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Volatility and Nigeria Stock Market Performance: Evidence from Naira-Dollar Exchange Rate and Market Capitalization

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ABSTRACT

This study investigates volatility and Nigeria stock market performance as evidenced from exchange rate and market capitalization using annual data spanning between 1986 to 2019 as extracted from the Central Bank of Nigeria (CBN) annual statistical bulletin. Johansen and Jesulius cointegration, Error Correction modeling and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) estimation technique was adopted. The GARCH result showed that, exchange rate and market capitalization constitute significant sources of volatility to stock prices in both the short-run and long-run, with coefficients: 103.4074 and 0.15649 of variations in NSE-All Share Index respectively. In addition, coefficient of 〖ECT〗_(t-1) (-0.049851) of error correction estimate indicated that previous years deviation from long run equilibrium is corrected at a speed of 5% implying that, there exists a long-run co-integration or equilibrium relationship among the variables. This paper therefore, recommended that consistent application of Dutch Auction System can be embarked upon by Central Bank of Nigeria (CBN) to serve the purposes of reducing the parallel market premium, thereby conserving the dwindling external reserves to achieve a realistic exchange rate for the naira. NSE should also create enabling market policy for companies traded on the stock market so as to improve the performance of stock prices through market capitalization.

1. Introduction

The stock market portrays the level of confidence of investors on various sectors in the economy. It is a reflection of the productive sector's strength and indicates expectations about the stability of the financial system. Persistent increases in the stock indices would encourage banks to increase loans and advances, both for direct investment in the stock market and other sectors of the economy. Foreign investors benefit from higher returns on investment at the stock market. There is direct inflow of foreign portfolio investment into the economy, which will boost the capital base of banks and induce further increase in lending thereby leading to growth and development of the economy.

Worlu and Omodero (2017) did a comparative study on the effect of macroeconomic variables on stock market performances in Africa using four (4) giant African countries which include: Nigeria, Ghana, Kenya and South Africa. The examination covered a period from 2000 to 2015 and the investigation uncovered that GDP, swelling and genuine conversion scale impact affected Nigerian stock market execution. On account of South Africa, GDP and swelling demonstrated negative effects while genuine swapping scale uncovered no effect. For Ghana, GDP sway was negative; different factors didn't influence the stock market. On account of Kenya, the genuine swapping scale had negative impact while different factors didn't have impact on stock market execution. The shifting discoveries were ascribed to various monetary climate the stock markets are working just as the pace of expansion and conversion scale inconstancy inside the periods covered.

Zubair and Aladejare (2017) studied exchange rate volatility and stock market execution in Nigeria utilizing information from 1986 – 2015 and Generalized Auto-backward conditional heteroscedasticity procedure for investigation. The examination found a frail connection between conversion standard and stock market execution intermediaries by stock market capitalization.

Mburu (2015) utilized expressive exploration plan and information covering a period from 2011 to 2015 to analyze the connection between conversion scale volatility and stock market execution in Kenya. The investigation found no huge connection between stock market execution and swapping scale volatility and subsequently no critical effect was set up.

Kennedy and Nourizad (2016) applied GARCH (1,1) model to conversion standard volatility on US stock market from 1999 – 2010. The examination contemplated other controlling factors and set up that conversion scale volatility affected stock returns.

Nkoro and Uko (2016) inspected the effect of conversion scale and swelling volatility on stock costs in Nigeria from 1986 to 2012 utilizing GARCH (1,1)- S models as an all-encompassing GARCH-X models. The examination uncovered among others that stock market costs had a negative relationship with swapping scale and swelling volatility.

Zubair (2013) utilizes Johansen's co-combination to test for the chance of co-coordination and Granger-causality to assess the causal connection between stock market file and money related pointers (conversion scale and M2) previously and during the worldwide monetary emergency for Nigeria, utilizing month to month information for the period 2001–2011. Results recommend nonattendance of since quite a while ago run relationship previously and during the emergency. The Granger-causality tests show a uni-directional causality running from M2 to ASI before the emergency while during the time of the emergency there is nonattendance of causality between the factors. This recommends that ASI show responsiveness to M2. In this way, nonappearance of the immediate linkage among ASI and Exchange rate shows that the market is wasteful and maybe not determined or guided by the basics.

