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Error Correction Model Analysis of Determinants of Inflation in Nigeria (1970-2013)

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Abstract
The research study examined the "Error correction model analysis of determinants inflation rate in Nigeria'', for the period 1970 - 2013, employing the Error Correction Technique of econometric analysis. The data were sourced from the Central Bank of Nigeria statistical bulletin of various years. The test of both the Unit root and co-integration revealed that there is a long relationship between the variables while the Granger Causality test revealed an un-directional relation between the variables and inflation. However, the VECM test revealed that inflation, Gross Domestic Product (GDP) and exchange rate are negatively related and positively related to broad money supply (M_2) and domestic credit. The study is of the recommendation that Central Bank of Nigeria should balance its control instruments to achieve macroeconomic stabilization and development, money supply should be controlled to ensure high employment, interest rates should be liberalized to control price and output movement and the policy measures should be designed in a way that enhances the attainment of the macro-economic objectives.
Keywords: Error Correction Model, Determinants, Inflation, Nigeria

Introduction

In Nigeria, there have been several studies for various time periods on the causes of inflation. Oyejide (1972) made empirical enquiry into the impact of deficit financing on inflation and capital formation. He related domestic money supply to inflation using fisher's type of equation. There exist a direct correlation between general price level and measures of deficit financing, he concluded that less emphasis on deficit financing may limit the growth or price inflation. Emmanuel (2000) examined the impact of monetary policies on inflation in Nigeria, the findings revealed that exchange rate and M2 had a negative impact on inflation, however, while exchange rate was significant in explaining inflation for the period, M2 was not. On the other hand, both domestic credit and gross domestic product were positively significant in explaining inflation Nigeria.

Bagunjoko (1997) investigates the efficacy of monetary policy as a stabilization tool, using modified St. Louis model to take account of the peculiarity of the Nigeria economy and found that money matters in Nigeria economy and the appropriate monetary target is the domestic credit of the banking sector. Ajisafe and Folorunfo (2002) tested the relative effectiveness of monetary policy and fiscal policy exerts a greater impact on economic activity in Nigeria and concluded that emphasis on fiscal action by government had led to greater distortion in the Nigeria economy. Folawemo and Osinubi (2006) examined the efficacy of monetary policy in controlling inflation and exchange rates instability and showed the effects of monetary policy at influencing the finance of government fiscal deficit through the determination of the inflation and tax rates affect both the inflation and exchange rate, hereby casing volatility in the rates.

Chimobi and Uche (2010) examined the relationship between money, inflation and output in Nigeria and discovered monetary stability can contribute towards price stability in Nigeria. Akinnifessi (1984), conclude that factors such as changes in money supply, lagged changes in money supply, credit to government by the banking system, government deficit expenditure industrial production and 'food' price indices were variables captured explained inflationary tendencies in Nigeria and however, emphasized that increases in government expenditure financed by monetization of oil revenue and credit from the banking system were responsible for the expansion of money supply, which in turn, with a lagged in-effect contributed immensely to inflationary tendencies. Adeyeye and Fakiyesi (1980) estimated and tested the hypothesis that the main factor responsible for instability of prices and inflationary tendencies in Nigeria has been government expenditure and is linearly related to the rate of growth of money stock, government expenditure especially deficit and growth if government revenue especially monetization of foreign exchange from oil exports, there will be significant positive relationship between inflation rate and growth in bank credit, growth of money supply and growth in government expenditure while the relationship with growth of government revenue was uncertain.

Asogu (1991) used ten different specifications that covered monetary, structural and open economy aspects of

inflation. The results showed that changes in real income were significant and had an inverse relationship with the rate of inflation and domestic credit was not significant while government expenditure even though statistically significant had the wrong sign and concluded that real output especially industrial output, net export current supply, domestic food prices and exchange rate changes were the major determinants of inflation in Nigeria. Finally Enoma (2011), examined the impact of exchange rate on inflation in Nigeria and discovered that rate of depreciation of exchange rate, money supply and real GDP are the main determinant of inflation and recommend that exchange rate depreciation increase inflation, but should not be potent measure of controlling inflation. It should be complemented with other macroeconomics variables to stabilize the volatile inflationary rate.

