VOLATILITY SPILLOVER EFFECT BETWEEN REAL ESTATE INVESTMENT TRUST AND FINANCIAL ASSETS IN SOUTH AFRICA

A RESEARCH THESIS

BY

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Declaration

I, Rosalia NN Ndamanomhata declare that this thesis is a presentation of my original work and has not submitted to any other University or academic institution for the fulfilment of a degree or any other qualification. Acknowledgements of various literature works have been rightfully referenced.

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Abstract

This research examines the dynamics of volatility spillover effects between the real estate investment trust (REITs) and financial assets in South Africa. It examined the following financial assets; bonds, stock, currency and commodities based on selected indices recorded using closing prices. Using the Vector autoregressive and Dynamic Conditional Correlation MGARCH (DCC-MGARCH) model on weekly data from May 2013 to November 2017, there is evidence of both volatility spillover effects and correlation between assets. In appreciation of existing econometrics applications, a thorough examination of the methodologies available is done to understand how volatility is transmitted between markets and their interdependency from assets over stipulated periods. The dynamic conditional correlation model (DCC-GARCH) is used to examine correlation of variables over time. This research found that correlations are significant, and are both negative and positive dependant on the interaction to a particular asset. The assets are not independent of each other due to this their relation proves the existence of spillover effects.

Furthermore, this research sought to establish (based on literature) the degree of spillover effects to each financial asset. Results revealed there was a bidirectional volatility spillover between equity and bond markets. The presence of volatility spillover effects confirms the efficiencies of cross market information transmission and integration of financial markets of different economies. Similarly the effect of bonds to stock is uni-directional and yield different results compared to the relation of stock to bonds in line with similar studies done on emerging economies including South Africa. Results were analysed to determine asset correlation and determine the degree of varying

integration which is linked to investors risk premium expectations, cost of borrowing and diversification benefits for investors. Certain class of assets stood out as they were negatively correlated to other assets. Currencies were positively correlated to commodities, and negatively correlated to stocks, real estate stocks and bonds. These results are considered to be good news for managers who are in the business of minimizing risk and examine the optimal portfolio allocations in line with their risk preferences. Based on the correlation, optimal portfolios can be composed using asset substitution that yields the greatest return and less risk. In this regard, negatively correlated securities could produce a diversification benefit which reduces risks. Furthermore, the decomposition of the variance of forecast errors over a period of 1-20 weeks as to whether an effect of shock originates from REITS to other assets. Overall real estate accounts for 0.03 % to 53.43% of fluctuations of the forecast error variance for other assets.

Using the financial 15 and industrial 25 as point of reference for stock index for the over examination of externalities; real estate affects the returns of this index, accounting for 53.47% and while the Pula, palladium and British pound accounts for 3.52%,2.13% of the forecast error variances in for financial index companies. While the financials 15 index affects the returns of other indices as well, contributing 29.68%, 11,60% for real estate and 1,74% for palladium. For Industrial 25, Financials 15 and Reits had the least effects over time on its return with a decrease in fluctuations at 4.08% and 0.56% respectively. Compared to the 1st week, during the 20th week the index returns are increasingly caused by shocks from other assets as its estimation of returns by itself decreases at 6.66%. Which means the returns of the index is not independent of other variables.

CONTENTS

LIST OF TABLES

List of acronyms

AIC: Akaike information criterion

BEKK- GARCH : Baba, Engle, Kraft and Krone 1990

BESA: Bonds exchange of South Africa

CCC : Constant Conditional correlation

DCC : Dynamic conditional correlation

EREIT: Equity real estate investment funds

JSE : Johannesburg Exchange

MREIT: Mortgage real estate investment trust.

NAREIT : National Association of Real estate Investment Trust

OECD model: Organization for Economic Cooperation and Development

REIT: Real estate investment trust

SAPY: South Africa Property Listed property index

SIC: Schwarz-Bayesian information criteria

VAR: Vector Autoregression model

WFE: World Federation of Exchange

1. INTRODUCTION

1.1 Background of the study

The topic of volatility has been of interest to researchers from its core characteristics, ability to modelling and forecasting volatility. In modelling and forecasting of links between volatility and financial assets, it provides an understanding of causes of variation in prices of financial assets. In finance, the concept of volatility spillover effect is of importance to portfolio and hedge managers who model volatility to reduce risk and increase investment returns. With the spread of globalization, it has resulted in financial markets being more integrated and cross market information efficiency. Integrated markets tend to experience spillover effect amongst each other.

Spillover effects are unplanned consequences due to economic externalities between two or more countries. Depending on the portfolio mix, often investors in times of economic distress seek for portfolios that constitute safer investments, a concept known as "flight to quality phenomenon". A plunge in the performance of traditional assets such as bonds would lead to investors seeking to invest in equity. Researchers have a keen interest to establish why the movements of stock and bonds don't move together. Why does the fall of bonds results of increase in stocks return denoting a diversification benefit for investors. Scholars at large agree that such a change in bonds and stocks is a result of a change in the equilibrium discount rate. Using a simple time-varying discount model price of bonds and other assets should move closely with stocks and the change is caused by a common underlying discount factor, which can be terms as a risk free rate (Shiller, 1982). Furthermore there is little co-movement between the price of stock equity and bonds and attempt to determine the independence of bonds and equity stock, their dependence on increased risk or decrease in productivity growth. For an increase in stock price in a single tangible asset model, result that stock prices increase due to either an increase in risk or a decrease in productivity growth. Given reasonable parameter values in a two asset model, assumed factors have a simultaneous impact in the fall of stock prices, as well as a fall in real interest rates. It remains ambiguous as to the factors that impact the risk-free rate (Barsky, 1989) .

Since the merger of the Bond Exchange of South Africa (BESA) with the JSE, the JSE market has increased in terms of its liquidity and extended function ability with more instruments being able to be traded which include bonds and stocks. It is due to its size that the JSE has become important on the continent and its structures and development enables it involvement and the ability to be influenced by the global market. The market provides a diversification benefit to international investors. There are co-movements between the stocks on African stock market return and that of the world. There is low correlation amongst individual African states and existence of weak trends with each other as well as the world index (Alagidede, 2009). The JSE is ranked in 2013 by World Federation of Exchange (WFE) bond exchange platform with the nominal value of bonds exceeding ZAR 1570 billion in the year 2012,is active and has a high turnover ratio of 14.56 (Van Wyk, Ziets, & Goodspeed, 2015). South African Bond market can as well be one of the largest bond markets with ZAR 25 billion dollars' worth of bonds dealt on a daily basis. In 2013, JSE has 1600 listed debt instruments with a nominal value of ZAR 1.8 trillion dollars. March 31 2016, saw an increase of 1050 more instruments actively traded with ZAR 2.2 trillion nominal outstanding bonds. With the urgent need to fund government budget deficit, the government debt is at 64% with ZAR 1.4 trillion outstanding debts. Other key players such as the private financial sectors largely dominated by the banking companies and state owned enterprises accounted for 16% and 13% of the total debt(Department of national treasury 2016:4),respectively. However demand for new alternative investments such as REITS has risen. REITs index were introduce in the 1960's in the US and in 2007 Great Britain too adopted the structure. Much of the legislation and guidelines used by the South African National treasury is based on similar frameworks set by the USA and UK. Taxation laws draw on principles based on the OECD Model Tax convention. Under this convention, it permits that REITs structures are treated as different legal forms in consensus with parties involved and distinction is made based on the capacity of the investor.

The convention applies concepts based on section 124 of chapter 25 of the finance Act of 2006, with capital distribution included in property income distribution (?, ?)Muller, 2011). Real estate mutual funds such as the property-loan stock companies and property-loan stock (POTS) were the origin of real estate activities listed on the JSE. Introduction of the REIT came about as a result of the introduction of the new REIT tax legislation in 25 October 2012, under the Taxation legislation Amendment bill Section 25BB of the Income act. The new legislation was structured to cover flexibility and tax certainty to corporation in the industry as well investors. The reforms of the industry lead to September 2013 with 26 entries for REIT status approved by JSE and saw the industry become one of largest markets (De Klerk, 2013b). The JSE began the market consultation process for the implementation of a singular South Africa REIT is in the finalizing stages to replace the current South Africa property Index (SAPY).The index will be replaced by three indices; South Africa REIT, Trade-able Property and All property,a move to have an index that is a true indication of real estate companies or investment trusts with primary listings and operations in South Africa. SAPY index is criticized as it has predominant presence offshore property listed companies. Frameworks for the index are crafted to preserve the growth of the industry by it avoiding an over-regulation and effective means for government to generate revenue through established tax laws. Therefore listed company requirements are that :

- Companies must own a minimum of ZAR300 million property with debt below 60% of total asset value :
- Source of 75% of its income through property and have investment income as a result of indirect property ownership
- Companies will be required to pay at least 75% of its taxable earnings available for distribution to investors each year(De Klerk, 2013a).

The purpose of this research joins the academic community in accumulating knowledge and investing the nature of volatility spillover effects between the following assets: REITS, stocks, bonds, commodity and currency. Generally the relationship between stock-bonds gained popularity with many scholars with special attention to the performance of stock-bods in emerging markets. This research is essential for future studies that would reflect if any, impacts of a singular local REITs index. The growth of emerging markets has been an attraction to international investors for the following reasons:

- (i) Emerging markets are fast growing and expanding in terms of their presence and economy.
- (ii) Sources of funding through bonds by the government and estimated to be the second largest source of funding
- (iii) Market liquidity and more transparent emerging bond markets(Bunda, Hamann, & Lall, 2009).

1.2 Problem statement

Researchers have investigated the relationship between the REIT indexes in comparison with different type of stock. Of importance is the sensitivity of the NAREIT index to other assets return which in turn is a deterministic factor with regards to the type and the degree of risk exposure for asset portfolios. Using estimation methods the relationship between real estate investment index return on bonds, small caps stock, large cap stock and un-securitized real estate and such relations can be term as structural or cyclical by nature. The REIT indexes does provide portfolio with some exposure to the real estate asset class. This positive relationship observable in the 1900s, and as such saw a cyclical relationship among this assets (Clayton & MacKinnon, 2001).Within the South African context, REIT index has to compete with other such index across the globe.

It is acclaimed that it is the 8th largest index and with increasing daily transaction of bonds and equity on the JSE. Much is to be understood as to what attributes to the performance of the sector. Does the maturity of the real estate market in South Africa contribute to the performance of assets? Based a comparative study on the maturity of the real estate market in South Africa to that of Tanzania. Tests based JLL's emerging market survey attributes to market transparency, access to international capital markets, domestic and international corporate base. South Africa has outperformed countries within the Sub-Sahara Africa and place second to the United Kingdom for its scale of property financing. The market offers an array of real estate investment vehicles such as listed real estate stocks, open-end and closed-end real estate funds and debt securities with property as the underlying asset class. South Africa can be classified as an emerging real estate market (Rothacher & Candidate, 2013). This research seeks to examine the possible sensitivity among the chosen investment vehicle. Seek clarification on the performance of each individual investment, the degree of spillover effect as a result of an increase in demand or volatility. This paper seeks to examine if such investments options provide a diversification benefit t to investors.

1.3 Aim of study

The study objectives were as follows:

- :i. Examine the nature of the relationship between the REIT index to that of stocks, bonds, commodities and currencies
- ii. Examine the correlation between assets by investigating the extend and existence of spillover effect amongst the 5 instruments. Whether if a negative performance of stock translated into the same effect for all other assets.

1.4 Significance of the study

Market growth is anticipated with the estimated compound annual growth rate to be 6.1% growth for the five-year period 2015-2020 (Martketline: 7). REITS is a new alternative investment vehicle in South Africa whiles bonds and stock are traditional assets since the merger of the Bond Exchange of South Africa (BESA) with the JSE. Bonds and Stocks are common main asset classes and as such the correlation between this two has an impact on the investors' asset allocation and portfolio balancing. For risk management purpose, investors should be able to understand the risk and benefits of this two traditional assets, alternative assets as well as REIT index.

2. LITERATURE REVIEW

2.1 Volatility spillover effects

Literature is suggestive that, REIT has a strong linkage to equity than bonds. Various spillover effect hypothesis as an explanatory measure between equity and bonds, express the view that the effect of bonds to stock is unidirectional and yield different results stock to bonds. There is a strong linkage between REITS and main stock indices based on the use of daily returns to capture the dynamic volatility of returns. Study by (Cotter & Stevenson, 2007) confirmed the use of based GARCH model as a suitable analysis of such volatility. Frequency of data, daily compared to monthly has an implication on the results .The use of daily data result in outcome that is contrast to fundamental based and intuitive results. Daily data contains more noise and unable to depict accurately the nature of fundamental relationships or variation due to possible structural change in the relationship between REITS and other assets.

