Exchange Rate Pass through to Stock Prices: A Multi GARCH Approach

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ABSTRACT

This paper analytically examines the impact of exchange rate volatility on stock prices in Nigeria via both symmetric and asymmetric GARCH models. At the onset the descriptive statistics reveals that both series are non-normally distributed as indicated by the Jacque-Bera statistic, also the standard deviation implied that the stock price series is more volatile than the exchange rate. Furthermore both series are reported to be negatively skewed also reference to the kurtosis statistics presented it is observed that both series are leptokurtic distribution. Further the result obtained from the estimated model GARCH models reveals that the PGARCH gives the better fit of the stock prices volatility model given its minimum AIC value. In the symmetric models {GARCH (1, 1) and GARCH-in-Mean} the shocks on stock returns volatility are found to be mean reverting whilst in the asymmetric GARCH models {TGARCH, EGARCH and PGARCH} only EGARCH was found to be non-mean reverting. Further, the asymmetric term in all the 3 models indicates that bad news exerts more shocks on the stock returns volatility than good news of the same magnitude. The post estimation diagnostic test of ARCH effect demonstrate that all the models completely captured the ARCH effect. Immensely the findings of this study shall be of utmost relevance to investors, stock brokers, members of the academia, regulators and monetary authorities.

Keywords: Exchange rate, Stock Prices, All Share Index (ASI), TGARCH, EGARCH and PGARCH

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1.0 Introduction

Globalization and trade liberalization have successfully forged a link and as well breed interdependence between domestic and global financial markets, thereby shocks observed in global / foreign markets are transmitted to local capital markets through the mechanics of many variables of which exchange rate is among.

Apparently the 2008 Global Financial crisis has also affected the Nigerian stock market performance, according to Central Bank of Nigeria (CBN, 2011) statistical bulleting the All Share Index (ASI) which reflects the share/stock prices listed in the Nigeria stock exchange fell from N 61,833.56 in the first quarter of 2008 to N 20,244.73 in the last quarter of 2011, implying volatility and uncertainty in the stock market which was associated with the global economic meltdown then. The Nigerian stock market has advanced over time vis-à-vis the number of stock exchanges and other financial intermediaries, the number of listed stocks, trading volumes, market capitalization, investor population, turnover of stock exchanges and stock price indices. Developments in the stock market serves as a major indicator for growth and development for any nation.

According to a report by Price waterhouse coopers (PWC, September 2019) that capital importation declined by 31% from $8.49bn in Q1 2019 to $5.82bn in Q2 2019, due to a decline in foreign portfolio investments by 40% from $7.15bn in Q1 2019 to $4.3bn . Also in the same report it was noted that investment in equity and bonds declined by 52.60 % y/y and 20.96 % y/y respectively. Furthermore the ASI of the Nigerian stock exchange (NSE) recorded a decline of 5% from 31,430.50 at the end of December 2018 to 29,966.87 as at the end of June 2019. Moreover, in another related report by NSE that the end of December 2018 the market capitalization stood at N 11. 73 trillion.

Capital market serves as an apparatus or platform through which savings are mobilized and appropriately distributed for further investment. Stock market facilitate long term financing for government developed projects, act as source of funds for private sector long term investments for expansion and diversification plans.

Exchange rate, inflation rate, interest rate and stock prices constitute major tools of assessment of an economy's robustness or otherwise vulnerability. Stability of exchange rate and development of financial markets are routine objectives of economic policies. Exchange pass through (ERPT) is generally used to refer to the effect of exchange rate changes on import and export prices, consumer prices, investments or trade volumes (Frimpong, S. and Adam, A.M., 2010). (Goldberg, Pinelopi K. and Michael M. Knetter , 1997) Referred ERPT as the percentage

change in local currency import prices resulting from a one per cent change in the exchange rate between the exporting and importing economies.

Similar to interest rate, exchange rate also affects stocks prices. A rise in interest rate negatively affects the value of assets by increasing their required rate of return. Also it can induce investors to change the structure of the investment in their portfolio from capital markets to fixed income securities market, on the contrary a decline in interest rate leads to increase in the present value of future dividends. The exchange rate is one of the most important macroeconomic variables in both developed and developing countries. It affects inflation and causes changes in exports and imports thereby influences prices, profits of firms and the entire economic activities. A very strong exchange rate signifies a robust and viable economy while a weak and exchange rate reflects a very weak and vulnerable economy. Exchange rate volatility affects the value of firms through the impact it has on future cash flows thereby when a local currency depreciates the competitiveness of local firms is affected as a result domestic firms experience an increase in the demand for exports which translates to rise in earnings and ultimately leads to upward movement of its stock prices. On the contrary reverse occurs if local currency is to appreciate. Nowadays the exchange rate increasingly fluctuating and it is impossible to predict it with certainty in the current (floating) exchange rate system. Indeed, this fluctuation will have major effects on the financial market it possess all the potency for bullish or bearish stock prices.

