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Stock Market Response of Exchange Rate and Inflation Shocks in Nigeria: A Structural VAR Approach

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Abstract:
Motivated by the high inflation rates and fluctuating exchange rates as currently being experienced in Nigeria, this study investigates the stock market response of exchange rate and inflation shocks in Nigeria within the VAR methodology using the popular impulse response function, forecast error variance decomposition and Granger causality/exogeneity test. The data used consist of 258 monthly time series observations on inflation rates, end period Naira/dollar exchange rate and NSE All-share index from January 1996 to June 2017. Stock market index and exchange rate data are converted into continuously compounded returns by taking the log difference. The results show that although, stock market responds negatively to exchange rate shock and positively to inflation shock, the effect of these shocks is insignificant. The main source of error variance in stock returns is own shock as both exchange rate and inflation shocks contribute less than 2% of the observed variation in stock returns up to the tenth period. There is no causal impact of both inflation and exchange rate on the Nigerian stock market. However, there is a long-run relationship between stock market returns, exchange rate returns and inflation. Thus, both inflation and exchange rate are not systematic risk factors that influence the stock market. Based on these findings, the study recommends that the monetary authorities should not allow the exchange rate and inflation to exceed the current level as this may have significant adverse effects on the stock market.

Keywords: *Stock market returns, exchange rate, inflation, VAR*

1. Introduction

Stock market development is a multi-dimensional concept which is usually measured by stock market size, liquidity, volatility, concentration, integration with world capital markets and the legal rule (regulation and supervision) in the market. As an integral part of financial development, stock markets have received over the last decade, a great deal of attention as a source of economic growth. The stock market increases flexibility in the financial intermediation process, as it provides investors with a clear exit strategy. Furthermore, the stock market provides an important indicator for information sharing among investors, company valuation, and the prospect of macroeconomic fundamentals.

Moreover, efficient market hypothesis proposed by Eugene Fama in 1960's also advocated that stock prices are related to the fundamental macroeconomic indicators. The hypothesis also suggested that the prices at the stock market reflect every piece of substantial information that could affect the stock price in any way including the company specific factors, market factors and macroeconomic factors. This theory however, could not withstand, effectively, the criticism on the inefficiencies found by empirical evidence (Shiller, 1981). Yet, the importance of the macroeconomic factors in determining the stock market activity has been proven by many studies such as Hussainey and Ngoc (2009) and Masudussama (2012).

The Nigerian economy has experienced significant changes in its macroeconomic aggregates in the recent past. The inception of the Structural Adjustment Programme (SAP) in 1986 came with fundamental economic reforms (a major aspect was the far-reaching liberalization of various sectors of the economy). Similarly, the transition from a military to civilian rule in 1999 witnessed various programmes of deregulation, privatization and commercialization, with implications for stock market index.

This study seeks to determine the stock market response of inflation and exchange shocks in Nigeria within the VAR framework using the Impulse response function, variance decomposition and the popular Granger causality/blocked exogeneity tests. The present study is motivated by the contradicting results found by previous studies on the nature of the relationship between stock returns, inflation and exchange rates. Further, given the strategic role of the stock market in resource mobilization and allocation, it may be the case that both inflation and exchange rates shocks, as currently being experienced in Nigeria, have no real impact on investors' expected returns.

The structure of the rest of the paper is as follows: Section 2 reviews the extant literature, section 3 describes the methodology and data, section 4 analyses data and section 5 concludes the study.

2. Literature Review

2.1. Theoretical Framework

The theoretical argument for linking financial development to growth is that a well-developed financial system performs several critical functions to enhance the efficiency of intermediation by reducing information, transaction, and monitoring costs. Indeed, several previous studies on finance and development highlight that countries with better developed financial systems would experience faster economic growth. Then, the question of what determines stock market development becomes important and is the subject of a large and still growing research literature, from which some general conclusions can be drawn. In brief, there is agreement that countries should adopt appropriate macroeconomic policies, encourage competition within the financial sector, and develop a strong and transparent institutional and legal framework for financial sector activities. The development of equity markets is crucial toward further development of the financial system. Other theories and hypotheses have been propounded by several scholars to explore the nature of relationships that may prevail between stock prices and macroeconomic variables. However, these macroeconomic variables are mostly from the monetary side and not strictly focused on the fiscal aspect of the macro economy. However, they still exert significant importance and bearing on our current study and there need to be highlighted.

