THE RELATIONSHIP BETWEEN REITS AND STOCK MARKET PRICES DURING PERIODS OF VOLATILITY: A BIVARIATE GARCH ANALYSIS

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ABSTRACT

The relationship between real estate and the stock market is essential because they are the two most highly invested assets. In addition, examining the volatility of any asset is important for risk management and investor portfolio returns. The general motivation for analysing the relationship is that it can provide insight to policymakers and investors about the behaviour of stocks and real estate assets. The purpose of this research is to examine the relationship between Real Estate Investment Trusts (REITS) and stock prices in South Africa using daily data from 2 January 2013 to 31 May 2023. The wealth and credit effects are the two mechanisms used to interpret the relationship. The wealth effect is a mechanism that states that the causal relationship between the two markets runs from increasing stock prices which tends to increase real estate. The credit effect claims that real estate prices influence stock prices.

Most of the existing literature has examined the relationship between the two markets but less attention has been given to the volatility spillover effects. Therefore, the analysis presented in this thesis extends the existing research by examining the relationship and the spillover effects between the REITs and stock markets. The study employs quantitative research methodology using the following econometric methods i)Vector Autoregression model, ii) Granger Causality Tests and Bivariate GARCH models. The study found that there is no long-run relationship between REITS and stock prices. In addition, the Granger Causality results showed a unidirectional relationship between REITs and stock prices. The results indicate the presence of a wealth effect in South Africa, meaning that changes in stock prices influence the real estate market. Moreover, the GARCH analysis found volatility spillover effects from the stock to the REITs markets. These results are helpful for policymakers and investors interested in the portfolio and risk management of the two markets.

DECLARATION

I Ntsali Makara, declare that except for references specifically indicated in the text, and such help has been acknowledged, this thesis is wholly my own work and has not been submitted to any other University, Technikon or College for degree purposes.

Signed by Ntsali Makara on this 10th day of January 2024

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LIST OF ABBREVIATIONS

ADF – Augmented Dicky Fuller

AIC – Akaike Information Criterion

ARCH– Autoregressive Conditional Heteroskedasticity

BEKK – Baba Engle Kraft Kroner

CAPM – Capital Asset Pricing Model

CCC- Constant Conditional Correlation

CIS – Collective Investment Scheme

CPI- Consumer Price Index

EMH – Efficient Market Hypothesis

FTSE – Financial Times Stock Exchange

GARCH – Generalized Autoregressive Conditional Heteroskedasticity

GDP – Gross Domestic Product

JB- Jarque Bera

JSE – Johannesburg Stock Exchange

MPT – Modern Portfolio Theory

NET- New Equilibrium Theory

PLS – Property Loan Companies

PP – Phillips Perron

PUT- Property Unit Trust

REIT – Real Estate Investment Trust

TGARCH – Threshold Generalized Autoregressive Conditional Heteroskedasticity

TVAR – Threshold Vector Autoregression

VAR – Vector Autoregression

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CHAPTER ONE

INTRODUCTION

1.1 CONTEXT OF RESEARCH

The relationship between South African real estate and stock market prices during periods of volatility is of significant interest in view of recent shocks such as the Covid-19 pandemic. In this context, volatility is defined as the rate at which the price of an asset moves around its mean price. It is important to investigate the dynamics of real estate returns and volatility to aid in understanding risk management, investment decisions and portfolio allocation. From an investor's perspective, there are various ways to invest in real estate through rentals, land ownership, commercial real estate, Real Estate Investment Trusts (REITs) and crowdfunding (Benson, 2023). The difference between these forms of real estate investing is that some require physical ownership of property while others such as REITs and crowdfunding do not. Crowdfunding in the context of real estate investing is when investors pool and raise money to finance real estate investments (Benson, 2023). REITs are known as commercial equity real estate trusts and investors trade them on public stock markets.

REITs have become increasingly attractive to investors' interest in real estate because they are real estate investments with low risks and high liquidity (Ryu, Jang, Kim and Ahn, 2021). Investing in physical real estate such as land and commercial and residential properties tends to be labor-intensive, and an investor is likely to incur high ongoing costs. Whereas investing in non-physical property such as crowdfunding and REITS allows for low cost and few barriers to entry for investors which allows for high returns at a low price (Benson, 2023). The housing market is among the key positive market drivers in the South African economy (Luus, 2005). The market is essential for investors, policymakers, job creation, property developers and the economy. Razali (2015) states that real estate is an asset class that can provide investors with consistent cash flows and benefits. The main driving forces in the South African property market are migration trends, security issues, economic growth, income and employment, foreign investment, fiscal and monetary policy, and investment returns (Luus, 2005). The real estate market in South Africa has been forecasted to grow more than 9% between 2022-2027 (Mordor Intelligence, 2022). Although it was expected that the real estate market would perform badly during the Covid-19 period it evidently performed very well as the number of first-time homeowners worldwide increased due to low interest rates. However, Covid-19 did impact liquidity and capital risk in the housing markets.

The stock market is a market where there is issuing, selling and buying of stocks. The stocks come from listed companies and are traded on the exchange market or over the counter. Over the counter markets in the context of this research, the South African stock market is the determinant being examined regarding its relationship to REITS. Therefore, it is important to show the characteristics that are specific to the South African stock market. The stock market has been subject to experiencing a higher level of volatility due to the Covid-19 pandemic. Mokoena and Nomlala (2022) examined the effect that Covid had on the performance of the Johannesburg Stock Exchange (JSE). The study found that the pandemic caused South Africa to have an unstable financial environment. Moreover, the pandemic led to high financial volatility in the stock market. Moreover, Muthu and Wesson (2023) examine the impact that covid had on various industry sectors with companies listed on the JSE. The study found that understanding the impact that Covid 19 had on JSE listed companies was important for the listed companies are a foundation of the GDP and the South African economy. In addition, the real estate industry was one of the industries that were negativity impacted by Covid 19 (Muthu and Wesson , 2023).

The research uses the FTSE/JSE is an index that represents the performance of 99 percent of the market value of the listed South African Companies (Johannesburg Stock Exchange, 2023). The objective of the index is that it is designed to track the funds and derivatives as a benchmark for the performance of the stock market. Moreover, the characteristics of the FTSE/JSE All Share index are investability, liquidity, transparency and availability (Johannesburg Stock Exchange, 2023). Investability and liquidity is important for it ensures that the stock that are on index are investable and are easy to trade. Transparency and availability of the FTSE/JSE All Share ensure rules are adhered to (Johannesburg Stock Exchange, 2023).

The theories that ground the relationship between the stock and real estate market prices are the wealth and credit effect theories (Gounopoulos, Kosmidou, Kousenidis and Patsika,2018). The wealth effect states that whatever occurs in the stock market spills over into the property market. The credit effect states that the property market impacts the stock market. However, most studies simply find that the two markets are highly correlated (Razali, 2015). Therefore, from a risk diversification perspective, there are few benefits from diversification if one's portfolio is made up of equities and real estate. For example, starting with the international literature, Ali and Zaman

(2017) examined a long-run relationship between housing and stock prices using data from 22 European Union countries from 2007 to 2012. The findings were that among the 22 countries, five countries had a negative relationship, and 15 countries had a positive relationship between the housing and stock price variables. The relationship between housing and stock market prices varies from country to country hence a country-specific study is important.

Refai, Eissa and Zeitun (2021) examined the relationship between the real estate and stock markets in an energy-based economy focusing on Qatar. The researchers analyzed data from 2006-2020 and examined the data using Enders and Siklos (2001) nonlinear model and nonlinear autoregressive distributed lag models. They use the theories of the wealth and credit effects to examine the channel of transmission between real estate and stock market prices (Refai, *et al* 2021). The findings were that the non-linear ARDL model provides evidence of the positive relationship between the two market prices. However, the linear ARDL provided support for the wealth effect but didn't show a strong correlation between the markets (Refai *et al* 2021). In South Africa, Aye, Balcilar and Gupta (2014) used a nonparametric Granger causality test to examine the relationship. The findings were that there is a long-run relationship between housing and stock market prices and bi-directional causality between the two market prices (Aye *et al* 2014). These results indicate that stability in the housing market leads to stability in the stock market and vice versa. Aye *et al* (2014) results using non-parametric approaches indicate that in the short run stability in the stock market is critical for stability in the housing market and vice versa.

Volatility is a concept that has been increasingly of interest in investment management because it represents the movement of stock prices. According to Admed and Huo (2018) as emerging markets grow there comes a need to adopt market-oriented policies. In addition, the study finds as these policies are implemented, movements in stock prices are important indicators in examining internal and external economic vulnerability (Admed and Huo 2018). Therefore, to understand real estate investment trust volatility, the underlying risk from the real estate market cannot be ignored. Understanding asset pricing models is important in providing insight into identifying asset characteristics and expected returns from holding an asset (Li and Zhu, 2022). The Capital Asset Pricing Model (CAPM) finds that the risk of holding an asset is measured by two parts, unsystematic and systematic risk. Systematic risk is the risk that is inherent in an asset and is measured by *beta* and unsystematic risk is not shown in the beta; it is unique to an asset (Li and Zhu 2022). *Beta* is known as the measure of the exposure to market risk of an asset and the market risk is the risk that comes from macroeconomic events that can influence the movement in asset prices (Howells and Bain, 2005).

Real estate studies often find that the capital asset pricing model and arbitrage pricing theory model are not adequate measures of real estate returns and asset characteristics (Titman and Warga 1986). Ibbotson, Diermeier and Sigel (1984) state that asset characteristics are divided into risk and non-risk characteristics. Non-risk characteristics include marketability, taxation, and information costs. Therefore, Ibbotson and Brinson (1993) propose the use of a new equilibrium theory (NET) where the asset characteristics of real estate assets are not only measured by the risk as the CAPM model suggests but also by its non-risk factors. As a result, it is useful to use the CAPM and NET literature to explain risk and non-risk impacts on the volatility of the real estate market.

During the last period of economic volatility in 2020 the prime lending rate (7%) in South Africa was lower than pre-covid rate of 10.25% (Reserve Bank, 2023). There was an increase in the number of first-time buyers of property in South Africa during the volatile economic period of Covid-19 (Mordor Intelligence, 2022). The recent trends in the rise of property purchases even during a recession, provide a key reason why there is a need to examine the property market during periods of volatility. In the context of financial markets forecasting, volatility is important to understand the potential riskiness of investing in an asset (Cheteni,2016). Real estate investment trusts (REIT) in the context of the South African financial markets are categorized under collective investment schemes CIS (Zyl, Botha, Skerritt & Goodspeed 2011). Collective investment schemes are funds that come from different investors and are pooled together. Each investor receives a share of ownership in underlying assets, which, in this research context is commercial investable property.

Due to real estate being an investment subject to low liquidity and high costs, real estate investors seek to invest in real estate that is going to produce high returns at a low cost. Therefore, there have been some studies that examine the benefits of investing in REITs as opposed to appraisal-based real estate. Miles, Cole, and Guilkey (1986) conducted a study on transaction-driven commercial property return series and found that the values of real estate are not stable and that appraisal-based returns need to convey volatility of the real estate market. In addition, the study found that the REIT return series does not mask nor overstate the volatility of property market returns, meaning that REITs reflect the market conditions in the real estate market accurately. Goetzman and Ibbotson (1990) conducted a study in the United States based on the performance of real estate returns as an asset class. The findings were that the compound annual return and standard deviation for commercial REIT were higher than all the other real estate asset classes. The reason is that REITs trade on an exchange and new information regarding the future value of the underlying assets is reflected in the share price.

In the South African context, Fateye, Ajayi and Ajayi (2022) examined daily property stock prices listed on the Johannesburg Stock Exchange during the 10 years from 2008-2017. The study analysed the South African real estate investment trusts (REIT) price volatility with a GARCH (1,1) model. The model revealed that daily property market prices represented by the ARCH term and volatility (GARCH term) have a significant and positive impact on current daily market price volatility. These results show that positive news has a bigger impact than negative news in the property market, therefore investors will likely react more to positive than negative news in the real estate market in South Africa. These findings suggest that there is a need to examine the volatility pattern between stock market prices and SA-REITs for an announcement of good or bad news that leads to market volatility.

This thesis aims to aid foreign or local investors, financial advisors and portfolio managers in market predictions of the commercial South African real estate market by examining volatility in the market through REITs using econometric ARCH and GARCH models. In addition, the study aims to use CAPM and NET literature to examine the risk and non-risk characteristics that contribute to real estate market volatility. Finally, use wealth and credit effect theories to examine the relationship between stock and real estate in the South African context. The significance of this research has come in light of the economic crisis associated with Covid-19. As opposed to other sectors, the housing market in South Africa performed well during the crisis. The reason is that the prime lending rate during the pandemic was low, however, due to recent inflationary pressures the Reserve Bank has increased the repo rate which in turn has impacted the housing market. These changes in policy indicate that there is a need to examine the relationship between stock and housing market indices to further examine volatility in the markets and expand on current investment risk management literature for property investors.

There is value in examining the relationship between REITs and stock market prices due to the current volatile economic climate, particularly its contribution to real estate price returns. The 2020 health crisis has caused global financial markets to fluctuate and has caused negative and positive impacts on investment returns in countries worldwide. The instability in the South African economy has caused the South African financial markets to be more volatile, particularly the real estate market. The housing market is the market of interest of this research and the research uses the real estate investment trust index as an indicator of the housing market for it represents largescale income-producing real estate for investors. Several studies (Gounopoulos *et al* 2018; Refai, *et al* 2021; Ali and Zaman 2017; Razali, 2015) have examined the relationship between housing and stock market prices, however, they are mostly international studies, and the empirical evidence is inconsistent.

In addition, there are a few studies (Aye, Balcilar and Gupta 2014; Muzindutsi and Mutangwa 2015) that examined this relationship in South Africa, and they used different indexes and methods of analysis to examine the interdependence and causality between housing and the stock market. Due to previous findings, the expectations of the research are to find a positive relationship between REITs and the JSE/All Share indices that is supported by the wealth effect theory. Firstly, this research will contribute to the existing literature in understanding the relationship between real estate investment trusts and stock market prices in the context of South Africa. It is essential to examine the dynamics of real estate and stock price returns in the context of volatility to aid in understanding risk management, investment decisions and portfolio allocation in South Africa. Secondly, the research aims to examine the dynamic linkages between REITs and stock price indices to aid investors, REIT companies, policymakers and portfolio managers understand volatility as a critical variable in the risk management of investments in the listed South African housing market.

1.2 GOALS OF RESEARCH

This research aims to investigate whether there is a relationship between the REITs and the stock market prices during periods of volatility in South Africa during the examined period 2 January 2012 to 31 May 2023. This is to make inferences about the relations between the two market indexes and how it impacts returns thereof.

- This study sought to determine the historical relationship and the direction of association between REITs and stock market prices with reference to the theories of credit and wealth effects.
- Secondly, determine whether the relationship between the two market price indexes changes during high and low volatility periods.
- Lastly, model volatility in REITs and stock market prices to examine the index's reactions to good or bad news and the volatility spill overs.

1.3 METHODS, PROCEDURE AND TECHNIQUES

The data used in this study is collected from the JSE's statistical bulletin with the sample period of 2 January 2013 to 31 May 2023. The reason for the sample period is that the study that examined this relationship was last conducted in 2015 (Muzindutsi and Mutangwa 2015) and it used the Housing Price Index (HPI) whereas this study is using the REIT index. In addition, REITs were listed on the JSE in 2013 and the last study that examined the volatility of only 12 of the 27 SA-REITs was in 2017 using property price indexes (Fateye *et al* 2022). The frequency of the data is daily, and the housing market is represented by the REIT price index. The JSE FTSE All Share index represents the stock market price data. The same data and sample period will be used throughout all the research objectives. The following was done to achieve the objectives stated in the methodology, firstly use a Bivariate VAR model and Granger causality tests to examine the nature of the relationship between the REITS and stock markets prices using daily REIT prices and JSE ALL Share index data. These tests were conducted after the cointegration, unit root and stationarity tests. Secondly, a threshold model based on a pre-determined measure of volatility was used to determine whether the relationship between the two price indexes differs in low or high volatility periods using a Threshold VAR model. Lastly, model the volatility of daily REITs and JSE FTSE All Share market prices using a Bivariate GARCH model. A Bivariate GARCH model helps analyse two financial assets or economic variables for interdependence in volatility.

1.4 STRUCTURE OF THE THESIS

The thesis is organized as follows,

Chapter two presents a review of the literature and offers an overview of the relevant theoretical and empirical literature on the relationship between general property and stock market prices. The chapter starts by discussing the main literature relating to the property and stock market relationship and the qualities of the underlying assets. Furthermore, the chapter analyzes the empirical literature that has previously examined the relationship both internationally and in South Africa. Chapter three provides a detailed description of the data and methodology that will be used to address the main goal and subgoals of the research. Chapter four presents the study's results. Chapter five is the conclusion of the thesis, and it makes concluding remarks on the study and makes suggestions as to where the research could further be extended.

CHAPTER TWO

THEORETICAL AND EMPIRICAL LITERATURE

2.1 INTRODUCTION

This chapter consists of two sections, the first section (2.2) discusses the theoretical principles that relate to the study. It first examines the wealth and credit effect theories that explain the dynamic linkages between general property and stock market prices. The section further goes on to discuss the literature on REITS and stock markets. The last part of the section discusses portfolio theory and theories of the Capital Asset Pricing Model (CAPM) and New Equilibrium Theory (NET) that explain the roles of the risk and non-risk factors of asset characteristics. The second section (2.3) of the chapter presents a review of the empirical findings on the relationship between the general housing and stock markets in developed and developing countries. In addition, the section presents the models used to model volatility and lastly, the section summarizes how these theories are relevant to this research.

2.2 THE RELATIONSHIP BETWEEN REAL ESTATE INVESTMENT TRUSTS AND STOCK MARKET PRICES

A number of studies have examined the relationship between two popular assets, namely real estate and stocks. Over the past decades, the fluctuations in the stock and real estate markets have been central to financial instability, notably the global financial crisis in 2008. Institutional investors in most countries invest in both REITs and stock markets to benefit from arbitrage trading or to diversify the risk in their portfolios. Tsai, Lee and Chiang (2012) find that whether real estate allows for diversification benefits to a stock portfolio would be subject to the magnitude and direction of the two markets' relationship. Aye, Balcilar and Gupta (2013) argue further that examining the relationship between real estate and the stock market is essential for understanding the importance of asset diversification, portfolio allocation and household welfare.

There are two transmission channels that have been used to explain the relationship between housing and stock prices which are the wealth and credit effects. There are varying scholars who have different perspectives on whether the interactive relationship between the two market indices exists. If the relationship does exist, the issue of directionality and casualty comes to light because it determines how the prices of the stock and real estate markets influence each other. The causality and direction of the relationship between these two markets can assist institutional investors, policymakers and financial advisors predict the performance of the markets.

2.2.1 Wealth Effect

The wealth effect describes the mechanism where unexpected gains in stock prices can lead to an increase in real estate consumption. In order to understand this effect wealth is defined as follows. Wealth is defined as the total value of an individual's financial and non-financial assets after tax considerations. Fang, Lee and Chang (2017) find that the mechanism of the wealth effect works as follows. An investor's wealth increases when the price of stocks increases and the returns from the increase in stock market prices are then transferred to real estate. Real estate prices then increase due to the transfer of funds from the stock market to the real estate market. Therefore, this leads to the conclusion that the wealth effect is a mechanism that finds that any change in the stock market leads to a change in the real estate market. Green (2002) has described the wealth effect as occurring due to wealth being a function of consumption and it is producing income through interest payments and dividends.

Green (2002) concludes that as the returns to stock market prices increase, household wealth does too and therefore consumption will increase which allows investors to invest in real estate. According to Hong and Li (2020), the wealth effect is likely to occur during booming markets and it is more pronounced when the stock market performs better than the real estate market. Aye *et al* (2012) state that the wealth effect is found more often in developed countries. This is so due to the stock and housing markets being equally developed in larger economies. Lean (2012) examined the relationship between stock and housing market prices in Malaysia and found the wealth effect present in more developed states. The study found the likely explanation to be that the developed Malaysian states had a lot of wealthy individuals who use real estate as their main investment. Lean and Smyth (2014) find that when there is a positive economic shock that increases an investor's stock holdings, an unanticipated permanent stock gain will increase household wealth. Moreover, the stock gains, therefore, affect the price and demand for real estate.

2.2.2 Credit Effect

In contrast, the credit effect suggests that the housing market influences the stock market. The theory suggests that the transmission mechanism operates through higher property prices which then stimulate the economy. According to Lean (2012), the credit effects' foundation is based on the balance sheet position and credit-constrained firms which are explained as follows. Real estate is collateral for loans, such that credit-constrained households and firms can borrow for investments when housing prices increase (Su, Yin, Chang and Zhou 2019). This leads to a decline in borrowing costs and the value of collateral increasing which then leads to an increase in stock prices. Aye *et al* (2013) hold that due to real estate being collateral for credit-constrained firms, when housing prices increase it is favourable for the firms because it makes a firm's balance sheet position better. The strong balance sheet position for firms allows them to expand investments, increases a firm's value and therefore the stock price of a firm will increase leading to more firms demanding real estate. Sim and Chang (2006) find that the credit effect is shown by an upward spiral and persistent feedback effects between stock and real estate prices. In addition, several studies find that the credit effect occurs in emerging market economies. The credit effect is likely to be in emerging markets because housing is a consumption good in developing economies, therefore, movement in housing prices will lead to stock price changes (Aye *et al* 2013).

2.3 REAL ESTATE INVESTMENT TRUST LITERATURE

2.3.1 Real Estate Investment Trusts

Real estate is one of the assets that investors often include in their investment portfolios. A Real Estate Investment Trust is an entity that receives income from financing or owning property (Parker, 2012). The inception of Real Estate Investment Trusts was in the 1960s and their original purpose was to securitize real estate investment that was illiquid (Seiler, Webb, and Myer 1999). There have been various models of REITs, and they differ globally depending on the sector and geography a REIT company focuses on (Krewson-Kelly and Thomas 2016). REITs are sector-specific, and they focus on identifying and providing real estate investment in residential property, commercial property, retail spaces, offices and industrial real estate like storage, prisons, and healthcare facilities. An important factor for real estate investors and fund managers is ensuring they receive high returns at low risk. However, real estate in a portfolio tends to have low liquidity and high transaction costs; however, they are important because they serve as a hedge against inflation. According to Seiler *et al (*1999), the high costs and low liquidity associated with investing in residential real estate have caused investors and property managers to investigate another form of investing in real estate which is REITs. In addition, REITs have increased foreign direct investment because they provide less cash-heavy access to real estate investment (Ijasan, Junior, Tweneboah and Adam 2021).

