GP_t)$*** *= % change in gold price from t-1 to t*

The graph below shows how well the model (in appendix 2) is able to predict future JSE-listed property indices. (Note, the model was trained on data from the period Jan 2005 to Jun 2014, but forecasted for the period Jul 2014 to Jun 2015).

Figure 5.4: The forecast below uses a static approach (it relies on past estimated values).



5.8.2.3 Third stepwise short-term model for JSE-listed property returns

The resulting model (from the 3rd stepwise procedure) has an R^2 of 0.87, which means the model explains 87% of the variation in JSE-listed property returns. The researcher added the CPI (lagged by 10 months) and constant terms as adjustments to the 2nd stepwise result to arrive at the 3rd result described below (by equation D). This reduced the DW statistic to 2.42, which is lower than the 2.52 observed in the 2nd result above. The correlogram in the appendix 4 shows that all the PACs and ACs are less than 0.23 (where the cut off is 2/(N)^0.5 = 0.23, and N=79, which is the sample size used to determine the 3rd stepwise model) – which means the model fit is now tighter.

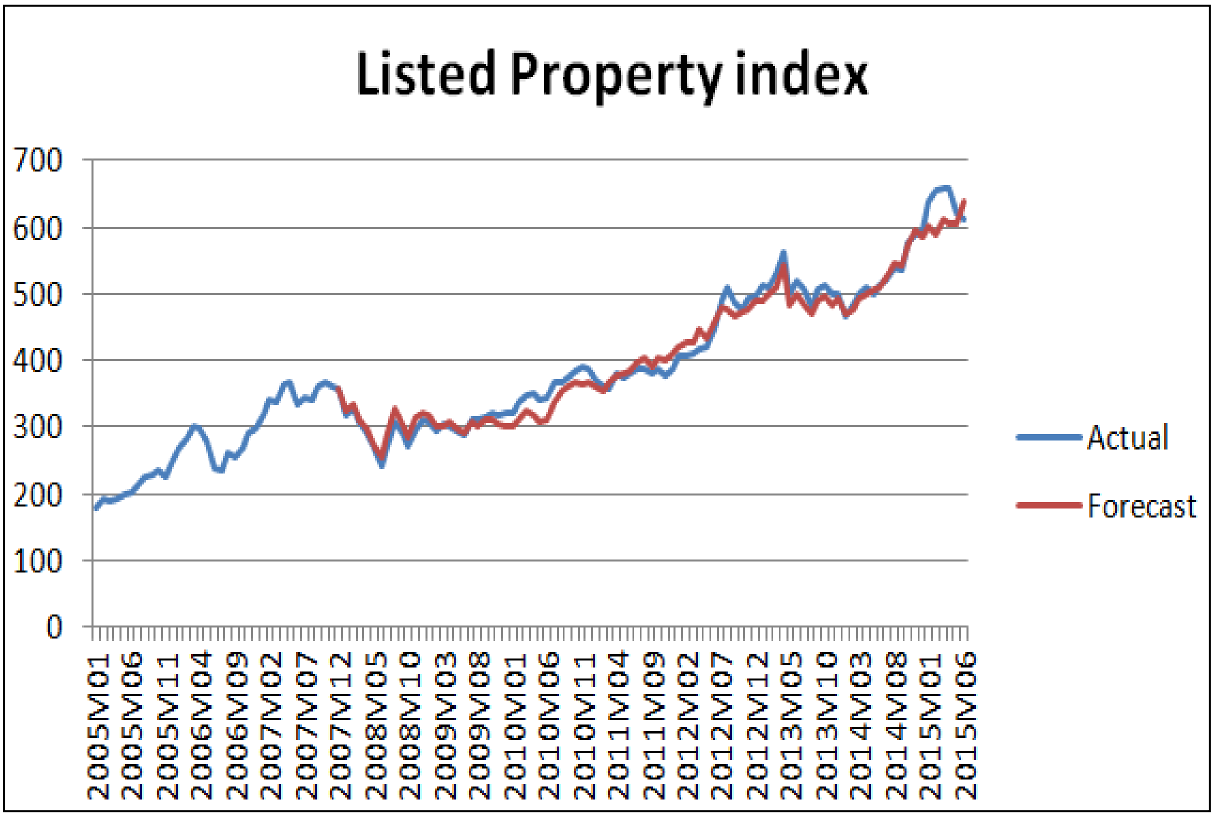
The equation of the model is as follows:

$$dLn(LP_t) = 0.201*AR(24)_t - 0.913*MA(24)_t - 1.796*dLn(CPI_{t-10}) - 8.17*dLn(GDP'_{t-10}) + 0.127*dLn(GP_{t-5}) - 0.228*dLn(GP_t) + 1.374*dLn(ALBI_t) + C........(D)$$

Where: $dLn(LP_t)$ = *JSE-listed property returns from time t-1 to t,* $dLn(GDP'_{t-10})$ = *% change in GDP trend from time t-11 to t-10 ,* $dLn(ALBI_t)$ = *All bond index returns for from t-1 to t,* $dLn(GP_t)$ = *% change in gold price from time t-1 to t,* $AR(24)_t$ = *autoregressive term of order 24 at time t,* $MA(24)_t$ = *moving average term of order 24 at time t,* $dLn(CPI_{t-10})$ = *% change in the CPI from times t-11 to t-10,* **C** = *constant,* $dLn(GP_{t-5})$ = % *change in the gold price from time t-6 to t-5.*

The graph below shows the predictive ability of the model outlined by equation D above in relation to the JSE-listed property index. (Note, the model was trained on data from the period Jan 2005 to Jun 2014, but forecasted for the period Jul 2014 to Jun 2015).

Figure 5.5: The forecast below uses a static approach (it relies on past estimated values).



5.8.2.4 Fourth stepwise short-term model for JSE-listed property returns

Table 5.8: *Stepwise procedure* 4th result (excludes GDP growth trend)

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/09/15 Time: 06:09				
Sample (adjusted): 2007M12 2014M06				
Included observations: 79 after adjustments				
Convergence achieved after 11 iterations				
MA Backcast: 2005M12 2007M11				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-10))	-1.99	0.59	-3.38	0.001
D(LN_GOLDPRICE_(-5))	0.13	0.04	3.31	0.001
D(LN_GOLDPRICE_)	-0.23	0.04	-5.75	0.000
D(LN_ALBI_)	1.42	0.15	9.67	0.000
C	0.02	0.00	5.46	0.000
AR(24)	0.19	0.07	2.86	0.006
MA(24)	-0.92	0.02	-59.86	0.000
R-squared	0.86	Mean dependent var		0.00
Adjusted R-squared	0.85	S.D. dependent var		0.05
S.E. of regression	0.02	Akaike info criterion		-5.12
Sum squared resid	0.02	Schwarz criterion		-4.91
Log likelihood	209.33	Hannan-Quinn criter.		-5.04
F-statistic	76.76	Durbin-Watson stat		2.38
Prob(F-statistic)	0.00			

The 4th stepwise procedure produced the results in the table above. The results show that after excluding the GDP growth trend variable from the model produced by the 3rd stepwise procedure, autocorrelation was reduced (the DW statistic dropped from 2.42 to 2.38). Moreover, all independent variable were highly significant at a 5% level; the correlogram (in appendix 6) shows that none of the lag terms showed PAC and AC factors higher than the cut off of 0.23. This indicates that the model's risk of autocorrelation is almost none existent.

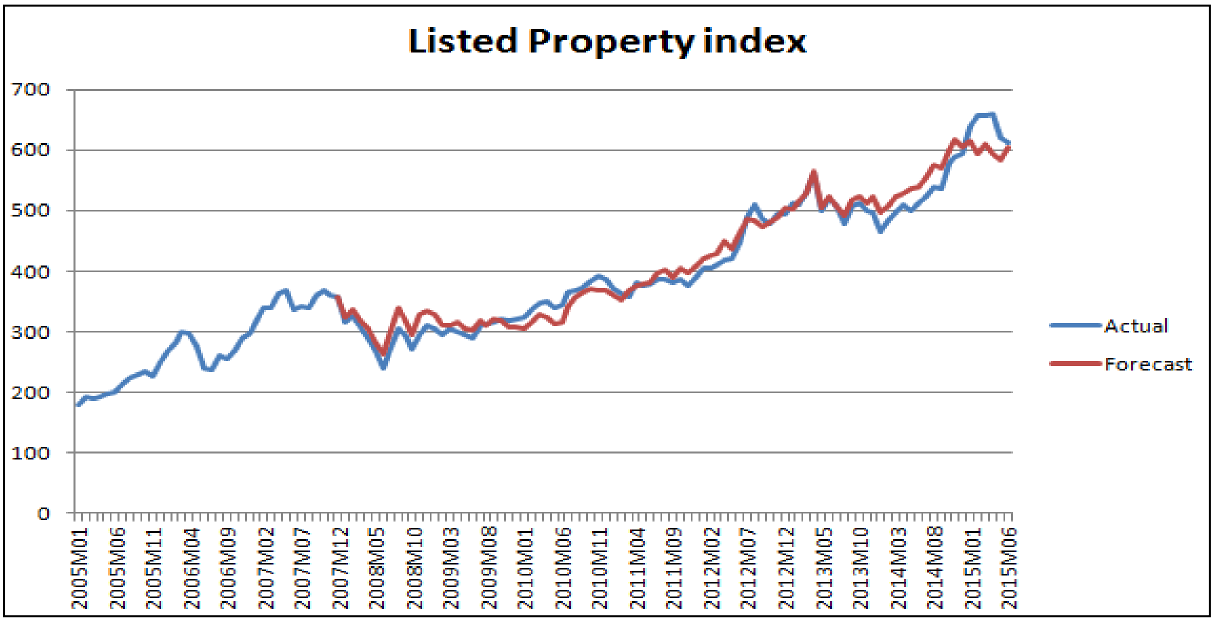
The formula for the model is outline below:

$dLn(LP_t)$ = 0.19*AR(24)- 0.92*MA(24) – 1.99*$dLn(CPI_{t-10})$ + 0.13*$dLn(GP_{t-5})$ - 0.228*$dLn(GP_t)$ + 1.42*$dLn(ALBI_t)$ + C.......(E)

Where: ***$dLn(LP_t)$*** = *JSE-listed property returns at time t,* ***$dLn(ALBI_t)$*** = *All bond index returns at time t,* ***$dLn(GP_{t-5})$* = %** *change in the gold price for the month starting at time t-6 to time t-5,* ***$AR(24)_t$*** = *autoregressive term of order 24 at time t,* ***$MA(24)_t$*** = *moving average for the 24 months prior to time t,* ***$dLn(CPI_{t-10})$*** = *% change in the CPI for the month starting at time t-11 to t-10,* ***C*** = *constant,* ***$dLn(GP_t)$*** **= %** *change in the gold price for the month starting at time t-1 to time t*

The graph in figure 5.6 below shows the predictive ability of the model in table 5.8 above in relation the JSE-listed property index. (Note, the model was trained on data from the period Jan 2005 to Jun 2014, but forecasted for the period Jul 2014 to Jun 2015).

Figure 5.6: The forecast below uses a static approach (it relies on past estimated values).



5.8.2.5 Fifth stepwise short-term model for JSE-listed property returns

Table 5.9: The 5th *Stepwise procedure* result (includes the JSE-all share index and rand dollar exchange rate variables) – the model is based on Jan 2005 to May 2015 data.

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/16/15 Time: 06:19				
Sample (adjusted): 2007M08 2014M06				
Included observations: 83 after adjustments				
Convergence achieved after 11 iterations				
MA Backcast: 2005M08 2007M07				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-5))	-2.27	0.78	-2.92	0.00
D(LN_RANDDOLLAREXCHANGE_(-6))	-0.22	0.09	-2.43	0.02
D(LN_ALSI_INDEX_(-4))	0.19	0.07	2.57	0.01
D(LN_GOLDPRICE_(-5))	0.12	0.05	2.56	0.01
D(LN_ALBI_)	1.41	0.17	8.44	0.00
C	0.02	0.00	3.50	0.00
AR(24)	0.30	0.07	4.10	0.00
MA(24)	-0.91	0.02	-53.80	0.00
R-squared	0.82	Mean dependent var		0.00
Adjusted R-squared	0.80	S.D. dependent var		0.05
S.E. of regression	0.02	Akaike info criterion		-4.83
Sum squared resid	0.03	Schwarz criterion		-4.60
Log likelihood	208.52	Hannan-Quinn criter.		-4.74
F-statistic	47.89	Durbin-Watson stat		2.30
Prob(F-statistic)	0.00			

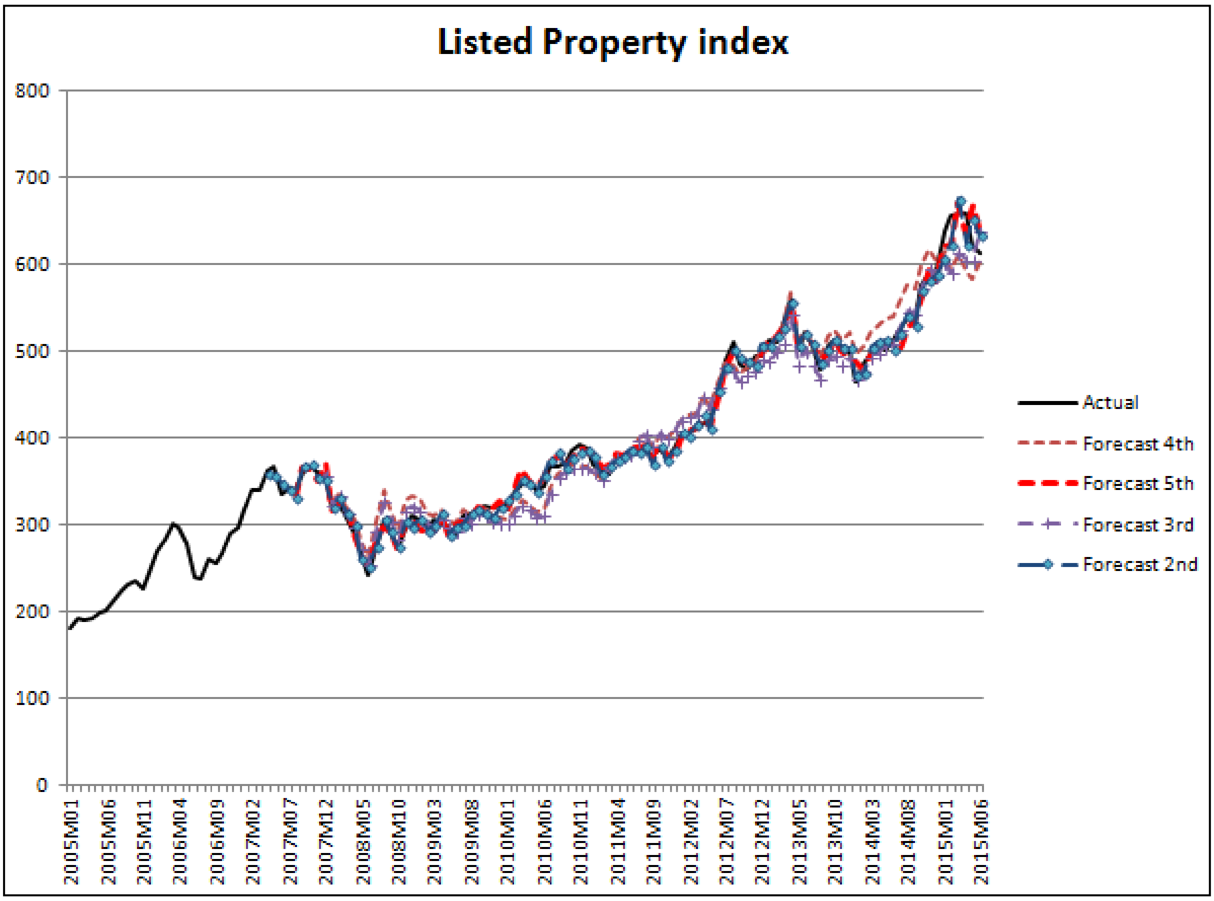
The above model output has the following equation:

$$dLn(LP_t) = -2.27*dLn(CPI_{t-5}) + 0.19*dLn(ALSI_{t-4}) - 0.22*dLn(RD_{t-6}) + 1.41*dLn(ALBI_t) + 0.30*AR(24)_t - 0.91*MA(24) + C........(F)$$

Where: $dLn(LP_t)$ = *JSE-listed property returns at time t,* $dLn(ALBI_t)$ = *% change in All bond index from t to t-2,* $dLn(ALSI_{t-4})$ = *% change in the JSE-all share index from time t-5 to t-4,* $AR(24)_t$ = *autoregressive term of order 24 at time t,* $MA(24)_t$ = *moving average for the 24 month period to time t,* $dLn(CPI_{t-5})$ = *% change in the CPI from time t-6 to t-5,* $dLn(RD_{t-6})$ = *% change in the RD from time t-7 to t-6,* **C** = *constant*

From equation (F) above it is clear that JSE-listed property returns are delayed by 5 months (when CPI changes). The relationship is such that when CPI changes by 1% it translates into a 2.27% change in the JSE-listed property index. Moreover, factors such as the rand dollar exchange rate and the all share index appear to play a significant role in explaining the short-term changes in JSE-listed property returns.

Figure 5.7: The forecast below uses a static approach (it relies on past estimated values).



From the above graph it is clear that the 2nd model has a good predictive ability and fits the 2005 – 2014 period adequately, however, it is not a function of CPI inflation. The 3rd model underestimates the 2010 and 2015 periods while overestimating most of 2012. The 4th model appears to overestimate 2013 to 2014 period; it also underestimates the 2010 and 2015 periods (which is similar to the 3rd model underestimation).

The 5th model has superior (which is depicted by the 5th forecast in the above diagram) forecasting ability than the 4th model – the underestimation in 2015 is minimized and the forecasts seem to exhibit the same tempo as the actual JSE-listed property index. Moreover, the movement of the 5th model seems to be similar to that of the underlying JSE-listed property index for the period from Aug 2007 to Jun 2014 and is a function of CPI inflation.

5.9 JSE-listed property index long-term models

In this section of the paper the researcher will spend time determining the long-term relation between the JSE-listed property index returns and the universe of independent variables (CPI inflation, gold price and JSE-listed bond index returns in this case) collected for the study. The independent variables were determined through a stepwise variable selection procedure.

The JSE-listed property long-term models are outlined in the sections that follow.

5.9.1 First JSE-listed property long-term model

Equation 1: ***$Ln(LP_t)$=2.91*$Ln(GDP'_t)$ - 0.2*$Ln(CPI_t)$ + 1.21*$Ln(ALBI_t)$ - 2.79*$Ln(GP_t)$ + 0.22*$Ln(ALSI_t)$ +0.28*$Ln(RD_t)$+C........(G)***

LP_t = *JSE-listed property index at time t,* ***$ALBI_t$*** = *JSE-all bond index at time t,* ***GP_t=*** *the gold price at time t, at time t,* ***CPI_t*** = *the CPI at time t,* ***$ALSI_t$*** = *JSE-all share index at time t,* ***RD_t*** = *Rand dollar exchange at time t,* ***GDP'_t =*** *gdp trend at time t ,**C** = constant*

Table 5.10:

Dependent Variable: LN_LISTEDPROPINDEX_				
Method: Least Squares				
Date: 09/12/15 Time: 06:12				
Sample: 2005M01 2015M06				
Included observations: 126				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_GDP_TREND_	2.91	0.31	9.24	-
LN_GOLDPRICE_	-0.20	0.05	-3.81	0.0002
LN_ALBI_	1.21	0.13	9.07	-
LN_CPI_	-2.79	0.43	-6.51	-
LN_ALSITREND_	0.22	0.03	6.97	-
LN_RANDDOLLARTREND_	0.28	0.08	3.61	0.0005
C	-32.01	2.52	-12.68	-
R-squared	0.96	Mean dependent var		5.89
Adjusted R-squared	0.96	S.D. dependent var		0.31
S.E. of regression	0.06	Akaike info criterion		-2.77
Sum squared resid	0.41	Schwarz criterion		-2.62
Log likelihood	181.74	Hannan-Quinn criter.		-2.71
F-statistic	542.73	Durbin-Watson stat		0.51
Prob(F-statistic)	-			

In table 5.10 above, it can be seen that the R^2 is 0.96, which implies that the model is able to explain 96% of the long-term movements of the JSE-listed property index. The above model suggests that a 1% change in the GDP trend creates 2.91% change in the JSE-listed property index; 1% change in gold price creates a -0.2%

change in the JSE-listed property index, while a 1% change in CPI translates to a -2.79% change in the JSE-listed property index (just to mention a few variables).

The Hansen instability test suggests that the series is not cointegrated (meaning that the GDP trend, gold price, ALBI, CPI, ALSI trend and rand dollar exchange rate do not necessarily drift with the JSE-listed property index) - the output depicts the findings. Moreover, the Engle and Granger test in appendix 8 shows the same results as well. In both tests equation (G) above fails the parameter stability test.

