

# MACRO-ECONOMIC VARIABLES AND STOCK PRICE VOLATILITY IN NIGERIA STOCK MARKET

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## Abstract

*This study examined the relationship between macro-economic variables and stock price volatility in Nigeria stock exchange using quarterly data from the central bank of Nigeria statistical bulletin through the period January 1990 to December 2009. The selected macro-economic variables used in this study are exchange rate, inflation rate, interest rate and the GDP. The study revealed that only inflation has a positive relationship on stock price volatility. Other variables do not have well defined effect on volatility. We recommended that to stabilize stock price volatility, inflation should be the main factor to address apart from other internal factors that affect liquidity such as stock market liquidity, volume of shares.*

**Keywords:** Macro-economic variables, Stock price volatility, EGHARCH

## Introduction.

Stock market plays a very crucial role in assessing economic conditions of any country through improved stock returns usually signified by higher profit to firms. This therefore enhances economic growth. Traditionally, stock exchange market serves as a channel through which surplus funds are moved from Lender-Savers to Borrower-Spenders who have shortages of funds (Mishkin, 2000). As a result of this, volatility in stock prices can significantly affect the performance of the financial sector as well as the entire economy. However, understanding the origin of stock price volatility and its relationship with macroeconomic variables has long been a topic of considerable interest among researches based on varying findings. The fundamentalist school, the technical school, the random walk hypothesis school, the Behavioural School of finance and macro-

economic hypothesis have their various views on stock price behaviour (Maku & Atanda, 2009). To the fundamentalist, the value of a corporation's stock is determined by expectations regarding future earnings and by the rate at which those earnings are discounted. This school of thought applies present value principles to the valuation of corporate stock, using dividends, earnings, assets and interest rate to establish the price of stock (Chandra, 2006). The technical school on the other hand, opposes the fundamentalists' arguments, and claims that stock price behaviour can be predicted by the use of financial or economic data. They acquiesce that stock prices follow a definite pattern and each price is influenced by preceding prices, and that successive prices depend on each other. Technical analysts engage themselves in studying changes in market prices, the volume of trading and investors' attitude (Smith 1990). Scholars who belong to **random-walk hypothesis** see stock price movements in terms of a probability distribution of different possible outcomes. The random-walk hypothesis is based on efficient market assumption that investors adjust security prices rapidly to reflect the effect of new information. Believers in the efficient capital market hypothesis argue that stock prices are essentially random and therefore, there is no chance for profitable speculation in the stock market. The behavioural school of finance holds that market might fail to reflect economic fundamentals under three conditions. When all three apply, the theory predicts that pricing biases in financial markets can be both significant and persistent. The first behavioural condition is irrational behaviour. It holds that investors behave irrationally when they don't correctly process all the available information while forming their expectations of a company's future performance. The second is

systematic patterns of behaviour, which hold that even if individual investors decided to buy or sell without consulting economic fundamentals, the impact on share prices would be limited. Lastly, limits to arbitrage in financial markets ascertain that when investors assume that a company's recent strong performance alone is an indication of future performance; they may start bidding for shares and drive up the price. Some investors might expect a company that surprises the market in one quarter to go on exceeding expectations. The macroeconomic approach attempts to examine the sensitivity of stock prices to changes in macroeconomic variables. The approach posits that stock prices are influenced by changes in exchange rate, gross domestic product (GDP), interest rate, inflation and other macroeconomic indicators. It employs a general equilibrium approach, stressing the interrelations between sectors as central to the understanding of the persistence and co-movement of macroeconomic time series, based on the economic logic, which suggests that everything does depend on everything else (Maku & Atanda, 2009).

This study therefore examines the asymmetric cum symmetric association between macroeconomic variables (exchange rate, gross domestic product (GDP), interest rate, inflation) and stock price volatility in Nigeria. It also analyses the theoretical relationship that exists between macroeconomic variables and stock price volatility in Nigeria for twenty years beginning from 1990 to 2009.

The paper is organized as follows: Section 2 looks at the review of relevant literatures. Section 3 discusses the methodology employed in achieving the asymmetric and symmetric relationship between macroeconomic variables and the stock price volatility in Nigeria. In section 4, we present the estimated results of the analysis. Finally, in section 5, we present the conclusions and recommendations.

