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ANALYSIS OF SECTORS ON NIGERIA STOCK MARKET: EVIDENCE FROM CORRELATION, SERIAL CORRELATION, AND HETEROSCEDASTICITY

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Abstract

The objective of this paper is to evaluate the behaviour of Nigerian Stock Exchange (NSE) sector indices. Specifically, the paper analyzes the returns correlation, serial correlation and heteroscedasticity on the NSE All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index, using daily returns ranging from 02 July 2008 to 31 December 2015. The study employs descriptive statistics, autocorrelation function (ACF) and Ljung-Box Q (LB-Q) statistics, as well as the autoregressive conditional heteroscedasticity Lagrange multiplier (ARCH-LM) techniques in conducting the empirical analysis. Descriptive statistics obtained from the NSE sector returns show negative skewness, leptokurtosis, and non-normal distribution. Estimates from the ACF and LB-Q statistics indicate evidence of serial correlation in majority of the sectors' returns. Furthermore, estimates from the ARCH-LM model provide evidence of heteroscedasticity in most of the sectors' returns. Overall results from the study suggest that the returns of NSE sectors are serially correlated and heteroscedastic. There is therefore the need to model the volatility of these sectors to increase understanding of their behaviour.

Keywords: *stock market sectors, correlation, serial correlation, heteroscedasticity, ARCH model, Nigeria*

JEL Classification: *G11, G23, C22, C43*

Introduction

It is well established among finance scholars and professionals that stock market sectors information allows investors and scholars to observe the performance of a

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particular stock in relation to other stocks and/or stock index. Campello, Giambona, Graham and Harvey (2011) indicate that overall market conditions have large effects on the prices of individual stocks. Hence, understanding the behaviour of market indices and the various industry groups can be a valuable tool in portfolio management. Stock market sector analysis also provides the basis for benchmarking the performance of a particular stock or sector, as well as a guide to domestic and international diversification of investments. The principle of portfolio diversification describes the optimal combination of portfolio returns and risks required to maintain the expected portfolio return. It stresses the importance of selecting portfolio components that have low correlation in their returns as well as low covariance (see, Markowitz, 1952; Cappiello, Engle & Sheppard, 2006; Emenike, 2015). Analysing the performance of stock market sectors will reveal the nature of interaction between the sector, which will in turn form the basis for portfolio selection and investment decisions.

Stock markets are usually divided into sectors by industry classification. Each of the sectors or combination of sectors has an index, which reflects the general sector(s) movement. A stock market index, according to Guha, Dutta, and Bandyopadhyay (2016), is considered as a barometer to judge the sentiment of the market. The index is usually monitored by different stock market stakeholders, such as financial markets researchers and analysts for providing accurate analysis, investors to purchase or sell financial assets, policy makers for future policy formulation, and so on. The Nigerian Stock Exchange (NSE) created and maintains eleven indices, which are: All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, Premium Index, Lotus Islamic Index, and Alternative Securities Market Index.

Numerous empirical studies have recently been conducted to examine the correlation between sectors of stock markets both in developed and developing economies (see for example, Sharabati, Noor, and Saymeh, 2013; Cao, Long & Yang, 2013; Rajamohan and Muthukamu, 2014; Yilmaz, Sensoy, Ozturk & Hacihasanoglu, 2015; Guha, Dutta, and Bandyopadhyay, 2016); however, the performance and correlations of sectors and their portfolio diversification implications have not been explored adequately in the NSE. Comparative analysis of the NSE sectors indices will provide investors with an idea of how well a given group of companies is expected to perform as a whole. Thus, there is need for empirical comparative analysis of the sectors of the NSE.

The objective of this study is to analyze the behaviour of sector indices of the NSE. Specifically, NSE All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index were evaluated for evidence of returns correlation, serial correlation, and heteroscedasticity. This study is useful to investors (both individual and institutional), regulators of the NSE, and future researchers. To the investors for instance, the empirical findings of this study provides information required to benchmark the performance of a particular stock, sector or industry. In addition, serially correlated sectors' returns have implication for weak form efficiency. The findings also provides basis for the review of poorly performing sector indices in the NSE. The regulators could therefore formulate policies to enhance performance of such sectors of the market. The study is also useful to researchers as it contributes to knowledge on the performance of sector indices in Nigeria and serves as reference material to future study. The remainder of the paper is organised as follows: the next

section presents an overview of the NSE indices and brief review of empirical literature. Section three contains the methodology and description of data, while section four provides empirical results and discussion. Finally, section five provides the summary and concluding remarks.

1. Overview of NSE Indices and Brief Review of Empirical Literature

1.1 Overview of NSE Indices

The NSE, according to the Nigerian Stock Exchange (undated), has eleven indices including: All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, Premium Index, Lotus Islamic Index, and Alternative Securities Market Index. The All-Share (ASI) Index tracks the general market movement of all listed equities on the Exchange, including those listed on the Alternative Securities Market (ASeM), regardless of capitalization. It is a market capitalization weighted index and was formulated in January 3, 1984 with a base value of 100 points. The ASI is calculated on a daily basis, and adjusted for corporate actions, new listings, rights issue, and placing. As at 01/02/2016, the ASI stood at 23826.76 points.