2.3.2 The Characteristics of REITs

REITs can either be public or publicly listed and they are available to any investor interested in the real estate market. Publicly listed REITs provide benefits to investors because they don't need to directly finance or purchase properties to get their return on investment (Parker, 2012). Garrigan and Parsons (1997) state that two features that separate listed REITs and unlisted real estate are that REITs are corporate or trust equities and they are listed. The corporate trust entity of REITs means that they not only provide access to real estate investment as a company, but they also bring capital budgeting and management expertise like a corporate firm does. In addition, due to REITs operating as a business, they can generate value by trading at a net premium (Garrigan and Parsons 1997).

Moreover, investors select certain REITs based on the type of property they invest in, whether retail, residential or business buildings. The evolution of REITs differs between countries due to factors such as legislation, categories, and tax regulations (Parker, 2012). There are two different categories of REITS namely equity and mortgage real estate investment trusts. Firstly, equity REITs obtain most of the revenue from the rent paid between a tenant and landlord. There is usually a *fee simple interest* in properties invested in by the REIT and it uses debt towards the purchase price of a property. According to Parker (2012) in real estate a *fee simple interest* allows the buyer of the property to get a title deed and any existing building on the acquired land. There are some cases where the REIT does not own the ground, only the building operations on the land, this is known as a *ground lease*.

Mortgage REITs, directly and indirectly, lend income to real estate owners by issuing mortgages or taking possession of mortgage-backed securities (Krewson-Kelly and Thomas 2016). This kind of REIT accrues income from the interest received from residential and commercial-based real estate investments or commercial mortgage loans. Mortgage REITs are comparable to banks which lend to real estate developers and landlords, the difference is how they raise capital (Krewson-Kelly and Thomas 2016). Unlike banks, mortgage REITs raise capital through the financial markets by issuing equity and debt privately or publicly. One of the important methods of classifying a REIT for investment purposes is through its growth strategy. According to Krewson-Kelly and Thomas (2016), an investor looking at the growth strategy of a REIT would examine the tactics used to grow income and cash flow. An example is the cost of capital where companies with low cost of capital grow more quickly and have better-quality investments than companies with more costs. Therefore, it is important to identify what strategy a REIT uses for it to be optimal considering the real estate market and cost of capital.

2.3.3 Are REITS Stocks Or Real Estate?

Corgel, Mcintosh and Ott (1995) state that the literature on REITs can be divided into three major topics: financing decisions, investment decisions and return and risk issues affecting REITs. REITs tend to be characterized as financial assets and there are studies that have examined whether REITs can be considered as stocks or not. Clayton and MacKinnon (2001) find that REITs returns reflect the true nature of generally listed real estate returns which makes them have a strong relationship with securitized real estate. In addition, REITs are claims to real estate which have low transaction costs and a trading market aspect that securitized real estate does not have.

There have been views that REITs are true return series and that the returns are a true measure of the underlying assets if the market is efficient (Ennis and Burik 1991). True real estate returns are a measurement of the profit earned on real estate as a percentage of the total costs incurred on the investment (Dimson, 2002). Should inefficiencies be present, the market tends to be exploited through arbitrage, liquidation, and asset sales. Market inefficiencies would mean that REIT share prices are not reflecting the true value of the underlying assets. However, the market efficiency argument supports Ennis and Burik's (1991) claims of volatility observed in REIT returns being consistent with accepted expectations about volatility observed in true real estate returns. Therefore, using this argument, it can be concluded that REITs are indeed a true series reflection of underlying real estate returns.

2.4 THE STOCK MARKET LITERATURE

Stocks are also known as equities or shares, and they are used to describe the financial instruments of companies that are listed on any equity market (Zyl *et al* 2011). Equity is defined as a share of ownership of an asset by a listed company. There are two different classes of shares, preference, and ordinary shares. Preference shares are higher in the ranking than ordinary shares because preference shares ensure that the rights of distributing earnings to preference shareowners are prioritized before ordinary shareholders receive their income from dividends (Zyl *et al* 2011). An ordinary share is the most common share, and it represents the co-ownership of a company. The stock market is categorized under two markets either primary or secondary markets. Primary markets are where stocks are newly issued through an initial public offering (IPO) (Howells and Bain 2005). Investment banks underwrite the stock by determining the agreed terms of an issuer of the stock and the purchaser of the stock (Zyl *et al* 2011). The secondary market is a market where shares that were already being bought and sold are traded. In addition, the secondary market is divided into a formal market, off-exchange, over the counter and direct trades. A formal market is where listed shares are traded like the NASDAQ, JSE and NYSE. An over the counter (OTC) market is a market with unlicensed trades and it doesn't have exchange supervision (Zyl *et al* 2011).

2.4.1 Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) is often used to explain the functioning of equity markets in the academic literature. When stock markets are efficient, it means that assets are valued and priced by the supply and demand of rational traders in a competitive market. Fama (1970) established the EMH to examine the behaviour of stock markets. Eugene Fama's work titled "The Behaviour of Stock Prices ", articulated the modern approach to the EMH findings stating that stock prices fully reflect information available at any time. The economic ideology in financial markets coined "no free lunch" is an articulation of the EMH (Howells and Bain, 2010). Essentially, the term means that stock prices follow a random walk meaning that they are unforecastable and unpredictable. There are three different forms of the EMH, the weak, semi-strong and strong forms which are distinguished by Fama (1991).

The weak form of the EMH states that an asset's current prices contain all historical and current information. The weak form of the EMH essentially holds that investors and portfolio managers cannot use past information to predict the direction of asset prices to "beat the market" (Howells and Bain, 2010). Fundamental analysts determine a stocks market value using external influences, industry trends and a company's financial statement (Abarbanell and Bushee, 1998). The semi-form EMH challenges fundamental analysts because it states that public information such as macroeconomic factor expectations and financial statements of firms is already included in stock prices (Bohl, Putz and Sulewski 2020). Lastly, the strong form of the EMH states that all information known by investors and market participants about firms is reflected in the prices of the assets. This form is extreme because it suggests that it would be very difficult for investors to make abnormal profits using the information they have about assets (Bohl *et al* 2020). However, phenomena such as insider trading could be an opposition to the strong form of the EMH because investors could possibly buy or sell assets based on the non-public information of a firm in some instances.

Although the EMH is used as the main literature regarding the behaviour of stock prices, there are criticisms regarding the theory. Konstantinos (2010) study provides evidence of there being inefficiencies in stock markets due to pricing irregulates and unpredictable stock patterns and irrational investors. Moreover, examining the volatility of the stock market gives insight into the anomalies of the efficient market hypothesis (Delcey and Sergi, 2023). Volatility is currently among the crucial factors in the behaviour and movement of stock prices and its models give insight to whether the market is efficient and to what extent.

2.5 INVESTMENT PORTFOLIO THEORIES AND ASSET RISK FACTORS

It is important to examine portfolio theory and asset pricing models because they set the foundation for understanding the nature of assets and the factors that impact asset returns. To have a holistic understanding of the relationships between any two assets the fundamentals and characteristics of each asset need to be understood. Therefore, the theories discussed in this section of the empirical literature are the Modern Portfolio Theory, Capital Asset Pricing Model and New Equilibrium Theory**.**

2.5.1 Modern Portfolio Theory

Modern portfolio theory was developed by Harry Markowitz, and it focuses on a range of various financial instruments; however, it has a primary focus on the stock market (Markowitz, 1991). The important aspect of Markowitz's contribution to portfolio theory was placing an emphasis on the risk and return characteristics of a portfolio rather than individual assets (Elton and Gruber, 1997). The theory states that there are two components to risks associated with the returns of a stock, systematic and unsystematic risk. The return caused by the systematic risk of a stock is due to price fluctuations of an asset caused by changes in fiscal policy, interest rates and business cycles (Elton and Gruber, 1997. In addition, the theory holds that systematic risk cannot be removed through the diversification of a portfolio. The return caused by the unsystematic risk of a stock is due to factors associated with the firm that has listed the stock (Elton and Gruber, 1997). These factors could be due to the management of listed firms and this risk can be eliminated through diversification.

Aldiena and Al-Hakim (2019) examined the impact that the internal factors of a company have on the stock returns of the listed company. The findings were that the listed companies' Return on Assets (ROA), Price to Book (PBV), Net Profit Margin (NPM), and Debt to Equity (DER) have a direct effect on listed companies' stock returns (Aldiena and Al-Hakim 2019). The main assumption in MPT is that an investor's preferences are caused by the expected return and the risk that comes with the investment (Markowitz, 1991). The theory holds that the higher the standard deviation and variance the higher the risk. Elton and Gruber (1997) stated that one of the key issues with investors is allocating wealth amongst assets. In addition, Markowitz stated that the problems in a portfolio had to do with the choice of variance and mean. Furthermore, Markowitz's MPT proved the theorem of a mean-variance portfolio of assets by keeping variance and expected return constant and maximizing the asset's expected return (Elton and Gruber 1997).

The proof led to the introduction of the Mean-Variance Theory which finds that the Markowitz Efficient Frontier represents a combination of risky assets and the return and risk characteristics. The main premise of the MPT is that assets should not be selected on their own unique characteristics, but rather how they perform in a portfolio relative to other assets (Elton and Gruber 1997). The Mean-Variance Theory has been at the core of the Modern Portfolio Theory, and it was created to find the optimum portfolio for an investor who is concerned with asset return dynamics for a single period. In addition, MVT assumes that an investor is expected to estimate the mean and variance returns for assets in a portfolio. Fama and French (1989) further went on to extend the MPT and examine the return dynamics of an investor concerned with the return dynamics for multi-periods. The findings of Fama and French (1989) were that under multiperiod portfolio analysis, the variance and mean returns are related over time.

2.5.2 Capital Asset Pricing Model

The Capital Asset Pricing Model is a model that was influenced by Markowitz two-parameter model for portfolio analysis and the theory forms part of the capital market theory. The CAPM shows how capital markets price securities and shows the inputs that determine the expected returns on capital investments (Mullins, 1982). CAPM graphically depicts the relationship between the return on a security and risk through the security market line. The equation for the security market line does represents the nature of the CAPM and it is denoted as required K_A rate of return , K_{rf} risk free rate , B_A market risk exposure or the stocks Beta , $(K_m – K_{rf})$ market risk premium.

$$K_A = K_{rf} + B_A (K_m – K_{rf}) \quad (1.1)$$

Essentially, the above equation shows that the CAPM model holds that an asset's required rate of return is determined by the risk-free rate and the standard risk (Bodie, Kane and Marcus, 2018). These assumptions are rigid compared to the modern finance theory which has two assumptions. The first assumption is that the equity markets are competitive and efficient. Secondly, the markets are dominated by rational investors who maximize their utility based on their returns on investment (Bodie, Kane and Marcus, 2018). The CAPM is important for it gives simplified predictions of the relationship between risk and asset returns (Bodie, Kane and Marcus,2018)

Under the CAPM framework Lintner (1965) examined the systematic risk determinants of hotel REITs. The study defined the systematic risk as beta and found that hotel REITs risk is related to debt and growth and negatively related to the size of REITS firms. The study further found that

REITs value and the decrease in risk is due to financing through mergers and acquisitions not debt leveraging (Lintner, 1965). Li and Zhu (2022) examined the REITS return volatility by using the beta of the CAPM. The findings were that REITs volatility comes from risk from the local property markets. In addition, the study finds that a 1% increase of the underlying property's standard deviation increases REITs volatility by 1.38% (Li and Zhu, 2022). Voicu and Seiler (2013) study used the Black, Jenson, and Scholes (1972) one-factor model to analyze the risk -return dynamics of housing markets in the United States. The study analyzed the systematic risk of the U.S. real estate market and found that there is high systematic risk in the U.S real estate index. The study concludes that REITs would be a better investment for investors interested in real estate than the U.S. real estate index. The reason for the finding was due to REITS having a lot of diversification effects which decreases systematic risk (Voicu and Seiler, 2013).

The CAPM is subject to criticism regarding the unsystematic risk not being an important factor in valuing and pricing an asset because this assumption only holds under perfect markets (Gu and Kim, 2003). Therefore, as financial markets are increasingly becoming imperfect, there is a need to examine unsystematic risk when valuing an asset. Crain, Cudd and Brown (2000) found that unsystematic risk cannot be excluded when pricing an asset. Therefore, Gu and Kim (2003) conducted a study in the United States that allowed for investors to have comprehensive knowledge on the nature of risk regarding the investment they took. The study examined the unsystematic risk factors of hotel REITs to help investors and portfolio managers with the risk reduction of REITs. The study concluded that the unsystematic risk with REITs accounted for over 70% of total risk with REITS stocks. These studies have shown the importance of investors having extensive information on the systematic and unsystematic risks of an asset in terms of risk reduction. Moreover, the New Equilibrium Theory was developed to extend the literature on asset pricing and certain asset characteristics that conventional asset pricing models do not illustrate.

2.5.3 New Equilibrium Theory

New Equilibrium Theory was developed by Ibbotson, Diermeier and Siegel (1984) in response to criticism of the CAPM regarding the focus of systematic risk being the only risk recognized in asset pricing. The theory suggests that, as investors hold an asset, they desire to know the asset's characteristics. Conventional asset pricing theories such as CAPM and APT examine only risk characteristics of an asset and the NET proposes that investors also look at non-risk characteristics of an asset (Ibbotson *et al*,1984). NET states that factors such as tax, marketability and information costs are non-risk asset characteristics that affect the assets returns and pricing. In addition, the theory provides a framework where the demand for an asset's returns is determined by the returns and compensation that an investor receives for holding certain assets with various asset characteristics (Ibbotson *et al* ,1984). The NET objective is to establish the equilibrium cost of capital for an asset given the asset characteristics and utility functions of investors.

The NET argues that the CAPM assumption of a rational investor diversifying residual risk to be hindered by cost therefore, residual risk is not eliminated by diversification as the CAPM assumes. NET states that it is costly to diversify risk and non-risk asset characteristics are the cause. Moreover, taxability impacts the cost of an asset for various countries that have complex tax systems that require individuals to pay according to their tax brackets which leads to investors having different tax costs for the same asset. Marketability is a non-risk characteristic that is defined as part of the entry and exit costs associated with buying or selling an asset. In addition, Ibbotson *et al (*1984) state that marketability costs are made up of search and transaction, information, and divisibility costs. Search and transaction costs include bid-ask spread, which is the difference between the price a buyer is willing to buy for an asset and the lowest price a seller is willing to accept (Economic Times, 2023).

2.6 FINANCIAL MARKET VOLATILITY: A REVIEW OF THE EMPIRICAL LITERATURE OF STOCK AND REAL ESTATE MARKETS.

2.6.1 Behaviours of stock and real estate during periods of volatility

According to Helleiner (1995) financial market volatility studies have increased due to financial deregulation in the 1980s and the rise in globalization. Since the efficient market hypothesis has been met with several criticisms that asset prices sometimes do not efficiently incorporate publicly available information, the literature on financial market volatility has been at the centre of portfolio management (Helleiner, 1995). Volatility is a very important aspect of risk management for investors' portfolios and expected returns on assets. Volatility is defined as the rate that the price of stock fluctuates. According to Granger and Poon (2001) when volatility is rapid during the short term there is high risk and when stock prices fluctuate slowly, there is low risk. Examining volatility in the stock markets allows portfolio managers and investors to establish possible fluctuations concerning an asset's returns in the future.

In Li, Chang, Miller, Balcilar and Gupta's (2015) study on the causal link between housing and stock markets in the US they found that stocks experience immediate price fluctuations during volatile periods due to high liquidity and trades. In addition, market news and investor sentiment due to short term speculation leads also leads to price changes of the stock market (Li et al 2015). In contrast, housing markets, tend to exhibit more gradual volatility because the process of selling or buying a property takes time. Thus, market participants in the housing market are slower in making decisions during volatile periods (Li *et al* 2015). However, changes in interest rates, credit availability and economic conditions can cause fluctuations in housing prices and demand over time.

2.6.2 Market drivers and volatility in stock markets

There are certain market drivers that explain the cause of volatility, namely economic and political factors, industry and sector factors, and company performance. Economic and political factors lead to stock market volatility due to international trade alliances and agreements, policy, and regulation. Aisen and Veiga (2011) studied the impact that political instability has on economic growth over a 5-year period in 169 countries. The study used a linear dynamic panel data model, and the findings were that when political instability is high there are lower rates of GDP. Political instability is harmful to the economy because it leads to short term changes in macroeconomic policies which creates volatility thus adversely affecting private investments and capital accumulation (Aisen and Veiga 2011). Hira (2017) conducted a study on the impact that political instability has on stock market volatility using an ARDL cointegration model.

The findings were that factors that represent political instability such as riots, assassinations, government changes, government longevity and regimes had a negative relationship with stock prices (Hira, 2017). However, there is a positive relationship between real estate and stock prices. Economic factors that lead to volatility in the market are inflation, interest rates, global events, fiscal and monetary policy. Large global events lead to volatility in the financial markets, the main ones in the past two decades being the 2008 Global Financial Crisis and the COVID-19 health crisis. Cheng, Liu, Yao and Zhao (2022) examined the impact that the COVID-19 pandemic had on the volatility connectedness of the global stock market. The study examined 19 economies worldwide and used a Diebold-Yilmaz volatility network model to model the volatility spillover index. The findings of the study are that the pandemic caused high volatility across the global stock markets because it hindered economic growth.

2.6.3 Market drivers and volatility in the housing market

Braun, Burghof, Langer and Sommervoll (2022) examined the impact that financial intermediaries have on the housing market volatility. The paper focused on two financial intermediaries, conventional banks and building and loan associates. It was found that conventional banks contribute to housing markets that are prone to recessions. These results are due to financial institutions offering real estate financing; therefore, the disparities of the financial institutions indirectly affect the real estate market (Braun *et al* 2022). Building and loaning associations have shown to cushion volatility in housing markets caused by the procyclical mortgage lending from conventional banks (Braun *et al* 2022). Deng, Giradin and Joyuex (2016) conducted a study on the fundamentals of the volatility of housing prices in China. The study argues that the drivers behind housing market volatility in China are sector specific, macroeconomic, and speculative factors. Housing-price boom and bust are shown by expectations-driven cycles and the study finds that when investors anticipate a change in regime their behaviour impacts aggregate output and housing prices (Deng *et al* 2016).

The Table 1. 1in the appendix summarises studies that have examined the volatility of housing markets across various countries using ARCH and GARCH models. Most of the papers studied volatility of the housing market in the respective countries to determine whether there were any leverage effects, volatility clustering and risk-return dynamics. Leverage effects describe how debt can impact the return on equity. In terms of volatility a leverage effect is the tendency of the volatility of an asset to be negatively related to the returns on an asset (Ait-Sahalia, Fan and Li, 2013). Volatility clustering is an observation of volatility, these observations are large changes in stock prices clustered together followed by smaller changes (Ait-Sahalia *et al* , 2023).

In the African context the Table 1. 1 in the appendix includes studies from Nigeria, South Africa, and Namibia. Alkali, Sipan and Razali (2019) conducted a study on the impact that bad news has on volatility in the Nigerian housing market. The study used a GARCH model and found that there is volatility in real estate prices and that it differs depending on the category of property. In addition, it was found that negative news such as cost of building supplies, crude oil prices and macroeconomic policy inconsistencies lead to volatility of the housing prices (Alkali *et al* 2019). Kaulihowa and Kamati (2019) examined the macroeconomic determinants of housing price volatility in Namibia and their casual relationships. The study used ARCH and GARCH models and found persistent volatility in housing prices. The results further establish that GDP in the past volatility period and mortgage loans are the main determinants of housing price volatility.

2.7 EMPIRICAL EVIDENCE ON THE RELATIONSHIP BETWEEN STOCK AND REAL ESTATE MARKETS

This section reviews the empirical evidence on the relationship between the real estate and stock markets in developed and developing countries as illustrated in Table 1. 2 in Appendix A. As described in the literature the two theories that explain this relationship are the wealth and credit effects. Starting with developing countries, in Germany Hesami (2018) studied the relationship between stock and housing prices. The study used a of Johansen Cointegration test and a Vector Error Correction Model (VAR) to examine the relationship and found that there is a long run relationship between stock and housing prices. These findings indicate that there is no benefit from diversification if investors only have real estate and stock in their portfolios (Hesami,2018). Lee, Lee and Laio (2016) focused on examining the price linkages between housing and stock prices in Australia. The study used a VAR model and Granger Causality tests. The results showed that the casualty went from the housing to the stock market indicating the presence of a wealth effect.

Liow, Huang and Song (2019) examined the stock and housing market dynamic linkages in the United States and Ohman and Yazdabfar (2016) in Sweden. Su (2010) also conducted the same study in Western European countries, and all these studies used Granger causality tests to determine the direction of the relationship. The findings were that there is evidence of bidirectional causality between the two markets. Therefore, indicating that the wealth and credit effects were both present in the long run. Moreover, the stock and housing markets indices have high returns with volatility transmission effects in Sweden, Western Europe, and the United States. In China, Su and Liu (2010) examined the relationship using a non-linear Threshold Error Correction Model (TECM) and a linear Granger causality test. The findings of the study were that the Granger causality test favours the wealth effect in the short run and in the long run there is the wealth effect according to the TECM results (Su and Liu 2010).

In the context of developing countries, Aye, Balcilar and Gupta (2013) examined the short and long run relationship between the stock and housing price in South Africa. The study used a linear cointegration test and a nonparametric Granger causality test. The findings were that the linear cointegration test did not find any long run relationship between the two markets and the nonparametric Granger causality test found bi-directional causality. These findings indicate the presence of a wealth and credit effect and the two markets drive each other Aye *et al* (2013). In Thailand, Ibrahim (2010) study examined the relationship between housing and stock prices. The study used a Vector Autoregression model and Granger causality test and found that were that there is causation from the stock to housing prices indicating a wealth effect. Hui, Zuo, Hu (201) examined the relationship between residential housing and stock price in Hong Kong and the United Kingdom. The study used Granger and Cointegration tests and found that there is a bidirectional relationship. In the short-term housing prices led the stock prices and in the long run stock prices led housing prices, thus indicating the presence of both wealth and credit effects.

