Partial Autocorrelation Modelling of Capital Market Efficiency in Nigeria: The Random Walk Hypothesis

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ABSTRACT

This paper examines whether the Nigerian capital market follows a random walk. In the course of this study, secondary data were sourced from the Nigerian stock exchange fact book and the partial autocorrelation was employed for the all share index proxy for stock price index. The result shows that the Nigeria capital market follows a random walk and is efficient in the weak form. Furthermore, the year 1987, the period of financial deregulation, 1988 when some public companies were privatized, 1995 the period of internationalization of the Nigeria capital market and the year 2000-2006 recorded persistent volatility clustering suggesting weak form inefficiency in the market for the years, springing up till 2008 of the stock price crash. Nevertheless, parameter estimates of their conditional mean equation excerpt 1995 were insignificant. Besides these years, other years were conspiously and significantly found to exhibit weak form efficiency. Thus, the Nigerian stock market is weak form efficient to beat the market and make abnormal profit.

1. INTRODUCTION

The relevance of capital market as an efficient channel of financial intermediation and a tool for promoting economic growth and development has been recognized globally by scholars in the academia. Studies by Petru-Ovdiu, (2010), Afees and Kazeem, (2011), Chiwuba and Amos, (2011), Kolaps and Adaramola, (2012), Odetayo and Sajuyibe, (2012), Iwedi and Igbanibo, (2015), Igbanibo and Iwedi, (2015) supported the view that efficient financial intermediation is crucial to economic prosperity and positively influences well-being of a country. The Nigeria capital market has continued to play its additional role of mobilizing medium and long-term funds for development purposes and its activities have been boosted by the privatization programme of the federal government of Nigeria Sunday, Evah and Jude, (2009).

There fundamental channels through which capital markets and economic growth may be connected are identified by Pagano (1993). First, capital development increases the

proportion of saving that is channelled to investment, second, capital market development may change saving rate and hence, affect investments. Third capital market development increases the efficiency of capital allocation. In recent times, the Nigeria capital market has undergone tremendous reforms. Noteable among these is the introduction of the central security clearing system (CSCS), an automated clearing settlement and delivery system aimed at easing transactions and fostering investor's confidence in the market. Equally important is the linking of performance information on the Nigeria stock exchange to international system in order to disseminate relevant market information to subscribers.

However, the question of what determines the equilibrium prices in the stock market, or what are the right prices for an investor to buy or sell a stock in the stock market, leads to the question of what risk factors investors consider or should consider, in determining their expected rates of return from the stocks. This highlights the need to have a suitable model that can identify such risk factors and explain how investors expected rates of return are determined. The overextended stock prices in the second half of the1990s which led to the stock market collapse of the year 2000 casts' doubts on the proper mechanism for stock valuation. The knowledge of what factors determine investors return expectations enables investors to evaluate if at any particular point of time the stock or portfolio of stocks they are considering to invest in or are holding is undervalued, overvalued, or properly valued by the market and thus make the right buy, sell or hold decisions. The theory of investment posits that investors value any market that is somewhat efficient, where the rate of return commensurate with the inherent risk of investment. In other to guide against investment risks, there is the need for market to be studied in terms of pricing of securities, its efficiency and whether its price can be predictable, ideas from these will guide against investment loss and measure the extent to which a market is efficient or not, Nigeria capital market over the years cannot really be placed to be efficient or following a random walk, which form the basis for this study.

2. LITERATURE REVIEW

2.1 Theoretical Underpin

The theoretical support on the nexus between capital market and economy growth is well expanciated using the **Efficient Market Hypothesis (EMH).** The efficient market hypothesis according to Fama (1965) is an academic concept which provides a framework for examining the efficiency of the capital market. According to the EMH, capital market are efficient when prices on traded assets, have already reflected on all known information and therefore are unbiased because they represent the collective beliefs of all investors about future prospect, Olawoye (2011). Furthermore, the EMH states that all relevant information is immediately reflected in a security market price. Previous test on the EMH have relied on long range dependence of equity return. It shows that past information has been found to be useful in improving predicative accuracy. This assertion tends to invalidate the EMH in most developing countries. Using Egyptian data, Mecagni and Sourial (1999), applied the GARCH estimating methodology to show that four of the popular stock market indices did not conform to the efficient market hypothesis. Osei (2002), using Ghanaian data, explored the character of asset pricing and the response to earning announcement on the stock exchange. He found the abnormal and cumulative abnormal return of selected securities were not efficient with respect to annual earnings.