To the best of our knowledge, combination of both monetary indicators of exchange rate and market capitalization has not been used to model Nigeria Stock market performance in the presence of volatility in the past. This is therefore, one of the contributions of this research study.

2. Materials and Methods

In this section, the procedures for building Vector Error Correction and Generalized Autoregressive Conditional Heteroscedasticity models are discussed. Yearly data spanning between 1986 to 2019 of the Nigeria Stock Exchange are used in this study. The data was sourced from Central Bank of Nigeria statistical bulletin. The methods adopted in the analysis of this study comprises of both descriptive and inferential. The descriptive method consists graphical representation of the variables measuring stock market prices. These graphical representations depict the pattern of the observations emanating from the study period, so as to know the fluctuation pattern of the aforementioned stock market variables. In addition, the inferential technique consists of the application of Johansen Co-integration to confirm the existence of long run relationship among variables of interest, adjustment for long run effect using vector error correction modeling and studying the fluctuation pattern of stock market using exponential GARCH (1,1) approach. In achieving this, we test the stock market variables for unit root using Augumented Dickey Fuller (ADF) approach to ensure maximum of I(1). The ADF is given as:

$$\Delta y_t = a_0 + a_1 y_{t-1} + \sum_{i=1}^{p} a_i \Delta y_{t-i} + \varepsilon_i \qquad (1)$$

It must be noted that in order to select each model’s optimal lag length we maximize the log-likelihood function of the corresponding model.

Johansen’s Cointegration method

Bivariate Johansen test between each of our three variables within the sample periods was conducted after ensuring that the series are integrated of the same order. This is a maximum likelihood method that determines the number of co-integrating vectors in a non-stationary time series Vector Autoregression (VAR) with restrictions imposed, known as a vector error correction model (VEC). Johansen’s estimation model is given as:

$$\Delta X_t = \mu + \sum_{i=1}^{p} \Gamma_i \Delta y_{t-i} + \alpha\beta' X_{t-i} + \varepsilon_i \qquad (2)$$

X_t= (n x 1) vector of all the non-stationary indices in our study

Γ_i= (n x n) matrix of coefficients

α = (n x r) matrix of error correction coefficients where *r* is the number of cointegrating relationships in the variables, so that 0 < *r* < n. This measures the speed at which the variables adjust to their equilibrium. (Also known as the adjustment parameter)

β'= (n x r) matrix of *r* cointegrating vectors, so that 0 < *r* < n. This is what represents the long-run cointegrating relationship between the variables.

In determining lag lengths for the Johansen's procedure, we chose between using Akaike's (AIC) and the Schwarz's Bayesian (SBIC) information criterion processes. The SBIC is usually more consistent but inefficient, while AIC is not as consistent but is usually more efficient (Brooks, 2008). However, the Johansen (1991) method defines the Trace Test and Maximum Eigenvalue test. The follow test is a joint test that tests the invalid speculation of no cointegration (H_0: r = 0) against the elective theory of cointegration (H_1: r> 0) while the most extreme eigenvalue test conducts test on every eigenvalue independently as it tests the invalid theory that the quantity of cointegrating vectors is equivalent to$r$ against the alternative of $r + 1$ cointegrating vectors. (Brooks, 2008). The trace equation is given as:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{g} \ln(1-\hat{\lambda}_i) \quad (3)$$

The maximum eigenvalue equation is given as

$$\lambda_{max}(r, r+1) = -T\sum_{i=r+1}^{g} \ln(1-\hat{\lambda}_{r+1}) \quad (4)$$

r = number of cointegrating vectors; $\hat{\lambda}_i$= estimated *i*th ordered eigenvalue from the $\alpha\beta'$ matrices. A significantly non-zero eigenvalue indicates a significant cointegrating vector.

Error Correction Method (ECM) was used to represent the long run (static) and short run (dynamic) relationships between stock market prices and other set of predictor variables. ECM model is purposely fitted to indicate the speed of adjustment from the short run equilibrium to the long run equilibrium state. The greater the coefficients of the parameter, the higher the speed of adjustment of the model from short run to long run.
The vector error correction model is given by

