Modelling of Daily Price Volatility of South Africa Property Stock Market Using GARCH Analysis

*Tosin B. Fateye[1], Oluwaseun D. Ajayi[2], Cyril A. Ajayi[3]

[1]Ph.D Candidate (Real Estate Finance and Investment), Estate Management Department, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria
[2]Ph.D Candidate (Real Estate Finance), School of Construction Economics and Management, University of the Witwatersrand, Johannesburg, South Africa
[3]Professor of Estate Management, Estate Management Department, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

Corresponding Author: fateyetosin@gmail.com

Purpose: The study examined the volatility of the daily market price of listed property stocks on the Johannesburg Stock Exchange (JSE) for a 10year period (2008-2017). The primary aim of the study is to investigate the volatility pattern of the daily market price; in an attempt to document and model the nature of volatility characterised by the daily price of the listed property stock market for informed investment decision making.

Design/Methodology/Approach- The study used daily prices from January 2, 2008, to December 29, 2017 of twelve (12) quoted property companies out of the twenty-seven (27) listed on Johannesburg Stock Exchange (SA REIT Association, 2020). The property stocks were selected based on the quoted property companies that have sufficient published data on daily prices for the period under review. The data were obtained from the JSE published statistical bulletin. The study computed the average daily price of the selected (12) property stocks and was used as a proxy for the daily market price for the property stock market in the analysis. The study deployed mean, standard deviation, maximum and minimum analytical tools for descriptive statistics, Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS); Jarque-Bera, Breusch-Godfrey LM and Heteroskedasticity tests for unit root, normal distribution, autocorrelation, and ARCH effect tests respectively. The diversification benefits and modelling of SA-REIT market price volatility were analysed using correlation matrix and generalised autoregressive conditional heteroskedasticity (GARCH 1, 1)

Finding: Analysis of residual estimate of the series documents the evidence of volatility characterised by prolonged high and low clustering patterns for the period under review. The GARCH model reported that the previous day's information of both the daily market price (ARCH term) and the volatility (GARCH term) have a positive and significant ($p<.05$) effect on the current day’s daily market price volatility in the property stock market. The result of the model implies that investment in the property stock market is strongly driven by positive news on daily price than a negative shock; meaning that South Africans' investors are more sensitive and exhibit a sharp response to good news on daily market price than bad news when thinking of investing in listed property company shares on Johannesburg Stock Exchange.

Practical implications: The study documents and models the statistically significant influence of conditional variance (volatility) of the daily price of the South Africa property stock market.

Originality/Value: The study added to the existing body of knowledge by documenting the volatility pattern and model structure of SA-property stock markets for informed investment decision making.

Keywords: GARCH, Property stock, Stock Market, Volatility, Model

1. INTRODUCTION

Prior studies have linked volatility to the occurrence of the unexpected swing of events in the stock market (Hanousek, Kocenda & Kutan, 2008; Mitra, Iyer & Joseph, 2015; Mashamba & Magweva, 2019 and Trivedi et al., 2021). While the stock market is geared towards wealth creation, investors are more confused and lose confidence in the investment potentials of the stock market and by extension listed property stock and property company shares amidst striking market volatility. Early studies including Shiller (1990) explained that increasing striking events in the stock market have been happening time immemorial but the concern on unexpected events started gaining the attention of market experts and academicians following the crash of the stock market on October 19, 1987.

In recent time, Quoreshi, Uddin & Jienwatcharamongkhol (2019) expressed that the reoccurrence of unpredicted events associated with high-level volatility has continued to pose a big threat to investment goals and property stock market potential. Generally, volatility measures the variability of price or expected returns to its mean value. A high volatile stock implies that the price moves greatly up-and-down around the average price per time. Mamtha and Srinivasan (2016) explained volatility clustering in stock price to mean a period of prolonged low volatility for a period that is followed by prolonged high volatility for another in that series. The author attributed the main future of volatility clustering mean to collections of small and large fluctuations in stock prices sequentially preceding one another.

During the volatile marker period, the stock prices behave irrationally, fluctuate, and made market predictions less significant. In some cases, the fundamental and technical analyses are difficult to proof, and a large number of the participants are left to uncertain market condition. The changes in the volatility clustering contributed to the frightened stock market risk and uncertainty. Lahaye, Laurent & Neely (2009) and Haritha & Rishad (2020) stressed that rapid fluctuations in stock price have resultant effects on the investors' trust, confidence, and volume of trading activities in the general stock market.

Meanwhile the fluctuation of the stock price amidst volatile market period is attributable to some factors which include economic factors, market news and investment sentiments (Ramanthan & Gopalakrishan, 2013; Mamtha & Srinivasan, 2016; Haritha & Rishad, 2020). Engle and Rangel (2008) concluded that emerging stock market is characterised by higher volatility of unpredicted events compared to developed ones. However, the volatility of stock price has been modelled by authors in different markets across globe (Cavalcante & Assaf, 2002; Mondher, Chaker & Ezzeddine, 2005; Quoreshi, Uddin & Jienwatcharamongkhol, 2019 and Quoreshi & Mollah, 2019). Trivedi et al. (2021) posited that modelling of volatility in stock market helps the market participants such as investors, investment/financial analysts and fund managers to predict the possibility of great risk loss as well as the opportunity of higher return during the unpredictable market condition.

2. LITERATURE REVIEW

2.1 Stock Exchange Market and Volatility Pattern

In real estate economics, risk management, finance and investment literature, a number of studies have examined the relationship between volatility and the stock market, and its attendance implications. Some of the studies in recent decades include Samanta (2010), Wang, Tianyi & Huang (2012), Abbas, Khan & Shah (2013), Bhowmik (2013), Issam, Achraf & Boujelbene (2013), Gospodinov & Jamali (2014), Li & Giles (2015), Mitra, Iyer & Joseph (2015), Ghufran, Awan, Khakwani & Qureshi (2016), Sehgal & Garg (2016), Chung, Fung & Shilling (2016), Melo-Velandia (2017), Olbrys & Majewska (2017), Hussain, Murthy & Singh (2019), Quoreshi, Uddin & Jienwatcharamongkhol (2019), Saranya (2019) and Trivedi et al. (2021).

The findings from these studies have shown a different behavioural pattern of volatility in stock markets owing to the peculiarities of local stock markets and varying degrees of physical, social, economic, and political development. Chung, Fung & Shilling (2016) concluded that despite the huge studies; the relationship between the stock market and volatility is still subject to debate. Mitra, Iyer & Joseph (2015) examined the characteristics of volatility transmission in 10 international stock markets (Australia, Brazil, China, Egypt, China, Egypt, France, India, Israel, Japan, United Kingdom and United State). The primary aim of the study is to capture the spill-over effect of volatility during crisis and non-crisis economic periods. To achieve this, the study reviewed period spanned over 20yrs i.e. from January 1995 – December 2014 (total observation of 3,465); with data obtained from Bloomberg Database. Statistical evidence of spill-over volatility was observed during crisis and post-crisis economies and described the volatility pattern among the observed international stock markets to be non-random in nature.