The studies of Ross (1976), Roll (1977), Roll (1979), Roll and Ross (1980) culminating in the Arbitrage Pricing Model is somewhat similar to CAPM above. While CAPM is a single-factor model, the APT is a multi-factor model with many beta values as necessary. In APT, there are a number of industry-specific and macro-economic factors that affect the security returns. Thus, a number of factors may measure the systematic (non-diversifiable) risk of an asset under APT. The fundamental logic of APT is that investors always indulge in arbitrage whenever they find differences in the returns of assets with similar risk characteristics.

Francis (1980) and Oka for (1983) assert that two major theories dominate thinking on investor behavior. These are the bandwagon theory and contrary opinion hypothesis. While the former asserts that errors of judgment in stock market transactions will be minimized by an investor who follows the lead market-makers, and therefore more likely to avert mistakes and losses, the later argues that if the market is efficient the best strategy is to do exactly the opposite of what the lead market makers do thereby, investing in the stocks they shy away from.

The relationship between stock prices and macroeconomic variables is further espoused by the works of Modigliani and Miller (1961) here in referred to as the Dividend Discount Model (DDM). Accordingly, the current price of stock equals the present value of all future cash flows. Consequently, the determinants of stock prices constitute the required rate of return and expected cash in-flows.

2.2. Review of Some Empirical Studies

Using the VAR methodology, the study by Granger, Huang and Yang (1998) seek to determine whether there is causality between stock returns and exchange rates in Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Thailand, and Taiwan. n a VAR framework using unit root and co integration tests, Granger causality test and Impulse response function. The results show evidence of a unidirectional causality with positive correlation running from exchange rates to stock returns for Japan and Thailand. On the contrary, the results show evidence of a unidirectional causality with negative correlation running from stock returns to exchange rate for Taiwan. For Korea, Malaysia and Philippines, the results how a strong feedback causal relationship between stock returns and exchange rate. However, there is no recognizable pattern for Singapore.

In Egypt, Omran and Pointon (2001) examine the impact of inflation rate on the Egyptian Stock Market using the error correction model. The results show, among other things, that indicate that inflation has a negative effect on the Egyptian stock market.

Using GARCH models, the study by Yaya and Shittu (2010), which examine the effect of inflation and exchange rate on the conditional stock market volatility, find that both exchange rates and inflation have significant effects on the stock market volatility.

In South Africa, the study by Eita (2012) which examines the relationship inflation and stock market returns from 1980 to 2008 within the VAR methodological framework, show among other things, that inflation and stock returns are positively related.

In Pakistan, Khan, Khan, Rukh, Imdaduallah and Rehman (2012) investigate the effects of interest rate, exchange rate and inflation on the return on Karachi stock exchange for ten years from July 2001 to June 2010 using multiple regression and ANOVA methods. The results show that stock return is a positive function of inflation and a negative function of both interest rate and exchange rate. However, while inflation and interest rates show in significant effects, exchange rate shows significant effect.

In Nigeria, Emenike and Nwankwegu (2013) investigate the relationship between stock returns and inflation from 1985 to 2011 using cointegration test and error correction methods. Monthly data on All-Share Index (ASI) and Consumer price index (CPI) are used. The results indicate, that there is a long-run relationship between stock returns and inflation. However, inflation shows no significant short-term effects on stock returns.

Using multiple regression and correlation techniques, Mohan and Chitradevi (2014) examine the impact of Inflation and Exchange Rate on Stock Market Performance in India. The study covers the period from 2013 to 2013:9 and the results that stock prices is a negative function of inflation and a positive function of exchange rate.

More recently, Nkoro and Uko (2016) examine the relationship between stock market volatility and exchange rate and inflation volatility in Nigeria within the GARCH methodology using quarterly data from 1986Q1-2012Q4. The findings show evidence that stock market volatility has a negative relationship with both exchange rate and inflation volatility in Nigeria.

Ogboghro and Anuya (2017) investigate the impact of exchange rate and inflation on stock market prices in Nigeria using trivariate VAR model. Based on monthly data, the indicate that there is unidirectional negative causal relationship from inflation to stock market prices, and a bidirectional positive causal relationship between exchange rate and stock prices.

