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## Aims and Scope

The *Economic and Financial Review (EFR)* is a quarterly publication of the Research Department of the Central Bank of Nigeria. The Review contains articles on research undertaken at the Bank, in particular, and Nigeria, in general, mainly on policy issues both at the macroeconomic and sectoral levels in the hope that the research would improve and enhance policy choices. Its main thrust is to promote studies and disseminate research findings, which could facilitate achievement of these objectives. Comments on or objective critiques of published articles are also featured in the review.

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## Notes to Contributors

Information on manuscript submission is provided on the last and inside back cover of the Review.

## Contents

# Inflation Threshold in Nigeria Revisited

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***Abstract***

*The paper reexamined the inflation threshold that is consistent with sustainable growth in Nigeria, using two separate approaches, namely; the factor-augmented mixed data sampling (FAMIDAS) regression and four versions of the factor-augmented least squares (FALS) regression. Estimating for the period 1991Q1 to 2018Q2, a turning point of about 6-7 per cent was attained, beyond which there exist a significant shift in the inflation-growth relationship in Nigeria. This was further validated with the application of an optimisation technique, within the framework of a third order polynomial FALS regression model, which revealed an optimal point of 9 per cent level of inflation. At this level of inflation, growth is expected to be maximised. In line with these findings, it is recommended that the Management should aim at inflation rate of 9 per cent to maximise growth; be at rest when inflation rate lies within the band of 6 and less than 10 per cent; and tighten monetary policy, when inflation rate gets to 10 per cent and beyond.*

**Keywords**: Inflation, Growth, Threshold Effects
**JEL Classification Numbers:** E31, O40

## I. Introduction

Globally, low and stable inflation has been identified as suitable for sustainable economic growth and development. However, this may be difficult to achieve, simultaneously, in an environment of uncertainties, coupled with the existence of rational expectations and inflationary spiral. Consequently, policymakers, particularly, central banks, all over the world, place more priority on price stability objective, as against other objectives.

In recent decades, the debate on inflation-growth nexus has gained renewed momentum, leading to different schools of thought on the subject matter. For instance, the structuralists argue that inflation is crucial for economic growth, while the monetarists posit that inflation is inimical to economic growth (Munir et al, 2009). From an empirical perspective, Drukker et al. (2005) identifies four major predictions in the literature regarding the impact of inflation on output and growth[1].

In Nigeria, the economy has experienced remarkable growth for most of the post-GFC era, oscillating around 3.58 and 9.69 per cent between 2008Q1 and 2014Q4. However, the economy witnessed a slowdown in 2015, and later slipped into recession in 2016, owing, largely to adverse external shocks, including falling oil price and production, sluggish global growth, and the US monetary policy normalisation. For most of the period under review, inflation was in double-digit, and averaged 11.8 per cent, except in 2011 and between 2013Q1- 2015Q4, when single-digit inflation was recorded.

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* The contributors are staff of the Research Department, Central Bank of Nigeria. *The views expressed in this paper are those of the authors and do not necessarily reflect the opinions of the Central Bank of Nigeria.*

[1] Sidrauski (1967) concludes that there is no effect of inflation on growth, that is, money is super-neutral; Tobin (1965) assumes that money is a substitute for capital, causing inflation to have a positive on long-run economic growth; Stockman (1981) postulated the forward cash-in-advance model, in which money is complementary to capital, causing inflation to have a negative effect on long-run growth; and a new class of models in which inflation has negative effect on long-run growth, but only if inflation rate exceeds certain threshold level.

The Central Bank of Nigeria is shouldered with the responsibility of ensuring price stability, conducive for economic growth. With this objective, it is, therefore, imperative to reconsider the nature of relationship between inflation and growth, given the recent macroeconomic dynamics.

A number of studies have been conducted on inflation-growth threshold in Nigeria[2]. However, just as their methodological approaches vary, their results also vary. This may not be unconnected with the measurement techniques employed in these studies. For instance, most of the studies employed structural models of economic growth with limited control variables, undermining the role of many other economic indicators in explaining growth. This leaves room for further study on this important subject, as the search for the optimal threshold level of inflation may require the adoption of structural models of economic growth that incorporate as much drivers of economic growth, in its estimation, as possible.
To this end, the Research Department of the Bank decided to revisit the threshold level of inflation that is consistent with sustainable growth in Nigeria. This was necessary in view of the Bank's continuous drive towards achieving the goal of price stability, and sustaining economic growth and development. The mandate involved reviewing the existing models and results on the issue, and building structural models of threshold inflation that maximises the data-rich environment on drivers of economic growth, in its estimation.