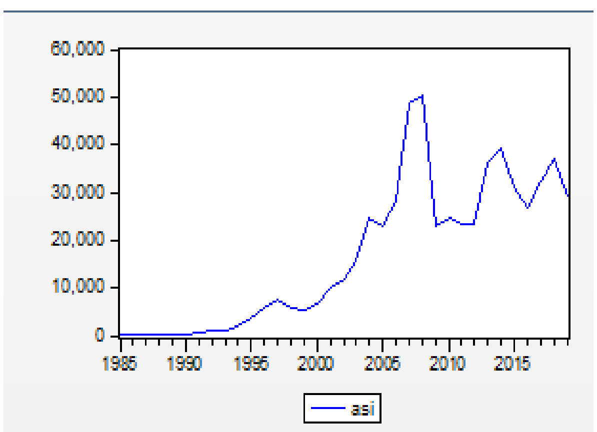
$$\Delta y_t = \beta_0 + \beta_1\sum_{t=1}^{n} x_{1t} + \beta_2\sum_{t=1}^{n} x_{2t} + \cdots - 1\delta ECM_{-1} + \varepsilon_t \quad (5)$$

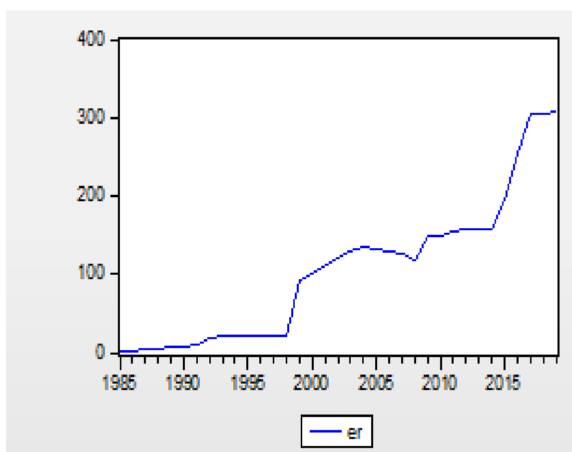
The GARCH model for this research is specified as:

$$\sigma^2 = \alpha_0 + \alpha_1\mu_{t-1}^2 + \alpha_2\sigma_{t-1}^2 \quad (6)$$

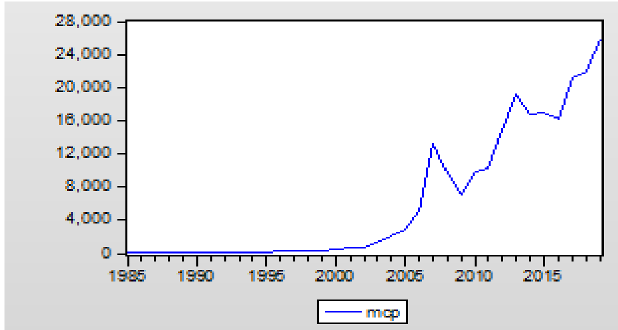
The conditional variance of μ at time t depends not only on the squared error term in the previous time period (as in ARCH [1]) but also on its conditional variance in the previous time period as suggested in equation (6). The model was generalized to a GARCH (*p*, *q*) model in which there are p lagged terms of the squared error term and q terms of the lagged conditional variances.

3. Results and Discussion





(a) NSE All-share Index **(b) Exchange rate**



(c) Market capitalization

Figure 1 (a-c): *Time plot of (a) Nigerian stock market prices (b) Exchange Rate (c) Market Capitalization*

Figure 1 showed the stock market performance, exchange rate and market capitalization. Pictorial representation of the graph indicated irregular variation of the measured stock market from year to year. The market capitalization showed incremental rate from year to year until year 2007 when the variable experienced volatility till date. Variations in these stock market performance variables has shown that the series possess unit root.

Table 1: Descriptive Statistics of Stock Market Selected variables

Statistic	ASI	ER	MCP
Mean	16569.55	104.9520	6221.907
Median	11631.87	118.5669	764.9000
Maximum	50424.70	306.9206	25890.22
Minimum	117.2800	0.893800	6.600000
Std. Dev.	15312.98	92.14589	8083.427
Skewness	0.541584	0.694193	0.976828
Kurtosis	2.147733	2.752392	2.527315
Jarque-Bera	2.770266	2.900518	5.891963
Probability	0.250291	0.234510	0.052550

Source: Extracted From E-views 9.0

Table 1 shows the summary of statistics for the series used in the empirical study, all the series has a very large mean values, from the values of their respective standard deviations, all the series have a lower standard deviation especially NSE-all share index (ASI) and Exchange Rate (ER) as it suggested that, the variables had a significant effect in the model and they are very close to their respective mean values. Only Market Capitalization (MCP) has extreme values to its mean but may also contribute significantly to the stock market index. The series are asymptotically normally distributed (Jarque-Bera p-values > 0.050. Similarly, skewness and kurtosis present the nature of departure from normally in the series. This suggested that, all variables are positively skewed and asymmetry distributed in the model except, the real exchange rate and interest rate. Also, in the case of kurtosis, all the variables are platykurtic as shown from the kurtosis statistics of 2.7703, 2.9005, and 5.892 for variables ASI, ER and MCP respectively.