## 2. Review of Related Relevant Literatures

Stock market is an important institution in a country. It acts as a barometer to economic growth and is of great concern to investors, stakeholders and the government. Mobilization of resources in the economy has been a conundrum to investors, stakeholders, analysts and regulators to solve (Osinubi 2010). Effective and efficient resource mobilization in an economy foster sustainable growth and development, therefore funds must be

effectively mobilized and allocated to enable the economy realize optimal output. The stock market in an economy promotes efficiency in capital formation and allocation. Numerous attempts by emerging stock markets to develop the financial sector have been evident in the recent past, as they strive towards market efficiency (Rajni and Mahendra, 2007). Stock market, an efficient stock market, Policy makers therefore rely on market estimates of volatility as a barometer of the vulnerability of financial markets. However, the existence of excessive volatility, or "noise," in the stock market undermines the usefulness of stock prices as a "signal" about the true intrinsic value of a firm, a concept that is core to the paradigm of the informational efficiency of markets (Karolyi, 2001). Macro-economic variables such as inflation, interest rates and foreign exchange rates have been steadily rising due to a combination of internal and external factors. It is highly likely that growing inflation will pressurize interest rates upwards, a situation which may result in investors moving from the equities market to the bonds market to benefit from the higher returns (CMA, 2011). Therefore, exchange rate, inflation rate and interest rate play a critical role in the stock market.

Exchange rate refers to the rate at which the currency of one country is bought and sold in terms of the currency of another country. Exchange rate volatility has attracted much attention in financial economics in developed and developing economies due to its implications in the financial markets, especially the stock market. Different implications were observed between exchange rate volatility and stock market returns. Benita and Lauterbach (2004) posit that exchange rate volatility has real economic costs which affect price stability, firm profitability and a country's stability. Exchange rate movement affects output levels of firms and also the trade balance of an economy. Share price movements on the stock market also affect aggregate demand through wealth, liquidity effects and indirectly the exchange rate. A reduction in stock prices reduces wealth of local investors and further reduces liquidity in the economy. The reduction in liquidity also reduces interest rates which in turn induces capital outflows and in turn causes currency depreciation (Adjasi *et al.*, 2008). Hsing (2011) finds a positive relationship between exchange rate and the stock market in Johannesburg Stock Exchange. Cheng' *et al.* (2011) conducted a study on Taiwan stock market and the results indicate a positive relationship

between exchange rate and stock return. In Mexican stock market, Bailey and Chung (1995) conducted a study on Exchange Rate Fluctuations, Political Risk, and Stock Returns. The results show a positive relationship between exchange rate fluctuation and stock market return. Kandir (2008) conducted a study on Turkey stock exchange with the aim of determining the relationship between exchange rate and stock return. Using multiple regression model, the results show that exchange rate seems to have a positive relationship with portfolio return. Jefferis and Okeahalam (2000) study the relationship between stock prices and selected economic variables for South Africa, Zimbabwe and Botswana. For South Africa, they show that the stock market is positively affected by real GDP and the real exchange rate.

In a similar study Kolawole & Olalekan (2011) using exchange rate to represent macro-economic variable observe through the Error Correction model that exchange rate volatility has a negative impact on the Nigeria stock market. On the other hand inflation rate and interest rate did not have long run relationship with stock market capitalization. Secondary data were used for the study, these include International Monetary Fund (IMF) publication, Directory of Trade Statistics Year book and the Central Bank of Nigeria Statistical bulletin where data on volumes and values of exports and imports, foreign exchange rates, inflation rates, net capital flow, external reserve, degree of openness and trade deficit were obtained; the Nigeria Stock Exchange quarterly publications, where the data on stock indices were obtained. The data were tested for stationarity or the order of integration of the data series using the Augmented Dickey Fuller method. The exchange rate volatility was generated through GARCH technique.

In Ghana, contrary to the work of Kolawole & Olalekan (2011), Owusu-Nanti & John (2011) find a significant relationship between stock market returns and inflation rate. The study made use of macroeconomic factor model to test for the effects of macroeconomic factors on stock returns for the period from January 1992 to December 2008. Macroeconomic variables used are interest rate, exchange rate, crude oil price, 91 day Treasury bill rate and Ghana Stock Exchange All share index. Ordinary least squares regression model and time series methodology was employed to establish the relationships between

the stock market returns and the macroeconomic variables. Empirical findings reveal that inflation rate had a significant effect, while crude oil prices, exchange rate and Treasury bill rate do not appear to have any significant effect on stock market returns. The results of the study show that there is a positive significant relationship between inflation and stock market returns.

Arratibel, furceri, Martin and Zdzienicka (2009) find that lower exchange rate volatility is associated with higher growth, higher stocks, higher current account deficits, and higher excess credit. Adjasi and Biekpe (2005) showed that in the long-run exchange rate depreciation leads to increases in stock market prices in some countries, and in the short-run, exchange rate depreciations reduce stock market returns. Mishra (2004) observe that there is no Granger's causality between the exchange rate and stock return. The study of Mishra (2004) indicates that stock return, exchange rate, the demand for money and interest rate are related to each other though no consistent relationship exists between them. The work of Pan et al. (2007) in Malaysia shows that there is no co-integration between the exchange rate and the Malaysian stock market in the long run. On the other hand Ndri, Konan Leon (2008) posits interest rates to be an important factor in explaining stock market return rather than volatility.

