Journal of Economics Library

www.kspjournals.org

Volume 5 September 2018 Issue 3

Modelling dynamics of inflation in Nigeria

By Olatunji A. SHOBANDE [a†] & Lanre R. IBRAHIM [b]

Abstract. The study was motivated by the pervasively increasing inflation rate which has for the past 3 decades embattled and inhibited the potential growth of the Nigeria economy coupled with the fact that empirical studies on modeling the trend and behavior of inflation dynamics have remained largely neglected or scarcely researched. Hence, the pertinent concern of this paper is to model the dynamics of inflationary expectation in Nigeria by applying autoregressive distributed lag (ARDL) cointegration framework, Error Correction model, Ordinary Least Square methods and a host of diagnostic tests on time series (secondary) data, covering 1980 to 2015. While the empirical results expedite a cointegrated and stable long-run relationship between the variable of interests when price level is the dependent variable, money supply, interest rates, fiscal deficit to GDP and international oil price shock are found to be statistically significant in explaining the dynamics of inflation in Nigeria both in the long run and short run. Consequently, the study recommends the need for implementation of strategic diversification policy to reduce the vulnerability of the economy to oil price shock both locally and internationally and also, that the government and policymakers need to swing into urgent action in initiating fiscal policy that will further enhance stabilization of the country's exchange rate and raise the value of the Naira.

Keywords. Exchange rate, Industrialization, Export, Inflation.

JEL. L00, L16, F31.

1. Introduction

The specification, estimation, and testing of the dynamics of inflationary expectation in Nigeria have generated a lot of interest and intense debate among scholars and policymakers in recent times. At theoretical sphere, two strong kinds of literature exist in providing an explanation of the inflationary process. The first strand is the monetarist that suggests that inflation is a purely monetary phenomenon in two ways. The first is to control average prices, in other to stabilize the value of the domestic currency, the second is to moderate fluctuation in the path of domestic output relative to its trend rate of growth, by judiciously tightening and loosening the stance of monetary as circumstances dictate (Adam, 2008, Blanchard *et al.,* 2015). The second holds that inflationary expectation results from the fiscal operation and from the gap between potential output and aggregate demand.

While most empirical studies have followed the dichotomization with slight modification with a different application in providing evidence in their countries of studies, a study by Oyejide (1972) constitutes a pioneering attempt at providing an explanation of the causes of inflation in Nigeria, most especially from the structural

[a†] Department of Economics, Faculty of Social Sciences, University of Lagos, Akoka, Yaba, Lagos, Nigeria.

☎. +2348032712230

✉. olatunji.shobande@yahoo.com

[b] Department of Economics, Faculty of Social Sciences, University of Lagos, Akoka, Yaba, Lagos, Nigeria.

☎. +238026995957

✉. lanrid23@gmail.com

perspective. Specifically, he examines the impact of deficit financing in propagating the inflation process and came to the conclusion that there was a strong positive relationship between inflation and all measures of deficit financing during the period. Ajakaiye (2008) found more commitment to inflation targeting as an overriding objective with the model of predicting future inflation and operational procedure for adjusting monetary policy instrument in case forecast inflation differ from its targets. O'Connell (2008) found that inflation targeting in Nigeria is explained by fortunes at the international oil markets and lack of fiscal discipline among the government institutions.

While an elegant, sophisticated and comprehensive model has emerged to answer a number of policy questions with clear focus on the essence of keeping a low inflation and enhancing stability even when the long run growth is not guaranteed (Nellor, 2008), notable effort by Bechamann, *et al.,* (2015), Ichuie & Nishiguchi (2015), D'Acunto *et al.,* (2015), Duca, Kenny & Reuter (2016) have emphasised the stabilisation role of inflation expectation at lower bounded rate. Despite this phenomenal growth in the research effort, empirical relationship on inflation expectation modeling still remain scarce and what studies exist brought forward is more conflicting conclusions with respect to nature, direction and methodologies used in addressing the phenomenon (see Duca, Kenny, & Reuter, 2016). Possibly, the standard procedure sees in some studies using survey data measure of expected inflation from past experience without rigorous research effort, must have contributed to these dismal conclusions observed Bachmann, *et al.,* (2015).

Our contention in this paper is that these procedures are often inadequate and that alternative econometric method exists using the autoregressive distributed lag (ARDL) model which have begun to attract research attention in the last few years. We argued that the use of the past change in price to generate expected inflation is intuitively misleading and may not have importantly influenced the new price formation since there is possibility for agent to use all information at its disposal to make expected inflation given it financial status and economic circumstances, rather than been adaptive expectation in nature.

