The Efficient Market Hypothesis and Predictability of Equity Prices/Returns in Nigeria

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DOI: 10.56201/ijasmt.v10.no5.2024.pg74.100

Abstract

This study examines the efficiency of The Nigeria Stock Exchange in the weak-form level and the predictability of equity prices/returns using monthly observations. The data set covers the period of ten years- January, 2013 to December, 2022. The stocks were randomly selected based on their ability to trade frequently on the floor of the market, and absorb the shocks of thin trading with irregular hiking. All time-series data were obtained from The Nigeria Stock Exchange database. After testing for normality of the data (the returns of the companies follow normal distribution process), Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin unit root tests were also employed (which provide evidence that the Nigeria index are nonstationary at level). The study applied various parametric and non-parametric tools which include BDS test, serial correlation coefficient test, runs tests and variance ratio tests. The empirical evidence obtained from these studies are mixed. Indeed, while some studies show empirical results that support the weak form of EMH, other evidences reject the null hypothesis. The Brock-Dechert-Scheinkman and Ljung-Box tests suggest that the return of these companies is not significantly auto-correlated; that successive returns cannot be predicted. The results of the investigation based on runs test confirm evidence of randomness. The variance ratio statistic for each of the company is associated with probability value of 0%. This suggests the rejection of the null hypothesis of sustainable random process. Therefore, our test evidence shows that the returns of these companies are not random; rather stationary and predictable. The policy implication of

these analyses is that the Nigeria Stock Exchange, as an emerging market, must be closely monitored to achieve an optimal maturity level. It is therefore recommended that policy makers to enlighten potential investors of the opportunities that are available in the stock market. Such enlightenment should seek to stimulate their interest in capital market activities and thus increase the breadth and depth of the capital market.

Keyword: *Efficient market hypothesis, stock return predictability, BDS test, Ljung-Box, Runn test, Variance Ratio, The Nigeria Stock Exchange*

1.1 Background to the study

The stock market is the collection of exchanges and other venues where the buying, selling, and issuance of shares of publicly held companies take place (Afolabi, 1998). The shares, also known as equities, are fractional ownership in a company (Olowe, 1996; Levinson, 2006; Alfred, 2007; Bhalla, 2012).

Academic research suggest that share prices follow a random walk. That is, successive price changes (one-period returns) are independent of each other (Fama, 1970; Brealey and Myers, 2003). The search for an explanation of this apparent randomness led to the formation of Efficient Market Hypothesis (EMH) (Adams *et al*. 2003).

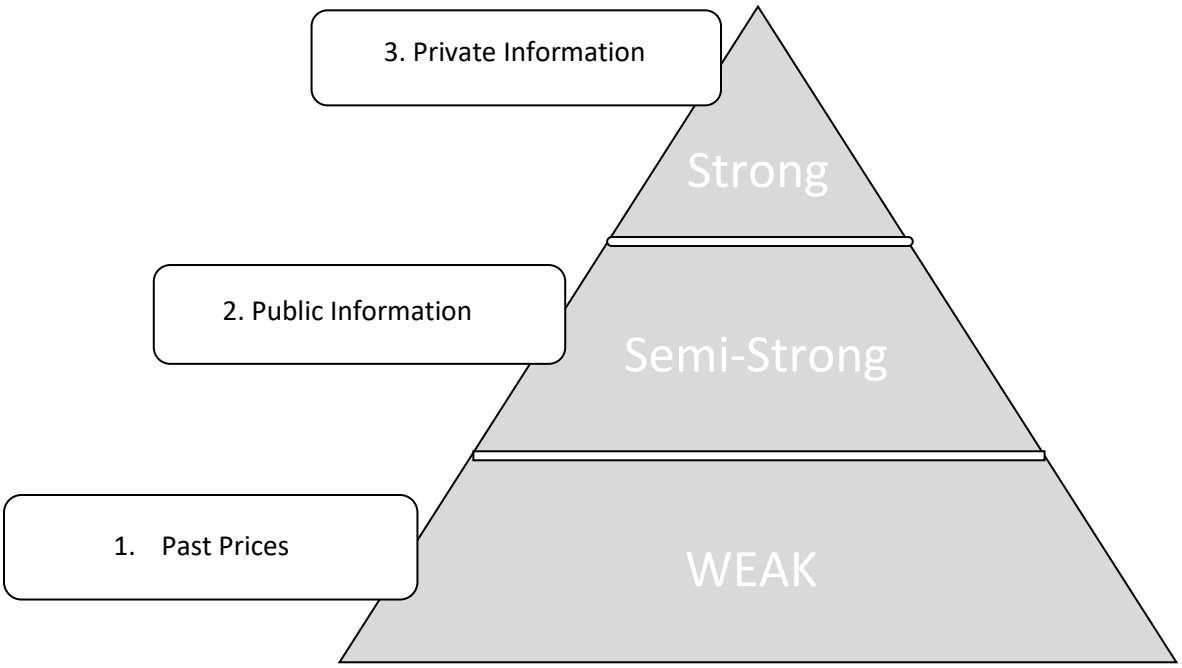

Figure 1.1: Basic Forms of Market Efficiency.
The three versions of efficient market hypothesis are varying degrees of the same basic theory.

A Stock market is said to be efficient if security (share) prices at any time "fully reflect" all available, relevant information (Fama, 1970, 1991); reflect information to the point where the marginal benefits would not exceed marginal costs (Jensen, 1978; Fama, 1991); and it will be impossible for an investor to beat the market (Fama, 1970, 1991). A precondition for this strong version is that the benefits of acting on the information equals the cost of collecting it, always 0 (Grossman and Stiglitz, 1980; Adams *et al.* 2003).

The Efficient Market Hypothesis deals with informational efficiency, which is a measure of how quickly and accurately the market digests information (Strong, 2006). Eugene Fama developed the idea of efficient market hypothesis as an academic concept of study; and classified it into three versions according to the levels of information (see fig. 1.1), namely: weak-form (How well do past returns predict future returns?); semi-strong form (How quickly do share prices reflect public information announcements?); and strong-form efficiencies (Do any investors have private information that is not fully reflected in the market prices?) (Fama, 1970; 1991; Roberts, 1959). As we move from weak-form to strong-form we are referring to progressively more information. Efficient market is a market which "adjust rapidly to new information" (Fama *et al*, 1969).

In an efficient capital market, there should not exist a significant correlation between the share prices over time (Brealey, 1969).

1.2 Motivation

Main-stream finance theory has traditionally held that markets cannot be beaten under the assumption that modern financial markets are efficient (e.g. Roberts, 1959; Fama, 1965; Samuelson, 1965). The efficient market hypothesis (EMH) demonstrates that knowledge of past security prices would not necessarily lead to high profits. Any information that could be used to predict stock performance is already reflected in the stock price today (Dremen, 1991). Because of the wide availability of public information, it is nearly impossible for an investor to beat the market systematically (Cowles, 1933,1934, 1960; Roberts, 1959; Fama, 1965; Samuelson, 1965 Fama, 1970, 1991).

This theory is, however, described notationally as follows:

$$E(\bar{p}_{j,\,t+1}|\Omega_t) = [1 + E(\bar{r}_{t,\,t+1}|\Omega_t)]p_{j,t} \tag{1.1}$$

Where:

E = expected value operator

$P_{j,\,t+1}$ = price of security j at time $t+1$ (with reinvestment of any intermediate cash income from the security)

$r_{j\,,t+1}$ = return on security j during period $t+1$(one period percentage return: $(P_{t+1} - P_{j,\,t})/\ P_{j,\,t}$

Ω_t = a general symbol for whatever set of information is assumed to be "fully reflected" in the price at t

$P_{j,\,t}$ = denotes the price of asset j at time t

The "fair game" models rule out the possibility of trading systems that have expected profits or expected return in excess of equilibrium. Thus, let

$$x_{j,\,t+1} = p_{j,\,t+1} - E\left(p_{j,\,t+1}|\Omega_t\right) \tag{1.2}$$

$x_{j,\,t+1} =$ the excess market value of security j at time $t+1$ (i.e. difference between the observed price and expected value of the price at t based on the information Ω_t).

In an efficient market, it must be true that:

$$E(\bar{x}_{j,\,t+1}|\Omega_t) = 0 \tag{1.3}$$

which, by definition, says that the sequence $(X_{j,\,t})$ is a "fair game" with respect to the information sequence (Ω_t) [Samuelson (1965); Mandelbrot (1966)].
Equivalently, let

$$z_{j,\,t+1} = r_{j,\,t+1} - E(\bar{r}_{t,\,t+1}|\Omega_t) \tag{1.4}$$

then

$$E(\bar{z}_{t,\,t+1}|\Omega_t) = 0 \tag{1.5}$$

so that the sequence of $(z_{j,t})$ is also a "fair game" with respect to the information sequence (Ω).

Does this theory/model provide a reasonably accurate description of reality?
This study therefore, sought to:

i. ascertain whether the Nigeria Stock Markets are not efficient at the weak-form; and
ii. most importantly, extend the test by examining the predictability of equity prices/returns.

