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The dynamics of inflation, public debt and exchange rate in Nigeria

A b s t r a c t

This study examines the dynamic relationship between inflation, public debt and exchange rate for Nigeria from 1980-2016. The study uses Exploratory Data Analysis (EDA) and non-parametric approach, vector error correction model and Granger-Causality technique to empirically investigate the relationships in the short and long run. The EDA shows that CPI rate of inflation has a strong positive relationship with domestic debt and exchange rate and a weak positive association with external debt with kernel fit. The short run results show that the past values of inflation and domestic debt significantly influences the current value of inflation while external debt and exchange rate are positive but less significant in the near future. The result also shows that the explanatory variables have negative influence on inflation in the long-run. In Nigeria, we can reject the hypothesis that inflation does not granger cause domestic debt, external debt and exchange rate. A unidirectional relationship is found for domestic debt, external debt and exchange rate. The study recommends that policy makers need to formulate appropriate and prudent policy targeted at reducing both the domestic debt and exchange rate simultaneously in the short run.

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1. Introduction

During the process of a country's development, inflation is inevitable. Monetary authorities, economists, as well as policy analyst have overtime worried over the adverse effects of inflationary pressure that emanate from exchange rate depreciation and public debts, knowing that exchange rate, public debts and inflation rate are the major determinants of economic performance of any economy (Philip and Oseni, 2012). Historically, domestic inflation is driven by imported inflation from oil price shock and increased food prices, particularly in developing countries, leading to ineffectiveness of domestic government in containing it. For example, Nigeria domestic inflation reached a double digit in 1984 by

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40.17%, 57.12% in 1993, 72.81% in 1995, 17.89% in 2005 and 14.9% in 2016 (CBN, 2016). This implies that policymakers should be mindful of rising inflation.

Nigeria government implemented fiscal structural adjustments and consolidation process due to its high level of debt and the newly defined external debt of ₦3,478.92 billion in 2016 (CBN, 2016). This rising trend in Nigeria's public debt has sparked some controversies about the relationship between inflation and public debt and also, the direction of causality between public debt and inflation. While some argue that public debt affects exchange rate and inflation, others are of the view that inflation and exchange rate rather affect public debt. The relationship between public debt and inflation is also an intermediate one. This somewhat indicates the difficulty of the government to borrow either domestically or from external sources due to its high and rising public debt and hence it has to resort to monetizing its debt. In the 1980's, the substantial accumulation of public debt led the government to finance most of its deficits through money printing which caused a sharp rise in money supply, resulting in a high rate of inflation.

According to Lin and Chu (2013), exchange rate is a key element in relation to inflation; inflation and exchange rate are expected to influence each other in many theoretical models, particularly in developing countries, during exchange rate crisis period. When domestic inflation reached 9.9% in 2015 and 14.9% in 2016, naira depreciated by 50.51% against the U.S. dollar. After the currency depreciation, CBN pegged the naira to U.S. dollar at ₦365 for several months and floated the exchange rate till date. With the current 'fast' depreciation of the naira, coupled with the increasing trend in inflation rates, this study analyses the dynamics of Nigeria's inflation rate, in the context of high public debt and a fast depreciating naira. Although the causes and consequences of a higher and rising inflation are many, this study focuses just on public debt (external and domestic) and the exchange rate.

The choice of Nigeria for the study is because, Nigeria is one of only two African countries in the list of Global Growth Generators (3G) countries. These countries have been identified as attractive places for investment because of the incredible growth potential they have. In fact, this anticipated growth implies that Nigeria may be a model for economic development for other countries in the developing world. Therefore, it is important to do an empirical assessment of the behaviour of some macroeconomic variables like, inflation, debts and exchange rate. The primary objective of this study therefore is to examine the dynamic relationship between external debt, domestic debt, exchange rate and inflation in Nigeria, since the volatility in these three macroeconomic indicators can significantly alter the growth prospects of Nigeria both in the short and long run. The study examines the causal linkages between these three macroeconomic variables using multivariate models using Nigeria data from 1981 to 2016.

In light of the above objectives, this study is motivated by these further questions. If high inflation is accompanied by soaring or increasing public debt and exchange rate depreciation, what do the public debt level and the exchange rate tell us about the growth of inflation, and vice versa? And what is the causal relationship between these variables? Domestic debt empirical gaps have largely been ignored in the vast empirical literature on inflation dynamism (see Reinhart and Rogoff, 2011). Hence, this study aims to find the causal relationships between inflation, external and domestic debt and exchange rate to

assist policy makers in the future in identifying the source of inflation and implementing a suitable fiscal reform.