2.2 Models for Measuring Market Efficiency

2.2.1 Capital Asset Pricing Model (CAPM)

The capital asset pricing model (CAPM) has been used for many decades, as one of the best tools for analyzing the risk-return trade off of investors and is considered one of the main contributors to academic research for financial managers. The only way an investor can get a higher return for his investment is by taking a higher risk. This intuition is summarized in the CAPM of Sharpe (1964) and Treynor (1961) and was extended further by Linter (1965), Mossin (1966), and Black (1972). This model, based on the assumption of a positive risk-return trade off, asserted that the expected return for any asset is a positive function of only one variable, its market beta which is the covariance of asset return and market return. In the present study we examine whether this relationship holds for the period between 1985 and 2012. The CAPM is based on Markowitz (1959) and Tobin (1958), who developed the "risk-return portfolio theory" based on the utility model of von Neumann and Morgenstern (1953).

The primary implication of the CAPM is the mean variance efficiency of the market portfolio. The efficiency of the market portfolio implies that, there exists a positive linear relationship between ex-ante expected returns and market betas and that variable other than beta should not have power in explaining the expected returns of stocks.

There have been several attempts to test the implication of the CAPM using historical rates of returns of securities and historical rates of return on a market index. The most famous studies according to Diacogiannis (1994) were: Linter (1965), whose study was reproduced by Douglas (1968), Jacob (1971), Miller and Scholes (1972), and Black, Jensen and Scholes (1972), whose methodology has been adopted for the empirical testing of CAPM in the NSE, Blume and Friend (1973), Fama and Macbeth (1973). The CAPM is based on some specific assumptions which have to do with the fact that all investors want to maximize the expected utility of their wealth. An addition to the risk aversion is that, they all have homogenous expectations about the return of the securities. These returns of the securities follow a normal distribution, which characterizes the phenomenon of homoscedasticity. There is also a risk free rate of return with the lack of risk. Finally, there are no taxes or other restrictions or obstacles which lead to an imperfection of every market.

Sharpe (1964) and Linter (1965), making a number of assumptions, extended Markowitz's mean-variance framework to develop a relation for expected excess returns (the return minus the risk-free rate). These returns equal the return of a security with the return on excess market portfolio times the coefficient beta that measures risk in the analysis. Most test of the CAPM have been performed by estimating the cross-sectional relation between average return on assets and their betas, over some time interval, and comparing the estimated relationship implied by the CAPM. In the absence of riskless asset, Black (1972) has suggested to use zero beta portfolio, $R_{Z,}$ that is $COV(R_{Z,}R_M)=0$, as a proxy for riskless asset. In this case, CAPM depends upon two factors, zero betas and non-zero beta portfolio and it is referred as a two factor CAPM.

The zero-beta model specifies the equilibrium expected return on asset to be a function of market factor defined by the return on market portfolio R_M and a beta factor defined by the return on zero-beta portfolio which is a minimum variance portfolio and it is uncorrelated with market portfolio. The zero-beta portfolio plays the roles equivalent to risk free rate of return in the Sharpe-Linter model. If the intercept term is zero, it implies that CAPM holds.
During the process of the test and after examining the traditional CAPM, we proceed to the verification of the zero-beta or two-factor model in the NYSE. Initial tests of the CAPM were performed by Black, Jensen and Scholes (1972) and Fama and Macbeth (1973). As it was

