MACROECONOMIC VARIABLES AND STOCK PRICE VOLATILITY IN NIGERIA.

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ABSTRACT: *The purpose of this paper is to examine the relationship between stock price volatility and few macroeconomic variables such as inflation, exchange rate, GDP and interest rate. Annual time series data ranging from 1980 to 2011 was used for this study. The generalized autoregressive conditional heteroskedasticity (GARCH) model was used in the empirical analysis. The findings of the study showed that stock prices in Nigeria are volatile. And that past information in the market have effect on stock price volatility in Nigeria. In addition, the study showed that interest rate and exchange have a weak effect on stock price volatility while inflation is the main determinant of stock price volatility in Nigeria. The authors recommend that inflation should be targeted as the main monetary policy aimed at directing the stock market.*

KEY WORDS: *GARCH model; volatility; inflation; stock price; stock market; Nigeria.*

JEL CLASSIFICATION*: O11; N2; C1.*

1. INTRODUCTION

Volatility is the statistical measure of the gyration (fluctuation) of the price or returns of financial markets instruments like stocks and stocks markets indexes. Given two securities or indexes, the one with the higher level of volatility is said to be relatively riskier than the other. And the average investor (individual or institutional) is assumed to be risk – averse, such that excessive volatility and hence riskiness often erode investors confidence.

According to Osaze (2007), confidence is the foundation upon which the whole edifice of the financial market is built. Little wonder the issue of volatility and

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the factors that determine the volatility of asset prices continue to elicit the interest of researchers, investors, policy makers and other financial market participants, (especially in developed countries).

The literature is relatively robust on the determinants of stock price volatility in developed countries like U.S.A and Germany. However, to the best of our knowledge, there are only a handful of empirical evidences on this subject in emerging markets. Most extant literatures concentrate on determinants of stock price or stock returns, and not their volatility. This study is an attempt to fill this void in knowledge by providing reliable answer to the pertinent question: what is the effect of key macroeconomic variables on stock price volatility in Nigeria?

Our specific objective is to empirically investigate the behaviour of stock price volatility in response to real income, exchange rate, inflation rate and interest rate in Nigeria from 1986 to 2011, within the GARCH framework as developed by Bollersler (1986). The rest of this study is divided as follows; in section two, we discuss our literature review and theoretical underpinning. Section three is methodology, section four is data analysis and in section five we present the summary of findings, recommendations and conclusion.

2. LITERATURE REVIEW AND THEORETICAL UNDERPINNING

The relationship between macroeconomic variables and stock price or stock return is basically linked to the arbitrage pricing theory in finance. Sangmi & Hassan (2013) examine the impact of macroeconomic variables on the stock price in the Indian Stock Market. They find that there is a significant relationship between macroeconomic variables (such as inflation, exchange rate, interest rate, money supply, gold price, and industrial production) and stock price in India.

Corradi, Distaso & Mele (2013), investigate the macroeconomics determinants of stock volatility and volatility premiums using the Vix index data maintained by the Chicago Board Options Exchange (CBOE) from 2007 to 2009. They developed and estimated a no arbitrate modern where stock market volatility is explicitly related to a number of macroeconomic and unobservable factors. The authors find that the level and fluctuations of stock volatility are largely explained by business cycle factors and that some unobserved factors contributes to nearly 20% of the overall variations in volatility, although not its ups and downs. The authors also argue that there is strong evidence that capital market volatility has a very conspicuous business cycle trending, being higher during economic slowdown than during economic boom. This position substantiates the empirical findings of Schwert (1989 a, b), Hamilton & Lin (1996), as well as Brandt & Kang (2004).

Engle & Rangel (2008) investigate the spline GARCH model for low frequency volatility and its macroeconomic causes. They find, that high frequency aggregate capital market volatility has both a short-run and long-rung component and suggest that the long-run, dimension is related to the fluctuation of economic activities. Attari & Safdar (2013) examine the relationship between macroeconomic volatility and stock market volatility in Pakistan. They employed the EGARCH technique to generate volatility from the Karachi Stock Exchange (KSE – 100 index). The macroeconomic

variables include interest rate, inflation and gross domestic product. The results show that macroeconomic variables have significant impact on the security prices.

Diehold & Yilmaz (2008) examine the relationship between macroeconomic variables and stock returns fluctuation of African and Asian emerging markets. The findings reveal a positive correlation between stock returns, GDP and consumption. On the contrary, Choo, Lee & Ung (2011) investigate macroeconomic uncertainty and performance of GARCH models in forecasting Japan stock market volatility. The result reveals that macroeconomic variables have no impact on the volatility of Japanese stock markets.