*Olweny & Omondi (2011) conducted a study on the effect of Macro-economic factors on the stock return volatility on the Nairobi Securities Exchange, Kenya. The study examined the effect of foreign exchange rate, interest rate and inflation rate fluctuation on stock return volatility at the Nairobi Securities Exchange. A monthly time series data for a ten years period between January 2001 and December 2010 was employed. The Empirical analysis employed was Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) and Threshold Generalized Conditional Heteroscedasticity (TGARCH). The result revealed that stock returns are symmetric but leptokurtic and not normally distributed. The results show evidence that Foreign exchange rate, Interest rate and Inflation rate have an impact on stock return volatility. Oseni & Nwosa (2011) find that there exists a bi-causal relationship between stock market volatility and macro-economic variables in Nigeria for the periods 1986 to 2010 using time series data. The study made use of*

secondary data and analysed the data using AR (k)-EGARCH (p, q) and LA-VAR. Granger Causality to estimate the volatility in each of the variables employed to determine the nexus between stock market volatility and macroeconomic variables volatility in Nigerian context. The result of the analysis suggests that there was a bi-causal relationship between stock market volatility and real GDP volatility, confirming the existence of a feedback phenomenon between Nigeria's real GDP and stock prices. Conversely, the study found no causal relationship between inflation volatility and stock market volatility. This suggests that inflation and interest rate were not significant in explaining stock price volatility. Maku & Atanda (2009) examine the long-run and short-run effect of macro-economic variables on the Nigerian stock market for the period 1984 to 2007. The properties of the time series variables were examined using Augmented Dickey-Fuller (ADF) test while exchange rate, inflation, money supply, and real output represent the macroeconomic variables. The Augmented Engle-Granger Cointegration test and error correction model (ECM) reveal that macro economic variables exert significant long-run effect on stock market performance.

Aliyu (2011) study applied the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to assess the impact of inflation on stock market returns and volatility using monthly time series data from the two West African countries: Nigeria and Ghana. The impact of asymmetric shocks was investigated using the QGARCH model developed by Sentana (1995). The study observes that inflation rates have significant effect on stock market volatility in the two countries.

### 3. 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, Interest rate, GDP. The data sourced for this study were from the central bank of Nigeria statistical bulletin and Nigeria stock exchange publications. The data were tested for stationarity using the Augmented Dickey Fuller method. The impact of macro-economic variables on stock price volatility is estimated using the EGARCH technique. This method measures the conditional variation in the dependent variable based on

changes in the explanatory variables. In this regard, the EGARCH model better captures the essence of this purported relationship between stock price volatility and macroeconomic variables. 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 EGARCH term and a first-order ARCH term (i.e., EGARCH [1, 1]) is specified in this model because of its simplicity.

$$ASR_t = \lambda_0 + \lambda_1 LR GDP + \lambda_2 LASR_{t-1} + \epsilon_t \quad (3.1)$$

$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \alpha \left( \frac{r_{t-1}}{\sigma_{t-1}} - \sqrt{\frac{\alpha}{\pi}} \right) + \gamma \frac{r_{t-1}}{\sigma_{t-1}} \quad (3.2)$$

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. is the conditional variance because it is the one-period forecast variance based on past information. The conditional variance equation specified in (3.2) is a function of four terms:

- The mean:  $\omega$
- News about volatility from the previous period (the ARCH term which has  $\alpha$  as coefficient).
- Last period's forecast variance:  $\sigma_{t-1}^2$  (the GARCH term).
- The leverage effect (with coefficient of  $\gamma$ ) which measures the level of asymmetry in the model.

Thus in this model the focus is on the conditional variance equation in the EGARCH. It is hypothesized that changes in this macro-economic variables 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 re-specified as:

$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \alpha \left( \frac{r_{t-1}}{\sigma_{t-1}} - \sqrt{\frac{\alpha}{\pi}} \right) + \gamma \frac{r_{t-1}}{\sigma_{t-1}} + \phi_1 LGDP + \phi_2 INFL + \phi_3 EXRT + \phi_4 INTR \quad (3.3)$$

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Table 4.1 Unit Root Test for Variables in Levels

Variable	ADF Test Statistic		95% Critical ADF Value
	Levels	First Difference	
LASI	-2.0758	-3.5351	-2.8996
LRGDP	1.5960	-14.5465	-2.8996
LINFL	-3.4907	-6.5056	-2.8996
LINTR	-2.6773	-5.0688	-2.8996
LEXRT	-1.6463	-5.9833	-2.8996

Result extracted from the Eviews 3.1 output.