mentioned earlier, these tests involved a two-stage procedure. Black, Jensen and Scholes (1972) estimated betas using the monthly return of each stock on the NYSE, over the 1926-1930 periods, and an equally weighted portfolio of all stocks on the NYSE. Their findings showed that CAPM did not hold in the examined period. Fama and Macbeth (1973) also estimated monthly market returns for all NYSE stock over 1926-1929, and they ranked all stocks by beta and formed 20 portfolios. They then estimated their average returns and their betas for the period 1930-1934, exactly the same way as Black, Jensen and Scholes did, and used these betas to predict portfolio returns in the subsequent period 1934-1938. Their results showed that the coefficient of beta was statistically insignificant and its value remained small for many sub-periods. They also found that the residual risk had no effects on security returns. Their intercept was much greater than the CAPM. Though initial empirical studies support the CAPM [Black, Jensen and Scholes (1972) and Fama and Macbeth (1973)], subsequent study shows that market beta does not carry a risk premium (Reinganum, 1981). Furthermore, empirical variables like the Market Value of Equity Ratio (MVER), the Earnings to Stock Price Ratio (E/P) and the Book –to – Market Equity Ratio (B/M) have been reported to have explanatory power beyond market beta (Banz, 1981,Basu, 1983, Rosenberg, Reid and Lanstein, 1985). All these variables are scaled versions of a firm's stock price and they have no clear role inside established asset pricing models and are now regarded as anomalies. An asset pricing model must be robust enough while simultaneously offering economic insight into the relations between returns and economic factors through specifying macroeconomic variables as candidates for pervasive risk factors (Chen, Roll and Ross 1986) didn't prove that the model is valid.

2.2.2 Random Walk Theory

The random walk hypothesis is a financial theory stating that stock market prices evolve according to a random walk and thus cannot be predicted. It is consistent with the efficient market hypothesis. The concept can be traced to French broker Jules Regnault who published a book in 1863, which state that stock prices are random, like the steps taken by a drunk and therefore are unpredictable. A few studies appeared in the 1930s but the random walk hypothesis was studied and debated intensively in the 1960s. The current consensus is that the random walk is explained by the efficient market hypothesis.

The basis of the efficient market hypothesis is that the market consists of many rational investors who are constantly reading the news and react quickly to any new significant information about the security. There are also many funds whose managers are constantly reading new reports and news and with the aid of high speed computers and constantly sifting through financial data looking for mispriced securities. High speed traders, likewise use high speed computer systems located near exchanges to execute trades based on price discrepancies between securities on different exchanges or between related securities that have interrelated prices, such as a stock and options based on the stock.

Finally, the random walk hypothesis states that prices of stocks cannot be predicted. The stock market is "informationally efficient" the people buying and selling stocks consist of a large number of rational investors with access to this information, while long term prices will reflect performance of the company over time, short term movements in prices can best be described as a random walk. The random walk hypothesis has some practical implications to investors. For example, since the short term movement of s stock is random, there is no sense in worrying about timing the market. A buy and hold strategy will just be as effective as any attempt to time the purchase and sale of securities. When investors buy stocks, they usually do so because they believe the stock is worth more than they paying. In the same way,

investors sell stocks when they believe the stock is worth less than the selling price. If the efficient market theory and random walk hypothesis are true, then an investor's ability to outperform the stock market is more luck than analytical skills.

2.3 Empirical Evidence

The first to point out that security prices and prices of other speculative commodities follow a random walk was Bachellier (1900). His study was not recognized until Working (1934) confirmed the same result. Since then, the weak form hypothesis has been tested in hundreds of studies. Fama (1965, 1991), Jennergren and Korsvold (1975), Rom (1997), Hadi (2006) and Raja *et al*. (2009) lend support to the random walk assertion while Magnus (2008) in his recent study obtained a contradictory result. Jensen (1998) studied the performance of 115 mutual funds, using annual data between 1955 and 1964. The result of his work shows that on the average, the mutual funds were not able to predict security prices well enough to outperform a buy- and-hold strategy. There was a little evidence that any individual fund was able to beat the market. This tends to show that the strong form of efficient market hypothesis hold. Detzler and Wiggins (1997) studied the performance of 35 actively managed international funds using 111 monthly returns. They used a multi-index benchmark. Their result suggests that these funds exhibit no significant performance persistence.