Ghufran, Awan, Khakwani & Qureshi (2016) study addressed the causes of volatility in the Karachi stock exchange market of Pakistan. The study examined the volatility pattern of the KSE index and the prominent causes. The authors observed the clustered nature of the KSE index market volatility over the reviewed period. The authors identified the political situation and investors herd behaviour as the most prominent causes of volatility in the Pakistan stock market. Sehgal & Garg (2016) analysed the cross-sectional volatility of stock markets in the BRIICKS (Brazil, Russia, India, Indonesia, China, South Korea, and South Africa) economies. The study investigated the systematic and unsystematic variation in expected stock returns because of stock exposure to market volatility in the regions. The authors found that systematic volatility showed low stock returns in Brazil, South Korea, and Russia with a significant negative risk premium. While Unsystematic volatility exhibited high returns with negative risk premium in all the BRIICKS countries except China.

Olbrys & Majewska (2017) studied the largest European stock markets (the United Kingdom, France and Germany) to examine the asymmetry effects of market volatility. The authors employed EGARCH to analyse the log form of daily percentage changes in London FTSE100, Paris CAC40 and Frankfurt DAX stock indexes for the period of 2007 to February 2009. The study found statistical evidence of asymmetry volatility in the European stock markets, but the degree varies with time. The authors concluded that European stock markets were more responsive to bad news than good news.

In a more recent similar study, Hussain, Murthy & Singh (2019) reviewed over forty empirical studies to examine the issues surrounding the volatility of different stock markets across the globe. Some of the volatility issues assessed by the authors include heteroscedasticity, asymmetric effect, risk-return framework, spill-overs and forecasting accuracy. Parts of the major findings were the evidence of statistical weak interaction between conditional volatility and expected returns. The study noted the significant level of economic development as a determinant of systematic shock among stock market volatility.

Quoreshi, Uddin & Jienwatcharamongkhol (2019) expanded the scope of volatility assessment to cover the BRIICKS, the major stock markets including United States, United Kingdom, Euro Zone and others totalling 35 stock markets across the globe. The study assessed return volatility equity stocks with a major focus on unexpected events during the Eurozone crisis and global financial crises (GFC). The authors used fractionally integrated generalized autoregressive conditional heteroskedasticity (FIGARCH) and found that all the 35 sampled stock markets exhibited long memory in equity stock returns and statistical evidence of intensive contagious (volatility) but at varying degrees across stock markets.

2.2 Volatility of Property stocks Market

The real estate sub-sector of the stock market in developing economies including South Africa has received little attention and debate on volatility. Li (2012) posited that the incorporation of REIT components into the broader stock market has contributed to the exposure of property stock to varying degrees of volatility, attributable to structural changes in market fundamentals, portfolio adjustments and macroeconomic shock. In Australia, Lee (2010) evaluated the effect of volatility dynamics on REIT features with the primary aim to inform investors on the extent to which REITs react to market news. The study analysed the Australian stock index from 2004-2008 and discovered that REITs features showed a stronger reaction to negative news than positive news in the market. The author concluded that news emanated from the general stock market exhibited a strong influence on REIT features than that news originated from REIT stock.

The work of Li (2012) attempted to identify the effects of market and economic trading activities on equity REIT components such as dividend yield (DY) and return on average equity (ROAE) in the US capital market. The author analysed US-REITs data from 1995 to 2009 and found a higher impact of systematic risk of REIT return volatility in the bull (up) than the bear (down) market periods, but dividend yield and return on average equity were negatively affected. The findings corroborated by the work of Kawaguchi, Aadu & Shilling (2016). The authors investigated the implication of volatility on equity REIT stock amidst financial crisis in the US Stock market. The REIT data reviewed period were from October 1985 to October 2012; the study found a significant increase in average equity REIT returns volatility at pre-and-post Greenspan era due to the leverage effect that was trigger by wealth transfer (from equity to debt) and declining interest rate.

Fei, Ding & Deng (2010) analysed the dynamic nature of volatility among returns on REITs, stock and direct real estate asset classes. The authors documented the time-vary implication of volatility among the asset class. A strong relationship was noted between stock (S&P) and REITs; and the future return of equity REIT and the direct real estate. The authors noted that the dynamism in volatility is explained by macroeconomic indicators. The work of Chung, Fung, Shilling & Simmons-Mosley (2016) probed the relationship between REIT stock market volatility and expected returns. The author revealed that REIT volatility has a negative relationship with stock returns but exhibited a significant positive relationship with future expected returns. The authors revealed a trading potential in REIT implied volatility in the stock market.

In Africa, there is a dearth of empirical evidence on volatility dynamics and property stocks in the stock market, including the South-Africa property stock market and constituted a major gap in the literature. The few available studies focused on volatility in the general stock markets. For instance, Emenike & Aleke (2012), Emenike & Okwuchukwu, (2014) worked on volatility in the Nigeria stock exchange market, Ndwiga & Muriu (2016) and Owidi & Mugo-Waweru (2016) investigated the Nairobi securities exchange of Kenya. In the Johannesburg stock exchange of South Africa, Niyitegeka & Tewar (2013), Mashamba & Magweva (2019) documented stock market volatility. For instance, Uyaebo, Atoi & Usman (2015) explained that the South Africa stock market has high volatility while the volatility in Nigeria and Kenya is low. Therefore, study on property stock market volatility from the African context becomes imperative owing to the fragility of the market and the need for local and international investors to be informed when thinking of investing in the property stock market especially in South Africa.

2.3 South Africa Stock Market

South Africa stock market is one of the fastest developing markets and its property sector is the only globally reported on the Africa continent. Akinsomi, Kola, Ndlovu & Motloung (2015) reported that South Africa is the only African country that was represented in the FTSE EPRA/NAREIT and the S&P Global REIT indexes. Generally, stock markets in Africa are characterised to be fragmented and ill-operational efficiency (Ntim, 2012). Ncube & Mingiri (2015) posited that Africa stock markets have been witnessing improvement with the significant level in Egypt and South Africa. However, the strong performance of South Africa stock indicates its significant contribution and prominence in the Africa continent and global property stock market. Generally, the SA market is the only African market ranked among transparent markets in 2018 (Global Real Estate Transparent Index 2018).

By extension, SA property stock and listed property company share have recorded significant performance especially since the introduction of real estate investment trust; where PUL and PUT stocks were listed as REIT in 2013. SA REIT Association (2016) report showed that between 2014 and 2015, SA REIT capitalization rose by 43%; by the end of 2015, SA REIT capitalization was worth 340 billion in SA currency (Rand). As of 2016, nine SA REITs were listed among the 100 most empowered companies in the world. As reported by FTSE Russell (2017), SA-REITs worth 16.863USD, ranked 9th position and accounts for 1.74% of REIT global market share.

3. DATA AND METHOD

The study is econometric and relies solely on published secondary data. The study focussed on the South Africa stock market with a major concentration on property stock prices. Daily stock price data from January 2, 2008, to December 29, 2017, of twelve (12) quoted property companies out of the twenty-seven (27) listed on Johannesburg Stock Exchange (SA REIT Association, 2020). The property stocks were selected based on the quoted property companies that have sufficient published data on daily prices for the period under review. The data were obtained from the JSE published statistical bulletin. The study computed the average daily price of the selected (12) property stocks and was used as a proxy for the daily market price for the property stock market in the analysis. Their acronymns as used in the study are presented in Table 1.