The pertinent concern of this paper is to model the dynamics of inflationary expectation in Nigeria. The paper inquires whether an understanding of change in price and macroeconomic stability matter when sustainable and inclusive long-term growth requires getting relative prices right which is fundamentally a general equilibrium problem over which monetary policy has little or no leverage? While a number of interesting variables have emerged to test various hypotheses to prescribe strategies for proper monetary policy formation, this paper hopes to contribute to the existing literature on macro-econometric modeling by analyzing the three dimensions in the Nigeria context. First, we provide some background evidence on the factor guiding the choice of monetary regimes and show how this moved the recent theoretical and policy debates in the direction of inflation targeting. We analyze the main sources of fluctuation in inflation and build a macro-econometric model that adequately explain the inflationary process in Nigeria. Our study is motivated by a potential serious caution provided by Blanchard (2005) who studies the behavior of inflation targeting when fiscal dominance prevails and conventional transmission of interest rate to aggregate demand is missing. In his analysis, a rise in the real interest rate produce capital flows and a real depreciation; will lead to deteriorating the fiscal account and provoking an increase in the default risk premium on government debt, rather than appreciation in domestic currency (Buffies, 2003, Buffies *et al.,* 2008 and Blanchard *et al.,* 2015).

The major inference that can be drawn from our analysis is that there is a strong relationship between future price level and current purchasing decisions. The implication is that putting expected inflation under control requires that the fiscal position of the government must be aligned with monetary objectives, while the effort of the Central bank to strengthen its analytical capacity to improve forecasting and understanding the transmission mechanism, combines with moves to improve communication strategy are appropriate complements. As expected, international oil prices were found to be significant in influencing inflation, suggesting a big challenge as the economy might be exposed to exogenous shock with greater fiscal consequences. As a measure, the fiscal rule is suggested.

The remaining part of this paper is broken into four segments. Following is the theoretical framework, modeling and methodological approaches. Results of the study are presented and discussed in part 3 while section 4 contains the conclusion including policy suggestions.

2. Theoretical architecture and modelling ideology

According to mainstream economic theory, under sticky nominal interest rates, an increase in inflation expectation should possibly lower real interest rates (due to the so-called Fisher Effects) and as a result boost consumption or aggregate demand by discouraging incentives to save in favor of investment (Blanchard, 2005). In Nigeria, when the interest rate is controlled from below, this relationship becomes more prominent as apex banks are deprived of the use of their main conventional policy instrument (short-term interest rate) in the face of an additional mandate.

Our data dictate our modeling strategy. Our model originates from both the aggregate demand and supply framework from our earlier understanding of AD-AS relations. Specifically, the supply side is captured by the tradable sector whereas the demand side represented by non-tradable sectors. The price of non-tradable goods responds to disequilibrium in the money market and the price of traded goods is governed by the movements in the exchange rate and foreign prices. The overall price level (P) is a weighted average of price of tradable which is the sum of P_T and P_N with φ representing the share of tradable goods in the total expenditure. Thus, the price index is:

$$P = XP_T{}^{\varphi} P_N{}^{1-\varphi} 0 < \varphi < 1 \quad (1)$$

Where X is the nominal exchange rate. We re-write equation (1) as:

$$P = X\frac{P_T{}^{\varphi}}{P_N{}^{\varphi}} P_N = x^{\varphi} P_N \quad (2)$$

Where $x^{\varphi} = \frac{P_T{}^{\varphi}}{P_N{}^{\varphi}}$ and x is the real exchange rate. It implies that:

$$P_N = P_{Nf}{}^{\delta} P_{No}{}^{1-\delta} \quad (3)$$

Expressed equation (3) in linear form using logarithm, where, $logP_{No}$ and $logP_{Nf}$ denote p_{No} and p_{Nf} respectively).

$$p_N = \delta p_{Nf} + (1-\delta)p_{No} \quad (4)$$

Where P_{Nf} and P_{No} are price of non-traded food and other goods respectively. Substituting equation (3) into (2) gives

$$P = x^{\varphi} P_{Nf}{}^{\delta} P_{No}{}^{1-\delta} \quad (6)$$

Expressed in log form as

$$p = \varphi x \, \delta p_{Nf} + (1-\delta)p_{No} \quad (7)$$

At equilibrium, Demand of and supply for money becomes:

$$M^s/_P = M^D/_P \ or \ p = \log(M^s) - \log M^D \tag{8}$$

Where $\log M^D$ is m^D Equating (6) and (7) and solving for P_{No} yields

$$p_{No} = \theta[\log(M^s) - m^D - \varphi x - \delta p_{Nf}] \tag{9}$$

Also, note that $\theta = (1-\delta)^{-1}$. The demand for real balances is assumed to be a function of all some of the following variables:

$$m^D = f(y, p^e, i) \tag{10}$$

Where y is real income, p^e is expected inflation and i is interest rate. Re-writing equation (10) explicitly becomes:

$$m^D = \gamma_1 y - \gamma_2 p^e - \gamma_3 i \tag{11}$$

Substituting (11) into (9) we have:

$$p_{No} = \theta[M^s - \gamma_1 y - \gamma_2 p^e - \gamma_3 i - \varphi x - \delta p_{Nf}] \tag{12}$$

