STOCK PRICE VOLATILITY MODELLING AND THE RELATIONSHIP WITH GDP: A STUDY OF THE INSURANCE COMPANIES IN THE NIGERIAN STOCK EXCHANGE (NSE) USING GARCH MODEL

MSc Research Project

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Abstract

The stock market is an outstanding sector of any given economy. In most cases, the stock market is being used to determine the strength of the economy. A growing stock market is indicative of a growing economy while a decreasing stock market is indicative of a contracting economy. This research studies two broad objectives. First, we seek to know the credibility of the GARCH model in terms of handling the randomness in stock price and secondly, we investigated the relationship between GDP and the insurance stock prices. Dataset used were obtained from the Central bank Of Nigeria (CBN) and m.investing.com covering from January 2012 to May 2020. The Exponential GARCH (eGARCH) and GJR GARCH models were used to investigate the distribution and the volatility clustering of the return. The Information criterion (Akaike, Bayesian, etc.) was used to determine the best model between the eGARCH and GJR GARCH model. The linear regression model was used to investigate the linear relationship and its significance between the Nigeria Total GDP and the Insurance stock market index. From the result, we observed that the eGARCH model is the better model for modelling the volatility of the daily returns of the Nigeria Insurances stock market index. Also, the total GDP has a negative and significant relationship on the Nigeria Insurance Stock index. We thus recommend that other researcher should other machine learning model for predicting the insurance stock prices such as ARIMA, ARIMAx and LSTM. Also, the relationship that exists between GDP and insurance stock prices should be studied using the nonlinear regression model.

1 Introduction

1.1 Background

The stock market is an outstanding sector of any given economy. This is so because in most cases the stock market is being used to determine the strength of the economy. A robust stock market shows a strong economy. A casual look at the stock market and the GDP of most developed countries shows that the two indices appear to be moving in the same trend over time
(Duca, 2007). This additionally infers a type of connection among GDP and the Stock market. It likewise depicts the capital market as a necessary part of the economy. As a rule, the relationship that exists in that is found over the long haul and not on the short-run (Popoola, et al., 2017). They also discovered that in the Nigerian economy, the stock market does not cause economic growth but economic growth causes stock market performance to

grow. This means that one can tell the nature of a given stable economy by looking at the performance of the stock market then. Although the stock market is also seen as an important facilitator of economic growth (Solomon, et al., 2020). This does not negate the point that the stock market does not cause economic growth as proposed by (Popoola, et al., 2017), it only explains that stock market helps in the smooth running of the economy. This is true because it provides investment opportunities for investors while raising capital for businesses.

The stock market reflects various sectors from the economy starting from the primary sector like Agriculture to the more advanced service sectors like insurance. The Nigeria capital market is said to have started at independence in 1960, although it was called the Lagos stock exchange. Later the market was changed to become the Nigerian stock exchange in 1977 with about 19 securities, (Popoola, et al., 2017). Since then till date, a lot of significant changes and growth has occurred in this market. The market has about 13 branches scattered across the cities of the country.
Stock price prediction is the process of trying to predict the future value of a company's stock or of other values of stock trading in the market (Osman, et al., 2013). This in itself is not an easy task because stock prices are very random and volatile (Osman, et al., 2013). This simply means there is a requisite level of skills needed to successfully predict stock prices

Predicting the stock market movement in terms of stock prices is a very technical and crucial issue. This is very particular especially for investors because they seek to maximize profit at a minimized risk. The methods of predicting stock prices are vast and most times is dependent on the need for the information. However, there are three main approaches one can follow, which includes: The fundamental approach. This involves the use of intuition and personal based knowledge. Another approach is the technical approach which involves the use of charts and trends and a more advanced approach is the technological approach which involves the use of machine learning algorithms (Ahmes 2018). These work will adopt the technological approach of predicting the stock prices of insurance companies considering the randomness of stock prices, the best methodology will be deployed as well.

1.2 Purpose of the Study

The prediction of stock prices is very sensitive especially predicting for insurance companies. This is largely because of the randomness of such data, as it can take a stochastic walk within the shortest possible time. However, this is very important especially when it comes to setting trade strategy or determining the appropriate time for executing a trade (Taewook & Ha Young, 2019). The wide objective of this work is to carefully display the costs of Nigerian stock trade (NSE) insurance agencies utilizing the technological approach while trying to look at their economic relationship.
To able to achieve this the following research question has been developed;

1.3 Research Questions

1. How well can the insurance stock volatility be modelled given the historical prices using the GARCH model,? This is an attempt to look away from the fundamental and technical approach to modelling stock volatility as well as the efficient market decision that was proposed by (Fama, 1970).
2. Does the GDP of Nigeria affect the insurance stock price? This is a way of establishing the relationship between economic growth and the movement of stock prices as well as understanding the impact of the economy on insurance stock prices.

With these questions, the following objectives have been developed

1.4 Research Objectives

Objective One: The researcher seeks to know the credibility of the GARCH model in terms of handling the randomness in stock price and how well it can model future prices given the previous prices.
Objective Two: The researcher would like to know the nature of the relationship that exists between GDP and insurance stock prices.

1.5 Significance of the study

This work is of great importance firstly to investors who seek to invest in the Nigerian stock exchange market as this will help in planning a strategy for investment (Taewook & Ha Young, 2019). Predicting stock prices well enough give a level of certainty to the investors and allows for their easy decision making.
Also, this work would add to the existing literature in this field of study making it easier for future researchers who seek to take a study in the field to access relevant findings. The work also could serve as an insight to the companies in the insurance sector of the Nigeria Stock Exchange giving them a better insight on how to position their business for better outcomes in the market, especially during the economic downturn.

1.6 Structure of the Study

Chapter one of this works serves as a foundation and introduction of various concepts about the merits and eligibility of the work. This chapter discusses the purpose of the study, the objectives as well as the question. It also explains the significance of the work and its contribution to literature. The chapter two of the work will be used to examine the various related works that are pertinent to this study examining the various theoretical, empirical and conceptual framework that will guide the basis upon which the work will be built on. The third chapter will be used for discussing the methodology that will be adopted for the empirical analysis of the work. This including the nature of the data and its sources and the various statistical and technological tools that would be deployed for analysis. The fourth chapter of the work discussed the implementation of the Methodology.The fifth chapter presents the result. The sixth chapter discussed the research result with in-depth insight. The final chapter concludes the research works and provides recommendation and possible future work that can be done in the field.