This research work is organised into 5 sections. Section 1 is the introduction, giving a general idea of the research. Section 2 covers the existing theoretical and empirical literature on the issue. Section 3 focuses on sources of data and method, while section 4 is the empirical analysis and discussion of results. Section 5 provides the conclusion, implications and recommendations of the study.

2. Review of Literature

2.1 Theoretical Review

Public debt and inflation: There are two main ways or channels through which public debt affects inflation, the 'monetization effect' channel and the 'wealth effect' channel.

The Monetisation channel: According to Niemann et al. (2010), a rise in public debt increases the inflation level and this is usually through the domestic debt when it is backed with money. Reinhart and Rogoff (2010) adds to this assertion that in fact, domestic debt is often much larger than the monetary base in the run-up to high inflation episodes, indicating that higher public debt contributes to higher inflation.

In the case where the public debt is monetized by the government, the government usually issues debts which are mandatorily bought by the central bank. The money which the government thus receives from the central bank is used to finance the budget deficit which substantially expands money supply as a result. The increase in money supply then generates inflationary pressures which may even lead to hyperinflation (see Ahmad, et al., 2012).

This incentive to monetise the debt, however, depends strongly on the level of the debt as predicted by Sargent and Wallace's (1981) in their paper, "some unpleasant monetarist arithmetic". They argue that an increase in public debt is typically inflationary in countries with large public debts and non-inflationary in countries with smaller public debts. Nevertheless, Niemann et al. (2010) posit that inflation is generally increases the level of debt, irrespective of the size. According to Ahmad, et al., (2012), one of the reasons why the government would monetize its debt is that any increase in government debt moves the demand for loanable funds upwards, which tends to push up interest rates. To keep interest rates unchanged, the government must then "monetize" the debt by expanding the money supply, usually through printing money to buy government debt from the public.

Aside the direct transmission channels already described, it is also believed by many that a greater likelihood of monetisation of the debt could increase inflation expectations, and hence also current inflation, without the actual monetisation even taking place (Nuatet and Meensel, 2011). According to Cochrane (2011), such inflation expectations are formed if people are convinced that the government will print money to cover its intractable debt. Hence, holders of government debt who would normally buy a new debt will instead buy real assets (like commodities). But there are only a few of these real assets around, which then generate inflation. It should be realized that this channel rather generates a positive relationship between public debt and inflation, which is different from the one discussed under the debt dynamics theory (where inflation negatively affects public-debt ratio).

The Wealth effect channel: The Fiscal Theory of the Price Level (FTPL) identifies the wealth effect of government debt as an additional channel of fiscal influence on inflation. This theory posits that a higher level of public debt leads to an increase in inflation through a higher wealth effect on households who hold government debt. That is, as the government rolls over its debt, bond holders would try to spend down their wealth, which then would force up the price level (Bhattarai, Lee and Park, 2012). Bhattarai, Lee and Park (2012) further explain that households usually perceive increases in government debt as increasing their wealth if it is not matched by tax increases.

Sims (2013) posits that if economic agents expect future tax increases, they will spend less today which will weaken the impact of the wealth effect and can even lead to deflationary pressures. On the other hand, the expectation of future tax cuts will boost consumption through a stronger wealth effect. Melike and Omer (2007) also add to this assertion that if rational agents expect that the primary surpluses response inefficiently to the domestic debt, the only equilibrium in the price level follows an increasing inflationary path through a magnified wealth effect.

Although the wealth effect under the FTPL assumes money supply to be endogenous, Kwon, et.al, (2006) suggest a possible link between the wealth effect and money supply. They posit that an increase in the price level as a result of the wealth effect will increase money demand and hence money supply will have to increase to accommodate the higher money demand. That is, both effects will then jointly lead to an increase in inflation as a result of a higher public debt. So, in a nutshell, it can be seen that both the monetisation channel and the wealth effect channel work through consumption and hence aggregate demand (AD) (see Dewald, 1980).

