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Measuring Leverage Effect on the Nigerian Stock Exchange in the Post Financial Meltdown TGARCH Vs EGARCH

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Abstract

The specification of appropriate leverage measurement capturing volatility in stock returns is of significant policy relevance to financial economic managers. Reliable leverage effect model of asset returns aids investors in their risk management decisions and portfolio adjustments. Researches modeling leverage effects for the Nigerian capital market are a few in the literature and many of them have been conducted prior to the 2007-2009 financial crisis. This study employed the TGARCH and EGARCH models under the three error distributional assumptions for the period of January 2010 to March 2016 using the All Share Index to generate the stock exchange return series. Findings revealed that there is leverage effect in the Nigerian stock exchange but not statistically significant under the distributional assumptions except in the Gaussian distributional assumption of the EGARCH model which shows that there is no leverage effect in the market. The EGARCH model under the student-t distribution provides the overall best estimates. This shows that the activities of rational investor to stock prices movement in expectation of future increase has not been able to drive the market in the direction of providing higher return for investors significantly. It is therefore suggested that the Nigerian Stock Market should be adequately equipped and given the necessary attention for the market to be attractive to rational and informed investors so that the leverage effect on the market can be significant and no investor will be able to earn abnormal profit or loss based on past information.

Keywords: Leverage effect, Garch, TGARCH, EGARCH, Error distribution

JEL Classification: C16, C52, G14

Paper classification: Research paper

Introduction

The investigations into capital market reaction to information, the utilization of the information and the resultant stock volatility are needed to understand how the capital market behaves. In 1970, Fama stated that a stock market is efficient if share prices fully reflect all

available information on any particular stock quoted in such market, providing no opportunities for investors to make abnormal returns by exploiting past share price movement chart for fundamental or technical analysis. The issue of efficiency is particularly important for emerging markets after the experience of the financial meltdown especially on the issues bordering on liquidity and institutional policy guidelines both of which are very important to investors as they affect risk and return exposure (Mun, Sundaram & Yin 2008).

Prior to the financial meltdown, the Nigerian Capital market witnessed considerable growth in capitalization from N764.9 billion in December 2002 which was a 10% share of the total gross domestic product at current market prices to N13.181 trillion by December 2007 as 64% share of the total market capitalization.(CBN Statistical Bulletin, 2014).

As a result of the meltdown, the market capitalization slumped to N9.563 trillion and N7.031 trillion in 2008 and 2009 respectively with 39% and 28% contribution to the GDP in those years. The market capitalisation started picking up from 2010 at N9.918 trillion to N10.275 trillion, N14.801 trillion, N19.077 trillion and N16.875 trillion in 2011, 2012, 2013, and 2014 respectively with a percentage contribution of 18%, 16%, 21%, 24%, and 19% to the GDP from 2010 to 2014 respectively (CBN Statistical Bulletin, 2014).

According to Ajakaiye and Fakiyesi (2009), the all share index has been growing over the years from a value of 11,214 and market capitalization of N663 billion in March 2002 to 63,016 in March 2008, with a market capitalisation of about N12.125 trillion after which the all share index fell to 21,813 points in January 2009, with a market capitalisation of N4.879 trillion because of the meltdown. The all share index further declined to 21,608 points, with a market capitalisation of N4.836 trillion, by the end of the second week of March 2009.

Table 1: Value of Nigerian Stock Exchange Capitalization as % of GDP (2000-2014)

Year	Market Capitalization in N' Billion	Gross Domestic Product (GDP) at current market prices in N' billion	% of market capitalization to GDP
2000	472.3	6,713.57	7
2001	662.5	6,895.20	10
2002	764.9	7,795.76	10
2003	1,359.3	9,913.52	14
2004	2,112.5	11,411.07	19
2005	2,900.1	14,610.88	20
2006	5,120.9	18,564.59	28
2007	13,181.7	20,657.32	64
2008	9,563.0	24,296.33	39
2009	7,030.8	24,794.24	28
2010	9,918.2	54,612.26	18
2011	10,275.3	62,980.40	16
2012	14,800.9	71,713.94	21
2013	19,077.4	80,092.56	24
2014	16,875.1	89,043.62	19

Source: CBN Statistical Bulletin, 2014

Therefore, there are concerns regarding how rapidly the global financial crisis penetrated the Nigerian capital market, which prompted studies (Arunma 2010; Ayuba 2011; Jenrola & Daisi 2012; Njiforti 2015; Olowe 2009; Ujunwa, Salami & Umar 2011; Yahya, Abdulraheem, Babaita, Aliu, & Yisau 2011; among others) on the effect of the global financial crisis on the Nigerian capital market. Findings on the impact of the financial meltdown have been mixed. While some studies found that the meltdown has affected the Nigerian capital market (Arunma 2010; Ayuba 2011; Njiforti 2015; Ujunwa et al 2011; Yahya, et al 2011) other studies (Jenrola & Daisi 2012 and Olowe 2009 among others) concluded that the financial crisis do not affect the capital market.

The crisis manifested itself affecting the world economies in the form of liquidity and credit crunch, breakdown of confidence in the banking system, de-leveraging and banks inability to improve capital adequacy, weak consumer demand, and fall in global output, affected Nigeria through both the financial and real (trade, remittances and aid) channels (Njiforti 2015). Black (1976) noted that a fall in the value of a firm's stock will cause a negative return on its stock, and will usually increase the leverage of the stock which will cause a rise in the debt-equity ratio. This increase in leverage raises the riskiness of the firm as the shareholders perceive their future cash flow stream as being relatively more risky thereby leading to higher level of volatility.

Volatility in the value of stock tends to have a corresponding effect on the economy; increase in share prices stimulates investment and increases the demand for credit, which eventually leads to higher interest rates in the economy (Spiro, 1990). Increase in interest rate is a potential danger because the variance (risk) of inflation positively responds to the increase in interest rate (Fischer 1981). The specification of appropriate leverage measurement capturing volatility in stock returns is of significant policy relevance to economic managers. More so, reliable leverage effect model of asset returns aids investors in their risk management decisions and portfolio adjustments.