The only way to prove the informational efficiency for a given stock market is to carry out a number of tests. If it is deemed statistically appropriate that historic share prices have predictive power, the efficient market hypothesis will be rejected.

1.3 The aim and objectives of the study

The aim of the study is to examine, model and explain the behavioural patterns of equity prices/returns in Nigeria stock markets; and to test whether The Nigeria Stock Exchange have not evolved into some efficiency. To achieve this aim, the following specific objectives are considered:
The specific objectives considered are as follows:

i. To examine the non-linear dynamically independent relationship (behavioural patterns) of equity prices/returns in Nigeria stock markets.
ii. To evaluate the sequence of randomness of equity prices/returns in Nigeria stock markets.
iii. To examine the significance of serial correlation associated with the lag for a given security.
iv. To ascertain the unpredictability of equity prices/returns over time.

1.4 Scope of the Study

i. This study considers only one form of market efficiency, i.e. the weak-form, where the information set which an efficient market is considered to fully reflect includes only historical prices.
ii. Further, It is restricted to ten (10) quoted companies whose stocks prices/returns are publicly available over the study period; and the companies are selected from the eight (8) sectors that make up the Nigerian Stock Exchange.

iii. The empirical enquiry covers the period 2013 – 2022 (ten years).

1.5 Significance of the Study

The outcome of the tests of the EMH are important in assessing public policy issues such as the desirability of merger and takeover, short-termism and regulation of financial institutions.

i. **Government**: If the efficient Market Hypothesis is valid, then, its consistency with the Nigerian Capital Market will have policy implications and thus, this study will be a reference point for government policies on capital market growth and efficiency.

ii. **Participants:** This study will also afford participants in the capital market, such as investors, stockbrokers, registrars, solicitors, and underwriters the opportunity of having access to useful data on the consistency of the Nigerian Capital Market with efficient market hypothesis. Such data will be useful as a predictive tool in achieving their objectives.

iii. **Academia and Practitioners:** The academia and practitioners will be acquainted with empirical data on the validity of efficient market hypothesis in the Nigerian capital market. This will trigger researches that may seek to test or validate the results of this study.

iv. Lastly, the results of this study will constitute data that will be useful to researchers as well as students of Finance, Business Administration and allied disciplines in the management Sciences.

1.6 Limitations of the Study

The Nigerian economy is one that has witnessed general price increases over time due to inflation. It is therefore, difficult to distinguish between the regular movement of stock prices and those induced by inflation, especially inflation occasioned by incessant fuel price increases. Such movements of stock prices induced by inflation constitute a limitation on the inference from this study.

2.1 Conceptual Review

2.1.1 Overview of Nigerian Capital Market

The Nigerian Capital Market is a channel of mobilizing long-term funds by providing mechanism for private and public savings through financial instruments (equities, debentures, bonds and stocks) with major components consisting of the Security and Exchange Commission (SEC) and the Nigerian Stock Exchange (NSE). Founded in 1960, the NSE is the second largest market in sub-Saharan Africa with fully automated exchange that provides the listing and trading services as well as electronic Clearing, Settlement and Delivery (CSD) services through Central Securities Clearing System (CSCS). The exchange keeps on evolving as a competitive market and meeting the needs of investors. It operates fair, orderly and transparent markets with over 200 listed equities and 258 listed securities, and had attracted the best of African enterprises as well as the local and global investors (NSE, 2013). The market has become an integral part of the global economy such that any shock in the market has contagious consequences. Moreover, the Nigeria's capital market has enjoyed a decade of unprecedented growth. The market capitalization increased by over 90.0%

from 2003 to 2008. However, from a peak in March 2008, the market capitalization went declined spirally by about 46% in 2009 (SEC Report, 2009).
The Nigerian capital market is an integral part of the Nigerian financial system. Other sectors of the Nigerian financial system include: the money market, the insurance market and the pensions. Each of these markets has a statutory regulatory institution namely: CBN, SEC, NAICOM and PENCOM for the money, capital, insurance and pension markets respectively. These regulatory institutions are empowered by statutes (laws) to supervise the various markets and facilitate the exchange of funds between the surplus and deficit units.
The Nigerian Stock Exchange ("The Exchange" or "NSE") operates fully electronic marketplaces for Equities, Bonds, Exchange Traded Products, with plans to include Derivatives trading shortly. The NSE operates an Automated Trading System (ATS) platform with a central order book which allows Dealing Members to participate on equal terms, competing on the hierarchical basis of Price, Cross and Time priority. The Exchange runs a hybrid market, allowing Dealing Members to submit orders and Market Makers to submit two-sided quotes into the order book (NSE, 2019).
The convergence of global economy makes all countries and all markets sensible to the happenings in other countries. The 2008 global financial meltdown originated from the United States of America (USA) had varying degree of impacts on different capital markets in various countries. This situation is compounded with the continuous volatility in the global oil price which in theory adversely and significantly affecting capital markets (Njiforti, 2015; Asaolu and Ilo, 2016). Nigeria recently experienced economic recession as a consequence of the 2014-2016 global oil price downturn. In view of these, the various SEC reports came with several recommendations to reposition the Market as a world class institution. The main recommendations are; the development of an enforcement framework to prevent market manipulation, and the establishment of principles for risk management for capital market operators.

2.1.2 The Concept of Efficient Market Hypothesis

The concept of Efficient Market Hypothesis stipulates that in a free market, that stock prices already fully reflected all available information, and securities are fairly priced (Samuelson, 1965; Fama, 1965, 1970, 1991). Considering the information reflected in the markets, market efficiency is broken down into three levels. The three versions of the efficient market hypothesis are varying degrees of the same basic theory (see figures. 2.1 and 2.2).

$$\text{Let } \alpha(\Omega_t) = [\alpha_1(\Omega_t),\ \alpha_2(\Omega_t),\quad .\ .\ .\ ,\ \alpha_n(\Omega_t)]$$

be any trading system based on Ω_t which tells the investor the amounts $\alpha_j(\Omega_t)$ of funds available at time *t* that are to be invested in each of the *n* available securities.
The total excess market value at $t+1$ that will be generated by such a system is:

$$V_{t+1} = \sum_{j=1}^{n} \alpha_j(\Omega_t)[r_{j,\,t+1} - E\left(r_{j,\,t+1}\middle|\Omega_t\right)],$$

which, from the "fair game" property of (1.5) has expectation,

$$E(V_{t+1}|\Omega_t) = \sum_{j=1}^{n} \alpha_j(\Omega_t) E\left(Z_{j,\,t+1}\middle|\Omega_t\right) = 0$$

Prices fully reflect all available relevant information

1. Weak form	2. Semi-strong form	3. Strong form
Prices fully reflect past prices	Prices fully reflect all publicly available information	Prices fully reflect all available information (private and public)

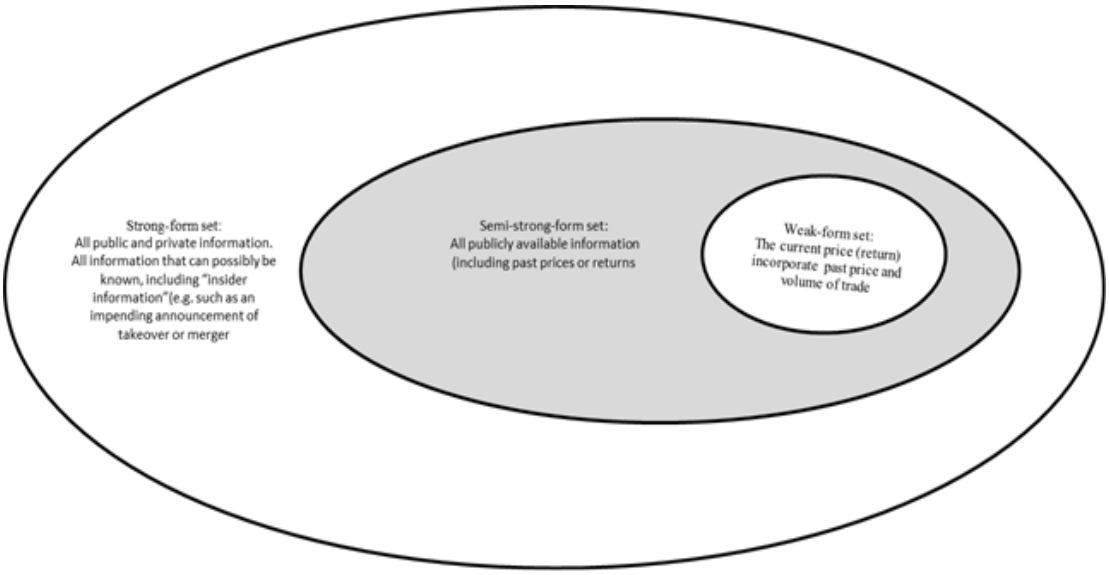

Fig. 2.1: Information and Levels of Market Efficiency

As we move from weak-form to strong-form we are referring to progressively more information.

The Figure 2.1 illustrates these three forms of efficiency. It should be noted that moving from weak to semi-strong to strong form efficiency, the set of information expands. Thus, if markets are strong-form efficient, then they are also semi-strong and weak form efficient. Similarly, if markets are semi-strong form efficient, then they are also weak form efficient.