Exchange rate and inflation: The Purchasing Power Parity (PPP) model of exchange rate is a crucial assumption in both versions of the monetary and portfolio balance models. It argued that consumers should be able to buy the same quantity of goods in any country at the same amount of currency (Asher, 2012). The major argument of the PPP model is that exchange rate determination depends on the levels of relative prices. That is, the equilibrium exchange rate between two inconvertible paper currencies would be determined by equality of their purchasing powers. The implication is that in every change in price level, exchange rate also changes. The theory attempts to explain the equilibrium value of the exchange rate in terms of differences in inflation rate between two countries, in that, it assumed that exchange rate of currencies of two countries move in a way that seeks to offset the inflation differential between the two economies thereby maintaining real purchasing power of the two currencies. In view of the theoretical reviews above, this study adopts PPP theory to explain the relationship between exchange rate depreciation and inflation in Nigeria.

The efficacy of the inflation channel is quite sensitive to the maturity structure of the government debt or bond as argued by Reinhart and Rogoff (2010). Thus, the inflation channel of reducing the public debt will be very weak or almost ineffective if most of the debts issued by the government are short term debts. Akitoby et al. (2014) argue that short-term debt will need to be refinanced at higher interest rates, which will erode the inflation effect on the public debt. Moreover, higher interest rate on short-term debts is likely to affect other floating rate debts which will also adjust automatically to higher rates and

therefore weaken the impact of inflation in reducing the public debt (Aizenman and Marion, 2009).

2.2 Empirical Review

It is being argued that the inclusion of public debt and exchange rate in the determination of inflation makes the model a bit complicated as it needs to reflect the effects of both domestic and external debt. There is evidence that, the fact that public debt and exchange rate are expected not to be stable does mean that inflation rate is also expected not to be stable. Jalil et al. (2014) found a positive relationship between debt and inflation for Pakistan using the autoregressive distributed lag for his work. Muhammad et al., (2012) found that public debt is one of the causes of the budget deficit in Pakistan and, hence, inflation during 1972-2009. Kwon, et.al, (2009) conducted studies in 71 countries during 1962–2004 with VAR and found that the relationship between inflation and debt is weak in inflexible exchange rate regimes. Using a granger causality test analysis, Habibullah et al., (2011) confirmed the existence of a long- run relationship between deficits and inflation, and concluded that deficiencies contribute to inflation in developing countries in selected 13 Asian countries.

According to Rasaq (2013), exchange rate is a key macroeconomic variable used as a measure for assessing international competitiveness. It can be described as an indicator of competitiveness of a country's currency in which there is inverse relationship between the competitiveness of the currencies. To this end, as the value of the indicator decreases, the competitiveness of the country's currency increases in the international arena. Noer et al. (2010) argued that the effect of exchange rate on inflation is a function of exchange rate policy position of a country. The regime of exchange rate policy of a nation plays key role in reducing fluctuations and risk in the real exchange rate, which affects inflation level and the entire economy. Lin and Chu (2013) found the impact of exchange rate regimes on inflation is stronger in higher inflation episodes than in lower inflation episodes during 1960-2006 in 91 countries. Sek et al. (2012) show a significant correlation between exchange rate movements and inflation in 1960-2010 in Asian countries.

Adeniji (2013) empirically examined the impact of exchange rate volatility on inflation in Nigeria using VECM model and Granger causality for the period of 1986 - 2012. VECM test results established positive and significant relationship among inflation, exchange rate, money supply and fiscal deficit, while gross domestic product showed negative relationship in that regard. Granger causality result showed a bi-directional relationship between all the variables; subsequently, exchange rate was found to influence inflation in Nigeria. Also, Bobai, Ubangida and Umar (2013) examined the impact of exchange rate volatility on inflation in Nigeria's economy for the period between 1986 and 2010, using VECM. The VECM result indicated a negative shock between exchange rate and inflation.

Victor and Samuel (2012) investigated the relationship between real exchange rate and inflation in Nigeria using co-integration test, error correction model (ECM) and ARCH technique for the period between 1970 and 2010. This result showed that inflation has been susceptible to real exchange rate fluctuations in Nigeria. Noer et al. (2010) conducted a comparative investigation of the relationship between inflation rate and the real exchange rate, using explorative statistics and granger causality test. The study found a

strong correlation between the movements of inflation rate and the real exchange rate in most countries investigated by using data covering 1986- 2008 and adopting autoregressive distributed lag model (ARDL) and co-integration techniques.