Table: 5.11: Hansen Instability test output for equation (G)

Cointegration Test - Hansen Parameter Instability				
Date: 09/12/15 Time: 20:26				
Equation: COINTEQTEST				
Series: LN_LISTEDPROPINDEX_ LN_GDP_TREND_ LN_GOLDPRICE_				
LN_ALBI_ LN_CPI_ LN_ALSITREND_ LN_RANDDOLLARTREND_				
Null hypothesis: Series are cointegrated				
Cointegrating equation deterministics: C				
	Stochastic	Deterministic	Excluded	
Lc statistic	Trends (m)	Trends (k)	Trends (p2)	Prob.*
2.303913	6	0	0	< 0.01
*Hansen (1992b) Lc(m2=4, k=0) p-values, where m2=m-p2 is the number				
of stochastic trends in the asymptotic distribution				
*Hansen (1992b) Lc(m2=4, k=0) p-values, where m2=m-p2 is the number				
of stochastic trends in the asymptotic distributionWarning: there are				
6stochastic trends in the asymptotic distribution. The reported p				
-values are approximations using results for four stochastic trends				

5.9.2 Second JSE-listed property long-term model

Equation 2: $Ln(LP_t)= 0.65*Ln(CPI_t)+0.14*Ln(GP_t)+0.57*Ln(RD_t)+C$.........**(H)**

LP_t = *JSE-listed property index at time t,* GP_t= *the gold price at time t, at time t,* CPI_t = *the CPI at time t,* RD_t = *Rand dollar exchange at time t,* **C** = *constant*

Table 5.12: Output for equation (H) above

Dependent Variable: LN_LISTEDPROPINDEX_				
Method: Least Squares				
Date: 09/12/15 Time: 06:55				
Sample: 2005M01 2015M06				
Included observations: 126				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_CPI_	0.6484	0.3148	2.0598	0.0415
LN_RANDDOLLARTREND_	0.5674	0.1383	4.1025	0.0001
LN_GOLDPRICE_	0.1389	0.0872	1.5929	0.1138
C	0.5712	0.5019	1.1381	0.2573
R-squared	0.844	Mean dependent var		5.893
Adjusted R-squared	0.840	S.D. dependent var		0.306
S.E. of regression	0.122	Akaike info criterion		-1.334
Sum squared resid	1.823	Schwarz criterion		-1.244
Log likelihood	88.062	Hannan-Quinn criter.		-1.298
F-statistic	220.080	Durbin-Watson stat		0.182
Prob(F-statistic)	-			

The results in table 5.12 above show that equation (H) explains 0.84 of the JSE-listed property index long-term movements. The gold price appears to lack significance in the above model, however, the rest of the variables seem to be significant at the 5% level.

The model explained by equation (H) above, suggests that for every 1% change in the CPI the JSE-listed property index responds by 0.65%; a 1% change in rand dollar exchange rate translate to a 0.57% change in the JSE-listed property index, meanwhile a 1% move in the gold price creates 0.139% move in the JSE-listed property index (assuming that only one variable changes at a time).

Below is a table that shows the Hansen instability test results – it can be seen that equation (H) also fails the test due to the instability of parameters. The Engle and Granger test (in appendix 10) also fails to reject the null hypothesis (which suggests that the weighted combination of CPI, rand dollar exchange rate and the gold price do not drift with the JSE-listed property index).

Table 5.13: Hansen Instability test (Equation (H))

Cointegration Test - Hansen Parameter Instability				
Date: 09/12/15 Time: 22:16				
Equation: COINTEQ4				
Series: LN_LISTEDPROPINDEX_ LN_CPI_ LN_RANDDOLLARTREND_				
LN_GOLDPRICE_				
Null hypothesis: Series are cointegrated				
Cointegrating equation deterministics: C				
	Stochastic	Determinis	Excluded	
Lc statistic	Trends (m)	Trends (k)	Trends (p2)	Prob.*
1.575032707	3	0	0	< 0.01
*Hansen (1992b) Lc(m2=3, k=0) p-values, where m2=m-p2 is the number of stochastic trends in the asymptotic distribution				

5.9.3 Third JSE-listed property long-term model

Equation 3: $Ln(LP_t) = 1.11*Ln(CPI_t) + 0.47*Ln(RD_t) + C$........(I)

LP_t = *JSE-listed property index at time t,* ***CPI_t*** = *the CPI at time t,* ***RD_t*** = *Rand dollar exchange at time t,*

C = *constant*

Table 5.14: Output for equation (I)

Dependent Variable: LN_LISTEDPROPINDEX_				
Method: Least Squares				
Date: 09/12/15 Time: 06:49				
Sample: 2005M01 2015M06				
Included observations: 126				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_CPI_	1.11	0.12	9.57	-
LN_RANDDOLLARTREND_	0.47	0.12	3.77	0.00
C	-0.04	0.32	-0.13	0.89
R-squared	0.84	Mean dependent var		5.89
Adjusted R-squared	0.84	S.D. dependent var		0.31
S.E. of regression	0.12	Akaike info criterion		-1.33
Sum squared resid	1.86	Schwarz criterion		-1.26
Log likelihood	86.77	Hannan-Quinn criter.		-1.30
F-statistic	324.79	Durbin-Watson stat		0.16
Prob(F-statistic)	0			

The results in table 5.14 above show that removing the gold price variables does not change the R^2 (which still remains at 0.84) – the model still explains 84% of the total variation in the JSE-listed property index. Moreover, it can be seen that a 1% change in CPI creates a 1.11% change in the JSE-listed property index. Similarly, a 1%

change in the rand dollar exchange translates into a 0.47% change in the JSE-listed property index. Unlike in equation (H), all variables in equation (I) are highly significant at the 5% level.

Below the Hansen parameter instability test shows that the cointegration equation (equation (I) above) is border line stable – the test still rejects the null hypothesis of cointegration at the 5% level. This suggests that the JSE-listed property index does not drift with the combination of CPI and the rand dollar exchange rate (the parameters are unstable, and therefore cointegration can't exist).

The Engle and Granger test (in appendix 12) also shows that the JSE-listed property index does not drift with the combination of CPI and rand dollar exchange rate.

Table 5.15: Hansen Instability test (Equation (I))

Cointegration Test - Hansen Parameter Instability				
Date: 09/12/15 Time: 22:19				
Equation: COINTEQ4				
Series: LN_LISTEDPROPINDEX_ LN_CPI_ LN_RANDDOLLARTREND_				
Null hypothesis: Series are cointegrated				
Cointegrating equation deterministics: C				
	Stochastic	Determinis	Excluded	
Lc statistic	Trends (m)	Trends (k)	Trends (p2)	Prob.*
0.50	2.00	-	-	0.0449
*Hansen (1992b) Lc(m2=2, k=0) p-values, where m2=m-p2 is the number				
of stochastic trends in the asymptotic distribution				

5.9.4 Fourth JSE-listed property long-term model

Equation 4: $Ln(LP_t) = 1.46*Ln(CPI_t) + C$.......... ***(J)***

LP_t = *JSE-listed property index at time t,* CPI_t = *the CPI at time t,* **C** = *constant*

Table 5.16: Output for equation (J)

Dependent Variable: LN_LISTEDPROPINDEX_				
Method: Dynamic Least Squares (DOLS)				
Date: 09/12/15 Time: 06:23				
Sample (adjusted): 2005M03 2015M05				
Included observations: 123 after adjustments				
Cointegrating equation deterministics: C				
Fixed leads and lags specification (lead=1, lag=1)				
Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_CPI_	1.46	0.13	11.16	-
C	-0.63	0.59	-1.08	0.28
R-squared	0.81	Mean dependent var		5.90
Adjusted R-squared	0.81	S.D. dependent var		0.29
S.E. of regression	0.13	Sum squared resid		1.95
Durbin-Watson stat	0.18	Long-run variance		0.07

The above table shows that the CPI alone is able to explain 81% of the total long-term variation of the JSE-listed property index – the R^2 is 0.81. Furthermore, a 1% change in the CPI translates into a 1.46% change in the JSE-listed property index.

The Hansen instability test results (in the table 5.17 below) suggest that there is cointegration between the JSE-listed property index and the CPI (the variables move closely together over time).

Table 5.17: Hansen Instability test (Equation (J))

Cointegration Test - Hansen Parameter Instability				
Date: 09/12/15 Time: 06:22				
Equation: COINTEQ02				
Series: LN_LISTEDPROPINDEX_ LN_CPI_				
Null hypothesis: Series are cointegrated				
Cointegrating equation deterministics: C				
	Stochastic	Deterministic	Excluded	
Lc statistic	Trends (m)	Trends (k)	Trends (p2)	Prob.*
0.003851	1	0	0	> 0.2
*Hansen (1992b) Lc(m2=1, k=0) p-values, where m2=m-p2 is the number of stochastic trends in the asymptotic distribution				

5.9.5 Rate cycle effects on the JSE-listed property index short-term models

In this section of the paper, the researcher demonstrates the effects of a changing repo rate cycle on the relationship between the JSE-listed property index returns and CPI inflation. For the period of investigation, the repo rate cutting cycle started from

Jan 2009 to Jul 2012; while in the other hand, the hiking cycle was from Apr 2005 to Dec 2008.

5.9.5.1 Repo cutting cycle effect on the JSE-listed property short-term relationship with CPI

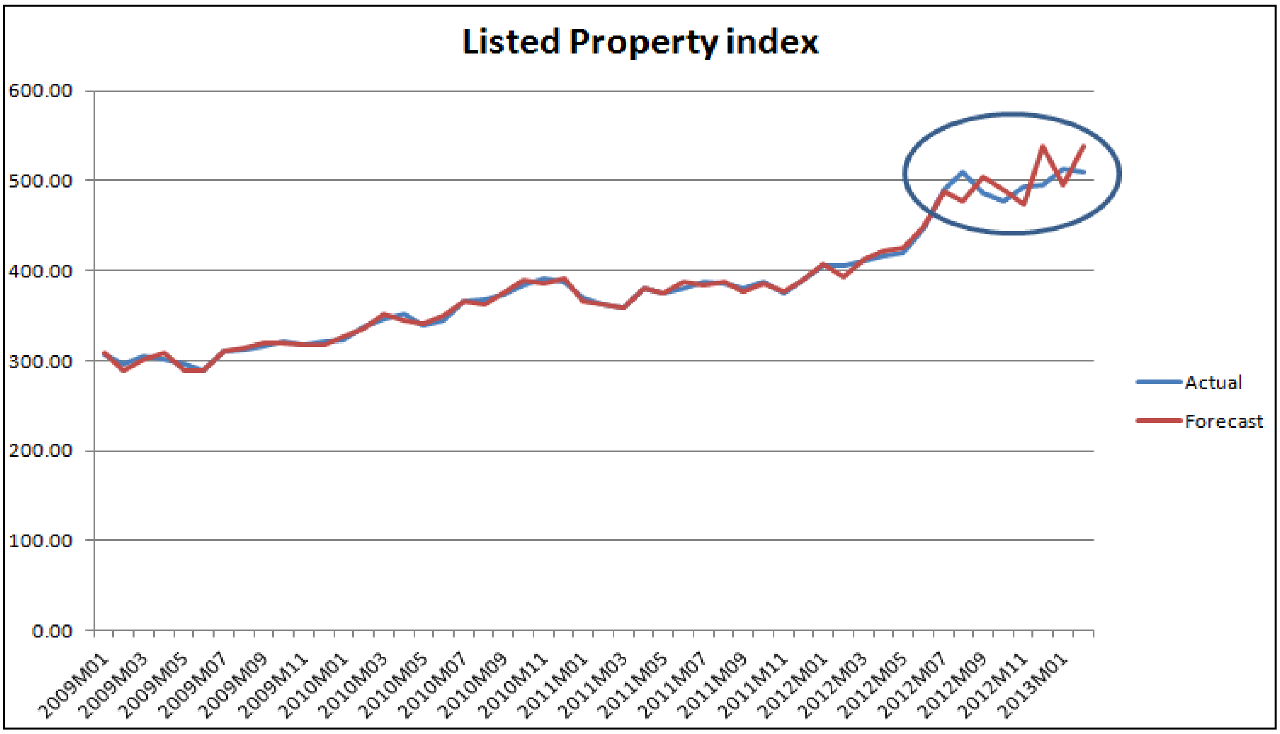
For the period starting on Jan 2009 to Jul 2012, the equation below describes the relationship between CPI inflation and the JSE-listed property index returns:

$$dLn(LP_t) = -2.02*dLn(CPI_{t-1}) - 0.43*dLn(GP_t) - 0.24*dLn(GP_{t-4}) + 1.03*dLn(ALBI_t) -0.60*AR(24) - 0.96*MA(24)+c..........(K)$$

Where: $dLn(LP_t)$ = *change in JSE-listed property index from time t-1 to t,* $dLn(CPI_{t-1})$ = *change in the CPI from time t-2 to t-1,* $dLn(GP_{t-4})$ = *change in gold price from time t-5 to t-4,* $dLn(ALBI_t)$ = *change in all bond index from time t-1 to t,* **AR(24)** = *autogressive term of order 24,* **MA(24)** = *moving average term of order 24,* $dLn(GP_t)$ = *change in gold price from time t-1 to t*

Figure 5.8 below shows the predictive ability of the model in relation to the actual JSE-listed property index:

Figure 5.8



The above diagram shows that the model is able to predict the movements of the JSE-listed property index during the rate cutting period, but fails to forecast accurately from Aug 2012 onwards (the area in the circle) due to the period being out of the repo cutting cycle. The model has the ability to explain 89% of the total monthly movement in the JSE-listed property index – the R-squared is observed to be 0.89 in the appendix 16. Also, a 1% change in CPI results in a -2% change in the JSE-listed property index – the change in JSE-listed property index is delayed by 1 month; the DW statistic is 2.2 (which can be seen in appendix 16) – this suggests that the negative autocorrelation is minimal.

5.9.5.2 Repo hiking cycle effect on the JSE-listed property short-term relationship with CPI

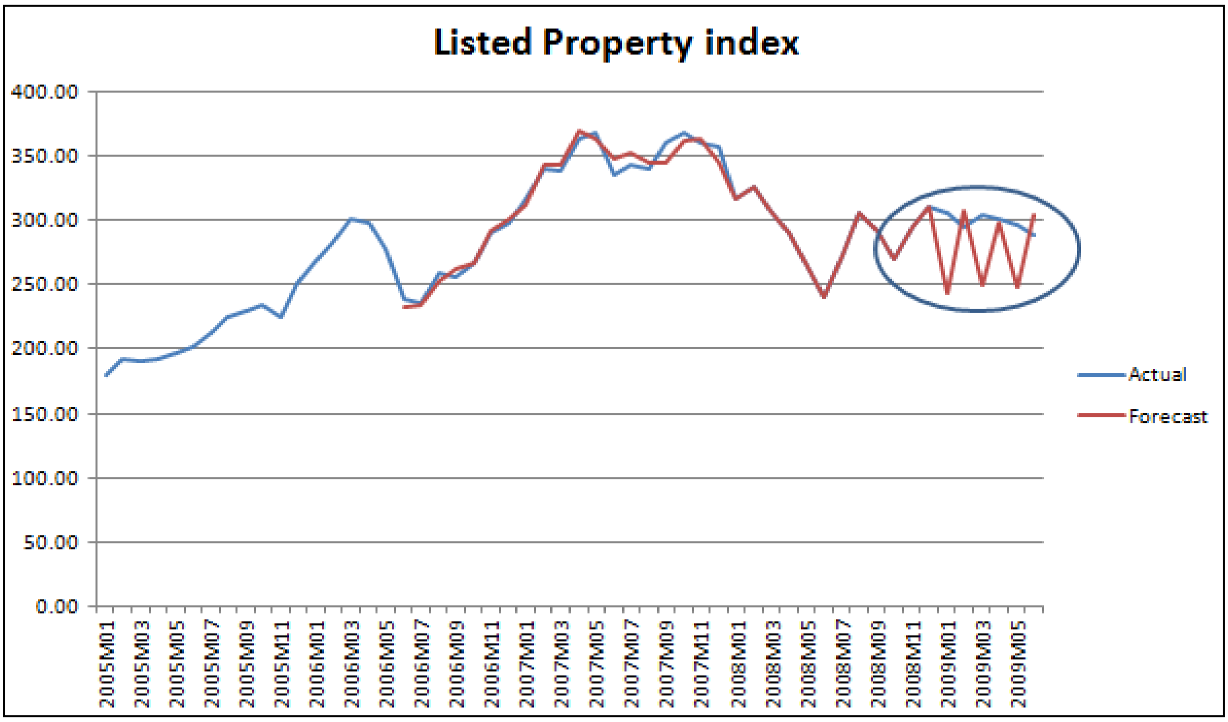
The period starting from Apr 2005 to Dec 2008 suggests that the relationship between the JSE-listed property index returns and CPI inflation is as follows:

$$dLn(LP_t) = 8.9*dLn(CPI_{t-4}) - 0.15*dLn(GP_t) - 1.37*dLn(GP_{t-4}) - 1.33*dLn(ALBI_{t-1}) - 0.24*AR(12) - MA(12)+c.........(L)$$

Where: $dLn(LP_t)$ = *change in JSE-listed property index from time t-1 to t*, $dLn(CPI_{t-4})$ = *change in the CPI from time t-5 to t-4*, $dLn(GP_{t-4})$ = *change in gold price from time t-5 to t-4*, $dLn(ALBI_{t-1})$ = *change in all bond index from time t-2 to t-1*, **AR(12)** = *autogressive term of order 12*, **MA(12)** = *moving average term of order 12*, $dLn(GP_t)$ = *change in gold price from time t-1 to t*

Figure 5.9 below shows the predictive ability of the model in relation to the actual JSE-listed property index:

Figure 5.9



The above diagram shows that the model fails to predict the period from Jan 2009 to Jun 2009 – it is outside the rate hiking cycle, and therefore the model is not trained to predict it. The R-squared of the model is 0.94 (in appendix 15), which means the model is able to explain 94% of the total monthly movements of the JSE-listed property index. Moreover, the DW statistic is 1.82, which suggests that there's minor positive autocorrelation in the model.

5.10 JSE-All share index return models

In this section of the paper will display results of the second proposition, which is stated as follows:

- JSE-listed real estate index returns are better at protecting investors from the South African CPI inflation than JSE-All share index returns.

Unlike in the section displaying the results for the first proposition, the researcher will skip the steps (as it is assumed that the reader now understands the process that needs to be followed in order to create models).

In similar fashion (to the JSE-listed property models) the long and short-term models are determined (and are only displayed in this section of the paper) for the JSE-all share index models.

5.10.1 JSE-all share index short-term models

The model output (in table 5.18) below displays the results of the final JSE-all share short-term model.

Table 5.18: JSE-all share index short-term model results

Dependent Variable: D(LN_ALSI_INDEX_)				
Method: Least Squares				
Date: 10/01/15 Time: 01:41				
Sample (adjusted): 2009M03 2014M06				
Included observations: 64 after adjustments				
Convergence achieved after 13 iterations				
MA Backcast: 2006M03 2009M02				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-3))	1.778	0.543	3.274	0.002
D(LN_GOLDPRICE_(-2))	0.256	0.065	3.951	0.000
D(LN_ALBI_(-13))	0.373	0.165	2.263	0.027
AR(36)	-0.163	0.077	-2.127	0.038
MA(36)	-0.940	0.017	-56.000	0.000
R-squared	0.832	Mean dependent var		0.016
Adjusted R-squared	0.821	S.D. dependent var		0.038
S.E. of regression	0.016	Akaike info criterion		-5.325
Sum squared resid	0.016	Schwarz criterion		-5.156
Log likelihood	175.391	Hannan-Quinn criter.		-5.258
Durbin-Watson stat	2.451			

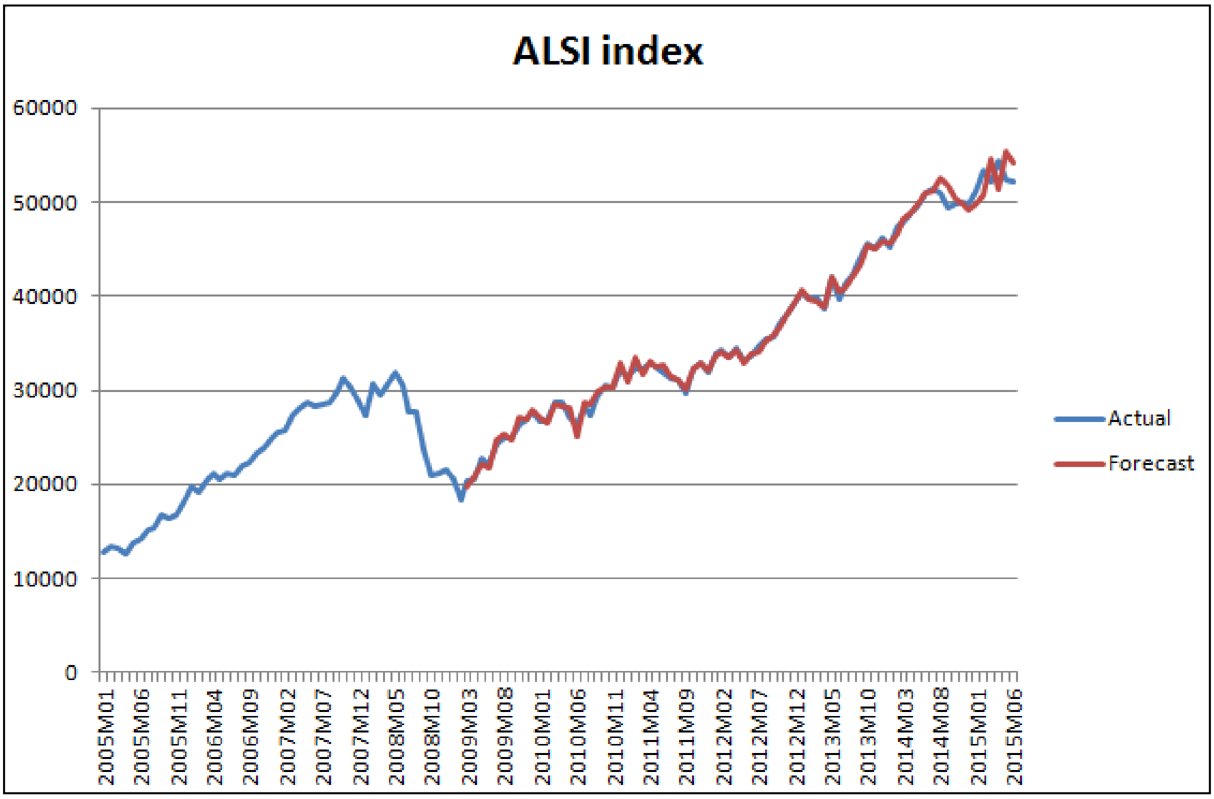
The above table shows that the model has an R-squared of 0.83, which means it is able to explain 83% of the total short-term movements in the JSE-all share index. More so, a 1% change in CPI (3 months prior) results in a 1.78% change in the JSE-all share index. The equation of the model is outlined below:

$$dLn(ALSI_t) = 1.78*dLn(CPI_{t-3}) + 0.26*dLn(GP_{t-2}) + 0.37*dLn(ALBI_{t-13}) - 0.16*AR(36) - 0.94*MA(36)...(M)$$

Where: $dLn(ALSI_t)$ = *change in JSE-all share index from time t-1 to t,* $dLn(CPI_{t-3})$ = *change in consumer price index from time t-4 to t-3,* $dLn(GP_{t-2})$ = *change in gold price from time t-3 to t-2,* $dLn(ALBI_{t-13})$ = *change in All bond index from time t-14 to t-13,* **AR(36)** = *autoregressive term of order 36,* **MA(36)** = *moving average term of order 36*

Figure 5.8 below shows that the model is able to adequately mimic actual movements in the JSE-all share index (ALSI) over time – the forecast seems to overstate the ALSI from Jan 2015 to Jun 2015.