2 Related Work

2.1 Theoretical Review

2.1.1 Stock Market Volatility

Predicting Stock market prices involves a good understanding of its volatility and this is a very crucial factor for risk management, asset pricing and even in portfolio management (Zhifeng, et al., 2020). This majorly one of the reasons why predicting stock has remained relevant over time. In a bid to be able to tackle the volatility problems, many researchers have designed and come with some robust methodologies. Some authors resorted to constructing the macroeconomic and financial variables in other to achieve a better result (Moshen & Sujata, 2019). Other authors focused on studying the relationship between the stock market implied volatility and the stock market volatility. Most of these authors used the GARCH multivariate model for their prediction. Example includes (Engel & Rangel, 2008) (Orlowiski & Sywak, 2019).

Although there are other known econometrics methods of forecasting times series data such the Autoregressive Integrated Moving Average (ARIMA) which is most widely used (Al-Fattah 2006) however it important to take into consideration the fact that the stock market data is highly volatile and as such should be handled with models that take into account this volatility. This one of the reasons while the GARCH model was introduced by (Bollerslev 1986).

Alles, (2001) contemplated the volatility just as the arrival example of the Irish financial exchanges. He places into thought the time of deregulated markets utilizing the ARCH series. The in-test brings about the GARCH models had done ideally well except for GARCH-IN-MEAN and the author reasoned that there is no proof which approvals that the effect of outer volatility was influenced by deregulation in any capacity.

Having established the fact that volatility is the task to deal with when trying to forecasting stock market data owing to fact that it is being affected by a lot of factors which then makes the data very volatile and difficult to appropriately forecasts, it is important then to look at the various forecast methodologies that can be used for prediction.

2.1.2 Methods of Stock Price Prediction

There are essentially three methods that are used for stock prediction which includes

1. The fundamental analysis
2. The technical analysis
3. The technological methods (Mohamed, et al., 2018)

The fundamental analyst uses price to earnings (P/E) ratio to examine the previous performance of the company before investing in it. It is also based on the assumption that the society will always need capital to thrive and if any company does well with its initial public offering, it will be rewarded with additional capital for more growth (Mohamed, et al., 2018). The technical analysts are more interested in predicting future stock price through the previous time-series data of the company. They are not truly concerned about the fundamentals of the company rather they employing charting tools such as the exponential moving average (EMA), the candlesticks and the Japanese rice merchants (Mohamed, et al., 2018)

The technological method became more popular with the advent of digital computers. The most popular techniques involve the use of Artificial Neural Networks (ANNs) and Genetic Algorithm (GA). One of the most important things to remember about the several artificial neural network methods is that it is best for dealing with nonlinear dependency between input and output (Zupan, 1994).

Nonetheless, on the other hand, considering the unpredictable idea of the stock market data the utilization of a few different models, for example, the autoregressive conditional heteroscedasticity (ARCH) model is being utilized. The model portrays the change of the current mistake term as an element of the real sizes of the past periods' error terms (Engle 1987). The ARCH model is supposed to be more reasonable when the error variance in a period arrangement follows the autoregressive (AR) model. Be that as it may, if an autoregressive moving average (ARMA) model is accepted for the error change, the model is a summed up autoregressive conditional heteroscedasticity (GARCH) model (Bollerslev 1986).

This work will make use of the different GARCH model for its prediction purposes.

2.1.3 The Stock Market And The Economy

The debate as to whether or not there is a relationship between economic growth measured by GDP or other economic factors and stock prices has been on for a while. It has been noted that some of the internal factors of a given economy such the fiscal and monetary policies might be related to the country’s capital market (Fama, 1990). Other researchers have also attempted to investigate the extent to which stock prices can be used to predict future economic growth. Although it was discovered that the share price can help predict future economic growth, but the strength of this prediction varies from country to country (Anthony & Jack, 2000). There seems to be a form of linkage between the activities of the stock market

and the macroeconomic activities. This is explained because the stock market is seen as one of the major aspects of any given economy.

In the discounted cash flow model, one of the assumptions is that the share prices reflect the result of the conducted business activities, which suggests a form of a unilateral causal relationship (Duca, 2007). It is said that the same model can be applied to understand the macroeconomic stance.
A more direct approach was taken by (Osamwonyi & Evbayiro-Osagie, 2012) to investigate the relationship between the stock exchange index and some macroeconomic variables such as inflation, money supply and domestic products. He discovered that the exchange index is dependent on the variables. On the other hand, research conducted in China to determine the causal link between stock market volatility and real GDP volatility shows that there is no relationship between the two (Wang, 2010). His result shows that stock price has no impact in explaining real GDP and vice versa. This negates the conclusions of (Osamwonyi & Evbayiro-Osagie, 2012) according to the Nigerian economy.

2.2 Empirical Review (Garch, Egarch)
The work of (Vasudevan & Vetrivel, 2016) was carried out using the symmetric GARCH (1,1) model and the Exponential GARCH (1,1) model. The analysis was carried out on the BSE-SENSEX Index returns of the Indian market. The result showed that the asymmetric GARCH model does better in predicting the conditional variance for the index, rather the symmetric models.
Another work by (Akoto, et al., 2015), that aimed at modelling the stock price volatility in the Ghanaian stock market using the GARCH (p,q) model revealed that the equities were volatile although the volatilities were not seen to be persistence. It also showed that the GARCH (1,1) was the best according to the AIC criteria. The study used historical data of over six-year and non-stationary data were transformed to become stationary

The stock price volatility modelling of the Kenya stock market which is another African country that shares similar economic conditions with Nigeria was done by (Henry, et al., 2018) showed that the ANN-GJR-GARCH model is better in modelling the stock price volatility. The study used the ANN-EGARCH model, GJR-GARCH and EGARCH model for its analysis. The study also shows that the combined statistical and machine learning models can successfully model stock prices for the sake of forecasting.
The diverse research seems to have different results. This may be as a result of various identified factors by the authors. However, the GARCH (1,1) is seen to be mostly accepted by most authors as one of the best for modelling the stock price volatility.

2.3 Conceptual Framework
Investors are more interested in understanding the viability of a stock market of which they invest in, as this is in most cases a reflection of the general economy, stock price prediction helps to identify the viability of the stock market (Peter, et al., 2012). Hence this work will be structured in such a way that investors who seek to take advantage of the Nigerian stock exchange market will gain the guidance they seek.