Table 2: Unit Root Test of Stationarity; H_0: The Series has a Unit Root

Variables	ADF @ Levels	ADF @ First Difference	Remarks
ASI	-1.459255 [8]	-6.023106 [8]**	**I(1)**
ER	-2.281476 [8]	-4.234097 [8]**	**I(1)**
MCP	-1.307067 [8]	-5.389277 [8]**	**I(1)**

ADF Critical Value at 5% = -2.95;
[8] Indicates that a maximum lag length of 8 was included in the tests.
** indicates significant at 5%
Source: *Extracted from E-views Output, Version 9*

Table 2 shows the result of Augmented Dickey-Fuller (ADF) test conducted to ascertain the stationarity of the time series data. Result revealed that all the variables are non-stationary since their calculated values are less than the critical values at 5%, implying that at levels, the null hypotheses that each of the variables has a unit root cannot be rejected (p-values > 0.05 level of significance). However, at first differenced, each of the variables becomes stationary (p-values < 0.05). Hence, all the variables are stationary at the same level and integrated of order one [I (1)]. Thus, the presence of a unit root in the series suggested that it is necessary to test for co-integration.

Table 3: Test for Co-integration Rank

Hypothesized No. of CE(s)	Eigen Value	Trace Statistics	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob. **
	Unrestricted Co Integration Rank Test (Trace)				Unrestricted Co integration Rank Test (Maximum Eigenvalue)		
None *	0.624258	45.86765	29.797	0.0003	32.302	21.132	0.0009
At most 1	0.331794	13.56550	15.495	0.0957	13.304	14.265	0.0705
At most 2	0.007886	0.261272	3.8415	0.6092	0.261	3.841	0.6092

Trace & Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
**** denotes rejection of the hypothesis at the 0.05 level***
*****MacKinnon-Haug-Michelis (1999) p-values***

Source: *Extracted from E-views Output, Version 9*

The result of co-integration in Table 3 above revealed that there is one co-integrating equations in the system with its maximum eigenvalue and trace statistic greater than critical values at 5 percent (p-value 0.0003 < $\alpha = 0.05$). Therefore, the null hypothesis of no co-integration is rejected.

Table 4: Estimated Long-run Co-integration Vectors

Variables	Coefficients	Standard Errors	t-statistics	P-values
ASI_{t-1}	1.0000			
ER_{t-1}	73.53393	214.281	0.3432	0.1246
MCP_{t-1}	6.101730	2.35710	2.58866	0.0134
Constant	-59665.88			

Source: Extracted from E-Views Version 9

The co-integrating equation and long run model as estimated in the table is specified as

$$ECT_{t-1} = 1.000ASI_{t-1} + 73.53393ER_{t-1} + 6.10173MCP_{t-1} - 59665.88 \qquad (7)$$

Analysis of the Co-integration long run estimates as shown in table 4 reveals that a percentage change in ER and MCP are associated with 73.5339 and 6.1017 incremental change in NSE-All-share index on average ceteris paribus in the next one year. Constant of -59665.88 indicates what the stock market would be when other variables of market enhancer are held constant on the long run. However, significance of the estimates can be depicted from the t-statistics as the absolute value of MCP is higher than the critical value of 2.101 at 5% level of significance. Only exchange rate does not contribute significantly to the model but cannot be underrated.