3. Methodology

3.1. Data

The data used in this study consist of 258 monthly observations on exchange rate and inflation rate for the period from January 1996 to June 2017. All data are obtained from the CBN statistical database. Both exchange rate returns and stock returns are in continuously compounded form which are obtained in the usual way by taking the log difference as follows:

$$R_t = \text{dlog(price)} = \ln\left[\frac{P_t}{P_{t-1}}\right] \times 100$$

where; P_t is the current price, P_{t-1} is the previous price, ln is the natural logarithm. E Views 9 is used to analyze the data.

3.2. Methods

In this study, the stock market response of exchange rate and inflation shocks in Nigeria using the VAR methodological framework. Since the introduction of VAR models by Sims (1980), they have been found in many empirical studies to perform better than the competing models such as simultaneous equations models. Also, the success of VAR models in capturing the joint dynamics of most economic and financial time series is well documented. The trivariate reduced VAR model, incorporating stock returns, exchange rate returns and inflation is given by:

$$\text{STK\_RTN}_t = \beta_{01} + \beta_{11}\text{STK\_RTN}_{t-1} + \beta_{21}\text{EXR\_RTN}_{t-1} + \beta_{31}\text{INFLATION}_{t-1} + u_{1t}$$
$$\text{EXR\_RTN}_t = \beta_{02} + \beta_{12}\text{STK\_RTN}_{t-1} + \beta_{22}\text{EXR\_RTN}_{t-1} + \beta_{32}\text{INFLATION}_{t-1} + u_{2t}$$
$$\text{INFLATION}_t = \beta_{03} + \beta_{13}\text{STK\_RTN}_{t-1} + \beta_{23}\text{EXR\_RTN}_{t-1} + \beta_{33}\text{INFLATION}_{t-1} + u_{3t}$$

where u_{it} are white noises that capture the innovations or shocks to the VAR system. The above VAR model treat all variables as endogenous and assumes there are no contemporaneous terms on the right-hand side of each equation. The model can be estimated using the popular OLS method.

4. Analysis and Discussion

4.1. Descriptive Statistics

Table 1 shows some summary statistics that describes the distributional characteristics of all the data. As this table shows, the average monthly inflation rate over the sample period is 12.32% while average monthly stock market returns and exchange rate returns are 0.66% and 0.56% respectively. The skewness coefficient of -0.546824 indicates that stock returns distribution is negatively skewed. On the contrary, the skewness coefficients of 0.585613 and 1.246043 indicate that both exchange rate returns and inflation have a positively skewed distribution. However, the kurtosis coefficient is substantially higher than 3 for all variables, indicating that they all have a leptokurtic distribution. The Jarque-Bera normality test statistic has a zero probability for all the variables, suggesting clear evidence that they all have a distribution that is not normal.

Statistic	STK_RTN	EXR_RTN	INFLATION
Mean	0.668208	0.568676	12.32424
Maximum	32.35158	20.29408	43.65000
Minimum	-36.58828	-15.91382	-2.490000
Std. Dev.	6.675940	3.598474	6.347763
Skewness	-0.546824	0.585613	1.246043
Kurtosis	8.653445	10.60376	6.915925
Jarque-Bera	352.2986	628.8823	228.9152
Probability	0.000000	0.000000	0.000000

Table 1: Descriptive Statistics for the Study Variables

Figure 1 shows the graphical plot for stock returns, exchange returns and inflation. A cursory look at the figure shows that all the time series data are stationary as there is no observable trend in the figure.