Carhart (1997) also conducted a study on the persistence in mutual fund performance. He used the average annual returns on 1493 U.S mutual funds and the market index for the period 1962-1992. He noticed that mutual funds underperform the market in approximately half the years. However, mutual funds beat the market in some years, but as often as not it was the other way round. One can thus infer from this that smarter managers can earn superior profits, but it seems difficult to spot the smart ones. In a further study by Jensen (1969), he plotted the average return and beta of different mutual fund managers over the period 1955-1964. The evidence of this study suggested that about half of the mutual funds outperformed the standard and poor composite index and about half underperformed the index. This evidence is therefore consistent with the market efficiency. Guy (1978) while examine the effects of international diversification of portfolios discovered that the British trusts do not significantly outperform the London stock exchange nor randomly selected portfolios of U.K. and U.S. stock. Most mutual funds do claim to be able to use their professional expertise to earn abnormal returns through successful prediction of future security prices. This was looked into by Howe and Pope (1996). They investigated the usefulness of Forbes equity fund performance ratings in predicting future mutual fund returns for the period of "September 1974 through August 1990," using the correlation analysis. Their result shows that Forbes equity fund rating show some ability to predict the fund's beta over virtually every period examined, while it is of little use in predicting future fund performance.

Brealey and Myers (2000) and Ross, Weston and Jaffe (1996) asserted that evidence on strong-form efficiency has proved to be sufficiently convincing that many professionally managed funds have given up the pursuit of superior performance, they simply "buy the index", which maximizes and minimizes the cost of managing the portfolio. The treatment efficient market hypothesis paradigm was critically re-examined by Russel and Torbey. They emphasized that the dynamics of stock market behaviour would perhaps be beat advanced by adopting a multi-disciplinary approach that incorporates both qualitative research tools. They thus proposed that the popular efficient market hypothesis paradigm be refined to embody the psychological and speculative aspect of the stock market.

Annaert, Vanden Broek and Vennet (2001) studied the determinants of mutual fund performance using the Bayesian Stochastic frontier approach. Their analysis of the European

equity fund over the period 1995-1998 reveals that size and historical performance are related to fund efficiency and fail to find a link between fund age and performance. Also, they find no relationship between efficiency and historical return in the top 80% of funds. This is in line with the fund performance persistence in literature.

In order to provide the strongest test of market efficiency, Dann, Mayer and Raab (1997) collected continuous transaction data during the day of a block trade for a sample of 298 blocks with large prices declines between July 1968 and December 1969. Their report shows the possibility of earning excess rate of return even after adjusting for risk, transaction costs and taxes. They thus interpreted this as evidence that the capital market is inefficient in the strong form. This is consistent with the position held by Copeland and Weston (1992) about individuals who participate at the block price. Individual who are notified of the pending block trade and who can participate at the block price before the information becomes publicly available do in fact appear to earn excess profits. Abnormal returns computed from the market model indicate that insiders are able "beat the market" on a risk-adjusted basis, both when selling and when buying, indicate that the strong form efficient market hypothesis does not hold (Jaffe, 1974 Finnerty, 1976; Copeland and Weston1992).

According to Grossman (1980) and main (1977), investors who utilize costly information will have higher gross rates of return than the uniformed investors. However, if the capital market is efficient in the strong forms, the net rates of return for the informed investors after paying for the information would equal to the rate of return of the uniformed investors. This is what Bauman (1999) referred to as a level playing field.