2.8 IMPORTANCE OF LITERATURE IN THE CONTEXT OF SOUTH AFRICA

2.8.1 The South African REITS Market

This research aims to investigate and model the relationship between South African real estate and the stock markets during periods of volatility. The housing market is among the key positive market drivers in the South African economy. The market is essential for investors, policymakers, job creation, property developers and the economy more broadly. Interest in the housing market grew during the housing bubble crisis that resulted in the global financial crisis in 2008. REITs were first introduced in South Africa in 2013 and prior to that there were only two forms of property investment entities that were publicly traded, namely property loan companies (PLS) and property unit trusts (PUT). PUTs and PLSs are now classified as REITs however, they differ from REITs structurally in particularly in relation to regulation and tax aspects (Olaleye,2011). REITs were then introduced to address the problems PUTs and PLS brought upon investors which included being subject to double taxation and not being recognised by foreign investors (Ntuli and Akinsomi, 2017).

REITs in South Africa are more appealing to foreign and local investors because they have a more favourable tax status, and they are similar to REITs in other countries. In addition, REITs are better suited for investors since South African legislation requires that a minimum of 75 percent of a REITs firms earnings to be distributed to the investors (Ntuli and Akinsomi, 2017). Ntuli and Akinsomi (2017) examined the initial performance of REITS in the South African market and found that REITs are the top performing assets in South Africa during the 2013 to 2015 period of the study. In addition, the study found that both REITs and stocks are not entirely influenced by the same factors, therefore they are good for diversification effects in an investment portfolio.

In a similar study Mpofu, Moobela and Simbanegavi (2023) examined the impact that COVID-19 had on the relationship between REITS and inflation in South Africa. VAR and cointegration tests were employed and the study found that there is no evidence of a relationship between REITS returns and inflation. As this research is examining the relationship between REITS and stock markets in South Africa, studies like Mpofu *et al* (2023) are important to show how REITS are impacted by changes in macroeconomic conditions and how REITS investors should position themselves.

2.8.2 Driving Forces of the South African Housing Market

The key driving forces in the South African property market are migration trends, security issues, economic growth, income and employment, foreign investment, fiscal and monetary policy and investment returns (Luus, 2005). The real estate market in South Africa has been forecasted to grow more than 9% between 2022-2027 (Mordor Intelligence, 2022). There was an increase in the number of first-time buyers of property in South Africa during the volatile economic period of Covid-19 (Mordor Intelligence, 2022). The reasons for the increase in property purchases were due to people wanting to build asset portfolios with property and the interest rates allowed for great conditions to buy property (Lekhuleni, 2023).

In addition, SA-REITs conducted a study that showed that all 27 listed REITs companies had higher returns than the All Share and All Bonds return indices (SA REITS, 2023). Due to the increasing prime lending rates the number of buyers and investors of real estate decrease, which leads to a decrease in demand for properties (Lekhuleni, 2023). The trend of purchasing of real estate is consistent with the theory of housing and interest rates. The theory of the relationship between housing and interest rate is supported by Kau and Keenan (1980) study, which found that the demand for real estate decreases as interest rates increase. Identifying the driving forces of the South African real estate market brings light to the significance of this research, which is to help facilitate homeowners, real estate investors and policymakers to identify the behaviour of the real estate market volatility

2.8.3 The South African Stock Market

The Johannesburg stock exchange (JSE) was established in 1887 to facilitate international trade after the discovery of gold in the Witwatersrand. According to Beer, Keyser and Van def Merwe (2015) for a stock market to contribute to a country's economic growth, it should reflect the macroeconomic indicators that influence the behaviour of a stock market. In addition, political and economic developments influence the returns to equites on the stock exchange. Beer *et al* (2015) study found that the major economic and political events are reflected in the returns to the JSE, but just not in a consistent manner.

2.8.4 Importance of examining real estate and stock markets in South Africa.

Examining the relationship between the housing and real estate market is important for it presents the behaviour of monetary movement in an economy. As outlined earlier in section 2.2, there are two effects that explain the direction of the causality between stock and real estate markets, namely, of the relationship which are the wealth and credit effects. The global financial crisis and the covid 19 periods of economic volatility have shown the importance of financial stability for investors, regulators, and policymakers. In addition, financial stability influences financial markets particularly highly integrated markets. Aye *et al* (2013) is the most recent study that has examined the relationship between real estate and stock markets in South Africa sample period 1966 to 2011 using a non-parametric cointegration model. Aye *et al* (2013) argue that examining this relationship is important for asset substitution, diversification, portfolio investment and household welfare. In addition, Nguyen and Bui (2019) find that housing prices and the stock market have a positive association with economic growth and serve as indicators for output and inflation.

In terms of this study, the housing market data is represented by the REITs index and the stock market by the FTSE/All Share index for sample period 2013-2023. In addition, real estate investment trusts were introduced in South African legislation in 2013 and the last study that conducted this relationship in South Africa was in 2013 (Aye *et al* 2013). Therefore, there is value in conducting this research and extending the existing literature. Moreover, South Africa's property and stock markets are the most efficient in the African continent, therefore, the theories examined in the literature could easily be applicable. As previously stated, financial stability is important in maintaining efficient financial markets, therefore examining volatile periods and the contributing factors to volatility is important for risk management, investor decisions and portfolio diversification. In South Africa, Fateye, Ajayi and Ajayi (2022) modeled the property market volatility using a GARCH analysis. The findings of the study were that property market investment increases more when there is positive than negative information on the daily housing prices (Fateye *et al* 2022). In addition, the GARCH effect showed that there is a presence of high and low volatility clustering. Moreover, the trading in the South African property market is driven by good news such as incentives, tax holidays and bonuses (Fateye *et al* 2022).

2.9 SUMMARY

Section 2.1 to 2.2 began by discussing the wealth and credit effect theories that explain the relationship between the REITs and stock markets. Section 2.3 further elaborated on the REITS literature and their characteristics to give an understanding of how they operate for investors interested in the real estate market. In addition, the literature on the stock market was reviewed to showcase the financial instruments and market participants in the stock market. In addition, the nature of the stock market was discussed through the efficient market hypothesis in section 2.4.

Moreover, section 2.5 expanded on the characteristics of assets and the determinants of risks that the assets experience. The section further discussed the importance of the modern portfolio theory, CAPM and the NET as they provide a foundation for the nature of the risk of an asset to be understood.

Section 2.6 reviewed a number of empirical studies that showed the importance of examining volatility patterns in both stock and housing markets since they have implications for policy makers and investors. In addition, policies and macroeconomic determinants lead to housing price volatility Therefore, analysing volatility is beneficial for investors when they are building a portfolio and are seeking to have effective risk management techniques. In summary, understanding the drivers of volatility and the differences between stock and housing markets may aid in interpreting and anticipating their behaviours during volatile periods. Both markets can be influenced by investor sentiment, economic indicators and global events. However, the distinct characteristics between the housing and stock markets can lead to varying degrees and patterns of volatility.

Section 2.7 described the empirical papers that showed the importance of examining the relationship between stock and housing markets since they are some of the most important assets in an investor's portfolio. In addition, examining the relationship showed the state of the economy through the wealth and credit effects. The difference in results of the relationship between the stock and real estate market from each country showed that a country specific study is needed to examine the relationship. Furthermore, section 2.8 discussed the South African stock and REITs context and the importance of examining the relationship using volatility models and establishing the movement of money in the economy depending which effect is present. In addition, examining the volatility is important because it provides insight to policymakers and investors to examine the risk of contagion brought upon by the markets. The spillover effects financial markets that in question for this research are the housing and stock markets.

Therefore, given the evidence, housing and stock prices are likely to cause a change in monetary policy, investor portfolios and the return on investment. The motivation to conduct this study in the South African context is that several studies have examined the relationship between housing and stock price. However, the findings have differed in the econometric models, sample period, housing market data, causality, magnitude, and significance of the relationship.

The next chapter presents the methodology of the research, an overview of the data source and a discussion of the develops the analytical framework used to address the main objectives of the research.

CHAPTER THREE

DATA AND METHODOLOGY

3.1 RESEARCH PARADIGM

The paradigm of this research is a post-positivist it focuses on seeking reliable and valid evidence in terms of the existence of a phenomenon instead of generalization (Panhwar, Ansari and Shah, 2017). Researchers in focusing on conducting studies under this paradigm aim for context-dependent generalizations (Cooper, 1997). Along with quantitative analysis, the research will have comparative, philosophical and historical analysis that is guided by theory. Moreover, the research aims to have an in-depth analysis to investigate and understand the question that the research is addressing.

3.2 DATA

The data analysed in this thesis was obtained from daily time series data 2 January 2013 to 31 May 2023 obtained from the IRESS database. The index used to represent real estate data is the FTSE/ JSE REITS (JS3512). The FTSE/ JSE REITS (JS3512) index exposed investors to real estate through JSE listed instruments. Since 2013 Property Loan Stocks companies and Property Unit Trusts listed on the JSE have been converted into REITs. The stock market data is the FTSE/ JSE All Share (J203), which measures the individually listed company share prices on the Johannesburg Stock Exchange. The FTSE/JSE All Share (J203) index is a result of a correlation between the JSE and the FTSE group which is a group that manages and creates indices. In addition, the index provides investors with information on the performance of industry segments and capital of the South African financial markets. Moreover, the FTSE/JSE All Share (J203) index measures 99% of the full market capitalization value of the eligible securities that are listed on the JSE main board.

3.3 RESEARCH METHODOLOGY

As noted earlier the main objective of this study is to examine the relationship between the stock and REITs indices to determine the channel of transmission present in the case of South Africa which is outlined by the theories of the wealth and credit effects. In doing so, the study follows several studies have examined this relationship (Hui *et al* 2011, Lean and Smyth, 2013; Lee et al, 2016; Ohman and Yazdabfar, 2016) by using unit roots tests (3.4) tests for cointegration, (3.5) and

VAR and Granger Causality models (3.6). The second objective is to estimate a threshold model that examines the relationship between the stock and REITS prices during a period of high and low volatility (3.7).

The last objective of the study is to firstly estimate univariate GARCH models (3.8). Moreover, estimate Bivariate GARCH models to determine if volatility of the REIT return index affects the volatility of the stock return index vice versa (3.9). The Bivariate GARCH models are going to be used to determine the volatility interrelatedness and covariances of the indices. There are different Bivariate GARCH models that are explored, Constant Conditional Correlation (CCC)and the Diagonal Baba, Engle, Kraft Kroner (BEKK) GARCH models.

3.4 UNIT ROOT AND THE INTEGRATED ORDER OF VARIABLES

A key process when dealing with financial time series data is one of *stationarity*. Unit roots often cause implications in financial market variables such as stock prices, futures contracts, forward exchange rates and real consumption (Phillips and Perron, 1989). A time series is said to be stationary when it has the following characteristics (Brooks, 2008). The mean, variance and covariances should be constant over time.

The research used the Augmented Dicky-Fuller test (ADF) developed to test for the presence of a unit root and non-stationarity. The ADF model is used in this research for it handles more complex models than the normal Dicky-Fuller test and the lag lengths are determined by Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC). The hypothesis for the test is the null hypothesis that there is a unit root I (1) and the alternative hypothesis is that the time series is stationary I (0) if the data has an ARMA structure. In addition, when performing the ADF methodology it is on the assumption that the error terms are uncorrelated and that there is a constant variance.

Another test the research uses to test for non-stationarity is the Phillips-Perron (PP) test which is a generalization of the ADF test. In the research, the Phillips-Perron test allows for there to be autocorrelated residuals compared to the ADF test. The PP test make corrections to the test statistic to account for serial correlation in the error terms unlike the ADF. However, the distribution of the Phillips-Perron test statistic is the same as the Augmented Dicky-Fuller test statistic. The PP test is a nonparametric approach that allows for weakly dependent and heterogeneously distributed data. Meaning that the test accommodates models with time trends and fitted drifts to be used to differentiate between unit root stationary and non-stationary around a deterministic trend (Phillips and Perron, 1989).

Appendix B Table 4.2 and 4.3 represent the results from the unit roots tests from the ADF and PP. The tests are estimated using the Akaike Information Criterion in three different specifications: trend and intercept; intercept; and no trend and intercept in the equations. The findings of these three different specifications don't differ greatly therefore, the research will use the results of the ADF and PP equation with trend and intercept. Based on the findings from the ADF model in level terms the test statistic is insignificant at the 5% level. In addition, the t statistics of stocks (-3.398) and REITS (-1.955) in level terms are not more negative than the critical values.

Therefore, we fail to reject the null and conclude that both the series are non-stationary in level terms and there are unit roots present. The tests were then conducted in first differences and the t statistics of both REITS (-22.767) and the stock market prices (-11.411) are more negative than the critical values, therefore, the null is rejected and it can be concluded that both series are stationary in first difference. The ADF and PP tests confirm that the data and variables are of the same order being integrated order one (I(1)). According to Brooks (2013) it is necessary for time series data to be stationary to avoid a spurious regression. Therefore, the data for both series is transformed into first difference to make them stationary as indicated by the results of the ADF and PP

3.5 COINTEGRATION

After conducting the unit root tests and establishing whether the series are stationary, the research proceeded to conduct cointegration tests. Cointegration is a test used to determine whether there is a long run relationship between two variables in a time series (Asteriou and Hall, 2007). The general definition of cointegration is that when a univariate series Y_t is integrated in order d *I(d)*, it means it needs to be differenced d times for it to be stationary (Chatfeild,2000). If two series $reits_{t1}$ and $ftse_{t2}$ are both *I(d)* then the combination of the series are *I(d)*. Should the combination of the two series have an order integrated less than d, shown as *I(d-b)* then the series is said to be cointegrated order (*d,b*) (Chatfeild,2000). There are three possible outcomes when a stationarity test is performed. The first outcome of the series is integrated order zero *I (0)* meaning that the *reits* and *ftse* series are stationary in level terms and do not require differencing (Chatfield, 2000). The second outcome is the *reits* and *ftse* series are integrated order 1, meaning that both series are stationary in first differences. The third outcome is that the *reits* and *ftse* series are integrated of different orders, meaning the series have a combination of both *I (0)* and *I (1)* (Chatfeild,2000). For the research, the first outcome is going to be discussed in the context of cointegration. This study uses the Johansen's approach and EViews to estimate these tests of cointegration.

3.5.1 Johansen Cointegration Test

The Johansen test is conducted to examine the long run relationship between daily REITs and JSE/All Share market prices and establishes whether there is a cointegrating relationship. The test centres around examining the Π matrix, which is a concept of eigenvalues of a matrix that is important in analysing long run relationships (Brooks, 2013). The Johansen methodology uses the trace and max statistics to determine the number of cointegrating vectors and whether the variables are cointegrated (Enders, 2010).

The ADF and PP have confirmed that the REITS and the JSE/All share prices are both integrated order one. The cointegration test is performed in level terms for the REITS and JSE/All Share market prices. Table 3.1 below show the results from the Johansen cointegration test

Table 3. 1 Johansen Cointegration test

Hypothesized No of CE(s)	**Eigenvalue**	**Trace Statistic**	**5% Critical value**	**Prob**
None*	0.006607	22.00020	25.872	0.1408
At most 1*	0.001858	4.819302	12.517	0.6225
Hypothesized No of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5% Critical value**	**Prob**
None*	0.006607	17.18090	19.387	0.1017
At most 1*	0.001858	4.819302	12.517	0.6225

Notes: Johansen cointegration test model specification with 8 lags intercept in CE and VAR, no trends in that are linear in CE, no trend in VAR $(\delta_2 = 0)$ *

The test is specified as having an intercept and trend, the results indicate that the trace statistic 22.00 is less than the 25.87 critical value and the probability value is 0.1408. The max-eigen statistic 17.18 is less than the critical 19.387 at a probability of 0.1017. Therefore, the hypothesis of there not being a cointegrating relationship is accepted, meaning there is no long run relationship between REITS and JSE/All Share market prices. These findings differ from other studies (Lin Hsu and Lin, 2019; Quan and Titman,1999; Yuksel, 2016) that showed that there is a long run relationship between the two markets. Reason being that most of the studies accounted for macroeconomic determinants such as inflation, real GDP and CPI that showed that they had an impact in there being a long run relationship between the housing and stock market prices. Since the results have indicated that there is no cointegrating relationship between the REITS and

JSE/ALL Share market prices, the VAR model is estimated and not the vector error correction model.

3.6 VECTOR AUTOCORRELATION REGRESSION MODEL

The results from the Johansen's method find there is no cointegration relationship between *reits* and *ftse* (JSE/ALL Share) therefore, the vector autocorrelation model (VAR) is estimated. The bivariate system below explains this as

$$reits_{sa} = \beta_{10} - \beta_{12} reits_t + \gamma_{11} ftse_{t-1} + \gamma_{12} ftse_{t-1} + \varepsilon_{yt}$$
$$ftse_{sa} = \beta_{20} - \beta_{21} ftse_t + \gamma_{21} ftse_{t-1} + \gamma_{22} reits_{t-1} + \varepsilon_{zt}$$

Where it is assumed that $reit_{sa}$ and $ftse_{sa}$ are stationary and ε_{zt} and ε_{yt} are white noise error terms which are uncorrelated. The above equations represent a first-order VAR due to the longest lag being unity (Enders, 2010). The equations are not in the reduced form therefore the system can be transformed into a more useful form through a matrix:

$$\begin{bmatrix} 1 & \beta_{12} \\ \beta_{21} & 1 \end{bmatrix} \begin{bmatrix} reits_t \\ ftse_t \end{bmatrix} = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{21} \end{bmatrix} \begin{bmatrix} reits_{t-1} \\ ftse_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix}$$

Or $$\mathrm{B}_{Zt} = \Gamma_0 + \Gamma_{1Z_{t-1}} + u_t$$

Where B = $\begin{bmatrix} 1 & \beta_{12} \\ \beta_{21} & 1 \end{bmatrix}$, $\mathrm{Z}_t = \begin{bmatrix} reits_t \\ ftse_t \end{bmatrix}$; $\Gamma_0 = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix}$; $\Gamma_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{21} \end{bmatrix}$ and $u_t = \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix}$

Multiplying both sides by B^{-1} where $A_0 = B^{-1}\Gamma_0$, $A_1 = B^{-1}\Gamma_1$ and $e_t = B^{-1}u_t$ to get:

$$z_t = A_0 + A_{1Z_{t-1}-} + e_t$$

And to rewrite the Vector Autocorrelation Regression Model as

$$reits_t = a_{10} + a_{11} reits_{t-1} + a_{12} ftse_{t-1} + e_{1t}$$
$$ftse_t = a_{20} + a_{21} ftse_{t-1} + a_{22} reits_{t-1} + e_{2t}$$

Or

$$\begin{bmatrix} reits_{sa} \\ ftse_{sa} \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} reits_{t-1} \\ ftse_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$

The benefits of the VAR approach are that each equation is estimated with OLS methods and the forecasts obtained from the VAR are better than most simultaneous models. In addition, the VAR allows for testing for the direction of causality between the two variables. (Asteriou and Hall, 2007). The main are criticism of the VAR are that the results are difficult to interpret, however, this research aims to use the impulse response functions and variance decompositions using the VAR to determine the response of shocks in the system caused by REITS and Stock prices.

3.6.1 Granger Causality Tests

The VAR estimation allows for examination of the Granger causality between the variables. In the case of two variables $reits_{sa}$ and $ftse_{sa}$ it is possible to have $reits_{sa}$ cause $ftse_{sa}$ and $ftse_{sa}$ cause $reits_{sa}$ (Asteriou and Hall, 2007). The Granger causality test is used to determine the causality between two tests and it is defined as follows: A variable $reits_{sa}$ is said to granger cause another $ftse_{sa}$ when it can predict using past values of $reits_{sa}$. In addition, when conducting the Granger test the null and alternative hypothesis are presented as

H0 : $\sum_{i=0}^{n} \beta_i = 0$ or $reits_{sa}$ does not cause $ftse_{sa}$

H0 : $\sum_{i=0}^{n} \beta_i \neq 0$ $ftse_{sa}$ does cause $reit_{sa}$

This study used the granger causality test to determine the direction of the casualty between real estate investment trusts ($reits_{sa}$) and stock market prices ($ftse_{sa}$) to effectively determine the presence of a wealth or credit effect for the two indexes during the selected sample period.

3.7 THRESHOLD VECTOR AUTOREGRESSION

The research estimates a two-regime threshold vector autoregression to examine the non-linear volatility interactions between the JSE/All Share and the REITs market prices. The aim of estimating the threshold VAR is to establish how the relationship between REITS and the JSE/All

Share market change during periods of high and low volatility. The Threshold VAR is specified as follows,

$$Y_t = A^1Y_t + B^1(L)Y_{t-1} + (A^2Y_t + B^2(L)Y_{t-1})I[s_{t-d} > \gamma] + U_t$$

Where Y_t represents the vector of endogenous variables, *I* being an indicator function with a value of 1 if the financial stress is higher than the threshold value of γ. d represents lags set to 1 and lag polynomial matrices are represented by $B^1(L)$ and $B^2(L)$. A^1Y_t *and* A^2Y_t are contemporaneous terms for these contemporaneous terms might be different across different regimes. The regime switch of the threshold model is determined by the transition variable being the JSE/All Share returns (S_t). As shown in the equation below, the model will switch with a delay in d beyond regimes if the threshold γ is surpassed.

$$S_t \begin{cases} 1, & \text{if } S_{t-d} < S \text{ ("low volatility")} \rightarrow \text{Regime 1} \\ 0, & \text{otherwise (" high volatility) } \rightarrow \text{Regime 2} \end{cases}$$

This model will be used to analyses the varying degree of interaction among different volatility regimes and the VAR co-efficient in each regimes captures the changing relationships between JSE/All share and REITS market prices.

3.8 MODELS OF VOLATILITY

The second section of the methodology examines the volatility spillover effects between the REITs and stock market prices. Similar to Fateye *et al* (2022) study on examining the volatility of daily property stocks using a GARCH (1, 1) model, this research aims to use a Bi-variate GARCH analysis to examine the ARCH and GARCH effects between REITs and Stock indexes. As mentioned in the literature review, studies such as (Akali et al, 2019; Cook and Watson 2017; Wang and Hartzell, 2021) used ARCH and GARCH models to examine the presence of volatility in the countries being examined. This study attempts to shed more light on the nature of the volatility between the stocks and REITS prices in South Africa**.** Section 3.8.1 describes the process of estimating volatility using ARCH and GARCH models. Section 3.8 further dissects the specifications of two different bivariate GARCH models, Constant Conditional Correlation (CCC), and the Baba, Engle, Kraft Kroner (BEKK) GARCH models to then establish the most suitable bi-variate specification.