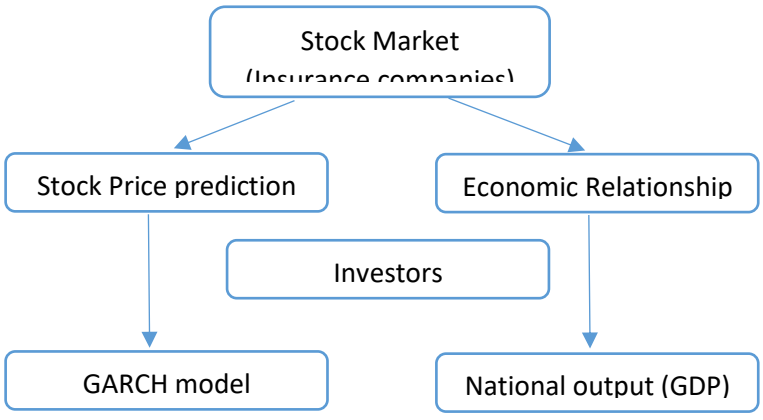

Figure 1: Conceptual Framework

The analysis that made in this work is in two folds. First is the prediction of the future stock prices of insurance companies, using the GARCH model, second is to determine the relationship between GDP and the insurance stock prices. These two keys are aimed towards giving the investor or the potential investor who intends to invest in the Nigerian stock market a clue as to how to achieve an optimal result.

2.4 Limitations

Generally, each literature consulted has its peculiarities, this implies that the attempt to predict stock prices and establishing a relationship between GDP and stock price differs in terms of study and the available data. However one outstanding limitation is on the fact that many works of literature did not consider their analysis from the perspective of an investor, rather they focused more on the establishment of a more suitable model. This, however, makes their researches most useful for academicians than it is to investors.

3 Research Methodology

This research aim to achieve two objectives, modelling the Nigeria insurance stock price return and checking for the relationship that exists between the Nigeria Gross Domestic Product (GDP) and the insurance stock return. The KDD was used for extracting this information from the dataset. The dataset employed was sourced from the official website of the Central bank of Nigeria (CBN) and m.ng.investing.com (An online data vendor) spanning the period from Jan 2012 to May 2020. The KDD Methodology involves the process of preparing the data, selecting the appropriate variables, data transformation/data cleaning for applying the proposed models and algorithm, data mining and finally, interpretation or evaluation of the model

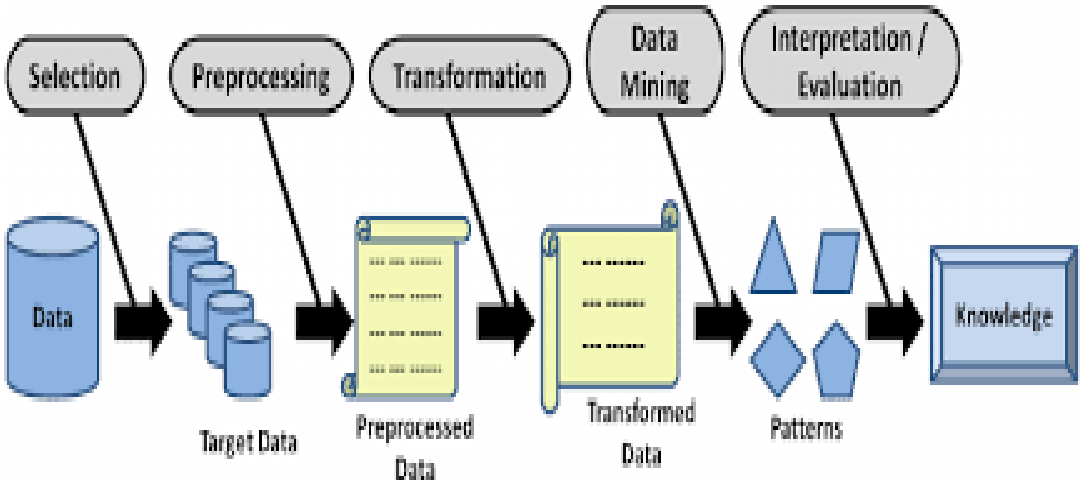

Fig 3.1 KDD Process

3.1 *Data*

The data collected and analysed for the research study are secondary, this is data published by government and private institutions on their periodic publication for public consumptions

To answer the first question, the stock index that tracks the entire insurance market of the Nigeria capital market was collected, the daily price of Nigeria insurance stock market index (NGSEINS10) which tracks the insurance sector is used for the analysis. The period covered is from the 1st of April 2014 to 30th of May 2020. This period was considered because the Nigeria Economy has experienced an economic cycle of peak, contraction, trough recovery and expansion. This period has invariantly affected the value of the stock index. This data was collected from the m.ng.investing.com, an online data vendor.

To answer the second question, Quarterly data was collected on Nigeria Gross domestic product (GDP) and the NGSEINS10. The period covered is from the first quarter of 2012 to the First Quarter of 2020. The period considered is because of statistical analysis, the sample size must greater than or equal to 30 for it to be statistically unbiased. This data was collected from the Central bank of Nigeria and m.ng.investing.com respectively.

The Central Bank of Nigeria is a government parastatal that house economic data and regulate the monetary policy in Nigeria, while m.ng.investing.com is an online internet organization.

3.2 Data Preparation

The collected data proposed for analysis using the stated models/algorithm may be inconsistent, it may contain some invalid data structures, missing values, and unnecessary variables .etc. The inconsistent of the data can lead to errors in the result. Data preparation is a vital step in the KDD process, it involves the transformation of the inconsistent dataset into a consistent form.

3.3 Model Development

3.3.1 GARCH

The problem faced when modelling financial time series is with the error variance, the error variance is usually not equal (Heteroscedasticity). As a result, the MA, AR and ARMA are not appropriate for modelling financial times series since they have the assumption of Homoscedasticity (equal Variance of error term). The ARCH model is developed by Engle (1982) and the GARCH model was developed by Bollerslev (1986) to model the conditional heteroscedasticity. The GARCH model gives a more parsimonious result than the ARCH model.

The unconditional distribution of the financial time series such as stock price return is heavier tailed(skewed) than the normal distribution(Asymmetrical), and the square of the values of the stock price return has a strong correlation and also exhibit volatility clustering. Putting all this into consideration, the asymmetrical GARCH model will be used and evaluated for modelling the NGSEINS10 stock return.

The EGARCH and GJR GARCH are both used to model the price of financial assets where volatility is higher in the declining market compared to the volatility in the rising markets. This

phenomenon is known as asymmetric volatility. Both models performed better than traditional GARCH model because of their ability to capture this phenomenon.

The distribution of NGSEINS10 return is negatively skewed, this implies that it is asymmetrical. Therefore the EGARCH and GJR GARCH modelled was adopted over other GARCH variants.