Figure 5.8:



5.10.2 JSE-all share index long-term models

The model output below (in table 5.19) shows the output for the JSE-all share index long-term model (which relates the JSE-all share index against the consumer price index).

Table 5.19

Dependent Variable: LN_ALSI_INDEX_				
Method: Fully Modified Least Squares (FMOLS)				
Date: 10/02/15 Time: 04:43				
Sample (adjusted): 2005M02 2015M05				
Included observations: 124 after adjustments				
Cointegrating equation deterministics: C				
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth				
= 5.0000)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_CPI_	1.685	0.164	10.258	0.000
C	2.772	0.731	3.790	0.000
R-squared	0.783	Mean dependent var		10.293
Adjusted R-squared	0.781	S.D. dependent var		0.345
S.E. of regression	0.162	Sum squared resid		3.192
Durbin-Watson stat	0.084	Long-run variance		0.111

The equation of the above model output is stated below:

$$Ln(ALSI_t) = 1.69*Ln(CPI_t) + C..........(N)$$

Where: $\boldsymbol{ALSI_t}$ = *JSE-all share index at time t*, $\boldsymbol{CPI_t}$ = *consumer price index at time t*

The researcher also conducted a Hansen instability test (and Engle-Granger test) to determine the stability of the parameters in the above model - the results can be seen in appendix 18. The results suggest that the parameters are unstable; hence the hypothesis for cointegration is rejected by both tests (although there appears to be a long-term relation between the JSE-all share index and the CPI, the relationship does not have a meaningful economic relationship).

5.10.3 Rate cycle effects on JSE-all share index short-term models

In this section of the paper, the researcher demonstrates the effects of a changing repo rate cycles on the relationship between JSE-all share index returns and CPI inflation. For the period of investigation, the repo rate cutting cycle started from Jan 2009 to Jul 2012. In the other hand, the hiking cycle was from Apr 2005 to Dec 2008.

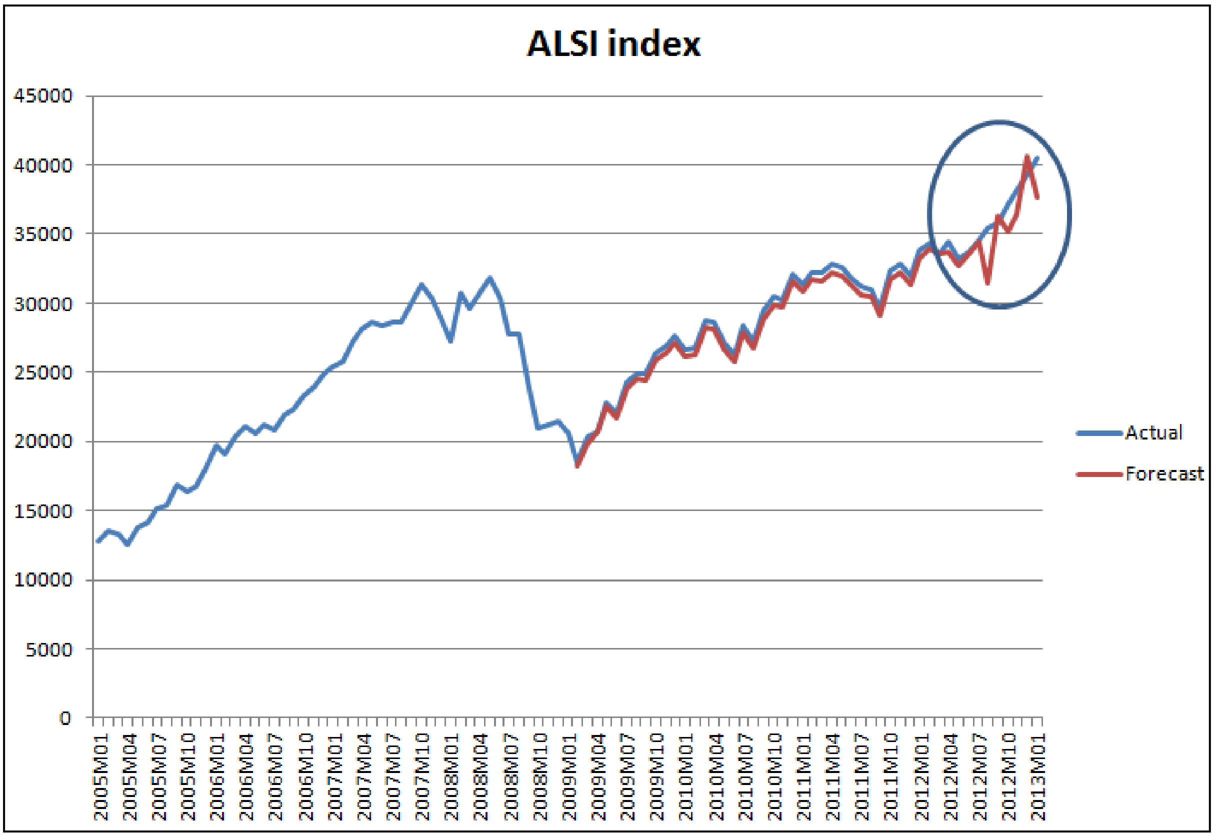
5.10.3.1 Repo cutting cycle effect on the JSE-all share index relationship with CPI inflation

For the period starting on the Jan 2009 to Jul 2012, the equation below describes the relationship between CPI inflation and the JSE-all share index returns:

$dLn(ALSI_t)$ = 4.14*$dLn(CPI_{t-3})$ – 0.21*$dLn(GP_{t-2})$ – 2.81*$dLn(ALBI_{t-12})$ +0.275*AR(36) – 0.99*MA(36)....(O)

where:***$dLn(ALSI_t)$*** = *change in the JSE-all share index from time t-1 to t*, ***$dLn(CPI_{t-3})$*** = *change in consumer price index from t-4 to t-3,* ***$dLn(GP_{t-2})$*** = *change in gold price from t-3 to t-2,* ***$dLn(ALBI_{t-12})$*** = *change in JSE-all bond index from t-13 to t-12,* ***AR(36)*** = *autoregressive term of order 36 months,* ***MA(36)*** = *moving average term of order 36 months*

Figure 5.9 below shows the fit of the above model.



From the above figure it is clear that the model fails to forecast the period from Jul 2012 to Dec 2013 (in the circle of the above diagram), this could be due to the fact that the period lies outside the rate cutting cycle. The statistical output for the above model is in appendix 19 – the R-squared of the model is 0.98, which means the model is able to explain 98% of the total monthly movements of the all share index. More so, a 1% change in CPI results in a 4.14% change in JSE-all share index (although the change is delayed by 3 months). Moreover, the Durbin-Watson (DW) statistic is 2.60 – this suggests that the model may have minor negative autocorrelation (which can be seen in the above graph as it has minor under estimation). However, the minor autocorrelation does not distort the predictive ability of the model – the direction between the actual and the forecast are consistently the same (except for the period in the circle in the above graph).

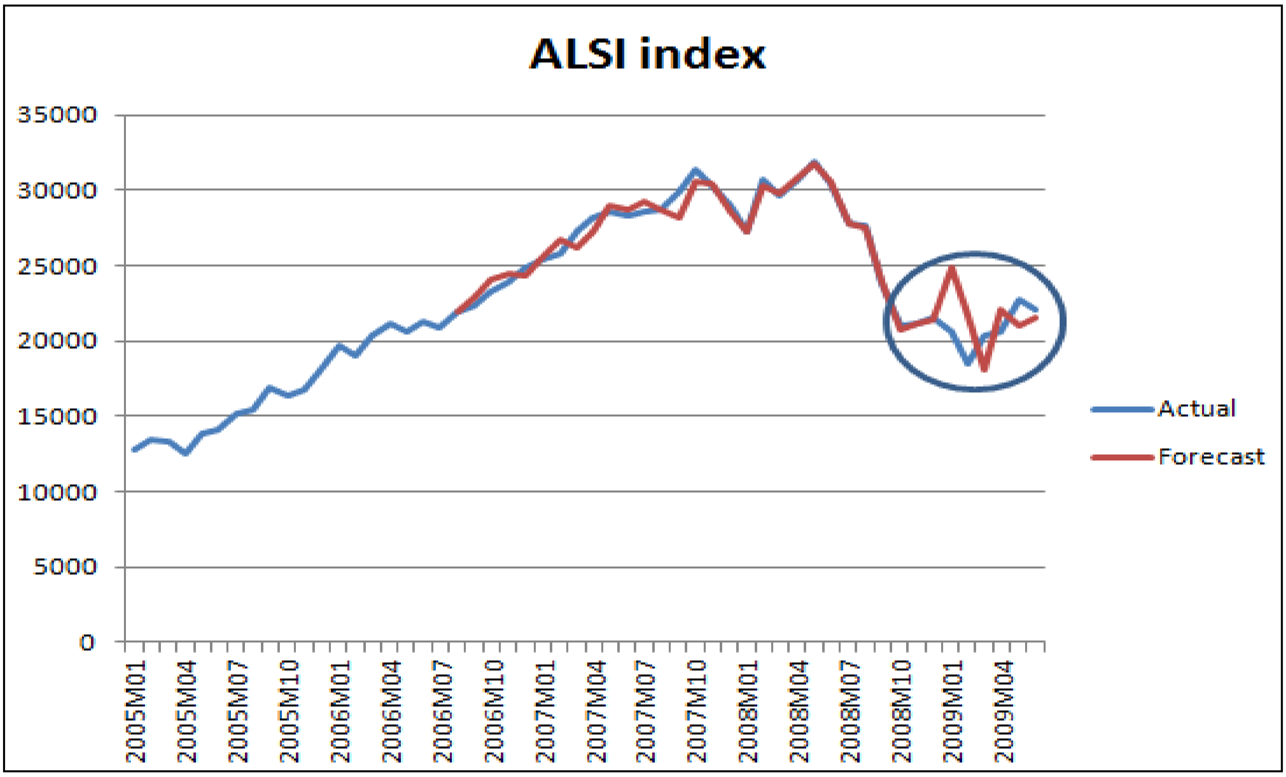
5.10.3.2 Repo hiking cycle effect on the JSE-all share index relationship with CPI inflation

The period starting from Apr 2005 to Dec 2008 seemed to suggest that the relationship between the JSE-all share index returns and CPI inflation is as follows:

$$dLn(ALSI_t) = -1.45*dLn(CPI_{t-2}) + 0.59*dLn(GP_{t-2}) - 1.07*dLn(ALBI_t) - 0.41*dLn(RD_{t-5}) - 0.9*AR(13) - 0.97*MA(12)$$

where: $dLn(ALSI_t)$ = *change in JSE-all share index from time t-1 to t*, $dLn(CPI_{t-2})$ = *change in consumer price index from t-3 to t-2*, $dLn(GP_{t-2})$ = *change in gold price from t-3 to t-2*, $dLn(ALBI_t)$ = *change in all bond index from t-1 to t*, **AR(13)** = *autoregressive term of order 13 months*, **MA(12)** = *moving average term of order 12 months*, $dLn(RD_{t-5})$ = *change in the rand dollar exchange rate from time t-6 to t-5*

The graph (figure 5.10) below shows the fit of the above model over time:



The above diagram shows that the model fits the actual movements of the JSE-all share index on a monthly basis, however, for the period starting from Jan 2009 to Jun 2009 (in the circle) the model fails to explain the movements – the period lies outside the rate hiking cycle hence why the model is unable to predict the movements from Jan 2009 to Jun 2009.

The output of the model can be found in appendix 20, where it can be seen that the model explains 86% of the total movement in the JSE-all share index – the R-squared is 0.86. The DW statistic is 1.65 (which suggests that there's minor positive autocorrelation) – this can be seen in the above diagram as there are periods where the red underestimates the blue graph.

CHAPTER 6: Summary of results

6.1 Results - Introduction

Given the objectives of the research proposal (covered by chapters 1 to 4) and the data collection (and analysis) in chapter 5; this chapter focuses on the results of the study.

The autocorrelations (and partial autocorrelations) for the JSE-listed property index were proven to be insignificant (in chapter 5 section 5.2 shows the results). From this fact it follows that a pure ARIMA could not be used to model the short-term movements in the JSE-listed property index (and the JSE-all share index). Moreover, Boshoff and Cloete (2012) demonstrated that the movement in the listed property index is as result of changes in the underlying economic and market variables – economic activity in the direct property market affects the listed property index (the listed property index leads the returns in the direct property market (Ling & Naranjo, 2015)). It therefore follows that to model the JSE-listed property index (and the JSE-all share index) effectively market and economic variables have to be included as independent variables – hence why a pure ARIMA could not be used to model both the JSE-all share and JSE-listed property indices.

A stepwise procedure (Analysis of variance (ANOVA)) was used to select variables that have the most influence in the movements (for the short and long-term) of the JSE-listed property and JSE-all share indices.

6.2 Results – JSE-listed property models

This section of the paper discusses the JSE-listed property model findings. The short-term models are presented first, followed by the long-term models and thereafter the rate cycle effects are presented (and analysed). Comparisons are then made to the literature review to assess similarities and points of difference between the researcher’s results and those of other scholars (work perused in the literature review).

6.2.1 Results – JSE-listed property short-term models

From the stepwise procedure the model below was determined to be the most suitable for describing the relationship between JSE-listed property returns and CPI inflation for the period of investigation (Jan 2005 to Jun 2014):

$$dLn(LP_t) = 0.19*AR(24)_t - 0.92*MA(24)_t - 1.99*dLn(CPI_{t-10}) + 0.13*dLn(GP_{t-5}) - 0.228*dLn(GP_t) + 1.42*dLn(ALBI_t) + C$$

Where: $dLn(LP_t)$ = *JSE-listed property returns at time t,* $dLn(ALBI_t)$= *change in All bond index returns from time t-1 to t,* $dLn(GP_{t-5})$ = **%** *change in the gold price from time t-6 to t-5,* $AR(24)_t$ = *autoregressive term of order 24 at time t,* $MA(24)_t$ = *moving average for the 24 month period to time t,* $dLn(CPI_{t-10})$ = *% change in the CPI from time t-11 to t-10,* **C** = *constant*

The estimated output from the above model (which can be seen in chapter 5 section 5.8.2.4) shows that all variables were significant at the 5% level. The R^2 is 0.86, which means the model is able to explain 86% of the total movement of the JSE-listed property index. From the above model, a 1% move in CPI inflation (10 months prior to time t) creates -2% (approx) change in the JSE-listed property index (assuming all other variables do not change).

In the short-term the movements of the JSE-listed property index seems to be similar to those of listed equities in the US (equities were noted to be effective at hedging inflation for terms longer than 5 years (Ahmed & Cardinale, 2005)), it appears that the findings from the research suggest that JSE listed properties do not provide a protection against inflation in the short-term (as the relationship is negative in the short-term). Kumari (2011) mentions in his study that the relationship between listed equities and inflation is weak – the findings from this study seem to show a similar relationship between JSE listed properties and CPI inflation (also the parameters changed signs depending on the repo cycle – section 6.2.3 takes the discussion further).

The negative relationship between CPI inflation and JSE-listed property returns that is derived from this study could be a signal for irrational investor behaviour (Boshoff & Cloete, 2012) or investor sentiment (Hong & Lee, 2013) in the short-term – this may explain the instability of the relationship in the short-term.

Hardin, Jiang and Wu (2012) research results indicated a negative relationship between inflation and listed property returns – the researchers also went further to suggest that the negative relationship is as a result of the market's inability to accurately price in the short-term effects of inflation. The finding from this paper also determined a negative short-term relationship for the period starting from Jan2005 to Jun2014, however, the researcher does not provide evidence that suggests that the market's inability to price in short-term changes in inflation as being the reason for the negative relation (the inflation illusion effect).

Hardin, Jiang and Wu (2012) used the dividend decomposition technique to arrive at the results – where a negative relationship between inflation and REIT returns was determined; the data used was for the period from 1980 to 2008. Despite the use of a different technique the results seem to be similar (to those derived in this paper).

Macroeconomic variables (such as CPI) were used to model the JSE-listed property index movements – according to Boshoff and Cloete (2012) this can only serve to shed light on the underlying economic activity within the direct property market (the macroeconomic variables used in the modelling process can be used as indicators for the direct property market, as they create (or eliminate) opportunities for property development) – the CPI index can be used as a leading indicator (although Boshoff and Cloete (2012) used GDP and unemployment) of the direction of the direct property market (which according to Boshoff and Cloete (2012) takes a lead from the listed property market). The short-term models derived in this study seem to show that in the event where CPI changes it takes a few months before the listed propety index changes.

Ling and Naranjo (2015) state that macroeconomic variables could be seen as drivers in the short-term movements of listed property – the findings from this paper seem to support this notion (a macroeconomic model was used to explain both the long and short-term movements in this paper – for both the JSE-all share index and JSE-listed property models). Moreover, institutional involvement is noted by Ling and Naranjo (2015) to be an essential process for validating transactions (or deals) in the listed property sector, this hypothesis was not tested in this paper.

6.2.2 Results – JSE-listed property index long-term models

A cointegration model was fitted with the aim of understanding the long-term relationship between CPI inflation and JSE-listed property returns (the results of the model can be seen in chapter 5 in section 5.9.4). The equation below represents the model that was derived from the study:

$$Ln(LP_t) = 1.46 * Ln(CPI_t) + C$$

Where: LP_t = *JSE-listed property index at time t,* CPI_t = *the CPI at time t,* **C** = *constant*

From the above it can be seen that a 1% change in CPI inflation results in 1.46% JSE-listed property returns. It is interesting to note that the long-term relationship between the CPI inflation and JSE-listed property returns is positive, mean while it is negative for the short-term relationship (discussed in section 6.2.1 above). The above model was proven to have stable parameters by the Hansen instability test – this means that the coefficients to do not change significantly as time progresses.

A study conducted by Wurstbauer and Schafers (2015) uncovered a positive long-term relationship (between CPI and Listed properties in the US) this is consistent with the Lee and Lee (2014) result. However, Lee and Lee (2014) goes further to suggest that institutional involvement as an explanation of the ability of listed properties in develop markets to protect investors from inflation risk in the long-term (developing markets lack the expertise to factor in the effects of changes in inflation correctly).

Lee and Lee (2014) conducted the study based on five countries, namely: France, UK, Germany, Czech Republic and Poland. A segmentation of the data was performed as three out the of the five were developed economies; the period of investigation spanned from Jan 1990 to Jul 2011. Given the context of the study conducted by Lee and Lee (2014) and similarity of the conclusions between the findings, this could suggest that the JSE may exhibit the trading patterns of a developed economy stock market.

In the other hand, Boshoff and Cloete (2012) suggested that the fluctuations in the short-term could be a result of irrational investor sentiments, however, the JSE-listed property index seems to be adjusting (compensating investors for the irrational short-term fluctuations in real returns) in the long-term – the Hansen instability test proved that the relationship was stable in the long-term.

It is worth noting that introducing the rand dollar variable resulted in the following model (the in appendix 12 and chapter 5 section 5.9.3):

$$Ln(LP_t) = 1.11*Ln(CPI_t) + 0.47*Ln(RD_t) + C$$

Where: LP_t = *JSE-listed property index at time t,* CPI_t = *the CPI at time t,* RD_t = *Rand dollar exchange at time t,*

C = *constant*

The above model (although proven to have border line stable coefficients by the Hansen instability test) suggests that a 1% change in CPI index results in a 1.11% change in JSE-listed property index – this shows that the long-term relationship is positive between the variables. Moreover, where the rand weakens against the dollar by 1% (which creates inflation in the country) it creates a 0.47% change in the JSE-listed property index (in the long-term the JSE-listed property index compensates investors for the additional inflation caused by the weakening of the rand against the dollar).

6.2.3 Results - Repo rate cycle effect on the relationship between CPI inflation and JSE-listed property returns

In this section of the paper an analysis on the results is provided where the impact of repo cycle on the short-term JSE-listed property models is explained to the reader. For both the rate cut and hike cycles, the lag between CPI and JSE-listed property index changes is reduced significantly.

The results in this paper seem to support the findings from most scholars who have done work on properties (with respect to its ability to protect investors against inflation risk); where the results suggest that the relationship between inflation and properties in general appears to be less evident (or lacks clarity) in the short-term (Wurstbauer & Schafers, 2015). In the case of this paper it is noted that the relationship changes from negative to positive depending on the Repo rate cycle – the results are presented in sections 6.2.3.1 and 6.2.3.2 below.

Wurstbauer and Schafers (2015) conducted the study based on data collected from 1991 to 2013 (a time frame which overlaps with the period of investigation of this paper)

6.2.3.1 Repo rate hiking period analysis (JSE-listed property)

The model is based on data collected for the period from Jan 2005 to Dec 2008 (the results of the model can be seen in appendix 15). The equation is outlined below:

$dLn(LP_t) = 8.87*dLn(CPI_{t-4}) – 1.37*dLn(GP_{t-4}) – 0.15*dLn(GP_t) – 1.32*dLn(ALBI_{t-1}) -0.24*AR(12)_t – 0.99*MA(12)_t + C$

Where: ***$dLn(LP_t)$*** = *change in JSE-listed property index from time t-1 to t,* ***$dLn(ALBI_{t-1})$***= *% change in All bond index from t-2 to t-1,* ***$dLn(GP_{t-4})$ = %*** *change in the gold price from time t-5 to t-4,* ***$AR(12)_t$*** *= autoregressive term of order 12 at time t,* ***$MA(12)_t$*** *= moving average for the 12 month period to time t,* ***$dLn(CPI_{t-4})$*** *= % change in the CPI from time t-5 to t-4,* ***dGP_t*** *= % change in the CPI from time t-1 to t,* ***C*** *= constant*

The above model suggests that for every 1% change in CPI (4 months prior to time t) the JSE-listed property index changes by 8.87% at time t. It is worth noting that in a rate hiking cycle, the relationship between CPI and JSE-listed property index is substantially magnified, and the lag is reduced significantly. The ALBI and gold price appear to remain significant variables under a repo rate hiking cycle.