2. METHODOLOGY

This research was designed to examine the effect of macroeconomic variables on stock price volatility in Nigeria Stock Exchange. The macro economic variables are inflation, exchange rate GDP and interest rate. The data sourced for this study were from the Central Bank of Nigeria statistical bulletin and Nigeria Stock Exchange publications. The determinants of stock price volatility are estimated using the GARCH technique. This method measures the conditional variation in the dependent variable based on changes in the explanatory variables. In this regard, the GARCH model better captures the essence of this purported relationship between stock price volatility and macroeconomic variables.

2.1. Data Sources

The data used in this study are annualized time series data covering the period 1980 to 2011. All the data are sourced from the Central Bank of Nigeria Statistical Bulletin and Nigeria Stock Exchange publications (2012).

2.2. Model Specification

In developing an ARCH model, two distinct specifications are considered - one for the conditional mean and one for the conditional variance. Moreover, a model with a first-order GARCH term and a first-order ARCH term (i.e.,GARCH[1,1]) is specified in this model because of its simplicity.

$$\text{ASI}_t = \lambda_0 + \lambda_1 \text{ASI} + \varepsilon_t \qquad (3.1)$$

$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \alpha \varepsilon_{t-1}^2 + \sigma_t \qquad (3.2)$$

Equation (3.1) is the mean equation and (3.2) is the variance equation. The mean equation is written as a function of exogenous variables (in this case, the major factors in stock prices) with an error term. σ_{t-1}^2 is the conditional variance because it is the one-period ahead forecast variance based on past information. The conditional variance equation specified in (3.2) is a function of four terms:
- The mean: ω

- News about volatility from the previous period (the ARCH term which has α as coefficient).
- Last period's forecast variance: σ_{t-1}^2 (the GARCH term).

Thus in this model the focus is on the conditional variance equation in the GARCH. It is hypothesized that changes in the determinant variable set up volatility in stock price volatility. In this study, the conditional variances or volatility over time in stock prices is hypothesised to be determined by the macroeconomic variables of real income (RGDP), exchange rate (EXRT), the inflation rate (INFL) and interest rates (INTR). Thus, the conditional variance equation is respecified as:

$$\text{Log}(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \alpha s_{t-1}^2 + \varphi_1 LRGDP + \varphi_2 LINFL + \varphi_3 LEXRT + \varphi_4 LINTR \quad (3.3)$$

Based on the results from the estimation of this EGARCH model, the volatility of stock prices would be explained based on changes in the macroeconomic variables.

3. EMPIRICAL ANALYSIS

In this chapter, the various aspects of the data analysis are presented and carried out. The goal of this study is to empirically estimate a model that helps explain the behaviour of stock price volatility in the face of movements in some macroeconomic variables in Nigeria. The nature of the research therefore requires that the time series properties of the data used in the study are to be investigated. As mentioned in the previous section, the GARCH methodology is used in the analysis. And the Eviews 7 Econometric software is used for the summary statistics as well as the Econometric estimations.

3.1. Descriptive Statistics

Table 4.1 presents the descriptive statistics for the annual data consisting the period 1986 – 2011 the table shows that all the macroeconomic variables have positive mean return values. The average all share index value is 12490.76 points for the 26 year period, which is relatively high. The standard deviation for All Share Index (ASI) is much higher than the mean value, thereby indicating that the price index of share prices has been expressly unstable and highly variable over the years. This result is confirmed by the high skewness value (showing that most of the ASI values in the sample are lesser than the mean value) and the significant J-B statistic (showing that the data is not normally distributed).

Inflation has similar results with that of ASI by showing high variability over the period. This indicates that these variables changed frequently during the period of analysis. Apparently, the price level in the country has been largely unstable, perhaps fueled by unstable money supply regimes as well as frequently changing international oil prices. The summary statistics however shows that GDP, and interest rate moved rather steadily during the period. The J-B statistics for these variables are lower than the critical values, suggesting a smooth and uniform distribution of the data over the estimation period.

Table 1. Descriptive Statistics for Variables

Variables	Mean	Median	Std dev.	Skewness	J-B Stat	Prob.
ASI	12490.78	6716.3	14067.11	1.47	14.37	0.00
EXRT	70.52	57.37	59.07	0.10	3.54	0.17
GDP	415527.6	320741.8	192538.8	1.00	4.55	0.10
INFL	22.25192	13.37	19.98	1.26	6.92	0.03
INTR	19.23	18.31	4.07	0.64	2.59	0.27

Source: Author's computations

3.2. GARCH Results

The results of estimating the GARCH model as stated in section three is presented in Table 2 below. The mean equation shows that the impact of lagged stock prices is significant at 1% level of significance confirming the correctness of adding the variable to correct for autocorrelation in the stock return series. The result also shows that, with a coefficient close to one, there seems to be a very long delay for share prices to return to its long run position after any shock. Thus, stock price shocks are seen to be persistent over time. The other variable in the mean equation fails the significance test at the 5 percent level, indicating that long run behaviour of stock prices is not predicted by the level of economic activities or real income.