Again, substituting equation (12) into

$$p_{No} = \tau_1 M^s - \tau_2 y + \tau_3 p^e + \tau_4 i + \tau_5 x \tag{13}$$

This remove the possibility of regressing food prices which is a component of CPI on CPI. From equation (7)

$$p = \varphi x + p_N \tag{14}$$

Substituting for p_N in equation (14)

$$p_t = \tau_1 {M^s}_t - \tau_2 y_t + \tau_3 {p^e}_t + \tau_4 i_t + \tau_5 x_t \tag{15}$$

Considering the possible linkage of international oil price shock with the domestic price level, equation (15) is augmented with international oil prices in domestic currency, say e to obtain

$$p_t = \tau_0 + \tau_1 {M^s}_t - \tau_2 y_t + \tau_3 {p^e}_t + \tau_4 i_t + \tau_5 x_t + \tau_6 e_t + \mu_t \tag{16}$$

Where M^s = money supply, y = real output, p^e= expected inflation, i= interest rate, x = real exchange rate, p = price level, d = international oil price, τ_0 is a constant and μ_t is a stochastic variable or error term.

Equation (13) can then be specified using a general dynamic process called Autoregressive Distributed Lag (ARDL) model of order k as follows:

$$\Delta p_t = \tau_0 + \sum_{j=1}^{n} \tau_{1j} \Delta p_{t-j} + \sum_{j=0}^{n} \tau_{2j} \Delta {m^s}_{t-j} + \sum_{j=0}^{n} \tau_{3j} \Delta y_{t-j} + \sum_{j=0}^{n} \tau_{4j} \Delta {p^e}_{t-j} + \sum_{j=0}^{n} \tau_{5j} i_{t-j} + \sum_{j=0}^{n} \tau_{6j} \Delta d_{t-j} + \varepsilon_t \tag{17}$$

All these variables does is to add 1 through k of the dependent variables and all independent variables to the original model.it can be seen that lags of the dependent variable start at j, and lag of the independent variable start at $j = 0$ because of the need to include contemporaneous values in equations as at equation

(17). This equation can be rewritten to obtain the error correction representation which is of this form:

$$\Delta p_t = \tau_0 + \sum_{j=1}^{n}\tau_{1j}\Delta p_{t-j} + \sum_{j=0}^{n}\tau_{2j}\Delta m^s{}_{t-j} + \sum_{j=0}^{n}\tau_{3j}\Delta y_{t-j} + \sum_{j=0}^{n}\tau_{4j}\Delta p^e{}_{t-j} + \sum_{j=0}^{n}\tau_{5j} i_{t-j} + \sum_{j=0}^{n}\tau_{6j}\Delta x_{t-j} \quad (19)$$
$$+ \sum_{j=0}^{n}\tau_{7j}\Delta d_{t-j} - \psi(p_{t-1} + \sigma_1 m^s{}_{t-1} + \sigma_2 y_{t-1} + \sigma_3 p^e{}_{t-1} + \sigma_4 i_{t-1} + \sigma_5 x_{t-1} + \sigma_6 d_{t-1} + v_t$$

Where; Δ is the first difference operator; the parameters j, where j = *1, 2, 3, 4, 5,6,7* are the respective long-run multipliers; the parameters $\tau_1, \tau_2, \tau_3, \tau_4, \tau_5, \tau_6, \tau_7$ are the short run dynamic coefficients of the underlying ARDL model in the equation; and v_t denotes the white noise error term. The Bounds cointegration test involves estimating the above equation and restricting the parameters of the lag level variables to zero. Based on this equation, we tested the following null and alternative hypotheses.

The null hypothesis

$$[H_0 : j_0 = j_1 = j_2 = j_3 = j_4 = j_5 = j_6 = j_7 = 0]$$
$$H_1 : not\ H_0$$

Data Description and Sources

M^s = money supply measures as monetary base define as the sum of currency in circulation and reserves balances.

y = real output is used to represent real GDP in our empirical analysis.

p^e= expected change in inflation measured as the difference of log the current price was used as approximate expected inflation in the empirical analysis. In exact literature, two major factors necessitated this approach of calculating for expected inflation. One it consisted of rational and adaptive expectation hypothesis as noted by D'Acunto *et al.,* (2015). Two, inflation cannot be filtered as in the case use of Hodrick-Prescott filter in the generation of potential output.

i= interest rate in our empirical analysis.

x = real effective exchange rate is used as a measure by the nominal effective exchange rate (a measure of the value of a currency against the weighted average of several currencies) divided by a price deflator of index cost. our empirical analysis.

p = price level measure by CPI

d = Control variables

d_1= control for an expected financial situation (proxy as fiscal deficit to GDP), this is crucial because an individual expected financial or debt status is most important for inflationary expectation.

d_2 =international oil price is used for possible linkage between world oil price with domestic price level augmenting world oil price with domestic price level as the exogenous factor might have implication on the domestic economy.