Aside from interest rates and exchange rate, firm's earning and investor's sentiments also affects stock prices/returns. Higher stock returns imply higher profitability by firms and corporate bodies and eventually more growth and prosperity of an economy, on the contrary reverse is the case if stock prices falls. (Karolyi, 2001) Affirms that strong asymmetric relationship exist between stocks returns and stock returns volatility and stock price volatility is higher when stock price decreases than when the price increases. In a nutshell stock returns volatility refers to variation in stock prices during particular period of time. Oftentimes volatility is perceived by investors and other agents as a measure of risk, while on their part, policymakers and rational investors use market estimate of volatility as a tool to measure the vulnerability of the stock market. In most studies on stock market returns, volatility clustering is usually apparent, a circumstance by which periods of large changes /shocks are normally followed by periods of further large changes while periods of low changes /shocks are followed by periods of low changes. Empirical evidence suggests the inappropriateness of linear models such as the OLS in explaining volatility of returns, hence, the resort to different phenomenon in explaining the 'peculiar characteristics' of stocks returns. The specification of appropriate volatility model for capturing variations in stock

returns is of significant policy relevance to economic managers. More so, reliable volatility model of asset returns aids investors in their risk management decisions and portfolio adjustments. Among the models employed to capture these dynamic features are the autoregressive conditional heteroskedasticity (ARCH) range of models proposed by (Engle, 1982) and extended to generalized autoregressive conditional heteroscedasticity (GARCH) by (Bollerslev, 1986). According to (Suliman, 2012), ARCH range of models successfully model and predict the time-varying conditional volatility of financial time series data by using past unpredictable changes in the returns of that series and is predominantly used in financial market research aside other fields.

Against this background, this paper seeks to investigate whether exchange rate volatility has any impact on stock returns volatility in Nigeria from 2004M1 to 2018M12. The rest of the paper is structured as follows: section two, which follows this introduction, provides a brief literature on the nexus between exchange rate and stock prices volatility, Section three discusses the methodology of the paper while section four captures the empirical results and discussions. Lastly, section five summarizes and concludes the paper.

2.0 Literature Review

2.1 Theoretical Framework

With regards to this paper four theories are uphold as the central premises to guide our analysis. The Efficient market hypothesis (EMH), The Capital Asset Pricing Model (CAPM), The Arbitrage Pricing Theory (APT), The Portfolio Balance Approach and The Rational Expectations Theory.

I. Efficient market hypothesis (EMH)

The efficient market hypothesis has been the central proposition of financial economics, it is one of the most widely studied financial theory and it was developed in the 1970s by the Nobel Prize winner Eugene Fama to explain movement of asset prices. The theory proclaimed that share prices /asset prices reflect all available information thereby suggesting that stocks traded at their fair value making it impossible for investors to either purchase undervalued stocks or sell stocks for inflated prices. The theory further asserts that no technical or fundamental analysis can guarantee risk-adjusted excess returns consistently, therefore cannot beat the market with the help of market timing and expert stock selection. The only way for investors to gain higher returns according to EMH is by taking riskier investments. In a nutshell a market is said to be efficient if stock prices fully reflects the information sets available to all market participants. However despite the improvement in quality and quantity of data as well as

advances in statistical analysis there's little consensus among financial economist on the validity of EMH.

There are 3 forms of EMH

a) Weak form hypothesis: According to weak EMH, fundamental analysis can help an investor to achieve above the market average returns only in the short term. That in the long run fundamental and technical analysis will be inefficient and incapable. Information set contain only history of prices.
b) Semi-strong form hypothesis: This principle suggest that neither technical nor fundamental analysis can give an advantages to investors. The information set here include all information known to all market players.
c) Strong form hypothesis: Generally this principle expressed that whatever information private or public won't gain any advantage over market average rate of return.

II. The Capital Asset Pricing Model (CAPM)

This model was developed by Jack Treynor , William F Sharpe, John Lintner and Jan Mossin in their prospect to determine the appropriate rate of return on an asset given the level of risk. The CAPM in a bid to quantify the expected return on an investment takes into cognizance the risk-free, expected market return, the beta of an asset or portfolio and investment risk.

Mathematically CAPM can be expressed as

$$E(ri) = rf + \beta i(E(rm) - rf)$$

So basically the CAPM describes the relationship between systematic risks and expected return for asset.