According to (Dean, Faff, & Loudon, 2010), there are five hypotheses that can explain the likely causes for spillover effect particularly between stock and bond: (i) **Asset substitution** hypothesis: author notes that bonds and assets are competing assets with a negative correlation and the type of information available impacts the perceived attractiveness of either two to the investor. Where new information results favourable for bonds leads to increase in bonds purchase and vis-a-visa.

(ii) **Financial contagion hypothesis**: is a result of proliferation of returns shocks based on overreaction to either new information or market news or noise. According to this hypothesis regardless of the economic fundamentals, bad news can be transmitted to other markets and spill over effects can be either direction.

(iii) **News specificity** hypothesis: states that the impact of news spread of price changes in both assets varies in degree in providing information about a certain asset classes. Furthermore the price change differs between stocks and bonds. Where bonds are a reflection of the general economic conditions and a broad view of the corporate sector. However the source of news has different impacts on the two assets. News from bonds affects both stocks and bonds in the same direction. Whereas stock returns shock spillover into bonds has the opposite effects.

(iv) **The news decomposition hypothesis**: impact of news has two valuation impacts; impact of news regarding future cash flows and that on discount rates. News causes different investor reactions to stocks and bonds and different spillover e effects to either two markets.

(v) **The hypothesis of asymmetric price adjustment**: the impact of news being impounded into market prices at varying rates leads to asymmetric transaction costs. Hypothesis further assumes due to asymmetric price returns, the impact of spillover between bonds and stocks is faster compared to good news. Such outcome is a common classical market behavioural reaction to bad news compared to good news. In an investigative study,(Zhang, Zhang, Wang, & Zhang, 2013) found empirical results that indicates there is a bidirectional volatility spillover between equity and bond markets in South Africa. As well that Brazil, another emerging market economy yielded the same results. Presence of volatility spillover effects confirms the efficiencies of cross market information transmission and integration of financial markets of different economies.

2.2 Empirical findings on REITS

The 1960 federal legislation in the United States transformed the feature of REIT to suit abroad range of investors. Firstly, the organizational firms had to meet the requirements to be qualified by having 75% of assets should be either mortgage. real estate or government securities. Secondly, at least 95% of taxable income should be distributed to REIT shareholders. Thirdly that 75% of the gross income should be derived from rent, mortgage and gains from the sale of real estate. Finally, real estate property must not be held primarily for sale in the ordinary cause of business. The classification by the National Association of Real Estate Investment Trust (NAREIT) being Equity, mortgage and hybrid REIT.Although worth trillions today, the period of 1960-1968 was defined by slow growth due a lack of understanding of the advantages of the asset by investors and later on a crisis linked to mortgage loans, bankruptcy and liquidation.

Similar root causes to the recent financial crisis of 2007 caused by poor loan underwriting and rising interest rates. The growth of the industry has since tripled compared to its recover since the mid 1970's crisis, the industry was worth 17 billion in 1985 and today stand at 1 trillion US dollars. The industry growth is attributed to the tax reform Act of 1986 which included the estate investment trust modernization Act which brought greater management flexibility via less taxation, legal structure and accounting reporting for depreciation. Furthermore to understand the economics of real estate, in-depth analysis should be done on the impact of; investment decision, financing decision and return and risk issues. Investment decision consist of a broad review of topics that are related to classifying the nature of REITs, by examining works on literature that post the question such as are REIT real estate or stock and reaction towards good and bad news?Impact of asset acquisition and dispositions and corporate restructuring on returns. How company dividend policy, capital structure, agency costs, IPOs, capital budgeting and financial performance is based on returns, risk and diversification (Corgel, Mcintosh, & Ott, 1995). Portfolio fund managers remain concerned about the correlation between REITS to other financial instruments. Integrated markets equate to less diversification benefit from the investment as they are affected by the same economic and financial stimuli. Their concern rises due to be a question amongst scholars on whether there is an appropriate classification of REITS as a financial asset. Legally, REITS return should mimic that of parent asset but does REITS embody the economic characteristics of the underlying assets? What is its performance towards volatility in the stock market? If markets are integrated according to (Wilson et al., 2014), there are varying degrees of integration between real estate and financial markets. They are as follows:

- **Lack of integration**: The absence of integration market means that the market is segmented and the inclusion of REITS and other financial assets into a portfolio will not increase excess return. Concept of market segments, assumes that such segmentation occurs due to isolation between two markets. This is a result of many factors. One factor can be due to market inefficiencies or imperfections.
- **Partial integration**: Occurs when physical real estate and financial markets are segmented however REITs and secondary mortgage markets are integrated. With integrated markets being more efficient.

- **full Integration**: Real estate and financial assets markets are integrated. Therefore there are no premium return or premium risk for either investors in real estate or stocks. Examined by the capital asset pricing model or the correlation analysis, segmentation occurs between real estate (residential) and commercial real estate based on market risk alone. Equity REITs are integrated with the stock markets and with indirect barriers such as cost, amount and quality of information are major sources of segmentation (Liu, Hartzell, Greig, & Grissom, 1990).

Using a multiple factor model by evaluating the same time period of the 1900s (Clayton & MacKinnon, 2001)) reported that in the period of 1970s to 1980s US NAREIT return was a result of the same economic factors as large caps, had a closer relation to small caps and real estate factors in the 1990s. Furthermore, from 1972-1990 using generalised asset pricing model US rerun could not be explained by either stock or bonds return. Upon examining specific economic factors, (Chiang, Lean, & Wong, 2008) established that REITS are affected by interest rates indirectly or directly. In comparison to other assets such as stock, effects are more apparent in stock compared to stocks. The interest rates and interrelationship between REITs return and other assets is dependent on the country. Market maturity and development would as a result affect the data available which affects the ability to identify relationships clearly in REIT markets. Their findings also concluded that the estimation of the return of REITs should not be based on a judgement regarding expectation of returns similar to that of stocks or its underlying direct property investment. Although corrected to other assets, this correlation varies with time and to maximize the benefits of its correlation to other assets, investors should opt for active management and be cautionary that although derived from the parent asset, it is not a substitute for its parent.

2.3 Stocks and Bonds Indices in South Africa

In terms of South African bond market, figures from the World Federation of Exchange state that, government bonds remain the most traded as they contribute to 96% of the nominal turnover on the JSE bond in 2012. Corporate bonds had a value of ZAR 73 billion in the year 2003, ZAR 498 billion in 2007 and with a nominal value of ZAR 1104 billion corporate bonds on the JSE. Bonds issued by local municipal governments and state owned parastatals is only 12.78% (Van Wyk et al., 2015). Therefore it is clear that the majority of the bonds on the South African markets are owed by government and would largely contribute to the gross domestic product of the country . The bond market in Kenya and Egypt precede as being the second most active markets in Africa. Debt instruments largely issued on the JSE are the fixed-rate instruments, inflation-linked bonds and floating-rate notes (FRNs).

Fixed-rate instruments represent 69% of total primary listing a net increase of R150 million. Inflation-linked bonds accounts for 15 percent. Banks issue the floating-rate notes, accounting for 14% and the debt issued in 2016 as a result of great demand by investors against potential change in macroeconomic variables. Although not of the same capacity, the secondary bond market does exist. The repurchase (repo) market is an example of such an instrument and contributed 69% of the volume traded in 2015 compared to a 66% in 2014. It has an ability to be sold to third party upon default of original seller, and is an attractive instrument for the private sector(Department of National Treasury, 2015: 15). This research did not sought to determine in-depth the relationships between equities and bonds, which is a notable question regularly asked as to which of these two assets outperform the other. Scholars have cautioned that contrary to market believes that equities outperform bonds, and based on a 27-year period of April 1986 till February 2013 concluded that even though not all bonds, but a majority of bonds outperformed equities. However this is not the case with all bonds as bonds experienced a prolonged out performance compared to other assets as a result of structural decline of inflation in South Africa in the mid-1990s (Auret & Vivian, 2014). South Africa is an emerging economy is an attractive market large market for global investors as to mitigate idiosyncratic risk.

The African stock returns provide a diversification benefit due to is a low correlation between the stock and bonds markets. Moreover, stocks tend to hold long term memory and therefore allow the use of past return data to forecast returns. However the memory retention is associated with the random walk theory where current stock price and past information has no relationship with the current market prices(Alagidede, 2011). There is a time-varying stock-bond correlation pattern that occur based on time horizons within a short time horizon performance. Correlation between the two is greatly influenced by monetary policies and often negative during times of economic crisis. While long time horizon performance is affected by inflation and stock market uncertainty and correlation is positive. Therefore emerging market stock and bonds move in the same direction. Furthermore there is a positive long run relationship between inflation and stock-bond correlation which suggests that both stock and bond prices in emerging markets tend to move in the same direction during periods of high inflation. In high equity market, uncertainty leads to a higher co-movement of stock and bond prices in emerging markets. Global stock market uncertainty plays a more significant role than global bond market uncertainty in explaining stock-bond correlations in emerging markets (Dimic, Kiviaho, Piljak, & Äijö, 2016).

2.3.1 Historical Performances of Commodities

There is a cyclical relationship between stock and commodities and the function of commodities in the agribusiness for portfolio mix. Factors such as the unstable demand for raw commodities from emerging market and bull market increased interest in commodities. An attractive asset class for investors is signalled by increased number of agricultural index funds and agriculturally related commodity prices. Commodities market experienced huge price declines during mid-2008 industry however it continued to attract investors and is viewed as a defensive investment. Supply and demand for commodities is linked to the societal trends in the agri-food and fibre firms. Firstly, increased global interest in human health education for healthier foods on domestic and international level have caused conglomerates such as Walmart to notice these trends and introduced organic product lines. Secondly, the acceptance and relaxation of restrictions of genetically modified and functional foods firms make huge profits. The growth of this industries has led to unprecedented demand for inputs. The industry is characterised by high competition their individual profitability is filtered into share prices and earned dividends.

Historically there is an inverse relationship with a correlation (0:71) coefficient between stock and commodity prices between price movement of stock and commodities. There is lead-follow position interplay between the two that has been observed over the last six major bull markets, making turns every 16-18 years in being a performance leader. From 1906-2018, incorporating the impact of market crashes, macroeconomic events and recent political events and based on an relative-prices strength cycle, there has been an alternated price leadership between the two assets with a cycle of 29-32 years with an average of 31 years in the United States. Thereafter a brief 15 years phase exist when stock outperform commodities. The down-phase of the relative-strength cycle concluded commodities have dominated the price performance in stocks and commodities.

Thirdly, the acceptance of the theory of cyclical pattern assumption means that price dominance of agricultural commodity markets for assets such as farm, food, energy and metal markets will expire and is expected to repeat as it has over the past 140 years. The asset has risen over the last decade from 2000 to mid-2008 and back post- financial crisis (Zapata & Detre, 2012).This is good news for portfolio and hedge fund managers who have interest in agricultural commodities such as yellow maize and wheat in this study.

Furthermore a review of the linkages between commodities future, stocks and bonds over a 45 year based on an average annual return, demonstrate (although they have slightly more volatile returns) that commodities futures are comparable to stocks and exceed bond returns. The difference of the two is attempted to be answered by the theory of stated cycle. This theory assumes that both stocks and bonds, are comparable as they tend to react differently during investment cycle with each boom in commodities leading to rising price maximums. Commodities are positively correlated with inflation. A study on the inflation cycle of 2002 to 2015, over a period of including 130 years including deflationary and inflationary cycles in the United States equity and commodities. It established that the two alternate in leading return on average every eighteen years. Currently, the market is considered to be in the fourth commodity growth trend based on the theory of repeating history and is estimated to end in 2017 or 2020 (Baran & Ranuša, 2011).

2.4 Diversification and Optimal mix

REITs display properties of asymmetric volatility returns with stronger asymmetric volatilities in comparison to stock, bond and commercial-mortgage backed security returns. A combination of, REITs and stock returns results in the two being conditionally correlated and asymmetric. The correlated variables for fund managers translated into implies less hedging potential of REITs to stock market investors during a financial crisis. However as REITS are characterised by asymmetrical volatility, often this can be equated to asymmetrical return. Investment into this asset class for asset managers and hedge funds is faced with challenges to achieve the highest rate of return through limited fund exposure to downside risk and volatility of returns. The use of asymmetric return investment strategies and risk management would yield maximised market potential and reduce downside risk in volatile markets. Asymmetric volatility of corporate bond and commercial-mortgage backed securities (CBMS) may provide diversification benefits for stocks and REITs.