Table 1: Data Description and Acronym

Listed REITs	Acronym
EMIRA Property Fund Ltd	EMIP
EQUITIES Property Fund	EQUP
FAIRVEST Property Holdings Ltd	FAVT
FORTRESS REIT Ltd	FORT
GROWTHPOINT Properties Ltd.	GRTP
HOSPITALITY Property Fund Ltd	HOSP
HYROP Investment Ltd	HYRP
INTU Property Plc	INTU
INVESTEC Australia Property	INTA
INVESTEC Property Fund Ltd	INTP
OCTODEC Investment Ltd	OCTD
RESILIENT REIT Ltd	RESR
JSE Property Sector	JSE_Prop

The study deployed mean, standard deviation, maximum and minimum analytical tools for descriptive statistics, Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS); Jarque-Bera, Breusch-Godfrey LM and Heteroskedasticity tests for unit root, normal distribution, autocorrelation, and ARCH effect tests respectively. The diversification benefits and modelling structure of SA-REIT market price volatility were analysed using correlation matrix and generalised autoregressive conditional heteroskedasticity (GARCH 1, 1) respectively.

3.1 Property Stock Price Volatility Index (VIX) Measurement- GARCH (1, 1) Approach

Measurement of the price volatility index (VIX) of stocks is fundamental to the underlying market information, trend pattern and prediction of future events in the capital market. Cavalcante & Assaf (2002), Mondher, Chaker & Ezzeddine (2005), Quoreshi, Uddin & Jienwatcharamongkhol (2019) and Quoreshi & Mollah (2019) noted that studies on stock volatility index are considered necessary in the estimation of capital asset pricing, portfolio and risk management including the formulation of the model to assess both the present and the future performance of the financial capital market. In an attempt to capture the volatility behaviour of stock prices, a number of studies have deployed different conditional variance models in different capital markets across the globe.

For instance, Fractionally Integrated Generalized Autoregressive Conditional Heteroskedasticity (FIGARCH) was adapted to measure VIX in Tunisian Stock Market (Chung, 1999) and the UK, US and BRICS countries (Quoreshi & Mollah, 2019). Quoreshi, Uddin, & Jienwatcharamongkhol (2019) deployed Fractionally Integrated Moving Average Conditional Heteroskedasticity (FIMACH) to document VIX in US, UK, Euro Zone and BRICS (Brazil, Russia, India, China and South Africa) stock markets. In the Pakistan stock market, Ghufran, Awan, Khakwani & Qureshi (2016) employed Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH). Similar, Mitra, Iyer, and Joseph (2015) used the same VIX model (i.e., EGARCH) to analyse stock markets across Australia, Brazil, China, Egypt, France, India, Israel, Japan, United Kingdom and the United States.

The use of Generalized Autoregressive Conditional Heteroskedasticity (GACH) is another VIX model that has increasingly gained the attention of researchers in recent times. The model was introduced in the mid-1980s by an economist Bollerslev Tim (Bollerslev & Mikkelsen, 1996) to redress the limitation of predictability power of ARCH parameters to explain the dynamic structure of real-time financial capital condition. Adeniji (2016) posited that the popularity and the widespread usage of the GARCH model are attributable to the ability of the model to provide a solution to the problem of finding cluster volatility in financial market, thicker tail stock price distribution pattern and aid the prediction of volatility using past information of the stock price. Also, Bera & Higgins (1993), Floros (2008) and Ghufran, Awan, Khakwani & Qureshi (2016) concluded that the GARCH model is characterised with good predictability power and gives significant results.

3.2 Descriptive Statistics

A descriptive statistical model is used to explain the characteristics of the property stock prices over the study period (i.e., 2008-2017). The statistical descriptive tools include the mean, standard deviation, minimum and maximum statistics. The mean–standard deviation model is use to obtain the average prices for individual and the market property stock. The minimum and maximum statistics help to reveal the highest and lowest property stock prices for the study period.

3.2.1 Unit Root Test

The nature of stationary of a data series over the observed period is very key to the reliability and validity of the result of any econometrics analytical models. The presence of unit root in a series signifies that the data is non-stationary and not fit for the model and vice-versa. Thus, in an attempt to know the stationarity nature characterised with the price of the property stock over the study period, the study deployed Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test. For ADF unit root test, the null hypothesis of the presence of unit root is rejected in favour of the stationary of data series when the p-value of the t-stats is significant ($p<.05$), while in the KPSS test, the data is said to be stationary when the calculated t-stats is less than any of KPSS critical vale at 1, 5 and 10%. The ADF and KPSS models are mathematically expressed in eqn. (i) and (ii).

Augmented Dickey-Fuller (ADF) test

$$\triangle y_t = \alpha y_{t-1} + x_t \delta + \epsilon_t \quad \text{------------------ (i)}$$

The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test

$$y_t = x_t \delta + u_t \text{ -------------------- (ii)}$$

3.3 Residual Diagnostics Test

Residual diagnostics test is a prerequisite test conducted to verify the appropriateness of the time-varying data for GARCH analysis. The test ascertains three things. First, if the residual estimate of the series is characterised with autocorrelation i.e., the previous days' estimates influence today's estimates. Second, if there is the presence of ARCH effect in the residual estimate of the series i.e. whether the series exhibit clustering volatility and move in a non-linear pattern and; Third if the series is normally distributed over the study period. Therefore, for the series to be fit for GARCH analysis, there must be evidenced of the ARCH effect and autocorrelation in the series over the study period.

Autocorrelation test: This test shows if the residual estimate of market prices of property stock is autocorrelation in nature i.e. the current day price ($\boldsymbol{u_t}$) is influenced by the previous days' price of property stock ($\boldsymbol{u_{t-1}}$). The autocorrelation test is conducted by using the Breusch-Godfrey LM test Autocorrelation Test. The test is computed mathematically as expressed in eqn. (iii).

$$u_t = \rho u_{t-1} + \epsilon_t - - - - - - - - - - -(iii)$$

The null hypothesis of *no serial correlation* is rejected if the p-value is less than 5% confidence level ($p<0.05$).

ARCH effect test: The study employed Heteroskedasticity Test to verify if the market price of the property stock exhibited a clustering volatility pattern, move randomly and in a non-linear pattern (ARCH effect). The ARCH effect test is computed mathematically as shown in the eqn. (iv).

$$e_t^2 = \beta_0 + \left(\sum_{\delta=1}^{q} \beta_\delta \; e_{t-\delta}^2\right) + v_t \qquad \text{---------- (iv)}$$

The null hypothesis of *no ARCH effect* is rejected if the p-value of the series is less than 5% confidence level ($p<0.05$).

Where e_t^2 is the squared residual up to order of lag *q.*

A normality test: To ascertain the pattern of normal distribution characteristics of the residue series for the period under review, the study deployed the Jarque-Bera test. The acceptance rule for a normal distribution data series of Jarque-Bera statistics states that series exhibit a normal distribution if the calculated JB value is less than or equal to the critical value of 5.99 (JB Cal. V≤5.99). Jarque-Bera test is mathematically express as thus in eqn. (v);

$$\mathrm{T}[SK^2/6 \;\; + (KUT-3)^2/24] \qquad - - - - - - - - (v)$$

Where SK- Skewness and KUT –Kurtosis

3.4 Generalised Autoregressive Conditional Heteroskedasticity (GARCH 1, 1)

GARCH (1, 1) model is specifically developed to perform two major functions i.e. to model volatility and to forecast the future occurrences in the stock market. The model analysis returns two results: the conditional mean equation and conditional variance (volatility) equation in a VAR environment. The conditional mean equation is synonymous with the autoregression analysis modelled after the ARIMA process, while the conditional variance equation (heteroscedastic error term) measures the volatility index (VIX). Thus, the (1, 1) GARCH specification indicates the presence of the ARCH term and GARCH term at the first order of lag length (ARCH 1 and GARCH 1). In a simple term, GARCH (1, 1) is mathematically expressed in equations (vi) and (vii).