Adetiloye (2010) investigated the relationship between exchange rate and consumer price index (CPI) in Nigeria, using the techniques of correlation and Granger causality analysis to examine the significance of the relationship existing between consumer price index and exchange rate. It was found that there is high positive relationship between the ratio of imports and the index that exists between the parallel and official rates. The coefficient between autonomous exchange rates and the consumer price index (CPI) is less significant than official rate.

In conclusion, domestic debt empirical gaps have largely been ignored in the vast literature explaining inflation dynamism (see Reinhart and Rogoff, 2011). Hence, this study aims to find the causal relationships between inflation, external and domestic debt, and exchange rate.

3. Data Sources and Methods

3.1 Data Sources

The data were generated in line with the period covered by the study which is 1980-2016, a period of 37 years. This choice is predicated by the research method adopted for this work and follows the purposes and objectives of the study. Data for consumer price index (2010=100) and official exchange rate (₦ per US$, period average) were collected from the Central Bank of Nigeria Statistical Bulletin (CBN, 2015 and 2016) and International Financial Statistics (2016).

3.1 Model Specification

From the above theoretical framework, we concentrate on the change that is induced on the growth of inflation rates by a change in the public debt and the exchange rate. In particular, we are interested in the influence of these variables (public debt and the exchange rate) on inflation rate. With inferences from the monetization effect channel, the wealth effect channel and the purchasing power parity (PPP) theoretical models above, an empirical model to study the relationship between inflation rate, public debt and exchange rate in Nigeria, would be defined in its empirical form as:

$$LOGCPI_t = \beta_0 + \beta_1 LOGDOD_t + \beta_2 LOGEXD_t + \beta_3 LOGEXR_t + \mu_t \quad (1)$$

For convenience, we define the above stated variables: CPI_t as the consumer price index at time t (proxy for inflation); DOD_t (+) as the domestic debt (proxy for government debt in Naira) at the end of period *t;* EXD_t (+) as the external debt (proxy for government debt in foreign exchange) at the end of period *t;* EXR_t (+) represents the rate at which a the country's currency exchange for another at the end of period *t*. b_0 is constant; b_1 - b_3 are slopes and μ_t ~NIID(0,1) is a white noise stochastic disturbance term and time t is annual. In order to reduce errors and to improve on the

linearity of the model, we introduce log in the model. We get the natural logarithms of sequence as CPI, DOD and EXD and EXR.

Based on the provisions of theory and the findings of previous studies by scholars with similar interest the study, the sign and magnitude of each included parameter are outlined as expected. Inflation derived from CPI due to its subjective measure as supported by Azam and Rashid (2015); DOD, EXR, and EXD are the determinants of CPI. Therefore, the apriori expectation is that the parameters b_0, b_1, b_2 and b_3 are greater than zero. These signs beneath each variable show the expected direction of CPI of inflation in response to the corresponding independent variable in the model.

3.3 Method of Data Analysis

The goal of this study is achieved in these following steps: first, this study used Exploratory Non-Parametric Approach and Data Analysis (EDA), Unit Root, Co-Integration, The Vector Error Correction Model (VECM) and Granger-Causality analysis.

Exploratory data analysis (EDA) and non-parametric approach: In non-parametric approach, graphical methods that include simple scatter plots, line graph, confidence ellipse and scatter with kernel fit are used. The EDA, is a quantitative method with little or no statistical hypothesis stated, it is used to identify the relationship between the dependent and independent variable in the model of interest.

Testing for Stationarity: This study takes into consideration the problem of non-stationarity. If the mean, variance and covariance of a model remain constant with respect to time, the time series is said to be stationary.

Testing for Co-Integration and Error Correction Mechanism (ECM): The analytical methods employed in the study include Co-integration test and Error Correction Mechanism (ECM). The Co-integration test examines the long run equilibrium relationship between exchange rate and inflation. To determine the number of significant co integration relationships, the Johansen cointegration test is used, that yields the log likelihood estimates for the unconstrained co-integration vectors for a single-equation test.

Vector Error Correction Model (VECM): The VECM looks into the short run dynamics and long run relationship between the variables. More so, the partial correlation coefficient analysis test investigates examine the degree of correlation between exchange rate and inflation in Nigeria

The Granger Causality Test: Granger causality test identifies the direction of causal relationship (Granger, 1969). To establish Granger causality test, we believe that all the explanatory variables are endogenous and therefore correlated with the residuals

4. Empirical Analysis and Discussion of Result

To identify the relationship between CPI and variables of interest the EDA and non-parametric analysis with Confidence Ellipse and kernel fit are used.