Where $E(ri)$ the expected return of investment is, rf is the risk free rate, βi is a measure of sensitivity of an asset to market risk/volatility and $(E(rm - rf)$ is the market risk premium.

If the β of a stock is > 1 a stock is riskier than the market risk, whilst if the $\beta < 1$ a stock is less riskier than the market risk meaning it will reduce the risk of a portfolio.

III. The Arbitrage Pricing Theory (APT)

Upon the shortcomings of CAPM, American Economist Stephen Ross developed the APT in 1975 as an improvement of CAPM to determine expected rate of return. The proposition of the theory implies that prices of securities /assets are affected by many factors which can be broadly classified into

macroeconomic or economic specific factors. APT uses the expected rate of return and the risk premium of a number of macroeconomic factors more specifically the model uses a factor – intensity structure that is calculated using a linear regression of historical returns of the asset for the specific factor being examined.

Mathematically APT can be expressed as

$$ri = \alpha i + \beta i1 \times f1 + \beta i2 \times f2 + \cdots \beta kn \times fn + \varepsilon_t$$

Where αi constant term for the asset is, f is a systematic factor, β is the sensitivity of an asset or portfolio relative to a specified factor and ε_t is the error term.

In another notation it can be expressed as

$$E(ri) = rf + \beta i1 \times RP1 + \beta i2 \times RP2 + \cdots \beta kn \times RPn$$

Where rf the risk free rate of return is, β is the sensitivity of the asset or portfolio in relation to the specified factor and RP is the risk premium of the specified factor.

IV. The Portfolio Balance Approach

This theory firstly assumes that domestic and foreign financial assets such as bonds to be imperfect substitutes. The essence of this approach is that the exchange rate is determined in the process of equilibrating or balancing the demand for and supply of financial assets out of which money is only one form of asset. This approach postulates that an increase in the supply of money by the home country causes an immediate fall in the rate of interest, which consequently leads to fall in returns of domestic denominated assets as it leads to a shift in the asset portfolio from domestic bonds to home currency and foreign bonds. The substitution of foreign bonds for domestic bonds results in an immediate depreciation of home currency. This depreciation, over time, causes an expansion in exports and reduction in imports. It leads to the appearance of a trade surplus and consequent appreciation of home currency, which offsets part of the original depreciation.

V. The Rational Expectations Theory (REH)

The REH was the actual theory of rational expectations was proposed by John F. Muth in his seminal paper, "Rational Expectations and the Theory of Price Movements," published in 1961. However it was made popular by Robert E. Lucas, Jr in 1970s. The central premises of the theory is that Economic agents base their decisions on three primary factors: their human rationality, the information available to them, and their past experiences. It suggests that

people's current expectations of the economy are, themselves, able to influence what the future state of the economy will become. At the core REH assumes Individuals use their ability to rationalize when making decisions.

- On average, people hold expectations that will be fulfilled.
- Rational expectations are the best guess for the future.
- Although people may be wrong some of the time, on average they are right.
- People learn from past mistakes.
- Values of variables like price, output, and employment are important.

Contemporarily macroeconomists today use rational expectations as a framework to base in their analysis of policies. When thinking about the effects of economic policy, the assumption is that people will do their best to work out the implications. Observably REH is widely applied in inflation analysis and perceptions as well as stock prices analysis. Prices will only deviate from the expectation if there is an 'information shock' caused by information unforeseeable at the time expectations were formed.

$$P = P^* + \varepsilon$$

$$\therefore\ E[P_t] = E[P_t\ /I_{t-1}]$$

Where P^* is the rational expectation and ε is the random error term, which has an expected value of zero, and is independent of P^*.

2.2 Empirical Literature

Several studies have been conducted on the nexus between exchange rate volatility and stock prices each with distinctive objectives, tools of analysis, mode of data set be it annually, semiannually, quarterly, monthly or daily and empirical findings. Asaola and Ogunmuyiwa (2011) and Lawal and Ijirshar (2013) in their studies reveal that there is unidirectional causality running from exchange rate to stock market. While Zubair (2013) revealed that there is no evidence of causality between exchange rate and stock market prices in Nigeria.

Bala and Hassan (2018) employed Autoregressive Distributed Lag (ARDL) modelling technique to analyze exchange rate and stock market interactions in Nigeria. The results show that exchange rate and economic growth have positive and statistically significant impact on stock market in Nigeria, while money supply has negative and statistically significant influence on stock market over the study period.

In another related study by Aliyu and Wambai (2018) analyzed exchange rate dynamics and stock market performance in Nigeria using daily data from 2010-2017 employed Markov Switching model. The empirical result in the transitional probabilities reveals that bear market is more persistent than bull market while in terms of duration of stay in the regime is higher in the bull market than in the bear market. Further analysis of volatility spillover between exchange rate and stock returns reveals that returns increases due to appreciation in the exchange rate in the bear market and diminishes in response to exchange rate depreciation in the bull market.

