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The Impart of Inflation and Exchange Rates on Stock Prices in Nigeria

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ABSTRACT

This paper uses a trivariate VAR model to examine the impact of inflation and exchange rate on stock prices in Nigeria. Monthly data in logarithmic form are used covering a period of 13 years from January 2000 to December 2012. There are altogether 156 observations for each data series. The variables are consumer price index, average exchange rate of ₦/$and closing prices of the Nigerian stock exchange All-share index. The hypothesis testing is based on ADF stationarity test, Johansen system cointegration test, Granger causality tests, Impact response function and Forecast error variance decomposition. The results indicate that although, the three variables are integrated of the same integration, there is no cointegration or long run relationships between them. When unrestricted VAR is estimated, the coefficients are found to be stable as no VAR root is found to lie outside the unit circle. The results of the Granger causality test suggest evidence of a unidirectional causality from inflation to stock prices and from inflation to exchange rate, and a feedback causality between exchange rate and stock prices. Although, the causality from inflation to stock prices and from exchange rate to stock prices is significant only at 10% level, there is evidence that both innovations in inflation and exchange rate have contemporaneous effects on stock prices. However, while the effect of inflation is negative, the effect of exchange rate is positive. Finally, the results indicate that own shocks explain most of the variations in stock prices.

KEYWORDS: ***Stock prices, Inflation, exchange rate, VAR, Granger causality test***

1.0 Introduction

The efficiency of any financial market in resource mobilization and asset allocation depends primarily on how information or news are incorporated in asset prices. It is generally believed that stock prices generally reflect at least, all available information or news about innovations in macroeconomic variables. Thus, unexpected changes in macroeconomic variables create bubbles and crashes in a typical stock market and affect the general market conditions in a manner that is prescribed by the level of informational efficiency of the market. Because investors are rational and risk averse, they tend to maximize the value of their investment by incorporating any new information arising from macroeconomic adjustments in their investment decisions. Thus, there is a direct link between stock prices and changes in macroeconomic variables.

One macroeconomic variable that has consistently shown to have great influence on stock prices is inflation. By inflation is meant the continuous and appreciable rise in the general price level. Inflation distorts economic activities, induces macroeconomic instability and leads to general economic disequilibrium. According to Ammer (1994), higher rates of inflation increase riskiness of assets and reduce corporate profits. This means that risk averse investors will require higher rate of return as compensation for taking additional risk arising from unexpected rise in inflation. According to Brooks (2008), inflation is an important determinant of stock prices and unanticipated inflation creates economic risk to investors. Consequently, investors will require an additional risk premium for being exposed to unanticipated inflation. Thus, there is a link between unanticipated inflation and stock prices.

Another macroeconomic variable that has direct influence on stock prices is exchange rate. Exchange rate is the price of a domestic currency in relation to another. Economic theory posits that exchange rate innovations affect stock prices through cash follows as stock market liquidity is directly tied to exchange rate shocks especially, in developing countries. Further, it may be the case that exchange shocks create currency risk especially to foreign investors and will require additional risk premium as compensation for taking the additional risk. Thus, there is a link between exchange rate shocks and stock prices. However, the issue of whether there is unidirectional or feedback relationship between exchange rate and stock prices, and whether the relationship between the two variables is positive or inverse have not been resolved.

This paper examines the impact of inflation and exchange rates on stock prices. The motivation is twofold. First, although, there is much empirical work on the relationship between stock prices, inflation and exchange rate, there is however little empirical work in this area of research in Nigeria especially, in the VAR framework. This paper will therefore, contribute to the growing literature by using trivariate VAR incorporating stock prices, inflation and exchange rate. Second, the issue of whether there is a unidirectional or feedback relationship between stock prices and inflation, and between stock prices and exchange rate is still a topic of debate among researchers in Nigeria and other countries.

The remainder of this paper is organized as follows: Section 2 reviews some of the empirical studies on the interaction between stock prices, inflation and exchange rate. Section 3 describes the data, methods and econometric models. Section 4 discusses the empirical results. Section 5 concludes.

2.0 Literature Review

The relationship between inflation, exchange rate and stock returns has been well researched and documented. However, whether there is a unidirectional or feedback relationship between stock prices and inflation, and between stock prices and exchange rate is yet to be concluded.