Against this background, this study re-examined the nature of the relationship between inflation and economic growth by employing and drawing inferences from two separate approaches, namely; the factor-augmented mixed data sampling (FAMIDAS) regression and a factor-augmented least squares regression (FALS). These two techniques are data-intensive, attempting to include all the relevant economic (monetary, fiscal, external and real) variables that determine economic growth. With these approaches, several structural models of economic growth were estimated, by reducing the dimensionality of matrix of explanatory variables into principal components (PC), before regressing them against real GDP growth. In the FAMIDAS approach, the PCs are constructed across the different frequencies, and the estimation technique is the mixed data sampling regression (MIDAS). In both cases, the inflation rate was disaggregated into two-regimes, which were selected across chosen threshold values, ranging between 2 and 45 per cent. Thereafter, the disaggregated values of inflation rate, for each chosen threshold, were regressed alongside the PCs, against the growth of real GDP in separate equations. The threshold value(s), ranging between 6 and 7 per cent, were obtained as those that corresponded to the least sum of squared residual (SSR), in both approaches. This decision rule is in line with Enders (2004).

This study contributes to the literature on inflation threshold in Nigeria, as it attempts to address some of the shortcomings of previous studies on Nigeria that modelled, mostly the relationship between inflation and growth with few drivers. In addition, it would serve as a useful input to the MPC members in taking decisions at the MPC meetings. The rest of the study is organised as follows. Section 2 provides the literature review, while Section 3 discusses trends of inflation and economic growth in Nigeria. Section 4 focuses on methodology, covering the data description, model specification and techniques of

[2] See Kremer et al, 2009; Espinoza et al, 2010; Salami and Kelikume, 2010; Christian et al., 2011; Bassey and Onwioduokit, 2011; Adamgbe and Agu, 2012 as noted in CBN (2017); Bawa and Abdullahi, 2012; Doguwa, 2012; CBN, 2013; and CBN, 2017

analysis. Section 5 presents the empirical results, while section 6 provides summary, policy recommendations and conclusion.

## II. Literature Review

The relationship between inflation and economic growth remains a key focus for monetary policy (Seleteng et al., 2013). Thus, a considerable amount of theories and empirical studies, on the relationship, have been explored. This section, therefore, provides a brief review of literature, examining the range of economic theories and empirical studies on the inflation-economic growth nexus.

### II.1 Theoretical Review

The effects of inflation on economic growth have been studied in the context of models of economic growth, which have evolved over time. The classical growth theories pioneered by Smith (1954) and Ricardo (1957), among others, set the foundation for a supply-side driven growth model, where output growth is assumed to be driven, predominantly by growth in the factors of production (land, labour and capital). With the force of the invisible hand, firms compete for labour, which drives up wages and prices, therefore, reducing profits. Thus, the relationship between growth and inflation is implicitly suggested to be negative, as indicated by the reduction in firms' profit levels through higher wage costs.

According to the Monetarists, an increase in the volume of money in circulation leads to a proportionate rise in the general price level (Friedman 1956). In this regard, there exists a direct relationship between inflation and money supply in an economy. This is explained further by the quantity theory of money specification developed by Fisher (1983, 1993).

$$MV = PT \tag{1}$$

which holds under full-employment assumption, and where M is the currency and other forms of money in circulation (M1, M2, M3), V is the velocity of money, which is the number of times money changes hands, P is the prevailing price level and T is the total volume of goods and services produced in an economy (GDP). The left-hand side of the equation represents money supply, while the right-hand side denotes demand for money, which arises from transactions.

The monetarist further argued that change in the quantity of money affects the monetary side of the economy, thereby excluding the real sector. The implication of this assumption is that prices, rather than quantities, are a result of variations in the money supply. Also, a major foundation is the long-run supply side properties of the economy, as against the short-run dynamics (Dornbusch et al.,1996). Likewise, the fiscal theory of price level (Leeper, 1991), states that an increase in the volume of money supply, as a result of government's expansionary fiscal policy, leads to an increase in the price level. Therefore, for prices to be stable, government finances must be sustainable by running a balanced budget over a business cycle, with no budget deficit.

In the case of Endogenous growth theories, the relationship exists between the rate of return of capital and inflation, which are inversely related. An increase in the price level decreases the rate of return on capital, which in turn reduces capital accumulation, thereby reducing economic growth (Lewis,1954, Romer,1986, and Lucas,1988).

