Stock market prices and the random walk hypothesis: Further evidence from Nigeria

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Accepted 29 January, 2010

The weak form hypothesis has been pointed out as dealing with whether or not security prices fully reflect historical price or return information. To carry out this investigation with the Nigerian stock market data, we employed the run test and the correlogram/partial autocorrelation function as alternate forms of the research instrument. The results of the three alternate tests revealed that the Nigerian stock market is efficient in the weak form and therefore follows a random walk process. Thus, the opportunity of making excess returns in the market is ruled out.

Keywords: Market efficiency, weak form hypothesis, stock market returns, equity, run test, autocorrelation test.

INTRODUCTION

A stock market is a public market for the trading of company stock and derivatives at an agreed price. The stocks are listed and traded on stock exchanges. The Nigerian stock exchange (NSE) is the center - point of the Nigerian Capital Market, while the Securities and Exchange Commission (SEC) serves as the apex regulatory body. The Nigerian stock exchange was incorporated on September 15, 1960 and it commenced business on June 5, 1961 as the Lagos stock exchange with 19 securities listed for trading. It is a non profit making concern and a private company limited by guarantee. Its excess of income over expenditure or its accumulated reserves are not available for distribution as dividend to the company’s shareholders, whose liability is limited to the stipulated amount of shares each has undertaken to contribute in the event of winding up (Nwankwo, 1980:132). In December 5 1977, following the recommendation of the Government Financial System Review Committee of 1976, the Lagos Stock Exchange was renamed and reconstituted into the Nigerian Stock Exchange, with branches established in different major commercial cities of the country. At present there are nine branches of Nigerian Stock Exchange. Each has a trading floor some of which are electronic. The exchange provides a means for trading existing securities and also encourages large - scale enterprises to gain access to public listing. The NSE operates the main exchange for relatively large enterprises and the second tier securities market (SSM) is where listing requirements are less stringent for small and medium scale enterprises. A close comparative observation in the trading activities of the Nigerian stock exchange reveals that the share of government stock from 1963 to 1990 had been overwhelmingly exceeding the industrial equities. But as from 1991 to date the reverse became the case to the extent that conspicuously, as the government stock traded in millions, the industrial equities accelerated to billions. Growth in the government stock stopped increasing in 1986 and started to decrease till data while industrial equities and bonds as well as Second tier Securities Market (SSM) continued to increase yearly. On the whole, the total number of the listed securities is on the increase. We believe that the deregulation of the economy in 1986 and the privatization of the public sector enterprises in 1988 necessitated this great change.

Despite the institutional arrangement and provisions, the Nigerian Capital Market still remains a small proportion of the national economy. Over the years, the total market capitalization has been increasing but its share of the Gross National Product as well as its proportion of the Gross Fixed Capital Formation has been very small. The proportion of market capitalization to the gross domestic product fluctuated between 5.1 and 24.69%, while its share of the gross fixed capital formation fluctuated between 54 and 27.36%. Apart from 1992 which registered a decline in the proportion of market capitalization to both GDP and GFCF, these proportions increased progressively from...
1990 to 1995. From 1996, while its share of GDP fluctuated between 9 and 18.02%, its share of GFCF grew consistently from 10.1 to 27.3%. A continued decline in its share of GDP from 1977 to 1999 could be attributable to a drastic fall in the growth rate of market capitalization, which on the average was 2%. As the market capitalization declined, the gross fixed capital formation and the GDP also declined. The share decline in market capitalization during this period could be associated with the widespread distress in the banking system. In 1998 alone, a total of 26 banks including listed ones were put to liquidation. Further, the repercussion is reflected on the negative growth rate of the Gross Domestic Product (GDP) (-27%) and the Gross Fixed Capital formation (GFCF) (-6%) (Okpara, 2006).

REVIEW OF LITERATURE

The efficiency or inefficiency of securities market has generated a lot controversy over a couple of decades in finance and economics discussions. The fundamental analysts try to study the company’s business by publishing various historical financial statements and hence uncovering information about its profitability that will shed light on the value of the stock. The efficient market hypothesis is an express tool that supports the assertion that the stock market leads economic activities since market efficiency ensures that past and available current information is fully reflected in current stock prices, investors cannot usurp any privileged information as to beat the market and make abnormal returns. Thus, in any information - efficient market, past/current levels of economic activity cannot be used to predict present/future stock prices. Fama (1970) categorizes the three types of efficient markets as weak - form, semi -strong - form and strong form efficient, if the set of information includes past prices and returns only, all public information and even private information.