Table 5: Estimated Short-run Dynamic Equation for ECM Dependent

Variables	Coefficients	Standard Errors	t-statistics
ΔASI_{t-1}	-0.049851	0.01695	-2.94045
ΔER_{t-1}	0.0000997	214.281	1.96274
ΔMCP_{t-1}	0.007030	0.00679	1.03571
Constant	-1146.700	1167.83	-0.9819
ECT_{t-1}	-0.402424	0.19293	-2.08584
Diagnostic Test			
Test	**Statistics**		**p-values**
R-squared	0.49461		

LM test	3.17863	0.9568
Jacque-Bera	57.51311	0.0724
ARCH test	7.608038	0.9385

Source: Extracted from E-Views Version 9

$$\Delta \ln(ASI) = -0.049851ECT_{t-1} - 0.04024\Delta \mathrm{ASI}_{t-1} + 0.0000997\Delta \mathrm{ER}_{t-1} + 0.00703\ \Delta MCP_{t-1} - 1146.7 \quad (8)$$

From the short run dynamic estimated error correction model in Table 5, it was estimated that the ECM is consistent with the expected negative sign and significant at 5% level. This revealed that there is feedback adjustment mechanism from short-run (dynamic) to long-run (static) equilibrium relationship among variables used in the analysis. The diagnostic statistics suggested that the data relatively fits the model well. The coefficient of ECM measures an annual speed of adjustment from long-run disequilibrium of about 40% per annum. This suggested that about 40% of the disequilibrium errors, which occurred in the previous year, are corrected in the current year. Furthermore, the lagged values of ASI (**ΔASI_{t-1}**) negatively but significantly influenced the current ASI. This suggested that a unit increase NSE-all share index (ASI) during the previous one year decreases the current stock price by about 5%t. It was also found that the lagged value of Real Exchange Rate and Market Capitalization have positive and significantly affected NSE-All share index (ASI) at 0.05 significance level. Thus, the R-square of the model show that about 49.5% percent of the variation of NSE-All share index (ASI) is explained by the combined effects of the two determinants, which also suggested that about 50.5% variation in Nigerian stock prices is accounted for by other factors not included in the model. Lagrange multiplier (LM) test statistics of 3.17863 with associated p-value of 0.9568 >0.05 significance level showed that there is absence of autocorrelation in the data for the short run adjustment model. It can also be deduced from the Jaque-Bera test statistic of 57.51311 with p-value > 0.05 that residual of the fitted VECM model follows normality assumption as also evidenced from the Autoregressive conditional heteroscedasticity (ARCH) test that the model error terms are homoscedastic.

Table 6: GARCH (1, 1) Mean Equation Model Results

Variable	Coefficient	Std. Error	z-Statistic	Prob.
SQRT(GARCH)	0.000189	9.34E-05	2.020259	0.0434
ER_{t-1}	102.4074	1.17E-99	8.7E+100	0.0000
MCP_{t-1}	0.156494	0.498138	0.314158	0.7534
C	586.0881	481.3048	1.217707	0.2233

Source: *Extracted from E-views Output, Version 9*

On the mean equation of the GARCH model in table 6, results indicated that the coefficient of exchange rate is positive and statistically significant at 1 percent level. This implies that a unit increase in ER during the previous year changes (increases) stock prices by about 102.4074. In addition, the coefficient of market capitalization is also positive but statistically insignificant with p-value 0.7534 > 0.05 level of significance. This implies that a unit increase in MCP during the previous year increases stock prices by 15.6%. The constant value depicts the stock value when the predictor variables are held constant. The Generalized Autoregressive Conditional Heteroscedasticity coefficient taking the mean equation model into consideration was also found to be statistically significant (p-value 0.0434 < 5% level of significance).

Table 4.7: GARCH (1, 1) Variance Equation Model Results

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	16.64851	0.045923	362.5338	0.0000
RESID(-1)^2	-0.562072	0.711995	-0.789433	0.4299
GARCH(-1)	1.436921	0.422333	3.402342	0.0007
ER	0.001631	0.009170	0.177860	0.8588
MCP	7.91E-05	0.000109	0.727513	0.4669

Source: *Extracted from E-views Output, Version 9*

From the variance equation model result, analysis revealed that exchange rate and market capitalization had positive but insignificant effect on NSE-all share index. This implied that, a unit increase in exchange rate and market capitalization to the economy resulted to increase in the stock market prices by about 0.02% and 0.008% respectively. This suggested that when exchange rate and inflation rate is higher, there would be a shift of investment from Nigerian stock market towards investment with higher exchange rates in Nigeria. In addition, the GARCH effect of the variance equation indicated that a unit increase in the persistence of the past year volatility explain the current year volatility by 1.4369 unit. However, previous squared residual indicated the impact of sign of a shock in the Nigerian stock market as the negative influence of the residual showed higher variance in the stock market prices (i.e. instability).