The neo-classical theory postulated by Solow (1956) and Swan (1956) explains that a decline in productivity leads to diminishing returns to scale and consequently, generates inflationary pressures that widen output gap. Similarly, a modification of the neo-classical theory, which pioneers the work of Stockman (1981), established a negative relationship between inflation and economic growth. According to the Stockman model, an increase in the price level leads to a lower steady state level of output and vice versa.

The Keynesian theory provides a holistic analysis to the inflation-economic growth nexus, in that it comprises the aggregate demand (AD) and supply framework, in the short- and long-run. The theory advocates that in the short-run, an increase in output from the demand-side, which stems from increases in the components of AD (C+I+G+NX), is not inflationary. However, once the economy approaches full employment, an increase in AD leads to a proportional rise in the price level.

Tobin (1960) opposes the negative non-linear relationship between inflation and economic growth. In his framework, he shows that a higher inflation rate raises the level of output, permanently through increased capital accumulation. As the price level rises, the return to money decreases, thus, consumers will substitute away from money, with its lower return, and move towards capital. In effect, inflation exhibits a positive relationship to economic growth.

Phillips (1958) provides a hypothesis, which explains the trade-off between inflation and unemployment. It is explained that high inflation, through lower unemployment, impacts on growth of the domestic economy, positively. However, the Phillips curve fails to justify the instance of stagflation, when both inflation and unemployment are commensurately high.
Traditionally, the relationship between inflation and economic growth is linear with the seminal works of Mundell (1965) and Tobin (1965), supporting a positive relationship. However, Stockman (1980) and Fischer (1983) propose a negative relationship between inflation and economic growth. Fischer (1993) proposes further, a non-linear relationship between inflation and economic growth. Similar works, which postulate a negative non-linear relationship, using the adverse selection mechanism, show that low levels of inflation stimulate economic growth while, high levels of inflation deter economic growth, due to credit rationing (Choi et al.1996).

Overall, several economic theories on the inflation-growth nexus have been proposed, with each contributing a different perspective. However, a considerable consensus has been reached on the inverse non-linear relationship between inflation and economic growth, upon which this study is based.

### II.2 Empirical Literature

Several empirical studies have been conducted both in developed and developing countries on inflation threshold. However, the results from the inflation threshold models are mixed, due to differences in methodologies and scope of the reviewed studies. Burdekin et al. (2004) examined inflation threshold on growth using nonlinear model. The study adopted panel data for 21 industrial and 51 developing countries from 1967 to 1992 using generalised least squares (GLS) estimator. The developing and industrial economies were separated to guard against estimating unreliable results, while nonlinearity of the model was to account for biases usually associated with downward effect of inflation on growth for linear models. The study showed that inflation begins to hurt growth at 3 and 8 per cent for advanced and developing economies, respectively. The result for the developing economies also showed that marginal growth costs declined significantly, when inflation is above 50 per cent.

Khan and Senhadji (2000) were interested in examining the nature of inflation-growth nexus. They re-examined the relationship between growth and inflation using econometric techniques that incorporated procedures for estimation and inference. Data of 140 developing and advanced countries were employed during the period 1960-1998 in a panel framework. The results strongly confirmed the existence of inflation threshold of 1-3 per cent for advanced countries and 11-12 per cent for developing countries, after which inflation exerts negative effect on growth. The authors concluded that policymakers, around the world, should target single digits, or close to single digits inflation.

Drukker et al. (2005) applied non-dynamic fixed effect panel data methodology to ascertain at what threshold inflation was inimical to growth. Sample of 138 countries' data, over the period of 1950 to 2000, was collected. The model results identified inflation threshold of 19.16 per cent for the full sample, above this level, increases in inflation affect growth, negatively. The advanced countries' sample identified two inflation threshold points at 2.5 per cent and 12.61 per cent.

Mubarik and Riazuddin (2005) estimated inflation threshold for Pakistan, using Khan and Senhadji (2001) approach during the period 1973-2000. The result indicated threshold of 9 per cent, beyond which, inflation impacted negatively on growth. Moreover, Kremer et al. (2009) introduced a dynamic panel threshold model to examine the existence of inflation and long-run growth threshold. The model used panel date of 124 countries during the period of 1950 to 2004. The study confirmed the general consensus that inflation distorted economic growth at a certain threshold. The result indicated 2 per cent inflation threshold for the advanced countries and 17 per cent for non-advanced countries. It further confirmed that below the threshold of 17 per cent for non-advanced countries, there was no evidence of growth-enhancing effect.