For one thing, not everyone has access to the same news, nor does everyone receive the news in a timely fashion. Because of this discrepancy, market participants commonly talk about three forms of the EMH, each of which is based on the availability of a different level of information (Strong, 2004). Copeland and Weston (1983) pointed out that the notion of efficient capital markets depends on the precise definition of information and the value of information. And an information structure may be defined as a message about various events which may happen.

2.1.3 Market price and Available information

At one level, capital markets are places where companies who need long-term finance can meet investors who have finance to offer. This finance may be equity finance, including issue of new ordinary shares, or it may be debt finance, in which case companies can choose from a wide range of loans and debt securities.

At another level, capital markets are places where investors buy and sell company and government securities, with their trading decisions reflecting information on company performance, insight provided by financial analysts, dividend announcements by companies, expectations on the future levels of interest rates and inflation, the investment decisions of finance managers, etc.

At both levels, companies and investors will want the capital markets to assign fair price to the financial securities being traded. In the language of corporate finance, companies and investors want the capital market to be efficient. It is possible to describe the characteristics of an efficient capital market by considering the relationship between market prices and the information available to the market.

Investors, finance managers and capital markets obtain a great deal of information about companies from their financial statements, from financial databases, from the financial press, etc. Through the application of ratio analysis, financial statements can be made to yield useful information concerning the predictability, solvency, performance, efficiency of operations and risk of individual companies (Watson and Head, 1998).

This information will be used, for example, by investors when reaching decisions about whether, and at what price, or offer finance to companies; by financial managers in making decisions in the key areas of investment, financing, and dividends; by shareholders making decisions on which securities to add or removed from their portfolios; and reference point for government policies on capital market growth and efficiency.

2.1.4 Price Movements in the Capital Market

The security prices have been observed to move randomly and unpredictably (Olowe, 1996), but what remained to be shown was why share price followed a random walk. There is therefore, the need for a model of share price behavior to explain the random walk. This need has been met in a general model based on the efficiency of the markets in which shares are traded. This model is known as the efficient market hypothesis (EMH) (Pandey, 2015; Kishore, 2004).

The price of an equity stock is a stochastic variable, i.e. it is a random variable whose value changes over time. It is usually assumed that the stock has an expected financial return which is exponential, but superimposed on this is a random fluctuation. This may be expressed mathematically as follows:

$$S_t = S_0 e^{\mu t} + RV, \tag{2.1}$$

where S_0 and S_t are the stock price now and at time t, μ is the return on the stock and RV is a random variable. It is further assumed that the fluctuations, which cause the stock price to deviate from its smooth part, are equally likely to be upwards or downwards: we assume the expected value

$$E[RV] = 0. \tag{2.2}$$

It follows that

$$E[S_t] = S_0 e^{\mu t}\,. \tag{2.3}$$

An efficient capital market is one in which prices of traded securities fully reflect all publicly available information concerning those securities. This implies that when security prices reflect all available public information about the economy, about the financial markets and about the company involved then an efficient market is in existence (Van Horne, 2002). Thus, in an efficient market security prices adjust instantaneously and in an unbiased manner to any piece of new information released to the market. As a result, security prices are said to fluctuate randomly about their "intrinsic" value. New information can result in change in the "intrinsic" value of a security but subsequent security price movement will follow what is known as a random walk (i.e. changes in price will not follow any pattern (Van Home and Dhamija, 2012; Ross *et al*, 1996). Efficiency and randomness imply that there should be no systematic correlation between the price movement on one day and that of another (Fama, 1970, 1991; McLaney, 2000).

But new information, by definition, cannot be predicted ahead of time; otherwise, it would not be new information. Therefore, price changes cannot be predicted ahead of time. The series of price changes must be random (Brealey, Myers, and Marcus 2007). This randomness may be interpreted to imply that investors in the capital markets take a quick cognizance of all information relating to security prices and that security prices quickly adjust to such information. Thus, if the market is efficient, it uses all information available to it in setting a price.

Therefore, the efficiency of security prices depends on the speed of price adjustment to any available information; the more the speed of adjustment the more efficient the prices. The capital market efficiency may therefore be defined as the ability of securities to reflect and incorporate all relevant information in their prices. If capital markets are efficient, then the current share price of a company is "fair". There is no question of the share price being under or over-valued. The phenomenon of under or over-valuation of securities is possible only in an inefficient capital market (Pandey, 2015). According to Omolehinwa (1991) and Block and Hirt (1998), there are several concepts of market efficiency and there are many degrees of efficiency depending on which market we are talking about. Markets in general are efficient when:

(i) The price of securities bought and sold reflects all the "relevant" information that is available and therefore known to the buyers and sellers.
(ii) No investor will consistently be able to obtain above normal returns since security prices will correspondingly incorporate all the available information.
(iii) No individual dominates the market.
(iv) Transaction costs of buying and selling are not so high as to significantly discourage trading.

Consequently, the above shows the benchmark against which the capital market can be evaluated so as to determine its efficiency or otherwise. The efficiency of the stock market has often generated controversy among analysts based on their study of developed and emerging markets. Some say, it is efficient in the weak form, some others say it is efficient in the semi-strong form while others say it is efficient in the strong form. The determination of overall growth of an economy depends on how efficiently the stock market performs its allocation, operational and pricing roles. As the stock market channel scarce savings from savers to productive investments, the funds must be transferred at a minimum cost and in a way that benefits market operators.

2.2 Theoretical Review

2.2.1The Capital Market Theories

Capital market theories are concerned with explaining and predicting the relationship between expected return and risk on investments in capital market (Markowitz, 1952, 1959; Treynor, 1961, 1962; Sharpe, 1964; Lintner, 1965; Mossin, 1966; Fama,1963, 1965a, 1965b, 1970, 1991; Samuelson, 1965; Fama and Blume, 1966; Fama, Fisher, Jensen, and Roll, 1969;; Jensen, 1978).

2.2.2 Competing Theories

The two competing theories in the financial world are:

i. Efficient Market Hypothesis (EMH)

The EMH in capital markets implies that the current market prices of stocks fully reflect fundamental information about companies (Fama, 1970, 1991). Since there are normally positive information and trading costs, however, a more practical definition is that share prices fully reflect all available information to the point where the benefits of acting on the information equals the cost of collecting it, always 0 (Jensen (1978); Grossman and Stiglitz (1980); Adams et al (2003).

$$E(X_{j,\,t+1}|\Omega_t) = 0 \tag{2.4}$$

Generally, the essence of an efficient market is built on the two pillars:

a. In efficient markets, available information is already incorporated in stock prices.
b. In efficient markets, investors cannot beat the market – earn a risk-weighted excess return.

The fair game for investors is an outcome of a market being efficient. If a market is efficient, then investing is a fair game.

If $\boldsymbol{\Omega_t}$ is defined to be a particular set of information concerning security j available at time t, then any abnormal or excess return achieved at time t+1 on security j can be written $\varepsilon_{j,\,t+1}$,

where

$$\varepsilon_{j,\,t+1} = r_{j,\,t+1} - [E(r_{j,\,t+1})/\Omega_t)]. \tag{2.5}$$

The equation (2.5) shows that the excess return will be the difference between the return actually achieved and the return expected given the risk. The EMH states that the stock market responds immediately to all available information. An individual investor cannot therefore, in the long-run expect greater than average returns from a diversified portfolio of shares (Davies *et al*, 2008). The EMH does not say that investors will never beat the market and will never make large profits. In other words, $\varepsilon_{j,\,t+1}$ can be large and positive. What it does say is that, on average, over a period of time, investing is a fair game. You win some, you loose some. Being an occasional winner is not what is important (Tyson, 2003; Jordan and Miller, 2009). So, the $\boldsymbol{\varepsilon_{j,\,t+1}}$ will sometimes be positive and sometimes negative, with the result that the sum of the excess returns over a number of periods of times will be average zero:

$$\sum_{t=1}^{n=1} \varepsilon_{j,\,t+1} = 0 \tag{2.6}$$

The EMH and the Central Assumptions

Three familiar economic theories arose between the 1950s and the early 1970s: The Capital Asset Pricing Model (Sharpe, 1964), the Modigliani- Miller Irrelevance Propositions (Modigliani and Miller, 1958), and the EMH (Fama, 1970, 1991). According to Gilson and Kraakman (2003), the three theories share a common methodology and are based on an extensive set of perfect markets assumptions which Gilson and Kraakman have distilled to the following key assumptions: rational investors, perfect information and no transaction costs.

The fundamental role of the capital markets is to efficiently allocate capital. In an ideal market, prices will reflect fundamental values such that resources are allocated to those willing to pay a certain price to obtain a stock of a certain value. It follows that a market will be efficient if prices fully reflect available information (Fama, 1970).