Table 8: GARCH (1, 1) Diagnostic Check

Test	Statistics	p-values
R-squared	0.8889	
Jarque-Bera	0.55464	0.7578
ARCH Heteroscedasticity test	0.83364	0.3769

***Source**: Extracted from E-views Output, Version 9*

From table 4.8, the R-square of the EGARCH model showed that about 88.9% percent of the variation of NSE-All share index (ASI) is explained by the combined persistent of the past year volatility, exchange rate, market capitalization and shock, which suggested that about 88.9% variation in Nigerian stock prices is accounted for by other factors not included in the model. It can also be deduced from the Jaque-Bera test statistic of 0.55464 with p-value > 0.05 that residual of the fitted EGARCH (1, 1) model follows normality assumption as also evidenced from the Autoregressive conditional heteroscedasticity (ARCH) test that the model error terms are homoscedastic.

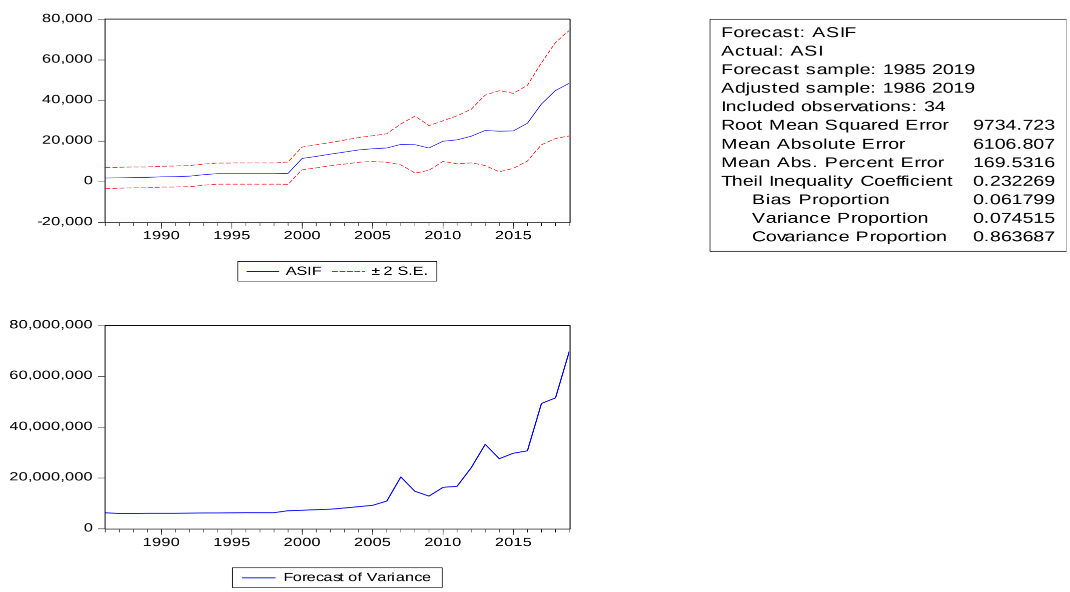


Figure 4: Stock Market Dynamic Volatility Forecast

Figure 4 indicates the stock market forecast. Pictorial representation indicates that the NSE All-share index forecast is within the threshold of the upper and lower bound. In addition, bias proportion of 0.061799 indicated that the GARCH model is accurate enough in the confirmation of stock market movement.

4. Conclusion and recommendations

Relationship existing between stock market prices and exchange rate and market capitalization volatility plays major role in Nigeria during the period of the study. It has also shown that due to strong evidence of cointegration, there is positive influence of exchange rate and market capitalization on stock market performance over the long run. This cointegration can be affected by economic shock such as global financial crisis. We also found out that the short-run adjustment coefficients indicated possibilities of excess performance of stock market based on speed of adjustment prevailing in each volatility determinants. The study thereby recommended that, consistent application of Dutch Auction System (DAS) can be embarked upon by Central

Bank of Nigeria (CBN) to serve the purposes of reducing the parallel market premium, thereby conserving the dwindling external reserves to achieve a realistic exchange rate for the naira. NSE should also create enabling policy for companies traded on the stock market so as to improve the performance of stock prices through market capitalization. Future research may look at other variables not examined in this present work.

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