3. Econometric analysis

The descriptive statistics for the designated variables are indicated in table 1. The mean values for all variables exhibited positive trend on average. A glance through the table reveals disparities in the trend of the various variables. For instance, it could be observed that exchange rate log(x), price level (p), fiscal deficit to GDP (d1) and international oil price (d2) which are associated with the mean values of 75.80, 45.42, 196.0, 72.86, are widely dispersed with standard deviation values standing at 75.96, 52.39, 289.0, 28.59 respectively.

Table 1. *Descriptive Statistics*

Variables	Details	Mean	Max	Min	Std. Dev.	Obs.
P	Price level	45.42	183.89	0.41	52.39	37
D1	Fiscal deficit	196	111	11.19	289	37
D2	international oil price	72.50	114.93	29.38	28.59	37
LOG_I_	Interest rate	17.51	31.65	8.43	5.14	37
LOG_X_	Exchange rate	75.80	304.75	0.55	75.96	37
MS	Money supply	24.22	43.27	13.23	6.53	37
PE	Expected future inflation	19.18	72.84	5.38	17.58	37
Y	Real output	3.79	33.74	-13.13	7.46	37

Source: Authors' computation (2017).

Table 2 presents the correlation matrix for the nature of relationships among the variables. The relationship between price level and all other variables is positive except for money supply and MS and expected future inflation which exhibits negative association. In respect to fiscal deficit, while international oil price, exchange rate and real output expedite positive association, others were negative. A similar pattern of relationship is closely analogous in regards to other variables.

Table 2. *Correlation Matrix*

	P	D1	D2	LOG_I_	LOG_X_
P	1				
D1	0.970957	1			
D2	0.855295	0.732264	1		
LOG_I_	0.024240	-0.023032	0.353240	1	
LOG_X_	0.928911	0.861983	0.890942	0.157846	1
MS	-0.200200	-0.195991	-0.352364	-0.389558	-0.199860
PE	-0.358872	-0.307525	-0.263933	0.380543	-0.376428
Y	0.305704	0.207261	0.478926	0.327400	0.408036

Source: Authors' computation (2017).

3.1. Cointegration Test

In order to empirically examine the long-run nexus and short-run dynamic relationships among our research variables, we explore the ARDL bounds test cointegration method developed by Pesaran & Shin (1999) and Pesaran *et al.,* (2001). Our choice of method was necessitated by the fact that the method is more explicit and reliable in probing the extent of the relationship among variables in comparison with other previous and traditional cointegration methods. Specifically, the ARDL is not preconditioned to the uniformity of cointegration order for all variables. That is, the need for all the variables to be integrated of the same order and it can equally be applied when variables are either integrated at level or first difference. More importantly, Harris & Sollis (2003), noted that applying the ARDL technique enhance unbiased estimates of the long-run model.

Table 3 presents the cointegration results of the variables of interest (money supply, real output, expected change in inflation, interest rate, exchange rate, price level, fiscal deficit to GDP and international oil price) using F-test with the new critical values (Pesaran *et al.,* 2001).

Table 3. *ARDL Bounds Test for Cointegration*

Variables	F– Statistics	Cointegration
F(P^e, D_1, D_2, Log(x), Log(i), Y)	11.54355	Cointegration Exist
Critical value	Lower Bound	Upper Bound
1%	2.96	4.26
5%	2.32	3.5
10%	2.03	3.13

Source: Authors' computation (2017).

Going by the underlining assumptions of the ARDL Model, one set assumes that all variables in the model are $I(0)$ and the other set assumes they are all $I(1)$. If the calculated F-statistic exceeds the upper critical bounds value, then the H_0 is rejected. If the F-statistic falls within the bounds then the test is inconclusive.

Lastly, if the F-statistic falls below the lower critical bounds value, it implies that there is no co-integration.

Hence, from the ARDL Bound Test cointegration results, the value of the F-static (11.54355) exceeds the critical values at the upper bound (4.26 at 1%, .3.5 at 5% and 3.13 at 10%). Therefore, the empirical findings lead to the conclusion that a long run relationship exists among inflation and other independent variables in Nigeria. Thus, we conclude that there is cointegration between our dependent variable (P) and the independent variables (money supply, real output, expected change in inflation, interest rate, and exchange rate, fiscal deficit to GDP and international oil price).

