International Journal of Economics, Commerce and Management
United Kingdom Vol. V, Issue 1, January 2017
http://ijecm.co.uk/ ISSN 2348 0386

FORECASTING INFLATION IN NIGERIA: A VECTOR AUTOREGRESSION APPROACH

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Abstract

The major objective of this study is to forecast the future path of inflation and its key determinants in Nigeria. For this, the study employed a Vector Autoregression (VAR) model. The study revealed that the inflation rate (at lag 1) is very significant in giving information about the current and future value of inflation rate in Nigeria. Although the influence of the selected determinants (money supply, fiscal deficit and output) were noted, theirs were not seen to be significant. Thus, Policy option requires that the current inflation rate should be closely monitored, managed and reduced to the barest minimum since the current level of inflation will most likely determine the inflationary trend of the next year.

Keywords: Inflation, Forecasting, Future Path, Vector Autoregression, Nigeria

INTRODUCTION

Inflation has been a constant feature in the Nigerian polity right from its evolution as a Nation State. Specifically, despite all attempts by successive governments through well-formulated policies and programmes to curb inflationary tendencies, Nigeria's inflation rate has been volatile and mostly double digit over the years. Thus, the inflation menace is one of the major and most persistent macroeconomic challenges that has beset the Nigerian economy since the mid 1960s. Inflation, which refers to a sustained rise or general increase in prices of goods and services over a period of time (Inam, 2012), affects individuals, businesses and the government. Generally, inflation is one of the causes of economic retardation, and also it is a major cause of both social and political unrest in many developing economies (Akinbobola, 2012). It is

generally regarded as an important problem to be solved and is often at the top of the political and policy making agendas. To solve the inflation problem, we need to know something about its causes. Furthermore, forecasting the future path of inflation is crucial to the effective planning and implementation of anti-inflation strategies.

There is a paucity of methodologically sound studies directly addressing the forecasting of the future path of inflation in Nigeria. Apart from recent studies by Adebiyi, Adenuga, Abeng, Omanukwe and Ononugbo(2010) and Uko and Nkoro (2012), to mention but a few, empirical studies that adequately forecast the future path of inflation are lacking. This indeed is a research gap and a problem, given the fact that apart from knowing the factors that cause inflation in Nigeria, the relevant authorities must know as precisely as possible, the future path of inflation and key factors that explain it. Moreso, having a reliable information about the future path of inflation and its key determinants is one of the first major steps to tackling the inflation menace in the country, Besides, given that macroeconomic stability is viewed in terms of price stability (Nenbee and Madume, 2011), any step taken towards tackling price instability is definitely in the overall interest of the macroeconomy.

Thus, what is the future path of inflation in Nigeria? This is the underlying question which this study seeks to answer. Thus, the broad objective of this study is to forecast the future path of inflation and key determinants in Nigeria thereby providing a more reliable framework for effective, efficient and goal-oriented actions by relevant authorities if the inflation menace is to be curbed in Nigeria.

This study is very significant in that it will serve as a guide to government authorities for effective planning and implementation of strategies to combat inflationary tendencies. The study will also prove quite useful to students and researchers alike. The paper is divided into five sections, section 1 is the introduction, section 2 contains the literature review while section 3 explains the methodology and the model specification. Section 4 presents and discusses the results. Section 5 embodies the summary, policy recommendations and conclusions of the paper.

LITERATURE REVIEW

Theoretical Literature Review

The literature identifies a number of theories of inflation. These theories are: demand–pull, cost–push, structural, monetary and internationally transmitted inflation (imported inflation). The demand pull theory holds that inflation occurs when the aggregate demand for goods and services exceeds the aggregate supply assuming that the economy is operating at full employment level. Umo (2007) asserts that demand-pull inflation is sparked off by a sustained

increase in aggregate demand in the face of a given level of supply of goods and services in the economy. The theory of cost-push inflation explains rising prices in terms of factors that raise per unit production cost at each level of spending. A per-unit production cost is the average cost of a particular level of output. This average cost is found by dividing the total cost of all resource inputs by the amount of output produced (McConnell and Brue, 2005). Rising prises per unit production cost squeeze profits and reduce the amount of output firms are willing to supply at the existing price level. As a result, the economy's supply of goods and services declines and the price level rises.