Granger, Huang and Yang (1998) examine the causal relationship between stock prices and exchange rates in a VAR framework using unit root and cointegration tests, Granger causality test and Impulse response function. They use 3097 daily data in logarithmic scale for Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Thailand, and Taiwan. The sample was from 03/01/1986 to 14/09/1997. The results indicate that there is unidirectional causality with positive correlation from exchange rates to stock returns for Japan and Thailand. By contrast, there is unidirectional causality with negative correlation from stock returns to exchange rate for Taiwan. The results for Korea, Malaysia, and the Philippines indicate a strong feedback causality between exchange rate and stock returns while for Singapore, there is recognizable pattern.

Nieh and Lee (2001) investigate the dynamic relationship between exchange rate and stock

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prices for G-7; which includes Canada, France, Germany, Italy, Japan, UK and the US. They used daily data covering the period from 01/10/1993 to 15/02/1996. They found evidence of a short-term causality running from exchange rate to stock prices, and that the German financial market is stimulated by currency appreciation while there is decrease in stock returns in Canada and the UK.

Yaya and Shittu (2010) examine the impact of inflation and exchange rate on conditional stock market volatility in Nigeria using GARCH class of models. The use of monthly data for share indices, inflation rate and average Naira/US dollar exchange rate for a period 18 years from 1991 to 2008. The results indicate that previous exchange rates and inflation have significant effects on stock market volatility.

Khan, Khan, Rukh, Imdaduallah and Rehman (2012) examine the impact of interest rate, exchange rate and inflation on stock returns of Karachi stock exchange 100 index, Pakistan using multiple regression OLS and ANOVA techniques. They used monthly data for stock for ten years covering the period of 31st July, 2001 to 30th June, 2010. The results indicate stock returns are positively related to inflation but negatively related to interest rate and exchange rate. However, while the impact of inflation and interest rates are not significant, the impact of exchange rate is significant at 5% level.

Emenike and Nwankwegu (2013) examine the relation between stock returns and inflation in Nigeria using the Engle-Granger two steps cointegration error correction techniques. They use monthly All-Share Index (ASI) which measures the average change in prices of all listed shares on the NSE and monthly Consumer price index (CPI) from 1985 to 2011. The results indicate that the stock returns and inflation are cointegrated and thus, related in the long run. The results also indicate that stock returns and inflation converge in the long-run but at a low rate of adjustment. However, inflation has 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.

3.0 Methodology

3.1 Data

The data used in this study consist of monthly series of three macroeconomic variables, namely; monthly closing prices of the Nigerian stock exchange All-share index, monthly consumer price index and monthly average exchange rate of ₦/$. The data were all log-transformed to give reliable results. The study covers a period of 13 years from January 2000 to December 2012, so there are 156 observations for each data series. The inflation and exchange rate data were sourced from CBN database through the data generator window while stock price data were sourced from Nigerian stock market. All data are analyzed in EVIEWS 9.5 student version and GRETL software packages. Figures 1 plots the graphs of natural logarithms of monthly stock prices (LSTKP), inflation (LINF) and exchange rate (LEXR) series, while figure 2 plots their first difference series.

As expected, all the data plots in figure 1 exhibit an upward trend. By contrast, the plots in figure 2 shows no trend. However, while the first difference series of LSTKP and LEXR exhibit some outlying behaviour, there is no clear outlying behaviour for the first difference series of LINF.

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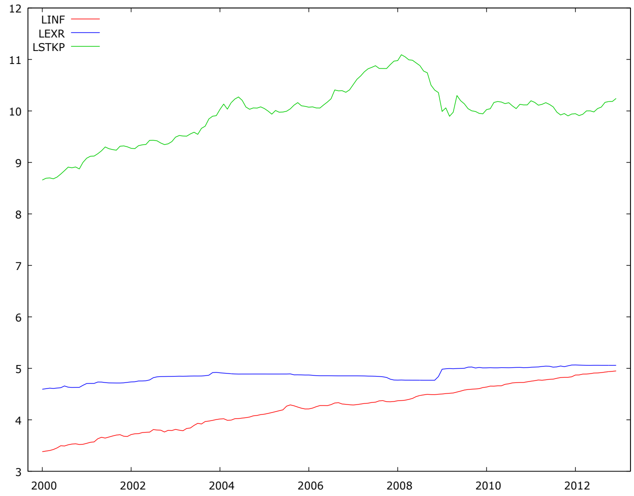