Their pairwise conditional correlations characterised based on statistical and economic predictability of key macroeconomic condition indicators can predict time varying correlations based of asset classes. The following pairs provided hedging opportunities against each other: CMBS-stock, equity REIT-corporate bonds, and eq-uity REIT-CMBS. For asset combination of stock and REITs, the assets follow a higher default spread and other combinations had lower correlation due to volatile markets. When the default spread is higher this translates into diversification benefit for investors (Yang & Zhou, 2009). There are economic benefits for investors with portfolios that contain equity REITS. REITs have a different risk-return structure compared to common stocks and investors can improve portfolio results utilizing REITs' risk and return pattern by reducing risk of portfolio. Often investment into these asset class provided benefits by hedging inflation and have liquidity characteristic similar to listed stocks.. These characteristics are used to attract investors' interest as they benefit from portfolio improvement effects due to the low correlation between stock market movement and real estate market movement. In the USA, investment trust beat are small and not significantly influenced by the market. As a result investors can have improved portfolio effects.(Won & Park, 2016).The question is, can it be proven that real estate stocks do have positive benefits. What is the optimal number of combination of different asset classes to derive a diversification benefit? A combination of five assets and more, a portfolio that consist of common stock and equity REITs has more risk reduction abilities compared to common stock only.

By increasing the number of stocks in portfolios, the risk level for each asset in a portfolio of five assets is reduced. In comparison to other types of REITS, investors should exclude mortgage REIT from their portfolio as it has high risk level and rather opt for balanced portfolio that consist of common stock and equity REIT. Mortgage REITs are highly volatile asset and requires a mix of more assets for there to be a benefit. In this case, rewards were only observed in an eight-asset portfolio (Bhuyan, Kuhle, Al-deehani, & Mahmood, 2015). However, when does this diversification benefit hurt investors and what market conditions breed benefits? At times when the market is at its lowest, this benefit is no longer beneficial. Using copula to measure the asymmetric dependence, (Knight, Lizieri, & Satchell, 2005) found that there was tail dependence between the FT Real Estate sector and the FT All Share Index is greater in the lower tail than in the upper tail. It implied that real estate stocks and common equities are closely related and have no diversification benefit due to poor returns when market is at its lowest. This questions the alluded defensive characteristics of real estate stocks and the expected performance. Further-more during the boom-bust cycle, stock classified as either value or defensive had a fluctuating performance. These stocks had underperformed but later on outperformed the market. Investors in the future benefit from the recovery of the market however, in times of crisis the same stocks demonstrate poor performance no economic benefits are derived by investors.

2.5 Model criticism

Although the DCC GARCH model is a widely used in finance literature,(Caporin & McAleer, 2013))observed various contradictions about this greatly praised model. A few of these contradictions will be discussed below. The DCC model is based on conditional second-order moments of standardized residuals and does not directly yield conditional correlation. The duo argue that based on the equation based on outer cross-product of standardised residuals (Engle, 2002):

$$Q_t = (1 - \alpha - \beta)Q + \alpha_{\eta_{\text{t-1}}}\eta_{\text{t-1}} + \beta Q_{\text{t-1}}$$

A set of assumption are made such as : the equation has scalar parameter$(\mu, \sigma^2)$and these properties provide a stability constraint whereby $\alpha + \beta < 1$. Q is a $k \times k$ positive-semi definite matrix that captures conditional correlation.Furthermore, for the equation:$R_t = \left[\rho_t^{\text{ij}}\right] = \text{diag}(Q_t)^{-1/2} Q_t \text{diag}(Q_t)^{-1/2}$. Noted no equivalence between the two equations below regarding standardization of the dynamic conditional correlation matrix. Further argue that the previous equation fails to satisfy the definition of a conditional correlation matrix and even with the standardization by Engle (2002).That not every standardization of the conditional covariance matrix is consistent with the dynamic conditional correlation matrix where:$\eta = D_t^{-1}(R_t = \mu)\ D(0, Q_t)$.

Another contradiction is noted based on the standardization of a conditional correlation matrix by Engle(2002), where $Q_t = (1 - \alpha - \beta)Q + \alpha_{\eta_{\text{t-1}}}\eta_{\text{t-1}} + \beta Q_{\text{t-1}}$. As the equation is formulated based on the structural scalar properties of the BEKK model of dynamic conditional correlation and there is inconsistency as how the model is derived should Q_t dynamic recurrence in the equation above. The substitution of Q_t into the BEKK model and interpretation as a dynamic conditional covariance matrix of the innovation term η_t infer that the following condition should hold:

$$\eta = D_t^{-1}(r_t - \mu)\ D(0, Q_t)$$

The argument is that, inconsistency arise due to the assumptions made in capturing time-varying second order moments when the covariance is decomposed. It is assumed that rt has time-varying conditional variance and modelled easily using a univariate GARCH process however calculations for the computation of dynamic conditional expectations and dynamic conditional correlation matrix are not consistent. Authors questioned the accuracy of the presented correlation model as based on their observation the model is rather stated as opposed to being mathematically derived. The representation lacks direct and testable mathematical properties. Furthermore, they are of the opinion that the model lacks testable regulatory conditions hence its consistency cannot be verified. This questions the compilation of estimates for dynamic conditional correlation in relation to give a definition of dynamic conditional correlation. If there was a methodology is used to derive asymptotic properties of parameter estimates.

The VAR model has not escape criticism itself, even though it is widely recognised for estimation characteristics which are simple and does not dictate which variable as endogenous or exogenous. Ordinary least square regressions can be applied to each equation separately as a result forecasts are better than those obtained from more complex simultaneous equation models.

However the model is criticised for being a-theoretical and too simplified. The mathematical calculations of simultaneous equation is a long process in which inclusive and exclusion of variables occur. As such, process there would be a loss of information through the simplification. This makes dilutes the capabilities of the model when used for policy analysis and forecasting. Furthermore, users are often challenged in choosing the appropriate lag length. It is observed that, the model is better for larger sample size, as estimating of many parameters comes a lot of degrees of freedom. Variables in an m-variable have to be jointly stationary or else they are transformed appropriately. Models can contain a mix of stationary and non-stationary variables. Differenced data omits potential important stationary variables and such parameter estimate may suffer from omitted variable bias (Gujarati & Porter, 2009).

3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter examines the econometrics frameworks used to carry out the study. It considers in detail the methods to establish interrelations between the variables by using the properties of a VAR model and the residual correlation using the dynamic conditional correlation model. In this chapter, the researcher discusses how data was analysed and in depth description of all models used.

3.2 Vector Autoregressive VAR

Used widely in finance, the VAR model is suitable for various finance and econometrics applications. The Vector Autoregressive model was developed by Sims (1980) who argued that for true simultaneity to exist amongst a set of variables, such a pure state is achieved by treating all variables as equal and avoiding priori distinction between endogenous and exogenous variables (Gujarati & Porter, 2009). The benefits of using the VAR model, is that the modelling consists of generating time-series with time invariant means, variance and covariance structure on condition of sufficient starting values.

3.2.1 Model Estimation

The p-th order of the (VAR(K)), is denoted as VAR (p) is:

$$y_t = c + A_1\text{yt} + A_2\text{yt-2} + ...A_p\text{yt-p} \tag{3.1}$$

Where A_i is a time-invariant $k \times k$ matrix ,ϵ_t is a $k \times 1$ vector of error terms that are assumed to follow the following statistical properties:where $E(e_t)$ has a mean of zero, has a $k \times k$ positive-semi definite matrix with no serial correlation in individual error terms.The model describes the evaluation on a set of k variables that are endogenous over the sample period($t = 1, ..., T$) as a linear function of their past values. Based on a parsimonious VAR(1) model specification to analyse the return of spillover effects.Fitting a vector autoregressive model into a quintic- variable log returns of time series ($REIT(_t), STOCKS(_t), BONDS(_t), CURRENCY(_t), COMMODITIES(_t)$ which has 4620 observation. A VAR($_p$) model equation is as follows:

$$\begin{pmatrix} REIT_{\text{t}} \\ STOCKS_{\text{t}} \\ BONDS_{\text{t}} \\ CURRENCY_{\text{t}} \\ COMMODITIES_{\text{t}} \end{pmatrix} = \begin{pmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \end{pmatrix} + \begin{pmatrix} \gamma_{1,1} & \gamma_{1,2} & \gamma_{1,3} & \gamma_{1,4} & \gamma_{1,5} \\ \gamma_{2,1} & \gamma_{2,2} & \gamma_{2,3} & \gamma_{1,4} & \gamma_{1,5} \\ \gamma_{3,1} & \gamma_{3,2} & \gamma_{3,3} & \gamma_{3,4} & \gamma_{3,5} \\ \gamma_{4,1} & \gamma_{4,2} & \gamma_{4,3} & \gamma_{4,4} & \gamma_{4,5} \\ \gamma_{5,1} & \gamma_{5,2} & \gamma_{5,3} & \gamma_{5,4} & \gamma_{5,5} \end{pmatrix} \begin{pmatrix} REIT_{\text{t-1}} \\ STOCKS_{\text{t-1}} \\ BONDS_{\text{t-1}} \\ CURRENCY_{\text{t-1}} \\ COMMODITIES_{\text{t-1}} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,\text{t}} \\ \varepsilon_{2,\text{t}} \\ \varepsilon_{3,\text{t}} \\ \varepsilon_{4,\text{t}} \\ \varepsilon_{5,\text{t}} \end{pmatrix} \tag{3.2}$$

Assuming a vector autoregressive (VAR) model for the conditional mean returns for REITs, stocks and bonds a trivariate model VAR (1) returns is as follows:

$$r_t^{\text{r}} = \mu^{\text{r}} + \alpha^{\text{r}} r_{t-1} + \beta^{\text{r}} r_{t-1}^{c} + \varepsilon_t^{\text{r}} \tag{3.3}$$

$$r_t^{\mathrm{s}} = \mu^{\mathrm{s}} + \alpha^{\mathrm{s}} r_{t-1} + \beta^{\mathrm{s}} r^{c}_{t-1} + \varepsilon_t^{\mathrm{s}} \tag{3.4}$$

$$r_t^{\mathrm{b}} = \mu^{\mathrm{b}} + \alpha^{\mathrm{b}} r_{t-1} + \beta^{\mathrm{b}} r^{c}_{t-1} + \varepsilon_t^{\mathrm{b}} \tag{3.5}$$

Where r_t^{r},r_t^{s} and r_t^{b} are the logarithmic returns for REITs, stocks and bonds indices. The residuals ε_t^r, ε_t^s and ε_t^b are assumed to be serially uncorrelated with a covariance$E(\varepsilon_t^{\mathrm{r}}, \varepsilon_t^{\mathrm{s}}, \varepsilon_t^{\mathrm{b}})$ are not equal to zero. Coefficients α^r, $\alpha^s and \alpha^b$ measure the cross-mean spillover between REITS, stocks and bonds. .

3.2.2 Prescribed Test

Prior to the investigation of the linear interdependencies of the selected index, the data was examined to investigate the generalize univariate autoregressive model (AR model) properties were performed. A set of preliminary tests such as the unit root, co-integration and Granger causality. Unit root test, examines the types of stationarity and it is assume that the under-lying time series is stationary if its mean and variance do not vary systematically over time. The assumption of stationarity is for the purpose of testing distributional proper-ties which otherwise would not be applicable (ie t-distribution nor an F distribution), hypothesis testing and have spurious results. The Granger-causality establishes fore-casting ability and the causality of volatility between REITs and other assets.

Furthermore it examines if the data set contains unique information about the potential future returns on assets for the investors. Lastly, the precision of diversification benefits derived from a portfolio are captured using co-integration. Based on modern portfolio theory, where investors are assumed to reduce the risk associated with a particular stock by having a basket of a variety of stocks. Hence, the technique identifies the preferred none correlated stocks which tend to over more rewards to investors. MGARCH models for conditional variance models dynamics of the conditional interdependence between the 3 investment assets: REITs, stocks and bonds using a multivariate GARCH (1,1) specifications.

3.3 Dynamic conditional correlation DCC

3.3.1 Conditional correlations

The Dynamic Conditional Correlation GARCH is an extension of the Conditional Correlation covariance(CCC) model by Bollerslev(1990). The CCC model has a constant conditional correlation which makes the conditional covariances matrix:($H_t = D_t * R * D_t$) proportional to the corresponding conditional standard deviations.CCC has parsimonious property as it is a simplified multivariate. Therefore the covariance matrix the CCC model is as follows:The estimation procedure and has less parameters. For specifications by Engle(2002) provides flexibility to model large variance using a two step estimation procedure for financial assets return.First stage uses a univariate volatility model to obtain a GARCH-estimate and stage two time-varying conditional covariances are estimated using standardized residuals.