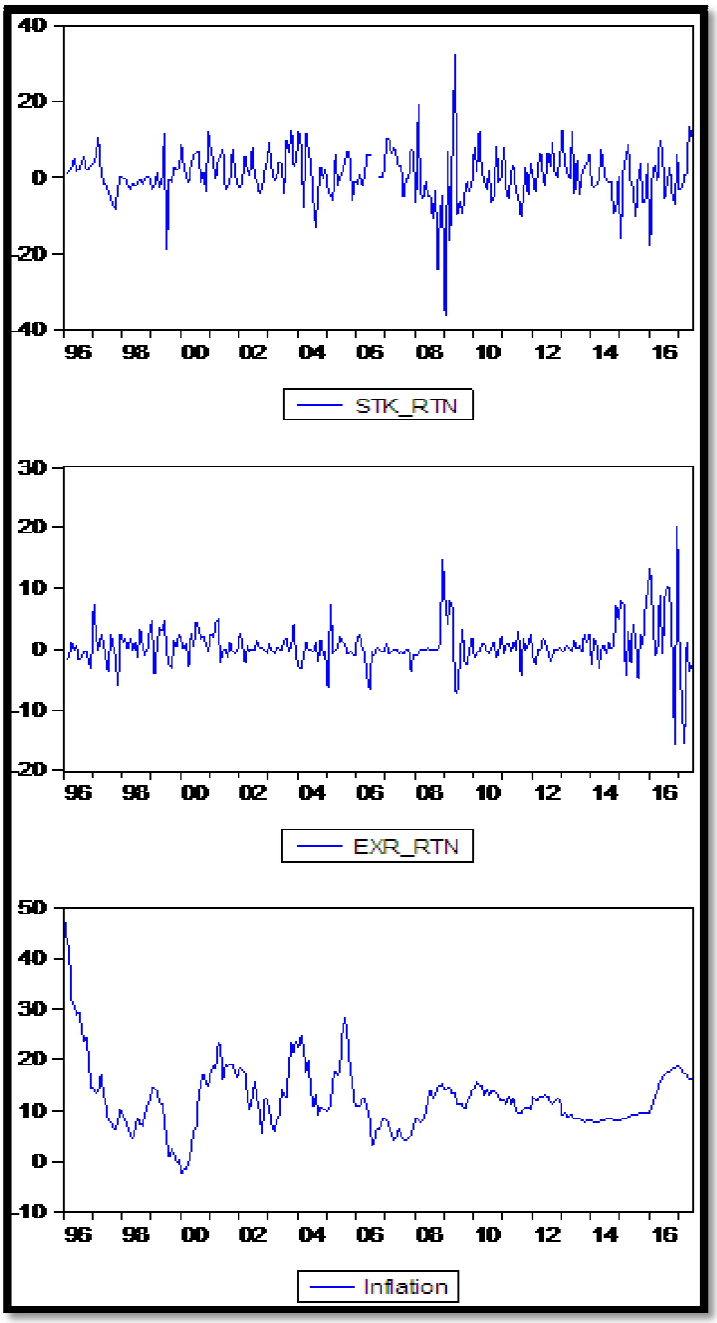

Figure 1: Graphical Plot of the Data

4.2. Stationarity/Unit Root Test

To determine whether our variables have the same order of integration, the popular Augmented Dickey Fuller (ADF) unit root/stationarity test is applied. The appropriate lag length for the test is determined using the Schwarz information criterion (SIC), allowing a maximum of 15 lags. The results are displayed in table 2. As the results in this table shows, the ADF statistic is associated with a probability of almost zero for all variables, indicating that the test is highly significant for all cases. This leads us to reject the unit root hypothesis and therefore, conclude that the data are all stationary at level series. Thus, they are all integrated of order zero or I(0) series. This agrees with the graphical plots in figure 1 and also motivates the use of VAR to capture the dynamic relationships between the variables being studied.

Variable	ADF statistic	p-value	Decision	Remark
STK_RTN	-13.45693	0.0000	Stationary	I(0)
EXR_RTN	-13.10586	0.0000	Stationary	I(0)
INFLATION	-3.341958	0.0000	Stationary	I(0)

Table 2: ADF Unit Root Test for the Study Variables

4.3. Unrestricted VAR Analysis

4.3.1. VAR Lag Length Selection

As it well known, the first step in estimating an unrestricted VAR model is to determine the optimum lag length for a parsimonious specification. To this purpose, we employ two automatic lag selection criteria; namely, Akaike information criterion (AIC) and Schwarz information criterion (SIC). The lag order that corresponds to the lowest value of AIC or SIC is the optimum lag length. The results are presented in table 3. As this table clearly indicates, the value of both AIC and SIC is lowest at lag 1, indicating that a VAR (1) specification is the parsimonious model and the plausible description of our data. We therefore, proceed to estimate a VAR (1) model for the dynamic relationship between stock returns, exchange rate returns and inflation rate.