Condition Mean Equation (eqn. vi)

$$Y_t = X_t\theta' + \in_t \qquad \text{------------------------- (vi)}$$

Condition Variance Equation (eqn. vii)

$$\sigma_t^2 = \omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad \text{------------------- (vii)}$$

From the GARCH (1, 1), the conditional variance equation (volatility) specification could be explained as thus

i). σ_t^2 is current day/today's volatility

ii) $\boldsymbol{\omega}$ is the constant term

iii). $\boldsymbol{\alpha\epsilon_{t-1}^2}$ - ARCH term: previous day's information about volatility with coefficient $\boldsymbol{\alpha}$

iv) $\boldsymbol{\beta\sigma_{t-1}^2}$ **–** GACH term: Previous day's residual volatility or forecast variance with coefficient $\boldsymbol{\beta}$

iv) Significant p-value at 5% confidence level ($p \leq .05$) indicate the statistically significant effect of the GARCH (1, 1) effects on the series at period t ($\boldsymbol{Y_t}$)

Therefore, in this study, σ_t^2 is the information on today's volatility of the market price of the property stock, $\boldsymbol{\alpha \neq 0}$ is the co-efficient of previous days' information about the stock market price volatility $\boldsymbol{\epsilon_{t-1}^2}$ while $\boldsymbol{\beta \neq 0}$ is the co-efficient of previous days' information about the market price variance or volatility $\boldsymbol{\sigma_{t-1}^2}$

4. RESULT AND DISCUSSION

4.1 Summary of Descriptive Statistics

Table 2 presents the summary of descriptive statistics such as mean, standard deviation, maximum and minimum analyses of the price of the listed property stocks on the JSE stock market for the year under review (2008-2017). Property stocks with an average stock price above 5,000Rands were HYPR (7583.51Rands); RESR (6204.58Rands) and INTU (5930.38Rands). This category of the stocks was also characterised with a high level of risk as reported by their corresponding standard deviation. For instance, the risk level recorded in the price of RESR is 3949.27 and the price varies from 1730.00 to 15,116.00Rands having a range value (difference) of 13,386Rands. HYRP has a standard deviation of 3076 and the price swings between 3,080.46 and 14,143.00Rands having a difference of 11,062.54Rands of range. This result implies that the price of the two property stocks experienced turbulence over the reviewed period but at varying levels i.e., the prices of RESR stock experienced rapid fluctuation over a longer period compared to HYRP and made the stock price of RESR to be more risk-prone than HYRP in the property stock market. Other categories of the property stocks with average price and standard deviation such as HOSP (2,686.99Rands; 1968.66), GRTP (2,108Rands; 517.67), OCTD (1,899.56Rands; 401.14), INTP (1,469.06Rands; 194.37), FORT (1,428.30; 234.73), EQUP (1,417.07Rands; 295.69), INTA (1,242.90Rands; 122.06) were traded at price above 1,000.00Rands, with relatively lower risk over the study period. FAVT stock recorded the lowest average price of 134.04Rands, the standard deviation of 34.58 and the prices vary from 70.00 to 225.00Rands. This result (for FAVT) could be attributed to many reasons including low volume of the stock being traded, low patronage and relatively low returns compared to its contemporaries in the market.

However, the estimation of the general market (JES_Pr) i.e., the mean, stand deviation and price range shows that the average price of traded property stock stood at 2,957.31Rands, risk level (standard deviation) of 544.51 and the market prices range from the least price of 2,035 to the highest price of 4,868.57. The study observed that HYPR (7583.51Rands; 3076.00); RESR (6204.58Rands; 3949.27) and INTU (5930.38Rands; 2649.69) enjoyed higher prices above market price (2,957.31), but their prices were highly risk-prone. HOSP stock price (2,686.99) is lesser than the market stock price but has a higher level of risk than the market risk. The associated higher risk level may be due to the influence of the stock-specific characteristics on the stock pricing. In summary, the price of the listed property stock exhibited fluctuations over the reviewed period as indicated by the standard deviation and range analyses. This result signals the likelihood of the presence of price volatility (either short or prolong or a combination of both) in the property stock.

Table 2: Summary of Descriptive Statistics of Property Stock Price on Johannesburg Stock Exchange (JSE) Market

Property Stocks	**Descriptive Statistics**				
	Mean	**Std. Dev.**	**Max.**	**Min.**	
EMIP	1342.64	223.54	1949.00	806.00	
EQUP	1417.07	295.69	2205.00	1030.00	
FAVT	134.04	34.58	225.00	70.00	
FORT	1428.30	234.73	1858.00	940.00	
GRTP	2108.34	517.67	3049.00	1090.00	
HOSP	2686.99	1968.66	7858.00	595.00	
HYRP	7583.51	3076.46	14143.00	3080.46	
INTU	5930.38	2649.69	16039.00	3460.00	
INTA	1242.90	122.06	1543.00	1021.00	
INTP	1469.06	194.37	1879.00	1010.00	
OCTD	1899.56	401.14	2852.00	1000.00	
RESR	6204.58	3949.27	15116.00	1730.00	
JSE_Prop	***2957.31***	***544.51***	***4868.57***	***2035.91***	

Note: Standard Deviation (S.D), Maximum (Max.), Minimum (Min.)

4.2 Correlation Analysis to Measure Diversification Benefits

The study conducted a correlation analysis of the property stocks to examine their level of diversification benefits in the property stock market and the result were presented in Table 3. According to Modern Portfolio Theory, Markowitz (1952) expressed that a negative correlation coefficient above 70% (>-0.70) indicate strong and 30% and below means weak diversification relationship. As indicated in Table 4.2, a strong negative correlation coefficient was observed between paired property stock: EQUP-INTU (-0.809). Paired property stock of EMIP-HOSP (-0.685), FORT-INTU (-0.676), EMIP-EQUP (-0.648) and EMIP-INTA (-0.632) showed a moderate correlation relationship, while a very weak correlation coefficient was observed between paired property stock price of AVGP-EMIP (-0.071), EMIP-FAVT (-0.068), and FORT-OCTD (-0.011). This result signals good diversification benefits especially between EQUP and INTU stocks. This means that the price of the two stocks moves in the opposite direction i.e., the rise/fall in the price of EQUP stock is strongly associated with the fall/rise in INTU stock. Therefore the investor can leverage it as a risk hedge when combined pairing property stock to achieving optimal diversification benefits in the asset. However, the correlation coefficient with positive sign showed poor diversification indicating a non-paring diversification relationship because both prices moved in the same direction.