The diagnostic statistics of the results are quite impressive. The adjusted R squared value of 0.988 reveals that over 98 percent of the systematic variations in stock prices are determined by the two explanatory variables in the mean equation. This demonstrates the predictive ability of past stock prices in the stock price equation. The F-value of 655.3 is very high and easily passes the significance test at the 1 percent level, implying that we cannot reject the hypothesis of a significant relationship between stock prices and the independent variables in the mean equation.

Table 2. The EGARCH Result

Variable	Co-efficient	z-Statistic
Mean Equation		
Constant	0.163	0.276
LASI(-1)	0.980	94.675
Variance Equation		
ω	-0.805	-0.252
α	-0.631	-2.959
β	0.790	10.912
LEXRT	0.024	0.281
LINFL	0.150	2.371
LINTR	-0.877	-1.214
LRGDP	0.222	0.927
Adj.R^2 = 0.988	F = 655.3	DW = 1.51

The equation of interest is that of the conditional variance which measures the effects of the macroeconomic variables on stock price volatility. The results of the conditional variance equation are interesting. Considering the role of each variable in the variance equation, it is shown that only the coefficient of inflation is significant. All the other coefficients fail the 5 percent significance test, indicating that these variables do not effectively predict volatility of stock prices in Nigeria. Inflationary pressures tend to deepen stock price volatility and extend its amplitude. In this regard the main macroeconomic variable to watch in moderating stock price volatility is the inflation rate.

The mean term in the result (ω) is negative and also fails the significance test at the 5 percent level. This shows that generally, the position of stock prices at any given period has no effect on its pattern of volatility.

The α parameter represents a magnitude effect or the symmetric effect of the model, the "GARCH" effect. The coefficient of this term is negative and highly significant at the 1 percent level. This shows the tendency of stock prices gaining a downward slide at any given shock.

The parameter β measures the persistence in conditional volatility irrespective of anything happening in the market (see Alexander, 2004). The b term is positive and relatively large, e.g. above 0.9. This shows that volatility takes long time to die out following a crisis in the Nigerian market. This result was also shown in the mean equation. Thus, long term measures must be put in place when taken short term arbitrary stock prices shocks in the Nigerian stock market.

The diagnostic tests for the GARCH model are considered in order to ascertain the appropriateness of the use of GARCH in this study. The Ljung-Box Q-statistics and their p-values are shown in table 3 below. The Q-statistic at lag k is a test statistic for the null hypothesis that there is no autocorrelation up to order k (the lag order of 16 is selected in this study).

Table 3. Ljung-Box Q-statistics

Lag	Q-Stat	Prob
1	0.1834	0.668
2	1.5352	0.464
3	1.5372	0.674
4	1.6081	0.807
5	1.6981	0.889
6	2.5397	0.864

Source: Author's computations

In the test above, all the lags have Q-statistics whose probabilities are higher than the 5 percent level. Hence, they all fail the significance test at the 5 percent level. This implies that we cannot reject the null hypothesis that the series are not serially correlated for the lag period of 16 quarters.

The ARCH test, which is presented in table 4 shows that the F-value and the R-squared values both fail the 5 percent significance F-test and Chi-square test

respectively. We would therefore conclude that the GARCH model effectively and satisfactorily eliminates any serial correlation in the series.

Table 4. ARCH Test

F-statistic	0.621526	Probability	0.648665
Obs*R-squared	2.572324	Probability	0.631734