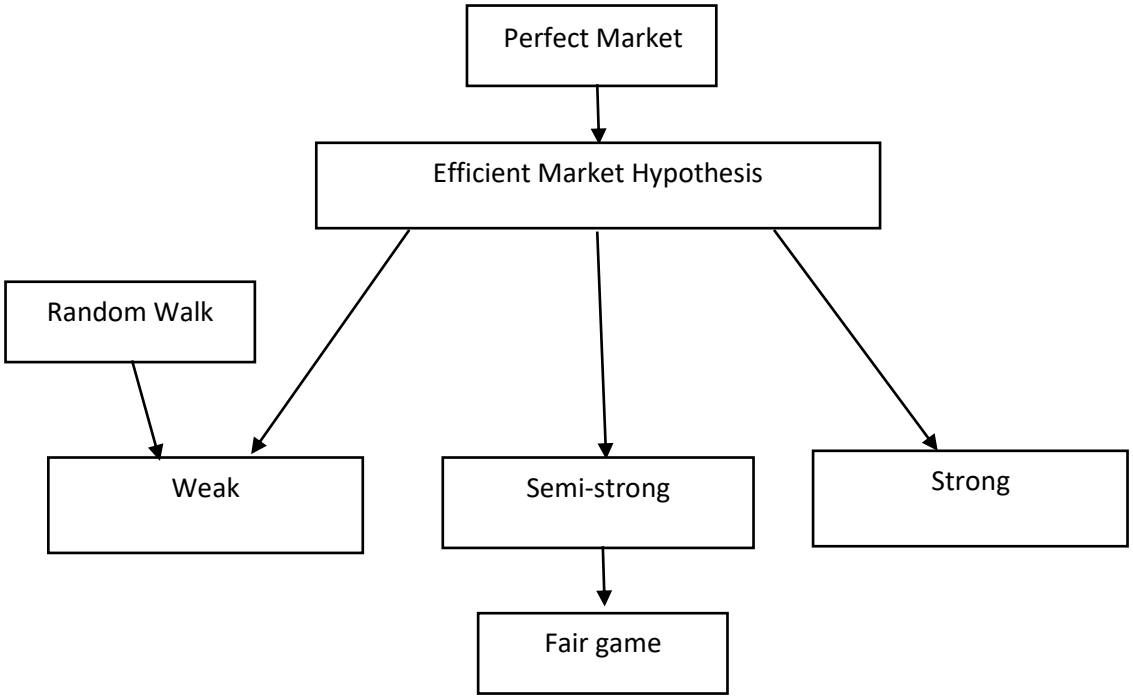

Fig 2.2: Models of share price behavior

The EMH was developed as a theory to explain why changes in security prices appear to be random; meaning that it is not possible to predict future changes in security prices based on historical price movements (Cunningham, 1994). The EMH attempts to explain this 'random walk model' by purporting that the price of a particular security changes in response to information about that security (Cunningham, 1994). This central thesis of the EMH is intuitive and as William Sharpe commented, 'simply put, the thesis is this: that in a well-functioning securities market, the prices of securities will reflect predictions based on all relevant and available information. This seems to be trivially self-evident to most professional economists – so much so, that testing seems almost silly' (Gilson and Kraakman, 2003).

Formal Definition of the Value of Information

The notion of efficient capital markets depends on the precise definition of information and the value of information (Copeland and Weston, 1983). An information structure may be defined as a message about various events which may happen. This massage may have various values to different people depending on:

a. Whether or not any actions can be taken based on the massage and,
b. What net benefits (gain in utility) will result from their actions.

A formal expression of the above concept defines the value of an information structure, $V(\Omega)$, as:

$$V(\Omega) = \sum_m q(m) \underset{\alpha}{\text{MAX}} \sum_e p(e|m)U(\alpha, e)\,, \tag{2.7}$$

Where
$q(m) =$ the marginal probability of receiving a message m,
$p(e|m) =$ the conditional probability of an event e given a message m,
$U(\alpha, e) =$ the utility resulting from an action α if an event e occurs. This shall be called a benefit function.

According to equation (2.7) a decision maker will evaluate an information structure (which, for the sake of generality, is defined as a set of messages) by choosing an action which will maximize his or her expected utility given the arrival of a message. For each possible message one can determine the optimal action. Mathematically, this is the solution to the problem:

$$\underset{\alpha}{\text{MAX}} \sum_e p(e|m)U(\alpha, e)\,, \tag{2.8}$$

Finally, by weighting the expected utility of each optimal action (in response to all possible messages) by the probability, $q(m)$ of receiving the message which gives rise to the action, the decision maker knows the expected utility of the entire set of the messages, which is called the expected utility (or utility value) of an information set, $V(\Omega)$.

ii. Random Walk Theory (RWT)

A random walk is defined by the fact that successive price changes (one-period returns) are independent of each other; and identically distributed (Fama, 1970,1991; Brealey *et al*, 2005). The random walk theory suggests that share price movements are independent of each other and that today's share price cannot be used to predict tomorrow's share price. Therefore, the movement of a share price follows no predictable pattern, but moves in a random fashion with no discernable trend (Davies et al 2008). Formally the model says:

$$f(r_{j,\,t+1}|\Omega_t) = f(r_{j,\,t+1}) \tag{2.9}$$

Prices will only follow a random walk if price changes are independent, identically distributed; and even then, we should say "random walk with drift" since expected price changes can be non-zero.

$$P_t = \mu + p_{t-1} + \epsilon_t \tag{2.10}$$

Ko and Lee (1991) argue that, "If the random walk hypothesis holds, the weak-form of the efficient market hypothesis must hold, but not vice versa. Thus, evidence supporting the random walk model is the evidence of market efficiency. But the violation of the random walk model need not be evidence of market inefficiency in the weak-form.

2.3 Empirical Review

The question of whether stock market returns contain a predictable component has attracted much attention from both academics and market participants. As a result, numerous financial and macroeconomic variables have been employed to address the issue. Studies have been devoted to the testing of the Weak-Form Efficiency in the Nigeria capital market.

Some of the recent studies include: Sunday & Olulu-Briggs (2021); Andabai, (2019); Nageri and Abdulkadri (2019); Okotori and Ayunku (2019); Onwukwe and Ali (2018); Ajekwe *et al* (2017); Ogbulu, (2016); Ikeora, Charles-Anyaogu and Andabai (2016) etc.

3. Methodology

3.1 Population and Sample Size

i) Population

The population of this study comprises all the stocks that made up the eight (8) sectors of The Nigerian Stock Exchange market, and they include the following:

(a) Financials: The financial sector includes Banks, Investment funds, Insurance companies, among others (b) Basic Materials - The utilities sector consists of electric, gas and water companies as well as integrated providers (c) Consumer Goods (d) Consumer Services (e) Energy (Oil & Gas) (f) Healthcare (g) Industrials (h) Technology

ii) Sample Size

The sample size is ten (10) stocks.

The ten (10) stocks include: Dangote cement, Dangote sugar, Guinness, J. Berger, Neimeth, Okomu Oil, PZ, UPDC, Vita form, and Zenith Bank.

iii) Sources of Data Collection

Data were collected from ten (10) stocks listed on the Nigerian Stock Exchange; monthly stock price data were obtained from the exchange database over the ten (10) years trading period. The start date is January 2, 2013 to December 31, 2022.

3.2 Sample Design

The study employs monthly raw stock prices of ten (10) companies, continuously traded in the Nigerian Stock Exchange (NSE). The age of the stocks on the floor of the Nigerian Stock Exchange was also considered. Consequently, only those stocks that were listed before January 1, 2010 were considered.

3.3 Background to the Study Area

The weak form of EMH states that Securities prices are essentially random and there is no chance of speculation in the stock market based on the assumption that successive price changes are independent of each other and follow a random walk. In other words, it means no individual can make abnormal profit from trading in securities.
The myths that the market is efficient and therefore cannot be outperformed can only be debunked statistically by employing some models/tests.

The study utilized the following statistical procedures/models:

i. Test for normality of distribution of prices of selected stock prices.
ii. Stationarity: unit root tests.
iii. The BDS non-linear model: to test for independence of successive stock prices, IID.
iv. Serial correlation / Ljung-Box test: for significant correlation (autocorrelation).
v. Runs test, to examine whether a sequence of data is not occurring randomly from a specific distribution.
vi. Variance ratio test, to examine/compare the variances of increments.

The most convincing test of the efficient market hypothesis is when it is proven that the professional investors can outperform the market as a whole.

i) Modeling the Behavioural Patterns of Equity Prices/Returns
This study used monthly market returns as individual time series variables.

$$R = \frac{P_E - P_B}{P_B} \quad (3.1)$$

Where:
R = Return or price
P_B = Return or Price at the beginning of the month
P_E = Return or Price at the end of the month

$$(P_{j,t+1} - P_{j,t})/\, P_{j,t} = \quad R_j = \frac{r_{j,t+1} - r_{j,t}}{r_{j,t}} \quad (3.1a)$$

Where:
R_j = return or price of security j
$r_{j,t+1}$ = Ending return or price of security j
$r_{j,t}$ = Beginning return or price of security j

Monthly returns is proxied by the log difference change in all share indices of the NSE (The key assumption underpinning the use of logarithm is that stock returns are not only log-normal, but are traded on a continuous basis) and are computed as:

$$R_m = In\left({}^{P_t}/_{P_{t-1}}\right) \quad (3.1b)$$

Where:
R_m = Monthly returns for All Share Index for period
P_t = All Share Index for month t

P_{t-1} = All Share Index for month *t-1*
In = Natural Logarithm

3.4 Normality Test:
It is usually assumed that population of data from which a sample or samples are drawn is normally distributed (Gupta, 2011). A graphical test for normality is conducted using Q-Q plot. If the underlying distribution of the data is normal, the points will fall along a straight line.