Table 3: Correlation Analysis to Measure the Diversification benefits among the property Stocks in the market

	EMIP	**EQUP**	**FAVT**	**FORT**	**GRTP**	**HOSP**	**HYRP**	**INTA**	**INTP**	**INTU**	**OCTD**	**RESR**
EMIP	1											
EQUP	-0.648	1										
FAVT	-0.068	0.659	1									
FORT	-0.268	0.653	0.470	1								
GRTP	0.509	-0.135	0.298	0.336	1							
HOSP	-0.685	0.354	-0.041	0.322	-0.339	1						
HYRP	0.030	0.337	0.467	0.195	0.290	-0.209	1					
INTA	-0.632	0.543	0.136	0.134	-0.342	0.261	0.465	1				
INTP	0.443	0.080	0.524	0.427	0.748	-0.310	0.227	-0.353	1			
INTU	0.747	-0.809	-0.463	-0.676	0.025	-0.551	-0.099	-0.437	-0.140	1		
OCTD	0.702	-0.323	0.300	-0.011	0.591	-0.396	0.355	-0.329	0.555	0.390	1	
RESR	-0.373	0.721	0.482	0.291	-0.170	0.002	0.654	0.662	-0.163	-0.326	-0.172	1

4.3 Unit Root Test for the Stationary of the Data Series

In Table 4, the study investigated the stationary status (unit root) of the data series as a pre-conditional test for time series data. Two different unit root tests i.e., Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) were conducted at a 5% level of significance. The results of the tests are to complement one another to substantiate the stationary status of the data series. As shown in the Table, the ADF test rejected the null hypothesis of the presence of unit root in favour of stationarity of the data i.e. the p-value in all cases were greater than 5% significant level (p>0.05) at the first order of lag I(1) for the listed property stocks. The complementary KPSS test exhibited a similar result. The calculated t-stat values of all the listed property stocks were lower than the critical value (CV) at 5% indicating no unit root in the series. The rejection of the presence of the unit root test by KPSS further ascertained the stationarity of the data series over the study period, suggesting that the data series are fit and suitable for model estimation in a VAR environment.

Table 4: Unit Root Tests of the Listed Property Stock Price

Property Stock	Augmented Dickey-Fuller					Kwiatkowski-Phillips-Schmidt-Shin			
	I(0)		I(1)			I(1)			
	t-stat	Sig	t-stat	Sig		1%	5%	10%	t-stat
EMIP	-2.1617	0.2207	-50.0832	0.0001		0.7390	0.4630	0.3470	0.0756
EQUP	-0.0584	0.9518	-35.3734	0.0000		0.7390	0.4630	0.3470	0.1667
FAVT	-1.5437	0.5113	-23.269	0.0000		0.7390	0.4630	0.3470	0.0274
FORT	-1.4816	0.5430	-38.5552	0.0000		0.7390	0.4630	0.3470	0.0266
GRTP	-1.2159	0.6698	-52.8970	0.0001		0.7390	0.4630	0.3470	0.0474
HOSP	-2.3516	0.1559	-39.6324	0.0000		0.7390	0.4630	0.3470	0.2744
HYRP	-0.5915	0.8701	-32.4577	0.0000		0.7390	0.4630	0.3470	0.0601
INTU	-3.3776	0.0119	-48.3953	0.0001		0.7390	0.4630	0.3470	0.4372
INTA	-2.3052	0.1705	-26.2878	0.0000		0.7390	0.4630	0.3470	0.3394
INTP	-1.6616	0.4507	-35.3525	0.0000		0.7390	0.4630	0.3470	0.0944
OCTD	-2.0857	0.2506	-33.4328	0.0000		0.7390	0.4630	0.3470	0.0702
RESR	1.0635	0.9973	-52.8210	0.0001		0.7390	0.4630	0.3470	0.3905

4.4 Residual Diagnostics Tests of Series for GARCH (1, 1) Model

The suitability of the data series for computing the GARCH model is of utmost concern in this type of study. To ascertain this, the study conducted residual diagnostics tests such as autocorrelation, heteroskedasticity, and normality tests to verify the presence of ARCH effects which are the preconditioned requirement for computing the GARCH model. The results of the residual diagnostic tests were presented in Table 5. The results of the tests showed that the price of the selected property stocks was strongly characterised with ARCH effects as reported by the p-value of the observed R-square (Obs*R-squared) of the Lagrangian multiplier (LM) autocorrelation and heteroskedasticity tests ($p>0.05$). The result of the ARCH effect characterised with the price of the property stocks indicates that the residual of the series exhibited an irregular pattern of variance, clustering prices volatility nature of the property stocks and the variance of the series error term moved in a non-linear pattern. However, the result of randomness in the variance of series error term further suggest the appropriateness of the GARCH model for estimating and modelling the price volatility in the property stock market. However, the Jarque-Bera test on a normal distribution of the property stock price for the reviewed period reports the non-linear distribution of the property stock price as indicated by the significant p-value ($p<0.05$). The non-conformity of time series data with normal distribution is expected since the distribution of the time-varying series is characterised by clustering of price and random movement.

Table 5: Residual Diagnostics Tests

Property Stock	Breusch-Godfrey LM Test: Autocorrelation Test		Heteroskedasticity Test ARCH Effect		Jarque-Bera Normality Test	
	Obs*R-squared	Prob.	Obs*R-squared	Prob.	Coefficient	Prob.
EMIP	2480.77	0.0000	2453.68	0.0000	10200.11	0.0000
EQUP	878.95	0.0000	873.00	0.0000	11169.01	0.0000
FAVT	2465.87	0.0000	2385.85	0.0000	22657.43	0.0000
FORT	2030.44	0.0000	2017.41	0.0000	11135.38	0.0000
GRTP	2489.89	0.0000	2450.23	0.0000	3961.42	0.0000
HOSP	2489.51	0.0000	2478.93	0.0000	84248.8	0.0000

HYRP	2494.17	0.0000	2469.08	0.0000	6521.463	0.0000
INTU	2480.98	0.0000	2480.32	0.0000	40296.01	0.0000
INTA	886.51	0.0000	107.18	0.0000	9047.894	0.0000
INTP	1639.71	0.0000	1616.59	0.0000	142724.4	0.0000
OCTD	2472.36	0.0000	2374.88	0.0000	35639.40	0.0000
RESR	2496.42	0.0000	2484.69	0.0000	2317.154	0.0000

4.5 Volatility of Market Price of Property Stock on JSE

Having verified and ascertained the fitness and suitability of the selected property stocks to model the volatility of market price on JES, the study computed the average price of the selected property stocks as a proxy for the market price of the property stocks and analysed the volatility of residual error term of the market price by GARCH (1, 1). The result of the analysis is presented in graphical illustrations (Fig 1&2). The value on the x-axis measures days of trading activities of property stock on JSE (January 2, 2008, to December 29, 2017, i.e., 2,499 observations). The daily trading price (excluding Saturdays and Sundays) have an interval of 100unit, starting from trading day 1 in 2008 to the last trading day in 2017; meaning that year 2008 represent 0, the year 2009 represents 100, the year 2010 represents 200 ditto to others up to 2016 and 2017 representing 800 and 900 unit respectively on the graph. The y-axis calibrated the fluctuations in the market price of property stocks through positive and negative swings especially for the volatility index (VIX) in the residual error term of the series (Fig.2). For the lines on the graph, the actual line (red) represents the trend in the market prices (i.e., movement of price in property stocks market), the fitted line (green) measures trend in the conditional mean-variance while the residue line (blue) measures trend in the conditional variance (volatility) in the residual (error terms) of the series.

However, to better understand the trend in volatility pattern of the price of property stock market, the study computed the residual estimates (volatility) of the series and the analysis was presented in Fig. 2.