The relationship between CPI and JSE-listed property index in a repo rate hiking cycle seems to suggest that listed properties become popular when rates are increasing – this is perhaps due to inflation fears (this is on the back of SARB's inflation targeting policy).

6.2.3.2 Repo rate cutting period analysis (JSE-listed property)

The model is based on data collected for the period from Jan 2009 to Jul 2012 (the results of the model can be seen in appendix 16). The equation is as follows:

$dLn(LP_t) = -2.02*dLn(CPI_{t-1}) – 0.24*dLn(GP_{t-4}) – 0.43*dLn(GP_t) + 1.03*dLn(ALBI_t) -0.60*AR(24)_t – 0.96*MA(24) + C$

Where: ***$dLn(LP_t)$*** = *% change in JSE-listed property index from time t-1 to t,* ***$dLn(ALBI_t)$***= *% change in All bond index from t to t-2,* ***$dLn(GP_{t-4})$ = %*** *change in the gold price from time t-5 to t-4,* ***$AR(24)_t$*** *= autoregressive term of order 24 at time t,* ***$MA(24)_t$*** *= moving average for the 24 month period to time t,* ***$dLn(CPI_{t-1})$*** *= % change in the CPI from time t-2 to t-1,* ***$dLn(GP_t)$*** *= % change in the gold price from time t-1 to t,* ***C*** *= constant*

It can be seen in the above model that for every 1% change in the CPI index the JSE-listed property index responds with a -2% change (all else remaining the same).

It is also worth noting that the coefficient changes signs from the hiking to cutting cycle – in fact the JSE-listed property index is more sensitive to CPI changes in a rate hiking cycle.

6.2.4 Rand dollar effects on the short-term relationship between JSE-listed property returns and CPI inflation

It was noted in chapter 5 section 5.7 that both the gold price and rand dollar exchange rate reacted to similar movements in the market, the research attempted to replace the gold price variable in the final model with a rand dollar exchange rate variable (the model was based on Jun 2005 to Jun 2014 history) – appendix 17 shows the results. Below is the equation describing the resulting model:

$$dLn(LP_t) = -2.27*dLn(CPI_{t-5}) + 0.19*dLn(ALSI_{t-4}) - 0.22*dLn(RD_{t-6}) + 1.41*dLn(ALBI_t) + 0.30*AR(24)_t - 0.91*MA(24) + C$$

Where: $dLn(LP_t)$ = *JSE-listed property returns from time t-1 to t,* $dLn(ALBI_t)$= *% change in All bond index from t-1 to t,* $dLn(ALSI_{t-4})$= **%** *change in the JSE-all share index from time t-5 to t-4,* $AR(24)_t$ = *autoregressive term of order 24 at time t,* $MA(24)_t$ = *moving average for the 24 month period to time t,* $CPI_{t-5} - CPI_{t-6}$ = *% change in the CPI from time t-6 to t-5,* $dLn(RD_{t-6})$= *% change in the RD from time t-7 to t-6,* **C** = *constant*

From the above model, it can be seen that a 1% change in CPI index (5 months prior to time t) the JSE-listed property index responds with a -2.27%. Replacing the gold price series by the rand dollar exchange rate only serves to increase the sensitivity of JSE-listed property index to changes in CPI index, however, the sign remains the same.

The above model seems to suggest that for the period of study, where CPI was observed to increase (5 months prior to today) the JSE-listed property index becomes less popular (all else equal) – this appears to be counter intuitive. However, it should be noted that this is only a short-term relation (which changes with interest rate cycles).

It should be noted that replacing the gold price series with a rand dollar exchange and the JSE-all share index (ALSI) series increases the models ability to predict the JSE-listed property index, as the latter model minimizes the risk of over estimating over the projection period. To see this one need’s to look at figure 5.7, where the 5th

forecast represents the model under discussion in section 6.2.4; the 4th forecast in figure 5.7 shows the model discussed in section 6.2.1. Appendix 17 shows that the model discussed in this section tracks the movements in the JSE-listed property index very closely.

6.3 Results – JSE-all share index models

This section of the paper the writer discusses the JSE-all share index model findings. A discussion on the short-term models is presented first, followed by the long-term models and afterwards the rate cycle effects are presented (and analysed). Comparisons are then made to the literature review to point out similarities differences between the researcher's results and those of other scholars.

6.3.1 Results - JSE-all share index short-term models

Through the use of the stepwise procedure, the researcher was able to determine the following short-term relationship between JSE-all share index (ALSI) and consumer price (CPI) – this was for the period from Jan 2005 to Jun 2014 (the model was used to forecast the period from Jul2014 to Jun2015 thereafter):

$$dLn(ALSI_t) = 1.78*dLn(CPI_{t-3}) + 0.26*dLn(GP_{t-3}) + 0.37*dLn(ALBI_{t-13}) – 0.16*AR(36) -0.94*MA(36) + C$$

Where: $dLn(ALSI_t)$ = % change in JSE-all share index from time t-1 to t, $dLn(CPI_{t-3})$ = % change in CPI from time t-4 to t-3, $dLn(GP_{t-3})$ = % change in gold price from time t-4 to t-3, $dLn(ALBI_{t-13})$ = % change in All bond index from time t-14 to t-13, ***AR(36)*** = *autoregressive term of order 36,* ***MA(36)*** = *moving average term of order 36*

From the above model, it is clear that a 1% change in CPI results in a 1.78% in JSE-all share index (although delayed by 3 months) – assuming all else remains the same. The results of the model can be seen in chapter 5 section 5.10.1. The R-squared of the model is 0.83, meaning that the model is able to explain 83% of the total monthly movements in the JSE-all share index. All the variables included into the model were seen to be significant at 5% level.

The positive relationship between CPI inflation and JSE-all share index seems to suggest that listed equities in the South African stock market seem to provide protection against inflation in the short-term. The findings from this research (the JSE-all share index short-term model for the period spanning from Jan 2005 to Jun 2014) are similar to that of Eita (2012) – both seem to suggest that the relationship between listed equities (JSE-all share index in this paper) and inflation can be positively related. Eita (2012) studied the relationship for the period starting from 1980 to 2008 (more than 20 years) – the period seems to be covering many interest rate and business cycles (this introduces time bias as most of the history precedes 2005).

In the short-term the movements of the JSE-all share index seems to differ to those of listed equities in the US (equities were noted to be effective at hedging inflation for terms longer than 5 years in the US (Ahmed & Cardinale, 2005)) – the paper mentions short-term asymmetric behaviour in the relationship between inflation and listed equities returns (which contradicts the results in this section of the paper but confirm the results in section 6.3.3 below).

Ahmed and Cardinale (2005) conducted the research based on data from early 1800 to early 2000 (for the US in particular); the period covers many business cycles and changes in economic structures (which introduces time bias, which is a type of selection bias) – perhaps this may explain the variance in findings between the results (Ahmed and Cardinale (2005) versus the results in section of the paper).

In another study conducted by Lee and Lee (2012) it is suggested that institutional involvement enhances flow of information, which makes listed assets (such as listed equities – the JSE-all share index in this case) to be a better hedge against inflation. Unfortunately this study has not been able to explore whether the same can be said about the JSE-all share index – as it has been observed to have a positive relationship with CPI inflation over the period from Jan 2005 to Jun 2014.

6.3.2 Results - JSE-all share index long-term models

Through the use of the stepwise procedure, followed by a process in which variables were manually added (and removed), the researcher was able to test the following long-term relationship between JSE-all share index (ALSI) and consumer price (CPI) – this was for the period from Jan 2005 to Jun 2015:

$$Ln(ALSI_t) = 1.69*Ln(CPI_t) + C$$

Where: $ALSI_t$ = *JSE-all share index at time t*, CPI_t = *consumer price index at time t*

The above model appears to suggest a long-term relationship between JSE-all share index and CPI (where for every 1% change in CPI the JSE-all share index is expected to change by 1.69%). The researcher after conducting further tests (Hansen instability and Engle-Granger tests) discovered that the relationship is not meaningful (the parameters were proven to be unstable).

Arjoon *et al.* (2012) were able to prove that a long-term relationship between inflation and stock returns was positive in the long-term (where it was demonstrated that an increase inflation results in a short-term decrease in real stock returns but followed by a long-term correction in stock returns) – a vector autoregressive frameworks was used. The study conducted by Arjoon *et al.* (2012) was based on data collected from January 1980 to February 2010 (collected on a quarterly basis) – this introduces time and selection bias, this may explain the difference in findings. In the other hand Ahmed and Cardinale (2005) also found a long-term relationship between listed equities and inflation in the US – the evidences seems to contradict the results of this paper as the relationship was proven to be unstable (agreeing to the findings based on UK and Japanese data in Ahmed and Cardinale (2005)).

6.3.3 Results - Repo rate cycle on the relationship between CPI inflation and JSE-all share index returns

In this section of the paper an analysis of the results is conducted (where the impact of the repo cycle on the short-term JSE-all share index models is explained to the reader). The rate cut and hike cycles seem not to have a significant impact on the lag between CPI and JSE-all share index changes. More so, the signs (of the coefficients that describe the relationship of CPI inflation against the JSE-all share index returns) were reversed for the two scenarios – negative for the repo hiking cycle and positive otherwise.

6.3.3.1 Repo rate hiking period analysis (JSE-all share index models)

The model is based on data collected for the period from Jan 2005 to Dec 2008 (the results of the model can be seen in appendix 20). The equation that describes the relationship is outlined below:

$$dLn(ALSI_t) = -1.45*dLn(CPI_{t-2}) + 0.59*dLn(GP_{t-2}) - 1.07*dLn(ALBI_t) -0.41*dLn(RD_{t-5}) -0.9*AR(13) - 0.97*MA(12)$$

where: $dLn(ALSI_t)$ = *% change in the JSE-all share index from time t-1 to t,* $dLn(CPI_{t-2})$ = *% change in consumer price index from t-3 to t-2,* $dLn(GP_{t-2})$ = *% change in gold price from t-3 to t-2,* $dLn(ALBI_t)$ = *% change in all bond index from t-1 to t,* **AR(13)** = *autoregressive term of order 13 months,* **MA(12)** = *moving average term of order 12 months,* $dLn(RD_{t-5})$ = *% change in the rand dollar exchange from time t-6 to t-5*

The model above indicates that for every 1% movement in CPI the JSE-all share index responds with a -1.45% - the response differs from the one derived for the period from Jan 2005 to Jun 2014 (where a coefficient of 1.78 was observed). All the independent variables in the model were significant at 5% level and the model is able to explain 83% of the total monthly movements in the JSE-all share index.

The change in signs seems to suggest that the context does affect the relationship between CPI inflation and the JSE-all share index returns. Moreover, the short-term relationship between the JSE-all share index and CPI cannot be deemed to be strictly negative or positive (therefore indeterminate) – Eita (2012) literature review also suggests that there's no consensus on the relationship between CPI and the JSE-all share index. From a long-term perspective Arjoon *et al.* (2012) literature review indicates that the debate is inconclusive as well.

Given the above, further research needs to explore the effects that context has on the relationship between CPI inflation and the JSE-all share index returns – this will shed light on the varied conclusions reached by scholars. Furthermore, techniques similar to those used by Lee and Lee (2011) where data from 1972 to 2007 was segmented (and models were created thereof based on size of REITs fund and time periods) could help to provide insights on whether the long-term relationship between the JSE-all share index and CPI becomes more stable (or less stable) once size (of companies included in the JSE-all share index) is taken into account.

6.3.3.2 Repo rate cutting period analysis (JSE-all share index)

The model is based on data collected for the period from Jan 2009 to Jul 2012 (the results of the model can be seen in appendix 19). The equation is as follows:

$$dLn(ALSI_t) = 4.14*dLn(CPI_{t-3}) – 0.21*dLn(GP_{t-2}) – 2.81*dLn(ALBI_{t-12}) +0.275*AR(36) – 0.99*MA(36)$$

where $dLn(ALSI_t)$ = *% change in the JSE-all share index from time t-1 to t*, $dLn(CPI_{t-3})$ = *% change in consumer price index from t-4 to t-3,* $dLn(GP_{t-2})$ = *% change in gold price from t-3 to t-2,* $dLn(ALBI_{t-12})$ = *% change in all bond index from t-13 to t-12,* **AR(36)** = *autoregressive term of order 36 months,* **MA(36)** = *moving average term of order 36 months*

From the above equation, it is clear that for every 1% change in CPI the JSE-all share index responds with a 4.14% increase (after 3 months). Unlike in the rate hiking scenario (in section 6.3.3.1 above) the relationship between CPI and the JSE-all share index is positive. The model fitted over the period from Jan 2005 to Jun 2014 indicated a relationship coefficient of 1.78 (which is less than 2 times the coefficient derived from over all period of investigation) – the relationship is more sensitive in the rate cutting scenario.

The model output in appendix 19 shows that the model is able to explain 98% of the total monthly movement in JSE-all share index returns. Moreover, the DW statistic is 2.60 (this indicates minor negative autocorrelation in the model).

The results from the both scenarios (the rate hiking and cutting periods) seem to suggest that the relationship is not universal, and that context is crucial to explaining the nature of the relationship. In the cases of the rate cutting scenario (which often relates to a low inflation environment due to the inflation targeting policy by the SARB) is it clear from the fitted models that the JSE-all share index provides sufficient protection in the short-term. However, fails to provide protection against inflation where the economy is in an inflation environment (this can be seen in section 6.3.3.1 – rate hiking results). Tien-Foo and Swee-Hiang (2000) (conducted using data from 1978 to 1999) mention that context is the precursor of the relationship between inflation and the returns of an asset (the paper focuses more on direct property).

CHAPTER 7: Implications, Limitations and Conclusion

7.1 Introduction

Given chapter 6 (a chapter that summarises and discusses the results of the study); this chapter uses the results to deduce meaning for both business and academic worlds; areas of future research and limitations of the research are also outlined.

7.2 Implications

The study has managed to provide evidence that there is a relationship between CPI inflation and listed property returns (negative in the short-term and positive in the long term). Moreover, it also can be seen that both short and long term movements in the listed property index can be predicted with the use of macroeconomic variables. Given these facts, the implications can be grouped into two, namely: theoretical and management implications.

7.2.1 Theoretical implications

A pure ARIMA model can't be relied upon to predict JSE-listed property index (and JSE-all share index) movements. A macroeconomic model is needed to create a reliable predictive model – the researcher was unsuccessful in creating a pure ARIMA model.

Macroeconomic variables such as gross domestic product, gross national saving and gross capital formation are production based variables. As a result, these are received on a quarterly basis, which requires interpolation for the months where the numbers are omitted. One must minimize using these variables (although useful) when modelling monthly time series, as information is lost when interpolation is used to fill-in data gaps (Wilkinson, 1967).

Techniques such as the Fisher relation can be used to determine the relationship between CPI inflation and JSE-listed property index (and the JSE-all share index) – these can be used successfully to arrive at the same conclusion (Inglesi-Lotz & Gupta, 2013). Moreover, in order to select variables for modelling purposes, the researcher needs an automated approach where all the variables from the universe of collected variables are plugged into a statistical package, from which the most influential variables are selected (without any outside influences). This explains why the researcher used the stepwise selection procedure in this paper (Derksen & Keselman, 1992).

7.2.2 Management implications

Investors that wish to protect their wealth from being eroded by CPI inflation need to add exposure of the JSE-listed property index into the portfolio, as there's a positive relationship in the long term between the JSE-listed property index and the South African consumer price index (CPI). Studies conducted by Lee and Lee (2014) uncovered the same result in the context of developed economies.

In the short-term, the relationship between JSE-listed property returns and CPI inflation although proven to be negative an investor cannot rely on this fact alone, as the parameters tend to be unstable (therefore the relationship will be unstable) in the short-term – it is thus important for investors to diversify investment portfolios as other market forces (such as the repo interest rate cycles) also do have a significant influence on JSE-listed property returns in the short-term (Tu & Zhou, 2011).

Given that the influence of international markets play a big role in predicting the movement of the JSE-listed property index, it is therefore quite essential that in predicting the movement of the JSE-listed property index that either the gold price or rand dollar exchange rate be incorporated in the model (from this investigation, it was noted that both variables seem to react to the same factors, therefore shouldn't be included into the same model at the same time) – figure 5.3 shows the relationship between the gold price and rand dollar exchange rate.

The rand dollar exchange rate is also quite essential as it is an indicator of the rate of flow of capital into all South African local markets, therefore, all models should factor it in (or at least test as to whether the variable should be included into a model) – the same can be said about the gold price (which the market interprets as an indicator of risk aversion (Qadan & Yagil, 2012)).

The relationship between CPI inflation and listed property returns appears to be lagged (only after 5 months where CPI growth is observed does the JSE-listed property index respond to the change). Researchers such as Anari and Kolari (2001) and more recently Kumari (2011) have also uncovered that there's a lag between inflation and stock price returns and that the relationship is rather weak. Given that JSE-listed property exhibits stock price movements in the short-term – due to the effects of unfounded investor sentiment (Ling & Naranjo, 2015). This means that the hedge against CPI inflation by buying exposure into JSE-listed property can only be relied upon in the long-term.

Interest rate effects were also noted by the researcher where in a Repo rate hiking cycle the effect that CPI changes have on the JSE-listed property index tend to be magnified (4 times higher and positive) and less delayed in comparison to the rate cutting cycle model result (4 months compared to at least 5 months for the model based on the period from Jan 2005 to Jun 2014). In the other hand, in an interest rate cutting cycle the relationship between CPI inflation and listed property returns is negative and less pronounced – a quarter of that seen for the rate hiking cycle in absolute terms. This means that it is crucial to adjust the model for interest rate cycles.

The JSE-all share index short-term relationship with CPI inflation is positive or negative depending on the repo rate cycle. This means that investors seeking protection from CPI inflation risk cannot rely on this index for the short-term. Furthermore, the long term relationship between CPI inflation and the JSE-all share index was proven to be unstable in this paper – meaning that it is not reliable for protecting investor wealth from CPI inflation risk in the long-term as well. This suggests that the JSE-listed property index is better (compared to the JSE-all share index) at protecting investor wealth from CPI inflation in the long-term.

7.3 Future Research

The researcher proposes the following topics on listed property returns:

- Modelling the REITs as dependent variable of macroeconomic variables – the researcher had initially intended to model this relationship, however, was unable to do so due to insufficient history (REITs were introduced in 2012) .
- Using Fourier methods to determine the relationship between JSE listed property and macroeconomic variables.

- Does institutional involvement validate deals (or transactions) in the JSE-listed property sector (this will be an extension on Ling and Naranjo (2015)).
- Investigating the effects of institutional involvement on the relationship between CPI inflation and JSE-listed property returns in the South African context.
- Investigating the causal direction of the relationship between CPI inflation and JSE-listed property returns (and JSE-all share index returns).
- Investigating the relationship between listed properties and CPI as a proxy for a stock market's state of development (testing whether a stock market is developed – does it have the expertise to factor in changes in inflation correctly).
- Investigating the relationship between repo rate and listed property returns in South Africa.
- Does the size of the corporates included in the listed property index influence the index's ability the protect investor from CPI inflation.

7.4 Limitations of the research

The research was conducted under a specific period of time (Jan 2005 to May 2015) where markets exhibited certain movements. Shocks in the market were limited (for instance the 2008 financial crisis was the only shock experienced during the period of investigation), which means that the models (and the relationships thereof) only apply to a particular context – this constitute time selection bias (which can change results substantially) (Steiner, Cook, Shadish, & Clark, 2010).

The modelling process also assumes that variables observed in the past are the best indicators of future movements in the JSE listed property index, which may not necessary be the truth (more especially where market shocks take place) – there are black swan events which are difficult to model due to insufficient data (Aven, 2013).

The recent outperformance by REITs (against all asset classes) in the recent years combined with the structural shift in the South African listed property sector (with UK shopping malls, residential REITs coming in) this may have increased the popularity of the sector, thus may have affected the returns (which means the results may not be valid under worst economic circumstances) (SA Property Insider, 2015).

Reliability issues are also introduced as the investigation period has a change in repo cycle (it is proven in this paper that both the JSE-all share and JSE-listed property models were affected by repo cycles) (Saunders & Lews, 2012).

7.5 Conclusion

The purpose of this paper was to determine the relationship between CPI and JSE-listed property (and the JSE-all share index) with the intention to prove whether the JSE-all share index and JSE-listed property index returns can protect investors from CPI inflation risk.

In order to determine the relationship between CPI and JSE-listed properties (and JSE-all share index) other macroeconomic variables were included into an econometric model as a pure time series model was not successful in modelling the short-term relationships. The econometric model (where time lags of up to 13 months were included) was successful in modelling the short-term relationships – the models were able to explain a significant amount (more than 80%) of the movement in JSE-listed property (and the JSE-all share index) returns.

The resulting short-term models revealed that the movement in the JSE-listed property (and JSE-all share index) indices were not only driven by the CPI, but rather by the ALBI index, rand dollar exchange (or gold price) and ALSI (when modelling the JSE-listed property index). Furthermore, it was determined that the repo rate cycle has an impact on the relationship between the CPI and JSE-listed property (or the JSE-all share) indices, as the relationship changes signs from a repo cutting to a hiking cycle (and vice versa) – both the JSE-all share index and JSE-listed property index models showed the same attributes.