Lag	AIC	SC
0	18.29551	18.33838
1	16.31061*	16.48210*
2	16.31832	16.61842
3	16.33555	16.76428
4	16.35299	16.91033
5	16.37523	17.06119

*Table 3: VAR Lag Selection Criteria; * Indicates Minimum Value*

4.3.2. VAR (1) Estimation

Table 4 presents the estimation results for a trivariate VAR (1) model, incorporating stock returns, exchange rate returns and inflation rate. However, since the E Views VAR results output does not include probabilities, we estimate an equivalent system model to obtain the p-values. As the results in table 4 indicates, the estimated VAR (1) model is correctly specified, with the LM diagnostic statistics up to lag 4 failing to reject the null hypothesis of no serial correlation at all usual significance levels. Thus, the estimated VAR(1) model is free from specification problems. In terms of the coefficients, it appears that the model for STK_RTN has a very poor fit as all the endogenous variables jointly explain only 3.8% of the variation in STK_RTN. However, since VAR models are atheoretical and non-structural, the economic implication of the estimated coefficients are very difficult to evaluate (Brooks, 2008; EViews, 2015; Gujarati 2003). Consequently, the coefficients are interpreted through a structural VAR analysis of impulse response function (IRF), forecast error variance decomposition (FEVD) and Granger causality/exogeneity test. However, structural analysis requires that VAR models satisfy stability condition (EViews, 2015; IMF, 2016).

	STK_RTN	EXR_RTN	Inflation
STK_RTN (-1)	0.126619 (0.0462)	-0.082348 (0.0142)	0.002674 (0.8930)
EXR_RTN (-1)	-0.178142 (0.1266)	0.153096 (0.0138)	0.072079 (0.0471)
INFLATION (-1)	0.094588 (0.1525)	-0.009571 (0.8115)	0.896306 (0.0000)
Constant	-0.471435 (0.6066)	0.658621 (0.1879)	1.115151 (0.0001)
R-squared	0.038831	0.053547	0.885222
LM-Stat (4)	10.07646	Prob(LM-Stat)	0.3443

Table 4: VAR (1) Estimation Results; Systemp-Values In ( )

4.3.3. The Stability Check

To examine the stability of the estimated VAR (1) model, we graphically plot the inverted roots in relation to unit circle. The estimated VAR model is stableif all the inverted roots lie inside the unit circle. The inverted root plot is shown in Figure 2. A cursory at this figure shows that all the roots are inside the unit circle, an indication that our VAR (1) model is stable. Thus, we proceed to evaluate the estimated VAR(1) coefficients using the impulse response function, forecast error variance decomposition and Granger causality/exogeneity test.

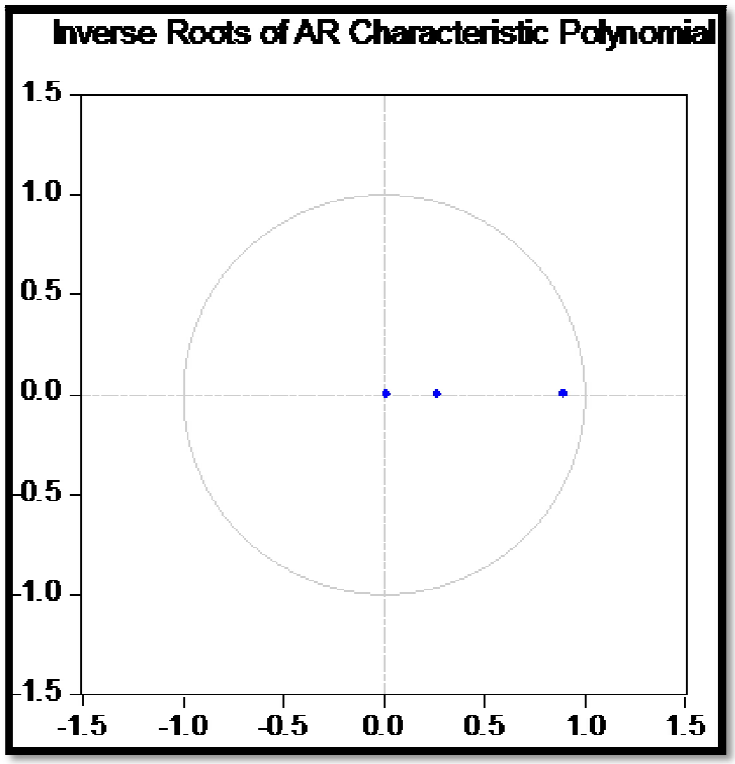

Figure 2: VAR Inverted Roots Plot

4.4. Structural VAR Analysis

4.4.1. The Impulse Response Function

To examine the dynamic impacts of unexpected changes in inflation and exchange rates on the stock market, we graphically plot the response function for stock returns for 10 periods (months). The impulse response function analyzes the effect of a one-time shock to an endogenous variable on the VAR system (EViews, 2015). The graphical plot is shown in figure 3. As this figure shows, stock market responds positively to own shock and shock to inflation but negatively to shock to exchange rate. However, while the effect of own shock dies out after the fourth period, the effect of shock to exchange rate dies out after the third period. The effect of inflation shock stays around zero throughout the response period.