Figure 1. EDA and Non-Parametric Test Analysis

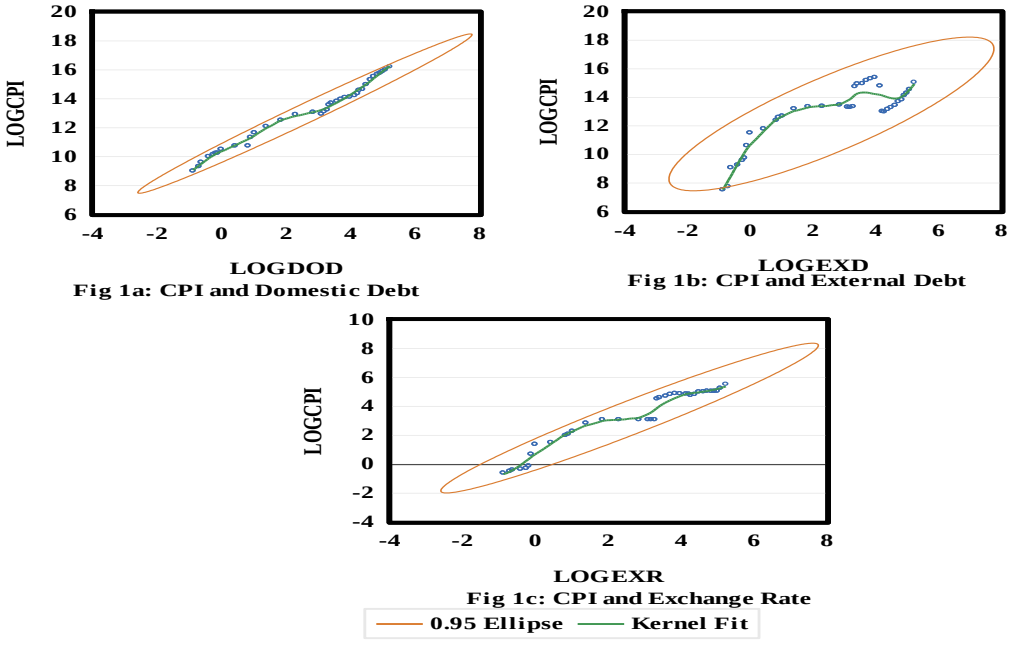

Figure 1a to 1c depict the relationship between the CPI, domestic debt, external debt and exchange rate in Nigeria during 1980-2016 with scatter plots. The degree of association was identifying by confidence ellipse, where CPI are found to have a strong association with domestic debt and exchange rate in Figure 1a and Figure 1c. CPI and external debt have weak association in Figure 1b. CPI is found to have a positive relationship with domestic debt, external debt and exchange rate with kernel fit.

Table 1 shows the ADF test statistics, comparing the variables *p* values levels with the first difference ADF unit root test statistic and various probabilities. The result shows all the included variables were integrated at order one, that is I(1) or they were stationary at first difference. Three variables were statistically significant at 1%, 5% and 10% critical values in first difference, while LOGCPI displaying p values less than 1% level. From the results a long rum equilibrium relationship exists between the dependent variable (LOGCPI) and the included explanatory variables.

Table 1. Summary of Results of Unit Root Tests

Series : LOGCPI, LOGDOD, LOGEXD, LOGEXR
Sample: 1980 2016

Method	Statistic	Prob.**
ADF - Fisher Chi-square	43.874	0.000
ADF - Choi Z-stat	-5.221	0.000

Intermediate ADF test results

Series	t-Stat	Prob.	Order of Integration	Max Lag	Obs
D(LOGCPI)***	-3.921	0.0219	I(1)	1	34
D(LOGDOD)	-4.582	0.0043	I(1)	1	35
D(LOGEXD)	-4.504	0.0052	I(1)	1	35
D(LOGEXR)	-5.3312	0.0006	I(1)	1	34
Test critical values:		1% level	-4.253		

	5% level	-3.548
	10% level	-3.207

*Source: Author's Computation. Notes: ***indicates significance at the 5% and 10% level. The optimum lags length for the ADF determined by Schwarz Information Criterion (SIC).*

The result of using Johansen cointegration test for the variables is shown in Table 2. There is two and one cointegration equation between the variables at 5% significance level for the Trace and Maximum Eigenvalue respectively, and the null hypothesis of no cointegration is rejected. This result indicates that there is a long run relationship between the dependent and all the independent variables used in both models.