The objective of this paper is to measure the leverage effect on the Nigerian capital market in the post financial meltdown using two GARCH models to provide empirical evidence to support which of the models is better. Many of the studies seen so far measure the leverage effect by using single GARCH model (Emenike 2014; Jayasuriya 2002; Ogum et al 2005; Olowe 2009; Osazevbaru 2014; among others) or varieties of the GARCH models (Adesina 2013; Atoi 2014; Bala & Asemota 2013; Hamadu & Ibiwoye 2010; Emenike & Aleke 2012; Olweny & Omondi 2011; Onwukwe, et al 2011; Osarumwense 2015; among others) but few of the studies (Atoi 2014; Hamadu & Ibiwoye 2010; Onwukwe, et al 2011; Osarumwense 2015) compare to ascertain which model is better to measure leverage effect on the Nigerian capital market. In the same vein, the studies were conducted prior to the financial meltdown while other studies used data that covers the period prior and during the financial crisis period.

Research Gap and Contribution of the study

Researches modeling leverage effect for the Nigerian capital market are a few in the literature and many of them have been conducted prior to the financial crisis (Jenrola & Daisi 2012; Ogum, Beer & Nouyrigat 2005; Okpara & Nwezeaku 2009; Onwukwe, Basse & Isaac 2011; among others) or even using data range covering the period of pre and during the crisis (Atoi 2014; Emenike & Aleke 2012; Olowe 2009; Osazevbaru 2014) and their findings have been mixed. Okpara and Nwezeaku (2009), found that unexpected drop in price (bad news) increases predictable volatility more than unexpected increase in price (good news) of similar magnitude; Emenike and Aleke (2012) in a study revealed that positive news produce higher volatility in the immediate future than negative news of the same magnitude in Nigeria capital market; Onwukwe, Basse and Isaac

(2011) found that return series exhibit leverage effect leptokurtosis, negative skewness, which are common to most economic financial time series and that the estimation results reveal that the GJR-GARCH (1, 1) gives better fit to the data and is found to be superior both in-sample and out-sample forecasts evaluation.

Osazevaru (2014) found that the estimates indicate that the Nigerian capital market exhibits volatility clustering; Atoi (2014) in a study revealed the presence of leverage effect meaning that volatility responds more to bad news than it does to equal magnitude of good news and also suggested that Power-GARCH (1, 1, 1) in student's distribution is the best predictive model.

A few studies have been done to capture the post financial meltdown data and prominent one is the work of Osarumwense, (2015). The work studied the day-of-the-week effect in the Nigerian stock market returns and volatility, the result indicated that the effect of good or bad news on volatility does not depend only on the asymmetric model but sensitive to the distributional assumptions adopted and as such, the day-of-the-week effect in the Nigerian stock market is not real.

This study will therefore fill the gap of measuring leverage on the Nigerian capital market after the financial meltdown and it will provide policy guideline for the regulators and investors on risk-return information on the Nigerian capital market. The contribution of this paper is to measure the leverage effect on the Nigerian capital market in the post financial meltdown using two GARCH models to provide empirical evidence to support which model is better to estimate and predict volatility and leverage effect on the Nigerian Stock Exchange in the post financial meltdown period.

The empirical model consists of weekly data over the period of January 2010 to March 2016 using the all share index on the Nigeria capital market. The study employed the EGARCH and the TGARCH models based on the finding of Engel (1982) that an adequate volatility model is the one that sufficiently models heteroscedasticity in the disturbance term and also captures the stylized fact such as volatility clustering, Autoregressive Conditional Heteroscedasticity (ARCH) effect and asymmetry.

Review of Related Literature

This section contains the reviews of the concept of leverage effect as related to the capital market, the theoretical background such as the information asymmetry theory, trade off theory are also discussed and the relevant empirical literatures are reviewed.

Conceptual Review

Leverage effect indicates that stock volatility is negatively correlated to stock return; stock volatility tends to increase when stock prices drop. There are two common economic explanations for the leverage effect. The first explanation is based on the relationship between volatility and expected returns, when volatility rises expected returns tend to increase, leading to a drop in stock price, indicating a negative correlation between volatility and stock returns. The second explanation is based on financial leverage, when stock prices fall financial leverage increases, leading to an increase in stock return volatility (Aydemir Gallmeyer & Hollifield, 2008).

Black (1976) explained that leverage effect implies that a negative shock to the conditional variance tends to cause volatility to rise by more than a positive shock of the same magnitude. Decrease in the value of a firm's stock will lead to negative return on its stock, and will usually

increase the leverage of the stock which will cause a rise in the debt-equity ratio. The increase in leverage raises the riskiness of the firm as shareholders will perceive their future cash flow being relatively more risky leading to increased volatility.

Volatility feedback is another explanation for asymmetric effects. Campbell and Hentschel (1995) opined that volatility is a measure of risk whereby an increase in volatility signals a higher risk with higher expected future return and hence, investors will pay less for the equity. Avramov, Chordia and Goyal (2006) explain that stock trading activity causes asymmetric effects because low level of return predictability as a result of time variation is consistent with rational asset pricing. Thus, irrational investors sell when stock prices fall, leading to an increase in stock returns volatility, while rational investors sell after stock price rises, which leads to a decline in volatility.

Theoretical Background

Profit opportunities as represented by the availability of the so called “undervalued” and “overvalued” stocks motivate investors to trade which in turn moves the prices of stocks. Thus, financial analysts’ search for stocks that are mispriced and the subsequent trading make stock prices to reflect their intrinsic values and the market becomes efficient. Information is randomly favorable or unfavorable relative, likewise changes in stock prices exhibit “random walk”, as such, abnormal profit or return cannot be earned by investors in an efficient market (Jones and Netter 2008).

Market Volatility proposes an innovative theory, backed by substantial statistical evidence, on the causes of price fluctuations in speculative markets. It challenges the standard efficient markets model for explaining asset prices by emphasizing the significant role that popular opinion or psychology can play in price volatility (Shiller 1990).