The Banking Index is designed to provide an investable benchmark to capture the performance of the banking sector. It comprises the most capitalized and liquid companies in banking and the computations are based on the market capitalization methodology. It started on 1st July 2008, with a base value of 1,000 points and is reviewed half-yearly. As at 01/02/2016, the Banking Index stood at 243.91 points.

The Consumer Goods Index is designed to provide an investable benchmark to capture the performance of the consumer goods sectors. The index comprises the most capitalized and liquid companies in food, beverages, and tobacco. The index is based on the market capitalization methodology. It was started on 1st July 2008 with a base value of 1,000 points and is reviewed half-yearly. As at 01/02/2016, the Consumer Goods Index stood at 616.17 points.

The Oil & Gas Index started on 1st July 2008 with a base value of 1000 points. It comprises of the top 7 most capitalized and liquid companies in the petroleum marketing sector. It was designed to provide an investable benchmark to capture the performance of the oil and gas sector. The index is based on the market capitalization methodology and reviewed half-yearly. The index stood at 312.78 points as at 01/02/2016.

NSE 30 tracks the top 30 companies in terms of market capitalization and liquidity. It is a price index and is weighted by adjusted market capitalization. It started on 29/12/2006 with a base value of 1,000 points. The NSE 30 index stood at 1,070.9 points as at 01/02/2016.
Designed to provide an investable benchmark to capture the performance of the insurance sector, the Insurance Index comprises the most capitalized and liquid companies in insurance. The index is based on the market capitalization methodology. It was started on 1st July 2008 with a base value of 1000 points and reviewed half-yearly. The index stood at 132.79 points as at 01/02/2016.

Industrial sector index is designed to provide an investable benchmark to capture

the performance of the industrial sector. It comprises the most capitalized and liquid companies in the industrial sector and is based on the market capitalization methodology. The index started on April 9, 2013, with base date and value of December 30, 2011 and 1,000 respectively. The Industrial index stood at 1,756.41 points as at 01/02/2016.

The NSE Pension tracks the top 40 companies in terms of market capitalization and liquidity. It is a total return index and is weighted by adjusted market capitalization. It is also adjusted for a free float factor. As at 01/02/2016, the NSE Pension Index stood at 710.5 points.

NSE Premium Index tracks the Premium Board companies in terms of market capitalization and liquidity. It is a price index and is weighted by adjusted market capitalization. Only fully paid-up common shares are included in the index.

The ASeM index tracks price movements of all equities listed on the Alternative Securities Market. Started on April 23, 2013, the ASeM index is a market capitalization weighted index. It includes all the companies listed in the Alternative Securities Market. The base date and value are December 31, 2010 and 1,000 respectively. As at 01/02/2016, the ASEM index stood at 1205.33 points.

The NSE-Lotus Islamic Index (NSE LII) tracks the performance of 15 Shari'ah compliant equities which have met the eligibility requirements of a renowned Shari'ah Advisory Board. The component stocks are rigorously screened and reviewed bi-annually to ensure their continuous compliance for inclusion. The index is based on the market capitalization methodology. NSE LII started on 31st December 2008 with a base value of 1,000 points, but stood at 1,680.15 points as at 01/02/2016.

1.2. Brief Review of Empirical Literature

There is no doubt that a good number of studies have recently been conducted to study the performance and correlation of stock market sectors. Cao, Long, and Yang (2013) use data of CSI 300 and its ten sector indices from July 7, 2007 to December 21, 2012 to examine the relationship between the stock market sector indices from the meso level, and divide the periods into two stages. One stage represents the drastic shock periods in 2007 and 2008, and the other represents the general ups and downs periods. In the first stage, when the market experiences drastic ups and downs, the sector indices tend to rise or fall together, and exhibit very close correlations between each other. In the second stage, however, much smaller correlations appear, and the stock price indices reflect the cyclical characteristics of the real sector economy. They conclude that during the stability or decline period of economy, the stock market can even better reflect the development status of the real economy.

In a similar study, Sharabati, Noor, and Saymeh (2013) investigate the influence of Amman Stock Exchange (ASE) sectors on ASE general index performance using daily observations from 29 December 1999 to 30 December 2012. The results of the study indicate positive significant relationships between Jordanian economic sectors and sub-sectors with ASE market performance. The results also show that the financial sector has the highest effect on ASE market performance, followed by the industrial sector, and then the services sector. They conclude that the fluctuations of prices in

one stock index can be determined or predicted to some extent using a part of the information set provided by the other stock indices.

Rajamohan and Muthukamu (2014) compare the performance of the sector indices of the National Stock Exchange of India. Their main objective was to measure the influence of the banking vis-à-vis the other sectors. They conclude that there is a positive correlation of the influence of the banking sector with other sectors.