Moving forward, we take the first differences of the respective variables and perform the unit root test on each of the resultant time series. The rationale behind this procedure is that Box and Jenkins (1978) have argued that differencing non stationary time series will make it attain stationarity. From the result shown in table 4.1, it is seen that the ADF test statistic for each of the variables is greater than the 95 percent critical ADF values (in absolute values). This implies that the variables are actually difference-stationary, attaining stationarity after the first differences of the variables. Thus, we would accept the hypothesis that the variables possess unit roots. Indeed, the variables are integrated of order one (i.e. I[1]).

**4.2 Empirical Results**

The results of estimating the EGARCH model as stated in Section three is presented in Table 4.2 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 4.2: The EGARCH Result

Variable	Co-efficient	z-Statistic
Mean Equation		
Constant	0.163	0.276
LRGDP	0.007	0.129
LASI(-1)	0.980	94.675
Variance Equation		
$\omega$	-0.805	-0.252
$\alpha$	-0.631	-2.959
$\gamma$	-0.089	-0.686
$\beta$	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 <sup>2</sup> = 0.988	F = 655.3	DW = 1.51

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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 4.4 below 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 EGARCH model effectively and satisfactorily eliminates any serial correlation in the series.

Table 4.3: Ljung-Box Q-statistics

Lag	Q-Stat	Prob
1	0.1834	0.668
2	1.3332	0.464
3	1.5572	0.674
4	1.6981	0.807
5	1.6981	0.889
6	2.5397	0.864
7	4.3179	0.743
8	5.9421	0.654
9	8.5861	0.476
10	9.9736	0.443
11	11.776	0.381
12	14.866	0.249
13	15.768	0.262
14	15.769	0.328
15	15.935	0.386
16	16.222	0.451

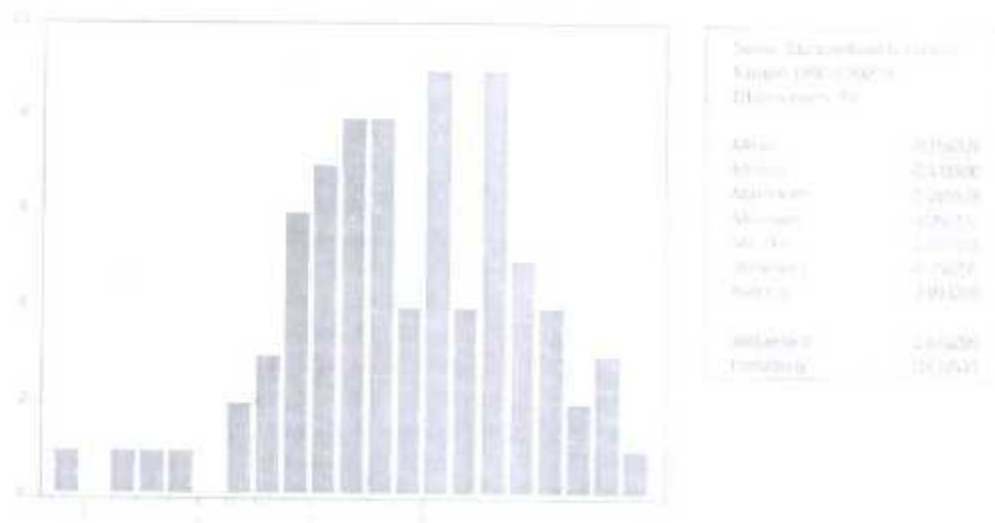
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Table 4.4: ARCH Test

F-statistic	0.621526	Probability	0.648665
Adjusted R-squared	2.572324	Probability	0.651733

As shown 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 EGARCH model estimates, even without the absence of serial correlation in the model. The Jarque-Bera statistics in the analysis further confirms the results.



### 5. Conclusion and Recommendation

Good numbers of studies have found that there exists a relationship between macroeconomic variables and stock price volatility using different macroeconomic factor models. This study considered four macroeconomic indicators and examines their effect on the NSE all share index (NSEIDX) from 1990 to 2009. The time series data set employed in this study comprise the annual observation of the NSE index, Exchange rate, Inflation rate, Interest rate, and real economic output (RGDP). The Augmented Dickey-Fuller (ADF) test was used to examine the presence of unit root in the time series variables. The result indicated that most of the variables have ADF values that are less than the 95 percent critical ADF value of 2.8991 implying that the time series for these variables are non stationary in their levels. The variable LINFL was shown to be stationary in levels. This implies that only inflation tends to fuel volatility of stock prices indicating that when there is a shock in inflation, it deepens the volatility of stock prices. Other variables do not have well defined effect on the volatility. To stabilize stock prices inflation should be the main factor to address apart from other internal factors that affect liquidity such as stock market liquidity, volume of shares.

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