The Structuralists view inflation as resulting from the manifestation of basic structural factors which create supply shortages and inadequate government revenue to pay for imports to augment inadequate domestic supply. Structural inflation result from: supply shocks including relative inelasticity of the supply of food; foreign exchange constraints; import substitution industrialization strategy; protective measures; market imperfections; social and political instability, and so forth(Kirkpatrick and Nixson, 1976; Thirwall, 1974; Aghevei and Khan, 1978). The Monetarists are of the view that inflation is always and everywhere a monetary phenomenon; (Friedman, 1968), hence inflation occurs as a result of the fact that money supply increases at a rate greater than the rate of increase in real output. Also, Blanchard (2009) opines that inflation ultimately comes from nominal money growth. The internationally transmitted inflation (imported inflation) results from international trade. Under this theory, three effects are generally identified as channels of imported inflation, viz: price effect (transmitted by internationally traded goods and services), demand effect (by spill-over of excess demand across countries); Liquidity effect (by changes in foreign reserves occasioned by balance of payment adjustments).

Empirical Literature Review

There are a variety of studies that have emerged with sole aim of forecasting inflation. On the foreign scene, Friedman and Kuttner (1992) examined a VAR model to forecast inflation for the United States and also to derive a structural inflation function. Their results indicated that both Narrow Money Supply (MI) and broad Money Supply (M2) are significant in explaining inflation prior to 1980 but were not significant when the data set was extended beyond 1980. Moreso, commercial paper bills was found to be very significant. Sekine (2001) employed a structural model to forecast inflation for Japan and to also derive a structural inflation function. The study found that excess money and output gap are very important in giving good information of inflationary process.

London (1989) employed time series regressions to study 23 African countries and found that exchange rate adjustments and monetary growth are very important in explaining inflationary developments. Agenor (1989) examined the trends of inflation in four African countries and concluded that parallel market exchange rates (as compared to official rates), and monetary expansion, play important role in explaining inflation.

In Nigeria, Adebiyi *et al.* (2010) identified different inflation forecast models such as ARIMA, VAR and VECM to forecast inflation in Nigeria. This study was based on Mordi *et al.* (2007) which developed a variety of inflation forecasting models. Also, Adebiyi *et al.* (2010) found that under core-consumer price index, it is demand shocks that influence CPI while supply shocks influence non-CPI.

Similarly, Uko and Nkoro (2012), examined the relative predictive power of ARIMA, VAR and ECM Models in forecasting inflation in Nigeria. Using annual data spanning 1970 to 2010, the study shows that significant relationship exists between domestic CPI and exchange rate, US-CPI (foreign price) and government expenditure in predicting inflation movements in Nigeria. Hence, in transiting into inflation targeting framework by CBN, these variables must be critically monitored, examined and put into consideration before resorting to any policy option.

Using annual data spanning 1990 to 1998, Mete and Adebayo (2005) examined whether monetary aggregates have useful information for forecasting inflation in Nigeria other than that provided by inflation itself. Employing two approaches: Mean Absolute percentage Errors (MAPEs) and VAR model, the study revealed that the Treasury Bill rate, domestic debt and Broad Money Supply (M2) provide the most important information about price movements. Treasury bill rate provided the best information, because it has the lowest MAPE. The deposit rate, dollar rate and Narrow Money Supply (M1) were found to be the least important variables. M2 was found to provide more information about inflation than M1 in the study period.

Synthesis of Empirical Literature

Empirical literature reviewed on the forecasting of the future path of inflation indicates that exchange rate and money supply are very significant in explaining the inflationary process. Furthermore, different inflation forecast models such as ARIMA, VAR and VECM are very useful in forecasting inflation.

METHODOLOGY

Model Specification

From the theoretical and empirical literature reviewed, this study specifies a model in which inflation is expressed as a function of growth rate of real broad money supply, fiscal deficits,

exchange rate, interest rate, growth rate of real gross domestic product and changes in the price of imports. However, for ease of presentation and explanation, only four of the variables are employed in the VAR model for analysis. The inflation model is specified thus:

$$INF = f(MS_t, FD, ER, IR, PGDP_t, IMP_t) \quad \text{(1)}$$
$$(+) \quad (+) \quad (+) \quad (+) \quad (-) \quad (+)$$

Where:

INF = Inflation rate

MS_t = Growth rate of Real Broad Money Suppy (M_2)

FD = Fiscal Deficit(as a % of GDP)

ER = Exchange Rate

IR = Interest Rate (proxied by prime lending rate)

$PGDP_t$ = Growth rate of Real GDP

IMP_t =Changes in Import Price (proxied by changes in the value of imports)

A Priori Expectations: The figures in parentheses represent a priori expectations about the signs of the coefficients.