Yilmaz, Sensoy, Ozturk, and Hacihasanoglu (2015) investigate the interactions between 10 major sectors belonging to Dow-Jones Islamic equity indices by applying dynamic conditional correlation (DCC) and dynamic equicorrelation (DECO) on daily observations from 3 January 1996 to 9 July 2014. Their results show that, prior to the financialization period, firm fundamentals and real economic factors had an important role in driving the Islamic equity prices. But also that, after the global financialization, the price driving force of the fundamentals seemed to disappear as the fast profit-making approach through financial markets started to dominate over the traditional indicators to price equities, leading to a high level of sensitivity to the information captured in other asset prices and, inevitably, to highly integrated Islamic equity sectors, just as in the case of the conventional part. They conclude that their results do not support the hypothesis of decoupling the Islamic equity markets from the conventional financial system.

Guha, Dutta, and Bandyopadhyay (2016) evaluate the performance of the different sector-based index of National Stock Exchange of India as well as measure the sensitivity of different sector indices with respect to Nifty index. They studied a total of eleven indices plus Nifty, using daily data ranging from 1 January 2004 to 31 March 2014. The indices are monthly closing price of all the sector indices of National Stock Exchange, namely CNX auto, bank, energy, finance, FMCG, IT, media, metal, pharma, PSU bank Index, realty indices was taken. Their results show among other things that all the changes in the indices are in the same direction with Nifty, since the value of beta are positive. They conclude, with 95% confidence, that the Nifty index can be predicted using six out of eleven sector indices return.

From the brief literature review, it is glaring that the there is scant empirical literature on correlation, serial correlation, and heteroscedasticity on NSE sectors. The dearth of such comparative analysis heightens the need to study the performance of stock market sectors in Nigeria.

2. Method of Analysis and Description of Data

2.1. Description of Data

Daily observations on the sector indices of the Nigerian Stock Exchange (NSE) were obtained from the NSE database. The sectors include NSE All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index for the period ranging from 02 July 2008 to 31 December 2015. This study period was chosen based on availability of data. The NSE sector indices were transformed to sector returns series by taking the first difference of the natural log series as follows:

$$Sr_t = [\ln(P_t) - \ln(P_{t-1})] * 100 \quad (1)$$

Where Sr_t is the sector index return and P_t is the sector index value in day *t*.

2.2. Method of Analysis

To analyse the behaviour of the NSE sector indices, I employ descriptive statistics, correlation, serial correlation, and heteroscedasticity tests. Descriptive analysis is the presentation of summary of the important statistics in a data set. The descriptive analysis involves plotting of time series graphs and computation of mean, standard deviation, skewness, kurtosis, and Jarque-Bera statistic.

The correlation coefficient (r) measures the linear dependence or association between the two variables. The sign (+ or -) indicates the direction of the relationship. The value can range from -1 to +1, with +1 indicating a perfect positive relationship, 0 indicating no relationship and -1 indicating a perfect negative or reverse relationship. The Pearson's product moment correlation coefficient *r* is specified thus:

$$r = \frac{n\sum(xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2]\sqrt{[n\sum y^2 - (\sum y)^2}}} \quad (2)$$

Where r is the correlation coefficient, n is the number of observations, while x and y are dependent and independent variables, in this case the NSE sector returns.

Serial correlation refers to the correlation of a time series with its own past and future values. Positive serial correlation might be considered a specific form of persistence, a tendency for a system to remain in the same state from one observation to the next. Serial correlation can be exploited for predictions: a serially correlated time series is predictable, probabilistically, because future values depend on current and past values. The serial correlation was examined in the NSE sectors indices using the autocorrelation function (ACF) and the Ljung-Box (1978) modification of Box and Pierce (1970) portmanteau (Q) test. The ACF measures the linear dependence between returns at current period and its past values. The lag-*i* sample autocorrelation of Sr_t is

$$\rho\ell = \frac{\sum_{t=\ell+1}^{T}(Sr_t - S\bar{r})(Sr_{t-\ell} - S\bar{r})}{\sum_{t=1}^{T}(Sr_t - S\bar{r})^2}, \quad 0 \le \ell < T-1. \quad (3)$$

Where $\rho\ell$ is the serial correlation coefficient of the returns of lag ℓ, *T* is the number of observations, Sr_t is the return for period *t* specified in equation (1), $S\bar{r}$ is the sample mean of return, and ℓ is lag of the period. The ACF is used to detect whether the serial correlation coefficients are significantly different from zero under the null hypothesis ρ_1=0 versus the alternative hypothesis $\rho_1 \neq 0$. If Sr_t is uncorrelated sequence, the

p-value is greater than α, the significance level (Emenike, 2014).