Figure 1: Level plot for LSTKP, LINF and LEXR

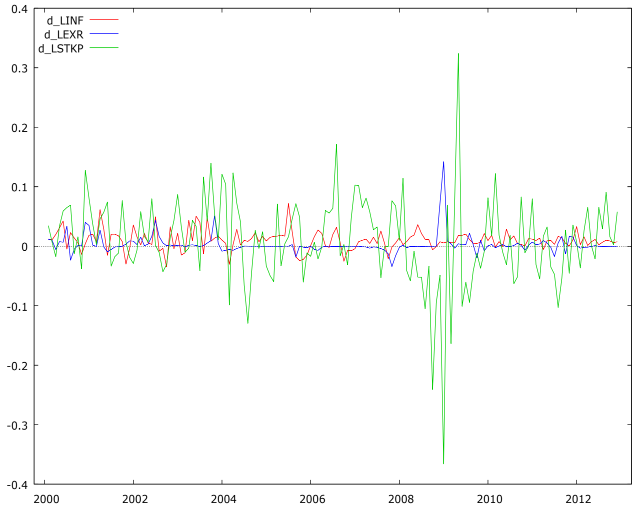

Figure 2: First difference plot for LSTKP, LINF and LEXR

3.2 Methods

In this paper, the dynamic relationship between stock prices, inflation and exchange rates are examined within the framework of VAR system of equations. This class of models was first proposed by Sims (1980) as an alternative to large scale simultaneous equations models which are plagued with identification problems (Brooks, 2008; Gujarati, 2004). The success of VAR in capturing the dynamic behaviour of most economic and financial time series and in forecasting is well established in the literature.

The reduced form trivariate VAR system incorporating monthly stock prices, inflation and exchange rate is specified as follows:

$$LSTKP_t = \beta_{10} + \beta_{11}LSTKP_{t-1} + \beta_{12}LINF_{t-1} + \beta_{13}LEXR_{t-1} + u_{1t}$$

$$LINF_t = \beta_{20} + \beta_{21}LSTKP_{t-1} + \beta_{22}LINF_{t-1} + \beta_{23}LEXR_{t-1} + u_{2t}$$

$$LEXR_t = \beta_{30} + \beta_{13}LSTKP_{t-1} + \beta_{23}LINF_{t-1} + \beta_{33}LEXR_{t-1} + u_{3t}$$

Where u_{it} are classical error terms, which capture the impulses or shocks to VAR system. The reduced form VAR assumes that all variables in the system are endogenous and there are no contemporaneous terms on the RHS of each equation. The popular OLS technique can effectively estimate each equation.

4.0 Analysis and Discussion

4.1 Stationarity/Unit root Test

To determine the order of integration for each series, we perform the popular Augmented Dickey-Fuller stationarity/unit root test. Here, we follow the usual procedure by performing the test on both the level and first difference series using two specifications, namely; a random walk with drift and a random with drift and a linear trend. The appropriate lag order is automatically selected using Schwarz information criterion while allowing for a maximum lag of 13 for each series. The results are given in table 1. The results are broadly similar for different specifications, with the ADF (tau) statistic failing to reject the null hypothesis of unit root in level series at conventional levels (p-value> 0.1) for each dataset. By contrast, however, the ADF (tau) statistic clearly rejects the null hypothesis of unit root in first difference series at less than 1% level of significance (p-value < 0.0001) for each dataset. This is clear evidence that our data are all integrated of the first order. Thus, there is good motivation to consider the hypothesis of cointegration among LSTKP, LINF and LEXR.

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Table 1: The ADF unit root test (p-values are in brackets)

Variable	ADF tau-statistic			
	Level		First difference	
	Drift	Drift& trend	Drift	Drift& trend
LSTKP	−2.3887 (0.1466)	−1.4762 (0.8337)	−10.3994 (0.0000)	−10.5674 (0.0000)
LINF	−1.4714 (0.5456)	−3.0074 (0.1336)	−10.7963 (0.0000)	−10.8470 (0.0000)
LEXR	−1.7185 (0.4200)	−2.4480 (0.3536)	−8.3928 (0.0000)	−8.3868 (0.0000)

4.2 Johansen System Cointegration Test

Figure 3gives the results of Johansen system cointegration test for LSTKP, LINF and LEXR. Unlike the Engle-Granger single equation residual-based two-steps procedure, the Johansen method is a system-based procedure and is associated with VAR/VECM estimation. An evidence of cointegration implies that the three series have long run relationships and VECM is appropriate to capture these relationships. On the other hand, an unrestricted VAR is appropriate if cointegration is not found. The Johansen method uses two test statistics, namely; trace and max eigenvalue statistics. As we can see, there is no evidence of cointegration among our variables as both the trace and max eigenvalue statistic fail to reject the null hypothesis of no cointegrating relation ($r = 0$)at conventional levels. Thus, we can proceed to estimate the dynamic relationships of interest using the unrestricted VAR.