The strong form of the efficient hypothesis states that current market price reflects all pertinent information including everything that is known whether it is public or private. In other words, the security prices reflect everything that is knowable, anything that a host of investment analysts could possibly uncover using all their talent and all the tools at their disposal. No group of investors has a monopolistic access to information relevant to forming opinion about prices as to make abnormal profit. Under such circumstance, it would be impossible to ferret out any information that is not already discounted in the market price of security (French 1986). Hence, in this form of efficient market hypothesis, it becomes impossible for any investor to make consistent supernormal returns over a long run since information will be equally available to all at the same time. Tape watching, charting and professional investment analyses are a waste of time. In fact, consistently superior performance is absolutely impossible. The strong – form hypothesis encompasses both the weak and semi strong forms. The semi –strong hypothesis contends that the price of any security reflects not only past prices of the security but also all available public information. This information includes both the original raw information about the economy, political news or an individual security and any publicly available analyses or projections made, using the raw data. According to this form, all information contained in the company’s financial statements, potential analysis of such information including news release, economic data and so forth are fully reflected by each security price.

The implication of this is that investors will have no generally available source of information that could lead to beat the market. Thus, it is of no use to pore over annual reports or other published data since the market prices adjust instantly to any sort of news carried by such reports or data. The random walk hypothesis otherwise called the weak form of the efficient market hypothesis which we are concerned with, states that current market prices reflect all the information contained in the record of past prices. In other words, all information conveyed in past patterns of a stock’s price is impounded into the current price of the stock. It will be useless to select stocks based on information about recent trends in stock prices. The fact that the price of stocks has risen for the past two or four days will give no useful information as what today’s or tomorrow’s price will be. Thus, tape watchers and chartists who follow the price trend in order to forecast price or determine when to buy and sell the stock are wasting their time. Existence of random walk hypothesis means that there are no regularities or patterns in security prices that repeat themselves over time as to predict future stock prices from past prices. Thus, each price change that occurs in the market is independent of the previous price changes. Because of these independencies, the price movement is said to behave randomly. Magnus (2008) noted that the implication of the efficiency analysis is that all markets can be weak form, but the reverse cannot be the case. The original and analytical empirical work on the random walk theory was done by Louis Bachelier (1900). He was the first to point out that security prices and prices of other speculative commodities follow a random walk. His study was not recognized until Holbrook Working (1934) confirmed the same result. Cowsis and Jones (1937) also produced the same result. In 1953 Kendall examined the behaviour of weekly changes in 19 indices of British industrial share prices, spot prices for cotton in New York and wheat in Chicago. He found successive arithmetic differences in British stock price averages to be largely uncorrelated. Other studies in support of the random walk theory include Roberts (1959), Osobrne (1959), Alexander (1961), Moore (1962), Mandelbrot (1964),
Fama (1965), Samuelson (1965), Mandelbrot (1966),
Fama and Blume (1966), Niederhofer and Osborne
(1966), Van Horne and Parker (1967), Shelton (1967),
Kemp and Reid (1971) Black and Scholes (1973),
Jennnergren and Korsvold (1975) Wan (1980) and more
recently in Nigeria Samuels and Yacout (1981). Of more
direct relevance to this study was the study by Samuels
and Yacout in 1981 on the Nigerian data. They tested for
several correlations in the weekly prices of shares in 21
companies quoted on the Nigerian stock exchange
between July 1979. They found a trace of dependence
with a one - week lag in only seven shares and a two -
week lag in four shares. The absolute mean serial
correlation coefficient was 0.146 with one - week lag and
0.086 with a two - week lag. The results of these tests
supports the theory that prices follow a random walk. It is
however unfortunate that their sample population
represented only about 2/10 of the entire listed
companies and as such their results were likely to be
biased.