The Ljung-Box Q test was applied to test whether several autocorrelations of Sr_t are zero. Ljung-Box Q involves subjecting the squared error series to standard tests of serial correlation based on autocorrelation structure using portmanteau tests as follows:

$$Q_{LB}(m) = T(T+2)\sum_{\ell=1}^{m}\frac{\hat{\rho}_{\ell}^{2}}{T-\ell} \quad (4)$$

Where *T* is the sample size, and *m* is the number of autocorrelation used in the test. Under the condition that Sr_t is serially uncorrelated sequence, the Q-statistic is asymptotically a chi-square random variable with degrees of freedom equal to the number of autocorrelations (*m*). The null hypothesis is that the first *m* lags of ACF of ε_t^2 are zero (Tsay, 2005: 101). The decision rule is, therefore, to reject the null hypothesis if the *p*-value is less than or equal to the significance level.

To evaluate the NSE sector returns for evidence of heteroscedasticity, we adopted the Engle (1982) autoregressive conditional heteroscedasticity Lagrange multiplier (ARCH-LM) test. The ARCH-LM, which examines whether a series contain heteroscedastic variance, is estimated as follows:

$$Sr_t = \theta + Sr_{t-i} + \varepsilon_t \quad (5)$$

$$\varepsilon_t^2 = c_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 + ... + \alpha_q\varepsilon_{t-q}^2 \quad (6)$$

Where Sr_{t-i} is lags return of the NSE sectors' returns, ε_t is residual term, ε_t^2 is squared residuals from the regression model specified in equation (5), c_0 is constant, and α_1 to α_q are coefficients of the lags of the squared residuals. If there is no heteroscedasticity (i.e., ARCH effects), the estimated values of α_1 through α_q should not be significantly different from zero. The decision rule, therefore, is to reject the null hypothesis of no heteroscedasticity if the *p*-value is less than the level of significance (Bollerslev, Chou & Kroner, 1992; Tsay, 2005; Rachev *et al.*, 2007). Evidence of heteroscedasticity in the NSE sectors would suggest that the sectors' returns are volatile, and that GARCH type models can be used to estimate volatility clustering, persistence, and asymmetry.

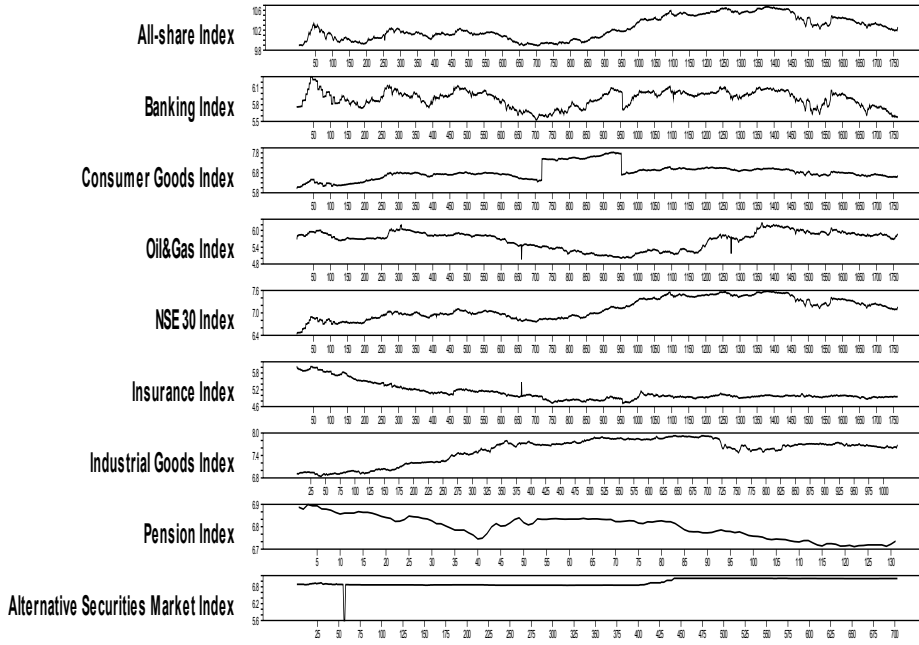
3. Empirical Results and Discussions

3.1. Descriptive Statistics

Figure 1 shows the time series graph of log-level series of the NSE All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index for the period ranging from 02 July 2008 to 31 December 2015 period. Visual

inspection of the graph suggests that the levels of the NSE sector series are not stationary. This implies that the mean and variance of the distribution from which the series is drawn, changes with time. Another noticeable feature of *Figure 1* is the downward spikes in NSE All-share Index, Banking Index, NSE 30, and Consumer Goods Index in the second quarter of 2008 as a result of the global financial crisis (GFC). The Oil & Gas Index and Insurance Index appear not to decline as the other were declining during GFC. Notice also that the Alternative Securities Market Index appears flat except for the one major spike in the second quarter of 2013. Observe also that the Pension Sector Index is facing southward right from the date it started. Generally, the level indices show absence of mean reversion.