Similarly Yaya and Shittu (2010) examined the impact of inflation and exchange rate on conditional stock market volatility in Nigeria. They applied Generalized Autoregressive Conditional Heteroscedasticity (GARCH) and Quadratic GARCH (QGARCH) models in the analysis using Monthly series data spanning from 1991 to 2008. Their analysis proved that inflation and exchange rates exert significant influence on conditional stock market volatility.

Comparatively (Aliyu, 2010) examined the impact of inflation on stock returns volatility in Nigeria and Ghana. Results for Nigeria show weak support for the hypothesis which states that bad news exert more adverse effect on stock market volatility than good news of the same magnitude; while a strong opposite case holds for Ghana. Furthermore, inflation rate and its three month average were found to have significant effect on stock market volatility in the two countries.

Moreover Oladapo et'al (2017) used market capitalization as a proxy for stock market performance in Nigeria in their study to evaluate the effect of exchange rate volatility on stock market using ARCH and GARCH models. Results revealed that exchange rate has a positive relationship with market capitalization rate in Nigeria in all the four models examined in the study.

Relatively Mechri et'al (2018) conducted a study on the Impact of the Exchange Rate Volatilities on Stock Market Returns Dynamic evidence from two Middle East and North Africa (MENA) countries Tunisia and Turkey employed the GARCH model. The results showed that exchange rate volatility have a significant effect on stock market fluctuations.

In a univariate study Ngozi (2014) tested volatility in the Nigerian stock market using GARCH models, the results obtained suggest the presence of leverage effect meaning that volatility responds more to bad news than it does to an equal magnitude of good news.

In the same vein Boako et'al (2014) conducted a similar univariate GARCH study of Volatility dynamics in equity returns in Ghana. The result obtained shows that

equity returns exhibit stylized characteristics such as volatility clustering, peakedness, and leverage effect found with most advanced stock markets. Further, results show that shocks to the Ghana equity market are usually transient with minimal instances of persistence. It is further confirmed that EGARCH (1, 1) is superior in modeling the volatility of returns on the equity market for the studied period.

(Sahadudheen., 2013) examined the effect of volatility in both rupee-dollar and rupee-euro exchange rates on stock prices in India using daily data from 3-Apr-2007 to 30-Mar-2012. Adopting a generalized autoregressive conditional heteroskedasticity (GARCH) developed by (Engle, 1982)and exponential GARCH (EGARCH) model by (Nelson, 1991), the study suggests a negative relationship between exchange rate and stock prices in India. Even though India is a major trade partner of European Union, the study couldn't find any significant statistical effect of fluctuations in Euro-rupee exchange rates on stock prices, while the effect of fluctuations in Dollar-rupee exchange rates on stock prices is highly significant

Ong and Izan (1999) used nonlinear least square method relationship between to ascertain the relationship stock prices and exchange rates. They found a very weak association between the US stock market and exchange rates.

Most studies on the interaction of exchange and stock market dynamics, focus particularly on the US and developed markets. For example, considering data for five European countries (France, Germany, Italy, Switzerland, United Kingdom), the United States of America, Canada and Japan, Inci and Lee (2014) have revealed that exchange rates have a significant impact on the stock prices of these countries developments.

3.0 METHODOLOGY

The paper applies Autoregressive conditional heteroscedasticity (ARCH) and its generalization (GARCH) models in estimating the effect of exchange rate volatility of the stock prices volatility in Nigeria. The GARCH models are used to capture the main characteristics (such as leptokurtic, leverage effects and volatility clustering) of the data used. In this paper, both the symmetric models [GARCH (1, 1), GARCH-M (1, 1)] and asymmetric models [EGARCH (1, 1), TGARCH (1, 1) and PGARCH (1, 1)] bivariate GARCH specifications are employed to model stock returns volatility in Nigeria. In addition, diagnostics tests (ARCH-LM test and Q-statistics) are performed to preview the econometric attributes of the underlying data in order to ascertain the fitness and accuracy of the model estimates. High frequency series such as stock returns are known with some

stylized facts, common among which are volatility clustering, fat-tail and asymmetry (Ngozi, 2014).

Categorically this paper uses 3 steps estimation procedure for volatility modelling.

1) Testing for ARCH effects: is the series in questions volatile?
2) Estimation with ARCH-type Models: This is considered only if the series (exchange rate and stock price) are volatile.
3) Post Estimation test: This is carried out to verify if the estimated ARCH-type model has captured the ARCH effects in the series. It involves testing for ARCH effects after estimation.