The qualitative difference between the EGARCH and the GJR GARCH is how they model the volatility, the EGARCH models the natural logarithm of the conditional Variance while GJR GARCH model the conditional variance is modelled directly (Ghulam, 2013).

3.3.1.1 EGARCH

This is a class of asymmetrical GARCH model that is used for modelling conditional Heteroscedasticity, it captures the leverage effect, that the negative shock at time t-1 have a stronger impact the variance at time t than the positive shock. It is described as:

$\text{Log}_{\sigma_t^2} = \omega + \sum_{k=1}^{q} \beta_k g(Z_{t-k}) + \sum_{k=1}^{p} \alpha_k \text{Log}\sigma_{t-k}^2$

Where:

$g(Z_t) = \theta Z_t + \lambda(|Z_t| - E(|Z_t|))$

σ_t^2 is the conditional variance,

$\omega, \beta, \alpha, \theta$ and λ Are coefficients and

Z_t is a standard Gaussian variable or from a generalized error distribution.

3.3.1.2 GJR GARCH

The GJR GARCH was proposed by Glosten, Jagannathan and Runkle in 1993 which can model the asymmetry in the ARCH Process

$$\sigma_t^2 = K + \delta\sigma_{t-1}^2 + \alpha \in_{t-1}^2 + \emptyset \in_{t-1}^2 I_{t-1}$$

Where $I_{t-1} = 0$ if $\in_{t-1} \geq 0$, $I_{t-1} = 1$ if $\in_{t-1} < 0$.

3.3.2 The Regression Model

The simple linear regression involves only one regressor variable, it explains the linear relationship between the dependent variable and the explanatory variable (regressor). The regression model is an approximating function, the true function between Y and X is Unknown. Mathematically, The Simple linear regression can be expressed as

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

Where:

Y = Dependent Variable, The NGSEIONS10 quarterly return T test can be used to test the Null hypothesis of "not significant" of the regression coefficient of the model. If the probability value is less than the significance level, the hypothesis of "not significant "is rejected otherwise do not reject the hypothesis.

X = Independent Variable, The quarterly GDP

While β_0 and β_1 are the regression coefficient, Intercept and slope respectively.

3.4 Evaluation:

3.4.1 GARCH model

The Akaike (AIC) and the Bayesian information criterion (BIC) will be utilized to assessed using two the eGARCH and GJR GARCH for a better model.

1. Akaike Information Criteria (AIC) is a statistical technique that estimates the likelihood of a model to predict future values. The model with the minimum AIC value is said to be the best model for the given dataset. Mathematically,

2. Bayesian Information Criteria (BIC) is another fine statistical technique for selecting a better model, it measures the trade-off between the model fit and the complexity of the model. The smaller the BIC, the better the model. Mathematically,

3.4.2 Regression Model

T test

The T-test will be used to test the hypothesis of "not significant" of the regression coefficient of the model. If the p-value is less than the significance level, the hypothesis of "not significant "is rejected otherwise do not reject the hypothesis.

F test

F test will be used to test the hypothesis of "not significant" of the regression model. If the p-value is less than the significance level, the hypothesis of "not significant "is rejected otherwise do not reject the hypothesis.

Coefficient of Determination (R^2)

The R^2 is a statistical technique that estimates how well the regression model fits the data, it also tells us about how the percentage variation in Y that is explained by X. The coefficient of determination lies between 0 and 1

4 Implementation

The R studio is used for running the algorithm and for the analysis. The Quandmod, ruguarch, xts, moments, PerformanceAnalytics, zoo, tseries, FinTS, and ggplot2 library are imported into R.
Function in these libraries will be used to make R perform our desired methodology.

First: The data used for this study was sourced from the central bank of Nigeria (CBN) and m.investing.com as CSV files. The read.csv function was used to import these files into R studio. The NGSEINS10 is the symbol for the Nigeria Insurance Stock index.
Second: The CSV data set was pre-processed to make it consistent, all variable of the stock information file was converted into numeric vector and date vector respectively using as.numneric and as. Date function, Redundant variable were removed. The CSV data was converted into an xts data structure for efficient modelling with the time series models. The

zoo and xts function from the zoo and xts packages respectively was used for these conversions.
Third: The period considered to be used for the GARCH modelling if from April 2014 to May 2020, the index function was used to extract this subset. The daily returns function was used to obtain the stock daily continuous return from the stock price information, the chart series function was used to plot the returns volatility clustering.
The exploratory data analysis for the stock returns was conducted, the table. Stats function was used to obtain the descriptive summary of the daily return of the NGSEINS10, chart. Histogram was used to obtain the density plot, which visualizes the statistical distribution of the return series, the jarquebera test was used to test the assumption of normality.

The three assumptions for GARCH modelling was tested. The unit root, serial correlation and the conditional heteroscedasticity. The unit root was tested using the adf.test function, the serial correlation was tested using box.plot function and conditional heteroscedasticity was tested using the Archtest.
The ugarchspec was used for model specification for the EGARCH and GJR GARCH model, the ugarchfit was used to fit the model to the return series.
The print function was used to print out the summary of the model estimations.
Fourth: For the regression analysis, the read.csv was used to import the data to be used, the ggplot was used to plot the scatter diagram with the line of best-fit superimposed. The lm function was used to model the regression model to the data and the cor.test was used to test for correlation and the significance of the correlation.

5Evaluation

In this section, we present our result from applying our stated algorithm and models. The dataset used for modelling is the price of NGSEINS10 from April 2014 to May 2020. The Quarterly return of
NGSEINS10 index and Quarterly GDP statistics are used for analysing the linear relationship between insurance stock price and GDP in Nigeria considering from January 2012 to May 2020.

5.1 GARCH Modelling

5.1.1 Descriptive summary/distribution of our data

Let Y_t be the stock index for Nigeria Insurance Sector(NGSEINS10) , t = 0,1,2,3,…..,1523, and X_t is the daily continuous(log) return ofY_t,

$$X_t = \left(\frac{Y_{t+1}}{Y_t}\right), \qquad t = 0,1,2,3,\ldots.., 1522$$

The table below is the summary statistics of daily return for NGSEINS10

Table 1: Statistical summary of the continuous daily returns X_t for NGSEINS10 Stock Price Index.