Espinoza et al., (2010) focused on the speed at which inflation could be inimical to growth using the logistic smooth transition regression (LSTR) model. The study was motivated by the global high level inflation episode of 2007–08 that could truncate growth. A smooth transition model that incorporated 165 countries panel data was employed to investigate the speed at which inflation beyond a certain threshold became harmful to growth. The results indicated that beyond the threshold of 10 per cent for developing countries, inflation becomes harmful to growth. The results further showed a much lower threshold for developed countries. However, among oil producing countries, the estimates reflected heterogeneity, signalling stronger and higher inflation for oil-producing nations.

Balanli (2010) constructed sacrifice ratio model for Turkey by using three disinflation episodes that covered three financial crises in Turkey's 30-year disinflation period. The study applied HP filter on the quarterly data to arrive at three different output gaps for the three episodes. For the first episode the sacrifice ratio was –0.011, 0.002 for the second episode and 0.031 for the third episode. The study found no significant loss of output within the periods for Turkey as the values are too small to be taken into consideration. This conclusion however, showed a steady upward trend in sacrifice ratio, indicating that successively higher levels of output have been lost in the disinflation periods.

Hasanov (2011) investigated the existence of threshold effect of inflation on growth in the Azerbaijani economy during the period 2000 to 2009. Estimated model exhibited non-linear relationship between economic growth and inflation and established 13 per cent threshold, beyond the level, inflation become inimical to growth.

Sumon and Miyan (2017) conducted empirical study that examined empirically the relationship between inflation and economic growth in Bangladesh using annual data from 1986 to 2016. The two steps Engle-Granger and Johansen Co-integration model was applied to test the long-run relationship between inflation and growth. The study employed the Conditional Least Square (CLS) method to forecast the threshold level, and found inflation threshold of 8 per cent, beyond which it influence growth negatively.

Ndou and Gumala (2017) used a number of econometric techniques to estimate thresholds beyond which inflation exerts negative effects on the growth–finance nexus. The results showed the threshold ranging between 4 and 5 per cent. Points above 5 per cent inflation threshold exerted negative effect on the finance–growth nexus. The study recommended keeping inflation target below 4 per cent to support growth and enhance a sustainable financial deepening.

Ngoc and Duy (2018) investigated inflation-growth relationship in Vietnam over the period 2000-2014, using non-linear Threshold Auto-regression (TAR) model. The study also used the Bootstrap method, introduced by Hansen (2000) to test the statistical significance of the threshold effect. The results established the existence of negative inflation-growth relation above 4.8 per cent inflation rate. They also found that, at lower inflation rate of 3.9 per cent, the monetary policy space was narrowed but financial stability mitigated growth-inhibiting effect of inflation, when it was above the threshold. The same year, Tran (2018) also estimated the inflation threshold in Vietnam and examined, simultaneously the linkage between inflation and economic growth. The results indicated inflation threshold of between 3 and 4 per cent, above which growth-inducing effect disappeared, and this effect started fading at inflation rates of 5.5 to 7.5 per cent.

In Nigeria, several empirical studies had been conducted on inflation threshold. A quick review of literature in Nigeria showed diverse methods of estimation of inflation threshold and mixed results. These studies included Fabayo and Ajilore (2006); Salami and Kelikume (2010); Doguwa (2012); Bawa and Abdullahi (2012); Ajide and Lawanson (2012); Ahortor et al (2012); Monetary Policy Department of the CBN (2013 and Tule et al. 2017) and Okafor et al. (2017).

Fabayo and Ajilore (2006) empirically examined inflation threshold in Nigeria, using Khan and Sendhadji (2001) over the period 1970 to 2003. The findings showed the existence of 6 per cent inflation threshold in Nigeria. Below the threshold, inflation was growth-inducing, while above the threshold, inflation tended to retard growth. They recommended single digits inflation target for optimum monetary policy.

Salami and Kelikume (2010) used the threshold model developed by Khan and Senhadji (2001) to estimate the inflation threshold for Nigeria, using two different intervals as samples; 1970-2008 and 1980-2008. For the period 1970-2008, they arrived at a threshold estimate of 8 per cent and for 1980-2008 an estimate of 7 per cent was gotten, although it failed the test of significance. They also used the Granger causality test to establish that none of the variables (inflation and economic growth) Granger-caused the other.