The Popular Models Theory

The popular models are a qualitative explanation of price fluctuations which asserts that investors’ psychological or sociological beliefs exert greater influence on their reaction to the market information than good economic sense arguments. Shiller (1981) is firm advocate of the popular model explanation of stock market volatility which was supported in the independent studies of Le Roy and Porter (1981).

The model does not totally disregard the Efficient Market Hypothesis (EMH) but advocates that investors’ attitudes are of great importance in determining price levels and the existence of excess volatility in the stock market which cannot be totally explained by the EMH. According to the theory, this excess volatility can be attributed to investors’ psychological or sociological behavior, such as a collective change of mind by the investing public as a result of the thoughts and beliefs on future events.

The popular theory proposes that the investing public can act inappropriately to information received, as such, freely available information is not necessarily already incorporated into a stock market price as proposed by the EMH. Also, since price equals the best possible forecast or expectation of ex-post value, therefore, capital gains or losses as a result of price fluctuations have no effect on ex-post values since true ex-post values only reflect the inflows that the investment itself produces. If the EMH fails to hold, the gains or may simply be a reaction to other investors’ actions.

If the efficient market is a reality these gains or losses are just related to changes in information about ex-post values. If the EMH does not hold, then these gains or losses have nothing to do with ex-post values and may simply be a reaction to other investors’ actions.

The theory argued that volatility in share price is too high is to be seen as a result of changes in information. It posit that the use of dividends does not accurately reflect the simple efficient market model and that earnings which can be manipulated to show what the accountant wants to show about a particular stock is only an accounting concept only relevant to the share price as indicator of future dividends.

Empirical Review

Many empirical studies have been conducted to confirm the existence or otherwise of leverage effect in different stock markets across the world using different kind of model to estimate leverage effect (Adesina 2013; Al- Hasan & Gupta 2013; Atoi 2014; Emenike & Aleke 2012; Giacomini, Ling & Naranjo 2014; Goudarzi and Ramanarayanan, 2011; Mun, et al 2008; Olowe 2009; Onwukwe et al 2011; Ur Rehman 2013; among others).

The Autoregressive Integrated Moving Average (ARIMA) model of Box and Jenkins (1976) and Black and Scholes (1975) models were frequently used in empirical works to investigate leverage effect and volatility of assets returns and option pricing (Haque, Hassan, Maroney & Sackley 2004 and Poon & Granger, 2003). The two models were based on the wrong assumptions of constant variance as documented by Baillie, Bollerslev & Mikkelsen (1996), Chou (1988), Fama (1965), Mandelbrot (1963) and Schwert (1989) while the lognormal distribution gave spurious results and the models failed to capture some salient stylized facts of returns dynamics such as volatility clustering, leverage effect and leptokurtosis which are widely documented empirical evidences (Emenike & Aleke 2012; Klar, Lindner & Meintanis 2012; Onwuke et al 2011).

Therefore, there is the need to construct models that will accommodate heteroskedasticity in order to estimate valid coefficient for the variance of the error terms. Such model was first introduced by Engle (1982) by relating the conditional variance of the error term to the linear combination of the squared error terms in the recent past known as the Autoregressive Conditional Heteroskedasticity (ARCH) model. According to Emenike and Aleke (2012), because of the long lag length and large parameters required to estimate ARCH model, Bollerslev (1986) introduced the GARCH model by modeling the conditional variance to depend on its lagged values as well as squared lagged values of the error terms.

The ARCH and GARCH models is able to capture a special type of non-linearity in the data process in a multiplicative non-linearity form, through its variance as a result of the presence of conditional heteroskedasticity (Hsieh 1989), but it failed to capture the asymmetric effects (the response of volatility to negative and positive news) hence, the Exponential GARCH (EGARCH) was introduced by Nelson (1991), the GJR-GARCH (Threshold GARCH) introduced by Glosten, Jagannathan, and Runkle (1993) modified by Zakoian (1994), Asymmetric Power ARCH (APARCH) introduced by Ding, Engle and Granger (1993) were some of the GARCH models that capture the asymmetric effect of financial time series.

Several empirical works have been done since the seminar paper of Engel (1982) on volatility modelling, especially in finance, even though a number of theoretical issues are still unresolved (Atoi 2014; Franses & McAleer 2002; Hsieh 1989). Wilhelmsson (2006) investigated the GARCH model forecasting performance in nine different error distributions using S&P 500 index return series from intra-day data and concluded that allowing for a leptokurtic error distribution provides significant variance forecast compared to the normal error distribution.

Yeh and Lee (2000) examined investors' response to unexpected returns and information transmission in the greater China area stock markets, employed the TGARCH model and

concluded that the impact of bad news (negative unexpected return) on future volatility is greater than the impact of good news (positive unexpected return) of the same magnitude in Taiwan and Hong Kong stock market, while the impact of good news on future volatility is greater than impact of bad news of equal magnitude in the Shanghai and Shenzhen markets. Coffie (2015) studies the performance of asymmetric GARCH models (GJR-GARCH and EGARCH) for Ghana and Nigeria stock market returns and shows that both the GJR and EGARCH models capture the leverage effect of Ghana's Stock Exchange returns which indicates the existence of leverage effect (negative shocks imply a higher next period conditional variance than positive shocks of the same magnitude).

Lee, Chen and Rui (2001) examined time series features of China Stock returns and volatility in the Shanghai A & B and Shenzhen A & B Index and employed the Variance Ratio Test, GARCH, EGARCH and GARCH-M. The study rejects the random walk hypothesis with strong evidence of time-varying volatility, leverage effect and volatility persistence. Mun et al (2008) estimated leverage effect of the Malaysian stock market and its efficiency using EGARCH and the Augmented Dickey-Fuller (ADF) by employing the weekly closing prices of the Kuala Lumpur Composite Index (KLCI). The results did not confirm the existence of the leverage effect and suggests that Kuala Lumpur Stock Market is weak form efficient.