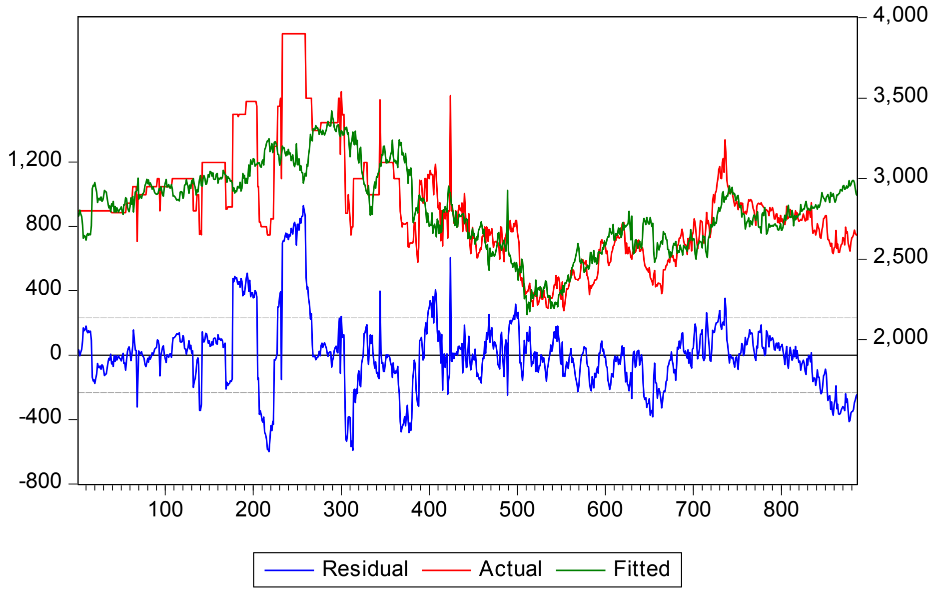

Figure 1: Actual, Fitted and Residual Estimates of the Data

As empirically evidenced from the graphical illustration in Fig. 2, the market price of property stocks on JES experienced turbulence as the price swings up and down frequently over the study period in a mixed pattern (i.e., high, and low level of volatility). The volatility of the market price started low from 2008 till the end of 2010. Prolong high volatility set in; as the market price began to experience high fluctuations between 2010 and 2012 with the noticeable high volatility occurrence between 2010 and 2011. Sharp fluctuations of market price were also recorded from 2011 to early 2012but at a relatively lower rate compared to high occurrences in previous years. Thereafter, the market price began to experience prolong low volatility especially from mid-2013 to late 2017. By implications, it means that the market price of property stock on JSE experienced both low and high prolonged volatility. The up and down swings of market price signal the reactions of property stock investors/breakers to the sentiment, technical, fundamental, news/pronouncement and sentiment in the stock market. However, the high level of volatility in the market price of property stock sends caution of high risk-prone of investment in property stocks in the volatile trading period.

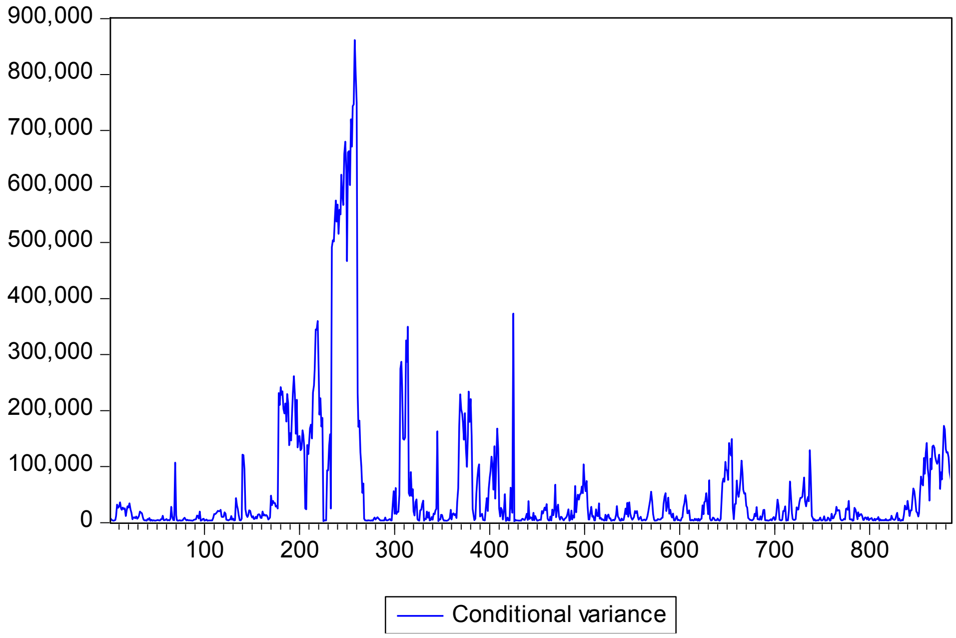

Figure 2: Market Price Volatility of Property Stock

However, evidence of volatility in property stock price on JSE market aligns with extant studies who have identified volatility patterns characterised with general property stock market and by extension property stock in different countries: For example, in Australia (Lee, 2010), India (Ramanathan & Gopalakrishnan, 2013; Ghufran, Awan, Khakwani & Qureshi, 2016; Saranya, 2019). European stock markets i.e., United Kingdom, France, Germany and BRIICKS regions (Sehgal & Garg, 2016; Majewska, 2017; Kawaguchi, Aadu & Shilling, 2016; Quoreshi, Uddin & Jienwatcharamongkhol, 2019). Local studies including Uyaebo, Atoi & Usman (2015), Ndwiga & Muriu (2016) and Mashamba & Magweva (2019) have documented the evidence of volatility in Nigeria, Kenya, and South Africa general stock exchange market. On the attributable causes, Ramanthan & Gopalakrishan (2013), Mamtha & Srinivasan (2016), Ghufran, Awan, Khakwani and Qureshi (2016) noted the prominent effect of stock-specific information, public information, economic indicators such as inflation, interest and exchange rates being the prominent, market strength i.e. size, volume traded and peers, herd behaviour and market sentiment, demand-supply interplay, speculations and uncertainty of the future prices on stock price volatility but at varying degree across countries.

4.5 Price Volatility Model of Property Stock Market on JES

In Table 6, the study modelled the volatility pattern of the market price using GARCH (1, 1) analysis at first-order lag and 5% level of significant specifications. The result of the analysis showed that the resid (-1) and the GARCH (-1) has a p-value of 0.000 and 0.0085 respectively which are less than a 5% level of confidence ($p<0.05$). The result of the positive and significant ($p<0.05$) of the ARCH term (resid) and GARCH evidenced the significant effects of information on historic market price and variance on the property stock market volatility. The resid (-1) which represents the ARCH effect is the previous day's market price information about volatility while the GARCH (-1) reports the previous day's residual volatility in the property stock (*see eqn. viii*). This means that both the previous day's information of the market price and the associated risk (variance) has a significant influence on the property stock market.