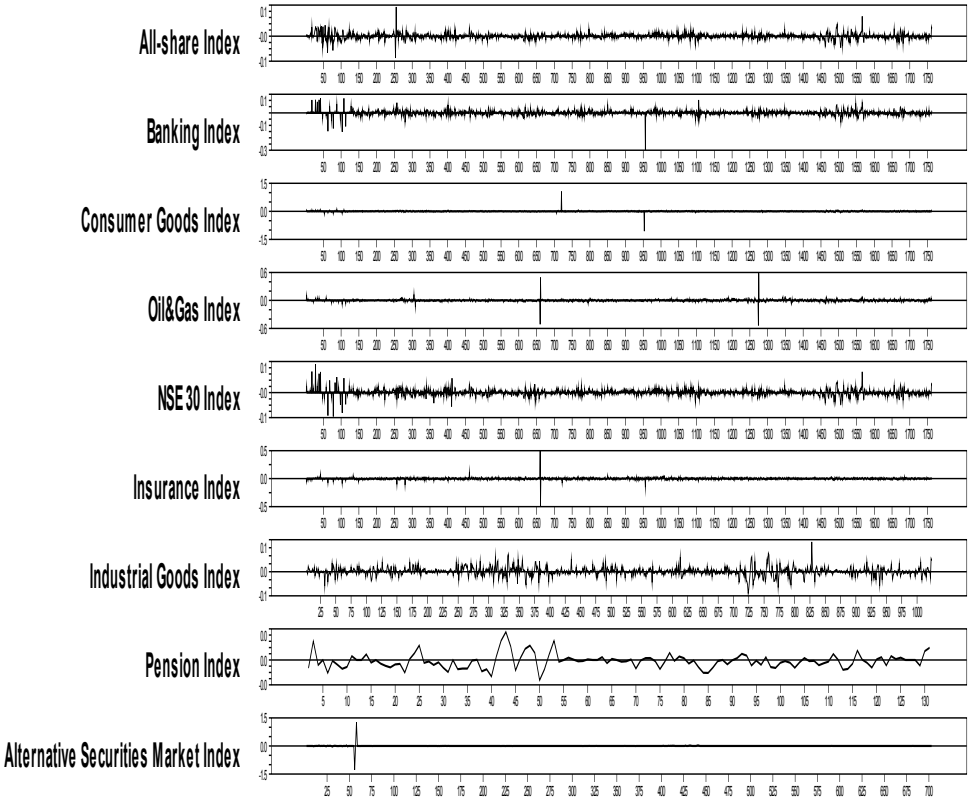
Figure 1. Time Plot of Level Series of Nigerian Stock Exchange Sector Indices
02 July 2008 to 31 December 2015



The time series graph of the return series of the of the NSE All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index are presented in *Figure 4.2*. We can see from *Figure 4.2* that all the NSE sector return series fluctuate around their mean value, though in different directions and other high and low volatility can be seen. Observe also that the most negative changes in most of the return series occur during the period of the GFC. However, the series show mean reversion tendency. This is easily seen in the ability of each series to return to the mean after a deviation. Given the mean reversion tendency of the sector returns data, the sectors return series that are less than their average, all things being equal, will likely rise in the long-run. This is so because stationary series will always return to

their mean irrespective of how far they deviate; that is one of the desirable attributes of stationary series and the reason for their choice in econometric estimation.

Figure 2. Time Plot of Return Series of Nigerian Stock Exchange Sector Indices
02 July 2008 to 31 December 2015



Univariate statistics for sector indices are presented in *Table 1*. The average rate of return for all the NSE sectors' returns for the study period is zero at the 5% significance level, except the Insurance sector, which exhibits a negative return. Notice the wide gap between the minimum and maximum returns for the study period. These clearly show the dispersion between returns in the NSE. Dispersion is captured by the standard deviation, which measures uncertainty of investing in the financial market. The annualized standard deviation of returns are 17.5%, 24%, 32.1%, 28.2%, 19.8%, 23.7%, 18.5%, 17.4%, and 42.2% for the All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market (ASeM) Index returns, respectively. The annualized standard deviation shows that the ASeM index has the highest standard deviation, whereas the Pension and All-share Indices have the lowest one for the study period.

The skewness of a normal distribution is zero. The bias towards positive or negative returns is represented by the skewness of the distribution. If the returns distribution is positively skewed, it implies that there is higher probability of large positive returns than negative returns (Ivanovski, Narasanov & Ivanovska, 2015), and vice versa. Notice from *Table 1* that the skewness coefficients of the All-share Index, Industrial Goods Index, and Pension Index are positive, whereas those of the Banking Index, NSE 30 index, and Insurance index are negative. The skewness of the Consumer Goods Index, Oils & Gas, and ASeM indices are zero.