Objective of the Study

The main objective of this study is to determine how error correction model are sued to analyze the determinants of inflation in Nigeria. However, the specific objectives of the study are:

(1) To analyze and explain the causes and dynamics of inflation in Nigeria since 1970.

(2) To examine the effect of determinants of inflation in Nigeria.

Research Questions

From the objective of the study, one can deduce the following research questions:

(1) What are the causes and dynamics of inflation in Nigeria?

(2) What are the effects of the determinants on inflation in Nigeria?

Hypothesis of the Study

Following from the objectives, we make the following hypothesis

H_o: The determinants have no significant impact in inflation in Nigeria

H_1: The determinants have a significant impact in inflation in Nigeria

Theoretical Framework

The theoretical underpinning of this work is centered on the quantity theory of money as advanced by Friedman. According to Friedman, (1976) the earliest theory regarding the determination of price level and changes in price level is the quantity theory of money. This theory in its simplest form postulates a direct proportional relationship between money supply and price level. According to the theory, if money supply were doubled, prices would increase proportionately. However, apart from money supply, other monetary policy variables that affect inflation are exchange rate and real Gross Domestic Product (Osakwe 1983, Adeyokumu 1982 and Sanyo (2000). In the model specified by Sanyo (2000), money supply, exchange rate and real Gross Domestic Product were the variables that have impact on inflation.

Model Specification

The model adopted in this study is a general specification type drawing from the literature on inflation in Nigeria. Hence, the model is based on the assumption that changes in price level depend on growth in real income, money supply, and exchange rate. Other factors include growth in domestic credit and government expenditure. Thus:

$$PF=f(RY, MS, EXR, DC, GEX) \text{ ----------1}$$

Where,

PF= inflation rate,

RY=real income growth,

MS=aggregate money supply growth rate

MXR=nominal exchange rate (US $/N)

DC=domestic credit growth rate,

GEX=growth in government expenditure

The linearized version of equation 1 in natural log form is given as:

$$InPF=a_0+a_1InRY+a_2InMS+a_3InEXR+a_4InDC+a_5InGEX+Ui\text{-------2}$$

The error-correction specification incorporating the long run equilibrium relationship and short-run dynamics for the model is given as:

$$InPF=d_0+d_1InRY+d_2InMS+d_3InEXR+d_4InDC+d_5InGEX+d_6InPF\text{-}1+d_7U\text{-}1+ei\text{---}3$$

Method of Analysis

Data collected for the study will be analyzed using the econometric analytical method. It is important to note that conventional regression analysis with time series data is conducted under the implicit assumption that the variables present in the regression are stationary over time. It has been pointed out in several studies that most economic time series data are not stationary over time, particularly in their levels, while their differences (first or second) are usual stationary (Pyndyck and Rubenfeld 1995). This is justifiable since the studies in empirical macroeconomics almost always involve trend variables and as such the variables employed in this study which includes GDP, money supply, exchange rate, domestic credit , inflation are always non stationary and trending (Greene, 2004). Thus, Ordinary regression analysis is only meaningful when applied to stationary data. However, the ordinary least square is advantageous because of its BLU property, i.e. the best, linear,

unbiased estimator .If the two different series are non-stationary individually, but are co integrated among the variables, we can, however, apply a Vector Error correction Mechanism (VECM) which will enable us to link the long run and short run relationships involved. Another justification for adopting the co integration technique with its implied (VECM) is that it has certain advantages over the traditional partial adjustment model that is, it is central to econometric modeling of integrated variable data consistency will be achieved given that the variables (GDP, money supply, exchange rate, interest rate, inflation used in the study are integrated of the same order, information is greatly enhanced sine both the short-run changes in the variables used in the research and the long-run relationship will be included in the VECM specification and the log in VECM is not as restrictive as the traditional model (Oluranti, 1996).

Analysis of the Vector Error Correction Model Estimation

Under this analysis (VECM) we are not interpreting the coefficients of the variables, (this is because in VAR and VECM the interest truly is not on the coefficients of the variables) rather, we are interested on the impulse response and the variance decomposition of the variables, though the result of the estimation of VECM is presented in table 4.5 below. Again, our interest here is how inflation has responded to the impulse of the monetary policy variables (broad money supply, exchange rate and interest rate and gross domestic product) selected for this study.