The primary data for their study consisting of Monday
closing prices of thirty shares recorded in the daily official
list of the Nigerian stock exchange using both non -
parametric test (Wald-Wolfowitz test and the number of
runs test) and parametric estimation test he came to a
conclusion that prices of shares quoted on the Nigerian
stock exchange follow an unpredicatable part despite
the fact that they are being administered. Ayadi (1983) used
non - parametric tests in testing the hypothesis that
successive weekly price changes are independent in a
sample of 30 quoted companies on the Nigerian stock
exchange over the period January 1997 to Dec. 1980.
His result also supported the weak form efficiency.
Ayadi's sample population seems encouraging, yet we
shall increase that sample to include almost every
registered company. Olowe (1999) using data consisting
of an end of the month quoted stock prices of 59
randomly period January 1981 to December 1992 on the
Nigeria stock exchange and employing a sample
autocorrelation test concluded that the Nigeria stock
market appeared to be efficient in the weak form. Olowe's
sample population though fair could be said to cover half
of the quoted companies over the years and not the
entire market or approximately the entire market. Kukah,
Amoo and Raji (2006) in order to represent the whole
market, focused their study on market indices in local
currencies rather than prices of individual stocks. In other
words, they used the capitalization weighted index of all
listed stocks. Using both parametric and non parametric
test in determining the efficiency of the Nigerian stock
market according to them, the results of the parametric
tests showed that the Nigerian capital market is weak
form efficient while the parametric tests showed that the
market is not weak - form efficient. In their work,
inconsistent answers have left a naıve researcher with
inconclusive result.

METHODOLOGICAL FRAMEWORK

The weak form hypothesis as has been pointed out, deals with
whether or not security prices fully reflect historical price or return
information. Since returns (Rj,t) can be computed from observations
on past stock prices, a market where returns are serially correlated
would be weak form inefficient. In other words, the hypothesis of
weak form efficiency should be rejected if stock returns are serially
correlated. It is only when there is absence of serial correlation that
the stock market follows a random walk (Olowe 1999). The
expected return on the holding of a financial security is usually
made up of expected dividends to be declared and the expected
capital gains. The capital gain is the difference between the
purchase price of the security and the selling price. Thus, in an
attempt to predict the expected returns, emphasis is usually laid on
the historical returns of the shareholding so that when past data of
returns are available, each period's returns for security j is
calculated as follows (Umoh, 1993: 108, Olowe, 1999). The discrete
compounding formula for determination of returns Rj is given by

\[
R_j = \frac{D_j + (P_{jt} - P_{jt-1})}{P_{jt-1}} \times 100
\]

Where;

- \( P_j = \) the stock market price.
- \( D_j = \) yearly dividend per share.
- \( P_{jt-1} = \) stock market price index for period t-1.
- \( R_j = \) return for security j.

However, to test the hypothesis that the Nigeria stock market is not
efficient in the weak form, the study uses the market return to
investors (Rt) for the entire stock market listed in the Nigerian stock
exchange derived from the log transformation of the price ratio as
used by Kokah, Amoo and Joseph-Raji in their work (CBN, 2007) to
convert the data into continuously compounded rates rather than
using discrete compounding. The formula is given by

\[
R_t = \ln \left( \frac{P_t}{P_{t-1}} \right)
\]

Where;

- \( \ln = \) natural logarithm

The yearly market return is used here for two reasons, namely:

i. Dividend in companies is paid yearly in Nigeria.
ii. The accounting period for companies in Nigeria is 12 months.
iii. The Exchange maintains an all share index formulated in January

Nevertheless, to capture the most current priced activities and
returns over time, we also use (average of) the end of the month
quoted stock prices of 121 randomly selected securities listed
through out the period January, 1984 to December 2006 on
Nigerian stock exchange and also the stock market monthly price
index for the years 2003, 2004 and 2005 for the 121 listed
companies as a supportive alternate test. The monthly stock prices
of the entire 121 companies were used to obtain monthly stock
returns over the period. The non parametric test, the Run test and a
more scientific test - autocorrelation involving correlograms and the
Ljung - Box Q - statistics, for a high order serial correlation will also
be used on the categorical data to test the random walk hypothesis.

A run is defined as a series of increasing values or a series of
decreasing values. The number of increasing or decreasing
values is the length of the run. Given a series of stock price changes, each price change is designated a plus (+) if it represents an increase or a minus (−) if it represents a decrease. The resulting series, for example may look as follows:

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+ + - + -
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A run occurs when there is no difference between the sign of two changes. When the sign of changes differs, the run ends and a new runs begin. Thus, in the above series of pluses and minuses, there are five runs (Chandra: 2005:303). A lower than expected number of runs indicates a market’s overreaction to information, while a higher number of runs reflects a lagged response to information (Poshokwale, 1996). Implicitly, an abnormally high (or low) number of runs indicate evidence against the null hypothesis of a random walk. However, to test a series of price (return) changes for independence, the number of runs in the series is compared to see whether it is statistically different from the number of runs in a purely random series of the same size.