3.8.1 ARCH Model

The Autoregressive Conditionally Heteroscedastic model is a model used for examining the volatile variance of a time series. It is used in time series where the sample period has increasing or decreasing variance (Enders ,2010). Variance measures the variability from the mean and the ARCH (1) model is presented as follows:

$$Var(y_t|y_{t-1}|) = \sigma_t^2 = \alpha_0 + a_1 y_{t-1}^2$$

Engle (1982) states that the variance (σ_t^2) at a specific time depends on the past square error terms (y_{t-1}^2). Due to this, it is assumed that the variance will change over time therefore, there is heteroskedasticity. In addition, the ARCH (1) models both the mean and variance of a series, shown as follows,

Mean equation: $Y_t = \alpha + \beta' X_t + u_t$

Variance equation: $h_t^2 = \alpha_0 + a_1 u_{t-1}^2$

The ARCH model holds that when a large shock in occurs in a period (t-1), the value of u_t will also be larger (Enders,2010). To estimate any ARCH model, there needs to be a test for ARCH effects assuming a null hypothesis of heteroskedasticity. The rejection of the null hypothesis suggests that there is a presence of ARCH effects (Ender,2010).

3.8.2 GARCH Models

Volatility is an important value regarding risk for it measures the deviations from the mean of a variable (Bessis,2011). In addition, volatility is also known as the standard deviation of a market variable. According to Bessis (2011) GARCH models show the behaviour of volatility, and the volatilities show a mean reverting process meaning that the high values in volatility tend to be smooth overtime. The GARCH model is a generalized ARCH model that allows for ARMA processes in the heteroskedastic variance (Enders ,2010). The GARCH (1,1) model is the simplest form of the GARCH (p,q) models and it is modelled as

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u_{t-1}^2$$

Where, ht is the conditional variance of the series at time t, γ0 is the constant term, δ_1 is the persistence of the past volatility, γ_1 represents the parameter associated with u_{t-1}^2 which represents the impact of past square error term. The research used the GARCH (1,1) model to examine the volatility returns of the JSE/All Share and REITS market individually. The aim of estimating a GARCH (1,1) model is to examine each markets behaviour of volatility.

3.8.3 Threshold GARCH models

The threshold GARCH model is a model developed by Zakoian (1994), it is estimated to examine the leverage effects in JSE/All Share and REITS prices. Leverage effects are defined as the correlation between future volatility and past asset prices Bouchaud, Jean-Phillippe, Matacz and Potters (2001).

The TGARCH (1,1), model is estimated as

$$h_t = \gamma_0 + \gamma u_{t-1}^2 + \vartheta u_{t-1}^2 d_{t-1} + \delta h_{t-1}$$

Where d_t has a value of 1 when $u_t < 0$ and 0 otherwise. So "bad news" and "good news" have different effects. In addition, good news impact is γ and bad news has an impact of $\gamma + \theta$ and if θ >0 there is asymmetry. γ is known as the asymmetric or leverage term.

3.9 BIVARIATE GARCH MODELS

In the case of this research, one of the objectives is to determine the nature of the volatility between REITs and stock prices and determine whether the two volatilities are interrelated. There are some cases in a time series that is made up of multiple variables where the shocks between the variables are correlated with each other. The correlations have an important role in risk management, asset returns and portfolio selection (Tsay,2006). Unlike univariate models, bivariate GARCH models allow for the examinations of how volatility shocks of one variable spill over and impact the volatility of another variable (Ender, 2015). In addition, a bivariate GARCH model is estimated to simultaneously model the conditional volatilities of the two variables. The research on volatility transmission has allowed for the development of complex econometric models that allow for complex interactions between financial markets Cardona, Gutierrez and Agudelo (2017). There are various multivariate generalizations of the GARCH models that the research estimates, particularly the Diagonal BEKK and the Constant Conditional Correlation model.

3.9.1 Diagonal BEKK Model

The diagonal BEKK is estimated after estimating the individual GARCH (1,1) models for the JSE/All Share and REITs. The GARCH (1,1) is not sufficient because it only shows the volatility of each market individually not its transmission effects. Therefore, a diagonal BEKK model is estimated to analyse the interactions of the ARCH and GARCH effects between the JSE/All Share and REITs market prices.

The BEKK model was developed by Baba, Engle, Kraft and Kroner (1995) and it is the most frequently used bivariate model for volatility (Allen and McAleer, 2019). Estimating and understanding a BEKK model is important for investments and making informed financial policies (Allen and McAleer, 2019). The BEKK (p,q,K) model is estimated as follows

$$H_t = CC' + \sum_{i=1}^{q}\sum_{k=1}^{K} B'_{i,k}\,\epsilon_{t-1}\epsilon_{t-1}B_{i,k} + \sum_{j=1}^{P}\sum_{k=1}^{K} B'_{q+j,k}\,H_{t-j}B_{q+j,k}$$

Where C represents non-singular $n \times n$ matrix, $B_{i,k}$represeswents $n \times n$ parameter matrix and K determines generality. The BEKK in the two variable case is a shown as follows.

$$h_{11t} = (c_{11}^2 + c_{12}^2) + (\alpha_{11}^2\varepsilon_{1t-1}^2 + 2\alpha_{11}\alpha_{21}\varepsilon_{1t-1}\varepsilon_{2t-1} + \alpha_{21}^2\varepsilon_{2t-1}^2) + (\beta_{11}^2 h_{11t-1} + 2\beta_{11}\beta_{21}h_{12t-1} + \beta_{21}^2 h_{22t-1})$$

$$h_{12t} = c_{12}(c_{11} + c_{22}) + \alpha_{12}\alpha_{11}\varepsilon_{1t-1}^2 + (\alpha_{11}\alpha_{22} + \alpha_{12}\alpha_{21})\varepsilon_{1t-1}\varepsilon_{2t-1} + \alpha_{21}\alpha_{22}\varepsilon_{2t-1}^2 + \beta_{11}\beta_{12}h_{11t-1} + (\beta_{11}\beta_{22} + \beta_{12}\beta_{21})h_{12t-1} + \beta_{21}\beta_{22}h_{22t-1}$$

$$h_{22t} = (c_{22}^2 + c_{12}^2) + (\alpha_{12}^2\varepsilon_{1t-1}^2 + 2\alpha_{12}\alpha_{22}\varepsilon_{1t-1}\varepsilon_{2t-1} + \alpha_{22}^2\varepsilon_{2t-1}^2) + (\beta_{12}^2 h_{11t-1} + 2\beta_{12}\beta_{22}h_{12t-1} + \beta_{22}^2 h_{22t-1})$$

Cardona *et al* (2017) used a BEKK model to test and examine volatility transmissions between the US and Latin American stock markets. Cardona *et al* (2017) hold that the BEKK model is a general way of estimating volatility transmissions and that it allows for estimations of time-varying conditional correlations. Cardona *et al* (2017) selected the BEKK model for it estimates cross effects of volatility across markets. In addition, the BEKK allows for there to be dependence between conditional volatility series.

3.9.2 Constant Conditional Correlation Model

The constant conditional correlation model is one of the popular bivariate GARCH models. The model restricts the correlation coefficient to be constant and it assumes that the off diagonal elements of H_t, $h_{ij,t}$ $(i \neq j)$ to be defined by the correlations shown by ρ_{ij} $(h_{ijt} = \rho_{ij}(h_{iit}h_{jjt})^{0,5}$. in addition, the fixed conditional variances in the model are the same as the univariate GARCH with fewer parameters (Enders,2015). The model is denoted as

$$h_{ii,t} = c_i + \alpha_i \epsilon_{i,t-1}^2 + b_i h_{ii,t-1} \qquad i=1,\ldots\ldots N$$

In the two variable case the CCC model is shown as

$$\begin{bmatrix} h_{11t} & \rho_{12}(h_{11t,} h_{22t})^{0.5} \\ \rho_{12}(h_{11t}, h_{22t})^{0.5} & h_{22t} \end{bmatrix}$$

This model is estimated to examine the spill over effects between the JSE/All share and REITs market prices and to understand the volatility transmissions between the two markets.

This chapter examined the data and methodology of the research first by presenting the post-positivist research paradigm. In addition, section 3.2 presents the daily data used for the objectives of the research being the JSE/All share and REITS market prices obtained from the IRESS database. Section 3.3 present the arrangement of how the research will be conducted. The tests of stationarity using the ADF and PP models are discussed in section 3.4. Thereafter, (3.5) showcases the Johansen methodology used to test for cointegration between JSE/All Share and REITs prices. VAR and Granger causality tests are discussed to show how the testing for casualty and simultaneous relationships will be conducted in (3.6). The models used to examine the behaviour of volatility through ARCH effects and the GARCH (1,1) are determined in (3.8). Lastly, the Diagonal BEKK and Constant Conditional Coefficient models that the research uses to establish the volatility spill overs between the JSE/All Share and REITS markets are discussed in (3,9)

The next section of the research presents the empirical findings of the research by firstly establishing the JSE All Share and REITs data's descriptive statistics. Thereafter, Chapter Four discusses the empirical findings using the methods discussed in this chapter.

CHAPTER FOUR

EMPIRICAL FINDINGS

4.1 INTRODUCTION

This study not only aims to establish the relationship between REITS and the stock market in South Africa but also to examine the presence of volatility spillover effects between the two markets. Through examining the nature of the relationship between REITs, it aids in determining whether in the case of South Africa there is a presence of a wealth or credit effect and the direction of causality between the markets. The empirical findings examined in Chapter Two of the literature review indicate that the presence of wealth and credit effects differ depending on the countries being examined and the index used to represent the housing market. As outlined earlier, this research uses real estate investment trusts as a representation of the South African housing market because they provide insight to investable and measurable real estate. As mentioned, the motivation to conduct this study is based on the fact there few studies that have examined the relationship between housing and stock markets in South Africa and the spill over effects between the two markets. In addition, real estate investment trusts are a new form of investments that are still in their infancy to real estate investors in South Africa.

This chapter, conducts the analytical framework that was discussed in Chapter Two of the literature review and Chapter Three of the methodology. The chapter is arranged as follows, Section 4.1 presents and discusses the descriptive statistics and correlations of the daily price data of REITs and the JSE/All Share data. Section 4.2 shows the unit root results in level and first differences using the Augmented Dicky-Fuller and Phillips Perron tests. Section 4.3 presents the selection of the optimal lag length using a VAR model and Johansen's cointegration methodology finding. Section 4.4 interprets the VAR models and the Granger Causality tests.

4.2 PRIMARY DATA ANALYSIS

Table 4.1 in Appendix B provides the summary for the 2601 observations descriptive statistics for daily prices of REITs and the JSE/ALL Share indexes. The data provides insights to the measures of central tendency through the mean and median values and shows the measure of dispersion through standard deviations. Among the two variables, the JSE/All Share market has the highest standard deviation of 9289.836 than REITs 246.6695. the standard deviation measures the spread the data these findings show that the risk from stock market returns is higher than the REITs. The skewness of the stock market 0.613 is positive and has a long right tail and the REITs -0.341 is negative with a long-left tail. The kurtosis of JSE/All share 2.98 and REITs 1.57 are platykurtic meaning that there is a negative kurtosis and there's more lower values in the data than the sample mean. The null hypothesis for the Jarque-Bera test is that there is a normal distribution in the data. However, the stock (163.172) and REITS (269.27) data indicate that the null should be rejected because the probability values are statistically significant.

Figure 2 and Figure 3 in Appendix A plot the daily prices for the JSE/All share and REITS markets in level terms. The stock prices show a general upward trend from 2013 to 2023, whereas the REITS prices show a downward trend. There was a large drop in market prices in January 2020 to April 2020 in both markets due to the covid 19 crisis. Since then, the JSE/All Share market has recovered by more than 66.3 percent compared with 18.5 percent for the REITs market prices as of May 2023.

Table 4.21 below shows the correlation coefficients and covariances of daily stock and REITs prices. The main findings of the table indicate that the correlation between the JSE/ All share and REITS is negative at 62.3 percent. The results indicate that there is a strong negative relationship between the two variables, and they move in opposite directions from each other. These results are consistent with other studies (Ibbotson and Siegel, 1994; Eichholtz and Hartzell, 1996) findings on the presence of a negative correlation between the housing and stock market prices. In addition, the results are statistically significant at the 1% level.

Table 4.2 1Correlation Coefficients and Covariances of Daily Stock and REITs prices

Correlation and Covariance table	JSE/ALL Share	REITS
JSE/All Share	1.000000 (86267869.17)	(-1427101)
REITS	-0.623014 (-147101.65)	1.000000 (69822.47)

Notes: Correlation and Correlation table for stock and REITs prices. Covariance's are represented in ( ).

In conclusion, the descriptive statistics, covariances, and correlation tables have highlighted some issues in the REITs and the stock market prices. The data showcases strong evidence against normality. However, according to Gujarati and Porter (2009), the assumption of normality is not necessary if the sample size is large, and that is the case here with 2601 observations. In addition, the negative correlations will be clarified when analysing the VAR and GARCH models. Therefore, these findings justify the investigation to examine the nature of the relationship and interdependence between the stock and REITs prices. The following sections will explore these matters in the subsequent sections.

4.3 OPTIMAL LAG LENGTH SELECTION

The assumption relating to the number of lags that should be included in a model is essential because they can affect the direction of causality between REITs and the JSE/All Share market prices. Gujarati and Porter (2009) state that having too many or few lags can lead to specification errors and multicollinearity and decrease the explanatory power of a model. Therefore, selecting the optimal lag is essential to estimating cointegration tests and the VAR model. Table 4. 4 in Appendix B shows the procedure used to select the optimal lag length. The Akaike information criterion (AIC) is applied to obtain the optimal lags using a VAR model using the JSE/ALL Share and REITs prices in first differences. The results indicate that the optimal lag length is 8, with an AIC of 22.136 and a log-likelihood of -28610.49. The optimal lag length is eight because it is chosen based on the lags that minimise the AIC (Brooks,2013).

4.4 VECTOR AUTOREGRESSION MODEL

A VAR model is estimated since no cointegrating relationship exists between the JSE/All Share and REITs market prices. As shown in the previous chapter, the JSE/All Share and REITs daily price data are non-stationary in terms of level. This leads to an issue of deciding whether or not to difference the variables in an unrestricted VAR. The data is I(1), and there is no cointegration; estimating the VAR with differenced variables is paramount, which is the case with the daily JSE /All Share and REITs price data. Enders (2015) provides three consequences of estimating a VAR for I(1) variables that need to be cointegrated in level terms. Firstly, there is potential for the VAR to lose its power, for each variable is estimated as an extra lag. Secondly, estimating a Granger causality test from a VAR in level terms for I (1) variables will not produce a standard F distribution statistic (Enders, 2015). Lastly, the impulse response functions for a VAR with I(1) variables forecast horizon periods that are inconsistent with their true estimates. Therefore, the VAR estimates the JSE/All Share and REITs I(1) variables in the first difference for consistent variance decompositions and impulse response functions of the variables.

4.4.1 Residual tests for VAR

Therefore, the VAR model estimates the JSE/ All Share and REITS prices in the first difference using the optimal eight lags selected in section 4.2. In order to ensure the efficiency of the data, the tests of heteroskedasticity, normality and Lagrange multiplier (LM) are performed. The VAR is tested for heteroskedasticity and white's heteroskedasticity test in Table 4. 5 of Appendix B and finds that the model residuals do feature heteroskedasticity with a probability value of 0.0000 and a chi-squares statistic of 1487.829. The Jarque-Bera test for normal distribution for the VAR model finds that there is a rejection of null at the 5% confidence level in Table 4. 6 of Appendix B. Therefore, the series is not normally distributed. The LM test is used for serial correlation. The probability values for all eight lags indicate no serial correlation in Table 4. 7 of Appendix B. Lastly, the stability of the VAR model was examined using an AR roots table. It was found that the VAR satisfies the stability condition shown in Table 4. 8 of Appendix B.

4.4.2 VAR Estimation Outputs and Granger Causality

The equation below shows the equations extracted from the VAR system, and they show the short-run dynamics of the relationship between the REITs and JSE/All Share market prices. There are 34 coefficients from both equations and 17 coefficients in each equation from estimating the VAR with the optimal lag length of 8. The Durbin Watson statistic of equations 1 and 2 is 2.00; this finds no autocorrelation in the equations. The equations below represent the estimated output for the coefficients of the VAR model for REITs and the JSE/All Share prices.

Equation 1 and 2 : Short run equation of REITs and JSE/All Share prices

1. REITS= 0.0565*REITS(-1) - 0.0349*REITS(-2) - 0.07271*REITS(-3) - 0.0304*REITS(-4) + 0.0300*REITS(-5) + 0.0067*REITS(-6) - 0.0074*REITS(-7) + 0.0283*REITS(-8) + 0.0002*FTSE(-1) + 0.0002*FTSE(-2) + 0.0008*FTSE(-3) - 0.0001*FTSE(-4) + 0.0004*FTSE(-5) - 0.0003*FTSE(-6) + 0.0004*FTSE(-7) - 0.0003*FTSE(-8) - 0.2060

2. FTSE = 0.6449*REITS(-1) + 1.9425*REITS(-2) - 0.3986*REITS(-3) - 0.3002*REITS(-4) + 1.5175*REITS(-5) - 0.2247*REITS(-6) - 2.6186*REITS(-7) - 2.5504*REITS(-8) + 0.0135*FTSE(-1) - 0.0521*FTSE(-2) + 0.0311*FTSE(-3) - 0.0426*FTSE(-4) - 0.0098*FTSE(-5) - 0.0334*FTSE(-6) + 0.0753*FTSE(-7) - 0.0296*FTSE(-8) + 13.8076[1]

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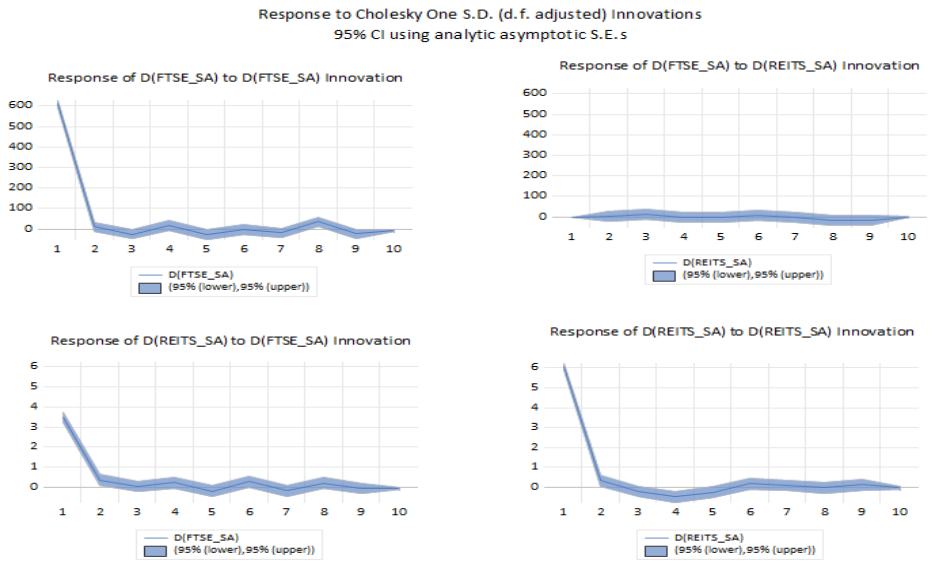
[1] The estimates of the VAR coefficients are statistically significant at the 5% level for both equations. The Log likelihood for *REITS = -8716.55 and Log for FTSE=-20302.80*

4.5 IMPULSE RESPONSE FUNCTION AND VARIANCE DECOMPOSITIONS

Granger causality test showcases the information regarding the likely direction of the relationship between the JSE/All Share and REITs. To compliment the granger causality tests, an impulse response function is estimated to ensure that the timing and size of the causality is explained. Panel A1 below presents show the VAR system responses to a shock in the error terms and shows how long the shocks take to dissipate.

Panel A 1 Impulse Response Function for VAR



Notes: table shows the impulse response function from a VAR system investigating innovations between REITS and JSE/ALL share, with a 95% confidence interval. Innovations are interpreted as shocks.

Panel A1 above shows the IRF of how one unit shock of one variable in the system impacts another over 10 periods. Looking at the lower left panel of the graph, of a response of REITS to a one-unit shock in JSE/All Share prices, from period 1 to 4 there is a 0.434 percentage increase in REITS prices. The market then experience's negative and positive fluctuations from period 5 to 8. In period 9 to 10 there is a negative shock that amounts to a 0.034 percentage influence on REITS prices. The of the response of the JSE/All share to REITS is not as volatile for there is a gradual increase from period 1 to 3. The shock disappears from period 4 to 7 to slightly experience a negative effect that disappears after period 10. The results from the IRF differs from the results of the correlation matrix of the descriptive statistics that there is mostly a negative relationship between REITS and JSE/All share prices. In addition, the granger causality findings of there being unidirectional causality from the stock market to the REITS are supported by the fluctuations in the IPF of how one unit shock in the JSE/All Share impacts the REITs.

4.5.1 Variance Decomposition

Table 4.51 and 4.52 below showcase the variance decomposition which allows the for the interrelationships between the JSE/All Share and REITs variables in the VAR system. The table consists of results with 8 lags presented that responds to the shocks. The forecast error variance deposition shows the proportion of movements in a series caused by its own shocks relative to the shocks to another variable (Enders,2015). The results in table 4.5 therefore illustrate the percentage change of a variation in the dependent variable that is caused by its own shocks.