However, limited number of empirical studies exists on the efficiency of capital market in Nigeria. Samuels and Yacout (1981) were the first to conduct a test on the efficiency of the Nigerian stock market. Their result using weekly data for a sample of 21 quoted companies over the period 1978 to 1979 concluded that the Nigerian stock market exhibit a random walk. Ayadi (1984), Olowe (1999), Kukah et al. (2007) and Mmeregini (2009) using Nigeria data as well and different parametric or non parametric tests joined others in developed world and Samuels and Yacourt for Nigeria to support the random walk assertion. Ayadi (1984) and Olowe (1999) also found that the Nigerian stock market exhibits a random walk hypothesis while Kukah *et al*. (2007) in their parametric test arrived at the same result of random walk. But their result of non parametric test contradicts the random walk hypothesis. In his work on test of capital market efficiency theory in the Nigeria capital market, Ogundina and Omah (2013), results showed that the Nigeria capital is efficient by using market capitalization. Azeez and Sulaiman (2012) In there empirical study on capital market efficiency: a test of the strong form in Nigeria, the analysis deduced that mutual funds were unable to out-perform the random portfolios created from the index stocks, which thus implies that the strong form of market efficiency holds in the Nigerian Capital Market. Similarly, Samuel and Oka (2010) study found that information has contributed to the efficiency of the Nigerian capital market. Nneji (2013), study on efficiency of the Nigeria capital market revealed that there is still room for improvement of the efficiency level of the Nigerian Capital Market. This was due to the fact that the speed of adjustment of stock price to stock information was not very high and the market was also found to be inefficient within the period under review. Fapetu and Adesina, (2013) investigated the empirical efficiency of the Nigerian capital market. Using the average monthly returns data of five banks over the period 2007 to 2011, the result indicates that the Nigerian stock market is efficient in the strong form.

3 METHODOLOGY AND DATA

In this section, we test using the Random Walk Hypothesis, Black, Jensen and Scholes methodology in the Nigerian Stock Exchange. This methodology was used because its enable us see at a glance the predictability nature of securities prices in the market. The main implication of the model is to assess the relationship between the trends of changes over years of the all share index. This study models capital market efficiency in Nigeria. It utilizes the quasi experimental research design because the relationship existing between the time series data could not be manipulated. It suits the study because of the descriptive nature of this research.

3.1 DATA

The entire listed securities in the Nigerian Stock Market were studied, thus the all share index is used as a parameter which covers all prices of securities quoted in the Stock Exchange. Data on daily closing prices of listed stocks traded in the market were collected and used. They are the raw prices in the sense that, they do not include dividends, but are adjusted for capital splits. These data were taken from the Nigerian Stock Exchange (NSE) data base (Factbook). Time series of all share indexes on market securities are taken over the period 1985-2015.

3.2 MODEL SPECIFICATION

The study employed the partial autocorrelation model to analyze the impact of the time series data of All Share Index (ASI). The model try to examine the relationship between the time series of ASI over the years, whether it follow a random walk or not. The series of data used is the All Share Index representing weighted average prices of all quoted securities traded in the market.

$$\Delta ASI = ASI \quad \textbf{(1)}$$

The autocorrelations for the trends is based on the above functional relation as:

$$Y = \beta_0 + \beta_1 + \beta_\infty + \mu_1 \quad (2)$$

The model can further be written in econometric form as

$$LnASI = \beta_0 + LnASI + Ln\infty + \mu_1 \quad (3)$$

Where:

$LnASI$ = Value of all share index's over the years

$Ln\infty$ = Series of ASI for as many years we may consider

μ = Error term

β is a measure of persistence of volatility clustering. The closer the value is to 1, the high the persistence of volatility clustering, If $\beta \leq 1$, the PAC is weakly stationary. In the evaluation of the efficiency market hypothesis, if the parameter of the exogenous variable in the equation for PAC model is insignificantly different from zero, that is $\beta = 0$, we accept weak form efficient market hypothesis otherwise, we reject the hypothesis that the market is weak form efficient. Also the closeness of the sum of β to 1 indicates a high persistence in volatility clustering which implies inefficiency in the market. Our apriori expectation is $\beta > 0$.