Kurtosis provides summary information about the shape of a return distribution. It measures peakedness and flatness of a return distribution relative to normal. The excess kurtosis of a normal distribution is 0. For symmetric unimodal distributions, a positive excess kurtosis coefficient indicates heavy tails and peakedness relative to the normal, whereas a negative excess kurtosis coefficient indicates light tails and flatness (DeCarlo, 1997). *Table 1* shows that all the markets return have heavy tails and are peaked. The excess kurtosis ranges from 2.4 for the pension index to 532 for the consumer goods one. The implications of heavy tails are that, for a large part of the time, markets return fluctuate in a range smaller than a normal distribution. But there are occasions where the markets return swing in a much wider scale than that permitted by a normal distribution. Thus, investors can make very high returns and as well lose large amounts of their investments (Emenike, 2015). Jarque-Bera test results show that the NSE sector returns are not normally distributed.

Table 1. Univariate Statistics for NSE Sectors' returns

Variable	Mean	Min. rtn.	Max. rtn.	Std. Dev.	Skewness	Kurtosis	J-B Stat.
ASI	-0.0354 (0.182)	-9.4752	11.7583	1.1771	0.3786 (0.000)	12.7857 (0.000)	13369 (0.000)
Banking	-0.0672 (0.181)	-29.5258	18.9193	2.2238	-1.7352 (0.000)	32.6832 (0.000)	88039 (0.000)
Cons. Goods	-0.0149 (0.867)	-106.132	106.4073	3.9747	-0.3234 (0.668)	532.1311 (0.000)	23077865 (0.000)
Oil & gas	-0.0527 (0.445)	-53.4415	58.1153	3.0563	0.0042 (0.938)	193.1993 (0.000)	3042067 (0.000)
NSE 30	-0.0074 (0.826)	-15.5546	13.2701	1.5056	-0.8958 (0.000)	26.9520 (0.000)	59464 (0.000)
Insurance	-0.0995 (0.042)	-49.979	49.4403	2.1653	-0.6686 (0.000)	287.3883 (0.000)	6731401 (0.000)
Ind. Goods	0.0755 (0.066)	-6.7986	9.3095	1.3171	0.2687 (0.000)	5.3344 (0.000)	1225.29 (0.000)
Pension	-0.1750 (0.087)	-3.2320	4.5001	1.1605	0.8681 (0.000)	2.4170 (0.000)	47.9728 (0.000)
ASeM	0.0297 (0.908)	-127.962	127.7405	6.8392	-0.0615 (0.506)	348.40 (0.000)	3550547 (0.000)

Note: P-values are displayed as (.). Std. Dev. and J-B Stat are the standard deviation and Jarque-Bera statistics for the NSE sectors' returns.

3.2. Results of Unit Root Tests for the NSE Sectors' returns

Table 2 displays the results of the augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests conducted to ascertain the stationary nature of the NSE sectors return series. The null hypothesis of the ADF test is that a time series contains a unit root. If the computed absolute tau value is less than the ADF critical tau values, reject the null hypothesis of unit root. Otherwise accept the null hypothesis. As shown in *Table* 2, the computed tau values of the ADF test statistics indicate that the return series do not contain unit root at the 1% significance level, implying that the NSE All-share Index, Banking index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index series are stationary at the first difference. The PP non-parametric unit root test also shows that the NSE sectors' returns series do not contain unit root with 99% confidence, thus confirming the results of the ADF test. These results, therefore, indicate that the NSE sectors' returns series are stationary.

Table 2. Unit Root Tests Results

Variables	ADF	Computed	PP	Computed	ADF	Computed	PP	Computed
	Level Series				**Return Series**			
ASI	-2.863	-1.813	-2.863	-1.738	-2.863	-30.281**	-2.863	-30.207**
Banking	-2.863	-3.063*	-2.863	-2.831	-2.863	-35.334**	-2.863	-35.189**
Cons. Goods	-2.863	-2.680	-2.863	-2.725	-2.863	-41.107**	-2.863	-41.137**
Oil & gas	-2.863	-1.295	-2.863	-1.408	-2.863	-36.786**	-2.863	-57.944**
NSE 30	-2.863	-2.508	-2.863	-2.516	-2.863	-34.571**	-2.863	-34.644**
Insurance	-2.863	-3.226*	-2.863	-3.329*	-2.863	-37.036**	-2.863	-58.211**
Ind. Goods	-2.864	-1.929	-2.864	-1.968	-2.864	-25.782**	-2.864	-25.801**
Pension	-2.884	-1.731	-2.883	-1.369	-2.883	-7.959**	-2.883	-7.689**
ASeM	-2.866	-3.018*	-2.866	-5.939**	-2.866	-22.735**	-2.866	-29.180**

*Note: * and ** refers to 5% and 1% statistical significance levels respectively. ADF and PP are the 5% critical tau value of the augmented Dickey-Fuller and Philips-Perron unit root tests.*

3.3. Correlation Analysis for the NSE Sectors' returns

Table 3 displays the Pearson's product moment correlation coefficients for the All-share Index, Banking index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index series. Notice from the *Table 3* that the NSE All-share Index has a positive, but very weak relationship with the other indices, except with the NSE 30 Index and the Banking Index. This result is similar to the study of Sharabati, Noor, and Saymeh (2013), which shows that the financial sector has the highest effects on ASE market performance. The banking sector has a very strong positive relationship

with the NSE 30 Index, and a very negative one with the Alternative Securities Market Index. The Consumer Goods Index has a very strong negative association with the Industrial Good Index and the Alternative Securities Market Index, without strong positive relationships with any index. The Oil & Gas Index has a negative association with the Insurance, Industrial Goods, and Alternative Securities Market indices. The NSE 30, Insurance and Pension indices have a negative association with the Alternative Securities Market.