3.1 Testing for ARCH (1) effects

The ARCH LM test proposed by Engle (1982) begins with estimation of AR model as specified in equation (1)

$$R_t = \alpha + \delta_1 R_{t-1} + \varepsilon_t \; ; \; \varepsilon_t \sim IID\ (0, \sigma^2) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where R_t is the rate of return of the series at time t.

Estimated residual is obtained from equation (1) then the squared estimated residual is regressed on its lag as follows;

$$\hat{\varepsilon^2}_t = \gamma_0 + \gamma_1 \hat{\varepsilon^2}_{t-1} + v_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$H_0 : \gamma_0 = 0$, While $H_1 : \gamma_1 \neq 0$

Conventionally, the test statistics for the null hypothesis are F-test nR^2 tests. The null hypothesis of no ARCH effects is rejected if the probability values (p-values) of these tests are less than (10%, 5%, and 1%) of statistical significance. The rejection of Ho implies presence of ARCH effect in the series. If ARCH effects are present, the estimated parameters should be significantly different from zero (the series are volatile). However, if ARCH effects are not present, then, the estimated parameters should be statistically insignificant (the series are not volatile) therefore estimating ARCH / GARCH family model is worthless.

3.2 Estimation with ARCH-type Models

Engle (1982) Pioneered volatility modelling, where it was shown that conditional heteroskedasticity can be modeled using an autoregressive conditional heteroskedasticity (ARCH) model. ARCH model relates the conditional variance of the disturbance term to the linear combination of the squared disturbance in the

recent past. Generally, the mean and variance equations of ARCH (p) are specified as

$$R_t = \alpha + \sum_{i=1}^{\rho} \varphi i \, R_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\sigma^2{}_t = \lambda_0 + \sum_{i=1}^{\rho} \lambda i \, \varepsilon^2{}_{t-i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where $\varepsilon^2{}_{t-i}$ is an ARCH term, $0 \leq \sum_{i=1}^{\rho} \lambda i < 1$ for a stationary series. The process is slow mean reverting if $\sum_{i=1}^{\rho} \lambda i \longrightarrow 1$ whilst it is fast mean reverting if $\sum_{i=1}^{\rho} \lambda i \longrightarrow 0$.

GARCH

It was later pointed out that the main drawback of the ARCH specification is that it looks more like a moving average specification than an Auto-regression. Therefore that paves way for the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model developed by (Bollerslev, 1986). This is an extension of the ARCH model which incorporates the lags of the conditional variance in the variance equation. On the basis of the extension, the mean equation remains the same as equation (3) and the variance equation is given as

$$R_t = \alpha + \sum_{i=1}^{\rho} \lambda i \, \varepsilon^2{}_{t-1} + \sum_{j=1}^{q} \gamma j \, \sigma^2{}_{t-j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The series is mean reverting if $0 \leq \sum_{i=1}^{\rho} \lambda i \, \varepsilon^2{}_{t-1} + \sum_{j=1}^{q} \gamma j < 1$, the process is fast mean reverting if $\sum_{i=1}^{\rho} \lambda i \, \varepsilon^2{}_{t-1} + \sum_{j=1}^{q} \gamma j \rightarrow 0$ whilst slow mean reverting if $\sum_{i=1}^{\rho} \lambda i \, \varepsilon^2{}_{t-1} + \sum_{j=1}^{q} \gamma j \rightarrow 1$ .However if q = 0 the model reduces to ARCH (P).

GARCH-in-Mean (GARCH-M)

The (GARCH-M) model which allows the conditional mean to depend on its own conditional variance, it was proposed by Engle, Lilien and Robins (1987). GARCH-M model follows the utility theory that an increase in variance (risk proxy) will result in a higher expected returns. In the GARCH-M model; the conditional mean is an explicit function of the conditional variance. This model is often used in financial applications where the expected return on an asset is related to the expected risk. A simple GARCH-M model of order P can be specified as follows:

$$R_t = \alpha + \sum_{i-1}^{\rho} \varphi_i R_{t-i} + \varepsilon_t + \vartheta \sigma^2{}_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The null and alternative hypothesis for the GARCH-M (1 1) are $H0$: $\vartheta = 0$, $H1$: $\vartheta \neq 0$. When the null hypothesis (H0) is rejected, then, the GARCH-M term is

statistically significant and the model provides useful information for the volatility (i.e. it improves the estimates of the GARCH model).