Statistics	Value
Minimum	-0.05837
Maximum	0.03706
Range	0.09543
Mean	-0.00002339
Variance	0.00009699

Standard Deviation	0.009848
Skewness	-0.1923
Kurtosis	5.5032

Source: Author

From table 1 above, the average daily return for NGSEINS10 index as shown by the mean value is -0.00002339. This value is slightly negative and as seen as the slight downward trend in NGSEINS10 index stock price as represented in Figure1. The daily return has a negative minimum value of -0.05837 and a positive maximum value of 0.05837 with the difference (Range) of 0.09543 under the period covered. The continuous daily return of NGSEINS10 has variance with value 0.00009699 and the standard deviation of 0.009848 (Highly greater than the mean). The high standard deviation indicates that the continuous return of the insurance stock index is highly risky (volatile) considering the period covered.

The daily return of NGSEINS10 has a skewness of -0.1923, indicating that the distribution of the return is asymmetrical (Non-Symmetrical) and is heavily tailed to the left as shown in Fig 2. The daily return has a kurtosis value of 5.5032(Greater than 3), indicating it is leptokurtic (meaning slender). It implies that the distribution of the daily return of NGSEINS10 has a flatter tailed than the normal distribution as also shown in Figure2.

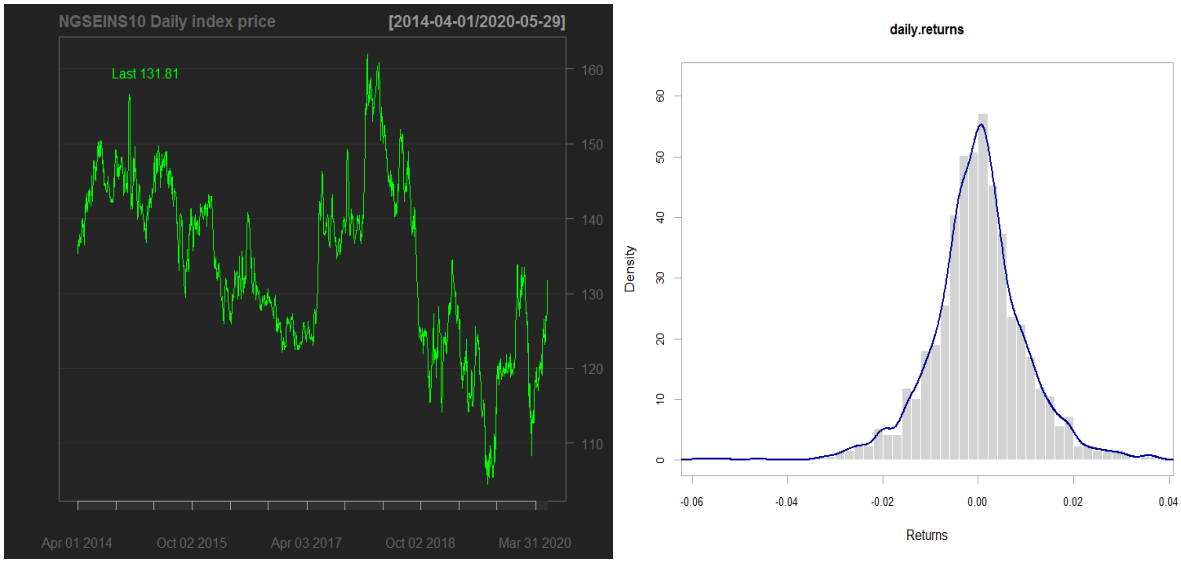

Figure 1 Time Plot and the density plot of the daily return of NGSEINS10

Table 2 Test for Normality for the daily return of NGSEINS10

Jarque-Bera	**P-value**
407.12	< 2.2 e-16

Jargue Bera test was used to test for normality of NGSEINS10
H_O: The continuous daily return NGSEINS10 is normally distributed
H_1: The centimes daily return of NGSEINS10 is not normally distributed

Conclusion: The P-value of Jarque Bera test is less than 0.05, as a result, the null hypothesis is rejected. The Jarque Bera test is indicative that the continuous daily return of NGSEINS10 is not normally distributed.

The continuous daily return of NGSEINS10 is asymmetrical and has produced a negative return over the period covered, Figure3 volatility clustering is the of the Return which is indicative that a large(small) changes in the return of NGSEINS10 are followed by Large(small) changes.

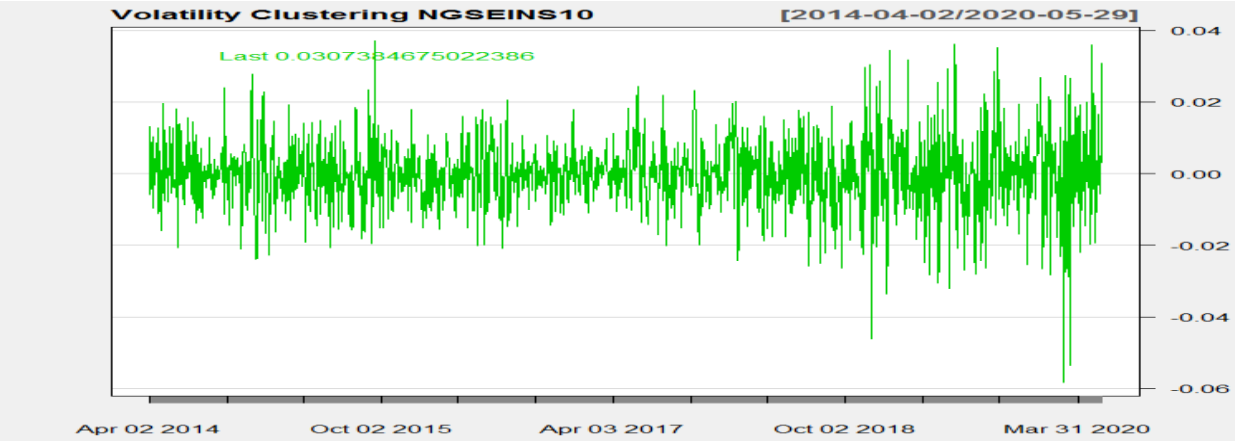

Figure 2 The volatility clustering of daily returns of NGSEINS10

5.1.2 Testing Assumption of GARCH model

a) Stationarity Test

Table 3 Test for stationarity for the daily return of NGSEINS10

Augmented Dickey-Fuller	Lag Order	P-value
-11.844	11	0.01

H_O: The daily return of NGSEINS10 is non-stationary (unit root exists)
H_1: The daily return of NGSEINS10 is stationary (unit root does not exists)