Date: 08/31/16 Time: 09:09
Sample (adjusted): 2000M06 2012M12
Included observations: 151 after adjustments
Trend assumption: Linear deterministic trend
Series: LSTKP LINF LEXR
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.082776	19.29109	29.79707	0.4721
At most 1	0.038748	6.244188	15.49471	0.6667
At most 2	0.001832	0.276884	3.841466	0.5987

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.082776	13.04690	21.13162	0.4479
At most 1	0.038748	5.967304	14.26460	0.6174
At most 2	0.001832	0.276884	3.841466	0.5987

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Figure 3: Johansen system cointegration test

4.3 VAR Lag Length Selection

Figure 4gives the results of the VAR lag length selection. The selection is based on several different lag selection criteria, namely; Likelihood ratio criterion (LR), Final prediction error criterion (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criteria (HQ). Each information criterion selects the lag length that minimizes its value while the likelihood ratio selects the lag length that maximizes its value. As figure 4 clearly shows, LR, FPE and AIC select 3 lags while SC and HQC select 1 lag for our VAR estimation as indicated by asterisks. Thus, it our view that one lag is appropriate for the estimation of our VAR model.

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VAR Lag Order Selection Criteria
Endogenous variables: LSTKP LINF LEXR
Exogenous variables: C
Date: 08/31/16 Time: 10:29
Sample: 2000M01 2012M12
Included observations: 153

Lag	LogL	LR	FPE	AIC	SC	HQ
0	62.09867	NA	9.27e-05	-0.772532	-0.713111	-0.748394
1	1029.298	1883.825	3.37e-10	-13.29801	-13.06033*	-13.20146*
2	1043.669	27.42865	3.14e-10	-13.36823	-12.95229	-13.19927
3	1053.335	18.06797*	3.11e-10*	-13.37693*	-12.78273	-13.13556

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Figure 4: Lag length selection: * indicates selected lag length

4.4 Unrestricted VAR Estimation

Figure 5 reports the results of the estimated unrestricted VAR model for LSTKP, LINFand LEXR data series. The motivation for estimating an unrestricted VAR is the result reported in the previous sections that although, the variables are integrated of the same order, there is no cointegrating relations among them. Further, based on the findings in sections 4.2 and 4.4 above, we include a constant and one lag of each variable, so there are 4 coefficients in each VAR equation and a total of 12 coefficients in the VAR system. However, our focus is only on LSTKP equationsince our main objective is to examine the impact of inflation and exchange dynamics on stock prices. The associated p-values of our VAR coefficients are obtained from estimating the system equations using OLS techniqueas reported in figure 6. As we can see from figure 5, although, VAR coefficients are difficult to interpret, it however, appears that only lagged value of LSTKP (own effect affect)has significant impact on stock prices. Inflation and exchange rate coefficients are only significant at 10% level.

Vector Autoregression Estimates
Date: 08/31/16 Time: 11:00
Sample (adjusted): 2000M02 2012M12
Included observations: 155 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LSTKP	LINF	LEXR
LSTKP(-1)	0.991230	-0.001711	-0.008849
	(0.01559)	(0.00354)	(0.00346)
	[63.5820]	[-0.48363]	[-2.56093]
LINF(-1)	-0.064488	0.995222	0.019725
	(0.03629)	(0.00824)	(0.00804)
	[-1.77711]	[120.852]	[2.45239]
LEXR(-1)	0.188902	0.007595	0.940772
	(0.10134)	(0.02300)	(0.02246)
	[1.86409]	[0.33024]	[41.8848]
C	-0.550308	0.010331	0.296164
	(0.44046)	(0.09996)	(0.09763)
	[-1.24939]	[0.10335]	[3.03365]
R-squared	0.983725	0.998628	0.984184
Adj. R-squared	0.983402	0.998600	0.983870
Sum sq. resids	0.768625	0.039584	0.037760
S.E. equation	0.071346	0.016191	0.015813
F-statistic	3042.435	36625.48	3132.159
Log likelihood	191.3243	421.2025	424.8593
Akaike AIC	-2.417087	-5.383258	-5.430443
Schwarz SC	-2.338547	-5.304718	-5.351903
Mean dependent	9.952682	4.238444	4.875399
S.D. dependent	0.553787	0.432776	0.124512