By implication, it means that investment in property stock on JSE is driven by good news rather than negative shock. The result is on one hand in agreement with some extent literature; while on the other hand, it opposed the findings of other studies reported in different property stock markets. This study corroborates with the findings of Gopal, Mahalakshmi & Thiyagaraja (2019) that document the direct positive influence of volatility on future price stock in the New York Stock Exchange (NSE) market. But contradict the findings of Chung, Fung, Shilling & Simmons-Mosley (2016), Sehgal & Garg (2016), Olbrys & Majewska (2017) and Mamtha & Srinivasan (2016) that reported the faster response of investors to bad news than the good news in the general stock market. However, Simmons-Mosley (2016) reported a negative relationship between REIT volatility and stock returns.

Tabel 6: Price Volatility Model of Property Stock Market on JES

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	285.5508	59.46454	4.802036	0.0000
RESID(-1)^2	0.873473	0.120069	7.274757	0.0000
GARCH(-1)	0.144308	0.054805	2.633130	0.0085

Dependent variable market price residue (H_t), Significant level at 5%

$$JES_{Vol} = 285.55 + 0.87\epsilon_{t-1}^2 + 0.144\sigma_{t-1}^2$$ ------------------ *eqn. (viii)*

5. CONCLUSION AND RECOMMENDATIONS

The study examined the volatility pattern characterised by the daily market price of property stock on the Johannesburg Stock Exchange (JSE). This was done to document and modelling the volatility pattern of the daily price of the property stock market. The study analysed the 10years (January 2, 2008 to December 29, 2017) daily price of property stock which was obtained from JSE published statistical bulletin using the GARCH (1, 1) model. The study computed the average daily price of the selected (12) property stocks and was used as a proxy for daily market price in the analysis. The result of the analysis showed the daily market price of property stock is characterised by autocorrelation and ARCH effects, but the series was not normally distributed over the study period. The study documents the evidence of volatility in the daily market price of the property stock characterised with prolonging high and low clustering patterns. The GARCH model reported the significant effect of period days information of both the stock market prices and the volatility on the current day market price volatility. By implication, it suggests that investors of property stock react more to good news than bad news when considering the option of investing in listed property company stocks on the Johannesburg Stock Exchange market. This result signals the reactions of investors to the property stock market and provides a caution for the financial/investment analysts, regulatory bodies and policymakers on risk conditions and management of the market.

REFERENCES

Abbas, Q., Khan, S. and Shah, S. Z. A. (2013). Volatility transmission in regional Asian stock markets. *Emerging Markets Review*, 16(3): 66–77.

Abdalla, S.Z.S. and Winker, P., (2012). Modelling stock market volatility using univariate GARCH models: evidence from Sudan and Egypt *International Journal of Economics and Finance* 4(8), 161–176.

Abken, P. A. and Nandi, S. (1996). Options and volatility. *Economic Review,* 21-35.

Adeniji S. O. (2016). An empirical investigation of the relationship between stock market prices volatility and macroeconomic variables' volatility in Nigeria. *European Journal of Academic Essays,* 2(11): 1-12.

Akinsomi, O., Kola, K., Ndlovu, T. and Motloung, M. (2016). The performance of the broad based black economic empowerment compliant listed property firms in South Africa. *Journal of Property Investment and Finance,* 34(1): 3-26.

Aliyu, S.U.R., (2011). Does inflation have an impact on stock returns and volatility? Evidence from Nigeria and Ghana. *Applied Financial Economics,* 22(6): 427–435.

Amita, B. (2004). *Stock return volatility patterns in India.* India Council for Research on International Economic Relations. India Habitat Centre, New Delhi.

Asteriou, D. and Begiazi, K. (2013). Modelling of daily REIT returns and volatility. *Journal of property Investment and Finance,* 31(6): 589-601.

Bera, A. K., and Higgins, M. L. (1993). ARCH models: properties, estimation and testing. *Journal of Economic Survey*, 7: 305-362.

Bhowmik, D. (2013). Stock market volatility: an evaluation. *International Journal of Scientific and Research Publications,* 3(10): 1-18.

Bollerslev T. and Mikkelsen, O. H. (1996). Modeling and pricing long memory in stock market volatility. *Journal of Econometrics* 73: 151-184.

Coffie, W., (2015). Measuring volatility persistence and risk in southern and east African stock markets. *International Journal of Economics and Business Research,* 9(1): 23–36.

Choi, Ki-Hong, C., Zhu-Hua J., Kang,S. H, and Seong-Min, Y. (2012). Relationship between trading volume and asymmetric volatility in the Korean stock market. *Modern Economy*, 3: 584-589.

Chung, R., Fung, S., Shilling, D. J. and Simmons–Mosley, X. T. (2016). REIT stock market volatility and expected returns. *Real Estate Economics,* 1–28.

Dimitrios, D., and Theodore, S. (2011). The relationship between stock returns and volatility in the seventeen largest international stock markets: a semi-parametric approach. *Modern Economy*, 2(1): 1–8.

Emenike, K. O. and Aleke, S.F., (2012). Modeling asymmetric volatility in the Nigerian stock exchange. *European Journal of Business and Management,* 4(12): 52–59.

Emenike, K. O. and Okwuchukwu, O. (2014). Stock market return volatility and macroeconomic variables in Nigeria. *International Journal of Empirical Finance*, 2(2): 75 – 82.

Engle, R. F. and Rangel, J. G. (2008) The Spline-GARCH Model for Low-Frequency Volatility and Its Global Macroeconomic Causes. *Review of Financial Studies*, 21(3), 1187-1222.

Fei, P., Ding, L. and Deng, Y. (2010). *Correlation and volatility dynamics in REIT returns: performance and portfolio considerations.* IRES Working Paper Series IRES2010-002

Floros, C. (2008). Modelling volatility using GARCH models: evidence from Egypt and Israel. *Middle Eastern Finance and Economics*, 2: 31-41.

Ghufran B., Awan, M. H, Khakwani, K. A, and Qureshi A. M. (2016). What causes stock market volatility in Pakistan? Evidence from the field. *Economics Research International*, 1-9.

Global Real Estate Transparent Index (2018). *Transparency: Data, disclosure and disruption*. Jones Lang LaSalle, LaSalle Investment Management. www.jll.com.

Gopal, N., Mahalakshmi, S., and Thiyagarajan S. (2019). The consequence of volatility index on stock market returns. *Journal of Stock and Forex Trading Research* 7(1): 1-6.

Gospodinov, N., and Jamali, I., (2014) The response of stock market volatility to futures-based measures of monetary policy shocks. *International Review of Economics and Finance*, http://dx.doi.org/10.1016/j.iref.2014.11.001.

Hanousek, J., Kocenda, E., and Kutan, A. M., (2008). *The reaction of asset prices to macroeconomic announcements in new EU markets: evidence from intraday data.* CERGE-EI, Czech Republic. http://ssrn.com/abstract=1113089.

Haritha P. H. and Rishad, A. (2020). An empirical examination of investor sentiment and stock market volatility: evidence from India. *Financial Innovation* 6(34) 1-15 https://doi.org/10.1186/s40854-020-00198-x.

Higgins, D. and Ng, B. (2009). Australian securitised property funds: an examination of their risk-adjusted performance. *Journal of Property Investment and Finance,* 27(4) 404-412.

Hussain, S, Murthy, K. V. B. and Singh, A. K. (2019). Stock market volatility: a review of the empirical literature. *Journal of Management,* 7(1): 96-105.

Issam, C., Achraf, G. and Boujelbene, Y. (2013). Volatility spillover and channels transmission during subprime crisis: empirical study of USA stock market and other developed stock markets. *Journal of Applied Economic Sciences*, 1: 7-21.