Having established the existence of cointegration from table 3 above, the conditional ARDL for the long run relationship can be estimated given the model as thus;

$$\ln(p_t) = \tau_0 + \sum_{j=1}^{p} \tau_{1j} \ln(p_{t-j}) + \sum_{j=0}^{q_1} \tau_{2j} \ln(m^s{}_{t-j}) + \sum_{j=0}^{q_2} \tau_{3j} \ln(y_{t-j}) + \sum_{j=0}^{q_3} \tau_{4j} \ln(p^e{}_{t-j})$$
$$+ \sum_{j=0}^{q_4} \tau_{5j} \ln(i_{t-j}) + \sum_{j=0}^{q_5} \tau_{6j} \ln(d_{t-j}) + \varepsilon_t \qquad (19)$$

Where all variables are as previously defined. The order of the ARDL $(p, q_1, q_{2,} q_3, q_{4,} q_5)$ model in six variables are selected by using AIC equation (19) is estimated using the ARDL (1,0,0,0,0,0,0) specification.

Table 5. *Cointegration Long Run Form and Coefficients*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PE	0.27	0.17	1.61	0.13
MS	0.87	0.45*	1.94	0.07
Y	0.12	0.22	0.56	0.58
LOG_X_	0.14	0.09	1.55	0.14
LOG_I_	-0.94	0.35**	-2.67	0.02
D1	0.02	0.002**	7.39	0.00
D2	0.78	0.14**	5.68	0.00
C	-45.38	18.94**	-2.40	0.03

Note: *, ** and *** signify significant level at 1%, 5% and 10% respectively. (#) Null hypothesis: No significant relationship. For variables' details, refer to table 1.
Source: Authors' computation (2017).

The estimated coefficients of the long-run relationship are statistically significant for money supply, interest rates, fiscal deficit to GDP and international oil price at 10%, 5%, and 1% respectively. The baseline regression result from table 5 suggests that a standard deviation of one increase in money supply, fiscal deficit to GDP and international oil price results in a 45%, 0.20% and 14% increase in the inflation rate in Nigeria. Conversely, interests rate which is negatively significant is indicative of the fact that a standard deviation of one increase interest rate results in 94% decrease in inflationary rate in Nigeria. These results are in conformity with our a priori expectation and portray a typical situational analysis of events unfolding in the economy. For instance, the economy of Nigeria in the last two to three years which went on recession has been attributed to the voluminous level of money in circulation (specifically USD) which consequently raised the general price level. This was further worsened by the rapid drop in the international oil price all of which increased the fiscal deficit to GDP. This situation has left inflation rate to a persistent two digit with 15.905 as the current standing rate putting the economy at risk in all ramification most especially discouraging foreign investors. However, it is believed that interest rates can serve as a check to reducing the inflation through the reduction of money in circulation brought about by discouraging borrowing from the commercial banks. However, a caution must be taken that for this to be effective the productive capacity of the economy must be fully exploited through the real sectors. This is analogous to the real output from table 5 which is insignificant in explaining the variation in inflationary rates in Nigeria. A similar perspective is equivalent to future expected inflation and exchange rate. Hence, the results suggest a non-static trend in the inflation rate in Nigeria which is a major standpoint of this paper.

Making inferences from the studies conducted by Odhiambo (2009) and Narayan, Smyth (2008) and Mounir (n.d.), we further estimate the short-run parameters through the error correction model in relation to the long-run parameters estimates. The stated hypothesis of no cointegration which is associated with the vector error correction model is stated as thus:

$$D(\ln(p_t)) = \tau_0 + \sum_{j=1}^{p}\tau_{1j}D(\ln(p_{t-j})) + \sum_{j=0}^{q}\tau_{2j}D(\ln(m^s{}_{t-j})) + \sum_{j=0}^{q}\tau_{3j}D(\ln(y_{t-j})) + \sum_{j=0}^{q}\tau_{4j}D(\ln(p^e{}_{t-j}))$$
$$+ \sum_{j=0}^{q}\tau_{5j}D(\ln(\Delta i_{t-j})) + \sum_{j=0}^{q}\tau_{6j}D(\ln(\Delta d_{t-j})) + \alpha ECT_{t-1} + \varepsilon_t \qquad (20)$$

$$D(\ln(m^s{}_t)) = \tau_0 + + \sum_{j=0}^{p}\tau_{1j}D(\ln(m^s{}_{t-j})) + \sum_{j=1}^{q}\tau_{2j}D(\ln(p_{t-j})) + \sum_{j=0}^{q}\tau_{3j}D(\ln(y_{t-j})) + \sum_{j=0}^{q}\tau_{4j}D(\ln(p^e{}_{t-j}))$$
$$+ \sum_{j=0}^{q}\tau_{5j}D(\ln(i_{t-j})) + \sum_{j=0}^{q}\tau_{6j}D(\ln(d_{t-j})) + \varepsilon_t \qquad (21)$$

$$D(\ln(y_t)) = \tau_0 + \sum_{j=1}^{p}\tau_{1j}D(\ln(y_{t-j})) + \sum_{j=0}^{q}\tau_{2j}D(\ln(m^s{}_{t-j})) + \sum_{j=0}^{q}\tau_{3j}D(\ln(p_{t-j})) + \sum_{j=0}^{q}\tau_{4j}D(\ln(p^e{}_{t-j}))$$
$$+ \sum_{j=0}^{q}\tau_{5j}D(\ln(i_{t-j})) + \sum_{j=0}^{q}\tau_{6j}D(\ln(d_{t-j})) + \varepsilon_t \qquad (22)$$