The existence of a strong positive relationship between the Banking Index and the NSE 30 Index suggests that the two indices move together. All things being equal, this implies that they are not good candidates for portfolio diversification. On the other hand, the sectors that are negatively related are very good combination for portfolio diversification.

Table 3. Correlation between NSE Sectors' returns

	RASI	*RBNK*	*RCONG*	*ROG*	*RNSE*	*RINS*	*RINDG*	*RPEN*	*RASEM*
RASI	1								
RBNK	0.4322	1							
RCONG	0.1647	0.2822	1						
ROG	0.1153	0.1629	0.0638	1					
RNSE	0.5294	0.8023	0.3492	0.1558	1				
RINS	0.1282	0.3082	0.0905	-0.2211	0.2796	1			
RINDG	0.0086	0.0082	-0.0158	-0.0111	0.0008	0.0166	1		
RPEN	0.2068	0.1274	0.1245	0.2860	0.2043	0.3301	-0.0248	1	
RASEM	0.0066	-0.0341	-0.0254	-0.0035	-0.0217	-0.0110	0.0383	-0.0327	1

Note: RASI, RBNK, RCONG, ROG, RNSE, RINS, RINDG, RPEN, RASEM are the return series of the All-share Index, Banking index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index indices respectively.

3.4. Results of the Serial Correlation Test for NSE Sectors' returns

Table 4 displays autocorrelation function, Ljung-Box Q (LBQ) statistic and the *p*-value of the LBQ estimated for stock returns series of the NSE sectors from lags 1 to 22. The *p*-value of the Ljung-Box Q coefficients for the lags 1 and 22 of the NSE sectors are all less than the 5% significance level, except for Consumer Goods and Alternative Securities Market sectors. Therefore, we cannot accept the null hypothesis of no autocorrelation in the returns series of the ASI, Banking, Oil & gas, NSE 30, Insurance, Industrial goods, and Pension sectors in Nigeria at the 5% level of significance. The existence of serial dependence in these sectors stock returns is an indication of stock returns predictability.

Table 4. Autocorrelation Function and Ljung-Box Q Statistics for NSE Sectors' returns

variables/lags	1	5	10	15	20
ASI	0.3328 {217.09} [0.0000]	0.0113 {271.94} [0.0000]	0.0355 {277.61} [0.0000]	0.0085 {280.32} [0.0000]	-0.0144 {293.90} [0.0000]
Banking	0.1085 {23.07} [0.0000]	0.0584 {31.50} [0.0000]	0.0072 {37.68} [0.0000]	0.0282 {40.66} [0.0003]	0.0046 {42.51} [0.0023]
Cons. Goods	0.0147 {0.42} [0.5153]	0.0114 {4.80} [0.4407]	0.0191 {5.89} [0.8243]	-0.0045 {12.64} [0.6300]	0.0088 {14.84} [0.7851]
Oil & gas	-0.2666 {139.26} [0.0000]	0.0195 {141.14} [0.0000]	0.0589 {149.87} [0.0000]	0.0145 {154.32} [0.0000]	0.0181 {158.42} [0.0000]
NSE 30	0.1042 {21.29} [0.0000]	0.0514 {29.38} [0.0000]	-0.0025 {31.18} [0.0005]	0.0214 {35.44} [0.0033]	-0.0165 {38.45} [0.0077]
Insurance	-0.2615 {133.96} [0.0000]	0.0610 {142.36} [0.0000]	0.0132 {144.49} [0.0000]	0.0019 {146.60} [0.0000]	0.0147 {147.87} [0.0000]
Ind. Goods	0.2066 {43.83} [0.0000]	-0.0438 {50.60} [0.0000]	-0.0187 {52.87} [0.0000]	-0.0420 {57.45} [0.0000]	0.0094 {67.41} [0.0000]
Pension	0.3268 {14.21} [0.0001]	0.2243 {31.18} [0.0000]	0.1177 {44.30} [0.0000]	-0.0550 {47.23} [0.0000]	0.0857 {51.05} [0.0001]
ASeM	0.0019 { 0034} [0.9439]	-0.0001 {316.49} [0.0000]	-0.0091 {316.87} [0.0000]	-0.0019 {317.08} [0.0000]	0.0014 {317.16} [0.0000]

Note: The Ljung-Box Q statistic for the autocorrelation functions are displayed in brace bracket, and p-values of Ljung-Box Q statistic are displayed in square bracket.