Conclusion: The p-value of the augmented dickey fuller is less than the level of significance ($\alpha = 0.05$), therefore the null hypothesis is rejected. The Augmented dickey fuller test indicates the presence of no unit root implying that the daily return of NGSEINS10 is stationary

b) Serial Correlation Test

Table 4 Test for serial correlation in the daily return of NGSEINS10

Ljung- Box Q-test	df	P-value
5.0239	1	0.025

The Ljung-Box Q-test was used to investigate serial correlation in the return of NGSEINS10
Ho: There is no serial correlation in the daily return of NGSEINS10
H1: There is serial correlation in the daily return of NGSEINS10

Conclusion: The p-value is less than the level of significance ($\alpha = 0.05$), therefore the null hypothesis is rejected. The Ljung- Box Q-test test indicates the presence of serial correlation

in the daily return of NGSEINS10. This can be seen from the autocorrelation Graph presented below

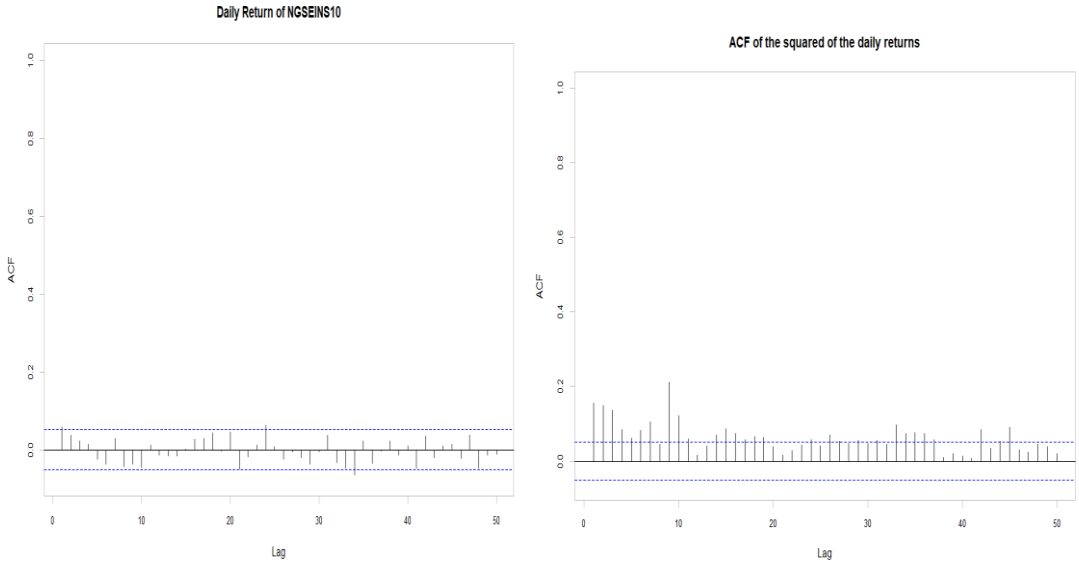

Figure3 Autocorrelation for the daily returns and square of the return for NGSEINS10

c) ARCH Test

Table 5 Arch Test for conditional heteroscedasticity in the continuous return of NGSEINS10

ARCH LM Test	df	P-value
144.94	12	2.2 e-16

The ARCH LM Test was used to investigate the conditional heteroscedasticity in the continuous return of NGSEINS10

H_0: There is no Arch Effect (Conditional Heteroscedasticity does not exists)

H_1: There is Arch Effect (Conditional Heteroscedasticity exists)

Conclusion: The p-value is less than the level of significance ($\alpha = 0.05$), therefore the null hypothesis is rejected. The ARCH LM test indicates the presence of conditional Heteroscedasticity in the daily return of NGSEINS10.

The distribution of the continuous daily return of NGSEINS10 is asymmetrical (Not following a normal distribution) and there is conditional heteroscedasticity. The asymmetrical GARCH Model will be used for modelling this return. The EGARCH and GJR-GARCH will be a model for the daily return and compared using the Evaluation criterion.

5.1.3 Modelling Using EGARCH and GJR- GARCH

5.1.3.1 Evaluating the Performance of the EGARCH and GJR- GARCH Models

The table below present the information criterion for the two models proposed to be used for modelling the insurance (NGSEINS10)

Table 6: Coefficient of the EGARCH model

Information Criterion	EGARCH	GJR- GARCH
Akaike	-6.5454	-6.5462
Bayes	-6.5209	-6.5217
Shibata	-6.5454	-6.5462
Hannan-Quinn	-6.5362	-6.5371

The information criteria is a statistical technique used to test how well a model used fits the data, it also measures the quality of a statistical model. Comparing the quality of the model for the Egarch and GJR-GARCH model using the Akaike, Bayes, Shibata and Hannan-Quinn Information Criterion. The Egarch model fits the data better than the GJR- GARCH model because it is the model with the minimum information loss, it has the highest value for AIC, BIC, SIC, HQIC. It is therefore considered a superior model than The GJR GARCH Model.

5.1.3.2 Optimum Parameters of the Egarch Models

The table below gives the estimate of the parameters of the Egarch Models for the returns of the Nigeria insurance stock exchange index.

Table 7: Parameters of the Egarch Models

Coefficient	Estimate	T-Value	P-value
Mu	-0.000053	-0.16993	0.86507
ar1	0.414498	1.44555	0.14830
ma1	-0.339834	-1.11986	0.26277
Omega	-0.348759	-5.23679	0.00000
Alpha1	0.024837	1.33794	0.18091
Beta1	0.961703	135.79625	0.00000
gamma	0.237744	7.82381	0.00000

The above table is an estimate of the parameter of the model. The alpha value of 0.024837 indicates the presence of volatility clustering in the series over the period covered although not significant at almost 10% significance level, it implies that the volatility clustering can be ignored. The beta value of 0.961703 indicates that the impact of old news on volatility is long-lasting (persistent). It means that present volatility changes will have a long impact on future volatility. Beta is significant at atmost 10% level of significance. The sum of alpha and beta is less than one indicate that volatility shock is persistent. The leverage effects as measured by gamma is 0.237744 and statistically significant, this indicated that bad news has much effects on the next period volatility than the good news(positive shock) of the same size.

5.2 Relationship between GDP and the Nigeria Insurance Stock

5.2.1 The Regression Model

The R programming output of the model is given below.