Jorge, C. and Assaf, A. (2002). *Long range dependence in the returns and volatility of the Brazilian stock market.* Working paper Rio de Janeiro, Banco Nacional do Desenvolvimiento.

Joulin, A., Lefevre, A., Grunberg, D., and Bouchaud, J. P. (2008). *Stock price jumps: news and volume play a minor role.* http://arxiv.org/abs/0803.1769.

Kawaguchi, Y., Sa-Aadu, J., Shilling, D. J. (2016). REIT stock price volatility and the effects of leverage. *Real Estate Economics,* 1-38.

Lahaye, J., Laurent, S., and Neely, C. J. (2009). Jumps, cojumps and macro announcements. *Journal of Applied Econometric*, 26(6): 1-33.

Lee, L.C. (2010). *An examination of volatility dynamics in Australian REIT futures* [Paper presentation]. The 16th Pacific Rim Real Estate Society Conference, Wellington, New Zealand, 24th-27th January 1- 42.

Lee, C. L. and Hwa, T. K. (2008). *Securitised real estate in a mixed-asset portfolio: the case of Malaysia* [Paper presentation]. The 14th Pacific Rim Real Estate Society Conference, Kuala Lumpur, Malaysia, 21-23 January.

Li, L. (2012), *The determinants of REIT volatility Graaskamp Centre for real estate.* Wisconsin School of Business, University of Wisconsin- Madison, 975 University Avenue Madison, WI 53706.

Li, Y. and Giles, D. E. (2015). Modelling volatility spillover effects between developed stock markets and Asian emerging stock markets. *International Journal of Finance and Economics*, 20: 155-177.

Manabu, A. and Unite, A. (2008). The relationship between stock return volatility and trading volume: the case of the Philippines. *Applied Financial Economics*, 18(16): 1333-1341

Mashamba, T. and Magweva, R., (2019). Dynamic volatility behaviour of stock markets in southern Africa. *Journal of Economic and Financial Sciences* 12(1): 396.

Melo-Velandia, F. (2017). Stock market volatility spill-overs: evidence for Latin America. *Finance Research Letters* 20: 207–16.

Mitra, A., Iyer,V and Joseph, A. (2015). Characterizing the volatility transmission across international stock markets. *Theoretical Economics Letters,* 5: 571-583.

NAREIT (2020). *Economic contribution of REITs in the United States in 2018*. EY Building a better working world. National Association of Real Estate Investment Trusts, United States of America http://www.reit.com.

NAREIT (2016). *Global real estate investing*. National Association of Real Estate Investment Trusts, United States of America. http://www.reit.com.

Ndwiga, D. and Muriu, P.W. (2016). Stock returns and volatility in an emerging equity market. Evidence from Kenya. *European Scientific Journal,* 12(4): 79–98.

Ncube, G. and Mingiri, F. K. (2015). Stock market integration in Africa: the case of the Johannesburg stock exchange and selected African countries. *International Business and Economics Research Journal,* 14(2): 367-386.

Newell, G., and Peng, H. (2012). The significance and performance of Japan REITs in a mixed-asset portfolio*. Pacific Rim Property Research Journal,* 18(1): 21-34.

Niyitegeka, O. and Tewar, D. D., (2013). Volatility clustering at the Johannesburg stock exchange: investigation and analysis. *Mediterranean Journal of Social Sciences,* 4(14): 621–626.

Ntim, C. G. (2012). Why African stock markets should formally harmonise and integrate their operations. *African Review of Economics and Finance,* 4 (1): 1-18.

Ogum, G., Beer, F. and Nouyrigat, G. (2005). Emerging equity market volatility: an empirical investigation of markets in Kenya and Nigeria. *Journal of African Business,* 6(2): 139–154.

Mamtha, D. and Srinivasan, S. K. (2016). Stock market volatility: conceptual perspective through literature survey. *Mediterranean Journal of Social Sciences,* 7(1): 208-212 Doi:10.5901/mjss.2016.v7n1p208.

Okonkwo, J. J. (2019). Volatility of stock return and selected macroeconomic variables: evidence from Nigeria Stock Exchange. *International Journal of Academic Research in Business and Social Sciences*, 9(6): 185–201.

Olaleye, A A, and Ekemode, B. (2014). Integration between real estate equity and non-real estate equity. *Journal Property Investment and Finance,* 32(3): 244-255.

Olbrys, J. and Majewska, E. (2017). Asymmetry effects in volatility on the EGARCH based approach. *Quantitative Finance and Economics,* 1(4): 411-427.

Owidi, O.H. and Mugo-Waweru, F., (2016), Analysis of asymmetric and persistence in stock return volatility in the Nairobi securities exchange market phases. *Journal of Finance and Economics,* 4(3): 63–73.

Quoreshi, S., A. M. M., Uddin, R. and Jienwatcharamongkhol, V. (2019). Equity market contagion in return volatility during Euro Zone and global financial crises: evidence from FIMACH model. *Journal of Risk and Financial Management,* 12(94): 1-8.

Ramanathan and Gopalakrishnan (2013). Volatility in Indian stock market: a study of post and pre-recession period. *Namex International Journal of Management Research* 3(1): 2250-20076.

SA REIT Association (2016). *Real estate investment trusts (REITS) shine among the JSE's most empowered companies*. http://www.sareit.com/news-302.php.

Samanta, G. P. (2010). *Stock market return, volatility and future output growth: some observations relating to Indian economy*. Assistant Advisor, NSE.

Saranya P. B. (2019). Impact and the relationship between volatility index on select equity index: an analysis. *Asian Journal of Research in Social Sciences and Humanities,* 9(5): 13-21.

Sehgal, S. and Garg, V. (2016). Cross-sectional volatility and stock returns: evidence for emerging markets*. The Journal for Decision Makers,* 41(3): 234–246.

Shegal, S. Garg, V. and Deisting, F. (2012). Relationship between cross-sectional volatility and stock returns: evidence from India. *International Management and Financial Innovation*: 9(2): 90-99.

Shiller, J. R. (1990). Market volatility and investor behaviour. *The American Economic Review,* 80(2): 58-62.

Trivedi, J. Afjal, M., Spulbar, C, Birau, R, Inumula, M. K. and Pradhan, S. (2021) Modeling emerging stock market volatility using asymmetric GARCH family models: An empirical case study for BSE Ltd. (formerly known as Bombay Stock Exchange) of India, *Revista de Științe Politice. Revue des Sciences Politiques*, 70(2021) 167 – 176.

Uyaebo, O. S., Atoi, N. V. and Usman, F. (2015). Nigeria stock market volatility in comparison with some countries: application of asymmetric GARCH models. *CBN Journal of Applied Statistics,* 6(2): 133-160.

Wang,T. and Zhuo, H. (2012).The Relationship between volatility and trading volume in the Chinese stock market: a volatility decomposition perspective. *Annals of Economics and Finance,*13(1):211-236.

Rajni, M. and Mahendra, R. (2007). Measuring stock market volatility in an emerging economy. *International Research Journal of Finance and Economics,* 8:126-133

Zakaria, Z. and Shamsuddin, S. (2012). Empirical evidence on the relationship between stock market volatility and macroeconomics volatility in Malaysia. *Journal of Business Studies Quarterly,* 4(2): 61-71.