The model further captures covariance matrices and explicit accommodation of cross market co-movement over time.Conditional variance-covariance matrix (H_t) of the residuals ($\varepsilon_t^{\text{Reit}}, \varepsilon_t^{\text{Sto}} \varepsilon_t^{\text{Bonds}}, \varepsilon_t^{\text{Cur}}, \varepsilon_t^{\text{Com}}$)as follows:

$$\varepsilon_t | \Omega_{t-1} \sim \mathcal{N}(0, \mathrm{H}_t), \mathrm{H}_t \equiv \begin{bmatrix} h_t^{\text{rr}} & h_t^{\text{rs}} \\ h_t^{\text{sr}} & h_t^{\text{sb}} \\ h_t^{\text{bs}} & h_t^{\text{bb}} \\ h_t^{\text{cb}} & h_t^{\text{cc}} \\ h_t^{\text{cc}} & h_t^{\text{cc}} \end{bmatrix} \tag{3.6}$$

Where ε_t is (5x1) vector of residuals from the VAR model and Ω_{t-1} is the information set containing all the information available to time (t-1). The DCC GARCH permits for direct inference for time varying correlations between five assets and the use of large number of variables. In a bivariate case, variance-covariance matrix of the residuals is specifies as :

$$H_t = D_t * R_t * D_t$$

Where $D_t = diag\sqrt{h_t^{\text{rr}}}\sqrt{h_t^{\text{ss}}}, \sqrt{h_t^{\text{bb}}}$is the (3×3) diagonal matrix of the conditional standard deviations of the residuals, a product of the square root of the conditional variance modelled by a univariate GARCH (1,1) process of,

$$h_t = \omega + \alpha\varepsilon_{\text{t-1}} + \beta h_{\text{t-1}}$$

Where R_t is a matrix of time- varying conditional correlations given by:

$$R_t = \left[\rho_t^{\text{ij}}\right] = \text{diag}(Q_t)^{-1/2} Q_t \text{diag}(Q_t)^{-1/2} \tag{3.7}$$

The (2x2) is a symmetric positive-definite matrix R_t depends on squared standardized residuals ($\mu_{\text{i,j}} = \varepsilon_t^{\text{i}} \div h_t^{\text{ii}}$), their unconditional variance-covariance matrix (Q), and its own lagged value. A bivariate DCC GARCH (1,1) model is written as follows:

$$H_t = D_t R_t D_t = h_t^{\text{rr}} \quad \rho_t^{\text{rs}} \sqrt{h_t}^{\text{rr}} h_t^{\text{ss}} \tag{3.8}$$

The correlation coefficient between REITs and stock at time t is given by:

$$\rho_t^{\text{rs}} = E_t|\varepsilon_t^r \varepsilon_t^s \div \sqrt{E_{\text{t-1}}[(\varepsilon_t^r)]} \times \sqrt{E_{\text{t-1}}[(\varepsilon_t^s)]} \tag{3.9}$$

The correlation coefficient between REITs and bonds at time t is given by:

$$\rho_t^{\text{rb}} = E_t|\varepsilon_t^r \varepsilon_t^b \div \sqrt{E_{\text{t-1}}[(\varepsilon_t^r)]} \times \sqrt{E_{\text{t-1}}}[(\varepsilon_t^b)] \tag{3.10}$$

3.3.2 Parameter estimation

As the second stage of the model, a Quasi-maximum likelihood (QML) is used to estimate the parameters using estimated parameters from the first stage to compute the dynamic conditional correlation. Log function is as follows:

$$= -(0.5) \sum_{t=1}^{\text{T}} [klog(2\pi) + 2log|D_t + log|R_t + \varepsilon_t' R_t^{-1} \varepsilon_t] \tag{3.11}$$

Three criteria will be used to examined to identify the appropriate lag order for the VAR model. Mainly the Akaike Information Criterion (AIC), the Schwartz Information criterion (SIC) and the Hannan-Quin Information criterion(HQI).

The DCC MGARCH model is used in this research due to its computational capacity in investigative studies on time-varying correlations. In a study on oil, gas and CO_2 prices correlation,in an empirical study to determine interrelationship between using three classes of MGARCH: BEKK, CCC and DCC models. DCC MGARCH model yield superior outcomes and highlighted potential flaws more obviously if only had a single univariate GARCH model been used in isolation.The BEKK MGARCH model exhibits a degree of autocorrelation and the model had misspecification. The constant-correlation model could not adequately capture the dependence between the conditional correlation of variables. Features of the DCC MGARCH such as the white noise residual properties and its reflection of dynamic correlations overtime contributed to its out performance of other models. The model uncovered the interaction between the VAR residuals with respect to conditional correlation (Chevallier, n.d.).

3.4 Data

The selection of the sectors for this study aims to represent an overall diversification benefit for an average investor with a vast interest in key industries and will examine the following assets; commodities, currency, bonds and stocks. To determine the impact of real estate investment trust, the following indices were selected.

3.4.1 South African Stock selection

This study included a selection of six indices across the South African market. All the data is sourced from Bloomberg terminal all in local ZAR currency based on the last price at the close of the day. The study evaluated the weekly returns for 4 years and 2 months period from 7th August 2013. The returns are continuously compounded and the return is calculated by the difference in the logarithms of 2 consecutive prices. The formula for the calculations for returns is: :

$$R_t = logP_t - logP_{t-1}$$

The indices are as follows: Health care, Financials 15, Industrials 25, Telecommunication, Auto-mobile and Parts, and consumer goods. Each index represents a basket of companies in the various sectors and weight allocation methodology was used to allocate the value of each company. It was designed that the largest stocks on the market, and each stock influenced the index relative to the size of the company. Below is a summary and justification of the selected index.

3.4.2 Real estate

The S&P 500 South Africa REITs and the JSE South Africa all listed property index (SAPY), and are two of the industry leading market benchmark in real estate. It should be noted that separations can be made regarding the S&P 500 Property Index. Two indices can be found namely the S&P 500 South Africa Composite Index as well as the S&P 500 SA Capped index, a variation commonly made through exchange traded funds platforms. For this study, a whole index was examined and not the individual index. Standard and Poor's South African composite index has invested in companies that are listed as property companies and index was made up of 15 companies, with weight of three-quarters of the index allocated to companies with operations in South Africa and the rest those in the United kingdom. The SAPY consists of the top 20 liquid property companies with primary listing on the JSE. Although the index has been criticised for not being tailored uniquely to the local real estate, the South African market is too diverse as it includes foreign companies listed on the JSE.

3.4.3 Bonds

A selection of Spot of exchange rate per ZAR dollar were chosen for currencies of the country's top trading partners. They are as follows; China, Japan, United Kingdom, Botswana and partners in the Eurozone.Theory dictates that there is a positive correlation between REITs and equity that their relation is a affected by time and similarly REITs can partially hedge against commodity price risk. Based on certain market conditions, REITs and equity tend to rise as markets become more integrated which result into some lost diversification benefits of the REITs relative to equities. REITS and bonds have become less correlated, as a sign of more segmented markets since 1990 which calls for portfolio managers to include REITs as strategic allocation in their portfolio. Correlation remains of importance as, due to asset's sensitivity to market movements. In times of average volatility and investors seeking coverage, however correlation increases which offers reduced diversification benefits for investors.

In this study it was proven that since the correlation between US government securities and REITs fell during period of above average interest rate higher risk translate for portfolio managers that a higher allocation towards real estate reduces portfolio risks in periods of high interest rate volatility (Chong, Miffre, & Stevenson, 2008).It was anticipated that there was efficiency in a currency asset class portfolio by engaging in different types of trading strategies. Based on the currencies of the G10 countries, individual currencies are not efficient and using a correlation matrix calculations such currencies would benefit from diversification. Efficient portfolios are dependent on investor's risk preference and funds should be proportionally distributed to each currency. Currency portfolios are an attractive investment vehicle however investors should examine the variables that affect individual currency risk and return as they affect the domestic investor's earnings. Currency asset classes are highly and positively correlated to equity ETF's (Safarzadeh & Molina, 2013). .

3.4.4 Conclusion

In this chapter preliminary analysis was done by applying a VAR $(_p)$process to the returns of each price series and followed by prescribed diagnostics test. Lastly, the application of MGARCH model and appreciation of its restrictive assumptions of constant conditional correlations examine.

4. RESULTS AND ANALYSIS

4.1 Introduction

This chapter provides a summary of the results, of the study presented according to the research variables under examination. In total 20 variables were considered, a single index represents the real estate investment trust. As for stock, bonds, currencies, commodities and a combination of 5 indices is selected to represent the variety within each asset.

4.2 Descriptive statistics

Table 4.1 summarises the descriptive statistics of the daily returns for the various sectors. There was a variation in the sample mean return for the different asset classes. Real estate, currency yielded positive returns whereas bonds had almost zero or negative returns for holders of the investment. Majority of the equity showed a positive return with the noticeable sectors being consumer goods, industrial 25 and financial 15, hence addition of these assets to a portfolio would yield benefits. Telecommunications and auto-mobiles had a negative daily return of -0.09% and -0.19% respectively, an indication that there is a decrease in return on investments, however, this can also be beneficial depending on their correlation with other assets over time .The majority of the bonds being risk-free asset had a positive return, however the 20 year current bond has a negative return which affects investors risk premium. Only one out of the six currency to have a negative mean return of 0.00176%,which would be a loss for a pro t seeking investors. For the class of commodities, Coal had the highest expected return of 0.36% followed by Gold with 0.13% with wheat at 0.05%. Palladium and yellow maize have a negative return of -0.30% and -0.04%. Investors in maize producing companies could expect lower returns even though there is a global demand for the commodity, farmers are challenged by global warming, drought and costs for pesticides.

There was a differences in the unconditional volatility of the assets with equity (0.09%-0.28%) and real estate (0.22%) being more volatile compared to currency (0.05%-0.09%) and bond (0.05%-0.08%). As a result return equity returns are stable, followed by Reits, whereas others are risky characterised by fluctuating returns. Normal distribution is characterised by a zero skewness and a kurtosis coefficient of 3, which indicate that the outcome is these requirements were not fulfilled for this study. The none zero Jarque-Bera test values confirms the rejection of normality. The p-value indicated that the null hypothesis that the data set is normally distributed should be rejected and any variables for this research that the null hypothesis cannot be accepted even at a 1 percent level of significance.

Tab. 4.1: Descriptive statistics

	Mean (%)	**Median (%)**	**Maximum (%)**	**Minimum(%)**	**Std. Dev.(%)**	**Skewness(%)**	**Kurtosis**	**Observatio**
				Bonds				
20 yr Treasury bond	-0.05	0.06	10.49	-17.20	1.99	-2.31	28.79	230.00
10 yr GRN Bond	0.08	-0.02	18.01	-10.28	2.30	1.82	19.49	230.00
30 yr GRN Bond	0.07	-0.07	17.52	-10.72	2.06	2.19	27.12	230.00
5 yr GRN bond	0.07	-0.05	19.02	-10.12	2.44	1.90	19.14	230.00
				Commodities				
Gold Future	0.13	0.10	10.23	-6.31	2.45	0.55	4.27	231.00
Merrill Lynch SA Coal	0.36	0.14	9.18	-16.72	3.36	-0.41	5.55	231.00
Palladium	-0.30	-0.64	30.53	-33.91	6.51	0.49	8.40	231.00
Wheat	0.05	0.12	6.49	-8.28	2.16	-0.35	4.09	231.00
Yellow maize	-0.04	0.15	15.87	-35.27	4.40	-2.56	22.21	231.00
				Stocks				
Financial 15	0.17	0.20	8.51	-13.29	2.59	-0.57	6.31	231.00
Industrial 25	0.28	0.24	6.23	-4.22	1.91	0.08	2.80	231.00
Automobiles	-0.19	-0.29	17.27	-13.84	4.29	0.23	4.89	231.00
Consumer goods	0.15	0.41	9.48	-10.46	2.25	-0.02	5.59	231.00
Telecommunication	-0.09	-0.23	10.63	-15.08	3.46	-0.38	4.55	231.00
				Real estate				
Reit	0.22	0.23	12.90	-19.09	2.64	-1.21	16.31	230.00
				Currencies				
Japanese Yen	0.08	0.00	11.70	-5.49	2.26	0.80	6.06	231.00
British Pound	0.08	0.04	10.63	-7.23	2.17	0 0.45	6.23	231.00
Euro	0.09	0.03	11.08	-6.31	2.12	0.60	5.71	231.00
Chinese Yuan	0.09	0.07	9.17	-5.60	2.05	0.61	4.80	231.00
Botswana Pula	0.05	0.03	5.63	-3.38	1.24	0.58	5.39	231.00