Table 4.5 1 Variance Decomposition of REITs prices for VAR

Variance Decomposition of REITs prices for VAR			
	S.E	***JSE/All Share***	***REITS***
1	7.009175	0.000000	100.0000
2	7.027794	0.050237	99.94976
3	7.030582	0.088859	99.91114
4	7.049632	0.468568	99.53143
5	7.055532	0.472085	99.52791
6	7.064477	0.520820	99.47918
7	7.067218	0.597539	99.40246
8	7.070468	0.671907	99.32809
9	7.072099	0.699530	99.30047
10	7.072258	0.701872	99.29813

Table 4.5 2*Variance Decomposition of* JSE/All *Share prices for VAR*

Variance Decomposition of JSE/ALL Share prices for VAR			
	S.E	***JSE/All Share***	***REITS***
1	612.2992	75.26647	24.73353
2	612.4023	75.25490	24.74510
3	613.0231	75.30408	24.69592
4	613.2785	75.31131	24.68869
5	613.8054	75.29159	24.70841
6	613.8707	75.28786	24.71214
7	614.1421	75.28244	24.71756
8	615.3965	75.37970	24.62030
9	616.0934	75.25078	24.74922
10	616.1249	75.25141	24.74859

The results of the table 4.51 and 4.52 explain how both the JSE/All Share and REITs prices explain their own variations. In table 4.51 from lag 1 to 8 the results indicate that REITs prices are explained by themselves with 100 in the first lag and 99 percent from the second to the 8th lag. These results mean that the variation from REITs prices are caused by its own shocks. On the contrary, the JSE/All Share prices explain REITs at 0 percent in the first lag and the variation that the JSE/All Share prices have on REITs price increase from 0.050 to 0.071 in the second to the eight lag respectively. This means that the influence of the JSE/ All Share prices become exogenous as time passes. Table 4.52 shows that the JSE/All Share Prices explain themselves by approximately 75.2 percent from lag 1 to 8, showing that the stock prices are endogenous with time.

The REITS explain the JSE/ All share market by 24.7% from the first to the eight lags, indication that the REITs prices are more exogenous. Overall, the results indicate that the variations in stock prices that are explained by the REITs prices are small. Therefore, this suggests the housing and stock markets in South Africa are segmented. These results are consistent with these studies findings on there being market segmentation between the housing and stock markets (Liu, Hartezell, Greig and Grissom 1990). Liu *et al* (1990) examined whether real estate and stock market prices are integrated or segmented. The study describes segmentation in the context the of CAPM, it found that the risk for real estate to be systematic, meaning the stock and real estate returns don't earn the same expected returns. Therefore, REITS and JSE/All Share prices can be placed in a portfolio for diversification.

4.6 GRANGER CAUSALITY TESTS

The Granger causality tests are performed based on the Equations 1 and 2 mentioned in the previous subsection 4.5 from the VAR system. Causality refers to the capability of one variable predicting another and table below show the direction of causality between JSE/All Share and REITS markets prices.

Table 4.6 1 Granger Causality test

Dependant variable REITS	*Chi-sq*	*df*	*Prob.*
FTSE(d)	*19.67578*	*8*	*0.0116*
All	*19.67578*	*8*	*0.0116*
Dependant variable FTSE	*Chi-sq*	*df*	*Prob.*
REITs(d)	*5.375345*	*8*	*0.7168*
All	*5.375345*	*8*	*0.7168*

Notes: table indicates the granger causality tests for 8 lags at 5% significance level

The null hypothesis of the granger causality test both for the JSE/All share and REITs market prices are as follows

H_0: JSE/All Share does not granger cause REITS

H_0: REITS does not granger cause JSE/All Share market prices

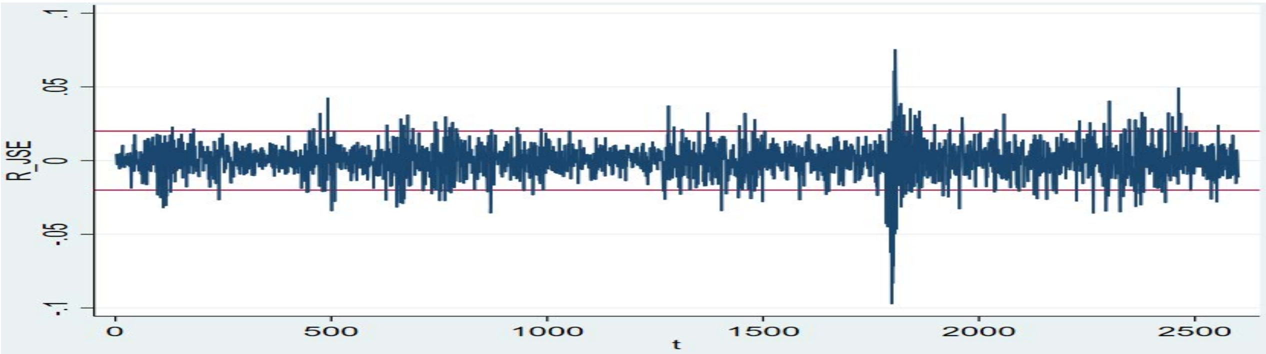
The results shown in Table 4.61 above indicate that in the case where REITS the dependant variable of JSE/All Share the null is rejected for the probability value 0.0116 is less than the 5 percent significance level. The case where the JSE/All share is the dependent variable there is a failure to reject the null for the probability value 0.7168 is more than the 5 percent significance level. These results imply that there is unidirectional causality from the JSE/All Share to the REITS, thus indicating a presence of the wealth effect in South Africa for the selected sample period. These findings are consistent with other studies findings on the relationship between housing and stock markets (Ibrahim,2010; Lean and Smyth, 2013 and Hui *et al* 2011). The findings from these studies are from emerging market economies namely Thailand, Malaysia and New Zealand which makes the Granger causality findings in the context of South Africa creditable. Jawadi (2014) finds that in emerging markets there is a strong positive correction between an increase in wealth and consumer spending.

Therefore, in the Granger causality findings imply that in South Africa when the stock market price increase, household wealth follows suit. The demand for consumption and investment opportunities increases with households investing in the housing market. The granger causality test and the cointegration tests have answered the first objective of the study. The cointegration results indicate that there is no long run relationship between the JSE/All Share and REIT market prices. Moreover, the granger causality tests have shown that there is a presence of a wealth effect in South Africa for the examined sample period.

4.7 THRESHOLD VECTOR AUTOREGRESSION MODEL

The TVAR model is a multivariate extension of the Threshold Autoregressive univariate model which was presented by Tong (1978). The TVAR model captures the nonlinearities in asymmetric shocks or regime switching and the model operates by separating time series in different regimes (Avdjiev and Zeng, 2014) A two-regime threshold VAR model is estimated to examine how the relationship between REITs and the JSE All Share model changes during a period of high and volatility. The model is estimated using the JSE/All Share series as the threshold variable and two different threshold models are estimated. The first model estimates a threshold dummy variable on the 90th percentile values and volatility is defined based on the values above 0.2 and below 0.006 as shown in Panel B1 below

<u>Panel B 1 Threshold VAR model for REITS based on 90th percentiles against REITS and JSE/All Share market prices between January 2013 to May 2023</u>



The results from the first threshold model are presented in Table 4.8 below. The results from Panel B1 show a threshold model defined by two regions, Region 1 represents a period of low volatility and Region 2 representing a period of high volatility. Tables 4.8 and 4.9 shows the TVAR results for the historical REITS prices against REITS and the JSE/All Share prices. The independent variables are differenced to 2 lags and it seen that in first regime only the first lag of REITS has a positive and statistically significant at a 5% level. This means that in a low period of volatility the relationship between REITs and JSE/All Share prices is not significant.

<u>Table 4.7 1Threshold VAR model for REITS based on the deviation of the REITS and JSE/All Share market prices at the 90th percentile between January 2013 to May 2023</u>

Dependant Variable	**REITS**			
Independent variable: REITS	**Regime 1**		**Regime 2**	
	Coefficient	**Prob.**	**Coefficient**	**Prob**
REITS (-1)	0.0729317	0.007*	-0.07304	0.181
REITS (-2)	-0.015123	0.585	-0.10316	0.046*
JSE/All Share (-1)	0.026376	0.368	0.09084	0.280
JSE/All Share (-2)	0.017080	0.564	0.24185	0.002*

*AIC: -2.264e+04 BIC: -2.253e+04 *significant at 10% level*

Table 4.7 2 Threshold VAR model for REITS based on volatility levels greater than the median deviation of the REITS and JSE/All Share market prices between January 2013 to May 2023

Dependant Variable	**REITS**			
Independent variable REITS	**Regime 1**		**Regime 2**	
	Coefficient	**Prob.**	**Coefficient**	**Prob**
REITS (-1)	0.0091216	0.821	0.064966	0.030*
REITS (-2)	-0.0093632	0.819	-0.053511	0.070**
JSE/All Share(-1)	0.0330237	0.433	0.0476084	0.207
JSE/All Share (-2)	0.0179259	0.685	0.0763526	0.037*

AIC : -2.253e+04 BIC : -2.242e+04 **significant at 5% level, ** significant 10% level*

In periods of high volatility in Regimes 2 both the coefficients of the second lags of the REITs and JSE/All are positive and statistically significant for both threshold models. These results indicate the JSE/All Share prices during periods of high volatility are positive associated with the REITS returns.

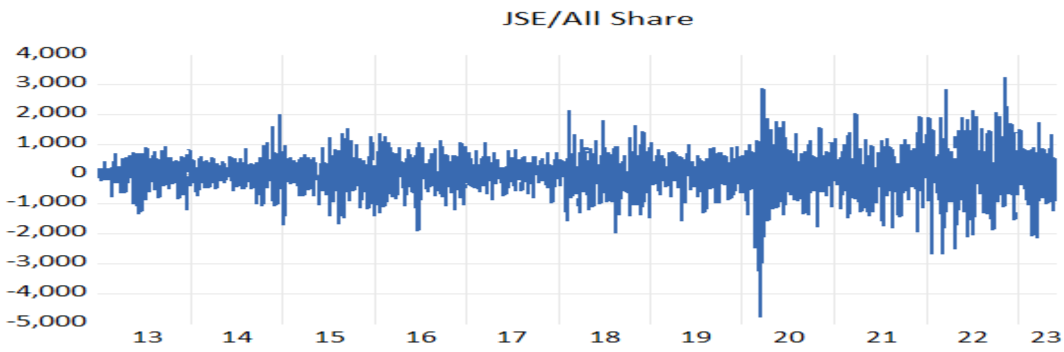
4.8 VOLATILITY TRANSIMISSION BETWEEN JSE/ALL SHARE AND REITS PRICES

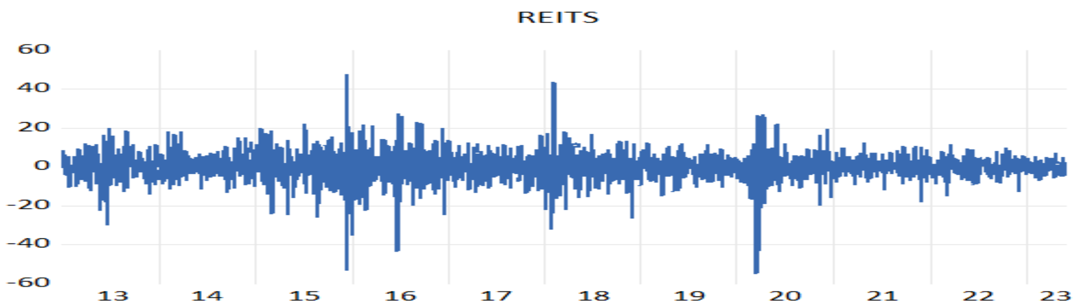
This section analyses the last objective of the study of examining bivariate GARCH models and the ARCH effects of each daily differenced time series. The bivariate GARCH mode is then employed to examine the volatility and spillover effects between the REITS and JSE/All Share market prices. The observed JSE/All Share and REITs prices are examined as differenced daily data.

4.8.1 Daily returns of JSE/ALL Share and REITs Prices

Panel C1 below shows the representation of JSE/All Share and REIT prices volatility patterns from 2 January 2013 to 31 May 2023.

Panel C 1Daily series plot of JSE/All Share and REITs from 2 January 2013 to 31 May 2013





The figures above show specific periods of high and low volatility. The periods of high volatility indicate that there are periods that are riskier than others for investors. In the JSE/All Share daily first difference graph, the period corresponding with high volatility is from 3 March 2020 to 6 April 2020 and 10 March 2020 to 7 April 2020 in the REITS daily returns. The observations from these significant changes in stock and REITs price returns followed by minor changes are called volatility clustering. The reason for this period of volatility in the stock market is the economic instability that came from the COVID-19 health crisis. Therefore, just by observation, these graphs indicate that the assumption of the disturbance term's variance being constant over time could be limiting. Therefore, the test for ARCH effects, which is the modelling of conditional heteroskedasticity, is estimated in the next subsubsection.

4.8.2 Testing of ARCH Effects

The ARCH model states that the variance associated with residuals at a time *t* is correlated with the variance in the past periods squared error terms (Asteriou and Hall, 2007). The model suggests that when there is suspicion that the conditional variance is not constant, estimating the variance and mean of a series is preferable. Therefore, Table 4.81 below shows the test results for ARCH effects in the JSE/All Share and REITs markets prices. The test is estimated for AR(1) and AR(6) models using the daily returns of the JSE/All Share and REITs through the least squares method.

***Table 4.8 1 ARCH Test*s for JSE/All Share and REITs**

	Heteroskedatiscity test for ARCH Effects for JSE/All Share			
AR 1test	F-Stat	44.30550	Prob. F(1,2596)	0.0000
	Obs*R-squared	43.59560	Prob. Chi-Square(1)	0.0000
AR 6 test	F-Stat	82.53880	Prob. F(6,2586)	0.0000
	Obs*R-squared	416.7613	Prob. Chi-Square(6)	0.0000

Note: Authors calculations : significance at 5% in first difference

	Heteroskedatiscity test for ARCH Effects for REITS			
AR 1test	F-Stat	300.8848	Prob. F(1,2596)	0.0000
	Obs*R-squared	269.8411	Prob. Chi-Square(1)	0.0000
AR 6 test	F-Stat	122.1959	Prob. F(6,2586)	0.0000
	Obs*R-squared	572.4411	Prob. Chi-Square(6)	0.0000

Note: Authors calculations: significance at 5% in first difference

The results indicate the presence of ARCH effects for the $T*R^2$ shown as the observed R-squared residual is 43.59 and 416.7613 in the JSE/All Share daily returns for the AR(1) and AR(6) models, respectively, at a probability of 0.000. In addition, an ARCH effect is present in the REIT's daily prices with test statistics of 269.84 and 572.44 at a probability of 0.000 for the AR(1) and AR(6) models, respectively. Therefore, there is a rejection of the null hypothesis of no ARCH effects in all models. The conditional standard deviation graphs for the ARCH (1) and ARCH (6) models are shown in the Appendix. The following subsection discusses the bivariate GARCH models used to model the volatility between the REITS and JSE/All Share market prices.

4.8.3 Univariate GARCH (1,1) for JSE/All Share and REITS

To better understand the characteristics of the volatility of the JSE/All Share and REITs market prices, univariate ARCH/GARCH models are estimated for each series using the GARCH (1,1) model. Table 4.82 shows the results of the univariate GARCH (1,1) models for both series.

The results indicate that the JSE/All Share ARCH (0.0677) and GARCH (0.9276) terms are significant at the 5 % level, and REITS ARCH (0.1132) and GARCH (0.8165) are also statistically significant at the 5% level. In both series, the GARCH term carries the 'weight' of the JSE/All share and REITs prices in the GARCH (1,1) estimation. The ARCH term is known as the "new effect", and the GARCH term is known as the 'persistence' parameter. The large persistence parameter indicates that in both the JSE/All Share and REITS daily prices, past volatility is more relevant than the "news effect". Therefore, it can be concluded that volatility clustering is indeed present in both the JSE/All Share and REITs series, as shown by the statistically significant and extensive GARCH term in the variance equation.

Table 4.8.2 1GARCH (1,1) table for JSE/All Share and REITS

Mean Equation		
	JSE/All Share	**REITS**
Variable	**Coefficient**	
Constant	17.63154 (0.0627)**	-0.068188(0.4952)
AR(-1)	0.019290 (0.3553)	0.055481 (0.0058)*
Variance Equation		
	JSE/ All Share	**REITS**
Constant	2519.496*	0.728074*
ARCH Term	0.067724*	0.113271*
GARCH Term	0.927606*	0.816514*
Information Criteria		
Akaike Info Criterion	15.43083	6.418599
Schwarz Criterion	15.44211	6.429878

**Significance at the 5% level, ** Significance at 10% level*

These results are consistent with Fateye *et al* (2022) findings on the volatility in the GARCH (1,1) model having a positive and significant impact on South African property markets. These research results indicate that investors in the stock and REIT markets are more driven by positive news than negative news, just like the study by Fateye *et al* (2022). In addition, Figure 3 and Figure 4 in Appendix C show the conditional variances for the JSE/All Share and REITS GARCH (1,1) models.

The heteroskedasticity and Jarque-Bera tests of the GARCH (1,1) in Table 4. 9 in Appendix C show that the normality tests show that the data of the JSE/All share and REITs market prices are not normally distributed. The results of the Jarque-Bera test are consistent with the findings of Fateye *et al.* (2022). They are expected for the distribution of both series showing the volatility clustering in the data. In addition, there are no ARCH effects, which means that the BEKK (1,1) model for the BEKK (known as a bivariate generalisation of the GARCH (1,1) model) can now be estimated (Tsay,2014).

The univariate estimation provides insight into the volatility of the JSE/All Share and REITS prices individually. The results of the large significant GARCH term indicate that the previous volatility significantly impacted the volatility in the following period. Therefore, these insights suggest that there is value in estimating a bi-variate volatility system to understand better whether and how the volatility of the JSE/All Share and REITS market prices impact each other.

4.8.4 Univariate TGARCH (1,1) for JSE/All Share and REITS

One of the significant restrictions of a GARCH (1,1) model is that there is symmetry, meaning that a positive shock will have the same impact as a negative shock of the same magnitude. However, it has been found that adverse shocks have a higher effect on market returns for stocks and some listed assets than positive shocks in financial time series data. The TGARCH model was developed by Zakoian (1990) and Glosten, Jagammathan and Runke (1993) to examine the asymmetries in financial time series data. The model is estimated by adding a multiplicative dummy variable to the variance equation to test whether there is a statistically significant difference when the shocks to a market are negative or positive. Therefore, the TGARCH (1,1) model is estimated for both the JSE/All Share and REITs market prices to estimate the leverage effects and asymmetries of positive and negative shocks.

Table 4.8 2 TGARCH (1,1) table for JSE/All Share and REITS

Mean Equation		
	JSE/All Share	**REITS**
Variable	**Coefficient**	
Constant	5.215078(0.5810)	-0.131479(0.2122)
AR(-1)	0.022209(0.2833)	0.055377 (0.0051)*
Variance Equation		
	JSE/ All Share	**REITS**
Constant	2761.343	0.713177*
ARCH Term	0.017617*	0.084652*
Asymmetric Term	0.089343*	0.043409*
GARCH Term	0.931703*	0.882604*
Information Criteria		
Akaike Info Criterion	15.41361	6.416910
Schwarz Criterion	15.42714	6.430445

**Significance at the 5% level, ** Significance at 10% level*

Table 4.83 above presents the results of the TGARCH (1,1) for both the JSE/All Share and REIT returns. Looking at the variance equation in the JSE/All Share model, the coefficient of the asymmetric term (0.0893) is statistically significant at the 5% level. This result indicates there are asymmetries present for the JSE/All Share series, and the coefficient is positive, which indicates that bad news has a more considerable impact on the volatility of the stock series than good news.

In addition, the REITS model also suggests asymmetric effects in the model since the coefficient for the TGARCH term (0.0434) is significant at the 5 % level and is positive. The results indicate that just like the JSE/All Share series, bad news in the REITS series has a more significant impact than good news (*b1 + > b1*). These results are supported by the conditional variance in Figure 5 and Figure 6 in Appendix C since the graphs illustrate that the conditional variance for both REITS and the JSE/All Share series was higher during the economic instability of the COVID-19 pandemic. Table 4. 10 in Appendix C presents the residual diagnostics for the TGARCH models for the JSE/All Share and REITs market prices. The results show no ARCH effects in the REITS and JSE /All Share series. In addition, the normality tests show that neither series is usually distributed.

4.9 BIVARIATE GARCH MODELS

In the previous subsection (4.8.2), the ARCH test was examined, and the results indicated the presence of the ARCH effect in both the JSE/All Share and REITs difference daily data. This section examines the modelling of volatility between the REITs and JSE/All Share prices. The reason for modelling bivariate instead of univariate models is the univariate time series needs to include information on interactions and co-movements between assets. Therefore, there is a need to estimate models that can measure covariances between assets (Silvennoinen and Terasvirta, 2009). Measuring volatility using bivariate models was introduced by Engle (1982), and in the bivariate content, volatility is modelled by examining the conditional variance and covariances. This study estimates a diagonal BEKK in that regard and models volatility through the conditional correlations using the CCC model and following the approach used by Chang, McAleer and Tansuchat (2013) study on examining spill over between crude oil and stock prices.

4.9.1 Conditional Constant Correlation model

The most common bivariate models are the CCC models due to the simple estimation of the parameters. The foundation of this model is that it decomposes the conditional covariance matrix to a conditional correlation and standard deviation. The findings of the constant conditional correlation systems are as follows.

Table 4.9 1 Constant Conditional Correlation

Transformed Variance Coefficients				
Variables	**Coefficient**	**Std. Error**	**z-statistic**	**Prob**
M(1)	2326.559	518.5432	4.486721	0.0000
A1(1)	0.051135	0.005350	9.558123	0.0000
B1(1)	0.943398	0.005618	167.9388	0.0000
M(2)	0.658498	0.122940	5.356237	0.0000
A1(2)	0.085058	0.006159	13.81097	0.0000
B1(2)	0.901818	0.007210	125.0789	0.0000
R(1,2)	0.479833	0.013369	35.89245	0.0000

Notes: log likelihood : -28061.10; Akaike info criterion 21.59239; Schwarz criterion 21.61268; Avg. log likelihood -5.396

Table 4.9.1 shows the results of the CCC; the results indicate that the ARCH and GARCH terms are statistically significant. The findings indicate that the volatility of REITS and JSE/All Share market prices is sensitive to their past shocks and the past conditional variance. The persistent effects B1(1) 0.943398, B1(2)0.901818 are larger than the news effect A1(1) 0.051135, A1(2) 0.085058. the results mean that the persistence of the JSE/All Share prices is larger than the REITs. In addition, looking at the spill overs, a 1% increase in a shock in the JSE/All Share today will increase the volatility of the REITs returns by 0.05%.