$$D(\ln(p^e{}_t)) = \tau_0 + \sum_{j=1}^{p}\tau_{1j}D(\ln(p^e{}_{t-j})) + \sum_{j=0}^{q}\tau_{2j}D(\ln(m^s{}_{t-j})) + \sum_{j=0}^{q}\tau_{3j}D(\ln(p_{t-j})) + \sum_{j=0}^{q}\tau_{4j}D(\ln(y_{t-j}))$$
$$+ \sum_{j=0}^{q}\tau_{5j}D(\ln(i_{t-j})) + \sum_{j=0}^{q}\tau_{6j}D(\ln(d_{t-j})) + \varepsilon_t \qquad (23)$$

$$D(\ln(i_t)) = \tau_0 + \sum_{j=1}^{p}\tau_{1j}D(\ln(i_{t-j})) + \sum_{j=0}^{q}\tau_{2j}D(\ln(m^s{}_{t-j})) + \sum_{j=0}^{q}\tau_{3j}D(\ln(p_{t-j})) + \sum_{j=0}^{q}\tau_{4j}D(\ln(y_{t-j}))$$
$$+ \sum_{j=0}^{q}\tau_{5j}D(\ln(p^e{}_{t-j})) + \sum_{j=0}^{q}\tau_{6j}D(\ln(d_{t-j})) + \varepsilon_t \qquad (24)$$

$$D(\ln(d_t)) = \tau_0 + \sum_{j=1}^{p}\tau_{1j}D(\ln(d_{t-j})) + \sum_{j=0}^{q}\tau_{2j}D(\ln(m^s{}_{t-j})) + \sum_{j=0}^{q}\tau_{3j}D(\ln(p_{t-j})) + \sum_{j=0}^{q}\tau_{4j}D(\ln(y_{t-j}))$$
$$+ \sum_{j=0}^{q}\tau_{5j}D(\ln(p^e{}_{t-j})) + \sum_{j=0}^{q}\tau_{6j}D(\ln(i_{t-j})) + \varepsilon_t \qquad (25)$$

Where $(\tau_1, \tau_2, \tau_{3,} \tau_4, \tau_{5,} and \tau_6)$ are short-run dynamic coefficients of the model 's convergence to equilibrium and α is the speed of adjustment. Equation (20)-(25) are estimated using the OLS regression separately.

Table 6. *Vector Error Correction Model*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.16	4.31**	-2.59	0.02
D(PE)	0.02	0.02	1.002	0.33
D(MS)	0.17	0.06**	2.89	0.01
D(Y)	-0.02	0.04	-0.59	0.56
D(LOG_X_)	0.01	0.02	0.51	0.62
D(LOG_I_)	-0.16	0.08*	-1.97	0.07
D(D1)	0.01	0.002***	3.95	0.00
ECTE(-1)	*-0.25*	*0.12**	*-2.07*	*0.06*
R-square	0.99			
Adjusted R-square	0.99			
F-statistic	4065.69***			0.000
WD-Statistic	2.15			

Note: *, ** and *** signify significant level at 1%, 5% and 10% respectively. (#) Null hypothesis: No significant relationship. For variables' details, refer to table 1.
Source: Authors' computation (2017).

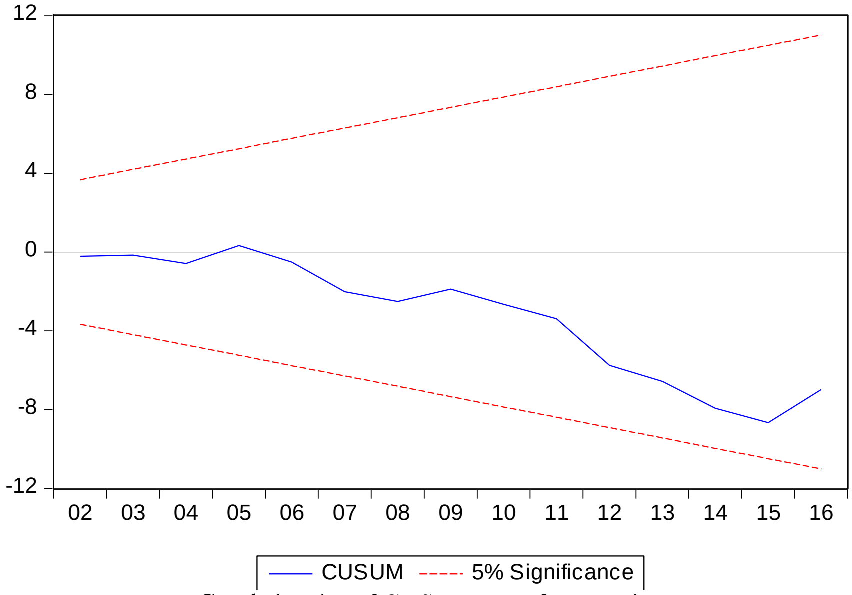
Table 6 presents the results of the long-run relationships with the estimated short run dynamic of inflation in Nigeria when the price level is the dependent variable. Taking reference point from results of the long-run, the coefficient on the lagged error-correction term is statistically significant at 10% level with the a priori expectation of the sign duly met, which further corroborates the bounds test estimates for cointegration on table 3. ECT negative value of (-0.25) implies that there is long-run causality running from independent variables (variables (money supply, real output, expected change in inflation, interest rate, and exchange rate, fiscal deficit to GDP and international oil price) to the dependent variable (price level). It could also be inferred that disequilibria from the preceding year converge back to the long-run equilibrium in the present year with a high speed of adjustment at 25%. Similarly, our analysis from the table suggests that in the short run, only money supply, interest rates, and fiscal deficit are statistically significant at 5%, 10% and 1% levels in explicating the dynamics of inflation in Nigeria. The F-value calculated is 4065.69 with probability value 0.00 and this shows that the whole model is statistically different from zero.