Bonds= South African government bonds indices; Commodities= Gold futures,Merrill Lynch South Africa coal, palladium,wheat and yellow maize; Stock = indices of the financial , industrials, auto-mobiles,consumer goods; Reits=Real estate investment trust; Currencies= spot exchange rates for selected countries

Tab. 4.2: Unit root test

Null Hypothesis: DBWPZAR has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-12.07	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DCNYZAR has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-11.91	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DEURZAR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-16.23	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: FINI15 has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-12.03	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DGBPZAR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-14.83	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Tab. 4.3: Unit root test

Null Hypothesis: DGOLD_FUTURE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-13.65	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DGTZAC10YR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-17.80	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DGTZAC20YR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-18.60	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DGTZAC30YR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-18.85	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DGTZAC5YR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-16.81	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Tab. 4.4: Unit root test

Null Hypothesis: DINDI25TR has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=14)			
		t-Statistic	Prob.*
ADF test statistic		-15.00	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	
Null Hypothesis: DJAUTOTR has a unit root			
Exogenous: Constant			
Lag Length: 2 (Automatic - based on SIC, maxlag=14)			
		t-Statistic	Prob.*
ADF test statistic		-10.81	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	
Null Hypothesis: DJNCSV has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=14)			
		t-Statistic	Prob.*
ADF test statistic		-16.2015	0.00
Test critical values:	1% level	-3.45872	
	5% level	-2.87392	
	10% level	-2.57344	
Null Hypothesis: DJCCGD has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=14)			
		t-Statistic	Prob.*
ADF test statistic		-14.25	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	
Null Hypothesis: DPALLADIUM has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=14)			
		t-Statistic	Prob.*
ADF test statistic		-15.47	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Tab. 4.5: Unit root test

Null Hypothesis: DWHEAT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-16.30	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DMLIVSAC1 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-16.63	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DYELLOW_MAIZE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-15.26	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DSPZARN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-17.34	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

Null Hypothesis: DJPYZAR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
ADF test statistic		-16.09	0.00
Test critical values:	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	

4.3 Vector Autoregression and Impulse Response Analyses

Analysis of the model, consists of an estimation stage which entails the performance of diagnostic tests to evaluate the time-series properties of the data set. One of the required test is the unit root. Non-stationary data are characterised by a non-constant mean and the use of such data results in spurious regressions. Such regressions tend to have a line that looks good under standard measures with a significant coefficient estimate. However a high R^2 outcome is valueless as standard distribution tests (t or F distribution) and hypothesis testing cannot be performed. As such the process of stationarity validates the usefulness and reliability of the data and table 4.2-4-5 summaries the results . Concurrently, the vector autoregressive model is criticised for the lack of rules regarding optimal lag length. The selection of lags is chosen using either of the following criterion; SIC information SIC information ,Akaike information (AIC)and Schwarz information criterion (SIC) and (AIC) is used to select the number of optimal lags.

The proceeding step is that of the Granger Causality/Block Exogeneity Wald to examine any casual effect between variables by performing a hypothesis test for causality and results are found in the appendix. An examination of variables, Palladium appears to be dependent on most of the assets for the data set based on a 5% significant level. South Africa produces 40% of all mined palladium, with supply similar to Russian global supplier Norilsk Nickel and there are limited alternative substitutes for the metal. Various price drivers factors for the commodity can explain its dependency on other assets. Foremost, a change in US monetary policy results in the adjustment of interest rates accordingly which affects investors attitude towards holding non-interest bearing asset like palladium. Federal interest rate, also known as risk free rate affects the flow of borrowing in an economy. Vehicle manufacturing accounts for 75% of palladium demand from the auto-catalyst sector and this percentage is likely to increase due to tighter passenger petrol vehicle emission standards. Demand from large economies such as China and the United State, increases trade opportunities and affects the balance of payments (Sainsbury, 2017). Variables such as the financial 15 index, 20 year bond, industrial 25 and auto-mobile index are dependent on the performance of coal. Backed by results from a few variables, it is demonstrated that there is a uni-directional effect. Which is consistent with the hypothesis that some assets have greater impact and can potentially perform better than others. Having fitted the VAR model and established significant parameter estimates between Reits and other assets, proceed to the variance decomposition. The interpretation of the fitted module is done using the variance decomposition. Whereby, the decomposition of variance of the forecast errors of the returns of a given asset indicates the relative importance of the various assets in causing the fluctuations in returns of that market.

The decomposition of variance of the forecast errors measures the contribution of individual asset movements and shocks in relation to other assets. As such, a superior asset is that which has the explanatory power with a large percentage of the error variance of other assets while its own forecast error is not explained by shocks in other assets. Tables 4.6-4.10 summarises the outcome of the forecast error variance for 1-week,5-weeks, 10-weeks, 15-weeks and 20-weeks horizons. Firstly, examine the effects of shocks that originates from Reits then moves to currencies, commodities, bonds then stocks. Over the 1st week, Reits have no effects on other assets except itself estimating a 100% forecast error variance. In week 5, shocks at minimum of 0.13% and the highest shock is seen towards the Botswana Pula at 4.21% followed by shock estimates for palladium at 3.89%.

Tab. 4.6: Variance decomposition

Volatility spillover effects of:

REIT	Horizon (periods) Period	BWPZAR	CNYZAR	EURZAR	FINI15	GBPZAR	GOLD	G10YR	G20YR	G30YR	G5YR	INDI25
	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	4.19	0.58	0.54	0.59	1.67	0.55	0.21	0.49	0.99	0.98	0.30
	10.00	4.21	0.60	0.56	0.60	1.67	0.60	0.23	0.52	1.02	0.99	0.31
	15.00	4.21	0.60	0.56	0.60	1.67	0.60	0.23	0.52	1.02	0.99	0.31
	20.00	4.21	0.60	0.56	0.60	1.67	0.60	0.23	0.52	1.02	0.99	0.31
BWPZAR												
	1.00	80.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	63.30	0.78	0.93	0.38	2.72	0.72	0.40	0.40	0.63	0.43	0.55
	10.00	62.77	0.83	0.99	0.39	2.74	0.72	0.53	0.45	0.65	0.45	0.61
	15.00	62.76	0.83	0.99	0.39	2.74	0.72	0.53	0.45	0.65	0.45	0.61
	20.00	62.76	0.83	0.99	0.39	2.74	0.72	0.53	0.45	0.65	0.45	0.61
CNYZAR												
	1.00	61.95	16.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	50.61	14.43	0.09	0.44	2.70	0.42	0.47	0.64	0.68	0.09	0.72
	10.00	50.30	14.36	0.15	0.44	2.69	0.43	0.58	0.65	0.68	0.10	0.78
	15.00	50.30	14.36	0.15	0.44	2.69	0.43	0.58	0.65	0.68	0.10	0.78
	20.00	50.30	14.36	0.15	0.44	2.69	0.43	0.58	0.65	0.68	0.10	0.78
EURZAR												
	1.00	57.28	0.17	16.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	48.55	1.07	13.92	0.32	1.92	0.14	0.19	0.56	0.38	0.43	0.54
	10.00	48.28	1.10	13.90	0.33	1.93	0.14	0.26	0.57	0.38	0.44	0.58
	15.00	48.28	1.10	13.90	0.33	1.93	0.14	0.26	0.57	0.38	0.44	0.58
	20.00	48.28	1.10	13.90	0.33	1.93	0.14	0.26	0.57	0.38	0.44	0.58

Notes: Spot exchange rate:BWPZAR denotes, Botswana/ South Africa;CNY= Chinese Yen/ South Africa; EURO/ South Africa. Where Gold Fut= Gold future; Government bonds=G5YR,G10YR,G20YR and G30YR; Indi25=industrial 25; Fin15=financials 15; JAUTO=Auto-mobile; JCCGD=consumer goods and services; JNCSV=Telecommunication; Yell maize=yellow maize;Coal= Merrill Lynch South African coal index

Tab. 4.7: Variance decomposition

FINI15															
	1.00	3.62	0.00	0.27	42.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	3.50	0.30	0.60	37.06	1.94	0.61	0.11	0.06	0.53	1.28	0.36	0.13	0.49	0.80
	10.00	3.52	0.32	0.65	36.91	1.96	0.65	0.12	0.08	0.54	1.29	0.36	0.14	0.52	0.82
	15.00	3.52	0.33	0.65	36.91	1.96	0.65	0.12	0.08	0.54	1.29	0.36	0.14	0.52	0.82
	20.00	3.52	0.33	0.65	36.91	1.96	0.65	0.12	0.08	0.54	1.29	0.36	0.14	0.52	0.82
GBPZAR															
	1.00	51.30	1.64	0.99	1.56	19.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	41.91	1.77	0.99	1.35	17.84	0.05	0.64	0.27	0.50	0.31	1.64	1.60	1.03	0.64
	10.00	41.66	1.81	1.04	1.35	17.75	0.06	0.69	0.29	0.52	0.33	1.67	1.62	1.11	0.64
	15.00	41.66	1.81	1.04	1.35	17.75	0.06	0.69	0.29	0.52	0.33	1.67	1.62	1.12	0.64
	20.00	41.66	1.81	1.04	1.35	17.75	0.06	0.69	0.29	0.52	0.33	1.67	1.62	1.12	0.64
GOLD_FUT															
	1.00	17.51	0.68	0.70	4.63	0.06	60.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	16.95	2.67	0.78	3.88	0.73	49.99	0.64	0.26	0.33	0.27	1.07	1.77	0.15	1.43
	10.00	16.91	2.72	0.82	3.87	0.74	49.78	0.65	0.29	0.34	0.27	1.07	1.78	0.17	1.42
	15.00	16.91	2.73	0.82	3.87	0.74	49.78	0.65	0.29	0.34	0.27	1.07	1.79	0.17	1.42
	20.00	16.91	2.73	0.82	3.87	0.74	49.78	0.65	0.29	0.34	0.27	1.07	1.79	0.17	1.42
G10YR															
	1.00	18.50	5.07	0.08	0.43	0.37	0.08	37.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	15.48	5.84	1.11	0.42	0.76	0.16	29.12	0.66	0.66	0.60	0.66	1.64	1.30	0.18
	10.00	15.38	5.83	1.12	0.43	0.76	0.25	28.96	0.68	0.69	0.67	0.69	1.67	1.39	0.18
	15.00	15.38	5.83	1.12	0.43	0.76	0.25	28.96	0.68	0.69	0.67	0.69	1.67	1.40	0.18
	20.00	15.38	5.83	1.12	0.43	0.76	0.25	28.96	0.68	0.69	0.67	0.69	1.67	1.40	0.18
G20YR															
	1.00	20.19	3.41	0.06	0.13	0.45	0.01	33.00	5.09	0.00	0.00	0.00	0.00	0.00	0.00
	5.00	16.27	4.62	0.86	0.22	0.55	0.33	26.37	4.92	0.82	0.78	0.60	1.64	0.99	0.23
	10.00	16.17	4.64	0.88	0.22	0.55	0.42	26.23	4.91	0.85	0.84	0.61	1.69	1.07	0.23
	15.00	16.16	4.64	0.88	0.22	0.55	0.42	26.23	4.91	0.85	0.84	0.61	1.69	1.08	0.23
	20.00	16.16	4.64	0.88	0.22	0.55	0.42	26.23	4.91	0.85	0.84	0.61	1.69	1.08	0.23