Moreover, Doguwa (2012) used GARCH methodology to re-examine the existence of inflation threshold in Nigeria. Three approaches were used, which included Sarel's (1996), Khan and Senhadji (2001) and Drukker et al. (2005). The first two approaches yielded different thresholds of 9.9 and 10.5 per cent, while Drukker et al. (2015) suggested two thresholds of 11.2 and 12.0 per cent. The paper concluded that inflation threshold in Nigeria ranged from 10.5 to 12.0 per cent. Bawa and Abdullahi (2012), made use of quarterly time series data during the period 1981-2009 to estimate the inflation threshold for Nigeria. Adopting the regression model developed by Khan and Senhadji, they arrived at a threshold of 13 per cent, below which inflation had a mild effect on economic growth and above, which the effect was high, but negative.

Ajide and Lawanson (2012), using annual time series data over the period 1970-2010 and followed the Khan and Sehadji (2001) model, estimated a 9 per cent threshold level of inflation for Nigeria. They also made use of the error correction model (ECM) and established that financial index, terms of trade, degree of openness had significant impact on real GDP growth in the long-run. The pairwise Granger causality test in their study depicted an independent relationship between inflation and growth. Moreover, Omotosho and Doguwa (2012) empirically estimated inflation threshold for Nigeria, using Logistic Smooth Transition Inflation Threshold (LSTR) as in Espinoza et al. (2010). The study established inflation threshold that ranged between 10.0 and 12.0 per cent.

Ahortor et al. (2012) estimated optimal range of inflation threshold for the West African Monetary Zone (WAMZ) with a special focus on Nigeria and Ghana. Non-linear model was formulated to reflect the structure of the economies, using a conditional least squares estimation technique. The study confirmed the existence of inflation thresholds above a single in both Nigeria and Ghana.

In the quest to achieve core mandate of price stability with non-inflationary growth, Monetary Policy Department of the CBN (2013) constructed a short-to- medium-term inflation threshold model for Nigeria. The study adopted five different approaches namely, Sarel's (1996), Khan and Senhadji (2001), Espinoza et al (2010) Logistic Smooth Transition Inflation Treshold (LSTR) model and Drukker et al. (2005). The results showed that both Sarel's (1996) and Khan and Senhadji (2001) estimated 10.0 per cent inflation threshold, LSTR model suggested10.0 to 14.0 per cent thresholds, while Drukker et al. (2005) proposed 10.0 to 14.0 per cent threshold. Conclusively, the study recommended inflation threshold, ranging from 10.0 to 12.0 per cent.

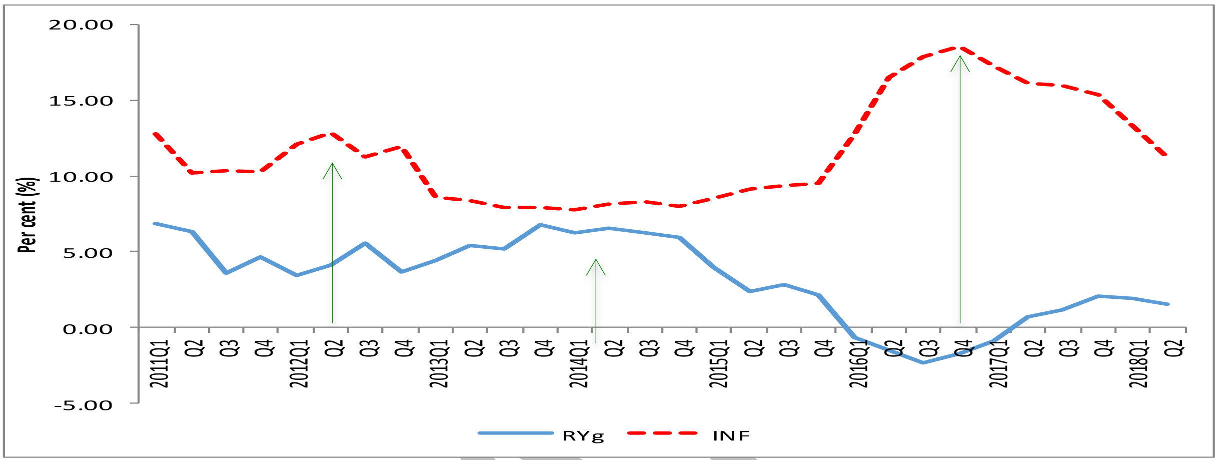
Moreover, CBN (2017) re-assessed the balance of risks between inflation and growth in Nigeria, due to the adverse economic shocks in 2015. Several approaches were adopted, which included: quadratic approach; Durlauf and Johnson (1995) approach; the Threshold Autoregressive Model (TAR) 1983 and 1990 approach; Espinoza et al. (2010) Inflation Threshold Model; and Drukker (2005) approach. The results of the three methods confirmed 10.0 per cent inflation threshold, two returned 11.0 per cent threshold, while the remaining one reported range of 10.0 to 14.0 per cent threshold.