3.5 Stationarity/ Unit Root Tests:
Stationarity is a phenomenon when there is no systematic difference over time in mean and variance in the time series. Unit root tests are commonly employed to examine the stationary property of a time series data, e.g. financial time series: stock prices, exchange rate, etc.
The following unit root tests are investigated:

i. Augmented Dickey-Fuller (ADF) test,
ii. Phillip-Perron (P-P) test, and
iii. The Kwiakowski, Phillips, Schmidt and Shin (KPSS) test.

While ADF and P-P have the null hypothesis of stationary, KPSS has the null of nonstationary.

And the idea behind the test is that in a nonstationary series, the value of the series today does not help you predict the value of the series tomorrow, while the opposite is true for the stationary series.

3.6 Testing for Independence

Model Specification
Test for Non-Linear Dynamically Independent Relationship

One of the specific objectives of this study is to test the assumption that a non-linear dynamically independent relationship exists to a considerable extent in the Nigerian stock market; making the predictability of the selected stocks impossible. We propose the BDS test to examine the existence of this characteristic. Brock, Dechert and Scheinkman (1996) developed a non-parametric test that is commonly called the BDS test.

The BDS test is based on integral correlation originally introduced by Grassberger and Procaccia (1983) as a measure of spatial correlation for n-dimensional space.

i. BDS Test

BDS is defined as: $BDS = \frac{C_m(\varepsilon, T) - [C_1(\varepsilon)]^m}{\sigma_m(\varepsilon, T)/\sqrt{T}}$ (3.2)

Where $\sigma_m(\varepsilon, T)/\sqrt{T}$ is the standard deviation of the difference between the two correlation measures $C_m(\varepsilon, T)$ and $[C_1(\varepsilon)]^m$

Under the null hypothesis of IID, $C_m(\varepsilon)^m = C_1(\varepsilon)^m$.

If the null hypothesis of IID is violated,$C_m(\varepsilon)^m > C_1(\varepsilon)^m$.

When ε is serially correlated, tomorrow's price depends upon today's price and is therefore (partly) forecastable from the information available today.

Testing for Independence

Another assumption of the weak-form efficiency is that, in an efficient capital market, there should not exist a significant correlation between the share prices over time.

ii. Ljung-Box Test

The $Q - Statistic$ is a useful diagnostic instrument to test this hypothesis, as presented Box and Pierce (1970) and later expanded by Ljung and Box (1978).

The Q is defined as:

$$Q = T(T+2)\sum_{k=1}^{n}\frac{\rho_k^2}{T-1} \tag{3.3}$$

where

T = the number of observations in the series;
n = the total number of lags being tested
ρ_k = the autocorrelation of the series at lag k

This test is used to pick up any departure from zero autocorrelation in either direction at all lags (Bhattarai and Margariti, 2018). The null hypothesis suggests that the time series is independent.

In general, the lag$k$ sample **autocorrelation of r_t** is defined as:

$$\hat{\rho}_k = \frac{\sum_{t=k+1}^{T}(r_t - \bar{r})(r_{t-k} - \bar{r})}{\sum_{t=1}^{T}(r_t - \bar{r})^2}\ ,\ 0 \le k < T-1$$

and the ACF is estimated by the sample **autocorrelation function** (or sample ACF)

$$r_k = \hat{\rho}_k = \frac{C_k}{C_0}\ ,\quad k = 0,\ 1,\ .\ .\ .\ .,\ k$$

Test for Randomness

iii. Runs Test

It is sometimes useful to test the likelihood that a series of price movements occurred by chance. This can be done with a handy nonparametric statistical technique called a run test.

A **run test** is a statistical procedure that examines whether a sequence of data is occurring randomly from a specific distribution (Bujang and Sapri, 2018; Simon and Laryea, 2004; Dickinson and Muragu, 1994). A runs test measures the likelihood that a series of two variables is a random occurrence (Strong, 2006).

Run: A **run** is an uninterrupted sequence of the same observation (Strong, 2004). If there are too many runs, it would mean that the residuals change signs frequently, thus indicating negative serial correlation. Similarly, if there are too few runs, they may suggest positive autocorrelation.

- Test Statistics:

$$Z = \frac{r - \mu_r}{\sigma_r} \tag{3.4}$$

Where:

r = the number of runs

μ_r = the expected number of runs; and

σ_r = the standard deviation

Z = standard normal variable*

*The standard normal variable comes from a normal distribution with a mean of 0 and a standard deviation of 1. Approximately 95 percent of the distribution lies within two standard distributions of the mean. Z statistics with large absolute values do not often occur by chance.

The values of μ_r , $\sigma^2 r$ and σ_r are computed as follows:

$$ur = E(R) = \frac{2n_1n_2}{N} + 1$$

$$\sigma^2 r = \frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1 + n_2)^2(n_1 + n_2 - 1)};$$

$$\sigma_r = \sqrt{\frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1 + n_2)^2(n_1 + n_2 - 1)}}$$

iv. Variance Ratio Test

The variance ratio test compares the variances of increments of the different time intervals/lengths to test the null of RWH against the alternate hypothesis of stationary (Campbell, *et al*.1997). Hence, the VR, defined as the ratio of 1/*k* times the variance of the *k*-period return to the variance of the one-period return, should be equal to one for all values of *k*.

The test is conducted by constructing an estimator for k-period variance ratio [VR(k)] statistic.

$$VR(k) = \frac{\sigma^2(k)}{\sigma^2(1)} \quad (3.5)$$

Where $\sigma^2(1)$ is one-period return variance that is estimated using the one-period return $S_t - S_{t-1}$.

$$\sigma^2(1) = \frac{1}{T-1}\sum_{t=1}^{T-1}(S_t - S_{t-1} - \bar{r})^2$$

$$\Rightarrow \sigma^2(1) = \frac{1}{T-1}\sum_{t=1}^{T-1} r - \bar{r})^2$$

Where $\bar{r}$ is the estimated average of the one-period return.

To reject the alternate hypothesis that return follows a stationary process, $\sigma^2(k) \approx \sigma^2(1)$.

4.Results

The study employs monthly raw stock prices/returns of ten (10) companies, continuously traded in the Nigerian Stock Exchange (NSE) over the period January 2013 to December 2022. Monthly time plots of the data obtained is provided in Figure 4.1 which allows for a visual interpretation of the changes in price experienced by the Stock Exchange.

The companies were randomly selected based on their ability to trade frequently on the market and absolve the shocks of tin trading with irregular hiking (and they include: Dangote cement, Dangote sugar, Guinness, J. Berger, Neimeth, Okomu Oil, PZ, UPDC, Vita form, and Zenith Bank).

We were prompted to begin investigating the predictability and behavior of the selected stocks in the year 2013. This timeline captures the year the NSE all-share index rose astronomically by 42.8 percent, thereby enforcing attraction of investments to further deepen the market. A sight view of the trajectories of the selected company prices/returns are shown in the figures below.

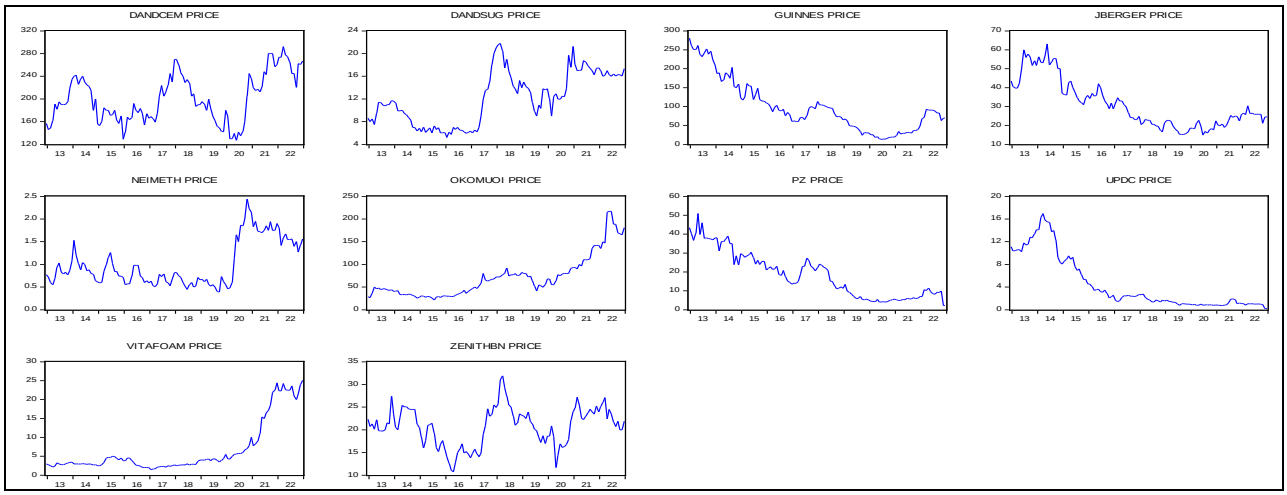

Figure 4.1-Prices movement of Selected Stocks over the Period Jan. 2013 to Dec. 2022.