Tab. 4.8: Variance decomposition

G30YR														
1.00	19.06	3.19	0.13	0.05	0.50	0.02	30.54	6.70	1.05	0.00	0.00	0.00	0.00	0.00
5.00	15.16	4.27	0.79	0.14	0.57	0.49	24.57	6.50	1.54	0.90	0.58	1.86	0.88	0.29
10.00	15.06	4.29	0.81	0.15	0.57	0.57	24.43	6.47	1.57	0.97	0.59	1.92	0.97	0.29
15.00	15.06	4.29	0.81	0.15	0.57	0.57	24.43	6.47	1.57	0.97	0.59	1.92	0.97	0.29
20.00	15.06	4.29	0.81	0.15	0.57	0.57	24.43	6.47	1.57	0.97	0.59	1.92	0.97	0.29
G5YR														
1.00	12.86	5.01	0.03	0.40	0.14	0.10	38.17	1.37	0.06	4.16	0.00	0.00	0.00	0.00
5.00	12.36	5.13	1.27	0.41	0.43	0.53	29.87	1.89	0.26	3.53	0.48	1.66	1.46	0.19
10.00	12.30	5.11	1.28	0.42	0.43	0.63	29.69	1.89	0.30	3.58	0.51	1.70	1.53	0.19
15.00	12.30	5.11	1.28	0.42	0.44	0.63	29.69	1.89	0.30	3.58	0.51	1.70	1.53	0.19
20.00	12.30	5.11	1.28	0.42	0.44	0.63	29.69	1.89	0.30	3.58	0.51	1.70	1.53	0.19
INDI25														
1.00	0.54	0.58	0.04	36.28	0.12	0.74	0.10	0.03	0.14	1.39	48.44	0.00	0.00	0.00
5.00	0.88	0.70	0.58	32.31	1.96	0.77	0.46	0.52	0.22	2.47	41.93	1.00	0.31	1.37
10.00	0.91	0.70	0.59	32.20	1.99	0.79	0.50	0.52	0.22	2.46	41.78	1.04	0.32	1.40
15.00	0.91	0.70	0.59	32.20	1.99	0.79	0.50	0.52	0.22	2.46	41.78	1.04	0.32	1.40
20.00	0.91	0.70	0.59	32.20	1.99	0.79	0.50	0.52	0.22	2.46	41.78	1.04	0.32	1.40
JAUTO														
1.00	2.87	1.27	1.27	5.16	0.93	0.11	0.14	0.02	0.06	0.00	0.00	83.71	0.00	0.00
5.00	3.14	1.89	1.30	5.13	1.37	1.59	1.51	0.60	2.03	1.09	0.24	71.86	0.83	1.17
10.00	3.14	1.89	1.31	5.12	1.41	1.62	1.51	0.63	2.03	1.09	0.26	71.68	0.84	1.18
15.00	3.14	1.89	1.31	5.12	1.41	1.62	1.51	0.63	2.03	1.09	0.26	71.68	0.84	1.18
20.00	3.14	1.89	1.31	5.12	1.41	1.62	1.51	0.63	2.03	1.09	0.26	71.68	0.84	1.18
JCCGD														
1.00	11.11	0.93	1.20	14.62	2.58	0.83	0.05	0.56	0.22	0.60	30.41	0.30	36.57	0.00
5.00	10.84	0.79	1.29	12.53	3.39	0.92	0.51	0.98	0.65	0.72	26.56	2.60	31.04	0.17
10.00	10.80	0.79	1.31	12.46	3.46	0.95	0.60	0.99	0.67	0.72	26.41	2.61	30.88	0.22
15.00	10.80	0.79	1.31	12.46	3.46	0.95	0.60	0.99	0.67	0.72	26.41	2.61	30.88	0.22
20.00	10.80	0.79	1.31	12.46	3.46	0.95	0.60	0.99	0.67	0.72	26.41	2.61	30.88	0.22
JNCSV														
1.00	1.16	0.44	0.31	11.30	0.00	1.31	0.01	0.01	0.06	0.05	5.56	0.91	4.50	59.84
5.00	1.51	1.70	0.83	10.33	0.87	2.00	0.28	0.31	0.31	0.56	4.95	2.16	4.07	53.53
10.00	1.52	1.71	0.84	10.31	0.87	2.00	0.30	0.32	0.33	0.56	4.94	2.17	4.09	53.42
15.00	1.52	1.71	0.84	10.31	0.87	2.00	0.30	0.32	0.33	0.56	4.94	2.17	4.09	53.42
20.00	1.52	1.71	0.84	10.31	0.87	2.00	0.30	0.32	0.33	0.56	4.94	2.17	4.09	53.42

Tab. 4.9: Variance decomposition

JPYZAR														
1.00	46.00	3.21	1.75	3.34	0.30	3.11	0.07	0.03	0.01	0.02	0.01	0.02	0.01	0.34
5.00	38.32	4.46	1.67	3.32	1.88	4.01	0.37	0.32	0.30	0.17	0.67	1.57	0.13	0.89
10.00	38.10	4.48	1.78	3.30	1.87	3.98	0.42	0.34	0.31	0.19	0.71	1.61	0.22	0.90
15.00	38.10	4.48	1.78	3.30	1.87	3.98	0.42	0.34	0.31	0.19	0.71	1.61	0.22	0.90
20.00	38.10	4.48	1.78	3.30	1.87	3.98	0.42	0.34	0.31	0.19	0.71	1.61	0.22	0.90
COAL														
1.00	17.35	0.34	1.13	0.08	0.00	0.01	0.09	0.06	0.05	1.00	0.57	0.07	0.79	0.08
5.00	14.55	2.49	1.70	1.22	0.36	0.07	0.36	0.53	2.21	1.10	2.09	3.40	1.35	0.55
10.00	14.53	2.52	1.79	1.22	0.36	0.08	0.39	0.54	2.21	1.10	2.09	3.45	1.39	0.55
15.00	14.53	2.52	1.79	1.22	0.36	0.08	0.39	0.54	2.21	1.10	2.09	3.45	1.39	0.55
20.00	14.53	2.52	1.79	1.22	0.36	0.08	0.39	0.54	2.21	1.10	2.09	3.45	1.39	0.55
PALLADIUM														
1.00	0.00	2.33	0.21	3.00	1.42	6.79	0.11	0.09	0.55	0.62	1.60	1.34	0.01	1.72
5.00	0.19	5.34	0.88	2.92	2.57	5.70	3.35	0.53	0.83	2.94	1.36	5.05	1.56	1.61
10.00	0.48	5.32	0.92	2.91	2.57	5.65	3.35	0.55	0.83	2.91	1.35	5.08	1.67	1.67
15.00	0.49	5.32	0.92	2.91	2.57	5.65	3.35	0.55	0.83	2.91	1.35	5.08	1.67	1.67
20.00	0.49	5.32	0.92	2.91	2.57	5.65	3.35	0.55	0.83	2.91	1.35	5.08	1.67	1.67
WHEAT														
1.00	10.03	4.97	0.75	0.11	0.64	0.03	0.22	0.24	0.16	0.11	0.64	0.10	0.02	0.45
5.00	8.95	5.55	1.79	1.41	0.84	0.20	0.63	0.61	0.18	1.03	1.03	4.49	2.82	1.20
10.00	8.96	5.55	1.82	1.42	0.88	0.21	0.63	0.62	0.23	1.07	1.03	4.48	2.83	1.21
15.00	8.96	5.55	1.82	1.42	0.88	0.21	0.64	0.62	0.23	1.07	1.03	4.48	2.83	1.21
20.00	8.96	5.55	1.82	1.42	0.88	0.21	0.64	0.62	0.23	1.07	1.03	4.48	2.83	1.21
YELL_MAIZE														
1.00	5.85	2.15	0.11	0.08	0.08	0.31	0.16	1.61	0.26	0.41	0.33	0.18	0.59	0.02
5.00	7.17	3.08	0.60	0.19	1.67	1.20	0.70	3.43	1.93	1.75	0.96	1.75	0.99	1.51
10.00	7.14	3.14	0.62	0.22	1.69	1.22	0.72	3.44	1.93	1.74	0.96	1.78	1.02	1.54
15.00	7.14	3.14	0.62	0.22	1.69	1.22	0.72	3.44	1.93	1.74	0.96	1.78	1.02	1.54
20.00	7.14	3.14	0.62	0.22	1.69	1.22	0.72	3.44	1.93	1.74	0.96	1.78	1.02	1.54

Tab. 4.10: Variance decomposition

JAUTO	**JCCGD**	**JNCSV**	**JPYZAR**	**COAL**	**PALL**	**REIT**	**WHEAT**	**YELL.MAIZE**
0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
0.66	0.89	0.30	0.16	0.57	3.89	81.78	0.13	0.55
0.71	0.95	0.30	0.17	0.62	3.95	81.30	0.14	0.56
0.71	0.95	0.30	0.17	0.62	3.95	81.30	0.14	0.56
0.71	0.95	0.30	0.17	0.62	3.95	81.30	0.14	0.56
0.00	0.00	0.00	0.00	0.00	0.00	19.49	0.00	0.00
2.18	0.50	0.75	0.21	0.89	6.29	16.50	0.98	0.46
2.18	0.62	0.76	0.21	0.89	6.37	16.36	1.00	0.48
2.18	0.62	0.77	0.21	0.89	6.37	16.36	1.00	0.48
2.18	0.62	0.77	0.21	0.89	6.37	16.36	1.00	0.48
0.00	0.00	0.00	0.00	0.00	0.00	21.46	0.00	0.00
1.24	1.08	0.63	0.39	0.36	5.15	19.11	0.32	0.43
1.24	1.19	0.64	0.40	0.37	5.25	18.96	0.35	0.45
1.24	1.19	0.64	0.40	0.37	5.25	18.96	0.36	0.45
1.24	1.19	0.64	0.40	0.37	5.25	18.96	0.36	0.45
0.00	0.00	0.00	0.00	0.00	0.00	26.47	0.00	0.00
1.37	0.47	0.32	0.86	0.46	3.90	23.91	0.31	0.40
1.39	0.56	0.34	0.88	0.46	3.93	23.75	0.35	0.41
1.39	0.56	0.34	0.88	0.46	3.93	23.75	0.35	0.41
1.39	0.56	0.34	0.88	0.46	3.93	23.75	0.35	0.41
0.00	0.00	0.00	0.00	0.00	0.00	53.41	0.00	0.00
0.13	0.49	0.80	0.23	0.28	2.13	48.58	0.75	0.26
0.14	0.52	0.82	0.24	0.30	2.15	48.39	0.78	0.27
0.14	0.52	0.82	0.24	0.30	2.15	48.39	0.78	0.27
0.14	0.52	0.82	0.24	0.30	2.15	48.39	0.78	0.27
0.00	0.00	0.00	0.00	0.00	0.00	25.35	0.00	0.00
1.60	1.03	0.64	1.28	0.32	5.01	21.36	0.96	0.55
1.62	1.11	0.64	1.29	0.33	5.09	21.23	0.97	0.56
1.62	1.12	0.64	1.29	0.33	5.09	21.23	0.98	0.56
1.62	1.12	0.64	1.29	0.33	5.09	21.23	0.98	0.56
0.00	0.00	0.00	0.00	0.00	0.00	15.70	0.00	0.00
1.77	0.15	1.43	0.81	0.70	2.84	13.48	0.67	0.57
1.78	0.17	1.42	0.81	0.71	2.88	13.46	0.69	0.60
1.79	0.17	1.42	0.81	0.71	2.88	13.46	0.69	0.60
1.79	0.17	1.42	0.81	0.71	2.88	13.46	0.69	0.60
0.00	0.00	0.00	0.00	0.00	0.00	38.27	0.00	0.00
1.64	1.30	0.18	0.61	0.83	8.41	30.24	0.08	1.24
1.67	1.39	0.18	0.63	0.87	8.44	30.01	0.10	1.25
1.67	1.40	0.18	0.63	0.87	8.44	30.01	0.10	1.25
1.67	1.40	0.18	0.63	0.87	8.44	30.01	0.10	1.25

Over all real estate accounts for 0.03% to 53.43% of fluctuations of the forecast error variance for other assets. Using the financial 15 and industrial 25 as point of reference for stock index for the over examination of externalities; real estate affects the returns of this index, accounting for 53.47% and while the Pula, palladium and British pound accounts for 3.52%,2.13% of the forecast error variances in for financial index companies.

The financials 15 index affects the returns of other indices as well, contributing 29.68%, 11,60% for real estate and 1,74% for palladium. For Industrial 25, Financials 15 and Reits had the least effects over time on its return with a decrease in fluctuations at 4.08% and 0.56% respectively. Compared to the 1st week, during the 20th week the index returns are increasingly caused by shocks from other assets as its estimation of returns by itself decreases at 6.66%. Which means the returns of the index is not independent of other variables. An examination of two commodities indices, currencies such as the Chinese yuan and British pound have increased influence towards the returns of Palladium at 2.99% and 1.15% respectively. After the United States, the Chinese are second highest consumers of the metal and further studies need to investigate if such demand drives affects the returns for investors. Auto-mobiles, maize and 5 year bond had the same impact at 3.74%, 2.43% and 2.32%. Over the chosen period gold and financial 15 have had a decreasing impact on Palladium at 0.03% and 1.14%.The Pula and 20 year bond have increase fluctuation impacts on yellow maize at 1.29% and 1.83%.While coal has the opposite effect with a change of 0.36%. Returns of the Pula, fluctuations arise over time contributed by the pound and auto-mobiles at 6.37%, 2.74% and 2.18%. The Euro spot exchange rate returns decreased by 9% and increased by 3.93%. For the 5 year and 30 years bond, their decrease is caused by similar assets, they being the Pula, 10 year and 20 year bonds. Most currencies have a weak insignificant impact except for the Japanese yen and British pound have an impact of 3.023% and 3.54% respectively.