To determine the long-term relationship between CPI and JSE-listed property (and JSE-all share) indices a least squares method was used, where the Hansen instability (and the Engle Granger) tests were conducted to determine stationarity of the resulting residuals from the fitted models. The long-term relationship between CPI and JSE-listed property proved to be stable and positive, which means that as CPI adjusts the JSE-listed property index adjusts in the same direction in the long-term. Moreover, the rand dollar exchange rate appears to have some impact on the JSE-listed property index in the long-term (the model suggests that as the rand weakens against the dollar the JSE-listed property index adjusts upwards by a factor of 0.47) – intuitively this means that as the rand weakened during the period of investigation the JSE-listed property index gained popularity (as foreign investors perceived South African assets to be cheap) or alternatively the JSE-listed property index compensated investors for the additional inflation caused by a weakening rand against the dollar.

The findings from this paper are sufficient to reject the null hypothesis that JSE-listed property (and JSE-all share) indices can protect investors from short-term movements in the CPI, the alternative hypotheses are supported. In the long-term the null hypotheses that purport to suggest that JSE-listed property (or the JSE-all share) indices can protect investors from CPI movements is supported in the case of the JSE-listed property index, however, it is not supported in the case of the JSE-all share index (and the alternative is accepted rather in this case) – this serves to demonstrate that JSE-listed property returns provide superior protection (when compared to the JSE-all share index returns) to investors against CPI inflation in the long-term over the period of investigation.

The stronger relationship between CPI and the JSE-listed property index (which was proven to be stable in this paper) supports the assertion made by the South African REITs association pertaining to the outperformance of the JSE-listed property sector (in relation to other asset classes – against JSE-listed equities to be specific) in the last 15 years – this takes into account the context (in terms of the state of the repo rate cycle and structural shifts in the listed property sector in South Africa).

Appendix:

1. Table providing descriptions of variables in the study

Variables	Descriptions
ALBI	Johannesburg Stock Exchange(JSE) All Bond Index
ALSI	Johannesburg Stock Exchange(JSE) All Share Index
CPI	South Africa Consumer Price Index (CPI) - core index
GDP_Trend	Trend of GDP BY EXPENDITURE AT MARKET PRICES (AR) : South Africa
GDP	GDP BY EXPENDITURE AT MARKET PRICES (AR) : South Africa
GoldPrice	Gold Prices in Rands
HouseIndex	Absa price Index
ListedPropIndex	Johannesburg Stock Exchange (JSE) Listed Property Index
RandDollarExchange	Rand Dollar Exchange rate
RepoRate	South African repurchase rate
SA_CapForm	South African Capital formation
SA_BusConIndex	GCF - GROSS FIXED CAPITAL FORMATION (AR) : South Africa
SA_GrossSav	GROSS SAVING (AR) : South Africa
SA_Unemploy	OFFICIAL UNEMPLOYMENT RATE (METHODOLOGY BREAK Q1 2008) : South Africa
Ln(ALBI)	Natural log of ALBI
Ln(ALSI)	Natural log of ALSI
Ln(CPI)	Natural log of CPI
Ln(GDP_Trend)	Natural log of GDP_Trend
Ln(GDP)	Natural log of GDP
Ln(GoldPrice)	Natural log of GoldPrice
Ln(HouseIndex)	Natural log of HouseIndex
Ln(ListedPropIndex)	Natural log of ListedPropIndex
Ln(RandDollarExchange)	Natural log of RandDollarExchange
Ln(RepoRate)	Natural log of RepoRate
Ln(SA_CapForm)	Natural log of SA_CapForm
Ln(SA_BusConIndex)	Natural log of SA_BusConIndex
Ln(SA_GrossSav)	Natural log of SA_GrossSav
Ln(SA_Unemploy)	Natural log of SA_Unemploy
dLn(ALBI)	First Difference of the natural log of ALBI
dLn(ALSI)	First Difference of the natural log of ALSI
dLn(CPI)	First Difference of the natural log of CPI
dLn(GDP_Trend)	First Difference of the natural log of GDP_Trend
dLn(GDP)	First Difference of the natural log of GDP
dLn(GoldPrice)	First Difference of the natural log of GoldPrice
dLn(HouseIndex)	First Difference of the natural log of HouseIndex
dLn(ListedPropIndex)	First Difference of the natural log of ListedPropIndex
dLn(RandDollarExchange)	First Difference of the natural log of RandDollarExchange
dLn(RepoRate)	First Difference of the natural log of RepoRate
dLn(SA_CapForm)	First Difference of the natural log of SA_CapForm
dLn(SA_BusConIndex)	First Difference of the natural log of SA_BusConIndex
dLn(SA_GrossSav)	First Difference of the natural log of SA_GrossSav
dLn(SA_Unemploy)	First Difference of the natural log of SA_Unemploy
d(Ln(SA_GrossSav),2)	2nd Difference of the natural log of SA_GrossSav
d(Ln(HouseIndex),2)	2nd Difference of the natural log of HouseIndex
d(Ln(SA_CapForm),2)	2nd Difference of the natural log of SA_CapForm

1 a.) First Listed property Short Term model

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/06/15 Time: 17:26				
Sample (adjusted): 2005M02 2015M04				
Included observations: 123 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_)	-1.632	0.883	-1.848	0.067
D(LN_ALBI_)	1.248	0.174	7.177	0.000
D(LN_ALSI_INDEX_)	0.227	0.080	2.845	0.005
D(LN_GDP_)	-0.787	1.099	-0.716	0.475
D(LN_GOLDPRICE_)	-0.124	0.061	-2.051	0.043
D(LN_HOUSEPRICEINDEX_)	0.459	0.538	0.852	0.396
D(LN_RANDDOLLAREXCHANGE_)	-0.271	0.113	-2.407	0.018
D(LN_REPO_RATE_)	-0.079	0.107	-0.736	0.463
D(LN_SA__CAPFORM_)	0.731	0.402	1.820	0.072
D(LN_SA_BUSCONINDEX_)	0.154	0.178	0.868	0.387
D(LN_SA_GROSSSAVING_)	0.058	0.170	0.342	0.733
D(LN_SA_UNEMPLOY_)	0.155	0.350	0.444	0.658
C	0.016	0.009	1.731	0.086
R-squared	0.480	Mean dependent var		0.011
Adjusted R-squared	0.423	S.D. dependent var		0.048
S.E. of regression	0.036	Akaike info criterion		-3.692
Sum squared resid	0.145	Schwarz criterion		-3.394
Log likelihood	240.035	Hannan-Quinn criter.		-3.571
F-statistic	8.465	Durbin-Watson stat		2.183
Prob(F-statistic)	0.000			

1 b.) Second Listed property Short Term model

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/06/15 Time: 17:34				
Sample (adjusted): 2005M02 2015M04				
Included observations: 123 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_)	-1.456	0.805	-1.808	0.073
D(LN_ALBI_)	1.237	0.170	7.267	0.000
D(LN_ALSI_INDEX_)	0.230	0.079	2.924	0.004
D(LN_GDP_)	-0.642	0.990	-0.648	0.518
D(LN_GOLDPRICE_)	-0.127	0.060	-2.128	0.036
D(LN_HOUSEPRICEINDEX_)	0.465	0.524	0.888	0.376
D(LN_RANDDOLLAREXCHANGE_)	-0.264	0.111	-2.388	0.019
D(LN_REPO_RATE_)	-0.084	0.105	-0.801	0.425
D(LN_SA__CAPFORM_)	0.682	0.377	1.807	0.073
D(LN_SA_BUSCONINDEX_)	0.167	0.174	0.962	0.338
C	0.015	0.009	1.706	0.091
R-squared	0.479	Mean dependent var		0.011
Adjusted R-squared	0.432	S.D. dependent var		0.048
S.E. of regression	0.036	Akaike info criterion		-3.722
Sum squared resid	0.146	Schwarz criterion		-3.470
Log likelihood	239.886	Hannan-Quinn criter.		-3.620
F-statistic	10.290	Durbin-Watson stat		2.180
Prob(F-statistic)	0.000			

1 c.) Third Listed property Short Term model

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/06/15 Time: 17:53				
Sample (adjusted): 2005M02 2015M06				
Included observations: 125 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_)	-1.664	0.824	-2.020	0.046
D(LN_RANDDOLLAREXCHANGE_)	-0.405	0.097	-4.187	0.000
D(LN_ALBI_)	1.236	0.177	6.965	0.000
C	0.021	0.005	3.989	0.000
R-squared	0.382	Mean dependent var		0.010
Adjusted R-squared	0.367	S.D. dependent var		0.048
S.E. of regression	0.038	Akaike info criterion		-3.663
Sum squared resid	0.176	Schwarz criterion		-3.572
Log likelihood	232.909	Hannan-Quinn criter.		-3.626
F-statistic	24.917	Durbin-Watson stat		2.216
Prob(F-statistic)	0.000			

1 d.) First stepwise procedure Listed property Short Term model

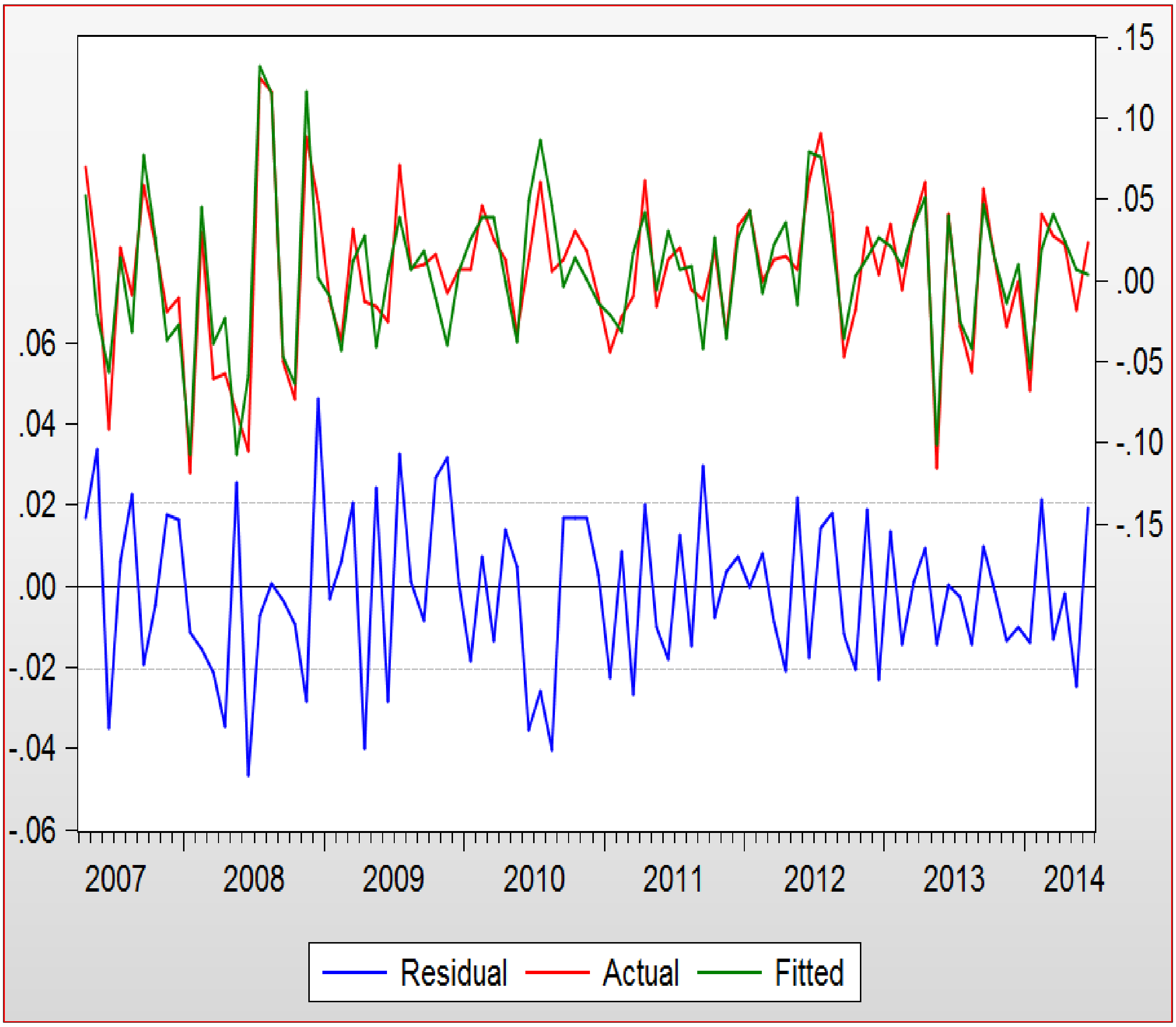
Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/07/15 Time: 23:51				
Sample (adjusted): 2005M10 2014M06				
Included observations: 105 after adjustments				
Convergence achieved after 17 iterations				
MA Backcast: 2005M05 2005M09				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_GDP_TREND_)	2.407	0.743	3.240	0.00
D(LN_ALBI_(-2))	0.535	0.130	4.117	0.00
D(LN_REPO_RATE_(-3))	0.215	0.068	3.140	0.00
D(LN_GOLDPRICE_(-3))	-0.160	0.041	-3.899	0.00
D(LN_ALSI_INDEX_)	0.327	0.073	4.458	0.00
D(LN_GOLDPRICE_)	-0.246	0.046	-5.303	0.00
D(LN_CPI_(-3))	-1.458	0.745	-1.958	0.05
D(LN_ALBI_)	1.329	0.145	9.175	0.00
AR(5)	-0.441	0.083	-5.335	0.00
MA(5)	0.941	0.020	48.131	0.00
R-squared	0.63	Mean dependent var		0.0076
Adjusted R-squared	0.59	S.D. dependent var		0.0503
S.E. of regression	0.0322	Akaike info criterion		-3.95
Sum squared resid	0.0983	Schwarz criterion		-3.69
Log likelihood	217.1364	Hannan-Quinn criter.		-3.84
Durbin-Watson stat	2.57			

2. **Table showing the model output of the 2nd stepwise procedure (Listed property model) – correlogram, results and residuals**

Date: 09/08/15 Time: 00:20				
Sample: 2005M01 2014M06				
Included observations: 87				
Q-statistic probabilities adjusted for 2 ARMA terms and 4 dynamic regressors				
	AC	PAC	Q-Stat	Prob*
1	-0.278	-0.278	6.978	
2	0.061	-0.018	7.316	
3	-0.006	0.007	7.319	0.007
4	-0.149	-0.160	9.384	0.009
5	0.204	0.134	13.324	0.004
6	-0.174	-0.088	16.212	0.003
7	0.149	0.083	18.354	0.003
8	-0.143	-0.111	20.346	0.002
9	-0.055	-0.088	20.642	0.004
10	0.079	-0.006	21.263	0.006
11	-0.152	-0.090	23.608	0.005
12	0.144	0.017	25.747	0.004
13	-0.182	-0.125	29.224	0.002
14	0.114	0.043	30.612	0.002
15	-0.095	-0.106	31.575	0.003
16	0.005	0.009	31.578	0.005
17	-0.080	-0.211	32.285	0.006
18	-0.229	-0.264	38.160	0.001
19	0.111	-0.150	39.559	0.001
20	-0.164	-0.212	42.681	0.001

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/08/15 Time: 00:13				
Sample (adjusted): 2007M04 2014M06				
Included observations: 87 after adjustments				
Convergence achieved after 13 iterations				
MA Backcast: 2005M04 2007M03				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_GDP_TREND_)	1.6135	0.3747	4.3057	0.00
D(LN_GOLDPRICE_(-2))	0.0959	0.0400	2.3964	0.02
D(LN_GOLDPRICE_)	-0.2587	0.0401	-6.4440	0.00
D(LN_ALBI_)	1.4126	0.1507	9.3740	0.00
AR(24)	0.1945	0.0707	2.7503	0.01
MA(24)	-0.9161	0.0169	-54.1727	0.00
R-squared	0.82	Mean dependent var		0.0047
Adjusted R-squared	0.81	S.D. dependent var		0.0468
S.E. of regression	0.0203	Akaike info criterion		-4.89
Sum squared resid	0.0334	Schwarz criterion		-4.72
Log likelihood	218.64	Hannan-Quinn criter.		-4.82
Durbin-Watson stat	2.52			

3. **Residual graph of the 2nd stepwise procedure (Listed property model).**

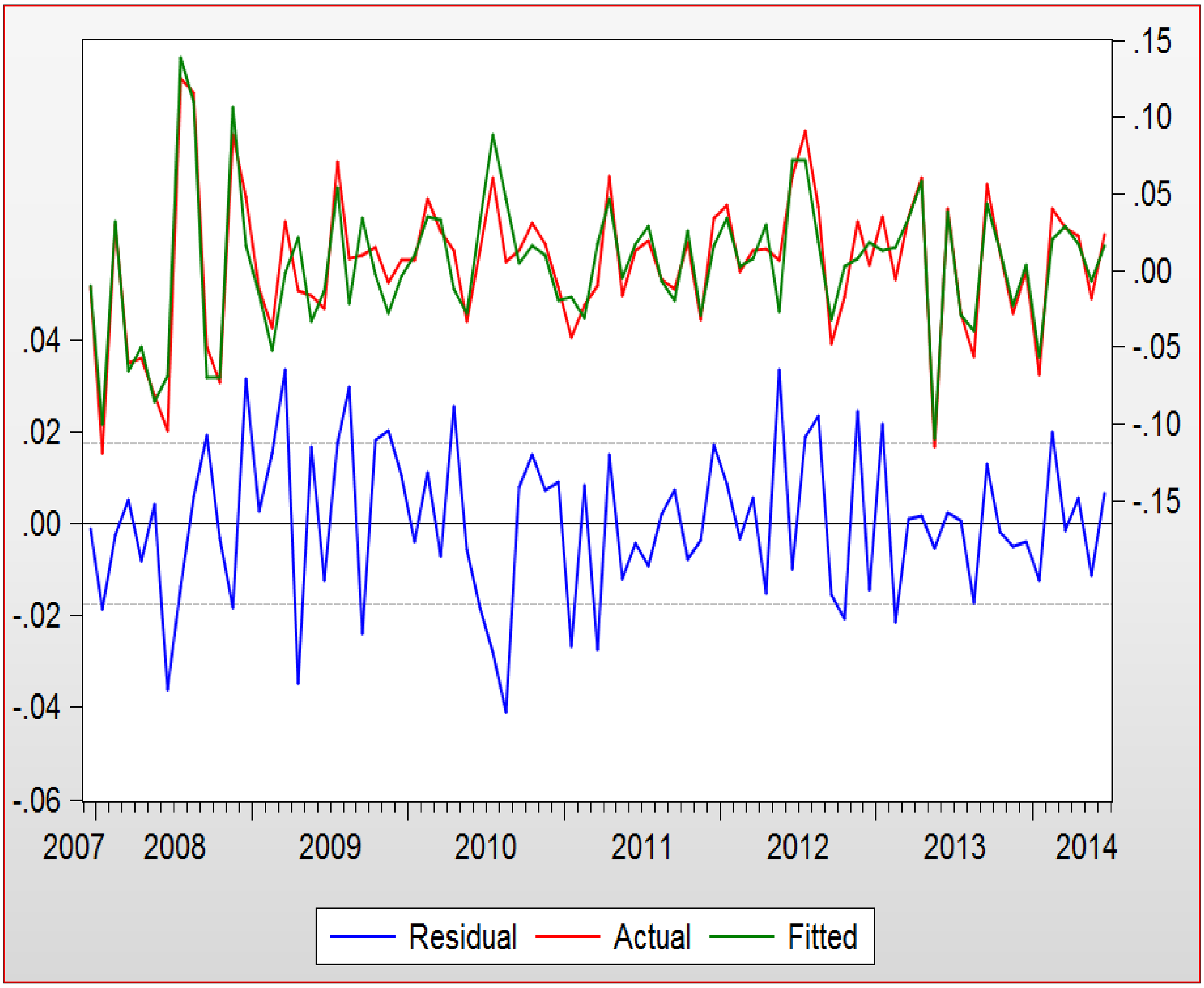


4. Table showing the 3rd stepwise procedure model results (Listed property model) – correlogram and model output

Date: 09/09/15 Time: 05:58				
Sample: 2005M01 2014M06				
Included observations: 79				
Q-statistic probabilities adjusted for 2 ARMA terms and 5 dynamic				
regressors				
	AC	PAC	Q-Stat	Prob*
1	-0.21	-0.21	3.71	
2	0.08	0.04	4.26	
3	-0.05	-0.03	4.50	0.03
4	-0.14	-0.17	6.23	0.04
5	0.27	0.23	12.54	0.01
6	-0.00	0.12	12.54	0.01
7	-0.08	-0.13	13.16	0.02
8	0.06	0.03	13.52	0.04
9	-0.19	-0.09	16.69	0.02
10	0.12	-0.00	18.09	0.02
11	0.07	0.08	18.51	0.03
12	-0.16	-0.12	20.83	0.02
13	-0.05	-0.17	21.06	0.03
14	-0.02	0.06	21.11	0.05
15	0.08	0.12	21.79	0.06
16	-0.05	-0.19	22.05	0.08
17	-0.23	-0.29	27.64	0.02
18	-0.16	-0.20	30.29	0.02
19	-0.01	-0.05	30.29	0.02
20	-0.05	-0.16	30.59	0.03

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/09/15 Time: 05:56				
Sample (adjusted): 2007M12 2014M06				
Included observations: 79 after adjustments				
Convergence achieved after 10 iterations				
MA Backcast: 2005M12 2007M11				
Variable	Coefficie	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-10))	-1.796	0.596	-3.014	0.004
D(LN_GDP_TREND_(-10))	-8.173	4.232	-1.931	0.057
D(LN_GOLDPRICE_(-5))	0.127	0.039	3.255	0.002
D(LN_GOLDPRICE_)	-0.228	0.039	-5.780	0.000
D(LN_ALBI_)	1.374	0.146	9.419	0.000
C	0.073	0.028	2.604	0.011
AR(24)	0.201	0.063	3.196	0.002
MA(24)	-0.913	0.017	-55.247	0.000
R-squared	0.87	Mean dependent var		0.004
Adjusted R-squared	0.86	S.D. dependent var		0.047
S.E. of regression	0.02	Akaike info criterion		-5.15
Sum squared resid	0.02	Schwarz criterion		-4.91
Log likelihood	211.34	Hannan-Quinn criter.		-5.05
F-statistic	68.80	Durbin-Watson stat		2.42
Prob(F-statistic)	0.00			