4 EMPIRICAL RESULTS

Date: 01/06/16 Time: 11:43
Sample: 1985 2015
Included observations: 31

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob

1	0.832	0.832	23.588	0.000
2	0.663	-0.093	39.093	0.000
3	0.574	0.161	51.150	0.000
4	0.478	-0.093	59.821	0.000
5	0.439	0.182	67.407	0.000
6	0.442	0.082	75.408	0.000
7	0.363	-0.202	81.020	0.000
8	0.242	-0.138	83.616	0.000
9	0.111	-0.192	84.193	0.000
10	0.026	0.072	84.226	0.000
11	-0.051	-0.163	84.362	0.000
12	-0.132	-0.122	85.294	0.000
13	-0.211	-0.138	87.816	0.000
14	-0.266	0.050	92.060	0.000
15	-0.308	0.030	98.145	0.000
16	-0.334	-0.030	105.77	0.000

Source: Eview 8 Output

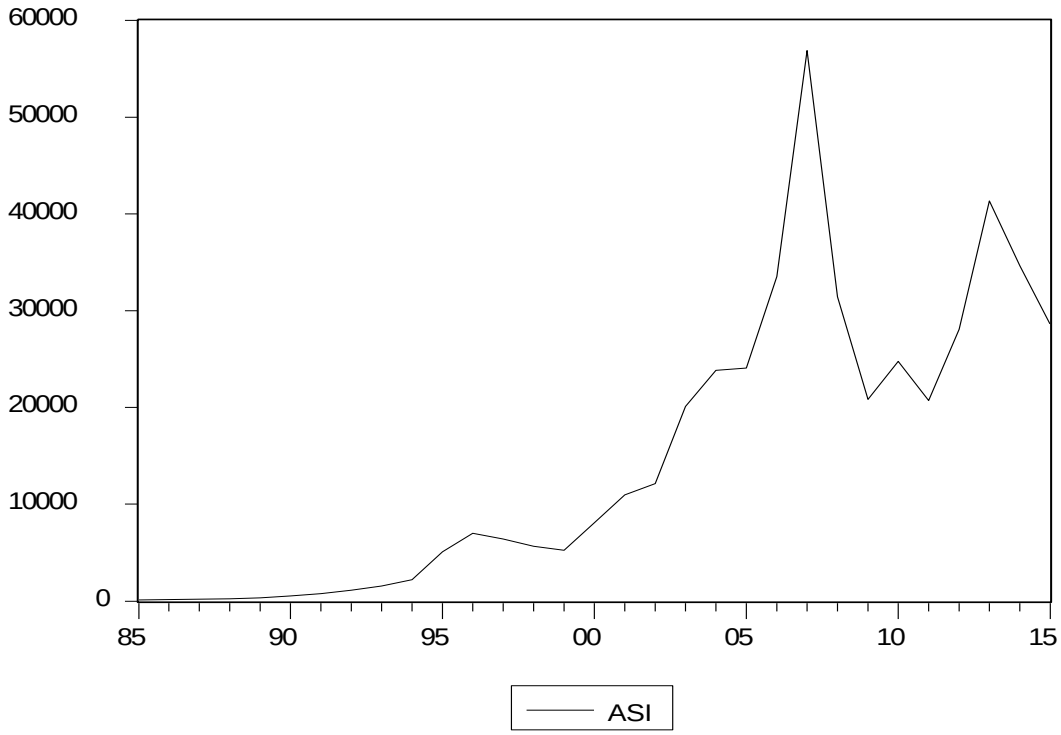
The table above shows that the probability value of 0.000 at all lags period is statistically significant. This is an evidence of monthly seasonality in the Nigeria stock market. The average return for the intercept (bench mark) for 1985 is 0.83% which is the highest comparatively. This is followed by the negative average return for lag 2 and 4 respectively. However the negative return for 1986 through 1988 is statistically insignificant. All other low and negative when compared with the bench mark for 1985. The lowest is recorded in the year 2015, with a negative value of -0.030.