In figure 1 below, the ARCH test is also presented in the Histogram format. The result shows sufficient signs of normality in the chart for the GARCH residual estimates, confirming the absence of serial correlation in the model. The Jarque-Bera statistics in the analysis further confirms the results.
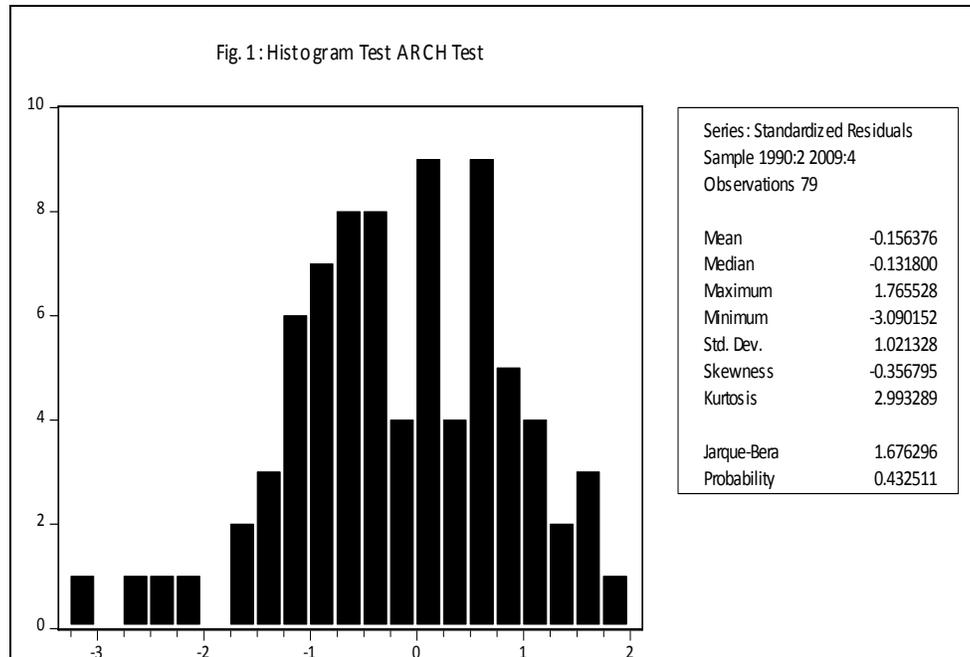

Figure 1. Histogram Test ARCH Test

4. SUMMARY OF FINDINGS

In this study, the main determinants of stock price volatility in the Nigerian stock market were empirically examined. Since volatility was the goal of the study, the Generalised Autoregressive Conditional Hetroskedasticity (GARCH) model was used in the empirical analysis. Data used covers the period 1986 to 2011 and were sourced from the CBN. The study did an explicit exposition on relevant literature to the study and also a theoretical framework to form the basis for the analysis. The main findings of the study are:

- That stock prices in Nigeria are volatile; rising and falling rapidly in successions. The GARCH model indicated a significant ARCH term in the analysis, suggesting that news in the market causes fluctuation in the prices.
- That previous news in the market also has a great effect on stock price volatility in Nigeria. The GARCH term was also significant.
- That inflation rate is the main determinant of stock price volatility in Nigeria. Rising prices tend to cause stock prices to move rapidly in the market.
- That exchange rate and interest rate have weak effect on stock price volatility in Nigeria.

4.1. Recommendations

The implications of the findings raise various areas of recommendations for policy:

- ✓ Inflation targeting should a crucial aspect of monetary policy aimed at directing the stock market. If inflation can be steadied in the economy, the stock market should improve and grow significantly over time.
- ✓ Investors can weigh the behaviour of stock prices by observing the level of inflationary trend in the country. They should participate more in the market when there is boom in the economy and prices are rising. In particular, investors will maximize returns if they buy during a downturn in the economy and sell during a boom. This kind of behaviour also helps to strengthen the stabilization of the stock market in the economy.
- ✓ The conduct of monetary policy should effectively incorporate the role of the stock market. Being an emerging economy, Nigeria needs to place a greater level of importance on the stock market as a channel for monetary policy transmission.
- ✓ Financial authorities should also develop and strengthen the synergy between the money market and the stock market as veritable sources of investible financing in the country. Policies that aim at adjusting the interest rate should take into account the indirect impact on the stock market as an alternative means of funds.
- ✓ Finally, investors should not base their investment decisions in the market only on macroeconomic variables. In fact, the result indicates that stock return is the most significant factor in determining stock prices. The investor should seek ways to balance his approach to market watching by combining economic factors with core market indicators in order to maximize returns.

4.2. Conclusion

It has become obvious that the factors behind changes in stock prices may be potent enough to create necessary directions in overall stock market performance in Nigeria. In this study, it has been shown that only inflation, among the monetary and real sector variables, exerts pressure on the stock prices in Nigeria. The analyses demonstrate that the Nigerian stock market is actually an emerging one where a strong competition is beginning to develop between the stock market and the other financial sector in terms of their instruments.

However, this pace of development should be handled with care because any false movements in the stock market may have resounding impact in the whole financial sector and even the entire economy. Findings of this paper suggest that the government should be cautious with how interest rates, and inflation rate are managed since they have ramifications for the budding stock price. In the years to come, it is likely that Central banks will be required to include financial stability among their macroeconomic responsibilities more directly and explicitly.

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