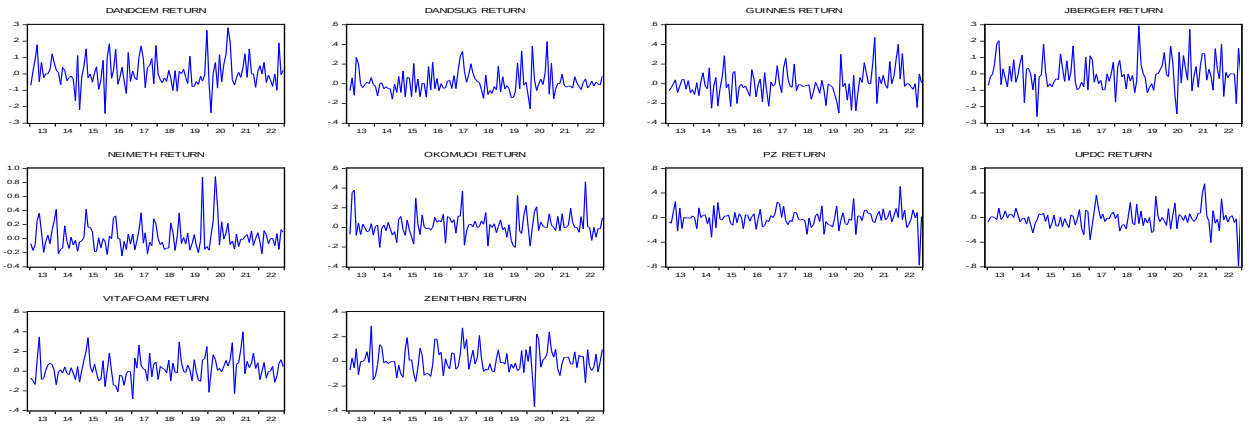

Figure 4.2-Increments/Returns of Selected Stocks over the Period Jan 2013 to Dec 2022

4.1 Normality Test Result

It is usually assumed that the populations from where the samples are collected are normally distributed. A graphical test for normality was conducted using Q-Q plot (by comparing a time series; see figure 4.3). The data points rest on the transfer lines for each case, implying that the returns of the companies follow normal distribution process, despite that they appear noisy in figure 4.2.

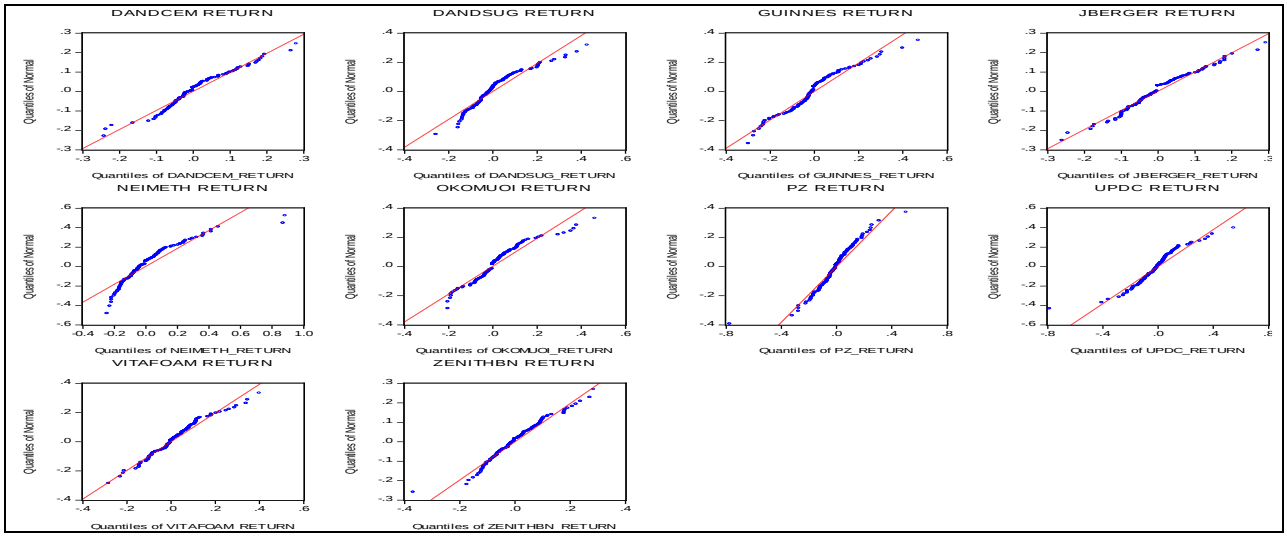

Figure 4.3 Normality Test Result

4.2 Stationary/Unit Root Rests Results

The ADF and PP statistics are in absolute terms larger than the associated 5% critical value for each of the stock (company) returns. This confirms the rejection of the null hypothesis that return has a unit root. The KPSS statistic shows lower values than the 5% critical values. Thus, there is a strong evidence that the underlying series is nonstationary at levels.

The results of ADF, PP, as well as that of KPSS provide evidence that the Nigeria index are nonstationary at level. Therefore, the results are consistent with the random walk hypothesis.

Table 4.1. Unit Root Result

Company	ADF-Test		PP-Test		KPSS-Test	
	Stat	CV @ 5%	Stat	CV @ 5%	Stat	CV @ 5%
DANGCEM	-11.22	-2.89	-11.23	-2.89	0.06	0.46
DANGSUG	-6.27	-2.89	-11.53	-2.89	0.08	0.46
GUINNES	-10.70	-2.89	-10.89	-2.89	0.26	0.46
JBERGER	-11.53	-2.89	-11.96	-2.89	0.16	0.46

NEIMETH	-9.02	-2.89	-8.88	-2.89	0.08	0.46
OKOMUOI	-11.17	-2.89	-11.17	-2.89	0.08	0.46
PZ	-12.89	-2.89	-12.79	-2.89	0.06	0.46
UPDC	-10.51	-2.89	-10.50	-2.89	0.06	0.46
VITAFOAM	-9.84	-2.89	-9.81	-2.89	0.63	3.12
ZENITHBN	-9.70	-2.89	-9.70	-2.89	0.06	0.46

Test of Non-Linear Independence

4.3 The BDS Test Result

The BDS test results reveal that the null hypothesis (IID) is rejected by only two of the companies' (Dangote Sugar and Okomu-Oil) returns at alpha value of 5%. This means that the returns of these companies are dynamically correlated, making prediction possible; while, we do not observe (significant auto-correlation) the possibility of precise prediction for the other eight companies.

Table 4.2 BDS test results

Company	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob
DANGCEM	2	0.006422	0.008379	0.766405	0.4434
DANGSUG	2	0.026640	0.008793	3.029581	0.0024
GUINNESS	2	0.006015	0.008789	0.684370	0.4937
JBERGER	2	0.003173	0.007693	0.412427	0.6800
NEIMETH	2	0.015649	0.008145	1.921417	0.0547
OKOMU-OIL	2	0.020116	0.009487	2.120321	0.0340
PZ	2	0.009669	0.007785	1.242011	0.2142
UPDC	2	0.011338	0.009260	1.224500	0.2208
VITAFOAM	2	0.014225	0.007998	1.778484	0.0753
ZENITHBN	2	0.012594	0.007020	1.793867	0.0728

Note the test was conducted strictly based on 2 embedded dimensions

4.4 The Box-Ljung Test Result of the Serial Correlation Coefficients

The tests show evidence of both positive (for Neimeth) and negative autocorrelation relationships (for the rest nine stocks). However, this relationship is found to be significant at 5% alfa level for Neimeth stock only.

The test result suggest that the serial correlation coefficient is significant for Neimeth at 5% alfa level while the serial correlation coefficient is not significant for the rest stocks. Taken together, there is no significant correlation between share prices over time.

The implication is that the changes in the prices of shares traded on the floor of the Nigerian stock exchange are independent and unpredictable.

When ε is serially correlated, tomorrow's price depends upon today's price and is therefore (partly) forecastable from the information available today. Insignificant serial correlations for all lags would indicate that the markets are perfect and may be efficient in the weak form and follow a

random walk. The presence of significant serial correlations would have led us to refute the random walk hypothesis.

Table 4.3 The Ljung- Box's Test Results

Company	Lag	ACF	PACF	Q-Stat	Prob
DANGCEM	1	-0.034	-0.034	0.1446	0.704
DANGSUG	1	-0.064	-0.064	0.5073	0.476
GUINNES	1	0.012	0.012	0.0163	0.898
JBERGER	1	-0.061	-0.061	0.4618	0.497
NEIMETH	1	0.180	0.180	3.9945	0.046
OKOMUOI	1	-0.031	-0.031	0.1191	0.730
PZ	1	-0.173	-0.173	3.7013	0.054
UPDC	1	0.027	0.027	0.0908	0.763
VITAFOAM	1	0.097	0.097	1.1638	0.281
ZENITHBN	1	0.106	0.106	1.3926	0.238

Note the test is based on 1lag length

4.5 Runs Test Result

It is important to note that the null hypothesis or weak-form market efficiency is accepted when the Z-score is less than the alpha value at 5%.