Determinant resid covariance (dof adj.)	3.00E-10
Determinant resid covariance	2.77E-10
Log likelihood	1045.638
Akaike information criterion	-13.33726
Schwarz criterion	-13.10164

Figure 5: The estimated unrestricted VAR results with p-values in parenthesis

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System: UNTITLED
Estimation Method: Least Squares
Date: 08/31/16 Time: 11:08
Sample: 2000M02 2012M12
Included observations: 155
Total system (balanced) observations 465

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.991230	0.015590	63.58202	0.0000
C(2)	-0.064488	0.036288	-1.777110	0.0762
C(3)	0.188902	0.101337	1.864092	0.0630
C(4)	-0.550308	0.440462	-1.249387	0.2122
C(5)	-0.001711	0.003538	-0.483627	0.6289
C(6)	0.995222	0.008235	120.8517	0.0000
C(7)	0.007595	0.022997	0.330239	0.7414
C(8)	0.010331	0.099957	0.103353	0.9177
C(9)	-0.008849	0.003455	-2.560933	0.0108
C(10)	0.019725	0.008043	2.452390	0.0146
C(11)	0.940772	0.022461	41.88481	0.0000
C(12)	0.296164	0.097626	3.033648	0.0026

Determinant residual covariance 2.77E-10

Equation: LSTKP = C(1)*LSTKP(-1) + C(2)*LINF(-1) + C(3)*LEXR(-1) + C(4)
Observations: 155

R-squared	0.983725	Mean dependent var	9.952682
Adjusted R-squared	0.983402	S.D. dependent var	0.553787
S.E. of regression	0.071346	Sum squared resid	0.768625
Durbin-Watson stat	1.734154		

Equation: LINF = C(5)*LSTKP(-1) + C(6)*LINF(-1) + C(7)*LEXR(-1) + C(8)
Observations: 155

R-squared	0.998628	Mean dependent var	4.238444
Adjusted R-squared	0.998600	S.D. dependent var	0.432776
S.E. of regression	0.016191	Sum squared resid	0.039584
Durbin-Watson stat	1.759650		

Equation: LEXR = C(9)*LSTKP(-1) + C(10)*LINF(-1) + C(11)*LEXR(-1) + C(12)
Observations: 155

R-squared	0.984184	Mean dependent var	4.875399
Adjusted R-squared	0.983870	S.D. dependent var	0.124512
S.E. of regression	0.015813	Sum squared resid	0.037760
Durbin-Watson stat	1.297042		

Figure 6: VAR system estimation using OLS

4.4.1 The Inverted AR Root Characteristic Polynomial

Figure 7 plots our estimated VAR inverse roots in relation to the unit circle. This plot is used to determine whether VAR coefficients are stable or stability or stationary. The stability requirement is a pre-condition for hypothesis testing and ensures that all VAR roots lie outside the unit circle. If this condition is satisfied, then the estimated VAR coefficients will be evaluated in terms of their statistical/economic significance or policy implications. As figure 7 shows, no VAR root lies outside the unit circle, suggesting that our estimated VAR coefficients are stable. Thus, we can proceed to evaluate the economic significance of our estimated VAR model using the Granger Causality test, the impact response function (IRF) and the forecast error variance decomposition (FEVD).

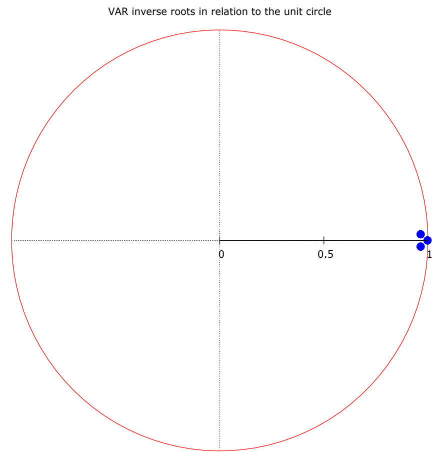

Figure 7: VAR inverse roots in relation to unit circle

4.4.2 Granger Causality/Block Significance Test

Figure 8 shows the results of the VAR Block significance and causality test. This is an F-test which tests thestatistical significance of the estimated coefficients in each of the VAR equations. As this table shows, there is weak evidenceof causality from LINF to LSTKP and from LEXR to LSTKP as the χ^2 statistic is only significant at 10% level for both LINF and LEXR in LSTKP equation. However, the causality from LSTKP to LEXR is significant at 5% level. These results suggest that shocks to exchange rate and inflation slightly affect stock prices in the Nigerian stock market, and both stock market and inflation information largely affectnaira to dollar