Table 2. Summary of Results of Johansen Cointegration Test

Series: LOGCPI LOGDOD LOGEXD LOGEXR
Unrestricted Cointegration Rank Test (Trace)

H_0	Eigenvalue	Trace Statistic	Critical Value 5%	Prob.**
r = 0*	0.667392	81.89566	63.87610	0.0007
r ≤ 1	0.521757	45.56957	42.91525	0.0265
r ≤ 2	0.396773	21.22754	25.87211	0.1700
r ≤ 3	0.128724	4.547301	12.51798	0.6621

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

H0	Eigenvalue	Max-Eigen Statistic	Critical Value 5%	Prob.**
r = 0*	0.667392	36.32609	32.11832	0.0144
r ≤ 1	0.521757	24.34202	25.82321	0.0774
r ≤ 2	0.396773	16.68024	19.38704	0.1185
r ≤ 3	0.128724	4.547301	12.51798	0.6621

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

*Authors' Computation. r indicates the number of cointegrating vectors. * Indicates rejection of the hypothesis at the 5% significance level and ** indicates MacKinnon-Haug-Michelis (1999) p-values. Also, the test statistics are based on a model with three (3) lags and a trend (rtrend). The trend (rtrend) model excludes linear trends in the differenced data but could allow for linear trends in the cointegrating equations.*

With this evidence, it can be interpreted that Nigeria's inflation rate, public debt, and the exchange rate moves together in the long-run. The economic reason behind co-integration analysis is that economic variables do not normally drift far away from each other, and this seems to be the case with the variables concerned in this study as shown in the results above.

The study is also about the post-regression derivation of long-run dynamics of the response of inflation to its fundamental determinants. It is an attempt to derive the long-run relationship between y_t and the k regressors. This long-run analysis procedure begins with the analysis of the VECM model. Under this ECM procedure, the long run relationship is embedded within the dynamic specification. The coefficients of a lag 1 of the explanatory variables means the effect of changes in past years values of explanatory variables results in a change in current values of explained variable or the current changes in explanatory variables affects values of explained variable in next time periods. This can also be positive or negative. Table 3 presents the long-run coefficients with their standard errors and *t*-values extracted from the estimated ECM. Having established the cointegration relationship in Table 2, the steady-state long-run relationship between LOGCPI and LOGDOD, LOGEXD and LOGEXR are solved from or implicit in the estimated error correction equation.

The results in Table 3, shows that the coefficients are not fully in line with our apriori expectation in the long run. In the estimated regression line above, the value of the constant term is 8.971 which means that holding the value of LDOD, LEXD and LEXR constant, the value of LCPI will increase by 8.971% in the long run. The results show that estimated coefficient of domestic debt (-0.602), external debt (-0.257) and exchange rate (-0.131) have no expected signs in the long run. The variables did not conform to a prior expectation. The result shows that a 1% increase in LOGDOD will decrease LOGCPI rate of inflation rate by 0.60% in the long run, while a 1% increase in LOGEXD will decrease LOGCPI by 0.26% in the long run. Also, the result shows that 1% increase in LOGEXR will decrease LOGCPI by 0.13%% in the long run. The result also shows that all the explanatory variables have a negative impact in explaining the inflation rate in the long-run.

Table 3. The Long-Run Coefficients

Cointegrating Eq:	CointEq1
LOGCPI(-1)	1.000000
LOGDOD(-1)	-0.601558
	(0.15721)
	[-3.82636]
LOGEXD(-1)	-0.257316
	(0.10846)
	[-2.37247]
LOGEXR(-1)	-0.131007
	(0.22908)
	[-0.57189]
C	8.970755

Source: Author's Computation. Standard errors in ( ) & t-statistics in [ ]

The empirical results discussed in this study finds support for some stated hypotheses in this work; this implies that they are partially conformed to some previous researches carried out. The positive coefficient on the difference variable means that the previous change in the explanatory variables affects current level of explained variable positively and negative sign of the difference variable means the previous change in explanatory variables affects current the level of the explained variable negatively.