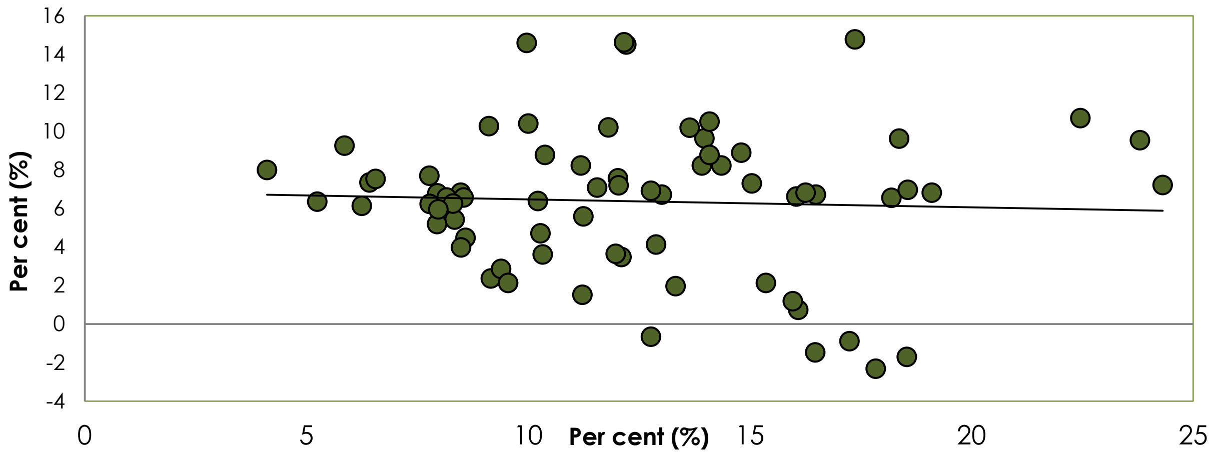
The link between inflation and output was also re-examined in Nigeria by Okafor et al. (2017), using annualised time series from 1960 to 2014. The authors adopted the Autoregressive distributed lagged (ARDL) model. The result revealed a long-run relationship existed between output and inflation. Further findings showed a bi-directional causality, running from inflation to output and from output to inflation. The authors concluded that inflation level, within a modest threshold, had the potential of influencing output growth, positively, and that past values of output were critical in forecasting inflation.

## III. Trends of Inflation and Economic Growth in Nigeria

The literature review in the preceding section broadly suggests a negative relationship between inflation and economic growth. It is imperative to further examine this relationship graphically as shown in Figure 1.

**Figure 1: Inflation and Real GDP Growth Rates, 2011Q1 – 2018Q2**




Source: NBS

Growth in real GDP remained constant at a little above 6 per cent in all four (4) quarters of 2001, before accelerating to 14 per cent between the last quarter of 2002 and the first quarter of 2003. In the years preceding the Global Financial Crisis of 2008, output growth varied between 8 and 10 per cent. Thereafter, growth plunged to a low of 4 per cent in the third quarter of 2011and remained relatively constant until the first quarter of 2015, when growth slowed down significantly, due to the huge plunge in crude oil production and prices in 2014Q2, coupled with capital reversals, occasioned by loss of investors' confidence. In the first quarter of 2016, output growth went negative, as the country went into a recession, which lasted for five consecutive quarters, owing, largely, to adverse external shocks and compounded by poorly-diversified economic base. Output growth recorded an all-time low of -2 per cent in the third quarter of 2016. The economy recovered and a 2 per cent growth was recorded in the third quarter of 2017.