H_0: The sequence of stock prices/returns is random
H_1: The sequence of stock prices/returns is non-random (systematic).

The results of our investigation based on the runs test are reported in table 4.4.
From the results of runs tests reported in Table 4.4, it is observed that the Z-statistic values of four (4) of the companies are all negative indicating that the actual runs are less than the expected runs. Since the Z values or standard scores in respect to four (4) of the companies, which include Guinness (-0.135), Neimeth (-0.42), Vital Form (-1.24) and Zenith Bank (-1.556), are negative (less than alpha value at 5%), the null hypothesis is accepted. Hence there is no real evidence to suggest that the returns are not random. The likelihood of observing a Z statistic near 0 is very high. We cannot be 95 percent certain that our observed stock prices do not happen by chance unless we get a Z statistic whose absolute value is 1.96 or greater.
However, in each of the other six (6) companies, the associated p-value to the Z-stat are more than alpha value at 5%. It means that there are indications that the returns are random (predictable).

Table 4.4-Runs Test Results

Company	Number of Runs	Z-Stat	Prob
DANGCEM	64	0.816	0.414
DANGSUG	62	0.828	0.408
GUINNES	60	-0.135	0.893
JBERGER	64	0.563	0.574
NEIMETH	56	-0.42	0.674
OKOMUOI	64	0.759	0.448
PZ	62	0.196	0.845
UPDC	68	1.287	0.198
VITAFOAM	54	-1.24	0.215
ZENITHBN	52	-1.556	0.12

4.6 Variance Ratio Tests Results

This evidence of randomness is reinforced by conducting variance ratio test. The variance ratio test has been suggested in the finance literature as a test of the random walk model.

The study therefore, compares the variances of increments of the different time intervals/lengths and test the null of RWH against the alternate hypothesis of stationary, keeping in mind that the test has a null hypothesis of a random walk.

H_0: Equity returns are random

H_1: Equity returns are non-random

The p-value measures the evidence against H_0 (the null hypothesis). The p-value is the smallest α (alpha) at which we do reject H_0. The smaller the p-value, the stronger the evidence against H_0. If the evidence against H_0 is strong, the p-value will be small.

The tests results presented in table 4.5 below reveal that the evidence against H_0 is strong (very small p-value, 0.0). Hence rejection of H_0. This test finds significant evidence of price predictability by rejecting the null hypothesis of the variance ratio that returns possess uncorrelated increments (random walk 3) – a violation of the efficient market hypothesis.

Table 4.5: Variance Ratio Test Results

Company	Period	Var. Ratio	Std. Error	z-Statistic	Probability
DANGCEM	2	0.517708	0.126269	-3.819568	0.0001
DANGSUG	2	0.372639	0.139784	-4.488082	0.0000
GUINNES	2	0.484274	0.114762	-4.493873	0.0000
JBERGER	2	0.490001	0.113685	-4.486083	0.0000
NEIMETH	2	0.666126	0.153766	-2.171307	0.0299
OKOMUOI	2	0.530744	0.120418	-3.896901	0.0001
PZ	2	0.325200	0.156205	-4.319956	0.0000
UPDC	2	0.493389	0.145475	-3.482448	0.0005
VITAFOAM	2	0.578492	0.113801	-3.703908	0.0002
ZENITHBN	2	0.644981	0.119694	-2.966051	0.0030

Note that our test is based on 2 periods, though similar results are obtained in longer periods.

5. Discussion of Results

An examination of the distribution patterns of stock price changes in the Nigeria Stock Exchange show that the pattern is approximately normal, thus suggesting that the changes in the prices of stocks traded on the floor of the Nigerian Stock Exchange is random.

One of the specific objectives of this study is to test the assumptions that a non-linear dynamically independent relationship exists to a considerable extent in the Nigerian stock market; making the predictability of the selected stocks impossible.

The overall result suggests that there is no significant correlation between the security prices over time. Consequently, past prices are independent, and cannot have any predictive power for future prices.

The results of this study are consistent with Olowe (2002), Rapuluchukwu (2010), Ajao and Osayuwu (2012); Okpara (2010); Olowe (1999) Keith and Graham (2005), Andabai, (2019), and Gbalam and Nelson, (2019) who had earlier conducted similar test using share price data from the Nigerian Stock Exchange. However, the results are inconsistent with the findings of Ekechi (2002), Inegbedion (2009). Emenike (2008, 2010); Gimba (2012); Afego (2012); Goudarzi (2013) and Ogbulu (2016), and Ogbonna and Ejem (2020).

6. Summary, Conclusion and Recommendations

6.1 Summary and Conclusion

This study first provides an overview of the theoretical literature on the EMH models as suggested by Fama (1970), Following the theoretical literature, empirical studies on the weak form of EMH in Nigeria stock markets have been extensively reviewed, especially in recent years. The empirical evidences obtained from this study is mixed. Indeed, while some evidences show empirical results that support the null hypothesis of weak form market efficiency, others report evidences to reject the weak form market efficiency. In general, emerging stock markets are unlikely to be efficient in weak form possibly due to their inherent characteristics, such as low liquidity, thin and infrequent trading, and lack of experienced market participants.

6.2 Policy Implication and Recommendations

The policy implication of this analysis is that the Nigeria Stock Exchange, as an emerging market, must be closely monitored to achieve an optimal maturity level.

It is therefore recommended that policy makers to enlighten potential investors of the opportunities that are available in the stock market. Such enlightenment should seek to stimulate their interest in capital market activities and thus increase the breadth and depth of the capital market.

6.3 Future Research

Future research should be dedicated to the other forms (semi-strong and strong) of the efficient market hypothesis to also establish their validity or otherwise.

6.4 Contribution to Knowledge

It used a combination of tests.

Most importantly, the study employs the BDS test to analyze the historical prices/returns in Nigeria.

Adds to the evidence that the efficient market hypothesis should not be an all or nothing condition but it should be stated as a time varying condition where prices fluctuate between periods of efficiency and inefficiency.

References

Adams, N. T., Booth, P. M., Bewie, D. C. & Freeth, D. S. (2003). *Investment mathematics*, Chichester, England: John Wiley & Sons Ltd.

Afolabi, L. (1998). *Monetary economics,* revised edition, Surulere-Lagos, Nigeria: PERRY BARR LTD.

Ajao, G & Osayuwu, R. (2012). Testing the weak form of efficient market hypothesis in Nigerian capital market. *Accounting and Finance Research*, 1(1)

Alfred, D. D. (2007*). Corporate finance: Issues, investigations, innovations and applications*, second edition, Lagos- Nigeria: High Rise Publications.

Andabai, P. W. (2019). Weak form efficient market hypothesis in the Nigeria stock markets: An empirical investigation. *Online Journal of Arts, Management and Social Sciences,4* (1), 174-181.

Asaolu, T.O. & Ilo, B. M. (2016). The Nigerian stock market and oil price: A co-integration analysis. *Kuwait Chapter of Arabian Journal of Business and Management Review*, 1(5), 28-36.

Bhalla, V. K. (2012). *Investment management: Security analysis and portfolio management*, Ramnagar, New Delhi, S. Chand & Company.

Block, S. B. & Hirt, G. A. (1998). *Foundation of financial management*. 6th ed. Boston: Richard Irwin Inc.

Box, George, E. P. & Pierce, David A. (1970). Distribution of residual autocorrelations in autoregressive-integrated moving average time series models. *Journal of the American Statistical Association 65(3),* 1509-1526

Brealey, R. A. (1969). *An Introduction to Risk and Returns from common stock,* Cambridge Mass MIT press.

Brealey, R.A. & Myers, S.C. (2003). *Financing and risk management,* New Delhi Tata McGraw-Hill Publishing Company Limited

Brealey, R.A., Myers, S.C. and Allen, F. (2005) *Corporate Finance,* eighth edition, New York: McGraw-Hill Irwin.

Brealey, R. A., Myers, S. C., & Marcus, A. J. (2007). *Fundamentals of corporate finance,* Fifth edition, New York: McGraw Hill/Irwin

Broock, W.A., Dechert, W., Scheinkman, J. A & LeBaron, B, (1996). A test for independence based on the correlation dimension. *Econometric Reviews, 5 (3*), 197-235.

Bujang, M. A, & Sapri, F. E. (2018). An application of the runs test to test for randomness of observations obtained from a clinical survey in an ordered population. *Malaysia Journal of Medical Science*; 25(4):146–151. https://doi. org/10.21315/mjms2018.25.4.15

Campbell, J. Y., Lo, A. W. & MacKinlay, A. C., (1997). *The econometrics of financial markets*.Princeton: Princeton University Press.

Copeland, T. E. & Weston, J. F. (1983). *Financial theory and corporate policy,* second edition; Canada: Addison- Wesley Publishing Company Inc.