Table 7. *Diagnostic Tests Results*

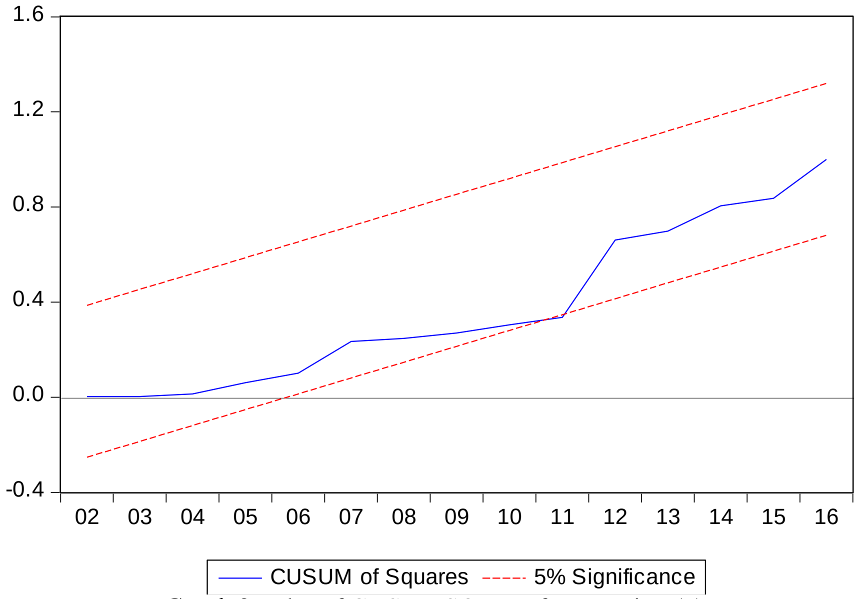
	F-Statistic	Probability
Breusch-Godfrey Serial Correlation test	2.74	0.10
Jarque-Bera test	0.81	0.67
Wald Test	21.42***	0.00
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.79	0.68
Ramsey RESET Test	0.01	0.93
Chow Forecast Test (Likelihood ratio)	50.86***	0.00

Note: *, ** and *** signify significant level at 1%, 5% and 10% respectively.
Source: Authors' computation (2017).

The model for the underlying ARDL fulfills the stated criteria examined by all the diagnostic tests observable from the serial correlation (Durbin Watson test and Breusch-Godfrey test) which suggests that the model is free from serial correlation indicating that the model is reliable in explaining the dynamics of inflation in Nigeria for the study periods. Similarly, The Breusch-Pagan-Godfrey Heteroskedasticity Test reveals that the disturbance term in the equation is equally homoscedastic. Going by the result of the Jarque-Bera (JB) test, the null hypothesis of normally distributed residuals cannot be rejected. While the Ramsey RESET test result shows that there is no specification error, the Wald test reinforces our standpoint about the validity, correctness of our obtained results. Finally, the Chow predictive failure test suggests that the model may possibly be useful for forecasting with 2008 as the breakpoint year.



Graph 1. *Plot of CUSUM Test for equation*



Graph 2. *Plot of CUSUMSQ Test for equation (7)*

The stability of the long-run coefficient is estimated by the short-run dynamics. The cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests are tested to evaluate the parameter stability (Pesaran and Pesaran (1997)). Graphs 1 and 2 plot the results of CUSUM and CUSUMSQ tests. The results indicate the absence of any instability of the coefficients because the plot of the CUSUM and CUSUMSQ statistic fall inside the critical bands of the 5% confidence interval of parameter stability.