Nature and Sources of Data

The series employed are annual observations of inflation rate (INF), real Broad Money Supply, (MS), Fiscal deficits (FD), real Exchange rate (EXR),Interest rate (IR), real Gross Domestic Product (RGDP) and Imports Prices(IMP) for the period 1970-2012. They were obtained from various issues of the Central Bank of Nigeria (CBN) Statistical Bulletin.

Estimation Techniques

Apart from the Unit root tests of stationarity, the study also employed a Vector Auto Regressive (VAR) Model to forecast the future path of inflation in Nigeria. VAR methodology superficially resembles simultaneous equation modeling in that we consider several endogenous variables together. But each endogenous variable is explained by its lagged or past values and the lagged values of all other endogenous variables in the model. Usually, there are no exogenous variables in the model (Gujarati and Porter, 2009). The term auto-regression in the acronym VAR, is due to the appearance of the lagged value of the dependent variable on the right-hand side. The VAR model for this study is stated below and each of the equations in the system was estimated using the ordinary least squares (OLS) method.

$$INF = \alpha \sum_{j=1}^{k} \beta_j INF_{t-j} + \sum_{j=1}^{k} \gamma_j \Delta Z_{t-i} + U_{1t} \quad \text{.....(2)}$$

$$\Delta Z_t = \alpha_1 \sum_{j=1}^{k} \theta_j INF_{t-j} + \sum_{j=1}^{k} \gamma_j \Delta Z_{t-i} + U_{2t} \quad \text{.....(3)}$$

Where:

INF = Inflation Rate

Z = A set of selected variables

α, β_i, α_1, θ_i and γ are parameters

t = time

i and k = lagged period

u = stochastic error term

Δ represents change measured as growth rates.

Equation (2) expresses current inflation as a function of its lagged values and a vector of selected variables (MS_t, FD and $PGDP_t$) that influence inflation. Equation (3) expresses the current value of the vector of selected variables as a function of their lagged values and the lagged values of inflation.

ANALYSIS AND DISCUSSION OF RESULTS

Results of Unit Root Tests

Tables 1 and 2 present the results of the Augmented Dickey Fuller (ADF) and Phillip Peron (PP) Unit root tests for the order of integration of the variables under investigation. The essence of the test is to determine whether the series: Inflation rate (INF); Growth rate of real Broad Money Supply (MS_t); Fiscal deficit (FD); and Growth rate of real Gross Domestic Product ($PGDP_t$); are Stationary (i.e have unit roots) and their order of integration.

Thus, the essence of the test is the null hypothesis of nonstationarity. To reject this, the ADF and PP statistics must be more positive or negative than the critical values and must be significant.

Table 1: Result of unit root tests based on Augmented Dickey-Fuller (constant, time and trend included) E-View 5 output

Variables	ADF Statistic	1% critical level	5% critical level	10% critical level	Order of Integration
INF	-3.414874	-3.600987	-2.935001	-2.605836	I (0)
MS_t	-4.466297	-3.600987	-2.935001	-2.605836	I (0)
FD	-3.853311	-3.600987	-2.935001	-2.605836	I (0)
$PGDP_t$	-6.713883	-3.600987	-2.935001	-2.605836	I (0)

Table 2: Result of unit root tests based on Phillip Perron (constant, time and trend included) E-View 5 output

Variables	PP Statistic	1% critical level	5% critical level	10% critical level	Order of Integration
INF	-3.283566	-3.600987	-2.935001	-2.605836	I (0)
MS_t	-4.350954	-3.600987	-2.935001	-2.605836	I (0)
FD	-4.016259	-3.600987	-2.935001	-2.605836	I (0)
$PGDP_t$	-6.876119	-3.600987	-2.935001	-2.605836	I (0)

Notes;

1) *Variables: The acronyms for variables are as earlier defined in section 3.3 under model specification.*
2) *The test was performed with trend and intercept and the critical values of the test are – at 1%, 5% and 10% levels of significance respectively*
3) *Order (0) and order (1) indicate stationarity of the various variables at level and at first difference respectively*
4) *The Ho is that series is non –stationary against alternative hypothesis H_1 of a series being stationary. The rejection of the Ho for the ADF and PP tests are based on the Mackinnon critical values. Lag lengths were determined in accordance with the SIC.*

After comparing the test statistic value against the Mackinnon critical value at 5% level of significance, it was noticed all the variables in the two tests employed, that is ADF and PP were stationary at levels. The results of both the ADF and PP test show that INF, MS_t, FD, $PGDP_t$ were stationary at levels.