Though in a more restricted case, the standard expected number of runs is usually set at one and the Z values should be negative for non-randomness. This test has the advantage of ignoring the distribution of the data, and does not require normality or constant variance of the data (CBN, 2006). The number of 'of' run test is given by

\[
\text{Mean} = \frac{N(N+1) - \sum_{i=1}^{3} n_i^2}{N}
\]

\[
\text{Standard deviation} = \frac{\sum_{i=1}^{3} n_i^2 (\sum n_i^2 + N(N+1)) - 2N^2 \sum_{i=1}^{3} n_i^2}{N^2 (N(N+1))^{92}}
\]

\[
Z - \text{Score} = \sqrt{\frac{\sum_{i=1}^{3} n_i^2}{\sum n_i^2 + n(n+1) - 2N\sum n_i^2 - n}}
\]

Where:
- \(N\) = total number of price changes
- \(n\) = the number of price changes of each sign
- \(n_1\) = number of "pluses"
- \(n_2\) = number of "minuses"
- \(n_0\) = number of "zeros"
- \(r\) = observed number of runs.

The expectation under this test is that standard (Z) scores obtained fall between the range of -1.96 and +1.96. It is when this happens that successive price changes are said to be independent. In other words, if the null hypothesis of randomness is sustainable, following the properties of the normal distribution, we should expect that \(Pr\{E(K) - 1.96_\alpha \leq K \leq E(K) + 1.96_\alpha\} = 0.95\), where \(K\) is the number of runs. Autocorrelation refers to the relationship not between two or more different variables but between the successive values of the same variable (Koutsoyianis 1972:200). Autocorrelation can be used to measure the persistence or predictability of the market prices on the basis of past market prices. (Hervey, 1995, Olowe, 1999). Random walk hypothesis implies independent residuals and a unit root which implies that observations (stock prices) vary around a constant mean, with constant variance and are probabilistically independent. The independent hypothesis can be investigated by examining the autocorrelation function (ACF). The ACF shows the pattern of autocorrelations present in the time-series as well as the extent to which current values of the series are related to various lags of the past data. Autocorrelation tests show whether the serial correlation coefficients are significantly different from zero.

In an efficient market, the null hypothesis of zero autocorrelation will prevail. This study tests the hypothesis of weak form efficiency by calculating sample autocorrelations. Sample autocorrelation of lag \(k\) according to Olowe (1999) is given by

\[
\rho_k = \frac{\sum_{t=k-1}^{T} (R_{jt} - \bar{R}_j) (R_{jt-k} - \bar{R}_{jt})}{\sum_{t=1}^{T} (R_{jt-k} - \bar{R}_{jt-k})^2}
\]

Where:
- \(\rho_k\) is the autocorrelation of lag \(k\)
- \(R_j\) is the return on security \(j\) at time \(t\)
- \(\bar{R}_j\) is the average expected return on security \(j\) over period \(t\)
- \(R_{jt-k}\) is the return on security \(j\) at time \(t\) \(-k\)
- \(R_{jt-k}\) is the average return on security \(j\) over period \(t-k\), and
- \(T\) is the total number of observations for a lag period of \(k\) periods

However, the autocorrelation function is often referred to as the correlogram when we are dealing with only an estimate (return) and the partial autocorrelation function. The correlogram shows the correlation between a variable \(R_i\) (return) and a number of past values. The correlogram thus comprises a number of values, one for each order of the lag length examined, which measures the correlation between the lag and the current observation. The partial autocorrelation function is similar to the correlogram except that it looks at the correlation between a particular lag and the current value after the effects of the other lags have been partialled out (Hall, 1994:12). The formula for the correlogram is given by

\[
C_i = \frac{1}{T} \sum_{t=1}^{T-k} (R_{t+k} - R_i)(R_t - R_i^*)^2
\]

Where:
- \(R_i^* = \frac{1}{T} \sum_{t=1}^{T} R_t\)
- \(C_i\) = Correlogram
- \(R_{t+k}\) = the next periods return
- \(R_t\) = the present period’s return
- \(T\) = the total number of observation
- \(t\) = the time period(s)

The partial autocorrelation function is given as the coefficient from a simple autoregression of the form:

\[
R_t = A_0 + \sum_{t=1}^{T} P_t R_{t-i} + u_t
\]

Where; \(P_i\) is the estimate of the partial autocorrelation function, and
Ao is a constant while \( u_t \) is the error term. The results from the three tests which may contradict or reinforce themselves will be used to analyze the efficiency condition of the Nigerian stock market. The reason for this alternate form method is to ascertain the reliability or validity of the result. This work will make different from others for the following reasons: Apart from using alternate methods to make inferences, rich set of data on 121 listed companies is used. Thus, the population is sizable enough to draw conclusion from.