3.5. Results of the Heteroscedasticity Test for the NSE Sectors' returns

Table 5 displays results of the autoregressive conditional heteroscedasticity Lagrange Multiplier (ARCH-LM) test conducted to examine the NSE sectors' returns series for heteroscedasticity. Under the null hypothesis of no heteroscedasticity in return series, asymptotic significance corresponding to the *p*-value should be greater than or equal to the significance level, in this case 5%. Observe from *Table 4* that the *p*-value of the ARCH LM coefficients for ASI, Oil & Gas, Insurance, Industrial Goods, and Pension sectors, up to lags 6, are less than the 0.05 significance level. Hence, we can reject the null hypothesis of no heteroscedasticity in the ASI, Oil & gas, NSE 30, Insurance, Industrial Goods, and pension sectors stock returns with 99% confidence,

since *p*-value is less than the significance level (0.05). This indicates that the squared residual of the ASI, Oil & gas, Insurance, Industrial Goods, and Pension sectors are heteroscedastic. The banking, consumer goods, and alternative securities markets sectors' returns are not heteroscedastic. Evidence of heteroscedasticity suggests the ASI, Oil & gas, Insurance, Industrial goods, and Pension sectors' returns are volatile. There is, therefore, the need to model the volatility of these sectors to increase understanding of their behaviour.

Table 5. Estimates of Heteroscedasticity for NSE Sectors' returns

variables/ lags	1	2	3	4	5	6
ASI	189.361 [0.000]	110.539 [0.000]	76.844 [0.000]	57.647 [0.000]	46.713 [0.000]	37.278 [0.000]
Banking	0.025 [0.874]	0.261 [0.769]	0.356 [0.785]	0.287 [0.886]	16.794 [0.000]	14.081 [0.000]
Cons. Goods	0.007 [0.935]	0.006 [0.994]	0.034 [0.991]	0.027 [0.998]	0.022 [0.999]	0.019 [0.999]
Oil & gas	484.957 [0.000]	288.315 [0.000]	197.213 [0.000]	148.490 [0.000]	118.791 [0.000]	98.932 [0.000]
NSE 30	0.011 [0.917]	0.593 [0.552]	0.713 [0.544]	0.546 [0.702]	93.651 [0.000]	78.142 [0.000]
Insurance	466.426 [0.000]	273.028 [0.000]	185.487 [0.000]	139.385 [0.000]	111.452 [0.000]	92.826 [0.000]
Ind. Goods	29.744 [0.000]	16.477 [0.000]	12.147 [0.000]	9.117 [0.000]	9.745 [0.000]	8.213 [0.000]
Pension	6.755 [0.011]	7.138 [0.001]	8.535 [0.000]	7.000 [0.000]	5.808 [0.000]	5.976 [0.000]
ASeM	0.006 [0.939]	28.424 [0.000]	18.895 [0.000]	18.636 [0.000]	14.866 [0.000]	13.791 [0.000]

Note: The p-values are displayed in square bracket.

Conclusion

This paper analysed the performance of the sectors in the Nigerian Stock Exchange (NSE) by evaluating the sectors' returns, for correlation, serial correlation and heteroscedasticity. Specifically, the paper estimated and analysed descriptive statistics, correlation coefficients, serial correlation and heteroscedasticity on the NSE All-share Index, Banking Index, Consumer Goods Index, Oil & Gas Index, NSE 30 Index, Insurance Index, Industrial Goods Index, Pension Index, and Alternative Securities Market Index using daily share indices ranging from 02 July, 2008 to 31 December, 2015.

The descriptive statistics obtained from the NSE sectors' returns show that the average rates of return for all the NSE sectors' returns for the study period are zero, except the insurance sector, which has negative returns. The skewness coefficients of

the All-share Index, Industrial Goods Index, and Pension Index are positive, whereas those of the Banking Index, Consumer Goods Index, NSE 30 Index, and Insurance Index are negative. All the sectors' returns have leptokurtic distribution. Estimates from Jarque-Bera normality test show that all the sectors' returns are not normally distributed. The estimates from the correlation analysis show a very weak relationship between the sectors, except for a very strong association between the Banking Index and the NSE 30 one. Weak relationships between sectors have applications in the portfolio selection and management; investors can combine negatively related sectors as a portfolio diversification and/or hedging strategy. The estimates from the autocorrelation analysis show that ASI, Banking, Oil & Gas, NSE 30, Insurance, Industrial Goods, and Pension sectors' returns are serially correlated. The existence of serial dependence in these sectors stock returns is an indication of stock returns predictability. ARCH LM coefficients for ASI, Oil & Gas, Insurance, Industrial Goods, and Pension sectors show evidence of heteroscedasticity, which indicate that sectors' returns are volatile. There is therefore the need to model the volatility of these sectors to increase the understanding of their behaviour.

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