For the consumer good index ,industrials accounted for 28.07% , financials at 10% and lastly the British pound at 6.93%. Botswana Pula at 15.79% and impact on coal index and similar accounting was observed at 6.97% for maize. Again the Pula featured with the highest impact on gold with a value of 17.35%, real estate is 14.28% and Japanese yen at 10.70%. Reits index accounted for the majority of explanatory power regarding the performance of other assets especially in the 1st week however as periods increase, its effects on other variables decreased. Overall the real estate performance was endogenous. A large portion expectation and return for investors is based on the strength and weakness real estate industry. Countries in close proximity to South African such as Botswana show strong linkages due to the currency being pegged to the Rand and increase percentage of trade between the two countries.

4.4 DCC GARCH model

DCC GARCH model is used by scholars to test for conditional correlation between certain variable and if such correlation is depended on time. Table 4.11 re-ports the results of the estimated set of 5 variable per group for MGARCH DCC $(1, 1)$ model. For group 1, for all the parameters were positive and particularly with the, $\alpha + \beta = 0.604225 + 0.031588 = 0.635816 < 1$.Group 2, product of: $\alpha + \beta = 0.01582 + 0.951996 = 0.982816$. Group 3, $\alpha + \beta = 0.031512 + 0.010223 = 0.041735$. Group 4,$\alpha + \beta = -0.00836 + 1.003246 = 0.994886$. Group 5, $\alpha + \beta = -0.013852 + 0.858083 = 0.844231$. Group 6, $\alpha + \beta = -0.0006226 + 0.915517 = 0.909291$.

Results confirmed that for all of the groups, all the positive conditions for the parameters were met for the model in conjunction with its non-negativity constraints. With outcomes < 1, this indicates that there is high persistence in the conditional variance.This is seen especially in the outcomes of group 2 (0:982816), group 4 (0:994886) and group 6 (0:909291), with values extremely close to 1. Values less than 1, means that conditional variances are finite with series being strictly stationary. Overall, the model met all the conditional properties of a good model for the conditional mean and variance with the confidence interval of $1 < 0 > 1$. It can be seen that there was dynamic conditional correlation and such correlation can be dependent on time. The value of the coefficient tends to change from small to large, positive and negative number. Therefore it can be implied that a high value and increase of coefficients results, is an indication of higher linkages between variables.

As a result the correlation will have a positive trend and can further imply that variables are not independent of each other over time. The presence of such influences amongst variables proves the existence of spillover effects. With greater precision, it can be stated that a portfolio with the 90% combination of assets similar to those in this research provides diversification benefits and can confirm spillover effects amongst the 5 asset classes.

Tab. 4.11: DCC GARCH results

		Coefficient	Std. Error	z-Statistic	Prob.
Group 1	theta(1)	0.03	0.02	1.47	0.14
REIT	theta(2)	0.60	0.22	2.76	0.01
JNCSV	Log likelihood	-2669.33	Schwarz criterion		23.97
JCCGD	Avg. log likelihood	-2.32	Hannan-Quinn criter.		23.68
PAL	Akaike info criterion	23.49			
BWP	* Stability condition: theta(1) + theta(2) ¡ 1 is met.				
Group 2	theta(1)	0.02	0.01	2.59	0.01
GOLD	theta(2)	0.95	0.02	43.87	0.00
30 YR BOND	Log likelihood	-2216.20	Schwarz criterion		20.03
FIN 15	Avg. log likelihood	-1.93	Hannan-Quinn criter.		19.74
CNY	Akaike info criterion	19.55			
EURO	* Stability condition: theta(1) + theta(2) ¡ 1 is met.				
Group 3					
MAIZE	theta(1)	0.03	0.03	1.24	0.21
COAL	theta(2)	0.01	0.33	0.03	0.98
INDI 25	Log likelihood	-2525.83	Schwarz criterion		22.72
GBP	Avg. log likelihood	-2.20	Hannan-Quinn criter.		22.43
20 YR BOND	Akaike info criterion	22.24			
	* Stability condition: theta(1) + theta(2) ¡ 1 is met.				
Group 4	theta(1)	-0.01	0.00	-3.18	0.00
5 YR BOND	theta(2)	1.00	0.00	498.90	0.00
JAUTO	Log likelihood	-2230.26	Schwarz criterion		20.15
BWP	Avg. log likelihood	-1.94	Hannan-Quinn criter.		19.86
WHEAT	Akaike info criterion	19.67			
FIN 15	* Stability condition: theta(1) + theta(2) ¡ 1 is met.				
Group 5	theta(1)	-0.01	0.00	-75.67	0.00
YELLOW	theta(2)	0.86	0.04	21.08	0.00
REIT	Log likelihood	-2435.40	Schwarz criterion		21.93
GBP	Avg. log likelihood	-2.12	Hannan-Quinn criter.		21.65
FIN 15	Akaike info criterion	21.46			
20 YR BOND	* Stability condition: theta(1) + theta(2) ¡ 1 is met.				
Group 6	theta(1)	-0.01	0.01	-1.15	0.25
GOLD	theta(2)	0.92	0.10	9.61	0.00
EURO	Log likelihood	-2326.19	Schwarz criterion		20.98
30 YR BOND	Avg. log likelihood	-2.02	Hannan-Quinn criter.		20.70
INDI 25	Akaike info criterion	20.51			
REIT	* Stability condition: theta(1) + theta(2) ¡ 1 is met.				

4.5 Asset correlation analysis

The usage of modern portfolio theory is common in the investment industry and is used to reduce the impact of fluctuations of the standard deviations of assets cause by market interactions. Diversification is often practised to reduce risk in volatile markets and in-crease returns. Investors require compensation via risk premium for their investments. Portfolio managers continuously seek negatively correlated assets. For this study, it was observed that the Reits index is negatively correlated and its relation is significant at 0:4 to 0:5 to currencies. A similar negative relationship is observed for wheat, maize and gold. Majority of stocks related investments would yield little diversification benefits as there were a positive correlation to majority of stocks with the exception of consumer goods and services index. A portfolio which combines stocks, bonds, currencies and commodities would however proof to have the desired benefits as they are negatively correlated.

For positive correlated assets mangers can select a combination of currencies against themselves as the highest positive correlated is 0:7 and the lowest at 0:7. Currencies tend to be lowly correlated to other assets. As a stand-alone investment class it has a favourable risk-return relationship that can act as a viable alternative to equity and especially fixed income investments. As opposed to other assets that move up in tandem and move in lock-step during and after a credit crisis, currency asset classes on the other hand have a low correlation as currency returns tend to be driven by factors that di er from those that drive the return of tradition asset classes (Funds, 2013). Results from this study are indifferent that commodities are positively correlated to currencies. Their relationship, confirms the theory by scholars that exchange rate can be determined using commodity prices. In the Australian case, using the nominal exchange derived from commodity prices, interest rate and impact of the financial crisis. The study confirmed that commodities tend to have a positive and significant impact on the exchange rate and short run exchange rate is influenced by lagged exchange rates. Furthermore, variables have a long-run relationship between the factors and established that there exists a two-way causality relationship between commodity prices and exchange rate .The nature of the relationship between the two is of importance as it affects the government export and import policy formation and implementation which trickles down to the restrictions imposed on portfolio managers. Policies for weaker currency tend to increase exports and beneficial long run growth; whilst as same results for exchange rate can be achieved via lower commodity prices. The latter's implication is linked to the industrialisation of the economy, central bank policy on reserves policies and involved and incentives for producers of commodities (Bashar & Kabir, 2013).

4.5.1 Conclusion

The analysis made, confirmed the volatility spillover between the real estate investment trust and the chosen financial assets. Real estate investment over the various period accounted a significant influence on the forecast error variance for other assets. Results from the DCC GARCH model concludes that correlation of assets are not independent of each other over time and based on the ranges of correlation coefficients indicates high linkage between variables were observed. Various positive and negative correlation relationships were established using the asset correlation analysis.

In the next Chapter 5, is discussion on, the conclusions and recommendations for central banks, portfolio manager and other regulatory authorities. Provides recommendation include an over view of the role of each assets in this study and suggestions regarding approaches for policy makers.

Fig. 4.1: **Asset correlation**

	REIT	INDI25	FINI15	JNCSV	AUTO	JCCGD	5YR	20YR	30YR	10YR	MAIZE	WHEAT	COAL	PALL	GOLD	GBP	JPY	CNY	EUR	BWP
REIT	1.0																			
INDI25	0.3	1.0																		
FINI15	0.7	0.6	1.0																	
JNCSV	0.4	0.5	0.5	1.0																
AUTO	0.2	0.2	0.3	0.2	1.0															
JCCGD	-0.1	0.7	0.2	0.1	0.0	1.0														
5YR	0.1	-0.1	0.0	0.0	-0.1	-0.2	1.0													
20YR	0.6	0.0	0.5	0.3	0.2	-0.3	0.2	1.0												
30YR	0.6	0.0	0.5	0.3	0.2	-0.3	0.2	1.0	1.0											
10YR	0.6	0.0	0.4	0.3	0.2	-0.3	0.2	1.0	1.0	1.0										
MAIZE	-0.2	0.0	-0.1	-0.1	-0.1	0.1	0.0	-0.2	-0.2	-0.2	1.0									
WHEAT	-0.2	0.1	-0.1	-0.1	-0.1	0.2	-0.1	-0.3	-0.3	-0.3	0.2	1.0								
COAL	-0.2	0.0	-0.2	-0.2	-0.1	0.2	-0.1	-0.4	-0.4	-0.4	0.2	0.2	1.0							
PALL	0.1	0.3	0.2	0.3	0.1	0.2	-0.2	0.0	0.1	0.1	0.0	0.0	0.1	1.0						
GOLD	-0.4	-0.1	-0.5	-0.2	-0.2	0.2	-0.1	-0.4	-0.4	-0.4	0.2	0.3	0.3	0.2	1.0					
GBP	-0.5	0.0	-0.4	-0.3	-0.2	0.4	-0.1	-0.7	-0.7	-0.7	0.3	0.4	0.4	0.0	0.5	1.0				
JPY	-0.5	-0.1	-0.6	-0.3	-0.3	0.3	-0.1	-0.6	-0.6	-0.6	0.2	0.4	0.4	-0.1	0.7	0.7	1.0			
CNY	-0.5	0.0	-0.4	-0.3	-0.2	0.4	-0.1	-0.7	-0.7	-0.7	0.3	0.4	0.5	-0.1	0.5	0.8	0.8	1.0		
EUR	-0.5	-0.1	-0.5	-0.3	-0.3	0.3	-0.1	-0.7	-0.7	-0.7	0.3	0.4	0.5	-0.1	0.6	0.8	0.8	0.8	1.0	
BWP	-0.4	0.0	-0.4	-0.3	-0.2	0.4	-0.1	-0.7	-0.6	-0.6	0.3	0.3	0.5	0.0	0.5	0.8	0.8	0.9	0.9	1.0

5. DISCUSSION AND CONCLUSION

This research investigated the time-varying correlation of the real estate investment trust in relation to stocks, bonds, currency and commodities using a multivariate modelling framework. The econometric methodology used consists of fitting various specifications of MGARCH to the residuals of a VAR model for the twenty closing price series. Two major objectives were explored: (1) to investigate the extent of volatility spillover from the real estate to other financial assets, and (2) to demonstrate correlation amongst assets. This research sought to answer the following questions: What are the spillover effects of real estate on other assets? Do some assets have superior impact on others and their correlation? The real estate investment trust index provides investor some exposure to the real estate class; due to its characteristic portfolio managers invest part of portfolios in the index for strategic asset allocation against risk.

5.0.1 Findings

The study of volatility spillover effects allows the user of this method to understand how volatility is transmitted between markets and their interdependency from assets over stipulated periods. The usage of variance decomposition analysis aids in the interpretation of the fitted VAR model for the sample period of $2013 - 2017$. Using the financial and industrial index as proxy to measure overall market interaction, REIT accounted for 53.47% percent of the forecast error variance with other assets having weak explanatory power about the performance of the index. Real estate accounted for 28.07%, financials 10% and British pound at 6.93%.The results indicated that commodities were impacted significantly by currencies with strong economic ties with South Africa.