4.4.2. Granger Causality/Blocked Exogeneity Test

To determine whether exchange rate and inflation shocks are exogenous to the stock market, we apply the popular Granger causality/blocked exogenous test. An endogenous variable in a VAR model istreated as exogenous if it is found to be significant in a VAR equation either individually or jointly with other endogenous variables in that equation (EViews, 2015). Table 5 shows the results of the Granger causality/Blocked exogeneity test. As this table clearly shows, the Chi-square statistic has a p-value that is above all usual significance levels for all variables, indicating that the causality test is not significant. This implies that none of the endogenous variables in the STK_RTN equation can be treated as exogenous individually and jointly. Thus, both exchange rate and inflation have no causal effect on the stock market. This is largely in agreement with the results in table 4; that both exchange rate and inflation have no explanatory power for stock returns.

Dependent Variable: STK_RTN		
Excluded	Chi-square	p-value
EXR_RTN	2.338325	0.1262
INFLATION	2.050995	0.1521
ALL	4.373545	0.1123

Table 5: Granger Causality/Blocked Exogeneity Test

4.4.3. Forecast Error Variance Decomposition (FEVD)

To determine the contribution of exchange rate and inflation shocks to stock market shocks, we separate the error variance of STK_RTN into the component shocks to the VAR. The results are given in table 6. The results indicate that the forecast error variance of STK_RTN is mainly caused by own shock with the contribution of both EXR_RTN and inflation being less than 2% even at the tenth period. This is expected given the results obtained from both impulse response function and Granger Causality test.