5. **Residual graph of the 3rd stepwise procedure (Listed property model).**



6. Table showing the 4th stepwise procedure (Listed property model) – correlogram and models output

Date: 09/09/15 Time: 06:11				
Sample: 2005M01 2014M06				
Included observations: 79				
Q-statistic probabilities adjusted for 2 ARMA terms and 4 dynamic regressors				
	AC	PAC	Q-Stat	Prob*
1	-0.19	-0.19	3.10	
2	0.11	0.07	4.06	
3	0.01	0.04	4.06	0.04
4	-0.13	-0.14	5.60	0.06
5	0.26	0.23	11.65	0.01
6	0.00	0.12	11.66	0.02
7	-0.09	-0.14	12.42	0.03
8	0.04	-0.03	12.54	0.05
9	-0.20	-0.13	16.25	0.02
10	0.12	0.02	17.60	0.02
11	0.06	0.09	17.98	0.04
12	-0.16	-0.12	20.28	0.03
13	-0.05	-0.16	20.53	0.04
14	-0.02	0.09	20.55	0.06
15	0.04	0.09	20.70	0.08
16	-0.07	-0.22	21.20	0.10
17	-0.23	-0.31	26.80	0.03
18	-0.15	-0.18	29.15	0.02
19	-0.01	0.01	29.17	0.03
20	-0.05	-0.08	29.40	0.04

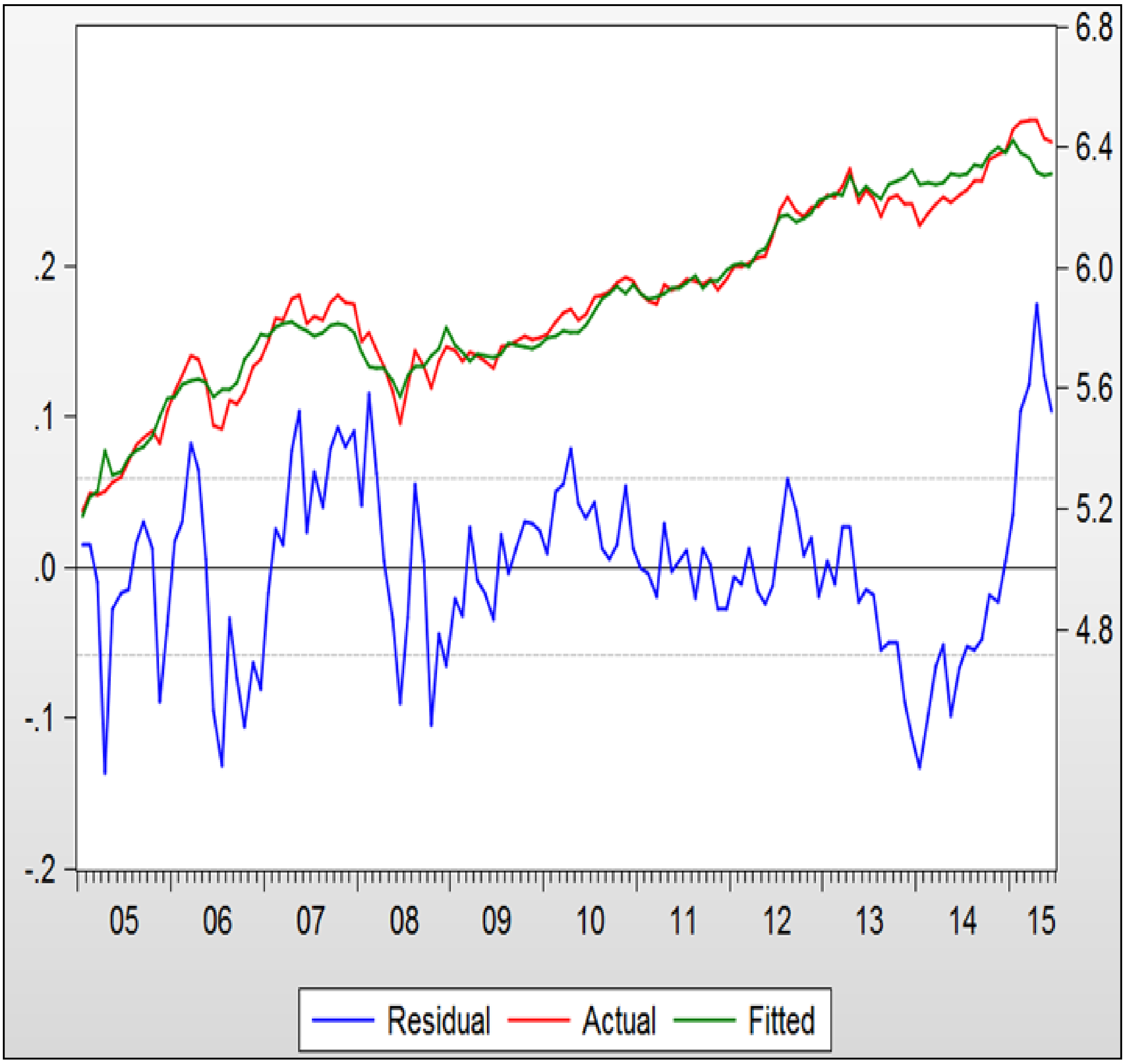
Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/09/15 Time: 06:09				
Sample (adjusted): 2007M12 2014M06				
Included observations: 79 after adjustments				
Convergence achieved after 11 iterations				
MA Backcast: 2005M12 2007M11				
Variable	Coefficier	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-10))	-1.99	0.59	-3.38	0.001
D(LN_GOLDPRICE_(-5))	0.13	0.04	3.31	0.001
D(LN_GOLDPRICE_)	-0.23	0.04	-5.75	0.000
D(LN_ALBI_)	1.42	0.15	9.67	0.000
C	0.02	0.00	5.46	0.000
AR(24)	0.19	0.07	2.86	0.006
MA(24)	-0.92	0.02	-59.86	0.000
R-squared	0.86	Mean dependent var		0.00
Adjusted R-squared	0.85	S.D. dependent var		0.05
S.E. of regression	0.02	Akaike info criterion		-5.12
Sum squared resid	0.02	Schwarz criterion		-4.91
Log likelihood	209.33	Hannan-Quinn criter.		-5.04
F-statistic	76.76	Durbin-Watson stat		2.38
Prob(F-statistic)	0.00			

7. Residual graph of the 4th stepwise procedure (Listed property model)

8. Engle and Granger Test Output(Equation G) - Listed property model

Cointegration Test - Engle-Granger				
Date: 09/12/15 Time: 07:15				
Equation: COINTEQ				
Specification: LN_LISTEDPROPINDEX_ LN_GDP_TREND_				
LN_GOLDPRICE_ LN_ALBL_ LN_CPI_ LN_ALSITREND_				
LN_RANDDOLLARTREND_ C				
Cointegrating equation deterministics: C				
Null hypothesis: Series are not cointegrated				
Automatic lag specification (lag=0 based on Schwarz Info Criterion,				
maxlag=12)				
		Value	Prob.*	
Engle-Granger tau-statistic		-4.091	0.347	
Engle-Granger z-statistic		-31.264	0.282	
*MacKinnon (1996) p-values.				
Intermediate Results:				
Rho - 1		-0.250		
Rho S.E.		0.061		
Residual variance		0.002		
Long-run residual variance		0.002		
Number of lags		0		
Number of observations		125		
Number of stochastic trends**		7		
**Number of stochastic trends in asymptotic distribution.				
Engle-Granger Test Equation:				
Dependent Variable: D(RESID)				
Method: Least Squares				
Date: 09/12/15 Time: 07:15				
Sample (adjusted): 2005M02 2015M06				
Included observations: 125 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.250	0.061	-4.091	0.000
R-squared	0.119	Mean dependent var		0.001
Adjusted R-sc	0.119	S.D. dependent var		0.041
S.E. of regress	0.039	Akaike info criterion		-3.656
Sum squared	0.186	Schwarz criterion		-3.633
Log likelihood	229.484	Hannan-Quinn criter.		-3.647
Durbin-Watso	1.995			

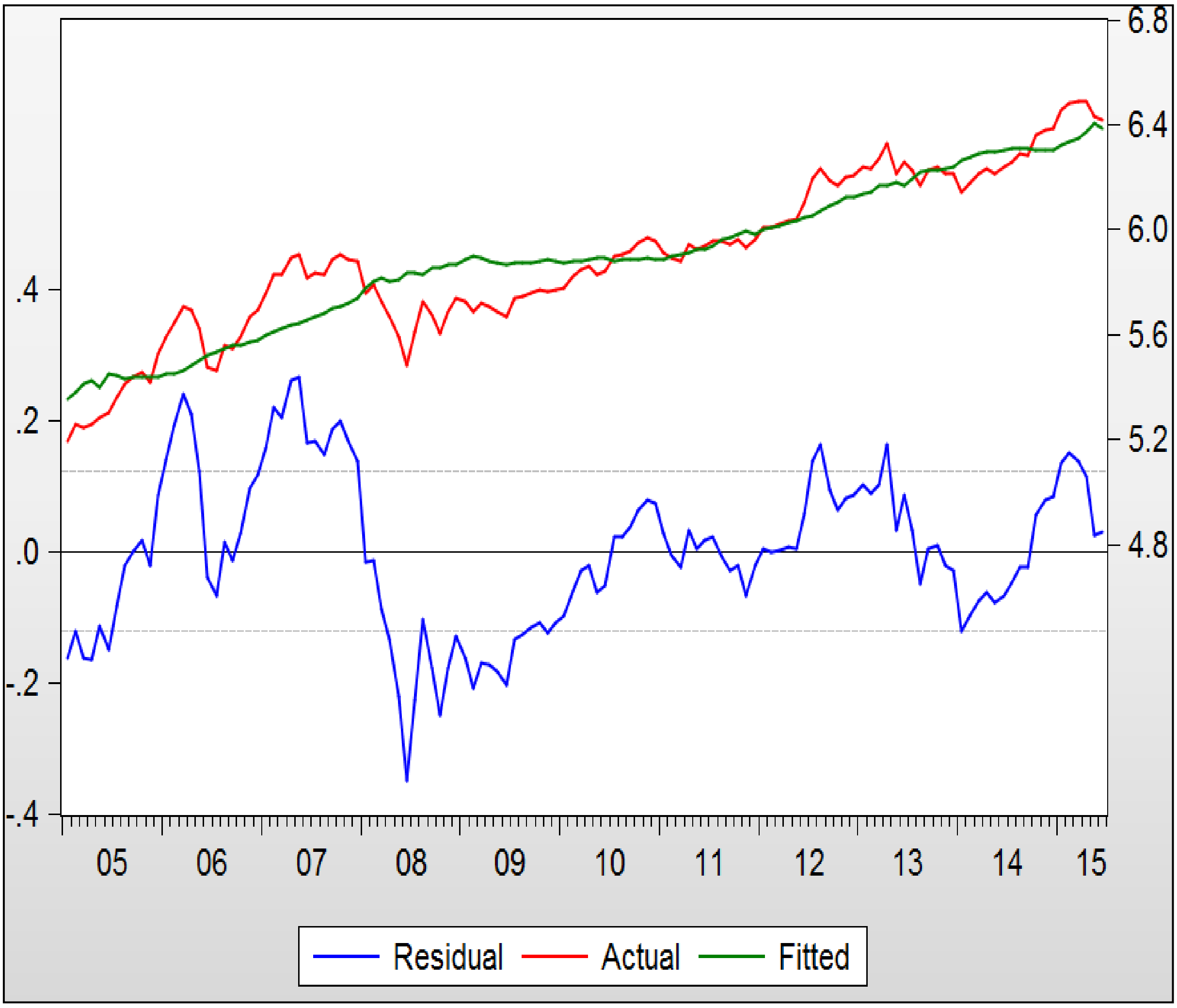
9. Fit of equation G (tested for cointegration) - Listed property model



10. Engle and Granger Test Output(Equation H) - Listed property model

Cointegration Test - Engle-Granger				
Date: 09/12/15 Time: 22:17				
Equation: COINTEQ4				
Specification: LN_LISTEDPROPINDEX_ LN_CPI_ LN_RANDDOLLARTREN				
D_ LN_GOLDPRICE_ C				
Cointegrating equation deterministics: C				
Null hypothesis: Series are not cointegrated				
Automatic lag specification (lag=0 based on Schwarz Info Criterion,				
maxlag=12)				
		Value	Prob.*	
Engle-Granger tau-statistic		-2.63	0.61	
Engle-Granger z-statistic		-12.26	0.66	
*MacKinnon (1996) p-values.				
Intermediate Results:				
Rho - 1		-0.10		
Rho S.E.		0.04		
Residual variance		0.00		
Long-run residual variance		0.00		
Number of lags		-		
Number of observations		125.00		
Number of stochastic trends**		4.00		
**Number of stochastic trends in asymptotic distribution.				
Engle-Granger Test Equation:				
Dependent Variable: D(RESID)				
Method: Least Squares				
Date: 09/12/15 Time: 22:17				
Sample (adjusted): 2005M02 2015M06				
Included observations: 125 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.10	0.037317388	-2.629209	0.01
R-squared	0.05	Mean dependent var		0.00
Adjusted R-squared	0.05	S.D. dependent var		0.05
S.E. of regression	0.05	Akaike info criterion		-3.13
Sum squared resid	0.31	Schwarz criterion		-3.11
Log likelihood	196.67	Hannan-Quinn criter.		-3.12
Durbin-Watson stat	1.71			

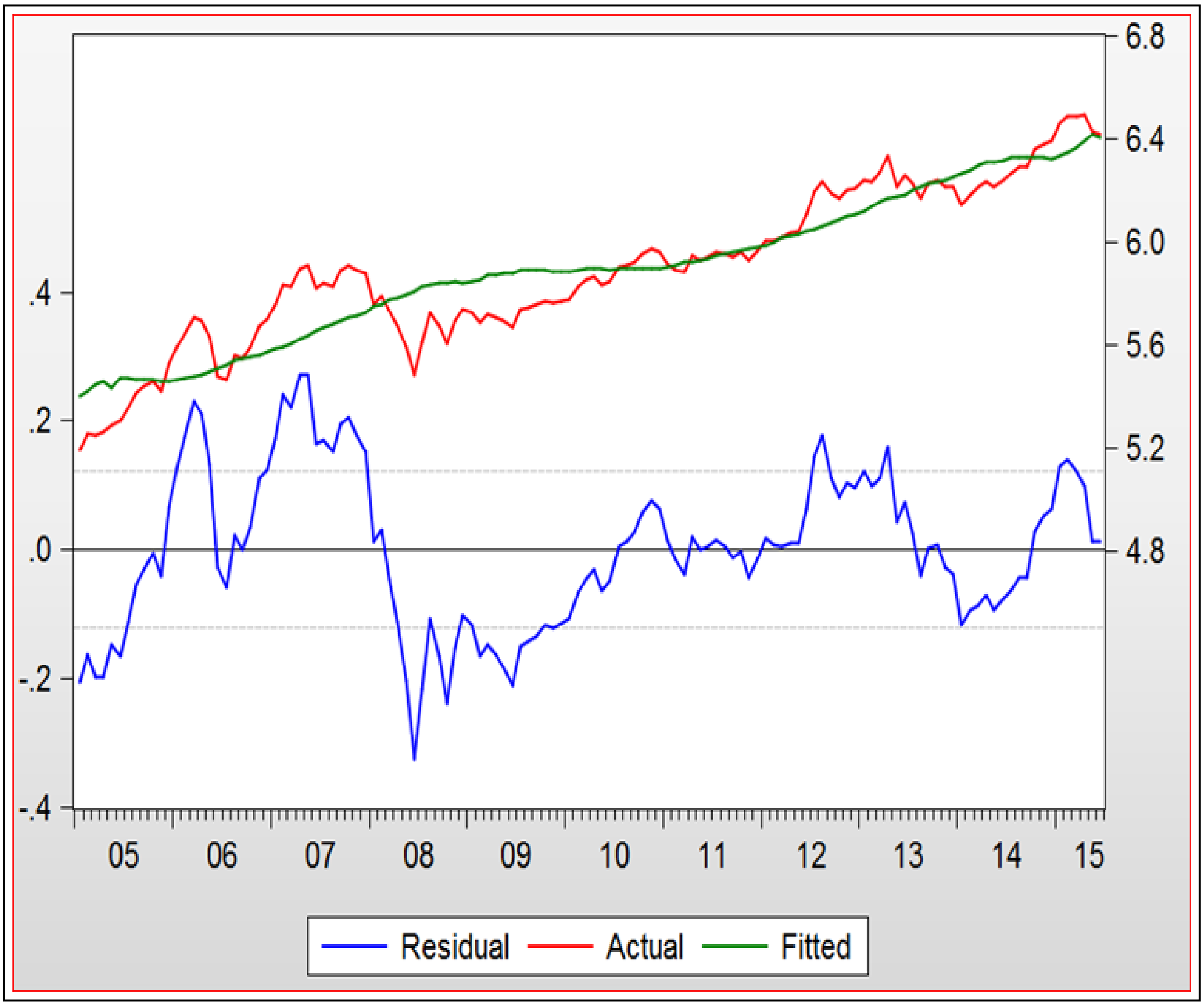
11. Fit of equation H (tested for cointegration) - Listed property model



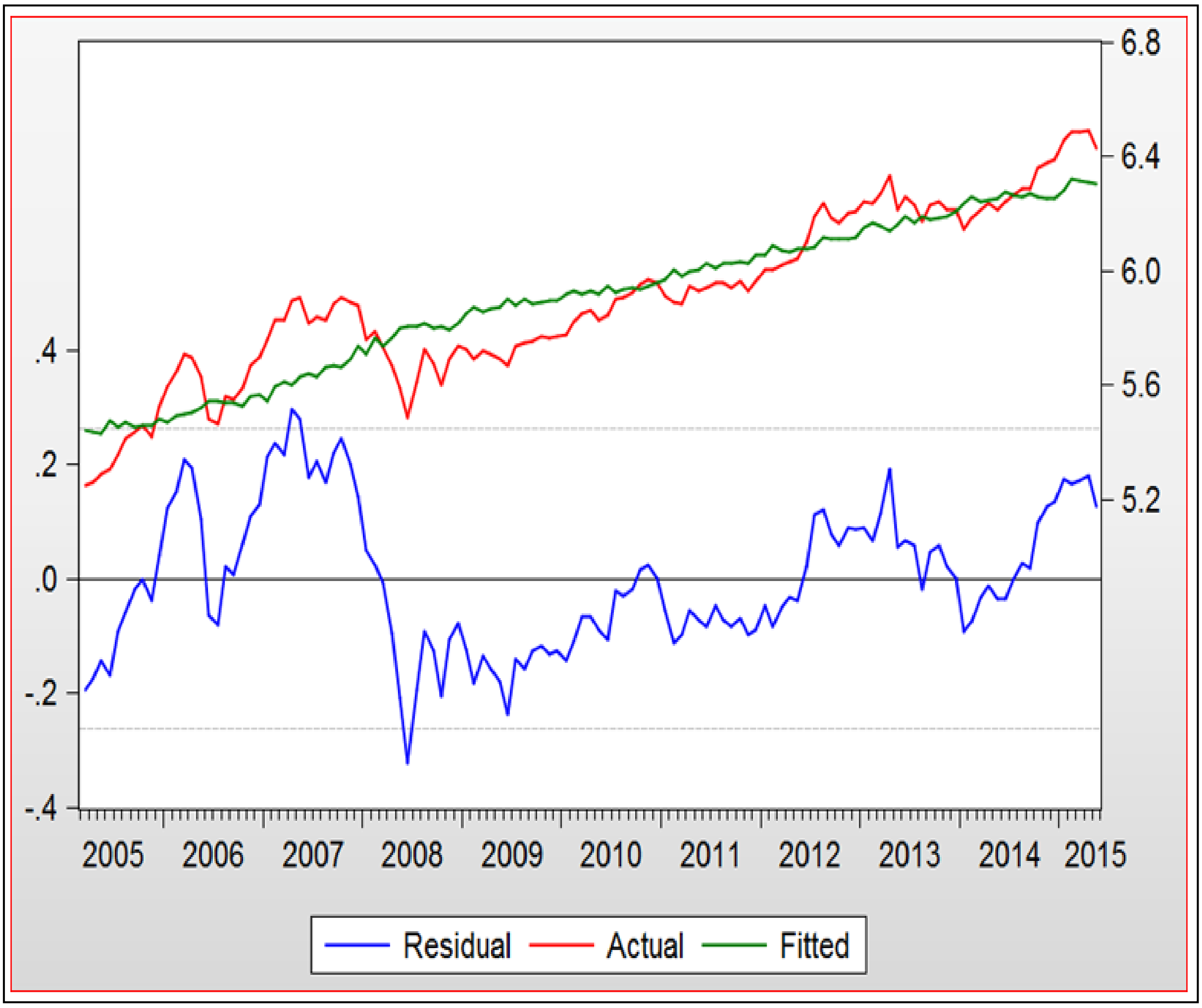
12. Engle and Granger Test Output(Equation (I)) - Listed property model

Cointegration Test - Engle-Granger				
Date: 09/12/15 Time: 22:22				
Equation: COINTEQ4				
Specification: LN_LISTEDPROPINDEX_ LN_CPI_ LN_RANDDOLLARTREN				
D_ C				
Cointegrating equation deterministics: C				
Null hypothesis: Series are not cointegrated				
Automatic lag specification (lag=0 based on Schwarz Info Criterion,				
maxlag=12)				
		Value	Prob.*	
Engle-Granger tau-statistic		-2.63	0.42	
Engle-Granger z-statistic		-11.65	0.49	
*MacKinnon (1996) p-values.				
Intermediate Results:				
Rho - 1		-0.09		
Rho S.E.		0.04		
Residual variance		0.00		
Long-run residual variance		0.00		
Number of lags		-		
Number of observations		125.00		
Number of stochastic trends**		3.00		
**Number of stochastic trends in asymptotic distribution.				
Engle-Granger Test Equation:				
Dependent Variable: D(RESID)				
Method: Least Squares				
Date: 09/12/15 Time: 22:22				
Sample (adjusted): 2005M02 2015M06				
Included observations: 125 after adjustments				
Variable	Coefficie	Std. Err	t-Statisti	Prob.
RESID(-1)	-0.09	0.04	-2.63	0.01
R-squared	0.05	Mean depende		0.00
Adjusted R-squared	0.05	S.D. dependen		0.05
S.E. of regression	0.05	Akaike info crite		-3.22
Sum squared resid	0.29	Schwarz criteric		-3.19
Log likelihood	202.02	Hannan-Quinn		-3.21
Durbin-Watson stat	1.66			