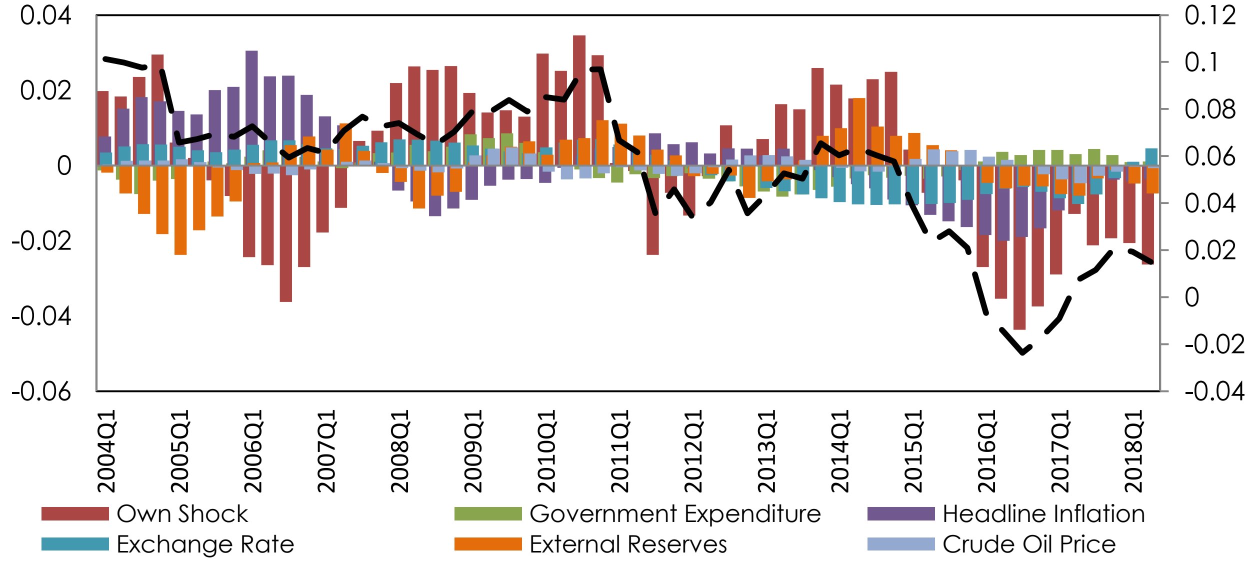
Headline inflation fluctuated prior to the Global Financial Crisis of 2008 reaching a high level of 23 per cent in 2004Q1, but dropped to 10 per cent in 2005Q1. Inflation peaked at 24.32 per cent in 2005Q1, but, hovered around 7.8 and 15.6 per cent between 2010 and 2015. It reached a high of 18.72 in 2017Q1, when the country was in a recession. However, it decelerated to 11.26 per cent in October 2018. Looking at the graphs, headline inflation and output growth appear to be inversely related. The trend line of the scatter diagram suggests a downward sloping relationship between headline inflation and output growth. Thus, an increase in inflation is associated with deteriorating growth. It is pertinent to mention that this relationship is more pronounced in the post GFC era with the graphs suggesting an era of stagflation in 2016.

From figure 1, there were three points between the period 2011Q1 to 2018Q2, where negative relationship between inflation and economic growth in Nigeria, were noticed. This shows that inflation has a negative effect on economic growth, thereby underscoring the need for monetary authorities to determine the threshold level of inflation, above which inflation is inimical to economic growth.

### III.2 Historical Decomposition of Real GDP Growth

An attempt was made to examine the contribution of inflation as a driver of growth in addition to other drivers of growth. A 6-variable vector auto-regression model was specified to reflect the possible drivers of growth. These variables include: crude oil price, foreign external reserves, nominal exchange rate, headline inflation, government expenditure and real output growth. Figure 2, suggests that shocks to inflation decelerate GDP growth rate during the periods: 2004q1 – 2008q1 and 2012 and 2013, among others. The economy recorded positive growth in the periods 2009 – 2011 and 3 quarters of 2014. This growth was influenced by significant contributions from increased oil production, positive oil price and government expenditure shocks. However, these periods coincided with negative contributions from price level shocks.

**Figure 2: Historical Decomposition of Real GDP Growth**



In summary, the relationship between real GDP growth rate and the contributions from price level shocks were found to be inverse, except for the recession period (2016Q1 – 2017Q1) where a positive relationship was observed. Negative contributions of inflation shocks coincided with increased growth.

## IV. Methodology

### IV.1 Data and Sources of Data

This study, utilised both monthly and quarterly data spanning 2000M1 to 2018M8 and 1990Q1 to 2018Q2, respectively for the analysis. The dataset include eighty one (81) variables from real, fiscal, monetary and external sectors (see Appendix for the list of variables). The idea is to simulate the relationship between real GDP growth and inflation under the conditions of mixed and same frequencies of the variables. These data were obtained from the Central Bank of Nigeria statistical database and the National Bureau of Statistics database.