Literature has documented that interaction of assets can be explained using the formulation of volatility spillover effect hypothesis to define relations to other financial assets. The various hypothesis were as follows; the asset substitution, financial contagion, news specificity, new decomposition and the hypothesis of asymmetric price adjustment. As confirms coexist with the markets and not immune to the economic and financial stimuli which determine the degree of varying integration which can be linked to investors risk premium expectations. The higher the cost of borrowing the higher the expected return. Positivity co-integrated assets in a well organised market that seek for arbitrage opportunities such assets provides little reward-ratio benefits as a result for strategic asset allocation thus, portfolio managers need to have negatively correlated assets to match rewards expectations.

5.0.2 Conclusions

This research concludes that currencies tend to be positively correlated to commodities, and negatively correlated to stocks, real estate stocks and bonds in South Africa within the examined period. This is good news for managers who are in the business of minimizing risk and examine the optimal portfolio allocations in line with their risk preferences. Based on correlation, optimal portfolios can be composed using asset substitution those that yield the greatest return and less risk. In so doing, negatively correlated securities produce a diversification benefit which reduces risks.

Classical paradigmatic portfolio theory of Modern Portfolio Theory (MPT), state that high return is not independent of risk and using the assumptions made by Markowitz . It is assumes further that for investments made, investors require returns that are high returns, dependable, stable and certain. The dynamic conditional correlation model (DCC-GARCH) was used to examine correlation of variables over time. This study found that correlations were dependent and not independent of each other, due to this their relation proves the existence of spillover effects. REITs have become a global trend for asset management companies who estimate the market value of global REITs to exceed US1000 in the future with some markets predicted to be undervalued.

This study is of value to central bankers, portfolio manager and any audience who have an interest in the various macroeconomic factors that impact real estate investment trust index return. For advanced economies such as Japan, Singapore and China via ARDL bounds for examination of the co-integration of macroeconomic variables. Evidence was found that there is a long-run equilibrium between interest rate, inflation rate and stock price index. With an existence of a unidirectional relationship in which inflation rate shifts causes Reits index changes in Japan and Singapore. A similar relationship was observed in which stock index movement causes Reits index changes in Singapore (Fang, Chang, Lee, & Chen, 2016) .It can be assumed that at varying degree that the same macroeconomic variables do have an impact on the REITs in South Africa, therefore of importance for investors. The Kenyan economy shares the same sentiments, where high inflation rate, interest rate and new technologies are linked to commercial banks responses to shield against credit risk. However their measure reduces investor confidence and the market is less predictable. The pricing of real estate investments is affected by government interference through fiscal economic tools (tax rate) and discounting rate. Central bank's role can be most influential in controlling the discounting rate linked to the annuity payments. There is application of control on the possible adjustment of annuity payment to match increasing mortgage rates to retain the attractiveness of the markets for investors and the viability of real estate investments to both parties (Muthaura, 2012). The interplay of all investments play a crucial part in the economy as a whole, more importantly currency trading is of important to central banks. The central bank core function is that of foreign currency reserves particularly to hedge risk. A result the bank is a non-pro t player who can have substantial influence on the currency price movements and valuations.

By so holding on to currencies they tend to have portfolios with a negative alpha. It is the intention and purpose of the various holders of currency that causes the movement of currencies to move in uncorrelated directions relative to other assets. It has been concluded that non-pro t seeking participants contribute the majority of total currency turnover. Hence as the market is dominated by such players, who do not seek pro t nor the expected return of currency transaction result in inefficiencies in the currency market. The control function of federal banks is termed as the "mania of policy makers". Where markets are inefficient as they are driven by policy makers and their policies are geared towards monetary policy targets instead of the underlying fundamentals(Funds, 2013).

5.0.3 Recommendations

Users of this study can appreciate the role of various tools and methods available to hedge inflation and seek maximum returns. Further research can be done to evaluate the stage of industrialization of the South African economy, its trade relations and farmer incentives for innovative production to maintain commodity prices in relation to number of exports and import. This in turn affects the balance of foreign currency reserves and long run economic growth targets. More studies can be done on whether there is a golden age of commodity prices in South Africa as observed in the United States and the development of the agribusiness.

5.0.4 Limitations of the study

It was di cult to get data that reflected the happenings of the real estate investment trust in South Africa. On the JSE, there are three indices; S&P 500, S&P 500 SA Capped and the South Africa All property (SAPY). S&P 500 South African composite index consists of 15 listed property companies each with a weight of three-quarters of their value allocated to companies with operations in South Africa and rest those in the United kingdom. While as for SAPY although it consists of the top 20 liquid property companies with primary listing on the JSE. The index has been criticised for not being tailored uniquely to the local real estate industry based on the to represent South African market too diverse as it includes foreign companies listed on the JSE. Data used is an estimated projections and with current studies in progress to craft an index for the market. Further studies will be able to all interested parties an in depth analysis of the local South African market.

5.0.5 Suggestions for Further Research

The study aimed to establish the volatility spillover effects between the real estate investment trust and financial assets in South Africa. The study did not take into account underlying causes for price adjustments as well as the causes of volatility spillover effects. More can be done to examine the degree of financial markets segmentation and impact on portfolios. Should there be an establishment a unique local index, further research can be carried out to investigate the implication on the economy should there be a residential real estate and commercial real estate index. There is a need to deepen existing knowledge of diversification properties of commodities, currency and bond portfolios.

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APPENDIX

Tab. .1: VAR Granger Causality /Block Exogeneity Wald Tests

VAR Granger Causality/Block Exogeneity Wald Tests
Included observations: 228
Dependent variable: DSPZARN

Excluded	Chi-sq	df	Prob.
DBWZAR	3.80	2.00	0.15
DCNYZAR	0.54	2.00	0.76
DEURZAR	3.57	2.00	0.17
DFINI15	0.12	2.00	0.94
DGBPZAR	1.28	2.00	0.53
DGOLD_FUTURE	1.43	2.00	0.49
DGTZAC10YR	3.63	2.00	0.16
DGTZAC20YR	3.77	2.00	0.15
DGTZAC30YR	1.82	2.00	0.40
DGTZAC5YR	2.89	2.00	0.24
DINDI25TR	0.26	2.00	0.88
DJAUTOTR	0.27	2.00	0.87
DJCCGD	0.81	2.00	0.67
DJNCSV	1.07	2.00	0.59
DJPYZAR	0.41	2.00	0.82
DMLIVSAC1	0.21	2.00	0.90
DPALLADIUM	11.92	2.00	0.0026*
DWHEAT	0.08	2.00	0.96
DYELLOW_MAIZE	0.93	2.00	0.63
All	42.07	38.00	0.30

Dependent variable: DBWPZAR

Excluded	Chi-sq	df	Prob.
DSPZARN	2.94	2.00	0.23
DCNYZAR	2.39	2.00	0.30
DEURZAR	1.97	2.00	0.37
DFINI15	2.83	2.00	0.24
DGBPZAR	3.85	2.00	0.15
DGOLD_FUTURE	1.68	2.00	0.43
DGTZAC10YR	0.03	2.00	0.98
DGTZAC20YR	1.78	2.00	0.41
DGTZAC30YR	1.99	2.00	0.37
DGTZAC5YR	0.50	2.00	0.78

Tab. .2: VAR Granger Causality/Block Exogeneity Wald Tests

DGTZAC5YR	0.50	2.00	0.78
DINDI25TR	1.15	2.00	0.56
DJAUTOTR	3.73	2.00	0.15
DJCCGD	0.93	2.00	0.63
DJNCSV	2.64	2.00	0.27
DJPYZAR	0.40	2.00	0.82
DMLIVSAC1	0.79	2.00	0.67
DPALLADIUM	13.65	2.00	0.00
DWHEAT	1.32	2.00	0.52
DYELLOW_MAIZE	0.16	2.00	0.92
All	**48.54**	**38.00**	**0.12**

Dependent variable: DGOLD_FUTURE

Excluded	Chi-sq	df	Prob.
DSPZARN	3.39	2.00	0.18
DBWPZAR	8.49	2.00	0.01
DCNYZAR	1.65	2.00	0.44
DEURZAR	0.21	2.00	0.90
DFINI15	2.42	2.00	0.30
DGBPZAR	2.77	2.00	0.25
DGTZAC10YR	0.32	2.00	0.85
DGTZAC20YR	0.53	2.00	0.77
DGTZAC30YR	0.53	2.00	0.77
DGTZAC5YR	2.08	2.00	0.35
DINDI25TR	0.43	2.00	0.81
DJAUTOTR	3.71	2.00	0.16
DJCCGD	0.02	2.00	0.99
DJNCSV	3.78	2.00	0.15
DJPYZAR	2.72	2.00	0.26
DMLIVSAC1	2.32	2.00	0.31
DPALLADIUM	11.45	2.00	0.0033*
DWHEAT	2.13	2.00	0.34
DYELLOW_MAIZE	1.11	2.00	0.58
All	43.31	38.00	0.26

Dependent variable: DGTZAC30YR

Excluded	Chi-sq	df	Prob.
DSPZARN	0.41	2.00	0.81
DBWPZAR	2.60	2.00	0.27
DCNYZAR	4.32	2.00	0.12

Tab. .3: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: DFINI15

Excluded	Chi-sq	df	Prob.
DSPZARN	3.52	2.00	0.17
DBWPZAR	0.36	2.00	0.83
DCNYZAR	0.79	2.00	0.67
DEURZAR	1.04	2.00	0.60
DGBPZAR	3.42	2.00	0.18
DGOLD_FUTURE	1.26	2.00	0.53
DGTZAC10YR	2.36	2.00	0.31
DGTZAC20YR	1.04	2.00	0.59
DGTZAC30YR	0.54	2.00	0.76
DGTZAC5YR	2.84	2.00	0.24
DINDI25TR	0.38	2.00	0.83
DJAUTOTR	0.12	2.00	0.94
DJCCGD	0.27	2.00	0.87
DJNCSV	3.26	2.00	0.20
DJPYZAR	0.68	2.00	0.71
DMLIVSAC1	0.41	2.00	0.82
DPALLADIUM	5.10	2.00	0.08
DWHEAT	1.13	2.00	0.57
DYELLOW_MAIZE	0.20	2.00	0.91
All	26.05	38.00	0.93

Dependent variable: DGBPZAR

Excluded	Chi-sq	df	Prob.
DSPZARN	2.37	2.00	0.31
DBWPZAR	0.35	2.00	0.84
DCNYZAR	0.45	2.00	0.80
DEURZAR	0.70	2.00	0.71
DFINI15	2.72	2.00	0.26
DGOLD_FUTURE	0.73	2.00	0.69
DGTZAC10YR	0.99	2.00	0.61
DGTZAC20YR	1.58	2.00	0.45
DGTZAC30YR	1.20	2.00	0.55
DGTZAC5YR	0.35	2.00	0.84

Tab. .4: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: DINDI25TR

Excluded	Chi-sq	df	Prob.
DSPZARN	1.86	2.00	0.40
DBWPZAR	0.21	2.00	0.90
DCNYZAR	0.26	2.00	0.88
DEURZAR	0.25	2.00	0.88
DFINI15	2.41	2.00	0.30
DGBPZAR	2.76	2.00	0.25
DGOLD_FUTURE	0.69	2.00	0.71
DGTZAC10YR	1.55	2.00	0.46
DGTZAC20YR	0.43	2.00	0.81
DGTZAC30YR	0.23	2.00	0.89
DGTZAC5YR	3.23	2.00	0.20
DJAUTOTR	1.54	2.00	0.46
DJCCGD	0.21	2.00	0.90
DJNCSV	2.77	2.00	0.25
DJPYZAR	2.30	2.00	0.32
DMLIVSAC1	0.28	2.00	0.87
DPALLADIUM	2.83	2.00	0.24
DWHEAT	1.85	2.00	0.40
DYELLOW_MAIZE	0.35	2.00	0.84
All	**30.16**	**38.00**	**0.81**

Dependent variable: DWHEAT

Excluded	Chi-sq	df	Prob.
DSPZARN	2.89	2.00	0.24
DBWPZAR	5.26	2.00	0.07
DCNYZAR	3.68	2.00	0.16
DEURZAR	2.18	2.00	0.34
DFINI15	1.80	2.00	0.41
DGBPZAR	0.28	2.00	0.87
DGOLD_FUTURE	0.76	2.00	0.69
DGTZAC10YR	1.49	2.00	0.47
DGTZAC20YR	0.01	2.00	0.99
DGTZAC30YR	0.17	2.00	0.92
DGTZAC5YR	3.21	2.00	0.20
DINDI25TR	1.34	2.00	0.51
DJAUTOTR	11.34	2.00	0.0035*