13. Fit of equation (I) (tested for cointegration) - Listed property model

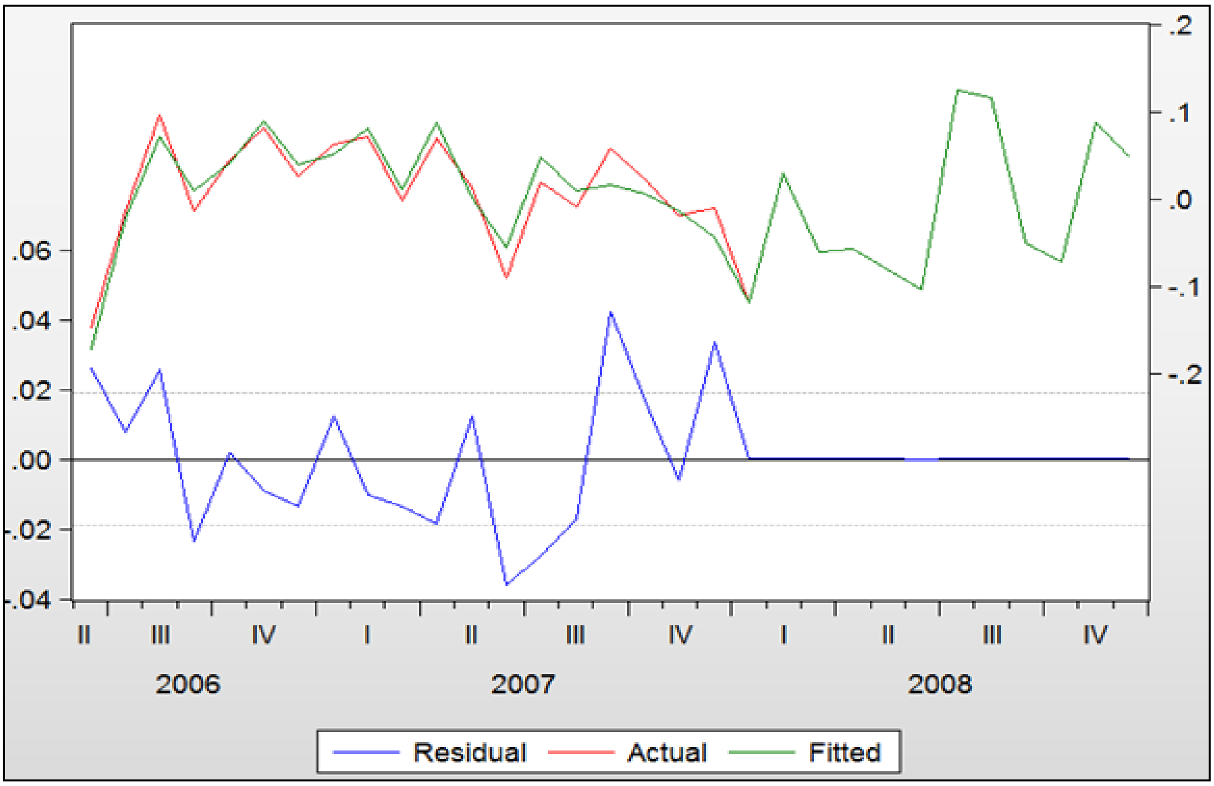


14. Fit of equation 4 (tested for cointegration) - Listed property model



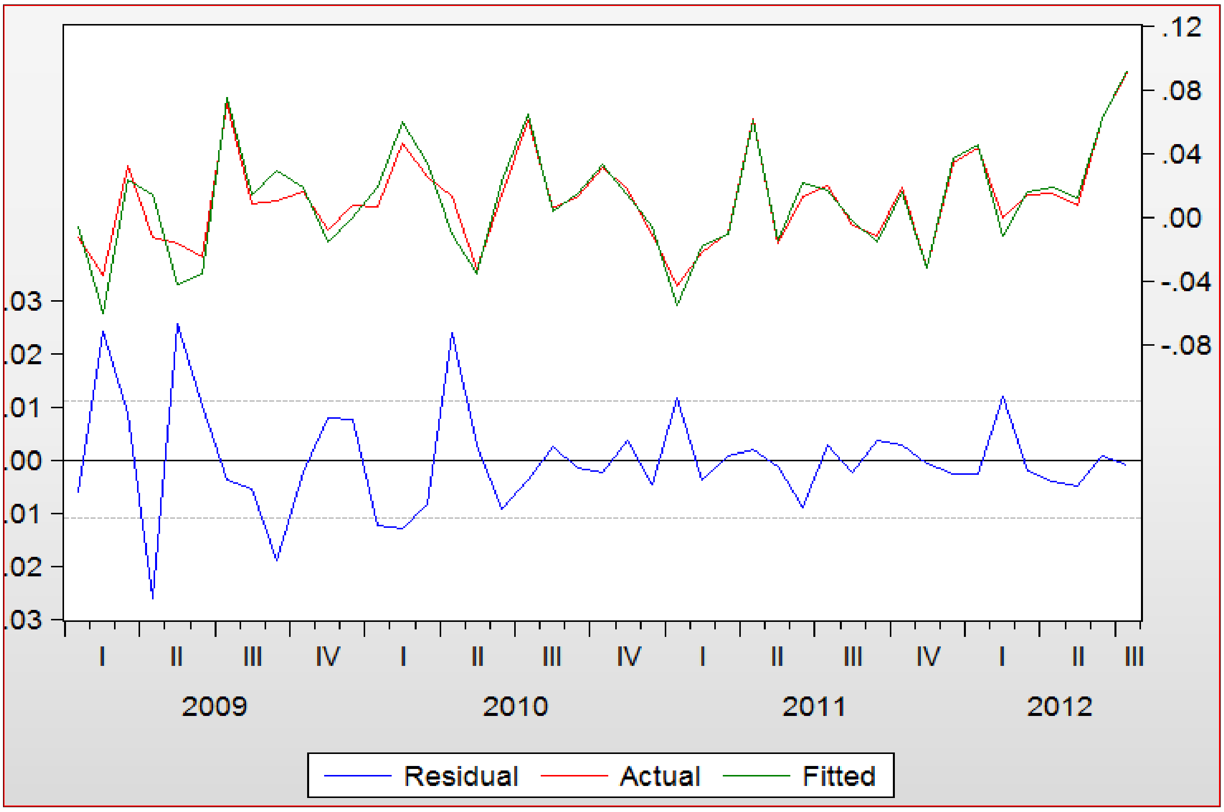
15. Rate hiking model (JSE-listed property short-term model)

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/16/15 Time: 05:20				
Sample (adjusted): 2006M06 2008M12				
Included observations: 31 after adjustments				
Convergence achieved after 21 iterations				
MA Backcast: 2005M06 2006M05				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-4))	8.875	0.81	10.92	0.000
D(LN_GOLDPRICE_(-4))	-1.368	0.08	-17.63	0.000
D(LN_GOLDPRICE_)	-0.153	0.06	-2.71	0.012
D(LN_ALBI_(-1))	-1.328	0.21	-6.27	0.000
C	-0.052	0.01	-7.16	0.000
AR(12)	-0.243	0.07	-3.56	0.002
MA(12)	-1.000	0.00	-3.19	0.000
R-squared	0.94	Mean dependent var		0.00
Adjusted R-squared	0.93	S.D. dependent var		0.07
S.E. of regression	0.02	Akaike info criterion		-4.89
Sum squared resid	0.01	Schwarz criterion		-4.56
Log likelihood	82.74	Hannan-Quinn criter.		-4.78
F-statistic	66.36	Durbin-Watson stat		1.82
Prob(F-statistic)	0.00			



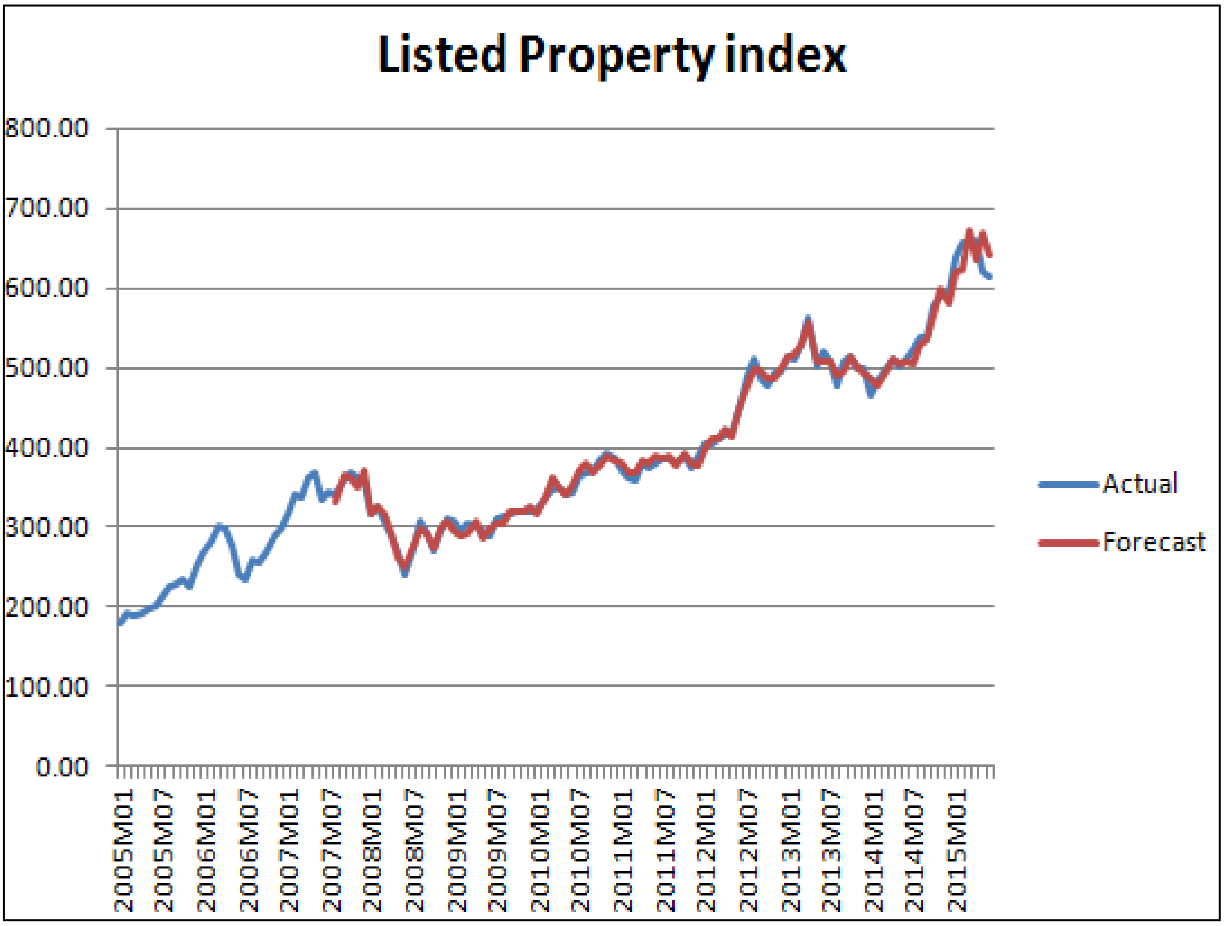
16. Rate cutting model (JSE-listed property short-term model)

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/16/15 Time: 04:58				
Sample: 2009M01 2012M07				
Included observations: 43				
Convergence achieved after 10 iterations				
MA Backcast: 2007M01 2008M12				
Variable	Coefficier	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-1))	-2.02	0.61	-3.29	0.00
D(LN_GOLDPRICE_)	-0.43	0.05	-9.27	0.00
D(LN_GOLDPRICE_(-4))	-0.24	0.05	-4.50	0.00
D(LN_ALBI_)	1.03	0.13	7.83	0.00
C	0.03	0.00	7.37	0.00
AR(24)	-0.60	0.08	-7.37	0.00
MA(24)	-0.96	0.01	-68.86	0.00
R-squared	0.89	Mean dependent var		0.011
Adjusted R-squared	0.87	S.D. dependent var		0.030
S.E. of regression	0.01	Akaike info criterion		-6.052
Sum squared resid	0.00	Schwarz criterion		-5.765
Log likelihood	137.12	Hannan-Quinn criter.		-5.946
F-statistic	47.36	Durbin-Watson stat		2.236
Prob(F-statistic)	0.00			



17. Rand dollar effects on short term relation (Listed property model)

Dependent Variable: D(LN_LISTEDPROPINDEX_)				
Method: Least Squares				
Date: 09/16/15 Time: 06:19				
Sample (adjusted): 2007M08 2014M06				
Included observations: 83 after adjustments				
Convergence achieved after 11 iterations				
MA Backcast: 2005M08 2007M07				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-5))	-2.27	0.78	-2.92	0.00
D(LN_RANDDOLLAREXCHANGE_(-6))	-0.22	0.09	-2.43	0.02
D(LN_ALSI_INDEX_(-4))	0.19	0.07	2.57	0.01
D(LN_GOLDPRICE_(-5))	0.12	0.05	2.56	0.01
D(LN_ALBI_)	1.41	0.17	8.44	0.00
C	0.02	0.00	3.50	0.00
AR(24)	0.30	0.07	4.10	0.00
MA(24)	-0.91	0.02	-53.80	0.00
R-squared	0.82	Mean dependent var		0.00
Adjusted R-squared	0.80	S.D. dependent var		0.05
S.E. of regression	0.02	Akaike info criterion		-4.83
Sum squared resid	0.03	Schwarz criterion		-4.60
Log likelihood	208.52	Hannan-Quinn criter.		-4.74
F-statistic	47.89	Durbin-Watson stat		2.30
Prob(F-statistic)	0.00			



18. JSE-all share index (short-term model) Hansen instability and Engle-Granger tests

Cointegration Test - Hansen Parameter Instability				
Date: 10/02/15 Time: 04:45				
Equation: EQUITYCOINT				
Series: LN_ALSI_INDEX_ LN_CPI_				
Null hypothesis: Series are cointegrated				
Cointegrating equation deterministics: C				
	Stochastic	Deterministic	Excluded	
Lc statistic	Trends (m)	Trends (k)	Trends (p2)	Prob.*
0.517786051	1	0	0	0.0365
*Hansen (1992b) Lc(m2=1, k=0) p-values, where m2=m-p2 is the number				
of stochastic trends in the asymptotic distribution				

Cointegration Test - Engle-Granger				
Date: 10/06/15 Time: 06:40				
Equation: EQUITYCOINT				
Specification: LN_ALSI_INDEX_ LN_CPI_ C				
Cointegrating equation deterministics: C				
Null hypothesis: Series are not cointegrated				
Automatic lag specification (lag=0 based on Schwarz Info Criterion,				
maxlag=12)				
		Value	Prob.*	
Engle-Granger tau-statistic		-2.130	0.463	
Engle-Granger z-statistic		-6.798	0.579	
*MacKinnon (1996) p-values.				
Intermediate Results:				
Rho - 1		-0.054819		
Rho S.E.		0.02573979		
Residual variance		0.0021121		
Long-run residual variance		0.0021121		
Number of lags		0		
Number of observations		124		
Number of stochastic trends**		2		
**Number of stochastic trends in asymptotic distribution.				
Engle-Granger Test Equation:				
Dependent Variable: D(RESID)				
Method: Least Squares				
Date: 10/06/15 Time: 06:40				
Sample (adjusted): 2005M02 2015M05				
Included observations: 124 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.055	0.026	-2.130	0.035
R-squared	0.032	Mean dependent var		0.003
Adjusted R-sq	0.032	S.D. dependent var		0.047
S.E. of regress	0.046	Akaike info criterion		-3.314
Sum squared r	0.260	Schwarz criterion		-3.291
Log likelihood	206.478	Hannan-Quinn criter.		-3.305
Durbin-Watso	2.008			


11.2
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10.4
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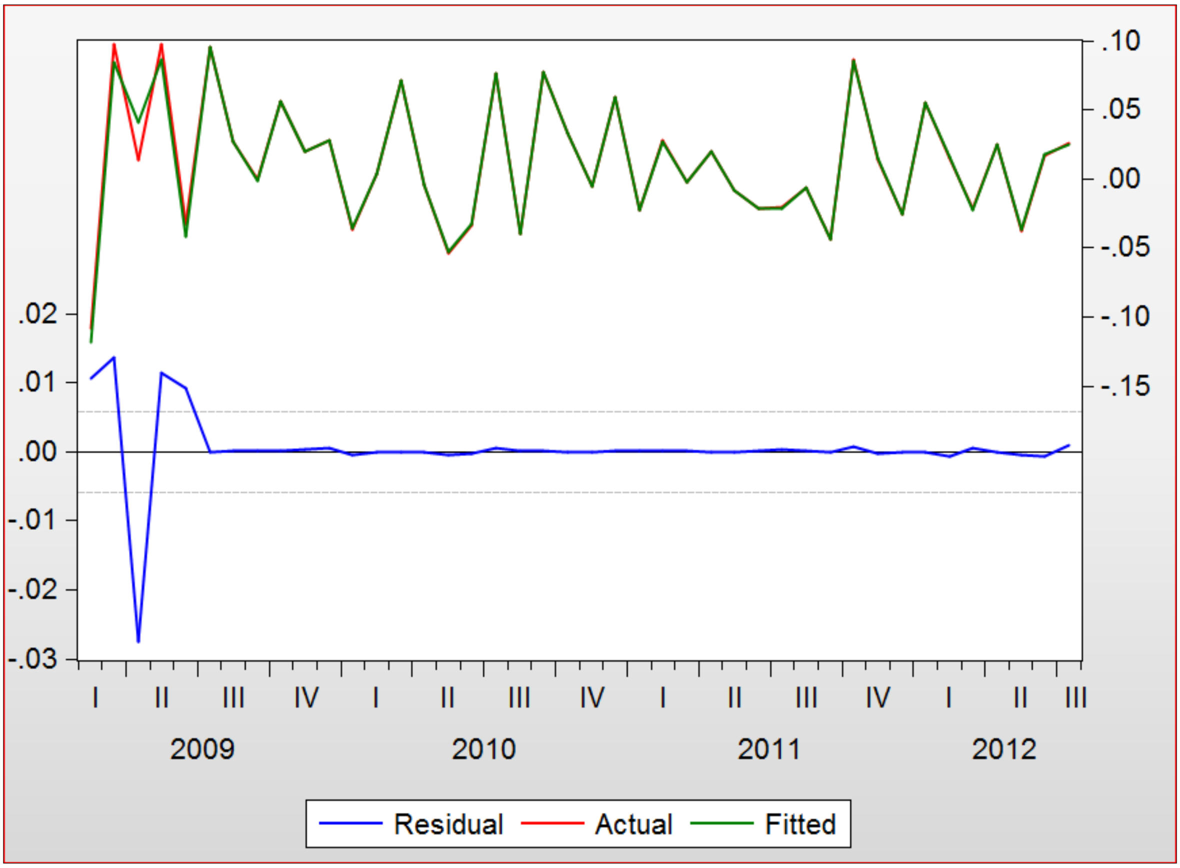
14
15
Residual
Actual
Fitted

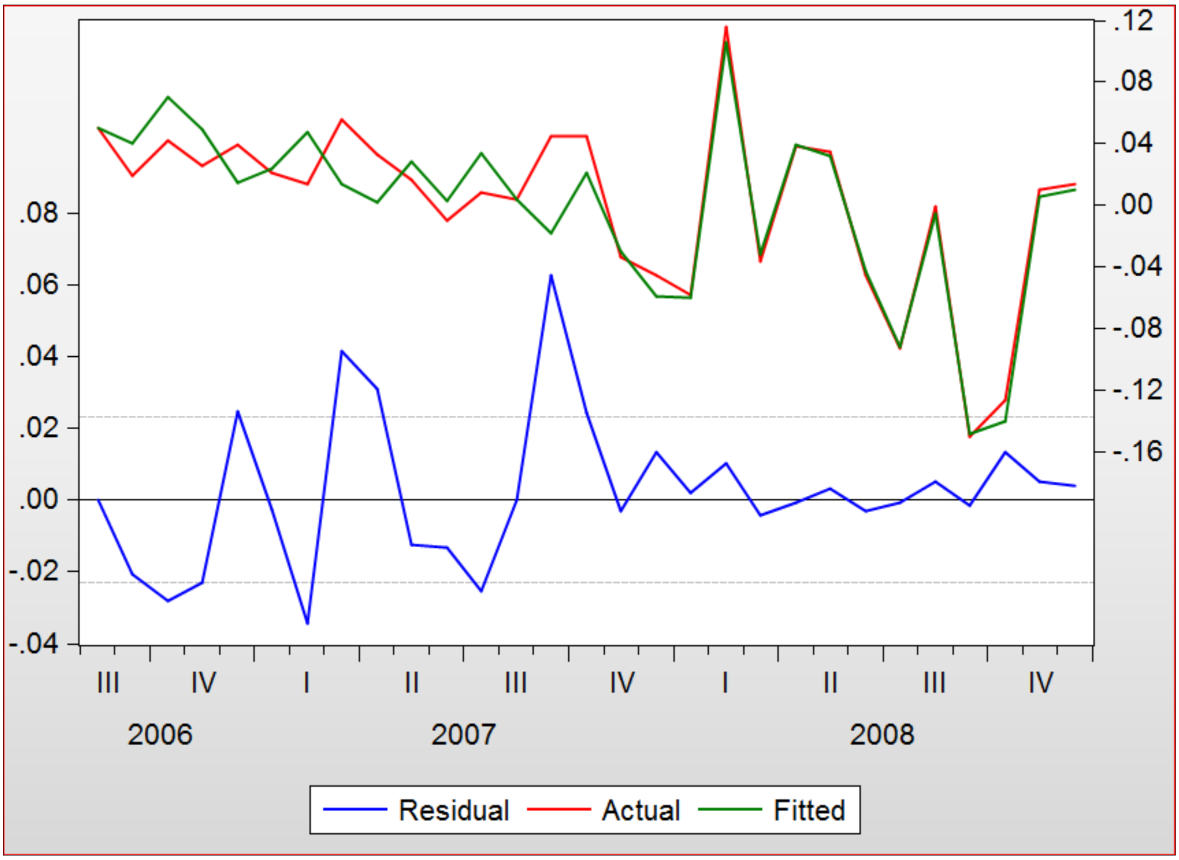
19. Rate cutting cycle model output for the JSE-all share index