Moreover, a 1% increase in shocks of REITs will lead to a 0.08% increase in JSE/All Share volatility. These spill overs are positive and significant, which means that contagion could be present between the two markets. R(1,2) represents the conditional correlation between the JSE/All Share and REITs, which is statistically significant. Therefore, it meets the assumption of the CCC that the correlation is constant over time. Overall, it is concluded that in the CCC model, the JSE/All Share market is more sensitive to shocks than the REITS, looking at the values of persistence. This further supports that standard deviation results from the descriptive statistics described earlier in the chapter that the JSE/All share market is riskier than the REITS.

Table 4. 11 in Appendix C presents the results of the residual diagnostics of the CCC model. The test for autocorrelation was estimated up to 8 lags, and the conclusion was to reject the null and conclude that there is no autocorrelation for the CCC model. The results of the joint Jarque-Bera test for normality indicate that the model does not conform to the normality condition in Table 4.

12 of Appendix C. In addition, Figure 7 in Appendix C illustrates the conditional variances and Figure 8 presents the conditional correlation of the Conditional Constant Correlation model.

4.9.2 Diagonal BEKK model

The Diagonal GARCH is estimated to show the correlations between the volatility and covariances of the JSE/All share and REITS market prices. The results of the volatility transmission between the two market prices are presented in Table 4.92 Below. Table 4.92 shows the diagonal coefficients of the spill over effects between the JSE/All Share and REITS market prices. The ARCH effects are represented by A1(1,1) 0.0407, A1(2,2) 0.0853 and the GARCH the terms B1(1,1) 0.9532, B1(2,2) 0.9053. moreover, the results indicate a larger volatility persistence for the JSE/All Share market prices than the REITS prices.

The spill overs are significant at a 5% level and are positive values. In addition, the ARCH and GARCH terms significance at the 5% level shows that the JSE/All Share prices significantly impact the future volatility of the REITs. Therefore, volatility spill overs move from the JSE/All Share market into the REITS market, not vice versa. These results are consistent with the granger casualty tests conducted in section 4.4.

Table 4.9 2 Diagonal BEKK GARCH

Transformed Variance Coefficients				
Variables	**Coefficient**	**Std. Error**	**z-statistic**	**Prob**
M(1,1)	2210.001	427.4771	5.169871	0.0000
M(1,2)	16.81582	3.755944	4.477124	0.0000
M(2,2)	0.557698	0.105955	5.263514	0.0000
A1(1,1)	0.201832	0.007979	25.29677	0.0000
A1(2,2)	0.292078	0.009147	31.93107	0.0000
B1(1,1)	0.976348	0.001969	495.9183	0.0000
B1(2,2)	0.951492	0.003292	293.4994	0.0000

Notes: log likelihood : -28046.66; Akaike info criterion 21.58127; Schwarz criterion 21.50157; Avg. log likelihood -5.3935588

The log-likelihood is -28046.66, and just like the univariate GARCH models for the individual series, the GARCH terms are more significant than the ARCH terms. Therefore, the bi-variate system's past volatility substantially impacts the current fluctuations, and the persistence of volatility is an essential factor between the JSE/All share and REITS market prices. The results are consistent with the volatility clustering findings previously found in section 4.8.1. In Appendix C Figure 9 illustrates the diagonal BEKK conditional covariance, and Figure 10 illustrates the conditional correlation.

Table 4. 13 in Appendix C presents the test for autocorrelation for the Diagonal BEKK models' results, and the results indicate that there is no autocorrelation in the model. Moreover, the Jarque-Bera normality test shows that the model does not conform to the normality condition in Table 4. 14 of the Appendix. The normality results are justifiable, for there is no asymmetry in the means of the JSE/All Share and REITs series.

4.10 CONCLUSION

This section presented the empirical analysis of the research; the overall results are that there is no long-run relationship between the JSE/All Share and REITS market prices. In addition, the VAR and variance decomposition estimations indicate a short-term relationship between REITS and the JSE/All Share market. These findings support the first objective of determining the relationship between REITS and JSE/All Share indices.

Moreover, the Granger causality tests suggest a unidirectional relationship from JSE/All to the REITS market; therefore, a wealth effect is present. These findings are consistent with studies of countries that are also developing, such as South Africa (Ibrahim, 2010; Lean and Smyth, 2013; Hui *et al* 2011). No other studies in South Africa have conducted TVAR and bivariate GARCH models to examine the dynamics between the REITs and JSE/All Share prices. Therefore, this study applies international research methods to analyse the TVAR and volatility transmission models. The TVAR shows that the JSE/All Share and REIT returns have a positive and significant association with each other during periods of higher volatility. Moreover, these findings answer the second objective of whether the relationship differs between periods of higher and lower volatility.

In addition, the univariate and bivariate GARCH models show the volatility dynamics between the JSE/All Share and REITs market prices. Results indicate spillover effects from the stock to the housing markets. These findings answer the last objective of modelling the relationship between REITs and JSE/All Share Markets using a Bivariate. The overall relationship between JSE /All Share and REITS prices is very complex, and this study has shown the value of examining the relationship for risk management, investors and policymakers interested in the dynamics of the two markets.

CHAPTER FIVE

CONCLUSION

5.1 INTRODUCTION

This chapter provides an overview of the study's objectives, a summary of the extant literature, a discussion of the findings, and then concludes by suggesting areas for further research. The research emphasised the importance of examining the relationship between the real estate and stock markets for investment, risk, and portfolio management. Studies on the relationship between real estate and stock markets have been examined in two ways. Firstly, by examining the relationship using vital macroeconomic indicators for both markets (Pham 2017 and Refai *et al* 2021) and secondly, using the transition mechanisms of the wealth and credit effect prices (Aye *et al* 2013, Liow *et al* 2019 and Ohman and Yazdabfar 2016). The research described in this thesis used the wealth and credit effect transmission mechanisms to examine the relationship between the two markets. The study used REITS, a new asset class in South Africa introduced in 2013, as a measure of the performance of the real estate market. In addition, REITs are better understood by international investors than the previously listed PUTs and PLS in South Africa.

Against this background, the main objective of the study was to examine whether there is a relationship between REITS and stock prices in South Africa. The studies that have previously examined the relationship have found that the direction of the relationship tends to differ from country to country, where most developed countries found the presence of both the wealth and credit effect, and developing countries found a wealth effect. Due to real estate and stocks being the assets investors seek to invest in, the research found value in examining the relationship in the context of the South African market.

Chapter One outlined the context of the research, goals of the research, methods, and contributions of the study. The research's main aim was to investigate the relationship between REITS and Stocks during periods of volatility using a sample period of 2 January 2023 to 31 May 2023 in South Africa. The second goal was to determine whether the relationship between REITs and stock prices changes during high and low volatility periods. The last goal was to model the volatility spill over effects between the stock and REITS market prices. These goals were achieved using quantitative techniques: unit roots and cointegration tests, vector autoregression model, Granger Causality tests, threshold vector autoregression model, ARCH, and univariate and bivariate GARCH models.

Chapter Two provided an overview of the empirical findings and literature from the international and local findings. Chapter Three provided an outline of the methodology and techniques used to analyse the objectives of the study. Lastly, Chapter Four presented the empirical findings of the research.

5.2 SUMMARY OF STUDY

The literature review in Chapter Two provided an in-depth overview of the literature that examines the relationship between stock and real estate markets locally and internationally. The two main theories that aid in interpreting the causal relationship between stocks and real estate are the wealth and credit effects. As outlined in Chapter Two, the wealth effect is a theory that holds that the stock market influences the real estate market because, when stock prices increase, household income increases, which allows investors to purchase more assets in the form of real estate.

The second theory is the credit effect, which suggests that the real estate market influences the stock market through credit-constrained firms. According to Sim and Chang (2006), the credit effect reflects a firm's financial position where houses are used as collateral when loans are sought. The effect implies that as housing prices increase, a firm's equity value also increases, stimulating the economy. Businesses and households have increased financial activity (Ohman and Yazdanfar, 2017).

In addition, the literature discussed the behaviours of real estate and stock assets through the Modern Portfolio Theory, Capital Asset Pricing Models, Efficient Market Hypothesis, and the New Equilibrium Theory. These theories are important because they aid in understanding the behaviour of assets and how they respond to factors that influence them. Finally, the chapter concluded by providing an overview of the current state of the South African REITs and stock markets. The analysis illustrated the history and nature of the REITS market in South Africa and how the REITs market was previously identified as PUTs and PLS. In addition, the chapter highlighted the importance of examining the REITS and stock markets in South Africa for portfolio management and household income diversification.

5.3 DISCUSSION OF FINDINGS

The study aimed to examine the relationship between JSE/All Share and REITs during periods of volatility. The study was separated into three sections according to the three objectives of the study. The first objective was to establish whether there is a relationship between REITs and the JSE ALL Share prices. The first section of Chapter Four analysed the relationship between JSE/All

Share and REITS market prices. Descriptive statistics were estimated to understand the data, and stationarity tests were conducted. The results from the ADF and PP were consistent, and both series were found to be stationary in the first differences. After that, cointegration tests were conducted using the Johansen methodology, and no cointegration was found between the JSE/All share and REITS. The results indicate no long-run relationship between REITS and JSE/All Share market prices. The VAR and Granger causality tests suggest a causal unidirectional relationship between the JSE /All Share and REITS market prices. The results of the VAR and Granger conclude that the JSE/All Share market prices Granger caused REITs and the findings are consistent with the wealth effect.

The findings are supported by most studies analysing the relationship between real estate and stock prices in developing countries. The study's second objective was to examine, using a Threshold VAR model, the possible nonlinearity s of the relationship between JSE/All Share and REITS market prices based on a two-regime threshold model. The results of the TVAR were presented, and the two regimes were separated into regime 1, which had low volatility, and regime 2, which had high volatility. The results indicated that in the regime of high volatility, the JSE/All Share returns are more positively associated with the returns to the REITS. The last objective was to examine the volatility transmission between the JSE/All Share and REITS prices. Sections 4.8 to 4.9 showed the volatility clustering of the JSE/All Share and REITs market prices and the testing for ARCH effects. ARCH effects were found, and univariate GARCH (1,1) models were estimated for the individual series. The findings are the GARCH term is large and significant for both the JSE/All Share and REITs series.

The results indicate that for each series, past volatility impacts current volatility. The leverage effects of the series were examined in the TGARCH models, and results from the JSE/All Share and REITS series show that "bad news" has a more significant impact than good news. These results are supported by the conditional variance graphs from Appendix C, and the highest variance increased during the recent volatile period in 2020.

Moreover, to understand the interconnected volatility spill overs between the JSE/All Share and REIT markets, two bivariate GARCH models were estimated: the Diagonal BEKK and the Constant Conditional Correlation models. The results of the bi-variate GARCH models were similar, with volatility persistence prominently represented by the GARCH terms. Tables 4.15 and 4.18 present the parameters and estimates of the CCC and Diagonal BEKK model results of the conditional variance between JSE/All Share and REIT returns. In addition, the diagonal BEKK model estimates the conditional correction between the REITS and JSE/All Share prices better than the CCC model, as illustrated in Figures 10 and 12 in Appendix C. The overall findings were that volatility spill over runs from the JSE/All share market prices into REITS prices at a statistically significant level.

5.4 AREAS FOR FURTHER RESEARCH AND LIMITATIONS

One of the significant challenges for the study was the unavailability of data, which hindered the analysis of the macroeconomic determinants and their impact on the relationship between REITS and stock prices in South Africa. Therefore, future research could analyse how the major macroeconomic determinants, such as inflation, interest rates, consumer price index, and gross domestic product, affect REITs and stock prices. The studies that have included the macroeconomic determinants found that there is a long-run relationship between real estate and stock markets, indicating the presence of cointegration. According to Lin and Lin (2011), macroeconomic conditions such as GDP, employment, inflation, and interest rates influence stocks and real estate. The results from other studies that found a long-run cointegration relationship between the two markets were due to the studies accounting for macroeconomic determinants in the analysis.

Examining the relationship between REITS and stock prices is essential for investors, portfolio and risk managers and policymakers. This study is the first of its kind in South Africa because it used REITS as a proxy to measure real estate prices in South Africa. REITs are a new financial instrument in South Africa, introduced in 2013. Therefore, there is value in examining the behaviour of REITs for local and foreign investors to better understand the nature of REITs. Therefore, another area of further research is using a capital asset pricing model to examine the systematic and unsystematic risks associated with holding REITs and stocks in an investor's portfolio and how they impact volatility (see, for example, Voicu and Selier's (2013) study. To that effect, future research can explore more country-specific studies on the relationship between REITs and stocks in the context of African markets.

REFERENCES

ABARBANELL, J.S. and BUSHEE, B.J., 1998. Abnormal returns to a fundamental analysis strategy. *Accounting Review*, pp. 19-45.

ABUL, S.J., 2019. The dynamic relationship between stock and real estate prices in Kuwait. *International Journal of Economics and Finance*, 11(5), pp. 30-42.

AISEN, A. and VEIGA, F.J., 2013. How does political instability affect economic growth? *European Journal of Political Economy*, 29, pp. 151-167.

AIT-SAHALIA, Y., FAN, J. and LI, Y., 2013. The leverage effect puzzle: Disentangling sources of bias at high frequency. *Journal of Financial Economics*, 109(1), pp. 224-249.

ALDIENA, E. and AL HAKIM, M.H., 2019. The Impact of Companies' Internal Factors on The Performance of Their Stock Returns. *Journal of Islamic Economic Laws*, 2(1), pp. 120-149.

ALKALI, M., SIPAN, I. and RAZALI, M.N., 2020. The effect of negative information on the volatility of real estate residential prices in Abuja, Nigeria. *International Journal of Housing Markets and Analysis*, 13(2), pp. 267-280.

ALLEN, D.E., MCALEER, M. and SINGH, A.K., 2019. Daily market news sentiment and stock prices. Applied Economics, 51(30), pp. 3212-3235.

AVDJIEV, S. and ZENG, Z., 2014. Credit growth, monetary policy, and economic activity in a three-regime TVAR model. Applied Economics, 46(24), pp. 2936-2951.

AYE, G.C., BALCILAR, M. and GUPTA, R., 2013. Long- and Short-Run Relationships between House and Stock Prices in South Africa. *Journal of housing research*, 22(2), pp. 203-220.

BESSIS, J., 2011. Risk management in banking. John Wiley & Sons.

BILLINGHAM, C.J., 1983. Strategies for Enhancing Bond Portfolio Returns. *Financial analysts journal*, 39(3), pp. 50-56.

BOHL, M.T., PÜTZ, A. and SULEWSKI, C., 2021. Speculation and the informational efficiency of commodity futures markets. *Journal of Commodity Markets*, 23, pp. 100159.

BOND, S. and XUE, C., 2017. The Cross Section of Expected Real Estate Returns: Insights from Investment-Based Asset Pricing. *The journal of real estate finance and economics*, 54(3), pp. 403-428.

BOUCHAUD, J., MATACZ, A. and POTTERS, M., 2001. Leverage effect in financial markets: The retarded volatility model. Physical Review Letters, 87(22), pp. 228701.

BRAUN, J., BURGHOF, H., LANGER, J. and EINAR SOMMERVOLL, D., 2022. The volatility of housing prices: Do different types of financial intermediaries affect housing market cycles differently? *The Journal of Real Estate Finance and Economics*, , pp. 1-32.

BUSINESS, L., MARSH, S.P. and STAUNTON, M., Elroy Dimson Long-Run Global Capital Market Returns and Risk Premia.

CARDONA, L., GUTIÉRREZ, M. and AGUDELO, D.A., 2017. Volatility transmission between US and Latin American stock markets: Testing the decoupling hypothesis. *Research in International Business and Finance,* 39, pp. 115-127.

CHANG, C., MCALEER, M. and TANSUCHAT, R., 2013. Conditional correlations and volatility spillovers between crude oil and stock index returns. *The North American Journal of Economics and Finance*, 25, pp. 116-138.

CHENG, T., LIU, J., YAO, W. and ZHAO, A.B., 2022. The impact of COVID-19 pandemic on the volatility connectedness network of global stock market. *Pacific-Basin Finance Journal*, 71, pp. 101678.

CHRISTIANTI, A., 2018. VOLATILITY SHOCK PERSISTENCE IN INVESTMENT DECISION MAKING: A COMPARISON BETWEEN THE CONSUMER GOODS AND PROPERTY-REAL ESTATE SECTORS OF THE INDONESIAN CAPITAL MARKET. *Journal of Indonesian Economy and Business*, 33(2), pp. 112-122.

Clayton J. The Relative Importance of Stock, Bond, and Real Estate Factors in Explaining REIT Returns. SSRN Electronic Journal. 2002;27(1).

COOPER, M.M., 1997. Distinguishing Critical and Post-Positivist Research. College composition and communication, 48(4), pp. 556-561.

CORGEL, J.B., MCINTOSH, W. and OTT, S.H., 1995. Real Estate Investment Trusts: A Review of the Financial Economics Literature. *Journal of real estate literature*, 3(1), pp. 13-43.

CRAIN, J., CUDD, M. and BROWN, C., 2000. The impact of the Revenue Reconciliation Act of 1993 on the pricing structure of equity REITs. *Journal of Real Estate Research*, 19(3), pp. 275-286.

DE BEER, J., KEYSER, N. and VAN DER MERWE, I., 2015b. The Johannesburg stock exchange (JSE) returns, political development, and economic forces: a historical perspective. *Journal for Contemporary History*, 40(2), pp. 1-24.

DELCEY, T. and SERGI, F., 2023. The efficient market hypothesis and rational expectations macroeconomics. How did they meet and live (happily) ever after? *The European Journal of the History of Economic Thought*, 30(1), pp. 86-116.

DENG, Y., GIRARDIN, E., JOYEUX, R. and SHI, S., 2017. Did Bubbles Migrate from the Stock to the Housing Market in China between 2005 and 2010? *Pacific Economic Review*, 22(3), pp. 276-292.

ECONOMIC TIMES, Bid-Ask Spread2023-last update. Available: https://economictimes.indiatimes.com/marketstats/pid-112,pageno-1,sortorder-desc,sortby-spread.cms [20 August, 2013].

EICHHOLTZ, P.M. and HARTZELL, D.J., 1996. Property shares, appraisals, and the stock market: an international perspective. *The journal of real estate finance and economics*, 12, pp. 163-178.

ELTON, E.J. and GRUBER, M.J., 1997. Modern portfolio theory, 1950 to date. *Journal of banking & finance*, 21(11-12), pp. 1743-1759.

ENDERS, W., 2015. Applied econometric time series fourth edition. New York (US): University of Alabama, .

ENGLE, R.F. and KRONER, K.F., 1995. Multivariate simultaneous generalized ARCH. *Econometric theory*, 11(1), pp. 122-150.

ENNIS, R.M. and BURIK, P., 1991. Pension Fund Real Estate Investment Under a Simple Equilibrium Pricing Model. *Financial Analysts Journal*, 47(3), pp. 20-30.

FAMA, E.F., 1990. Stock returns, expected returns, and real activity. *The journal of finance*, 45(4), pp. 1089-1108.

FAMA, E.F., 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. The *Journal of Finance,* 25(2), pp. 383-417.

FAMA, E.F., BLACK, F., BOOTH, D., BRADLEY, M., BRENNAN, M., BUSER, S., CAMPBELL, J., CHEN, N., COCHRANE, J., CONSTANTINIDES, G., FERSON, W.,

FRENCH, K., HARVEY, C., IPPOLITO, R., JENSEN, M., KAUL, G., LAKONISHOK, J., MCDONALD, B., MERTON, R., MITCHELL, M., PELTZMAN, S., REINGANUM, M., RITTER, J., ROBERTS, H., ROLL, R., SCHWERT, G.W., SEYHUN, H.N., SHANKEN, J., SHILLER, R., SHLEIFER, A., SINQUEFIELD, R., STULZ, R., THALER, R., VISHNY, R. and WARNER, J., 1991. Efficient Capital Markets: II. Wiley.

FATEYE, O.B., AJAYI, O. and AJAYI, C.A., 2022. Modelling of Daily Price Volatility of South Africa Property Stock Market Using GARCH Analysis. *Journal of African Real Estate Research*, 7(2), pp. 24-42.

Market Using GARCH Analysis. *Journal of African Real Estate Research*, 7(2), pp. 24-42.

FATEYE, O.B., DAMILOLA, D. and AJAYI, P., 2022c. Modelling of Daily Price Volatility of South Africa Property Stock Market Using GARCH Analysis. *Journal of African Real Estate Research,* 7(2), pp. 24-42.

GARRIGAN, R. and PARSONS, J., 1997. Real Estate Investment Trusts. 1st ed. New York: McGraw-Hill Education.

GRANGER, C.W. and POON, S., 2001. Forecasting financial market volatility: A review. Available at SSRN 268866, .

GREEN, R.K., 2002. Stock prices and house prices in California: new evidence of a wealth effect? *Regional Science and Urban Economics*, 32(6), pp. 775-783.

GU, Z. and KIM, H., 2003. An examination of the determinants of hotel REITs' unsystematic risk. *Journal of Hospitality & Tourism Research*, 27(2), pp. 166-184.

HABANABAKIZE, T. and DICKASON, Z., 2022. Political risk and macroeconomic effect of housing prices in South Africa. Cogent economics & finance, 10(1), pp. 1-11.

HE, K., XIE, C. and LAI, K.K., 2008a. Estimating Real Estate Value-at-Risk Using Wavelet Denoising and Time Series Model. Springer Berlin Heidelberg.

HE, K., XIE, C. and LAI, K.K., 2008b. Estimating Real Estate Value-at-Risk Using Wavelet Denoising and Time Series Model. Springer Berlin Heidelberg.

HELLEINER, E., 1995. Explaining the globalization of financial markets: bringing states back in. *Review of International Political Economy*, 2(2), pp. 315-341.

HESAMI, S., 2018. No title. Real Estate Prices and Stock Market Returns in Germany: Analysis Based on Hedonic Price Index, .

HONG, Y. and LI, Y., 2020. House price and the stock market prices dynamics: evidence from China using a wavelet approach. Applied Economics Letters, 27(12), pp. 971-976.

HOWELLS, P. and BAIN KEITH, The Economics of Money, Banking and Finance. Third Edition edn. London: Pearson.

HUI, E.C., ZUO, W. and HU, L., 2011. Examining the relationship between real estate and stock markets in Hong Kong and the United Kingdom through datamining. *International Journal of Strategic Property Management*, 15(1), pp. 26-34.

IBBOTSON, R.G., DIERMEIER, J.J. and SIEGEL, L.B., 1984. The demand for capital market returns: A new equilibrium theory. *Financial Analysts Journal*, 40(1), pp. 22-33.