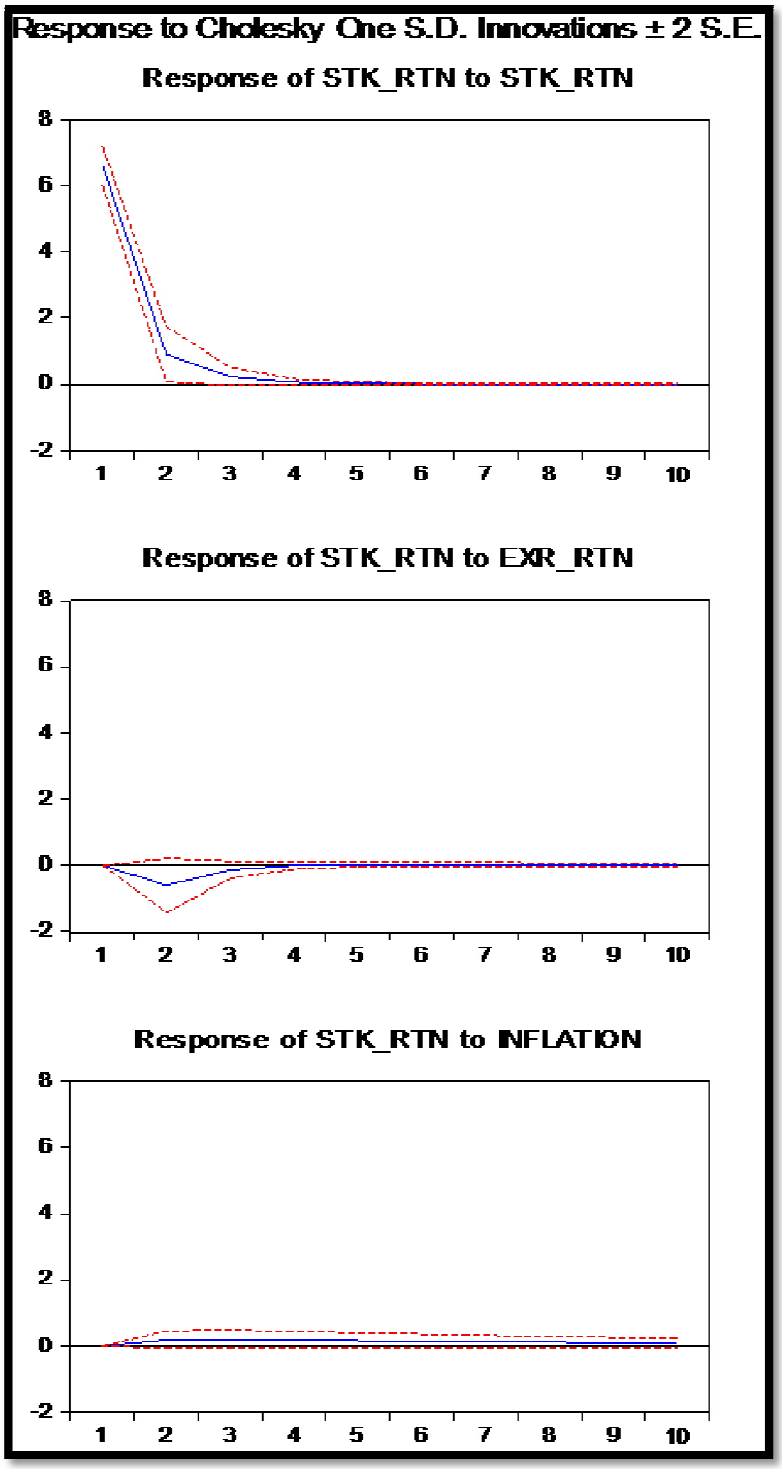

Figure 3: Impulse Response Function for STK_RTN

Period	STK_RTN	EXR_RTN	Inflation
1	100.0000	0.000000	0.000000
2	99.09001	0.826271	0.083717
3	98.96209	0.863914	0.174000
4	98.88475	0.863168	0.252083
5	98.81944	0.864636	0.315920
6	98.76574	0.866966	0.367295
7	98.72239	0.869152	0.408458
8	98.68762	0.870980	0.441400
9	98.65978	0.872461	0.467756
10	98.63750	0.873651	0.488844

Table 6: Forecast Error Variance Decomposition of STK_RTN

4.5. Test for Co integration

To determine whether there is a long-run relationship between stock returns, exchange rate and inflation, we apply the popular Johansen system co integration test using both Trace and Max-Eigen value statistics. The results are given in table 7. As this table shows, the associated probability of both trace and max-eigenvalue statistics is almost zero for all cases (r = 1, r = 2, r = 3), indicating that the test for each hypothesized number of cointegration is highly significant. This suggests clear evidence of three cointegrating relations among stock returns, exchange rate returns and inflations. Thus, the three variables have long-run relationships.

Hypothesized No. of CE(s)	Trace statistic		Max-Eigenvalue statistic	
	value	probability	value	probability
None * (r=0)	201.1492	0.0001	105.2527	0.0001
At most 1 * (r=1)	95.89648	0.0000	70.43549	0.0000
At most 2 * (r=2)	25.46098	0.0000	25.46098	0.0000

Table 7: Johansen System Co integration Test

5. Conclusion

In this study, we seek to determine the stock market response of exchange rate and inflation shocks in Nigeria using the VAR methodology. The data used consist of 258 monthly time series observations on stock market index, end period Naira/dollar exchange rate and inflation rates from January 1996 to June 2017. Stock market index and exchange rate data are converted into continuously compounded returns by taking the log difference. The main conclusions of the study are as follows:

The average monthly inflation rate over the sample period is 12.32% while the average monthly stock market and exchange rate returns are 0.66% and 0.56% respectively. Although, stock market responds negatively to exchange rate shock and positively to inflation shock, the effect of these shocks is insignificant. The main source of error variance in stock returns is own shock as both exchange rate and inflation shocks contribute less than 2% of the observed variation in stock returns up to the tenth period. There is no causal impact of both inflation and exchange rate on the Nigerian stock market. However, there is a long-run relationship between stock market returns, exchange rate returns and inflation. These results largely agree with the findings of Eita (2012), Khan, Khan, Rukh, Imdaduallah and Rehman (2012) and Emenike and Nwankwegu (2013) but disagrees with the findings of Omran and Pointon (2001), Chitradevi (2014) and Ogboghro and Anuya (2017).Thus, both inflation and exchange rate are not systematic risk factors that influence the stock market. Based on these findings, the study recommends that the monetary authorities should not allow the exchange rate and inflation to exceed the current level as this may have significant adverse effects on the stock market.

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