The result in the table show that apart from the response of inflation rate to its impulse, other monetary instrument show no impulse to inflation at the current period, all the response of inflation rate were seen in lag 1 period. The following impulse – response graph showed more clearer pictures of the relationship of inflation rate and other monetary policy instruments. It shows that inflation is negatively related with gross domestic product and exchange rate, and positively related with broad money supply and domestic credit. In the variance decomposition result is carried out. The result shows higher decomposition rate in all the variables except between log of gross domestic product,

Interpretation of Result

In the first test carried out, all the variables were tested and found to be stationary at their first differences. This can be seen from the values obtained. From the test statistics which were greater than that of the critical values at 5% significant level. In the second test carried in the granger causality test carried out it was found that inflation has a unidirectional causality with the Domestic credit and also, all the variables put together granger cause one another. Finally, in the VECM test, where the impulse responses and variance decomposition of the variables were determined, it was revealed that while inflation was positively related to the domestic credit and money supply it was negatively related to real Gross Domestic Product and Exchange rate. This is in line with Sanyo (2000) findings.

Discussion of Findings

Money supply, lag of exchange rate and government expenditure as admitted are positively associated with inflation in Nigeria. The most profound impact is recorded by contemporaneous exchange rate variable. The inflation rate rises as contemporaneous government expenditure rises. These results are consistent with economic theory, which posits the existence of a positive relationship between money supply, exchange rate and government expenditure on one hand and the rate of inflation on the other hand.

The exchange rate in Nigeria has been depreciating over the years and it has exerted a positive impact on the rate of inflation in the economy. The reason is apparent given the import dependence of productive units; especially in the industrial sector .A depreciating exchange rate in this instance has implications for cost of production and cost of finished goods in the market. The findings suggest that it takes some time for its effect to manifest in the rate of inflation.

Government expenditure is found to be positively associated with price inflation in Nigeria. Again this conforms to the position of economic theory. This is in line with findings from various empirical results .Domestic credit in Nigeria did not meet the behavioral expectation because of the structural and administrative problems involved in domestic credit policies in Nigeria.

Conclusion

This study assessed the determinants of inflation in Nigeria. This analysis is done using Vector Error Correction Model (VECM) estimate which is anchored on the use of monetary policy that is targeted towards the achievement of full-employment equilibrium, rapid economic growth, price stability, and external balance. And finally the study revealed that inflation affects volatility of its own rate as well as the rate of real exchange.

Policy Recommendation

Based on the findings of this study, the researcher recommends the following that:

1. The cost of inflation-focused monetary regimes should be checked, more than anything else. The cost of inflation-focused monetary regimes is to divert the attention of the some of the most highly trained and skilled economists and policy makers in Nigeria away from the tasks that previous generations of central bank took for granted as being their main job: to help this country develop, to create jobs, and to foster socially productive economic growth.

2. It is always crucial for central banks to balance their control instruments with the crucial task of macroeconomic stabilization. Otherwise both stabilization and development will be lost.
3. We have shown that in the short run, control of money supply may cause the attractor of actual unemployment because reducing inflation rate in any economy is also reducing employment due to the tradeoff between inflation and employment. If these conditions are not met, control of money supply and inflationary monetary policies may, under certain conditions, be unable to adjust the economy to the stable inflation equilibrium in the short run, but we have argued that these adjustment capacities may be asymmetric, and sometimes these monetary policies may be even be counterproductive.
4. To control inflation, there should be control of money supply by way of reducing government fiscal budgeting and society need to be sanitized ensuring fiscal discipline.
5. Also, government should stimulate the productive capacity of the economy especially the agricultural sector to increase food production so that prices will come down and consequently reduce inflation.