Since the serial correlation coefficient does not exceeds plus or minus two standard error, for all or significant proportion of the annualized lagged indices, we say that the Nigeria Stock Exchange stock index is significantly different from zero. Furthermore, the autocorrelation coefficient has been computed for stock market price index which shows significant autocorrelation with an annual lag. The presence of non-zero auto-correlation coefficient of the annualized stock index suggests that there is a serial dependence between the values. The non-zero auto correlations of the serial associated with the Q-statistic, which are significant at 5% level, suggest that the stock price index follow random walk model. Our result is consistent with the findings of Harvey (1994), Claessens, Dasgupta and Glen (1995), Poshokwale (1996) and Maberek and Keasey (2002).

The serial correlation coefficient test has provided an insight regarding the behaviour of stock prices changes of the Nigeria stocks over time. The results of the auto-correlation suggest that the price changes over time do not confirm strictly to the random walk model. Our result is however not much different from what does obtain elsewhere in European and Asian stocks. This could imply that stocks are not actively traded and or their prices are being manipulated.

Low trading volume in the Nigerian stock market is an indication of the fact that the stock market is inactive. These years, only 1995 have its vectors of exogenous variable in the conditional mean equation significant. Thus, the Nigeria capital market is weak form efficiency and does not concede the opportunity of making excess return.

4.3 GRAPH SHOWING THE TREND OF ALL SHARE INDEX



From the graphical representation above, it can be seen that the values of ASI maintained a regular and increasing trend for the first twenty two years (22years) of this study. The remaining eight years (8years) witnessed an irregular trend. In 1985, All Share Index value was 127.3million, it rose to 513.8million in 1990. It also increased from 5,092.0million to 8,111.0million between the year 1995 and 2000. ASI further increased from 24,085.8million to 56,863.41million between 2005 and 2007. It later decline to 28,087.8million in year 2012, increased again to 41,329.19million in 2013. It then stood at 28,642.25million in 2015.

5. CONCLUSION

This study tested the validity of efficient market in the Nigeria stock market. Understanding the nature of market efficiency is important to the investors who seek to find whether the opportunity of making excess returns does exist in a given stock market. If a market is efficient, no arbitrage opportunities can be usurped to make excess profits as all the available information has discounted in current price. In the light of this, this study investigated the issue of weak form efficiency on the Nigeria stock market by employing the PAC model on annual share index. The result of the study shows that the Nigeria stock market follow a random walk and is therefore weakly efficient. The implication of this is that expectation about overvaluation or under valuation of stock price in the market is ruled out. It is therefore a waste of time for investor to keep on studying and charting in search of the undervalued stock in the Nigeria stock market.

However, it is worth noting that findings revealed that the financial deregulation in 1987, the privatization of the public sectors in 1988 and the internationalization of the Nigerian capital market in 1995 were associated with persistent volatility clustering in the market suggesting the existence of weak form market inefficiency range from 2000 to 2006 (with the exception of the year 2002).

Notwithstanding, the study recommends that the exchange should ensure the general public are educated and encouraged to participate actively in the market. While SEC should pay

closer attention to the activities of the NSE particularly the area of stock price manipulations by top management of quoted firms. Finally the Government should establish veritable educational institute for capital market studies that will help in carrying research on security market and also help to educate the public regarding the importance of the stock exchange in capital formation that can be used to develop the Nigeria economy.

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APPENDIX 1 DATA FOR EMPIRICAL ANALYSIS

YEAR	ALL SHARE INDEX

1985	127.3
1986	163.8
1987	190.9
1988	233.6
1989	325.2
1990	513.8
1991	783.5
1992	1,108.0
1993	1,544.0
1994	2,205.0
1995	5,092.0
1996	6,992.0
1997	6,429.0
1998	5,673.0
1999	5,266.0
2000	8,111.0
2001	10,963.0
2002	12,137.7
2003	20,123.9
2004	23,844.5
2005	24,085.8
2006	33,540.01
2007	56,863.41
2008	31,450.78
2009	20,827.2
2010	24,770.5
2011	20,730.6
2012	28,087.8
2013	41,329.19
2014	34,657.15
2015	28,642.25

Source: Nigeria Stock Exchange Factbook for Various Years