Threshold GARCH (TGARCH)

The TGARCH belongs to asymmetric GARCH family models like the Exponential GARCH (EGARCH) and the Power GARCH (PGARCH).The idea behind the evolution of these models is based on the understanding that good news (positive shocks) and bad news (negative shock) of the same magnitude have differential effects on the conditional variance ie to capture leverage effects. The TGARCH proposed independently by (Zakoian, 1994) and Glosten, Jaganathan, and Runkle (1993).TGARCH also known as GJR model is specified to allow the conditional variance to depend on its lagged innovation and inclusion of multiplicative dummy variable to check whether or not there is statistically significant difference when shocks are negative. The specification for the conditional variance equation of order p is given as:

$$\sigma^2{}_t = \lambda_0 + \sum_{i=1}^{p} \lambda_i \, \varepsilon^2{}_{t-1} + \Phi \varepsilon^2{}_{t-1} d_{t-1} + \sum_{j=1}^{q} \gamma_j \, \sigma^2{}_{t-j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where the dummy variable $d_{t-1} = \begin{cases} 1 \; if \; \varepsilon_{t-1} < 0 \\ 0 \; if \; \varepsilon_{t-1} \geq 0 \end{cases}$

Φ = Asymmetric effect; $\gamma_j \sigma^2{}_{t-j}$ = GARCH term;

λ_i = Good news; $\lambda_i + \Phi$ = Bad news

Exponential GARCH (EGARCH)

Another asymmetric type model is the EGARCH which was proposed by (Nelson, 1991). Mechanically Natural logarithm of the conditional variance is allowed to vary over time as a function of the lagged error terms rather than lagged squared errors.

$$ln(\sigma^2{}_t) = \lambda_0 + \lambda_1 \left| \sqrt{\varepsilon^2{}_{t-1}/_{\sigma^2{}_{t-1}}} \right| + \phi \sqrt{\varepsilon^2{}_{t-1}/_{\sigma^2{}_{t-1}}} + \theta \, ln(\sigma^2{}_{t-1}) \ldots\ldots\ldots\ldots (8)$$

Where ϕ = Asymmetric effect, the natural log on the LHS makes the leverage effect exponential rather than quadratic.)

Power GARCH (PGARCH)

Initially (Taylor, 1986) and (Schwert, 1989) introduced the standard deviation GARCH model, where the standard deviation is modeled rather than the variance as in most of the GARCH-family. Subsequently Ding, Granger and Engle (1993) generalized and incorporated it into Power GARCH (PGARCH) specification. In

the PGARCH model, the power parameter of the standard deviation can be estimated rather than imposed. The PGARCH (p, d, q) can be specified as follows

$$\sigma^d{}_t = \beta_{0+\alpha_1}(|\varepsilon_{t-1}| + \gamma_1\varepsilon_{t-1})^d + \beta_1\sigma^d{}_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

The failure to accept the null hypothesis that shows the presence of leverage effect. The impact of news on volatility in PGARCH is similar to that of TGARCH when d is 1.

3.3 Data and Sources

The study uses monthly data of exchange rates (Naira/US dollar) and All Share Index (ASI) data of the NSE as a proxy of share prices spanning from January 2004 to December 2018. Data for both variables were sourced from Central Bank of Nigerian Statistical Bulletin 2018. The rate of return or growth rate of the variables is computed using the continuous compounded growth rate formula which is given as

$$GEXR = ln\left(\frac{EXR_t}{EXR_{t-1}}\right)$$

$$GASI = ln\left(\frac{ASI_t}{ASI_{t-1}}\right)$$

Where $GEXR$ and $GASI$ stands for returns of exchange rate and ASI respectively.

4.0 Empirical Result

Table 1- Descriptive statistics

	GEXR	GASI
Mean	-0.000715	-0.001016
Median	-6.55E-05	-0.000888
Maximum	0.271013	0.381978
Minimum	-1.000000	-1.000000
Std. Dev.	0.080406	0.105517
Skewness	-10.43082	-4.534800
Kurtosis	134.9528	47.05835
Jarque-Bera	133850.7	15175.47
Probability	0.000000	0.000000
Sum	-0.128687	-0.182840
Sum Sq. Dev.	1.157261	1.992962
Observations	180	180

From table 1 above which highlighted the summary statistics of the returns series of the variables employed in this study, it was observed that the average return for both exchange rate and stock prices is negative, meaning that variability in the external and financial sector of the Nigerian economy leads to the appreciation of the Naira and a fall in stock prices. Also the standard deviation implied that the stock price is more volatile than the exchange rate. Furthermore both series are reported to be negatively skewed also reference to the kurtosis statistics presented it is observed that both series are leptokurtic distribution characterized with heavy tails and risky investments. From the Jacque-Bera statistic both variables are non-normal as indicated by their respective probability in which their null hypothesis are rejected.