**ESTIMATION AND ANALYSIS OF DATA.**

The test of weak form efficiency of the Nigerian stock market (from 1984-2006) using run test is conducted and the results are presented in Table 1 as follows.

**Interpretation of results**

The \( z \) scores \((z = -1.701)\) falls between the range of -1.96 and +1.96 and it is statistically insignificant for a two tailed test for mean, (100 > 5%) and for median (58.5 > 5%). In 2004, the \( z \) scores for the mean \((z = 0)\) and the median \((z = -0.908)\) fall between the range -1.96 and +1.96 and it is not statistically significant for a two tailed test. While in 2005, the \( z \) scores for the mean \((z = -1.955)\) and the median \((z = -0.908)\) fall between the range -1.96 and +1.96 and these scores are insignificant for a 2 - tailed test at 5 percent critical level. Since for the mean, 5.1 > 5% and for the median, 36.4 > 5%. The results therefore support the fact that the successive price (return) changes are independent thereby lending credence to the assertion that the Nigerian stock market follows a random walk process and is therefore weak - form efficient. To ascertain the reliability or validity of this test, we also employ the autocorrelation test. The results of the autocorrelation and partial correlation obtained from correlogram are shown in Table 2.

The Table 3 shows the autocorrelation coefficients computed through correlogram of the discrete compounded return series. The data displayed insignificant autocorrelation pattern at 5 percent level while exhibiting some periodic inconsistency in temporal dependence. For example, lag 1, 5, 8, 11 and 12 exhibited positive autocorrelation while lags 2 - 4 and others have negative autocorrelation. From the above results, since all the autocorrelations and partial auto-correlations at all lags have their Q - statistics insignificant (Prob. > 5%), we say that \( p_k \) is not significantly different from zero and therefore accept the existence of weak form hypothesis in the Nigerian stock market. Thus, the prices and returns in the Nigeria stock market follow a random walk process. This situation suggests that the opportunity to make excess returns does not exist in the Nigeria stock market. The following graphs of the returns on Figure 1 and 2 indicate that the Nigerian stock market follows a random walk process.

The results of the retest of the autocorrelation using average monthly returns for the years 2003, 2004, and 2005 of the registered companies also show that the autocorrelations and partial autocorrelations at all lags are nearly zero, and all the Q statistics are insignificant. The results therefore support the fact that there is no serial correlation in the residuals and hence, the random walk process exists in the Nigerian stock market. The implication of these results is that it seems reasonable to assume that security returns data are independent. This implies that the Nigerian stock market appears to be efficient in the weak form, suggesting that the opportunity to make excess return does not exist in Nigerian stock market. This work, irrespective of its difference in time scope, volume of data or population coverage and analytical approach, the result lends support to the work of Samuels and Yacout (1981), Ayadi (1984), Olowe

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**Table 1. Npar tests.**

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a. Median.

**Table 2. Runs test 2.**

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a. Median
Table 3. Test of weak form hypothesis using autocorrelation and partial correlation.

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Date: 01/26/09 Time: 11:44; Sample: 1984 – 2006; Included observations: 23

Figure 1. Yearly returns.

Figure 2. End of the month average returns.
(1999) and the run test of Kukah et al. (2007).

**Conclusion**

The Nigerian stock market is efficient in the weak form and therefore follows a random walk process. This implies that all information conveyed in past patterns of a stock's price is impounded into the current price of the stock. It will be useless to select stocks based on information about recent trends in stock prices. The fact that the price of stocks has risen for the past two or four days will give no useful information as what today's or tomorrow's price will be. Thus, tape watchers and chartists who follow the price trend in order to forecast price or determine when to buy and sell the stock are wasting their time. Thus, the opportunity of making excess returns in the market is ruled out.

**REFERENCES**


## Appendix

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Sources: (1) Nigerian Stock Exchange. (2) Personal computation (for monthly, yearly and end of the month average returns).

The Nigerian stock exchange all share index month-end value (1984 - 2006).

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