Al- Hasan and Gupta (2013) investigated the effect of leverage on shareholders' return in the form of Earnings Per Share (EPS) of some listed companies under four industries in Bangladesh using simple regression model for the pooled data and the result revealed that leverage has statistically significant effect on the shareholders' return and proper management of leverage can maximize the value of EPS. Olweny and Omondi (2011) studied the effect of foreign exchange, interest and inflation rates fluctuation on stock return volatility on the Nairobi stock exchange by using the monthly time series data for ten years period of 2001 and 2010 and employing the EGARCH and TGARCH. The results showed that the stock returns are symmetric but leptokurtic and not normally distributed and there was evidence of leverage effect.

Bekaert and Wu (2000) simultaneously investigated the asymmetric volatility at the firm and market level and also examined leverage effect and volatility feedback using the market portfolio and portfolio with different leverage from the Nikkei 225 stock. Findings showed no leverage effect but there exists volatility feedback. In a similar study by Long, Tsui and Zhang (2014) on the mainland Chinese stock market indicated that there is significant leverage effect in the markets during the sample period in 2000–2013.

In the context of Nigeria, studies have documented evidence of stock returns to exhibit volatility clustering, leptokurtosis and leverage effect (Adesina 2013; Alagidede and Panagiotidis (2009); Emenike 2014; Onwukwe et al 2011; Atoi 2014; Olowe 2009; Osarumwense 2015; Aliyu 2011; Okpara & Nwezeaku 2009; Okpara (2008 & 2011); Coffie 2015; Emenike & Aleke 2012; Osazevaru 2014; Ogum et al 2005; Uyaebo, Atoi, & Usman 2015; Emenike 2010; among others) with mixed findings on the leverage effect of returns on the Nigerian stock market.

Adesina (2013), Coffie (2015), Emenike and Aleke (2012), Ogum et al (2005), Uyaebo et al (2015), Osazevaru (2014) in their respective studies covering various time horizon found that the Nigerian capital market exhibit volatility clustering and no leverage effect. On the contrary, findings of Onwukwe et al (2011), Atoi (2014), Olowe (2009), Okpara and Nwezeaku (2009), Okpara (2008 & 2011), Emenike (2010), Alagidede and Panagiotidis (2009), indicates the existence of volatility clustering and leverage effect in their respective studies covering different time horizon. The study of Emenike (2014) shows that there exist directional shock transmission

between the stock market and the foreign exchange market in Nigeria while Aliyu (2011) indicates the existence of volatility clustering but inconclusive on the leverage effect because the coefficient is rightly signed but not statistically significant.

The studies that made comparison of the models also have mixed results for the Nigerian capital market, TGARCH on student- t is best fit for estimating the volatility in the study of Uyaebo et al (2015), Onwukwe et al (2011) indicates the TGARCH(GJR-GARCH) is superior for both in-sample and out-sample forecast and evaluation, Atoi (2014) adjudged the Power-GARCH (1,1,1) in student- t error distribution as the best predictive model based on root mean square error and Coffie (2015) shows that the GJR-GARCH as the best model for estimating volatility.

Some of the authors have consistently ignored the contribution of error assumptions on volatility modeling which could undermine the appropriateness of model results (Uyaebo et al 2015) but Osarumwense (2015) testing for the day-of-the-week effect indicates that there is volatility clustering but it doesn't depend only on the asymmetric model but sensitive to error distribution assumption.

Methodology

This section discusses the empirical methodology used in this study to measure leverage effect on the Nigerian Stock Exchange after the financial meltdown. Commencing with the section that provides, justifies and explains the model followed by the measurement of variables and nature of the data that is used to measure the leverage effect on the Nigerian Stock Exchange and the method of data analysis.

Model Specification

In 1982, Engle observed in a study that the Auto-Regressive Conditional Heteroskedasticity (ARCH) and its extension models sufficiently captured the heteroskedasticity in the error term and volatility clustering term in stock return series. As such, the ARCH models used in this study are the Threshold Generalised Auto-Regressive Conditional Heteroskedasticity (TGARCH) also known as the GJR-GARCH and the Exponential Generalised Auto-Regressive Conditional Heteroskedasticity (EGARCH). The unit root test was conducted on the return series before applying the ARCH models.

Unit Root Model

Modeling the All Share Index (ASI) return, there is the need to check for the stationarity of the data. To achieve this, the Augmented Dickey-Fuller (ADF) unit root test is employed based on the following regression:

The ADF Model

$$\Delta ASI_t = \alpha + \beta_t + \gamma ASI_{t-1} + \sum_{i=1}^n \Delta ASI_{t-i} + \epsilon_1 \dots \dots \dots 1$$

Where α is the constant, β_t is the coefficient on a time trend, $t - i$ is the lag order of the auto-regressive process, Where ΔASI is the first difference of the series ASI , γ is the unit root coefficient, ϵ_1 is the white noise error term. The Augmented Dickey-Fuller (ADF) tests the null hypothesis of a unit root against a trend stationary. i.e $H_0: \gamma = 0$. Therefore, the a priori expectation set by the ADF test is that for the time series data to be applicable for analysis the series should be stationary.

The Conditional Returns Equation

The conditional returns equation is developed to ascertain the volatility of the residual and test it for the condition of applying the ARCH models. The general form of the return can be expressed as a process of autoregressive AR_(p) up to (p) lags. The equation that is developed for this purpose is

$$\begin{aligned}
 ASI_{rt} &= c + \sum_{i=1}^p \alpha_i ASI_{rt-i} + \varepsilon_{1t} \\
 ASI_{rt} &= C + \sum_{i=1}^p \alpha_i ASI_{rt-i} + \varepsilon_{1t} \dots\dots\dots 2
 \end{aligned}$$

The above equation implies that the current ASI return depends not only on ASI_{t-1} but also on the previous (p) values of ASI_{rt-p} . The ε_{1t} is the error terms which will be tested for ARCH effect and volatility clustering and from which the conditional variance equation will be derived for both EGARCH and TGARCH models.