Table 2- Unit Root Test

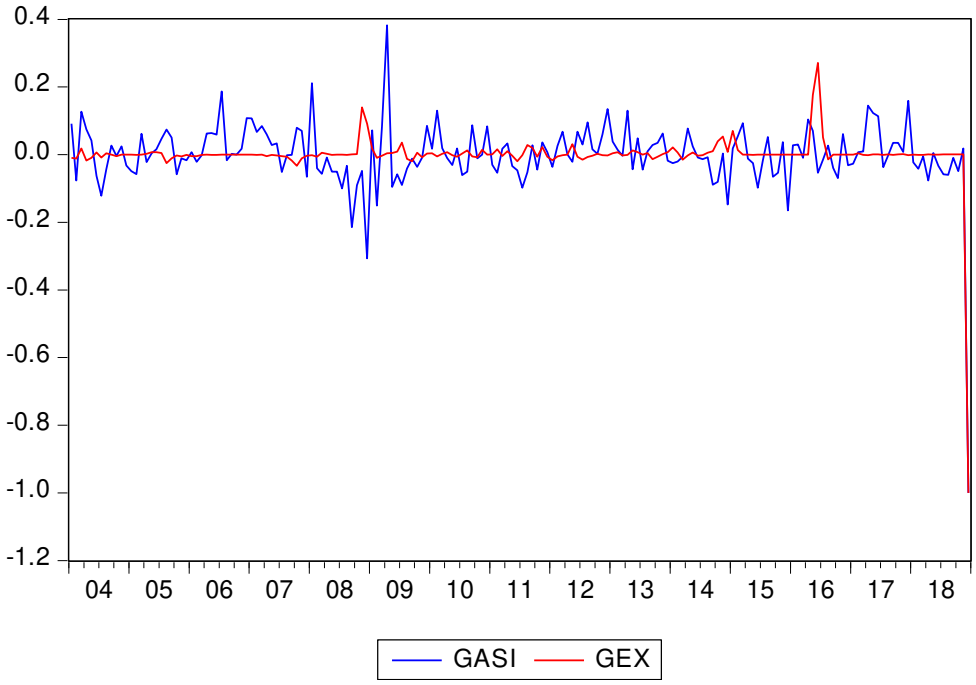
Variable	*ADF*		*PP*	
	With constant	**constant & Trend**	**With constant**	**constant & Trend**
GASI	**12.29912**	**12.30885**	**19.98559**	**20.18244**
GEX	**4.9560**	**4.9900**	**3.9562 ****	**3.9736 ****

***,**,* denotes rejection of null hypothesis at 1%, 5% and 10% respectively

From table 2 above, it was observed that both returns of the stock prices and exchange rate are found to be stationary at first difference $I(1)$. Both series are stationary at 1% significance level except at the Philips-Perron (PP) statistic of exchange rate returns which was found stationary at 5% significance level.

Trend Analysis

Figure 1- Trends in exchange rate and stock prices returns



Source: Authors' computation

Table 3- ARCH LM Test

F-statistic	***0.5645***	***Prob. F(1,177)***	***0.4534***
Obs*R-squared	**0.5691**	**Prob. Chi-Square(1)**	**0.4506**

Source: Authors' computation

Table 3 above which reported the ARCH LM Test alternatively known as ARCH effect test or Heteroscedasticity test indicates that the null hypothesis of no ARCH effect was rejected at 5% level and it's concluded that there is presence of ARCH effct in the data. This result have permitted was to conduct volatility modelling of the data.

Table 4- Estimate of stock prices volatility model

Variables	***GARCH (1,1)***	***GARCH-M***	***TGARCH***	***EGARCH***	***PGARCH***
		Mean Equation			
$Constant(\alpha)$	**0.007251**	**0.026996**	**0.004865**	**0.006358**	**0.098548**
$GEX(\beta)$	**0.936334**	**0.954573**	**0.892297**	**0.887128**	**0.923189**
$GARCH(\sigma^2)$		**3.120891**			

@SqrtGARCH(σ)					-1.301443
		Variance Equation			
Constant α	0.001282	0.001341	0.001245	-0.924348	0.008438
ARCH β_1	0.231489	0.241654	-0.072525	0.197653	0.151660
GARCH β_2	0.587261	0.563284	0.714069	0.849819	0.775581
Asymmetry γ				-0.132765	0.622748
Threshold Φ			0.312572		
$\beta_1 + \beta_2$	**0.81875**	**0.80494**	0.641544	**1.04747**	**0.927241**
AIC	-2.230222	-2.244717	-2.274959	-2.242466	-2.318927
ARCH LM Test					
F-test	0.415644	0.360568	0.042310	0.052468	0.072058
Prob	0.5200	0.5490	0.8373	0.8191	0.7887
nR^2	0.419356	0.363900	0.042778	0.053045	0.072843
Prob	0.5173	0.5463	0.8361	0.8178	0.7872

Source: Author's computation using Eviews 9.0

4.1 Results and Discussion

Given the evidence of ARCH effects in the returns of the series, the modelling of GARCH (p,q) equation followed by the various extensions specified in section 3 above were presented in table four (4) each of the GARCH model estimated was presented in a column order.