IJASAN, K., OWUSU JUNIOR, P., TWENEBOAH, G. and ADAM, A.M., 2021. How does South Africa's real estate investment trusts integrate with major global REITs markets? A time-frequency approach. *Scientific African*, 14, pp. e00993.

IRSHAD, H., 2017. Relationship Among Political Instability, Stock Market Returns and Stock Market Volatility. *Studies in Business and Economics,* 12(2), pp. 70-99.

KAU, J.B. and KEENAN, D., 1980. The Theory of Housing and Interest Rates. *The Journal of Financial and Quantitative Analysis,* 15(4), pp. 833-847.

KAULIHOWA, T. and KAMATI, K., 2019. Determinants of house price volatility in Namibia. *International Journal of Housing Markets and Analysis*, 12(4), pp. 807-823.

KNOTEK, E.S. and ZAMAN, S., 2021. Asymmetric responses of consumer spending to energy prices: A threshold VAR approach. Energy Economics, 95, pp. 105127.

KONSTANTINOS, A.P.C., 2010. Efficient Market Hypothesis: Review of existing research and criticism.

LEAN, H.H. and SMYTH, R., 2014a. Dynamic interaction between house prices and stock prices in Malaysia. *International Journal of Strategic Property Management*, 18(2), pp. 163-177.

LEAN, H.H. and SMYTH, R., 2014b. Dynamic interaction between house prices and stock prices in Malaysia. *International Journal of Strategic Property Management*, 18(2), pp. 163-177.

LEKHULENI, T.I. and NDLOVU, G., 2023. The dynamic effect of macroeconomic factors on housing prices: Evidence from South Africa. 18(11), pp. e0290552.

LI, L. and ZHU, B., 2022. REITs' Stock Return Volatility: Property Market Risk Versus Equity Market Risk. *The journal of real estate finance and economics*.

LI, X., CHANG, T., MILLER, S.M., BALCILAR, M. and GUPTA, R., 2015. The co-movement and causality between the US housing and stock markets in the time and frequency domains. *International Review of Economics & Finance*, 38, pp. 220-233.

LIN, T.C., HSU, S. and LIN, Y., 2019. The effect of housing prices on consumption and economic growth–the case of Taiwan. *Journal of the Asia Pacific Economy*, 24(2), pp. 292-312.

LIN, T.C. and LIN, Z., 2011. Are stock and real estate markets integrated? An empirical study of six Asian economies. *Pacific-Basin Finance Journal,* 19(5), pp. 571-585.

LINTNER, J., 1965. The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *The review of economics and statistics*, 47(1), pp. 13-37.

LIOW, K.H. and IBRAHIM, M.F., 2010. Volatility Decomposition and Correlation in International Securitized Real Estate Markets. *The journal of real estate finance and economics,* 40(2), pp. 221-243.

LIU, C.H., HARTZELL, D.J., GREIG, W. and GRISSOM, T.V., 1990. The integration of the real estate market and the stock market: some preliminary evidence. *The Journal of Real Estate Finance and Economics*, 3, pp. 261-282.

LUÜS, C., 2005. The Absa residential property market database for South Africa-key data trends and implications. *BIS Paper*, 21, pp. 149-170.

MARKOWITZ, H.M., 1991. Foundations of portfolio theory. *The journal of finance,* 46(2), pp. 469-477.

MCALEER, M. and DA VEIGA, B., 2008. Forecasting value-at-risk with a parsimonious portfolio spill over GARCH (PS-GARCH) model. *Journal of forecasting*, 27(1), pp. 1-19.

MOKOENA, S. and NOMLALA, B., 2022. Analysis of the relationship between COVID-19 and the stock market performance in South Africa. *International Journal of Finance & Banking Studies (2147-4486),* 11(2), pp. 25-33.

MOOYA, M., 2011. Valuers and the global financial crisis of 2008: implications for the (South) African valuation profession. *African Real Estate Society.*

MORDOR INTELLIGENCE, 2023. Mordor Intelligence. [Online] Available at: https://www.mordorintelligence.com/industry-reports/residential-real-estate-market-in-south-africa

MPOFU, B., MOOBELA, C. and SIMBANEGAVI, P., 2023. Effects of COVID-19 on the relationship between inflation and REITs returns in South Africa. *Journal of Property Investment & Finance.*

MULLINS, D., 1982. Does the Capital Asset Pricing Model Work? *Harvard Business Review.*

MUTHU, K. and WESSON, N., 2023. The impact of COVID-19 on company performance per industry sector: Evidence from South Africa. *Journal of Economic and Financial Sciences,* **16**(1), pp. 801

MUZINDUTSI, P., 2015. Analysis of short- and long-term interactions between the stock market and prices of different sizes of properties in South Africa. *Investment Management and Financial Innovations, 12(4). pp. 51-60.*

NAJIB RAZALI, M., 2015a. The dynamic of returns and volatility of Malaysian listed property companies in Asian property market. *International Journal of Strategic Property Management*, 19(1), pp. 66-83.

NGUYEN, M.T. and BUI, T.N., 2019. Stock market, real estate market, and economic growth: an ARDL approach. Investment Management & Financial Innovations, 16(4), pp. 290.

NTULI, M. and AKINSOMI, O., 2017. An overview of the initial performance of the South African REIT market. *Journal of Real Estate Literature*, 25(2), pp. 365-388.

ÖHMAN, P. and YAZDANFAR, D., 2017. The nexus between stock market index and apartment and villa prices: Granger causality test of Swedish data. *International Journal of Housing Markets and Analysis*, 10(3), pp. 450-467.

OKUNEV, J., WILSON, P. and ZURBRUEGG, R., 2000. The causal relationship between real estate and stock markets. *The Journal of Real Estate Finance and Economics*, 21, pp. 251-261.

OLALEYE, A., 2011. The effects of adding real estate into mixed-asset portfolios in South Africa. *Journal of Financial Management of Property and Construction*, 16(3), pp. 272-282.

PARKER, D., Global Real Estate Investment Trusts: People, Process and Management. 1st Ed. United Kingdom: BlackWell Publishing.

QUAN, D.C. and TITMAN, S., 1999. Do real estate prices and stock prices move together? An international analysis. *Real Estate Economics,* 27(2), pp. 183-207.

RESERVE BANK, 2023. [Online] Available at: https://www.resbank.co.za/en/home [Accessed 10 June 2023].

SEILER, M.J., WEBB, J.R. and MYER, F.C.N., 1999. Diversification Issues in Real Estate Investment. *Journal of Real Estate Literature*, 7(2), pp. 163-179.

SILVENNOINEN, A. and TERÄSVIRTA, T., 2009. Multivariate GARCH models. Handbook of financial time series. Springer, pp. 201-229.

SIM, S. and CHANG, B., 2006. Stock and real estate markets in Korea: wealth or credit-price effect. *Journal of Economic Research-seoul-*, 11(1), pp. 103.

SU, C., YIN, X., CHANG, H. and ZHOU, H., 2019. Are the stock and real estate markets integrated in China? *Journal of Economic Interaction and Coordination*, 14, pp. 741-760.

THOMAS, R. and KREWSON-KELLY, S., The Intelligent REIT Investor. 1st ed. New Jersey: Wiley.

TONG, H., 1978. On a threshold model. Pattern recognition and signal processing, pp. 575-586.

TSAI, I., LEE, C. and CHIANG, M., 2012. The Asymmetric Wealth Effect in the US Housing and Stock Markets: Evidence from the Threshold Cointegration Model. *The journal of real estate finance and economics*, 45(4), pp. 1005-1020.

TSAY, R.S., 2006. Multivariate volatility models. Lecture Notes-Monograph Series, pp. 210-222.

VOICU, C. and SEILER, M., 2013a. Understanding systematic risk in real estate markets. *Journal of housing research*, 22(2), pp. 165-201.

VOICU, C. and SEILER, M., 2013b. Understanding Systematic Risk in Real Estate Markets. *Journal of Housing Research,* 22(2), pp. 165-201.

XIANG, G., TANG, J. and YAO, S., 2022. The characteristics of the housing market and the goal of stable and healthy development in China's cities. *Journal of risk and financial management*, 15(10), pp. 1-17.

YUKSEL, A., 2016. The relationship between stock and real estate prices in Turkey: Evidence around the global financial crisis. Central Bank Review, 16(1), pp. 33-40.

ZAKOIAN, J., 1994. Threshold heteroskedastic models. *Journal of Economic Dynamics and Control,* 18(5), pp. 931-955.

APPENDIX A

Figure 1 WEALTH AND CREDIT EFFECT TRANSMISSTION

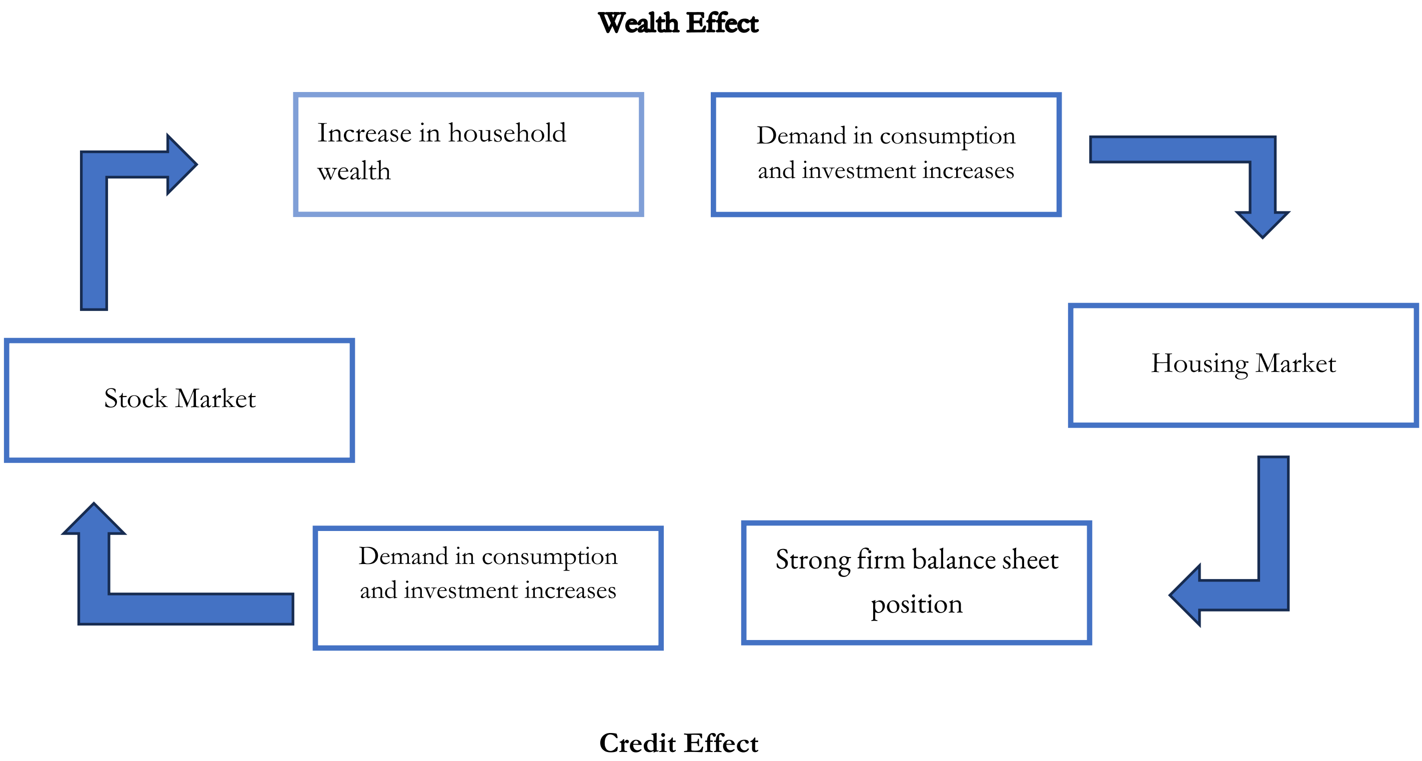


Table 1. 1 PAPERS ON HOUSING PRICE VOLATILITY

Study	**Country**	**Estimation Method**	**Findings**
Alkali, Sipan and Razali (2019)	Nigeria	ARCH and GARCH	Volatility differs from different categories of housing properties. Bad news exposes investors to higher risk and volatility
Cook and Watson (2017)	United Kingdom	GARCH and EGARCH	GARCH models allowed for examination of the risk-return relationship in the housing market.
Fateye, Ajayi and Ajayi (2022)	South Africa	GARCH	Investors react more to good than bad news. ARCH and GARCH effects have an impact on current days housing prices.
Kaulihowa and Kamati (2019)	Namibia	GARCH and ARCH	Namibian housing prices show persistent volatility and macroeconomic determinants impact housing price volatility
Lee (2009)	Australia	EGARCH	ARCH effects (Volatility clustering found in Australian capital cities
Lin and Fuerst (2014)	Canada	ARCH and EGARCH	Volatility clustering and leverage effects existing in largely populated provincial housing markets.
Mata, Razali, Bemtes and Vieira (2021)	Pan-Asian countries	EGARCH	Market integration causes volatility spill over effects in property markets caused by macroeconomic factors. GDP and money supply are key in influencing volatility
Miles (2011)	United Kingdom	GARCH	Assets that show GARCH effects in the returns experience a lot of loss during volatile periods, ARCH effects present in housing market
Reen and Razali (2016)	Malaysia	ARCH and GARCH	ARCH used the find housing market determinants. Presence of volatility clustering in most of Malaysia
Wang and Hartzell (2021)	Hong Kong	ARMA-GARCH	Presence of volatility clustering and price volatility is influenced by exchange rates (USD and RMB)

Table 1. 2 PAPERS ON THE RELATIONSHIP BETWEEN REAL ESTATE AND STOCK MARKET

Study	**Country**	**Estimation methods**	**Effect found**
Aye, Balcilar and Gupta (2013) *[2]	South Africa	Nonparametric cointegration and Granger causality test	Wealth and credit effect
Abul (2019)	Kuwait	Vector Autoregression (VAR model), Vector Error Correction Model (VECM), Johansen Cointegration test	Wealth and credit effect
Hesami (2018) **	Germany	Vector Error Correction Model (VECM), Johansen Cointegration test	No effect found, housing and stock prices are cointegrated
Ibrahim (2010) *	Thailand	Vector Autoregression (VAR model) and Granger Causality tests	Wealth effect
Lean and Smyth (2013) *	Malaysia	Cointegration and Granger causality tests	Wealth effect
Lee, Lee and Liao (2016) **	Australia	Cointegration tests; Toda and Yamamoto VAR model; Granger causality tests.	Capital switching effect
Lin and Lin (2011)	China, Hong Kong, Japan, Singapore, South Korea and Taiwan	Cointegration, Granger causality	Wealth and credit
Liow, Huang and Son2019)**	United States	Granger Causality tests	Wealth and credit effect
Ohman and Yazdabfar (2016) **	Sweden	Granger causality tests	Wealth and Credit effects
Pham (2017) *	New Zealand	Cointegration and Granger causality tests, VAR	Wealth effect
Su (2010) **	Western European Countries	Threshold error-correction model; Granger causality tests	Wealth and Credit effect
Su and Liu (2010) **	China	Granger Causality tests, TECM	Wealth effect in short run and credit effect in long run

[2] ** indicates developing countries ** indicates developed countries*

Okunev,Wilson and Zurbrugg (2000)	United States	Linear and non-linear Granger causality tests	Nonlinear causality tests show wealth effect. Linear shows credit effect
Okunev,Wilson and Zurbrugg (2002)	Australia	Granger Causality, non-linear causality	Non-linear model shows the presence of a wealth effect
Yuksel (2016) **	Turkey	Threshold cointegration framework	Wealth and credit effect present pre-crisis; credit effect only post-crisis

Figure 2 Daily JSE/All Share Prices 2 Jan 2013 to 31 May 2023

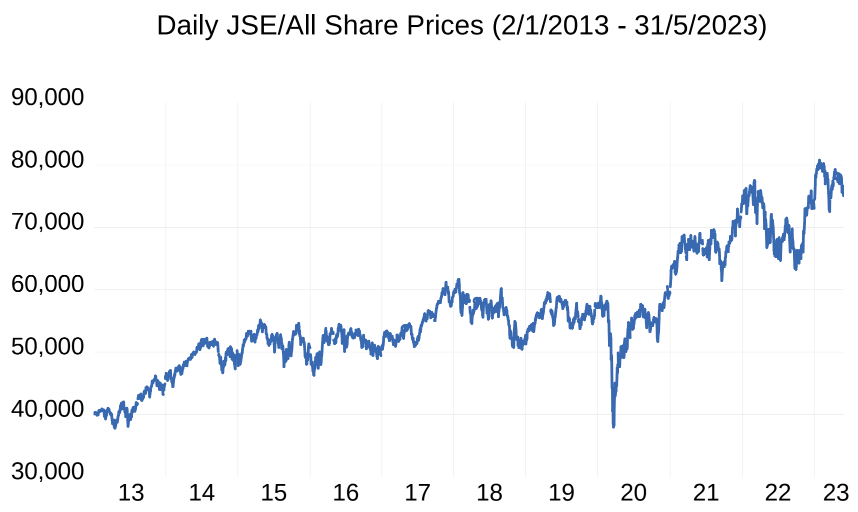
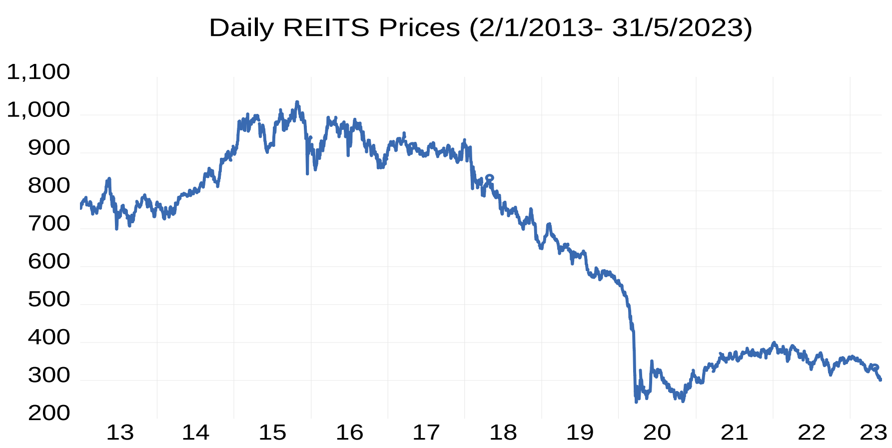


Figure 3 1Daily REITS Prices 2 Jan 2013 to 31 May 2023



APPENDIX B

Table 4. 1 : Descriptive Statistics Summary

	JSE/ALL Share	REITS
Mean	56198.11	668.2014
Median	54254.34	747.2500
Maximum	80791.35	1035.830
Minimum	37801.67	241.7100
Standard Deviation	9289.836	246.6695
Skewness	0.613440	-0.341064
Kurtosis	2.980240	1.578967
Jarque-Bera [Prob]	163.1722 [0.000000]	269.2724 [0.000000]
Sum	1.46E+08	1737992
Sum Sq. Dev	2.24E+11	1.58E+8
Observations	2601	2601

Notes: table reports the descriptive statistics of the level terms of the JSE/All Share and REITS data obtained from iress. The sample period is from 1/1/2013 to 31/5/2023 of daily price data, the Jarque- Bera statistic indicates the data is not normally distributed.