The Exponential GARCH and the Threshold GARCH Models

The Exponential GARCH (EGARCH) model proposed by Nelson (1991) allows for asymmetric effects between positive and negative asset returns. The specification of the EGARCH model according to Nelson (1991) is:

$$\log(\sigma_t^2) = \omega + \sum_{i=1}^p \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right| + \sum_{k=1}^r \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} + \sum_{j=1}^q \beta_j \log(\sigma_{t-j}^2) \dots\dots\dots 3$$

Where σ_t^2 is the conditional variance (one-period ahead forecast variance based on past information) of the error term from the return equations, ω is the constant, ε_{t-1} is the ARCH term depicting the previous period squared error term from the return equations and σ_{t-1}^2 is the GARCH term depicting the previous period conditional variance.

When ε_{t-i} is good or positive news the total effect is measured by $(1 + \gamma_k) |\varepsilon_{t-i}|$ and when ε_{t-1} is bad or negative news the total effect is measured by $(1 - \gamma_k) |\varepsilon_{t-1}|$. The EGARCH covariance stationary is provided by $\sum_{i=1}^q \beta_j < 1$. Therefore, the conditional variance equation for EGARCH (1,1) model used in this study is as follows:

$$\log(\sigma_t^2) = \omega + \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right| + \gamma_k \frac{\varepsilon_{t-i}}{\sigma_{t-i}} + \beta_j \log(\sigma_{t-1}^2) \dots\dots\dots 4$$

The Threshold GARCH (TGARCH) model also known as the GJR-GARCH was introduced by Glosten, et al (1993) and the Threshold ARCH (TARCH) model proposed independently by Zakoian (1994) also allows for asymmetric effects between positive and negative asset returns. The general specification of the TGARCH/TARCH model is given as:

$$\sigma_t^2 = \omega + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^r \gamma_i \varepsilon_{t-i}^2 d_{t-i} + \sum_{j=1}^q \beta_j \sigma_{t-i}^2 \dots\dots\dots 5$$

Where σ_t^2 is the conditional variance (one-period ahead forecast variance based on past information) of the error term from the return equations, ω is the constant, ε_{t-1}^2 is the ARCH term depicting the previous period squared error term from the return equations and σ_{t-1}^2 is the GARCH term depicting the previous period conditional variance.

$$d_{t-i} = \begin{cases} 1 & \text{if } \varepsilon_{t-i} < 0 \\ 0, & \text{if } \varepsilon_{t-i} \geq 0 \end{cases}$$

Depending on whether ε_{t-i} is above or below the threshold value (d_{t-1}) of zero, ε_{t-i} has different effects on the conditional variance σ_t^2 : when ε_{t-i} is positive news, the total effect is given

by $\alpha_i \varepsilon_{t-i}^2$ and when ε_{t-i} is negative news, the total effect is given by $(\sigma + \gamma_i) \varepsilon_{t-1}^2$. Therefore, the conditional variance equation for TGARCH/TARCH (1,1) model used in this study is as follows:

$$\sigma_t^2 = \omega + \alpha_i \varepsilon_{t-1}^2 + \gamma_i \varepsilon_{t-1}^2 d_{t-1} + \beta_j \sigma_{t-1}^2 \dots\dots\dots 6$$

Where $d_{t-1} = 1$ if $\varepsilon_{t-1}^2 < 0$ and $d_{t-1} = 0$ if $\varepsilon_{t-1}^2 > 0$.

A Priori Expectation of EGARCH and the TGARCH Models

The EGARCH model stipulates that to measure the leverage effect, $\gamma_k < 0$. In other words, for bad news to have a larger impact on volatility, the value of γ_k is expected to be negative.

The TGARCH model stipulates that to measure the leverage effect, $\gamma_i > 0$. In the same vein, for bad news to have a larger impact on volatility, the value of γ_i is expected to be positive.

Distributional Assumptions

GARCH models are estimated using the Maximum Likelihood Estimation (MLE) process (Coffie 2015) assumes that the error distribution is normal (Gaussian), though Nelson (1991) opined that the error exhibits non-normal distribution densities. Thus, to estimate the ARCH model, there is the need for the assumption of conditional distribution for the error terms.

In this study, three (3) conditional distributions for the standardized residuals of returns innovations; the Gaussian distribution, student-t distribution, and the Generalised Error Distribution (GED) are used in the empirical analysis.

The Gaussian (normal) distribution is expressed as:

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x-\mu)^2/\sigma^2}$$

Where μ is the mean value and σ^2 is the variance of the error from the return equation. The standard Gaussian distribution considers the mean value (μ) = 0 and variance (σ^2) = 1.

The student-t distribution is given as:

$$f(x) = \frac{\Gamma[\frac{v+1}{2}]}{\sqrt{v\pi[\frac{v}{2}](1+\frac{x^2}{v})^{\frac{v+1}{2}}}}$$

Where v is the degree of freedom ($v > 2$), if v tend to ∞ , the student-t distribution converges to the Gaussian distribution with an implied kurtosis of $k = (\frac{6}{v} - 4) + 3$ for all $v > 4$.

The Generalised Error Distribution (GED) is a symmetric distribution and platykurtic with the following density function:

$$f(x) = \frac{v e^{\frac{1}{2}|\frac{x}{\lambda}|}}{\lambda 2^{\frac{v+1}{v}} \Gamma_{1/v}}$$

Where $\lambda = [\frac{2^{-2/v} \Gamma_{1/v}}{\Gamma_{3/v}}]^{1/2}$

It includes the normal distribution if the parameter v has a value of two and when $v < 2$ indicates fat tail distribution.

Measurement of Variables and Nature of Data

Secondary data is used for this study, sourced through the Nigerian Stock Exchange internet. The research population is the Nigerian Stock Exchange, using the All Share Index (ASI) and the return indicator is defined in the log form as:

$$ASI_{rt} = \log(ASI_t - ASI_{t-1})$$

Where ASI_t is All Share Index at time t (particular/current week in this case) and ASI_{t-1} is All Share Index at time $t - 1$ (current/particular week minus previous week) to measure leverage effect on the Nigerian Stock Exchange after the financial meltdown.

The sample size is the weekly data of all share index during the post financial meltdown between the periods of January 2010 and March 2016. The period is chosen because the study aims to measure leverage effect on the Nigeria Stock Exchange in the post financial meltdown and the financial meltdown subsides in the year 2010 and the choice of the end period is as a result of the time frame available for the study.