4. Summary and policy recommendations

The study was motivated by the pervasively increasing inflation rate which has for the past 3 decades embattled and inhibited the potential growth of the Nigeria economy coupled with the fact that empirical studies on modeling trend and behavior of inflation dynamics have remained largely neglected or scarcely researched. The empirical evidence is conducted on for Nigeria countries averaged over the period spanning 1980-2015. Apart from the baseline OLS, different

diagnostic test like Durbin Watson test and Breusch-Godfrey test, Breusch-Pagan-Godfrey Heteroskedasticity, Jarque-Bera, Ramsey RESET and Wald test are employed. In conducting the various econometric tests, we utilize Bound cointegration tests to inquire whether there exist or not, a long run relationship between our stated empirical variables. Results suggest the existence of a long-run relationship among the variables. Similarly, the error correction model conforms with the a priori expectation of negative sign and significance at 25% speed of adjustment. A general overview of the empirical findings reveals that money supply, interest rates, fiscal deficit to GDP and international oil price shock are statistically in explaining the dynamics of inflation in Nigeria both in the long run and short run. Consequently, the study recommends the need for implementation of strategic diversification policy to reduce the vulnerability of the economy to oil price shock both locally and internationally. The need for more investment in the productive sector is required to increase the level of real output and also, the government and policymakers need to swing into urgent action in initiating a fiscal policy that will further enhance stabilization of the country's exchange rate and raise the value of the Naira.

References

Ajakaiye, O. (2008). Fiscal and monetary policy coordination in an inflation, *Proceeding of The One-Day Seminar on Monetary Policy and Inflation targeting*. January 19, pp.89-99.

Bechmann, R., Berg, T.O., & Sims, E.R. (2015). Inflation expectation and readiness to spend: Cross-sectional evidence, *American Economic Journal: Economic Policy*, 7(1), 1-33. doi. 10.1257/pol.20130292

Blanchard, O. (2005). Fiscal dominance and inflation targeting, *in* F. Giavazzi, I. Ggoidfajn, & S. Herra, (Eds), *Inflation Targeting, Debt and The Brazilian Experience*, 1999 to 2003. Cambridge, MA: MIT Press.

Blanchard, O., Cerutti, E., & Summers, L. (2015) Inflation and activity-two explorations and their monetary implications. IMF, *Working Paper Series*, No.WP/15/230: 7-29. [Retrieved from].

Buffies, E. (2003). Tight money, interest rates, and inflation in Africa, IMF, *Staff Papers*, 50(1), 115-135. [Retrieved from].

Buffies, E., Adam, E.C., O' Connell, S., & Pattillo, C. (2008). Riding the wave, monetary responses to aid surge in low-income countries, *European Economic Review*, 52(8), 1378-1395. doi. 10.1016/j.euroecorev.2008.02.001

D'Acunto, F., Hoang, D., & Webler, M. (2015). Inflation expectation and consumption expenditure, *Chicago Booth Global Market Working Paper Series*. [Retrieved from].

Duca, I., Kenny, G., & Reuter, A. (2016). How to do inflation expectations impact consumer behaviour, *European Central Bank Working Paper*, [Retrieved from].

Harris, R., & Sollis, R. (2003). *Applied Time Series Modelling and Forecasting*. Wiley, West Sussex.

Ichiue, H., & Nishigushi, S. (2015). Inflation expectations and consumer spending at zero bound: Macro evidence, *Economic Inquiry*, 53(2), 1086-1107. doi. 10.1111/ecin.12176

Mounir B., (n.d.). The relationship between trade, FDI and economic growth in Tunisia: An application of the autoregressive distributed lag model. Faculty of Economics and Management of Sousse, University of Sousse City Erriadh 4023 Sousse Tunisia.

Narayan, P.K., & Smyth, R. (2008). Energy consumption and real GDP in G7 countries: New evidence from panel cointegration with structural breaks, *Energy Economics*, 30, 2331-2341. doi. 10.1016/j.eneco.2007.10.006

O'Connell, S. (2008). Inflation targeting as a monetary policy framework: Issues and concerns, *Proceeding of The One-Day Seminar on Monetary Policy and Inflation targeting*. January 19, pp.9-33.

Odhiambo, N.M. (2009). Energy consumption and economic growth in Tanzania: An ARDL bounds testing approach, *Energy Policy*, 37(2), 617-622. doi. 10.1016/j.enpol.2008.09.077

Oyejide, T.A. (1972). Deficit financing and capital formation: An analysis of Nigerian experience, *Journal of Economic and Social Studies*, 27-43.

Pesaran, M., & Shin, Y. (1999). An autoregressive distributed lag modeling approach to cointegration analysis, *in* S. Strom, (ed), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, Cambridge University Press, Cambridge.

Pesaran, M.H., Shin, Y., & Smith, R.J. (2001). Bounds testing approaches to the analysis of the level relationship. *Journal of Applied Economics,* 16, 289-326. doi. 10.1002/jae.616