Table 4. 2 Augmented Dicky-Fuller Tests for Unit roots

Variable	*JSE/ALL Share*	*JSE/ALL Share*	*REITs*	*REITs*
Order	*First Difference*	*Level terms*	*First Difference*	*Level terms*
ADF - lag	27	27	27	27
T-stat	-11.411	-3.398	-22.767	-1.955
Critical values	-3.961* -3.411** -3.127***	-3.961* – 3.411** -3.127***	-3.961* -3.411** -3.127**	-3.961* -3.411** -3.127***
AIC	15.677	15.673	6.737	6.738
P value	0.0000	0.0517	0.0000	0.6247

*Notes: ADF test estimated in first difference and level terms using Akaike info criterion, with trend and intercept included in equation. * Represents significance at 1% level, ** significance at 5% level and *** significance at 10% level*

Variables	*JSE/ALL Share*	*JSE /ALL Share*	*REITs*	*REITs*
Order	*First Difference*	*Level terms*	*First Difference*	*Level terms*
ADF- lag	27	27	27	27
T-Stat	-50.371	-1.519	-47.647	-0.114
Critical values	-3.432* -2.862** -2.57***	-3.432* -2.862** -2.567***	-3.432* -2.862** -2.567***	-3,432* -2.862** -2.567***
AIC	15.677	15.689	6.741	6.746
P Value	0.0001	0.5237	0.0001	0.9461

*Notes: ADF test estimated in first difference and level terms using Akaike info criterion, with intercept included in equation. * Represents significance at 1% level, ** significance at 5% level and *** significance at 10% level*

Variables	*JSE/ALL Share*	*JSE/ALL Share*	*REITs*	*REITs*
Order	*First Difference*	*Level terms*	*First Difference*	*Level terms*
ADF-lag	27	27	27	27
T-stat	-50.357	0.856	-47.629	-1.137
Critical values	-2.565* -1.940** -1.616***	-2.565* -1.940** -1.616***	-2.565* -1.940** -1.616***	-2.565* -1.940** -1.616***
AIC	15.676	15.676	6.739	6.739
P Value	0.0001	0.8949	0.0001	0.2330

*Notes: ADF test estimated in first difference and level terms using Akaike info criterion, with no trend and intercept included in equation. * Represents significance at 1% level, ** significance at 5% level and *** significance at 10% level*

Table 4. 3 Phillips-Perron tests for unit roots

Variables	*JSE/ALL Share*	*JSE/ALL Share*	*REITs*	*REITs*
Order	First Difference	Level terms	First Difference	Level Terms
Adj t-stat	-50.402	-3.381	-47.578	-1.918
Critical values	-3.961* -3.411** -3.127***	-3.961* -3.411** -3.12***	-3.961* -3.411** -3.127***	-3.961* -3.411** -3.12***
P value	0.0000	0.0541	0.0000	0.6443

*Notes: PP test estimated in first difference and level terms using Akaike info criterion, with trend and intercept included in equation. * Represents significance at 1% level, ** significance at 5% level and *** significance at 10% level*

Variables	*JSE/ALL Share*	*JSE/ALL Share*	*REITs*	*REITs*
Order	First Difference	Level Terms	First Difference	Level Terms
Adj t-stat	-50.412	-1.468	-47.557	-0.041
Critical values	-3.432* -2.862** -2.567***	-3.432* - 2.862** - 2.567***	-3.432* -2.862** -2.567***	-3.432* -2.862** -2.567***
P value	0.0001	0.5499	0.0001	0.9537

*Notes: PP test estimated in first difference and level terms using Akaike info criterion, with intercept included in equation. * Represents significance at 1% level, ** significance at 5% level and *** significance at 10% level*

Variables	*JSE/ALL Share*	*JSE/ALL Share*	*REITs*	*REITs*
Order	First difference	Level Terms	First Difference	Level Terms
Adj t-stat	-50.385	0.914	-47.537	-1.169
Critical values	-2.565* -1.940** - 1.616***	-2.565* - 1.940** - 1.616***	-2.565* -1.940 - 1.616***	-2.565* -1.940** -1.616***
P values	0.0001	0.9041	0.0001	0.2215

*Notes: PP test estimated in first difference and level terms using Akaike info criterion, with no trend and intercept included in equation. * Represents significance at 1% level, ** significance at 5% level and *** significance at 10% level*

Table 4. 4 Test statistics for choosing optimal lag level using VAR

Lag	LogL	AIC	SBC	LR
/	-28654.07	22.14534	22.14987	-
0	-28646.82	22.14283	22.15641	14.48055
1	-28640.44	22.14099	22.16363	12.73892
2	-28632.17	22.13769	22.16938	16.49435
3	-28629.22	22.13850	22.17925	5.885844
4	28623.92	22.13750	22.18730	10.55001
5	-28623.28	22.13932	22.19817	3.275637
6	-28616.35	22.13783	22.20574	11.79201
7	**-28610.49***	**22.13639***	**22.21336**	**11.62695***
8	-28610.01	22.13911	22.22514	0.957539
0/	-28608.35	22.14092	22.23599	3.304156
00	-28606.52	22.14182	22.24596	5.603019
01	-28600.97	22.14140	22.25459	9.002408

*Notes: AIC = Akaike information criterion and SBC = Schwartz Bayesian criterion. Table shows the optimal selection of 8th lag using a VAR model in first difference. * Denotes the optimal lag*

Significance Tests for VAR

Table 4. 5 Whites test for heteroscedasticity for VAR

Whites test for heteroscedasticity for VAR		
Chi-sq	**Prob**	**Conclusion**
1487.829	0.0000	Heteroskedasticity

Table 4. 6 Jarque-Bera Normality tests for VAR

Jarque-Bera Normality tests for VAR			
	Jarque-Bera	df	Prob
JSE/All Share	1813.656	2	0.0000
REITs	4705.361	2	0.0000
Joint	6519.017	4	0.0000

Table 4. 7 VAR Residual Serial Correlation LM test

VAR Residual Serial Correlation LM test		
Lag	LRE*stat	Prob
1	0.938039	0.9190
2	1.102222	0.8939
3	3.201380	0.5247
4	4.004241	0.4054
5	2.468964	0.6502
6	1.758869	0.7800
7	1.963819	0.7424
8	7.033064	0.1342

table 4C

Table 4. 8 Roots of Characteristic Polynomial

Roots of Characteristic Polynomial	
Root	Modulus
-0.666407 - 0.340575i	0.748391
-0.666407 + 0.340575i	0.748391
-0.205583 - 0.693103i	0.722949
-0.205583 + 0.693103i	0.722949
0.467678 - 0.523679i	0.702113
0.467678 + 0.523679i	0.702113
-0.476924 - 0.471953i	0.670967
-0.476924 + 0.471953i	0.670967
-0.655350	0.655350
0.038078 - 0.649938i	0.651053
0.038078 + 0.649938i	0.651053
0.333382 - 0.551514i	0.644447
0.333382 + 0.551514i	0.644447
0.610512	0.610512
0.567214 - 0.182280i	0.595783
0.567214 + 0.182280i	0.595783

table 4D

APPENDIX C

Table 4. 9 GARCH (1,1) Residual Diagnostics Tests

Variables	Heteroskedasticity test for ARCH Effects		Jarque-Bera Normality test	
	Obs*R-squared	**Probability**	**Coefficient**	**Probability**
JSE/All share	0.001099	0.9736	148.6913	0.00000
REITS	3.055920	0.0804	437.4601	0.00000

Source: researchers own estimation

Figure 3 GARCH(1,1) Conditional Variance for JSE/All Share

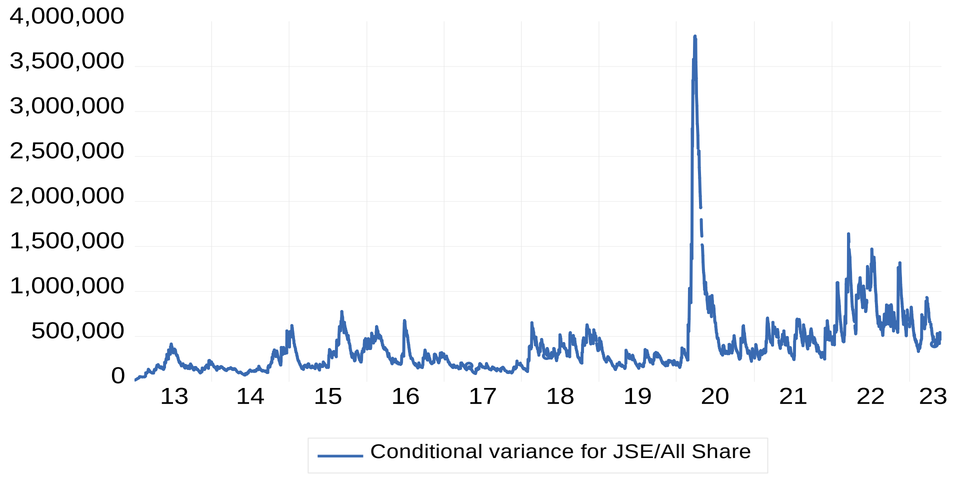


Figure 4 GARCH(1,1) Conditional Variance for REITS

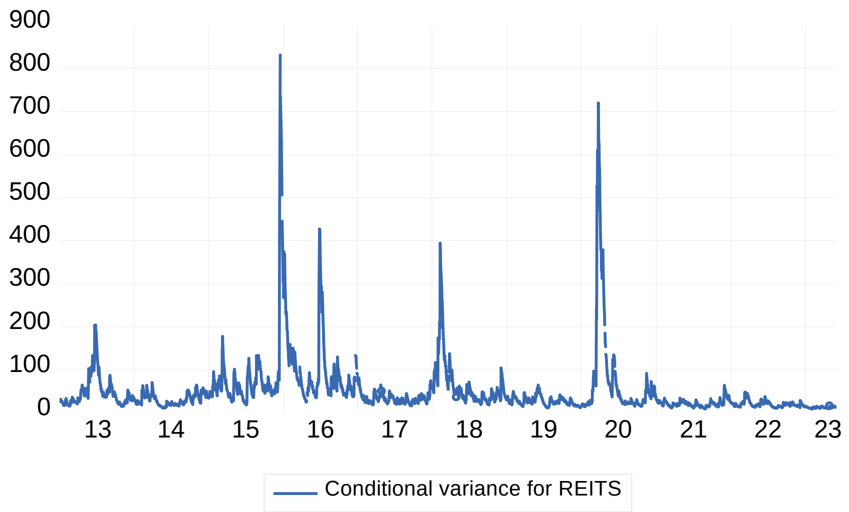


__Table 4. 10 Residual diagnostics for TGARCH__

Variables	Heteroskedasticity test for ARCH Effects		Jarque-Bera Normality test	
	Obs*R-squared	**Probability**	**Coefficient**	**Probability**
JSE/All share	0.021204	0.8842	139.4162	0.00000
REITS	3.173596	0.0748	390 .9234	0.00000

Source: researchers own estimation

__Figure 5 TGARCH Conditional Variance for REITS__

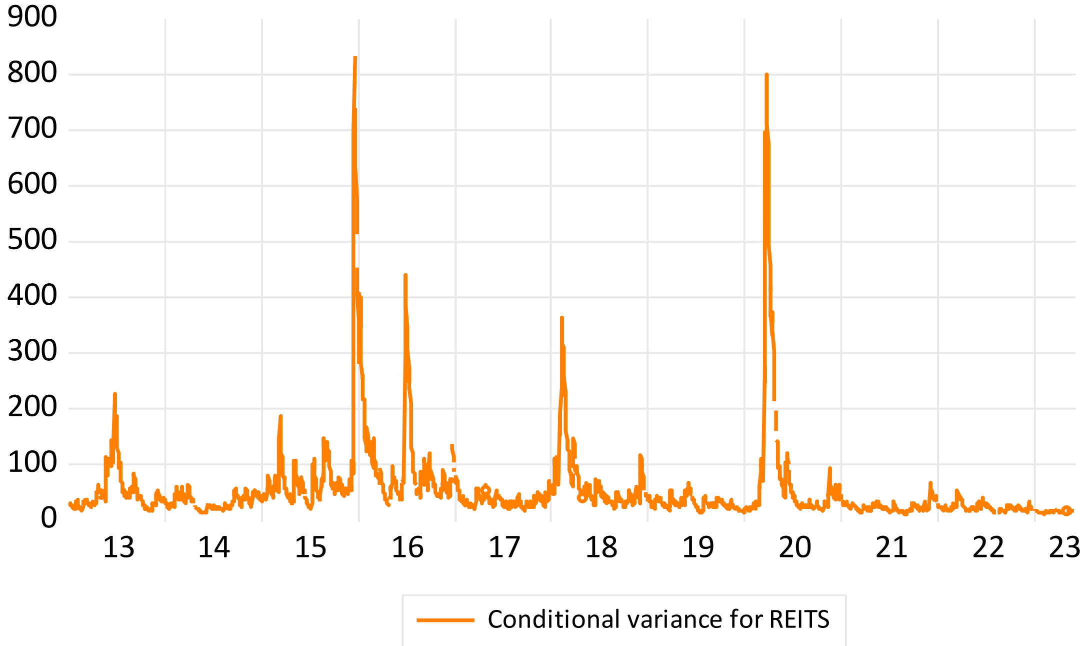


Figure 6 TGARCH Conditional Variance for JSE/All Share

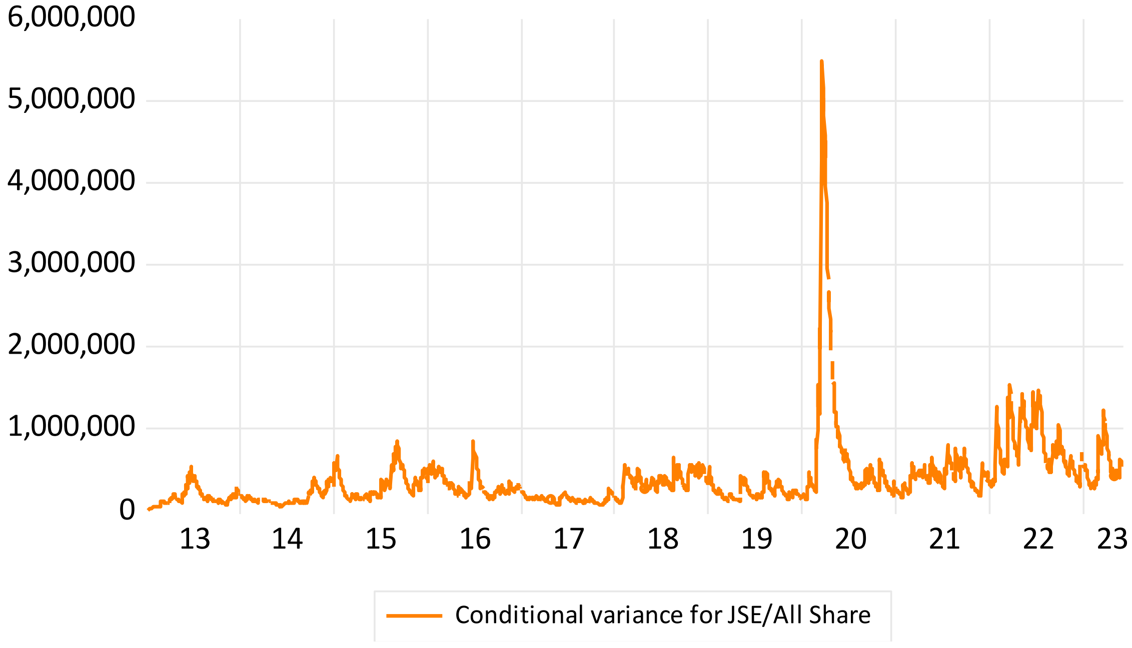


Figure 7 Conditional Covariance for CCC GARCH

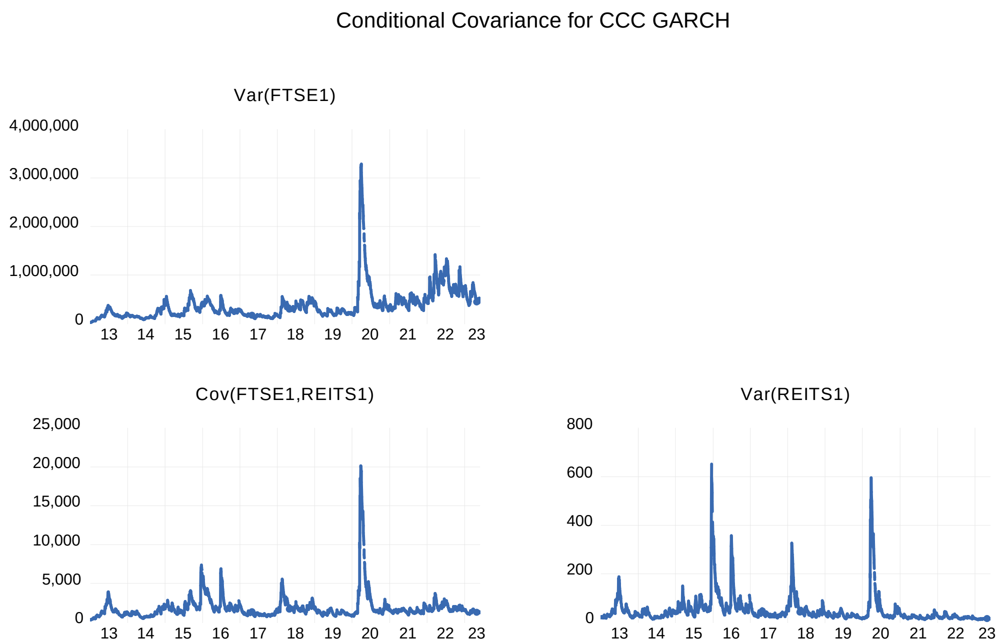
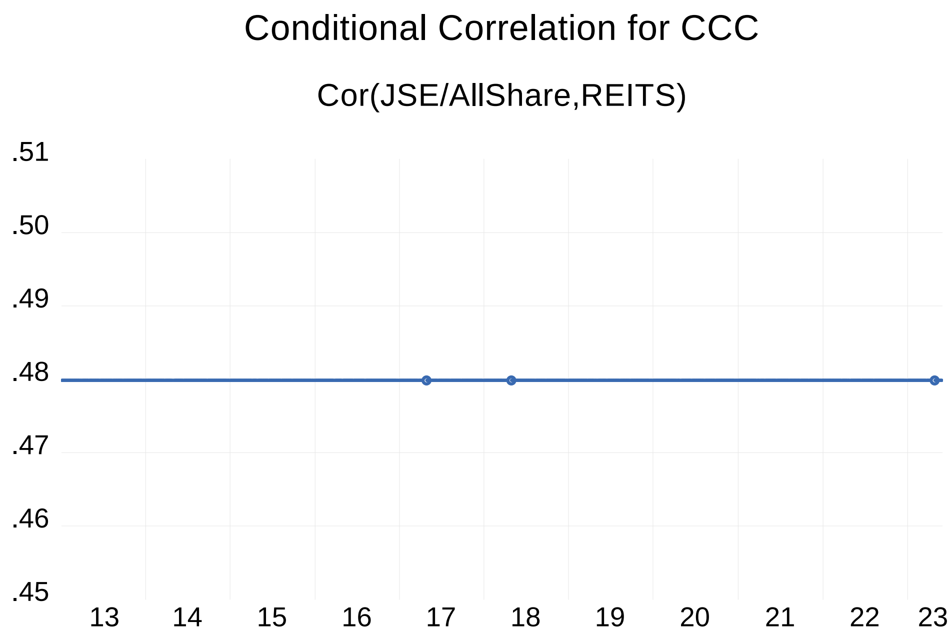


Figure 8 Conditional Correlation for CCC GARCH



Residual diagnostics for the Constant Conditional Correlation model

Table 4. 11 Portmanteau Test for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.
1	14.63518	0.0055	14.64081	0.0055
2	27.09379	0.0007	27.10902	0.0007
3	44.68642	0.0000	44.72197	0.0000
4	51.00123	0.0000	51.04650	0.0000
5	59.95955	0.0000	60.02209	0.0000
6	63.20784	0.0000	63.27789	0.0000
7	75.00135	0.0000	75.10324	0.0000
8	85.52283	0.0000	85.65719	0.0000

Table 4. 12 CCC Normality Tests

Component	Jarque-Bera	df	Prob.
1	185.3555	2	0.0000
2	425.1262	2	0.0000
Joint	610.4817	4	0.0000

Figure 9 Conditional Covariance for Diagonal BEKK

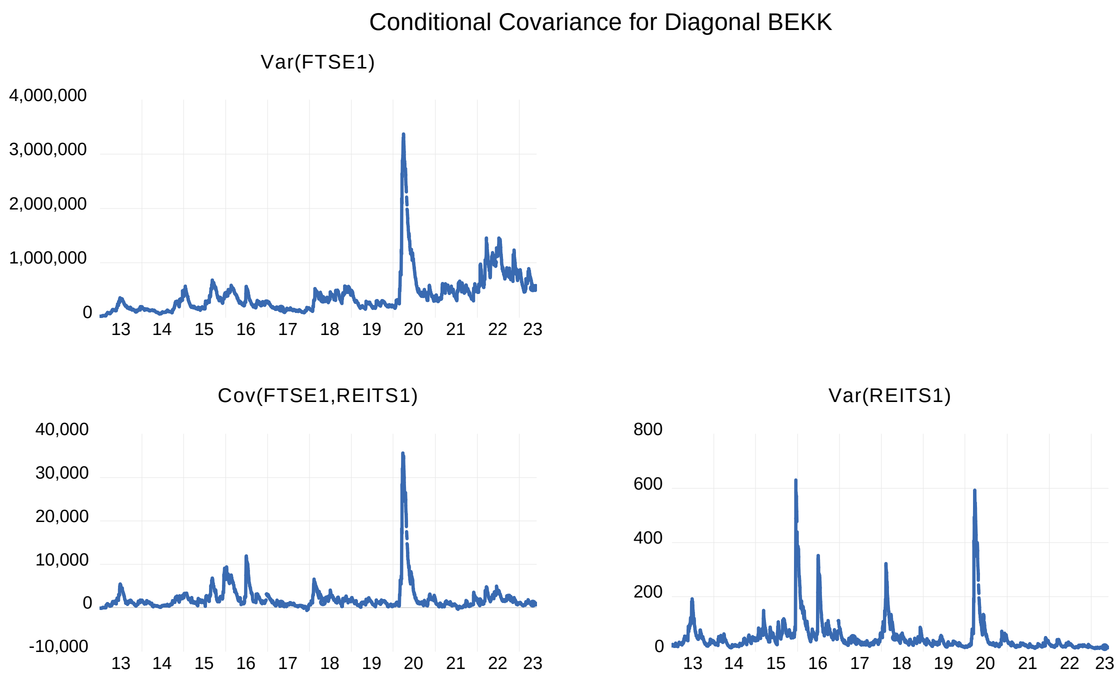
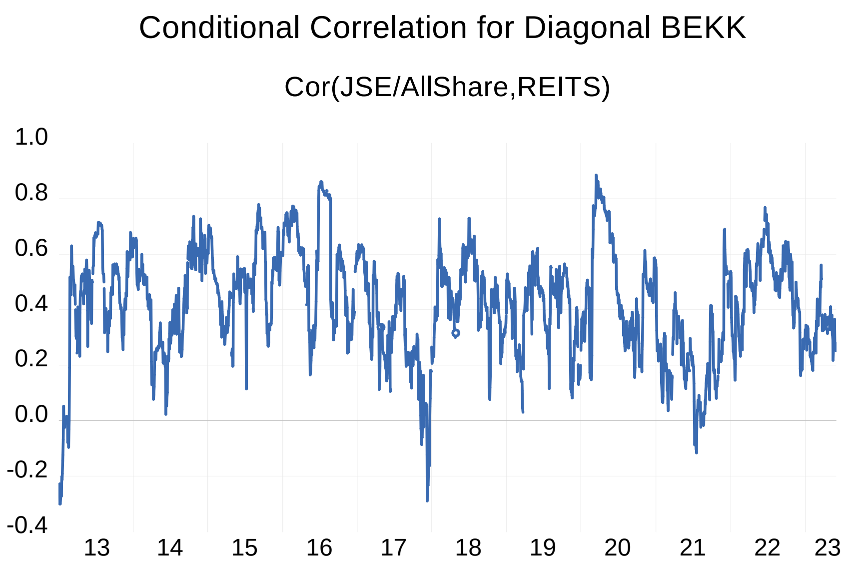


Figure 10 **Conditional Correlation for Diagonal BEKK**



Residual diagnostics for the Diagonal BEKK model

Table 4. 13 Portmanteau Test for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.
1	14.63518	0.0055	14.64081	0.0055
2	27.09379	0.0007	27.10902	0.0007
3	44.68642	0.0000	44.72197	0.0000
4	51.00123	0.0000	51.04650	0.0000
5	59.95955	0.0000	60.02209	0.0000
6	63.20784	0.0000	63.27789	0.0000
7	75.00135	0.0000	75.10324	0.0000
8	85.52283	0.0000	85.65719	0.0000

Table 4. 14 BEKK normality tests

Component	Jarque-Bera	df	Prob.
1	252.0582	2	0.0000
2	725.2256	2	0.0000
Joint	977.2839	4	0.0000