Hypothesis of the Study

In order to provide a framework to test for leverage effect on the Nigerian stock market in the post financial meltdown period, the following hypotheses was formulated in the null form:

Ho: There is no significant leverage effect on the Nigerian stock market after the financial meltdown.

Method of Data Analysis

The data collected will be tested and analyzed with the use of E-views 7 by applying the models as stated above. This software will be used to run the ARCH models to analyse the data in order to measure the leverage effect on the Nigeria capital market during the post financial meltdown.

The ASI_{rt} is tested for unit root using the ADF unit root test, and the conditional return equation is determined using the Ordinary Least Square (OLS) to estimate the error term. The behavior of the error term (ε_{1t}) of the returns equation is used to determine volatility persistence and ARCH effect of returns in the Nigerian capital market after the financial meltdown. The values of γ_k and γ_i as good or bad news are used to measure the leverage effect on the Nigerian capital market after the financial meltdown.

The EGARCH and TGARCH/TARCH (1,1) are tested to determine which of the model is best for estimation using the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) under the various distributional assumptions. Diagnostic checking is also done to test if the models {EGARCH (1,1) and the TGARCH/TARCH (1,1)} are good for policy consideration and implementation. The diagnostic test includes serial correlation test, ARCH effect and normality test of the residuals distributions.

Analysis and Discussion of Findings

This section presents the findings from the EGARCH and TGARCH models under the three error distributional assumptions as presented under empirical methodology section. The result is expected to show the leverage effect or otherwise on the Nigerian stock market in the post financial meltdown and its significance.

Unit Root Test

The result of the Augmented Dickey Fuller (ADF) stationary test conducted on the ASI_{rt} used for analysis is shown in Table 2. The ADF value of -17.14448 has a probability value of 0.0000 less than 1%, 5% and 10%. Therefore, the values of ASI_{rt} are stationary at level and there is no need to difference the values. In other words, the null hypothesis that the data need to be differenced to make it stationary (has a unit root) is rejected.

Table 2: Augmented Dickey-Fuller Test Statistics Result

Variables	ADF	1%	5%	10%	P-Value
ASI_{rt}	-17.14448	-3.450411	-2.870274	-2.571493	0.0000

*significant at 5%

Source: Authors computation, 2016.

Conditional Return Equation

The conditional return equation of the ASI_{rt} as produced by the OLS equation is given in Table 3 and the residuals behaviour is shown in Figure 1.

Table 3: Mean Equation Result

Variables	Coefficient	Standard Error	t-Statistics	P-Value
Constant	11.33427	48.97998	0.231406	0.8171
$ASI_{rt(-1)}$	0.044246	0.055747	0.793686	0.4280

Source: Authors computation, 2016.

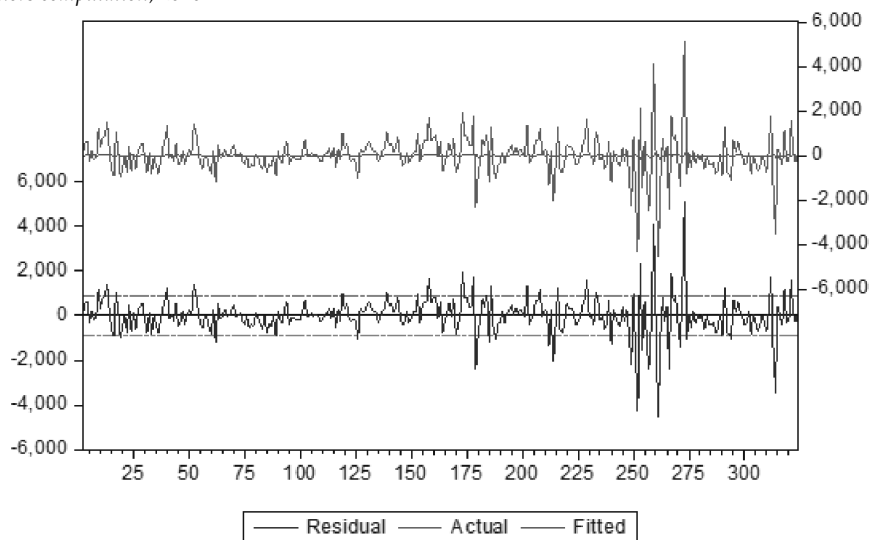


Figure 1: Residual Behavior of the Mean Equation

The residual as depicted in figure 1 indicates that volatility is persistent in the returns of the Nigerian Stock Exchange. In the same vein, high volatility in the return series is followed by another high volatility in the next period for prolonged time and low volatility in the return series is followed by low volatility in the next period for a prolonged time.

Table 4: Heteroskedasticity Test: ARCH Effect Result

Statistics	Value	P-Value
F-statistics	3.474615	0.0632
Observed R ²	3.458775	0.0629

Source: Authors computation, 2016.

Table 4 shows the ARCH effect test result of the residuals and it reveals that there is ARCH effect at 10% significance level with the probability value of 0.0629 indicating that the null hypothesis of no ARCH effect should be rejected as equally depicted in figure 1.

Therefore, the pre-conditions for the application of the GARCH models are to establish volatility clustering and the presence of ARCH effect in the residual the conditional return equation. These conditions have been fulfilled by the model and thus it is justified to proceed to the measurement of the leverage effect of the return series for the Nigerian Stock Exchange during the post financial meltdown.

EGARCH and TGARCH models under the Distributional Assumptions

Table 5 and 6 show the TGARCH and EGARCH estimates under various distributional assumptions.