Forecasting of the Future Path of Inflation and Some Macroeconomic Variables (Money Supply, Fiscal Deficit and Growth rate of Real GDP)

This section focuses on the forecasting of the future path of inflation and the variables that have with inflation. For this purpose, equations (2) and (3) were specified and Vector Auto Regressive (VAR) methodology was used to estimate the equations.

Before estimating equations (2) and (3), we have to decide on the maximum Lag length, K. This is an empirical question. We have 42 observations in all. Including too many lagged terms will consume degrees of freedom, not to mention introducing the possibility of multicollinearity. Including two few lags will lead to specification errors. One way of deciding this question is to use a criterion like the Akaike or Schwarz and choose that model that gives the lowest values of these criteria (Gujarati and Porter, 2009).

Using E-views 5, we obtained the VAR Lag Order selection criteria. The endogenous variable is the Inflation rate (INF) while the exogenous variables are: growth rate of real broad Money supply (MS_t), Fiscal deficit (FD) and growth rate of Real Output ($PGDP_t$). The result of the E-views lag order selection is presented in Table 3.

Table 3. VAR lag order selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: INF
Exogenous variables: C MST FD PGDPT
Sample: 1970 2011
Included observations: 38

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-161.6779	NA	358.8111	8.719890	8.892268	8.781221
1	-154.2801	12.84877*	256.4216*	8.383165*	8.598637*	8.459829*
2	-153.4530	1.393017	259.0581	8.392265	8.650831	8.484261
3	-153.0999	0.576112	268.4567	8.426313	8.727973	8.533641
4	-153.0862	0.021753	283.3643	8.478219	8.822974	8.600880

* 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

From table 3, the maximum lag length selected for the purpose of VAR estimation is lag order 4. And the optimal lag length is lag order 1. Lag order 1 is selected as the optimal lag length because it has the lowest values of LR, FPE, AIC, SC and HQ. Thus, it is the most preferable and is used in the VAR estimation. Table 4 presents the Vector Autoregression estimates computed by the author using E-views.

Table 4: Vector Autoregression estimates based on 1 lag

Vector Autoregression Estimates
Sample (adjusted): 1971 2011
Included observations: 41 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	INF	FD	MST	PGDPT
INF(-1)	0.505309	-2.11E-17	-1.69E-16	2.53E-16
	(0.13297)	(4.4E-17)	(2.1E-16)	(6.8E-16)
	[3.80007]	[-0.48054]	[-0.81929]	[0.37002]
FD(-1)	-0.807469	-2.01E-16	1.51E-15	8.04E-16
	(0.49490)	(1.6E-16)	(7.7E-16)	(2.5E-15)
	[-1.63157]	[-1.22916]	[1.96463]	[0.31548]
MST(-1)	0.191634	2.21E-16	-7.24E-16	-1.63E-15
	(0.13700)	(4.5E-17)	(2.1E-16)	(7.1E-16)
	[1.39874]	[4.87535]	[-3.41006]	[-2.31016]
PGDPT(-1)	-0.017883	-3.08E-18	-5.24E-17	-1.46E-17
	(0.02612)	(8.6E-18)	(4.0E-17)	(1.3E-16)
	[-0.68463]	[-0.35731]	[-1.29450]	[-0.10890]
C	-2.413792	-6.74E-15	3.88E-14	2.67E-14
	(5.74412)	(1.9E-15)	(8.9E-15)	(3.0E-14)
	[-0.42022]	[-3.55516]	[4.35864]	[0.90224]
FD	-0.089683	1.000000	-1.53E-15	0.000000
	(0.50251)	(1.7E-16)	(7.8E-16)	(2.6E-15)
	[-0.17847]	[6.0e+15]	[-1.95881]	[0.00000]

Table 4...

MST	0.155527	-4.38E-17	1.000000	1.36E-16
	(0.13833)	(4.6E-17)	(2.1E-16)	(7.1E-16)
	[1.12435]	[-0.95896]	[4.7e+15]	[0.19121]
PGDPT	0.010249	-3.05E-18	2.44E-17	1.000000
	(0.02622)	(8.7E-18)	(4.1E-17)	(1.3E-16)
	[0.39094]	[-0.35213]	[0.60036]	[7.4e+15]
R-squared	0.447572	1.000000	1.000000	1.000000
Adj. R-squared	0.330390	1.000000	1.000000	1.000000
Sum sq. resids	6766.936	7.38E-28	1.62E-26	1.79E-25
S.E. equation	14.31987	4.73E-15	2.22E-14	7.37E-14
F-statistic	3.819471	7.28E+30	3.82E+30	8.55E+30
Log likelihood	-162.8542			
Akaike AIC	8.334353			
Schwarz SC	8.668708			
Mean dependent	19.88439	-3.471951	26.45244	24.58585
S.D. dependent	17.49960	5.337307	18.13344	90.15476