R: Output

```
Call:
lm(formula = NGSEINS10_Price ~ Total.GDP.Billion., data = Reg_Data)

Residuals:
   Min     1Q  Median     3Q    Max
-28.449  -7.286   0.210   7.585  33.228

Coefficients:
                    Estimate  Std. Error  t value  Pr(>|t|)
(Intercept)       153.16136   1.02388     149.59   <2e-16
***
Total.GDP.Billion.  -0.71380   0.03802     -18.77   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 10.66 on 2060 degrees of freedom
Multiple R-squared:  0.1461,  Adjusted R-squared:  0.1457
F-statistic: 352.4 on 1 and 2060 DF,  p-value: < 2.2e-16
```

From the output above, the linear regression equation for the model can be written as

$Y_t = 153.16136 - 0.71380X_t$

Where Y_t the Nigeria insurance index is stock price and $X_t$is the Nigeria total GDP (In billions).

i.e. NGSEINS10 = 153.16136 - 0.71380 Total GDP

The result, the total GDP has a negative relationship with the Nigeria insurance stock index. It implies that as the Nigeria Total GDP increases with time, the Nigeria insurance stock index price decrease and Vice Versa. The Nigeria insurance stock index and the Nation total GDP moves in the opposite direction with each other. The relationship is significant and cannot be ignored as we observed that the P-value is less than the level of significance. The intercept indicates that if the Nigeria Total GDP is zero the Nigeria insurance stock index will have the price of 153.1614, this value is also significant as the P-value is less than the level of significance.

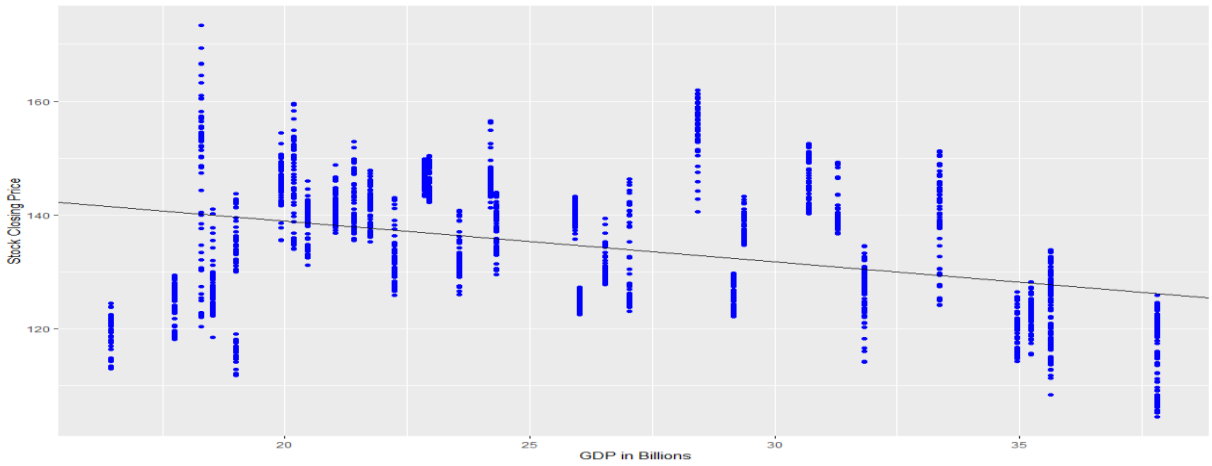

Figure 4 the scatter diagram of NGSEINS10 and Total GDP with the Regression line superimposed.

R: Output

Residual standard error: 10.66 on 2060 degrees of freedom
Multiple R-squared: 0.1461, Adjusted R-squared: 0.1457
F-statistic: 352.4 on 1 and 2060 DF, p-value: < 2.2e-16

From the Result, we observed that the coefficient of determination is 0.1457, it implies that 14.57% changes in the NGSEINS10 are explained by the Nigeria Total GDP. Given the P-value, the model is statistically significant and cannot be disregarded.

5.2.2 Correlation

.

Table 8 Summary of the correlation Analysis between GDP and the Insurance Stock price

Correlation	T statistics	df	p-value	Lower bound	Upper bound
-0.3822127	-18.773	2060	2.2e-16	-0.4184752	-0.3447337

From the result, the correlation is -0.3822127, it implied that the Total GDP and NGSEINS10 has a negative relationship, the strength of the relationship is low as the value is greater than -0.5. The strength of the relationship is also significant as the p-value is less than the level of significance.

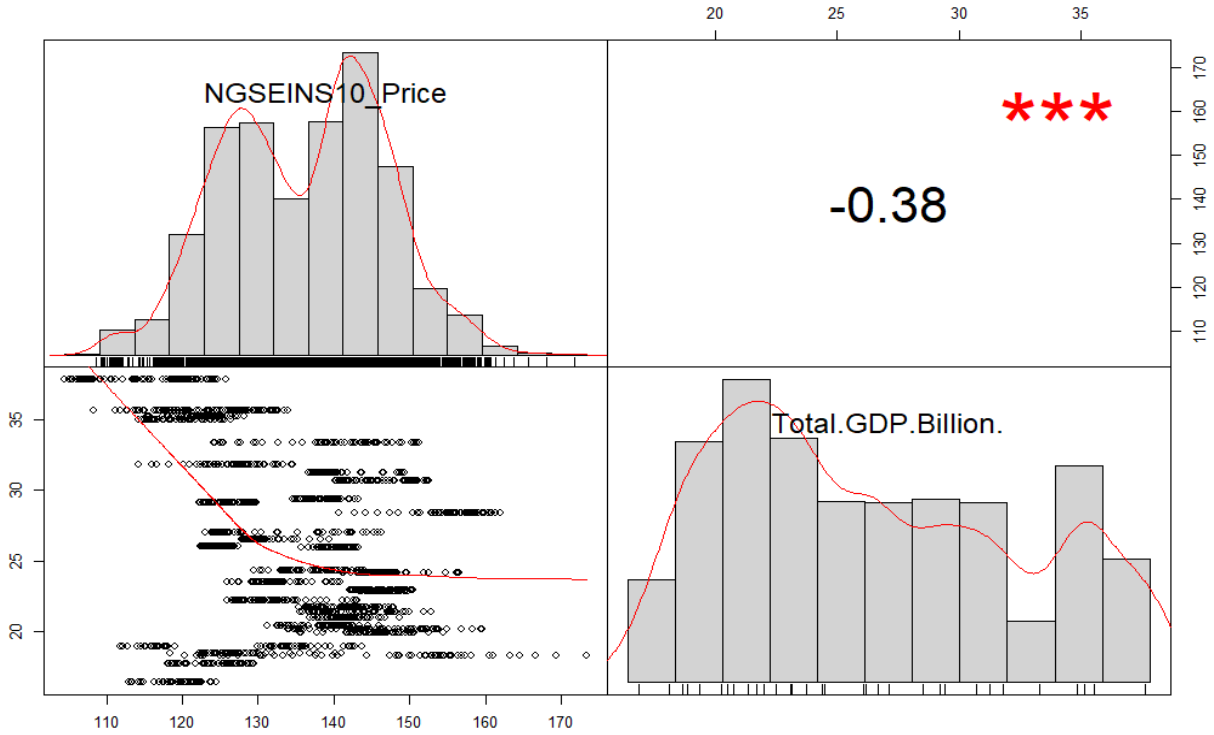

Figure 5 the correlation between the Total GDP and NGSEINS10

6 Discussion

The research aims to answer two questions, first to determine the extent at which the GARCH model can be applied to model the Nigeria insurance stock index (NGSEINS10) and secondly to determine if there is any relationship between the GDP and the Nigeria insurance stock prices. To answer this question, the EGARCH and GJR GARCH model was compared and the best model was used to model the volatility clustering of the returns. The linear regression model was employed to check for the relationship that exists between the Total GDP in Nigeria and the Insurance Stock price.