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exchange rate movements. Thus, there is unidirectional causality from inflation to stock prices and a feedback causal relations between exchange rate and stock prices. This is in agreement with a number of studies including Granger, Huang and Yang (1998).

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 08/31/16 Time: 11:55
Sample: 2000M01 2012M12
Included observations: 155

Dependent variable: LSTKP

Excluded	Chi-sq	df	Prob.
LINF	3.158120	1	0.0756
LEXR	3.474840	1	0.0623
All	3.582667	2	0.1667

Dependent variable: LINF

Excluded	Chi-sq	df	Prob.
LSTKP	0.233895	1	0.6287
LEXR	0.109058	1	0.7412
All	0.592192	2	0.7437

Dependent variable: LEXR

Excluded	Chi-sq	df	Prob.
LSTKP	6.558377	1	0.0104
LINF	6.014219	1	0.0142
All	7.475738	2	0.0238

Figure 8: Granger causality test

4.4.3 Impulse Response Function

Figure 9 shows the Impulse responses of LSTKP to own shock and shocks to LINF and LEXR. As this figure shows, consistent to the parameter estimates shown in figure 5, stock prices respond negatively to shock to inflation, and positively to own shock and shock to exchange rate, sand these effects do not die down even after 10 months. However, the size of the effect of own shock on stock prices is substantially more than those of inflation and exchange rate.

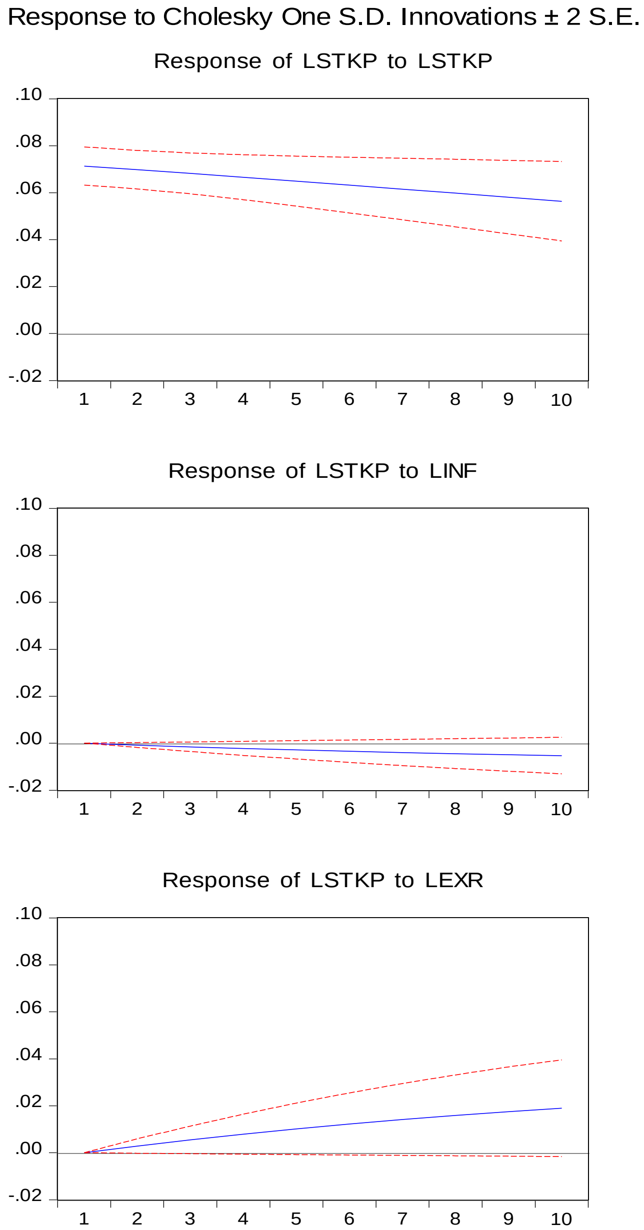

Figure 9: The Impulse response function

4.4.4 Forecast Error Variance Decomposition (FEVD)

Figure 10 shows the forecast error variance decomposition (FEVD) for LSTKP equation of the estimated VAR for 10 periods. As we can see, the major source of variation in LSTKP is own shock as own shock contributes all the variation in LSTKP in the first period, about98% in the seventh period and approximately 96% in the tenth period.