In the short run, domestic and external debts and exchange rate positively influence CPI rate of inflation. The result in Table 2, shows that the coefficients are fully in line with our apriori expectation in the short run. In the estimated regression line above, the value of the constant term is 0.056 which means that holding the value of LDOD, LEXD and LEXR constant, the value of LCPI will increase by 0.056%in the short run. The results show that estimated coefficient of domestic debt (LOGDOD)(0.249), external debt (LOGEXD)(0.018) and exchange rate (LOGEXR)(0.063) have expected signs in the short run. The variables did conform to a prior expectation. The result shows that a 1% increase in LOGDOD will increase LOGCPI rate of inflation by 0.25% in the short run, while a 1% increase in LOGEXD will increase LOGCPI by 0.018% in the short run. Also, the result shows that 1% increase in LOGEXR will increase LOGCPI by 0.063%% in the short run. The calculated t-statistics for past value of LOGCPI and LOGDOD are

3.71049 and 2.44117, respectively. The relationship between past value of LOGCPI, LOGDOD and LOGCPI are positive and significant with current level of LOGCPI.

Table 4. The Short-Run Coefficients

Variable	D(LOGCPI
D(LOGCPI(-1))	0.415007
	(0.11185)
	[3.71049]
D(LOGDOD(-1))	0.249899
	(0.10237)
	[2.44117]
D(LOGEXD(-1))	0.017505
	(0.03546)
	[0.49364]
D(LOGEXR(-1))	0.063166
	(0.06270)
	[1.00751]
C	0.055912
	(0.03236)
	[1.72794]
R-squared	0.685812
Adj. R-squared	0.631641

Source: Author's Computation. Standard errors in ( ) & t-statistics in [ ]

Also, the relationship between LOGEXD and LOGCPI is positive but less significant with current level of LOGEXD, while the relationship between LOGEXR and LOGCPI is positive and not significant with current level of LOGCPI. In the short run, the past value of LOGCPI and domestic debt are significantly influencing the current value of LOGCPI. External debt and exchange rate are less significant in the near future.

Table 4 indicates goodness of fit given that R^2 is 0.69 and Adjusted R^2, which is a better measure of goodness of fit, is 0.63. This indicates that over 63% variation in our dependent variable is explained by the explanatory variables. The result indicates that the overall model is well fitted as the independent variables explained over 63% movement in the dependent variable.

Given cointegration, movement in the CPI rate of inflation is estimated using an error correction model because, the estimation of inflation model takes place during a period in which there are large fluctuations in public debts and exchange rate. Therefore, there must also be an error correction model (ECM) that describes the short-run dynamics or adjustment of the cointegrated variables towards their equilibrium values. The error correction term (ECT) is used to determine the speed of adjustment of the deviation of the inflation from its equilibrium. The ECM estimation implies that the first difference of LOGCPI is regressed on explanatory variables. Although, the model estimated here is often called an error correction model, technically speaking it is an equilibrium correction mechanism.

Table 5 presents the VECM Error Correction regression with their standard errors and *t*-values extracted from the estimated ECM. The error correction term (ECT) or the ECM is included among the explanatory variables and is denoted as Cointegrating Equation (CoinEq) and it is derived from level results. The coefficient associated with this

explanatory variable is typically the speed of adjustment to equilibrium in every period. If variables are indeed cointegrated, we typically expect this coefficient to be negative and highly significant. This indicates there is no omitted variable bias. The coefficient of the lagged error term or equilibrium error correction model (ECM) (-0.171710), is negative and highly significant, confirming that a long-run (cointegrating) relationship exists between the real exchange rate and the set of explanatory variables (see Table 5). The size of this coefficient implies that adjustment to disequilibria towards long-run equilibrium via the equilibrium correction term is relatively weak, as 17.17% percent of disequilibrium in a given annual is corrected in the following annual.

Table 5. VECM Error Correction

Error Correction:	D(LOGCPI)
Ect_{t-1}	-0.171710
	(0.04715)
	[-3.64156]

Source: Author's Computation

The implication of this is that it takes about a year to eliminate 41.04% of deviation between the actual and equilibrium CPI rate of inflation as determined by the fundamentals. It is also shown that the inflation rate is slow to adjust back to equilibrium, implying policy ineffectiveness or inflexibility.