Determinant resid covariance (dof adj.)	7.00E-81
Determinant resid covariance	2.94E-81
Log likelihood	3568.650
Akaike information criterion	-172.5195
Schwarz criterion	-171.1821

In analyzing the vector autoregression estimates presented in Table 4, we used the information on the values of the t-statistics to decide on whether a parameter estimate is statistically significant or not. The t-test is a test of significance used to test the significance of Regression coefficients. A test of significance is a procedure by which sample results are used to verify the truth or falsity of a null hypothesis (Gujarati and Porter, 2009).

The null hypothesis for the t-test is that the parameter estimate or the regression coefficient is not statistically significant. The decision rule is that we accept the null hypothesis if the table value of t is greater than the computed t-value. We also reject the null hypothesis if the tabulated t-value is less than the calculated t-value. However, in this study we applied the rule of thumb that the null hypothesis would be rejected if the computed t-value is greater than 2.0 in absolute terms (Gujarati and Porter, 2009).

It is also pertinent to note that each column of Table 4 represents a particular regression. Thus, we have these regressions in the following order: Inflation (INF) equation, Fiscal Deficit (FD) equation, Money Supply (MSt) equation and Output (PGDPt) equation. Let us now identify the variables that have statistically significant coefficients in the different regressions.

From the INF equation, the only variable that has a statistically significant coefficient is INF (at lag 1). This implies that this variable is important in explaining the future path of inflation rate. In other words, the one-year past value of inflation rate has enormous implications and influence on the future value of inflation rate and thus can be used in predicting inflation.

From the FD regression, the variables that have statistically significant coefficients are: MSt (at lag 1) and current year FD. In other words the past one year value of growth rate of real broad money supply (MSt) and the current year value of Fiscal Deficit (as a % of GDP) are very important in explaining the future path of fiscal deficit. By implication, these variables influence to a great extent, the future value of FD.

From the MSt regression, the variables that have statistically significant variables are: MSt (at lag 1) and current year MSt. By implication, the past one year value of MSt and current year value of MSt are important in explaining the future path of growth rate of real broad money supply.

From the PGDPt regression, the statistically significant coefficients are those of MSt (at lag 1) and current year PGDPt. In other words, the past one year value of MSt and current year value of PGDPt are very important in explaining the future path of PGDPt.

Therefore, from the outlook of the autoregression estimates, we observe that the most important variable that can be used to forecast the future path of inflation is the past one year value of inflation rate. Although the other variables in the inflation regression exert some level of influence, their influence is not significant, rather it is the influence of the INF (at lag 1) that is statistically significant in addition to being positive. This influence is such that, for every unit increase in the past one year value of inflation rate, the inflation rate will increase by 0.51 units. Likewise, for every unit decrease in the past one year value of inflation rate, the inflation rate will decrease by 0.51 units. This result is a great departure from the findings of Uko and Nkoro (2012) and Mete and Adebayo (2005).

CONCLUSION AND POLICY RECOMMENDATIONS

The major thrust of this study is to forecast the future path of inflation and key determinants in Nigeria. The study employed a Vector Autoregression (VAR) model. From the findings of this study, the policy implications can be easily discerned. The study revealed that the inflation rate (at lag 1) is very significant in giving information about the current and future value of inflation

rate in Nigeria. Although the influence of the selected determinant variables were noted, theirs were not seen to be significant. Thus, Policy option requires that the current inflation rate should be closely monitored, managed and reduced to the barest minimum since the current level of inflation will most likely determine the inflationary trend of the next year. Indeed, going by the structural, monetary and balance of payment underpinnings of the inflationary process in Nigeria, a comprehensive policy approach should be adopted to maintain the inflation rate at single digit since its current rate is bound to determine the next year's rate. It is pertinent to note that high inflationary levels impacts negatively on the standard of living or social welfare of a greater percentage of the citizenry as well as on all aspects of the society. Therefore, it is quite expedient that government policies begin to adopt the inflation-targeting stance: the ultimate aim and approach of every government policy should be to stabilize the price level.

However, at this juncture, it is important to caution that, the 0.51 units forecast value of the inflation rate in Nigeria may not always hold true in all situations. This is because of the institutional and structural factors that are inherent in any developing economy. Thus, this serves as an impetus for more research now and in the future specifically in the area of employing other forecasting methods and determining which of them offers a more reliable forecast of the future path of inflation in Nigeria.

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