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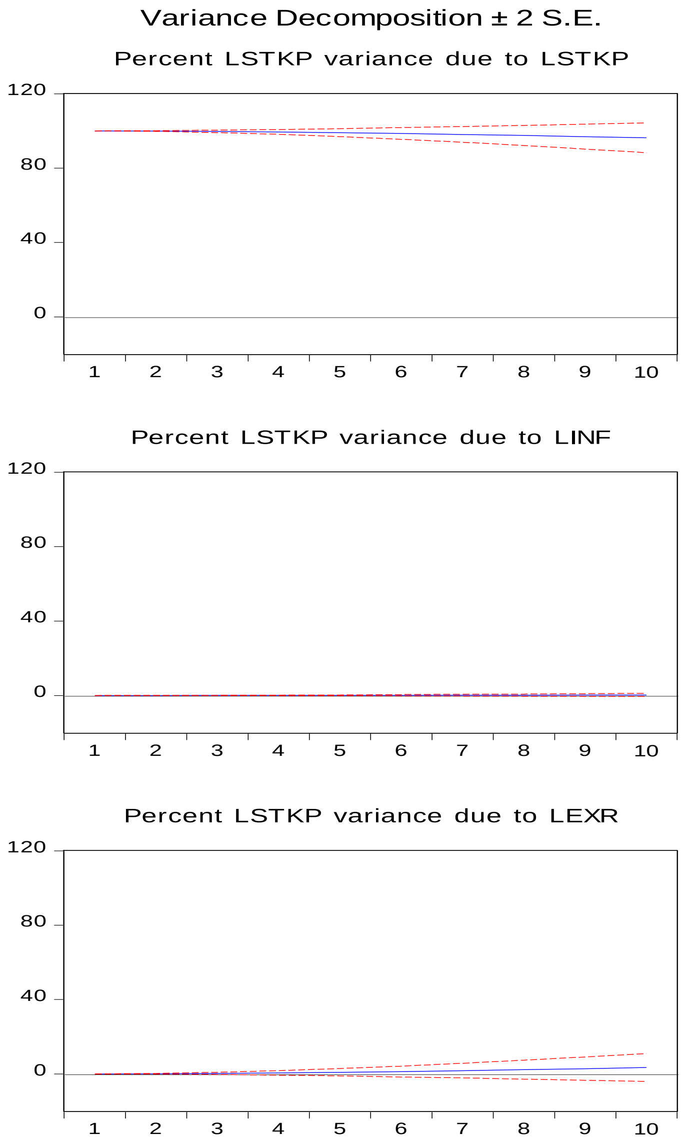

Figure 10: Forecast error variance decomposition

5.0 Conclusion

In this paper, we employ a trivariate VAR to examine the impact of inflation and exchange rate on stock prices. We use monthly data in logarithmic form for the period of 13 years from 2000 to 2012. The main conclusions are as follows:

Although, the stock prices, inflation and exchange rates have the same order of integration, the results of Johansen system cointegration test however, show no evidence of cointegration or long run relationships between these variables. When unrestricted VAR is estimated, the coefficients are found to be stable as no VAR root is found to lie outside the unit circle. The results of the Granger causality test suggest evidence of a unidirectional causality from inflation to stock prices and from inflation to exchange rate, and a feedback causality between exchange rate and stock prices. Although, the causality from inflation to stock prices and from exchange rate to stock prices is significant only at 10% level, there is evidence that both innovations in inflation and exchange rate have contemporaneous effects on stock prices. However, while the effect of inflation is negative, the effect of exchange rate is positive. Finally, the results indicate that own shocks explain most of the variations in stock prices.

We therefore, recommend that Nigerian monetary authorities should continuously moderate inflation given its potentials in exerting negative influences on stock prices. This will help in shaping the pricing behavior of investors in the stock market since unanticipated rise in inflation is a proven source of economic risk.

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