Granger causality test is covered in Table 6, domestic debt, external debt and exchange rate in Nigeria are found to granger cause CPI rate of inflation. We can reject the hypothesis that CPI does not granger cause domestic debt, external debt and exchange rate. A unidirectional relationship is found for domestic debt, external debt and exchange rate. Table 6 also shows that we can reject the hypothesis that external debt does not Granger cause domestic debt, also we can reject the hypothesis that domestic debt does not Granger cause external debt. We can reject the hypothesis that exchange rate does not Granger cause domestic debt, also we can reject the hypothesis that domestic debt does not Granger cause exchange rate. It appears that Granger causality runs two-way from EXR to DOD and not the other way. It is clear that we can reject the hypothesis that exchange rate does not Granger cause domestic debt, also we can reject the hypothesis that domestic debt does not Granger cause external debt. Therefore, it appears that Granger causality runs two-way from EXD to DOD, EXR to DOD and EXR to DOD and not the other way.

Table 6. Short run Pairwise Granger Causality Tests

Null Hypothesis:	Obs.	F-Stat.	Prob.
LOGDOD does not Granger Cause LOGCPI	36	6.93964	0.0127
LOGCPI does not Granger Cause LOGDOD		0.09829	0.7559
LOGEXD does not Granger Cause LOGCPI	36	8.47438	0.0064
LOGCPI does not Granger Cause LOGEXD		0.05212	0.8208
LOGEXR does not Granger Cause LOGCPI	36	11.3750	0.0019
LOGCPI does not Granger Cause LOGEXR		0.34165	0.5629
LOGEXD does not Granger Cause LOGDOD	36	2.2E-05	0.9963
LOGDOD does not Granger Cause LOGEXD		0.24115	0.6266
LOGEXR does not Granger Cause LOGDOD	36	1.45820	0.2358
LOGDOD does not Granger Cause LOGEXR		0.32087	0.5749
LOGEXR does not Granger Cause LOGEXD	36	2.4E-06	0.9988

LOGEXD does not Granger Cause LOGEXR	1.43802	0.2390

Source: Author's Computation

5. Conclusion, Implications and Recommendation

This work develops an integrated model of CPI rate of inflation rate behaviour that synthesizes many recent and older contributions to the theory of CPI rate of inflation determination. Several studies have been conducted on modelling inflation rates in other countries using the vector error correction model and concluded that depreciation of exchange rate are the main drivers of higher inflation in the short run. This study conforms and contributed to the conclusion of empirical literature that a unidirectional relationship is found for domestic debt, external debt and exchange rate and we can reject the hypothesis that CPI does not granger cause domestic debt, external debt and exchange rate

However, the results have shown significant and less significant relationship between some of the determinants and CPI rate of inflation. Further, the variables showed a distinctive result with the expected sign in the short run, but not in the long run. Based on the major findings, this research investigates some inverse result which compare with past researches. The exploratory data analysis show that CPI of inflation has a strong positive relationship with domestic debt and exchange rate and a weak positive association external debt and inflation with kernel fit. In the short run, the results show that the past value of inflation and domestic debt significantly influence the current value of inflation while external debt and exchange rate are positive but less significant in the near future. The result also shows that all the explanatory variables have negative impacts in explaining the inflation rate in the long-run.

Throughout the economic history of Nigeria according to previous findings, increasing and higher public debt and exchange rate fluctuation has always been one of the main economic challenges the economy has faced. More importantly, during these periods of higher public debt, the country has often recorded higher levels of inflation as well as a fast depreciating exchange rate. On the redefinition of external debt by IMF, this study found that external debt has no strong positive significant association with inflation in the short run and in the long run in Nigeria. Hence, this study affirmed that Nigeria as developing countries should prioritize adjustment on the domestic debt compared to external debt.

The empirical finding suggests that exchange rate has a significant negative relationship with price in the long run. This negative relationship is possible as explained by Ito and Sato (2008) that the interaction of exchange rate and domestic prices that varied from one country to another. In the long run, the study shows that exchange rate does not have significant effect influence on inflation. The weak correlation between exchange rate and price might be due to Nigeria government that pegged the Naira to U.S. dollar at ₦365 for almost three years running.

The results from the study imply that policy makers should choose external debt over domestic debt and exchange rate as a policy variable to reduce the domestic debt in the short-run. Moreover, a higher and rising external debt has no exchange rate risk or

inflation risk in the case of Nigeria, and hence the government can still borrow in the short run with no negative impact on inflation and exchange in the long run

Also, policy makers need to formulate appropriate and prudent policy targeted at reducing both the domestic debt and exchange rate simultaneously in the short run especially in the high inflation period because of the impact of these variable on inflation. It is normally a difficult task if the shocks to the exchange rate are external shocks. Hence, the government must guard against external shocks that affect the exchange rate in order to sustain inflation in the short run.

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