Table 5: TGARCH Result

Parameters	Gaussian Distribution		Student-t Distribution		Generalised Error Distribution	
	Estimates	P-Value	Estimates	P-Value	Estimates	P-Value
ω	72014.57	0.0001	75458.1	0.0275	68900.39	0.0165
α_1	0.332622	0.0001	0.246350	0.0372	0.257092	0.0257
γ_1	0.029337	0.8023	0.101419	0.5276	0.084998	0.5861
β_1	0.581823	0.0000	0.635587	0.0000	0.619815	0.0000
AIC	16.02441		15.96082		15.96105	
SC	16.09458		16.04269		16.04292	

Source: E-views output run by the Author, 2016

Table 5 shows the estimates of the TGARCH model indicates that the γ_1 coefficients under the distributional assumptions are 0.029337, 0.101419 and 0.084998 for the Gaussian, Student-t and Generalised Error Distributions (GED) respectively. The γ_1 estimates are positive as expected by the TGARCH model but they are all not statistically significant, which translates to mean that there exists leverage effect but it is not statistically significant.

Table 6: EGARCH Result

Parameters	Gaussian Distribution		Student-t Distribution		Generalised Error Distribution	
	Estimates	P-Value	Estimates	P-Value	Estimates	P-Value
ω	0.398094	0.0769	1.039597	0.0814	0.779274	0.1185
α_1	0.379797	0.0000	0.466382	0.0003	0.422339	0.0000
γ_1	0.000994	0.9821	-0.028915	0.6847	-0.019361	0.7673
β_1	0.948643	0.0000	0.896772	0.0000	0.917293	0.0000
AIC	16.02868		15.95860		15.96144	
SC	16.09885		16.04047		16.04331	

Source: E-views output run by the Author, 2016

Table 6 is the estimates of the EGARCH model showing that the γ_k coefficient under the Gaussian, Student-t and Generalised Error Distributions (GED) assumptions are 0.000994, -0.028915 and -0.019361 respectively. The student-t and the GED assumptions estimates are correctly signed as negative coefficients as expected by the EGARCH model but they are not statistically significant, which indicates that there exist leverage effect but not significant while the estimate of the Gaussian distribution is not correctly signed and not significant and it means that volatility responds more to positive (good) news than it does to negative (bad) news of equal magnitude pointing to the fact that there exists no leverage effect on the Nigerian Stock Market.

The finding is not in total support of Adesina (2013), Coffie (2015), Emenike and Aleke (2012), Mun et al (2008), Uyaebo (2015) and not in outright contrast with Atoi (2014), Emenike (2010), Okpara (2010), Okpara and Nwezeaku (2009) and Onwukwe et al (2011). The TGARCH and the EGARCH models indicate that the student-t distribution estimates are the better model while the EGARCH model provides the overall best estimates using the student-t distribution as indicated by the values of the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC) which is in support of the findings of Albergh, Shalit and Yosef (2008), Atoi (2014) and in contrast with the findings of Coffie (2015), Emenike (2010), Goudarzi and Ramaranayanan (2011) and Onwukwe et al (2011).

Diagnostic Tests

The diagnostic tests of serial correlation and ARCH effect were conducted on the estimates of the student-t distributional assumptions for both the EGARCH and the TGARCH models as they are the best models as indicated by the AIC and SC.

Table 7: Heteroskedasticity Test: ARCH Effect Result

EGARCH Model			TGARCH Model		
Statistics	Value	P-value	Statistics	Value	P-value
F-statistics	0.036313	0.8490	F-statistics	0.000032	0.9955
Observed R ²	0.036536	0.8484	Observed R ²	0.000032	0.9955

Source: Authors computation, 2016

In Table 7 the ARCH effect test estimates, indicates, that the residuals of the two (2) models have no ARCH effects with the F-statistics and observed R² value of 0.036536 and 0.36536 respectively with the probability values of 0.8490 and 0.8484 for the EGARCH model. The F-statistics and observed R² value of 0.000032 and 0.000032 respectively with the probability values of 0.9955 and 0.9955 for the TGARCH models respectively also indicates that there is no ARCH effect and this is a desirable outcome for the models.

Table 8: Residuals Serial Correlation Results

Serial Correlation Tests (EGARCH model)					Serial Correlation Tests (TGARCH model)				
Lag	AC	PAC	Q-Stat	P	Lag	AC	PAC	Q-Stat	P
1	-0.011	-0.011	0.0369	0.848	1	0.000	0.000	3.E-05	0.995
2	0.046	0.045	0.7166	0.699	2	0.028	0.028	0.2507	0.882
3	-0.045	-0.044	1.3714	0.712	3	-0.037	-0.037	0.6920	0.875
4	-0.012	-0.015	1.4180	0.841	4	-0.013	-0.014	0.7508	0.945
5	-0.016	-0.012	1.5047	0.913	5	-0.019	-0.017	0.8659	0.973
6	0.012	0.011	1.5528	0.956	6	0.014	0.014	0.9339	0.988
7	0.073	0.074	3.3280	0.853	7	0.040	0.040	1.4556	0.984

8	-0.041	-0.043	3.8993	0.866	8	-0.048	-0.051	2.2282	0.973
9	0.018	0.011	4.0018	0.911	9	0.028	0.027	2.4901	0.981
10	0.053	0.064	4.9384	0.895	10	0.037	0.043	2.9547	0.982
11	-0.081	-0.085	7.1673	0.785	11	-0.076	-0.081	4.9215	0.935
12	0.173	0.173	17.229	0.141	12	0.146	0.148	12.074	0.440
13	-0.064	-0.058	18.601	0.136	13	-0.067	-0.067	13.591	0.403
14	0.090	0.070	21.344	0.093	14	0.065	0.057	15.014	0.377
15	-0.007	0.020	21.359	0.126	15	0.013	0.030	15.072	0.446
16	-0.038	-0.061	21.849	0.148	16	-0.036	-0.055	15.514	0.487
17	0.015	0.030	21.921	0.188	17	0.019	0.036	15.633	0.550
18	-0.038	-0.030	22.416	0.214	18	-0.034	-0.033	16.042	0.590
19	-0.011	-0.047	22.458	0.262	19	-0.001	-0.022	16.042	0.654
20	0.039	0.074	22.975	0.290	20	0.060	0.093	17.285	0.634
21	0.115	0.096	27.564	0.153	21	0.138	0.117	23.940	0.296
22	-0.021	-0.047	27.717	0.185	22	-0.007	-0.024	23.959	0.349
23	0.038	0.082	28.227	0.207	23	0.029	0.064	24.250	0.390
24	0.115	0.072	32.868	0.107	24	0.138	0.110	30.963	0.155
25	-0.039	-0.006	33.404	0.121	25	-0.035	-0.005	31.391	0.176
26	-0.018	-0.037	33.515	0.148	26	-0.023	-0.039	31.579	0.207
27	0.012	0.006	33.569	0.179	27	0.008	0.005	31.602	0.247
28	-0.057	-0.050	34.717	0.178	28	-0.052	-0.036	32.549	0.253
29	-0.003	-0.004	34.721	0.214	29	-0.009	-0.015	32.580	0.295
30	0.013	0.009	34.785	0.251	30	0.016	0.011	32.671	0.337
31	-0.050	-0.070	35.667	0.258	31	-0.056	-0.073	33.800	0.334
32	-0.008	0.011	35.692	0.299	32	-0.015	0.002	33.877	0.377