Cowles, A. (1933). Can stock market forecasters forecast?.*Econometrica, 1,* 309-324.

Cowles, A. (1944). Stock market forecasting, *Econometrica*, *12*, 206-214.

Cowles, A. (1960). A revision of previous conclusions regarding stock price behavior. *Econometrica* 28, 909–15.

Cunningham, L. A. (1994). From random walks to chaotic crashes: The linear genealogy of the efficient capital market hypothesis. The George Washington Law Review 546- 551.

Davies, T., Boczko, T., & Chen, J. (2008). *Strategic corporate finance: Tests and cases*, Berkshire: McGraw-Hill Higher Education.

Dickinson, J. P. & Muragu, K. (1994), Market efficiency in developing countries: A case study of the Nairobi stock exchange. *Journal of Business Finance & Accounting*, *21(1),* 133–50.

Dremen, D. (1991). Flawed forecasts. Forbes, 342.

Fama, E. F. (1963). Mandelbrot and the stable Paretian hypothesis. *Journal of Business36,* 420-429.

Fama, E. F. (1965a.). The behavior of stock market prices. *Journal of Business 38*, 34–105.

Fama, E. F. (1965b.). Random walks in stock market prices. *Financial Analysts Journal 21*, 55– 59

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *Journal of Finance, 25*, 383– 417.

Fama, E. F. (1991). Efficient capital markets: II. *Journal of Finance, 6(5),* 1575–1617.

Fama, E. F. & Blume, M. (1966). Filter rules and stock market trading profits. *Journal of Business 39,* 226-241.

Fama, E. F., Fisher, L., Jensen, M. & Roll, R. (1969). The adjustment of stock prices to new information. *Economic Review 10*, 1-21.

Gbalam, P. E., & Nelson, J. (2019). Testing the weak-from efficiency of the Nigerian stock exchange, *European Journal of Accounting and Finance Research, 7(10),* 10- 22.

Gilson, R. J. & Kraakman, R. H. (2003). The mechanisms of market efficiency twenty years on: The Hindsight Bias. 5 (Harvard Law School John M. Olin Center for Law, Economics and Business Discussion Paper Series. Paper 446). http://lsr.nellco.org/harvard_olin/446 accessed 19 April 2011

Gimba, V.K. (2012). Testing the weak form efficiency market hypothesis: Evidence from Nigeria stock market. *CBN Journal of Applied Statistics*, 3(1), 117-136.

Grossman, S, J. & Stiglitz, J. E. (1980). On the impossibility of informational efficient markets, *American Economic Review 70,* 393-408.

Gupta, S. P. (2011). Statistical methods fortieth revised edition, Delhi, Sultan Chad & Sons.

Jensen, M. (1978). Some anomalous evidence regarding market regarding market efficiency. *Journal of Financial Economics 6,* 98-101.

Jordan, B. D. & Miller, T. W. (2009). *Fundamentals of investment: Valuation and management,* McGraw-Hill, Irwin.

Keith. J & Graham. S (2005). The changing efficiency of African stock markets. *South African Journal of Economics* 73,1.

Kishore, R. M. (2004). *Financial management.* 5th edition. New Delhi Tax man Allied Services.

Levinson, M. (2006). Guide to financial markets, fourth edition, London: The Economist.

Lintner, S. (1965). Predicting the bear stock market: Macroeconomic variables as leading indicators. *Journal of Banking and Finance,* 33, 211-223.

Ljung, G. M, & Box, G.E. (1978). On a measure of lack of fit in time series models. *Biometrika 65(2):* 297–303.

Lo, A. W. & MacKinlay, A. C. (1988). Stock market prices do not follow random walks: Evidence from a simple specification test, *The Review of Financial Study* 1, 41-66.

Ljung, G. M. & Box, G. E. P. (1978). On a measure of lack of fit in time series models. *Biometrika 65(2),* 773-785.

Markowitz, H. (1952). Portfolio selection. *Journal of Finance 7*, 77-91.

Markowitz, H. (1959). *Portfolio selection: Efficient diversification of investments;* Yale University Press.

McLaney, E. J. (2000). *Business finance: Theory and practice,* Fifth edition, University of Plymouth Business School. Financial Times Pitman Publishing.

Modigliani, F. & Miller, M. H. (1958). The cost of capital, Corporation finance, and the theory of investment, 48 *American Economic Review* 655.

Mossin, J. (1966). Equilibrium in a capital asset market. Econometrica, *Journal of Econometric Society,* 867-888

Nageri, K. I., & Abdulkadri, R. I. (2019). Is the Nigerian stock Market efficient? Pre and Post 2007-2009 Meltdown Analysis. *Studia Universitatis economics series*, 29(3), 38-63.

Njiforti, P. (2015). Impact of the 2007/2008 global financial crisis on the stock market in Nigeria. CBN. *Journal of Applied Statistics*, 6(1), 49-68.

NSE (2019) Market model and trading manual-equities, Issue 2, October.

Ogbulu, O. M. (2016). Weak form market efficiency, estimation interval and the Nigerian stock exchange: Empirical evidence. *International Journal of Economics and Business, 5* (1), 84-116.

Ogbonna, U. G. & Ejem, C. A. (2020). Nigerian stock exchange and weak form efficiency. *Research Journal of Finance and Banking, 11(8),* 82-94.

Okotori, T. & Ayunku, P (2019): An empirical investigation on efficient market test for the Nigerian stock exchange *(NSE).* Published in: *IOSR Journal of Economics and Finance* (IOSR-JEF), 10(6) Ser. IV (Nov. – Dec), 1- 9.

Okpara, G. C. (2010a). Stock market prices and the random walk hypothesis: Further evidence from Nigeria. *Journal of Economics and International Finance*, 2(3), 49-57.

Olowe, R. A. (1999). Weak-form efficiency of the Nigerian stock exchange market: Further evidence. *African Development Review*, *11(1)* 54-68.

Olowe, R. A. (1996*). Financial management: concepts, analysis and capital investments*. First edition. Lagos: Brierly Jones Nigeria Ltd.

Omolehinwe, A. (1991). Efficient market hypothesis: The Nigerian account. *Journal of the Institute of Chartered Accountants of Nigeria.* Lagos: ICAN, xxiv.

Onwukwe, E. K., & Ali, P. I. (2018). Weak form efficiency of the insurance industry: Empirical evidence from Nigeria. *Jurnal Keuangan dan Perbankan, 22* (1), 14–22.

Pandey, I. M. (2015). *Financial management,* Eleventh edition, International edition; VIKAS Publishing House, PVT Ltd

Rapuluchukwu, E. U. (2010). The efficient market hypothesis: Realities from Nigerian stock market. *Global Journal of Financial Management,* 2, (2),321-331.

Roberts, H. V. (1959). Stock-market "pattern" and financial analysis: Methodological suggestions. *The Journal of Finance 14:* 1–10.

Ross, S. A., Westerfield, R. W., & Jordan, J. (1996). *Corporate finance*. New York: Irwin (McGraw – Hill)

Samuelson, P. (1965). Proof that properly anticipated prices fluctuate randomly. *Industrial Management Review 6,* 41–9.

Sharpe, William, F. (1964). Capital assets prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, 19*(6),* 425-442.

Simons, D. & Laryea, S.A. (2004), Testing the efficiency of selected African stock markets, A Working Paper. http://paper.ssrn.com/so13/paper.cfm?abstract_id=874808.

Spiegel, M. R. (1992). *Theory and problem of probability and statistics.* New York: McGraw-Hill.

Strong, R. A. (2004). *Practical investment management*, 3rd edition, Canada: Thomson: South.

Strong, R. A (2006). *Portfolio management handbook*, Fourth Jaico Impression, Delhi-India, JAICO PUBLISHING HOUSE.

Sunday, D. D. & Olulu-Briggs, O. V. (2021). Weak-form efficiency of the Nigerian Capital Market: Prior and Post Internationalization Periods, *Gusau International Journal of Management and Social Sciences, 4(2)* 73- 85. Gusau, Federal University,

Titan, A. G. (2015). The efficient market hypothesis: Review of specialized literature and empirical research. *Procedia Economics and Finance 32*: 442-449.

Treynor, J. L. (1961). Market, time and risk. Unpublished manuscript.

Treynor, J. L. (1962). Towards a theory of market value of risky assets. Unpublished manuscript. A final version was published in 1999, in Robert A. kKojajczyk (ed.): Asset prices and portfolio performance metrices (15- 22), London, Risk Books.

Tyson, E. (2003). *Investing for dummies*, third edition, Indianapolis, Indiana: Wiley Publishing Inc.

Van Horne, J. C. & Dhamija, S. (2002). *Financial management and policy*, twelfth edition, India; Pearson Education, Inc.

Van Horne, J. C. & Dhamija, S. (2012). *Financial management and policy,* Delhi: PEARSON

Watson, D. & Head, T. (1998). *Corporate finance: principles and practice*, London, Financial Times Management; Pitman Publishing.

Woo, Kai-Yin, Chulinmai, Michael McAleer, & Wing-Keung Wong (2020). Review of efficiency and anomalies in stock markets. *Economics 8,* 1-51.