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Table1

Table4. 1: Unit Root Test Statistics

Variables	ADF*	Variables	ADF**
InPF	-4.0138	DInPF	-5.9150
InRY	-2.0318	DInRY	-3.6542
InMS	-3.1632	DInMS	-5.0721
InEXR	-2.2550	DInEXR	-3.7683
InDC	-2.3041	DInDC	-4.6663
InGEX	-1.8166	DInGEX	-3.7443

Source: Author's Computation
*95% critical value=-3.5671
**95% critical value=-3.5731

Table 2

Table4. 2: Co integration Test Statistics

Null	Alternative	Test Stat.(Max)	95% Critical	Test Stat(Trace)	95% Critical
r≤0	r=1	47.8971	43.6100	172.6574	115.8500
r≤1	r=2	41.2230	37.8600	124.7603	87.1700
r≤2	r=3	29.0549	31.7900	83.5450	63.0000
r≤3	r=4	22.8246	25.4200	54.4891	42.3400
r≤4	r=5	16.7373	19.2200	31.6645	25.7700
r≤5	r=6	14.9232	12.3900	14.9292	12.3900

Source: Author's Computation

Table 3

Table 4.3: Granger Causality Wald Test result

Equation	Excluded	chi2	Df	Prob > chi2
LogPF	LogRY	1.2335	1	0.269
"	LogM2	1.5974	1	0.207
"	LogEXR	0.03242	1	0.858
"	LogDC	2.7797	1	0.095
"	ALL	9.8346	4	0.043
LogRY	LogPF	1.714	1	0.190
"	LogM2	0.3232	1	0.570
"	LogEXR	0.52367	1	0.470
"	LogDC	2.6225	1	0.105
"	ALL	6.3189	4	0.177
LogM2	LogPF	4.0e-05	1	0.995
"	LogRY	1.7267	1	0.190
"	LogEXR	0.02714	1	0.864
"	LogDC	0.54706	1	0.460
"	ALL	2.3019	4	0.681
EXR	LogPF	0.77881	1	0.379
"	LogRY	0.78522	1	0.379
"	LogM2	0.0993	1	0.756
"	LogEXR	0.70443	1	0.403
"	ALL	6.6369	4	0.156
DC	LogPF	0.96605	1	0.326
"	LogRY	4.6251	1	0.031
"	LogM2	6.0114	1	0.014
"	LogEXR	0.11568	1	0.735
"	ALL	10.077	4	0.040

Source: The Author's computation

Table 4

Table 4.4: Vector error-correction model (VECM)						
Sample: 1961 – 2013		No. of obs = 52				
Log likelihood = -200.6244		AIC = 8.768178				
Det(Sigma_ml) = .0024772		HQIC = 8.96225				
		SBIC = 9.340698				
Equation	**Parms**	**RMSE**	**R-sq**	**chi2**	**P>chi2**	
D_logpf	2	.611296	0.5343	36.65695	0.0000	
D_logry	2	.183194	0.6242	51.74302	0.0000	
D_logm2	2	.065547	0.7079	113.9618	0.0000	
D_exr	2	11.433	0.0933	4.670816	0.2132	
D_dc	2	2.93313	0.0413	1.818217	0.5620	
	Coef.	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
D_logpf						
_ce1						
L1.	-.9028078	.1603376	-6.01	0.000	-1.197464	-.6081515
_cons	-.7903561	.1618048	-5.21	0.000	-1.087888	-.4928241
D_logry						
_ce1						
L1.	.035712	.0238737	1.08	0.281	-.0210796	.0825037
_cons	.1052912	.0241067	4.37	0.000	.058043	.1625395
D_logm2						
_ce1						
L1.	-.0042686	.0188969	-0.24	0.812	-.0357379	.0315006
_cons	.0900359	.0162735	4.93	0.000	.05652205	.1278513
D_exr						
_ce1						
L1.	-2.73044	3.299928	-0.84	0.399	-9.253784	3.681696
_cons	.5584599	3.3032133	0.17	0.867	-5.9728	7.08892
D_dc						
_ce1						
L1.	.832453	.7554001	1.13	0.271	-.6473033	2.392209
_cons	.9685611	.7849674	1.23	0.269	-.5730268	2.496149

Table 5

Table 4.5: Impulse – Response Functions

Step	(1) Irf	(2) irf	(3) irf	(4) Irf	(5) irf
0	1	0	0	0	0
1	-0.097192	-0.171137	0.404853	-0.003968	0.017287

(1) Irf name =order 1,Impulse=Log Inf and response=log Inf.
(2) Irf name =order1,Impulse=Log Gdp ,and response=Log Inf
(3) Irf name=order1,impulse=Logm2,and response=Log Inf
(4) Irf name=order1,impulse=Exr and response=Log Inf
(5) Irf name=order1,Impulse=DC,and response=Log Inf.

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