L, *AC*, *PAC*, *Q-Stat* and *P* indicate the lags, the autocorrelation function, the partial correlation function, the Ljung–Box *Q*-Statistic and the probability respectively.

Source: E-views output run by the Author, 2016.

The serial correlation test result is shown in Table 8 under the autocorrelation function, the partial correlation function, the Ljung–Box *Q*-Statistic and the probabilities with lag 1 to lag 32 for the EGARCH and TGARCH residuals. The probability values from lag 1 to 32 are all more than 5% which suggest that the null hypothesis of no serial correlation is accepted which is desirable. Thus, the diagnostic test of ARCH effect and serial correlation indicates that the model estimates are good for policy consideration.

Summary, Conclusion and Recommendations

The objective of the paper is to provide a measurement of leverage effect on the Nigerian Stock Exchange in the post financial meltdown. Leverage effect indicates that stock volatility is negatively correlated to stock return; stock volatility tends to increase when stock prices drop. Leverage effect implies that a negative shock to the conditional variance tends to cause volatility to rise by more than positive shock of the same magnitude. Decrease in the value of a firm's stock will lead to negative return on its stock, and will usually increase the leverage of the stock which will cause a rise in the debt-equity ratio.

The methodology adopted is the TGARCH and EGARCH models under the Gaussian, Student-t and the Generalised Error Distribution (GED) assumptions as they are well suited to assess leverage effect. The paper used the Nigerian stock market's All-Share Index (ASI) from January 2010 to March 2016 to generate the market return series for the period. Findings show that there exists leverage effect on the Nigerian capital market but not statistically significant which does not totally support the findings of the existence of leverage as found in some studies (Adesina 2013; Coffie 2015; Emenike & Aleke 2012; Mun et al 2008; and Uyaabo 2015;) and in total contrast with studies that found no leverage effect (Atoi 2014; Emenike 2010; Okpara 2010; Okpara & Nwezeaku 2009; and Onwukwe et al (2011)).

The estimates provided by the student-t distribution is found to be the best fit model while the EGARCH estimate of the student-t estimates is adjudged to be the overall best fit model in support of the findings of Alberg, Shalit and Yosef (2008), Atoi (2014) and in contrast with the findings of Coffie (2015), Emenike (2010), Goudarzi and Ramanarayanan (2011) and Onwukwe et al (2011). The paper has provided a glance on the leverage effect on the Nigerian capital market during the post financial meltdown.

This finding points to the conclusion that the market activities of rational and informed investors on the Nigerian capital market is not significant to drive the market in order to provide adequate increased return for medium to long term investment in the market. This also points to the fact that uninformed investors dominate the market as it was experienced during the bullish period in pre financial meltdown when share prices increased with no fundamental analysis or improved company performance to support such price rise while companies with improved fundamentals and performance have not been able to attract investments during the bearish periods in the post financial meltdown because of the characteristics of the dominant investors in the Nigerian capital market as mentioned earlier.

One key policy implication of the findings is that investors on the Nigerian Stock Exchange rush for stocks with positive news more than stocks with negative news of the same magnitude which is a short term investment strategy indicating that the investors are not ready to take additional risk for increased return. This investment attitude of investors will make it difficult for the Nigerian capital market to perform and achieve its perceived economic benefit. In advanced countries, the capital market performance is seen as an indicator of the economic health of the country, thus, the Government of Nigeria should give commensurate attention to the capital market to complement the monetary policy intervention effort and attention given to the money market in order to protect depositor and achieve economic objectives by encouraging and protecting the medium to long term investors in the capital market.

Therefore, it is hereby recommended that the regulators of the Nigerian capital market (Securities and Exchange Commission) should be coming up with up to date policies and regulations that will improve the leverage effect on the market and the regulator should be given adequate support by the government. The Nigerian stock market should be adequately equipped and given the necessary attention to protect investors and make the market attractive to rational and informed investors by discouraging irrational investment.

When the market is attractive, the leverage effect on the market can be significant and no investor will be able to earn abnormal profit or loss based on past information. The presence of leverage effect (though not significant) suggests that investors in the markets are ready to be rewarded for taking up additional leverage risks; hence, investors' confidence should be boosted by putting in place a transparent legal framework and adequate implementation without fear or favour in the Nigerian capital market.

Investors on the Nigerian Stock Exchange are attracted by positive news on stock more than negative news and tend to position themselves to benefit from the positive news which is a short term investment strategy and contravenes the motive of the market as market for medium to long term investment; thus, investors education is seriously needed to encourage investor that investments in the capital market is of medium to long term horizon and it can foster rapid and sustainable infrastructural growth.

Limitations of the Study and Scope for Future Research

The main limitation of this study is that it has focused on measuring leverage effect on the Nigerian Stock Exchange in the post financial meltdown using the All Share Index for the market, and generalizing the finding for quoted stocks. The result may be different if individual stock can be studied for its own leverage effect. Also the study only employed two (2) GARCH variant model that captures leverage effect. Further research can be carried out using other GARCH model that captures leverage effect and further estimate the volatility persistence in the market and for individual stock.

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