The estimate of GARCH (1, 1) was presented in the first column, it was observed that the coefficients of exchange rate volatility is found to be positive and statistically significant implying that 93% shocks of stock prices are initiated by exchange rate dynamics. The ARCH coefficients are found statistically confirming the presence of the ARCH effects. The sum of ARCH and GARCH coefficients is less than unity meaning that stock prices volatility is mean reverting, precisely a slow mean reverting process and from a broader perspective the effects of shocks on stock prices volatility is temporary. From the GARCH coefficients evidence of volatility is present, indicating periods of high volatility are followed by further high volatility while periods of low volatility are followed by periods of low volatility.

In the second column where estimates of GARCH-in-Mean are presented it is observable that the effects of exchange rate volatility is found to be positive and statistically significant. The GARCH term incorporated into the mean equation is clearly insignificant which signifies that investors do not require any form of hedging against stocks traded in the NSE because they were found to be less risky.

As for the volatility persistence the sum of the ARCH and GARCH coefficients are mean also slow mean reverting ie effects of shocks are temporary and the evidence of evidence of volatility clustering is present.

From the third column where the asymmetric model; TGARCH estimates are presented, it was observed that the volatility persistence is slow mean reverting characterized with temporary shocks on stocks returns. The asymmetric term is positively signed and statistically significant which implies that negative shocks (bad news) on the stocks returns volatility has larger impact than positive (good news) of the same magnitude.

The exponential GARCH model (EGARCH) presented in the fourth column also indicated the leverage effect of shocks on the volatility of stock prices is negative by implications bad news on the stocks returns volatility has larger impact than good news of the same magnitude. Further the shocks are non-mean reverting whereby the effects of shocks are permanent.

In the last column where the results of Power GARCH (PGARCH) are presented it is observed that with regards to the volatility persistence the shocks on stock prices are slow mean reverting and also effects of shocks are temporary. Further from the GARCH term coefficient it was highlighted that past volatility are instrumental to influencing future volatility of stock returns. The asymmetric term as well as the leverage effect implies that negative shocks on the stocks returns volatility has larger impact than positive of the same magnitude.

In general the coefficient of the exchange rate volatility (GEX) is significant in all the models. This portrays the importance of exchange rate volatility on stock returns volatility in Nigeria. From. Comparatively the PGARCH gives the better fit of the stock prices volatility model given its minimum AIC value as reported in the table 4 above the symmetric models {GARCH (1, 1) and GARCH-in-Mean} the shocks on stock returns volatility are found to be mean reverting whilst in the asymmetric GARCH models {TGARCH, EGARCH and PGARCH} only EGARCH was found to be non-mean reverting. Specifically in the symmetric models GARCH-in-mean gives better fit it has the minimum AIC value whilst from the asymmetric models the PGARCH has the minimum AIC. The results of the diagnostic test of ARCH effect demonstrate that all the models completely captured the ARCH effect. This is an indicator that the GARCH models are correctly specified.

5.0 Conclusion and Policy Recommendation

This paper analytically examines the impact of exchange rate volatility on stock prices in Nigeria via both symmetric and asymmetric GARCH models. Related works were studied and comparatively aligned to this paper. In this study it was observed that exchange rate is paramount in initiating shocks on stock returns in Nigeria.

The findings of this paper reveals that the PGARCH gives the better fit of the stock prices volatility model given its minimum AIC value. In the symmetric models {GARCH (1, 1) and GARCH-in-Mean} the shocks on stock returns volatility are found to be mean reverting whilst in the asymmetric GARCH models {TGARCH, EGARCH and PGARCH} only EGARCH was found to be non-mean reverting. The post estimation diagnostic test of ARCH effect demonstrate that all the models completely captured the ARCH effect. This is an indicator that the GARCH models are correctly specified.

Based upon the findings, this study would like to recommend both the CBN and the Federal Government to intensify efforts to revamp other sectors of the economy, embed them to a medium-long term diversification plan to revive agricultural sector, improve and efficient taxation, and solidify the economy as a service oriented and financially developed economic clime. Successful diversification of the economy will improve foreign receipts which will consequently stabilize the exchange rate and mitigate the vulnerability of its adverse effect on stock market thereby boosting investor's confidence and enhancing more funds inflow into the capital market.

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