Our findings revealed that the NGSEINS10 has a negative return during the period covered and the risk of investing in the insurance sector is high as the standard deviation of the daily return is 0.0009848(0.9848%). The negative return implied some loss on the principal invested in this sector. Some factors could have caused the negative return such as poor economic performance of companies in the sectors, economic instability in the sectors or the general economy. In 2016, Nigeria economy experienced recession as a result of declining oil price, this could have contributed to the negative return in the sector. Analysing the distribution of the daily return, we found out that it is not normally distributed as the mean, median and mode are different. The skewness indicated the data is asymmetric and tail to the left, the result also shows the daily reruns is leptokurtic. The economic implication of this is that the index returned many high daily negative returns when compared to the daily positive returns.

The assumption of times series was tested; the serial correlation, unit root and presence of conditional heteroscedasticity were tested. We found out that the series is stationary, there is serial correlation and conditional Heteroscedasticity in the series. The AIC, BIC, SIC, HQIC

was used to determine the best model for modelling the volatility of the daily returns of NGSEINS10 between the EGARCH and GJR model. The EGARCH model was adopted and used to model the series as it has the lowest information criterion. Our result is a sharp contrast to(Henry, et al., 2018), who obtained that the ANN-EGARCH model is a better model when compared with EGARCH and GJR GARCH.

The EGARCH revealed volatility clustering in the returns of the NGSEINS10, we observed a long-lasting memory in volatility clustering as old news has a lasting impact on the volatility clustering (persistency). It implies for instance the entrance of negative news (such as coronavirus) would have a lasting volatile effect on the stock returns.
The leverage effect also indicates that negative news has a higher impact on the market compared with positive news. As this is logical, Investors will naturally react faster to negative news regarding an investment in the market compared to positive news of the same magnitude.

The straight-line regression model was used to check the relationship that exists between the insurance stock price and Nigeria GDP. OLS method was used in estimating the coefficient of the linear regression model, we found out a negative relationship between Total GDP and NGSEINS10 and this relationship is significant. The correlation analysis was used to check for the strength of this relationship. It was found out that the relationship is negative and the strength is low but cannot be ignored since it is statistically significant. Logical reasoning to this effect is that, as the general economy of the Nigeria economy is deteriorating, the Nigerian insurance markets are not affected by the negative economy downturn and Vice Versa. The linear regression model might also not be the reason as the best model for modelling this relationship, Figure 5 indicates a kind of parabola relationship between these two economic variables.
The result shows that the insurance sectors does not play a significant role in the context of economic growth and development in Nigeria.
Despite the growth of the National total GDP the insurance sector Penetration in the country has continued to decrease. The possible cause could be lows financial literacy among the populace, Low level of income per citizen and low awareness of the insurance products throughout the country.

7 Conclusion and Future Work

This study has two broad aims. First, we seek to know the credibility of the GARCH model in terms of handling the randomness in stock price, we investigated the distribution of the return, the volatility clustering of the return and determine the best model to use by comparing the EGARCH to the GJR GARCH model. The EGARCH model is the best for modelling the return of the Insurance stock price. We observe that investors react quickly and rapidly to negative news in the market compared to the entrance of good news into the market. As a result, we can predict with precision the reaction of investors to the Insurance market when negative news enters, we expect investors to sell the position in the market, therefore, deriving the prices of stocks in the sectors downwards. Conversely, Investors do not react quickly, if not at all, to the entrance of goods news in the markets. Therefore prices of stock in the insurance sectors should fairly remain the same. It is worthy of note that the effects of bad news have a longer time to die down in the insurance sector.

Secondly, we investigated the relationship between GDP and insurance stock prices. There is a negative and significant relationship. The total GDP has a negative effect on NGSEINS10. The result of the coefficient of determination shows that the Total GDP explains only 14.57%

changes in the prices of stock in the insurance sectors. This indicates that other factors could affect the changes in stocks prices in the insurance sectors other than Total GDP.

Future Works

The future researcher should also consider other machine learning model for predicting the insurance stock prices. A model such as ARIMA, ARIMAx and LSTM should be considered. We suggest that researcher could study other economic factors such as Inflation rate, Interest rate, population growth rate, employment rate and GDP that affect the stock price in the insurance sector of the Nigeria stock market. This researcher could also study the relationship that exists between GDP and Nigeria insurance stock prices using the nonlinear regression model, As Figure 5 is showing a curve in the scatter diagram between Total GDP and NGSEINS10.

8 ANNEXURE - Key Terminology and Abbrevation

- **KDD:** Knowledge Discovery in Databases (KDD) is the broad process of finding information/knowledge in data
- **NGSEINS10:** The Nigeria Stock index that tracks the insuarance sector of the Nigeria Economy. It comprises of 10 insurance companies.
- **Gross Domestic Product(GDP):** This is the monetary value of all finished goods and services produced within a country during a specific period.
- **Daily Return:** Measures the Monetary change in a stocks price as a percentage of the previous closing price
- **Autoregressive Model(AR):** A times series model that predict value of stock price using it previous value
- **Moving Average Model (MA):** A times series model that predict value of stock price using it stochastic(error) term
- **Autoregressive Moving Average Model(ARMA):** A times series model that predict value of stock price using the combination of its previous value and the stochastic(error) term
- **Generalized Autoregressive Conditional Heteroscedasticity (GARCH):** It is used mostly in financial time series; it models the volatility in stock.
- **Linear Regression:** The simple linear regression involves only one regressor variable, it shows the linear relationship between the the dependent variable and the independent variable(regressor).
- **Coefficient of Determination (R-squared):** is a statistical technique that estimate how well the regression model fits the data, it also tells us about how the percentage variation in Y is explained by X.

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