Dependent Variable: D(LN_ALSI_INDEX_)				
Method: Least Squares				
Date: 10/02/15 Time: 04:04				
Sample (adjusted): 2009M02 2012M07				
Included observations: 42 after adjustments				
Convergence achieved after 11 iterations				
MA Backcast: 2006M02 2009M01				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-3))	4.140	0.641	6.459	0.000
D(LN_GOLDPRICE_(-2))	-0.208	0.048	-4.309	0.000
D(LN_ALBI_(-12))	-2.813	0.217	-12.963	0.000
AR(36)	0.275	0.023	11.936	0.000
MA(36)	-0.998	0.006	-179.521	0.000
R-squared	0.986	Mean dependent var		0.012
Adjusted R-squared	0.984	S.D. dependent var		0.046
S.E. of regression	0.006	Akaike info criterion		-7.327
Sum squared resid	0.001	Schwarz criterion		-7.120
Log likelihood	158.873	Hannan-Quinn criter.		-7.251
Durbin-Watson stat	2.606			



20. Rate hiking cycle model output for the JSE-All share index

Dependent Variable: D(LN_ALSI_INDEX_)				
Method: Least Squares				
Date: 10/02/15 Time: 04:39				
Sample (adjusted): 2006M08 2008M12				
Included observations: 29 after adjustments				
Convergence achieved after 16 iterations				
MA Backcast: 2005M08 2006M07				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_CPI_(-2))	-1.447	0.435	-3.327	0.003
D(LN_GOLDPRICE_(-2))	0.593	0.071	8.322	0.000
D(LN_ALBI_)	-1.070	0.263	-4.076	0.000
D(LN_RANDDOLLAREXCHANGE_(-5))	-0.413	0.144	-2.860	0.009
AR(13)	-0.901	0.140	-6.433	0.000
MA(12)	-0.974	0.023	-42.597	0.000
R-squared	0.863	Mean dependent var		0.001
Adjusted R-squared	0.833	S.D. dependent var		0.057
S.E. of regression	0.023	Akaike info criterion		-4.514
Sum squared resid	0.012	Schwarz criterion		-4.231
Log likelihood	71.448	Hannan-Quinn criter.		-4.425
Durbin-Watson stat	1.651			



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Signature:	Date:	

22. Ethic clearance

The study made use of publicly available information. Therefore, no confidentiality and anonymity agreements will be breached. The researcher is also committed to high standards of integrity and quality research. Below is proof of the Ethic clearance approval:

Gordon Institute of Business Science
University of Pretoria

Dear Mr Patrick Nkuna

Protocol Number: **Temp2015-01151**

Title: **SA listed real estate as protection against inflation**

Please be advised that your application for Ethical Clearance has been APPROVED.

You are therefore allowed to continue collecting your data.

We wish you everything of the best for the rest of the project.

Kind Regards,

GIBS Ethics Administrator

23. Time schedule

The author planned to complete the research in three stages. Stage one will consisted of an introduction, literature review and research methodology chapters of the final report. These chapters were completed in May 2015. The second stage was the data collection and analysis; all data analysis was completed by the end of June 2015. Stage three was the preparation of the final report, which was completed by the October 2015.

Below is a detailed project plan:

Task	Duration	Due Date
Submit Research Proposal		4 May 2015
Elective 1	4 days	09 – 16 May 2015
Marking of Proposal deadline		17 May 2015
Meeting with Supervisor for proposal feedback	1 day	In May 2015
Elective 2	4 days	13 – 20 June 2015
Complete literature review	2 months	Mid - July 2015
Elective 3	4 days	18 – 25 July 2015
Complete Ethics Clearance	1 day	27 July 2015
Draft chapter 1-4 and submit to supervisor	4 weeks	In August 2015
Elective 4	4 days	15 – 22 August 2015
Meeting with Supervisor to discuss feedback for chapter 1 - 4	1 day	In August 2015
Elective 5	4 days	27 – 30 August 2015
Start Data Collection	1.5 weeks	End of August 2015
Data Analysis	1.5 weeks	Mid September 2015
Draft chapters 5 - 7 and submit to supervisor	1.5 weeks	End of September 2015
Meeting with Supervisor for chapter 5 – 7 feedback	1 day	Early October 2015
Global Elective	10 days	10 – 19 October 2015
Finalise document	11 days	End of October 2015
Proof Read and print	3 days	02 November 2015
Submission of research project	1 day	09 November 2015

24. Resources

The cost associated with the completion of the research will be minimal, as all the data will be collected from Statistics South Africa, South African Reserve bank and I-net Bridge; the data is also readily available from GIBS university databases (such as Reuters), and can be collected at no additional cost.

25. Turnitit results

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Chapter 1: Problem Definition

1.1. Introduction

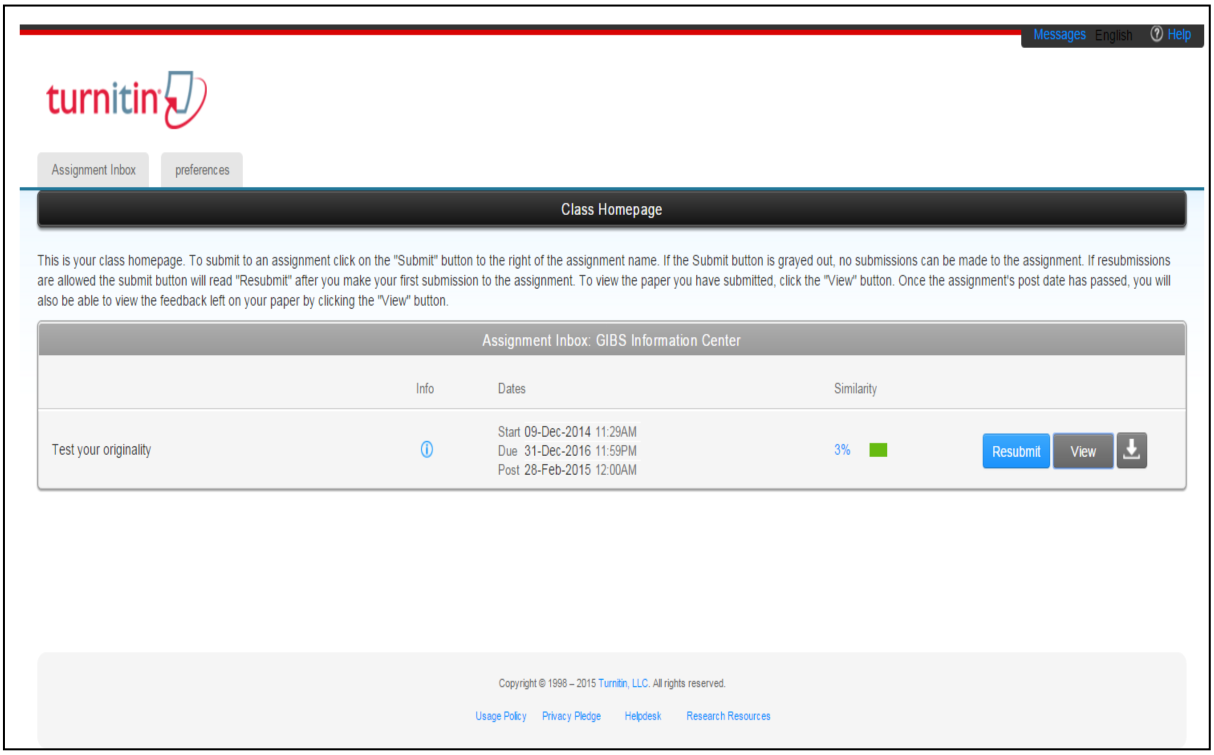
An article written by the South African REITs association comparing the performance of listed real estate to other asset classes grabbed the attention of the author and the idea to conduct a test to assess the effectiveness of JSE listed real estate as an inflation hedge was born.

The Research purpose and scope (RPS) section of the paper attempts to provides an overview as to why inflation is an issue in any economy, more especially in South Africa (which is one of the emerging markets that are most affected by inflation due to Quantitative Easying). Moreover, the author outlines the objectives of the research in this section as well.

Quantitative Easing (QE) and its effects are also discussed in the research motivation section, as this makes inflation - hedging topical in South Africa. This is owing to inflation fears that were created as a result of QE in most emerging markets.

The abovementioned section (the research motivation section) goes a step further to touch on some of the potential benefits of introducing Real Estate Investment Trusts (REITs) into the Johannesburg Stock Exchange (JSE). The introduction of REITs not only presents an opportunity to assess the effectiveness of South African listed real estate returns against hedging inflation but most importantly presents an opportunity to compare the results to the insights discovered in other countries. REITs are easier to compare between countries as they are a commonly used form of listed real estate asset class in most countries.

Although the author will focus on testing the relationship between South African listed real estate returns against inflation, however, the literature touches on a lot of research that was done in both the direct and indirect real estate markets - indirect real estate investment encompasses the purchase of listed real estate, where the investor may own a share of a diversified portfolio of properties, that is, the investor does not own the entire physical real estate portfolio, but rather a percentage of the real estate portfolio in conjunction with other investors (previously in South Africa,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South African listed real estate as protection against inflation

by Pat Nkuna

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the indirect real estate investment vehicles that were used were property unit trusts (PUTs) and property loan stocks (PLSs)) (Bauer, 2012). The aim of this approach was to draw from the knowledge of other scholars on how test the relationship between inflation and real estate returns. Moreover, the author wishes to compare the findings from the research to the common thread that is derived from the expansive literature on both direct and indirect real estate markets.

The approach that the author follows segments the literature by the state of economic development for direct investment into real estate and broader split between listed against direct investments. The purpose of such an approach (perusing the literature) is to ensure that the literature is scrutinized sufficiently, and to allow the literature to reveal a pattern in the findings from the different segments. Therefore, the segmentation is not meant to presuppose the difference in the findings from the various segments.

The listed equities section that contains literature on South African and international research will be crucial in enhancing the analysis of the findings from the current study on the relationship between South African listed real estate and inflation. Most importantly, the research on listed equities will also focus on the inflation-hedging ability for JSE listed real estate compared to JSE listed equities (based on the literature gathered).

1.2. Research Problem

The unexpected increase in inflation in South Africa presents the need to protect assets from inflation; listed real estate can protect investors from the negative effects of inflation (Hardin, Jiang, & Wu, 2012).

1.3. Research Purpose and scope

Quantitative easing presents a potential challenge to institutional investors in South African investment environment as inflation fears on the back of the policy have increased. To add to the problem, the South African CPI future and CPI-Linked Bond market is not large enough to absorb the potential demand resulting from the need to hedge against inflation (Roache & Attie, 2009).

This research sets out to explore the relationship between JSE listed real estate returns with inflation for the period 2004 to 2014. The research objectives are as follows:

I. Determine if there is a positive relationship between CPI inflation and JSE listed REIT returns.
II. Analyse the degree to which JSE listed real estate can protect the wealth of investors against CPI inflation.
III. Compare the effectiveness of general equities against listed real estate (both listed JSE indices) with respect to protecting investor value against CPI inflation.

1.4. Research motivation

1.4.1 Practical interest

The risk of inflation is more pronounced in emerging markets than developed markets(inflation in emerging markets tends to be higher relatively) (Lee M. T., Lee, Lai, & Yang, 2011); as a result, investors in emerging markets must make inflation-hedging part of their long-term investment policy, more especially due to the monetary policy mechanisms that the US has been using to re-ignite its economy over the last 5 to 10 years (Lee M. T., Lee, Lai, & Yang, 2011) and (Grelck, Prigge, Tegtmeier, Topalov, & Torpan, 2011).

The implementation of QE (Quantitative Easing) by the US Federal Reserve Bank saw the rise of inflation in most emerging markets as a result of increasing commodity and asset prices (Peng, 2011). This sudden rise in inflation reinvigorated the need to understand the relationship between most asset classes and inflation – as this will enable investors to hedge inflation.

Tapering started in December 2013 where the Federal Reserve Bank (which will be referred to as the FED from this point going forward) reduced its bond purchasing program from $85 billion to $75 billion per month (Zumbrun, 2013). This sparked the biggest sell-off of emerging market assets since 2009 in January 2014 (Xie & Detrixhe, 2014), where (Koester, 2014):

- Argentinean peso lost 23% in January 2014, which was the highest depreciation since 2002.

- Turkish lira lost 6%, this was followed by an initiative by the Turkish central bank to increase its lending rate for banks from 4.5% percent to 10%.
- The Rand lost 7.5%, its lowest level since 2008. The currency continued to fall even after the central bank raised its repo interest rate to 5.5% from 5.0% – the first rate hike in almost six years.
- Russian ruble lost 7%, hitting a five-year low. But Russia's central bank kept rates unchanged.

In South Africa this meant that inflation fears we re-ignited since the country's reliance on oil and other imports as production inputs (also referred to as inflation-pass through) implies that the prices for final goods could increase as result of the depreciation of the rand against major currencies (Marcus, 2014).

Inflation can be a huge risk to the South African economy as a result of the following:

- Inflation destroys the value of money over time, that is, the higher the inflation rate the more value it destroys.
- Inflation rates that are unpredictable make planning difficult for the investment community and policy makers
- The problem of negative real interest rates (that occurs when interest rates are lower than inflation) negatively affects those who rely on interest from their savings to meet livings expenses
- A country's global competitiveness is severely hampered as result of higher costs of borrowing; expensive exports; reduced inflow from foreign investors and higher labour costs as a result of high inflation in a country

All of the above affect the valuation of assets in an economy, thus investors have to pay special attention to changes in inflation in an economy in order to achieve positive real returns.

The introduction of REITs provides an opportunity for an assessment to be made on whether South African listed real estate does provide an adequate hedge against inflation; from which the findings can be compared to others studies conducted on REITs internationally.

Property unit trusts (PUTs) and property loan stocks (PLSs) dominated the listed real estate market before REITs were introduced in the South listed real estate market.

However, this presented many challenges to foreign institutional investors as PUTs and PLSs did not conform to global best practice (as listed real estate securities). The introduction of REITs into the Johannesburg Stock Exchange is expected to address some of the issues and will bring with the following benefits:

- Tax advantages (as a result of the removal of capital gains tax on the sale of properties) of the new structure will make the listed real estate sector more attractive to foreign investors (Lamprecht, 2013) – this will enhance institutional involvement
- Reduced transactions costs to local investors as there's no securities transfer tax payable on listed REITs (Lamprecht, 2013)
- Alignment to global best practice, which enhances transparency to investors (Lamprecht, 2013)

The current perception is that the move by PUTs and PLSs to a REITs structure will revive the South African listed real estate sector as REITs tend to have lesser gearing, which makes banks more comfortable to fund real estate developments and will also facilitate consolidation in the listed real estate market (Hedley, 2013).

1.4.2 Academic interest

The literature seems to highlight inconclusive results on how well listed equities hedge inflation in comparison to listed real estate. For example Arjoon *et al.* (2012) arrived to the conclusion that the relationship was only positive in the long-term while Bonga-Bonga (2011) established a weak relationship between inflation and listed equity returns. Moreover, most of the research covers REITs as an inflation hedge from an international perspective; however, the South African REITs case still needs be tested.

It is also important to note that there are other factors that influence the relationship between inflation and listed real estate returns in South Africa (as all countries have their own economic and institutional peculiarities), therefore to fully understand the relationship between inflation and listed real estate returns the author needs to also understand and take into account all the other factors (which seem to have a significant influence on the relationship based on the perused literature) that operate in the background. The factors are listed below:

- Context – whether the level of inflation is high or low (Tien-Foo & Swee-Hiang, 2000); markets are turbulent or normal
- State of economic development – emerging versus developed markets (Moazzami, 2010).
- Institutional involvement (Ling & Naranjo, 2015) and the variety of securities in the market to meet the demand to hedge inflation (Roache & Attie, 2009).
- The inflation range, that is, inflation is higher in South Africa than in the US. This means certain real estate assets may be better at protecting investors against unexpected inflation (which is common in South Africa) (Park & Bang, 2012).

Chapter 2: Literature Review

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2.1 Direct Real estate and Inflation

2.1.1 Direct real estate investment in emerging markets

The concept of hedging is a process in which an investment is made with an intension of neutralizing the risk of adverse price movements of an asset or portfolio – the intention of the investment is to protect the returns of an asset or portfolio from market risk (Investopedia, 2015). Inflation-hedging in particular, means protecting an asset or portfolio returns from inflation risk through an investment into a security in the market that will move in an opposite direction to inflation. Inflation is measured as the growth in consumer price index (CPI index) over a specified period of time for the purposes of this study – the all urban area index is used. The CPI index is composed of a weighted basket of goods that Statistics South Africa deems to be representation of the average consumer shopping basket.

Inflation has always been a pressing issue to all organs of the South African economy (affecting both private and institutional investors). So far, the long-term relationship between house prices and inflation in South Africa has indicated that household ownership does provide sufficient protection against inflation (the derived Fisher coefficients were bigger than one for the luxury segment, equivalent to one for the middle-segment and below one for the large and medium middle-segments, as well as the affordable segments) (Inglesi-Lotz & Gupta, 2013) – a fisher coefficient of 1 implies that the property price percentage change is equal to the inflation rate, and where it is greater than 1 the property price percentage change is higher than the inflation rate (Inglesi-Lotz & Gupta, 2013). The evidence seems to conform to intuition as the ownership of residential property implies that the owner is most likely to pay an instalment and mortgages' the outstanding loan balance with a bank; both these amounts are eroded by inflation as they are not adjusted upwards for inflation over the life of the mortgage (Inglesi-Lotz & Gupta, 2013).

A technique similar to that used by Gupta (2013) was used to analyse the relationship between inflation and residential property in Hong-Kong where the evidence suggested that residential property was the 9 only real estate type that had the ability to protect against actual, expected and unexpected inflation (which is the difference between actual and expected inflation) over a given period of time (Lee, 2013). Furthermore, the study indicated that there is a one way relationship between inflation and real estate returns where within this relationship inflation seemed to be the leading indicator (Lee, 2013) – inflation adjusts and real estate returns follow at a later stage.

The data collected during the period from 2000 to 2008 in China in which the autoregressive distributive lag (ARDL) cointegration technique was applied seemed to suggest that there was no relationship between inflation and real estate returns irrespective of the term (Zhou & Clements, 2010). The result seems to differ from the other literature perused thus far in this paper where some form of link between inflation and real estate was established – more especially in the long-term.

In the Korean market it was found 21 that the relationship between inflation and direct commercial real estate (CRE) had a positive relationship for both the long and short-term. What made this finding more interesting is the fact that this type of real estate showed a positive relationship with both expected and unexpected inflation for the short-term case (Park & Bang, 2012). Similar findings were uncovered by Lee (2013), where residential property in Hong-Kong demonstrated the ability to provide sufficient protection against both unexpected and expected inflation, however, Lee (2013) did not go further to distinguish between short-term unexpected versus expected inflation as is the case in the study conducted by Park and Bang (2012).

2.1.2. Direct real estate investment in developed markets

Real estate from the perspective of direct investment into infrastructure was introduced in a study in the US, where the results indicated that the asset class provided partial protection against inflation in the short-term but seemed to grant adequate protection against inflation in the long-term (Wurstbauer & Schafers, 2015). The study also revealed that infrastructure provided the best protection against inflation amongst the real estate asset classes that were tested in the study (Wurstbauer & Schafers, 2015).

In 2002, the relationship between residential property and inflation in the US 7 was also tested using the fisher relationship. The results lead to the conclusion that residential real estate made a stable hedge against inflation in the long-term (Anari &

Kolari, 2002). Interestingly though, this result somewhat differed to most of the literature that the researcher perused thus far, as residential property in the study conducted by Anari and Kolari (2002) was not presented as a comprehensive hedge against inflation, whereas it was presented to be a comprehensive hedge against inflation in most papers.

In the UK, it is noted that although direct real estate yields positive real returns, it provides partial protection (hedge) against inflation than a full hedge. In fact, it is mentioned that there are other asset classes in the country that are more effective in hedging against inflation than direct real estate (Is commercial property a hedge against inflation?, 2011).

The study conducted in Singapore showed that context was essential as the derived evidence indicated that residential real estate was a better hedge of expected inflation where inflation levels were low while direct industrial real estate was a better hedge for both unexpected and expected inflation where inflation levels were high (Tien-Foo & Swee-Hiang, 2000). What stands out from the research that Foo and Swee-Hiang (2000) conducted is the fact that it makes mention of the importance of context (where the extent of inflation determines how effective a particular type of real estate investment is in hedging inflation).

2.1.3. Direct real estate investment in general

Listed property (real estate) returns seems to correlate with those of direct investment properties in long-term only. In the short-term listed properties are also affected by short-term fluctuations (most of which are random by nature) – a quality that is seen with equities trading on a stock market. Therefore, direct real estate investment is able shed light on the long-term behaviour of listed properties, and therefore it is essential to peruse literature on it.

2.2 Listed Securities against Inflation

2.2.1 Inflation and Stock Returns

In the early 2000s, the relationship between inflation and that of stock price returns was tested; under the fisher relationship it was noted that stock price returns seemed

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