### IV.2 Techniques of Analysis

The main techniques of analysis employed in this study are the factor augmented mixed data sampling (FAMIDAS) regression and a factor augmented least squares (FALS) regression. Both approaches involve the estimation of several structural models of real GDP growth, estimated with varying threshold values of inflation rate. They begin with the reduction of matrix of explanatory variables of real GDP growth, excluding inflation rate, by compressing the variables in principal components (PCs). This comes with the advantage of including, as much as possible, all the key drivers of economic growth in the structural model, without exhausting the degree of freedom of the estimated regression. However, in the FAMIDAS regression models, all the drivers of real GDP growth were first of all separated into two groups of monthly and quarterly frequencies before the extraction of PCs from each group.

#### IV.2.1 Principal Component Analysis

Principal components analysis is a way of revealing patterns in sets of data, and expressing the data in such a way as to highlight their differences or similarities. It can be used to reduce the dimensionality of the given data set by compressing the data into smaller dimensions, called principal components, without loss of information of the entire data set. In this study, we applied the methodology heighted by Smith (2002) in extracting the principal components from a set of macroeconomic variables reflecting the real, financial, external and fiscal sectors of the economy.

Assume we have an *n* x *m* matrix of explanatory variables of say inflation, and that all the variables are of the same frequency. *n* is the rows of the matrix, showing the observations of the variables, and *m* is the columns of the matrix, representing the number of variables. According to smith, the first step towards constructing PCs from this set of variables is to subtract the mean of each variable from all the observations of the variables, respectively. Next, we estimate the covariance matrix of the adjusted variables. Normally the covariance matrix would be squared matrix of m x m dimension.

From the covariance matrix, we construct an m number of eigenvectors and their respective eigenvalues, and rearrange the eigenvectors in a descending order of their respective eigenvalues. The matrix of order eigenvectors is called Feature vectors. This matrix has all its columns as the ordered eigenvectors. The final step is to multiply the transpose of the feature vector, on the right hand side, by the matrix of explanatory variables.

The resulting matrix is called the matrix of principal components. This matrix would contain PCs, arranged in descending order of their respective eigenvalues, in the columns of the matrix. The first set of PCs, which should account for at least 50 percent of the total eigenvalues, can be taken as the new explanatory variables (regressors). Though, by selecting only few of the total PCs, some information about the entire set of explanatory variables are lost, the few PCs selected usually account for sufficient information about the large variable set. This would help to retain information about the set of explanatory variables, while shrinking the dimensionality of variables matrix.

### IV.3 MIDAS Regression

Traditional approaches to time series estimation and forecasting require the regressors and regressants follow the same frequency. However, most macroeconomic and financial variables are published/released at various frequencies. Given this prerequisite, it is pertinent to transform higher frequency variables to blend with lower frequency variables.

Two crude approaches have been adopted in estimating mixed frequency datasets namely; the time averaging and the individual coefficient approach. The first approach – time averaging - involves introducing sums and averages of higher frequencies data into lower frequency regression, depending on whether such variable is a stock or flow variable. This approach is, however, faulted on the grounds that each observation in this high frequency variable enters into their newly constructed low frequency, with equal weight. In this case, the information content in their DGP is distorted, leading to bias predictions of their future path.

The second approach which is the individual coefficients – involves feeding all components of the high frequency variable as independent regressors. The shortcoming of this approach relates to the increase in the number of variables and by implication, leads to over parameterisation of the model. This would certainly undermine the goal of parsimony in regression analysis, where more variables of lower frequencies are included as regressors. Thus, we start with a generic specification of MIDAS and how to deal with the challenges.

A typical model with mixed frequency variables could be specified as follows:

$$y_t = X_t^{'}\beta + f\left(\left\{X_{t/S}^{H}\right\}, \theta, \lambda\right) + \varepsilon_t \qquad (1)$$

Where:

- $y_t$ is the dependent variable, sampled at low frequency, at date t;
- $X_t$ is the set of regressors sampled at the same low frequency as $y_t$;
- $\left\{X_{t/S}^{H}\right\}$ is the set of regressors sampled at higher frequency with S values for each low frequency value. Note that $\left\{X_{t/S}^{H}\right\}$ is not restricted to the S values associated with the current t as it may include values corresponding to lagged low frequency;
- $f$ is a function describing the effect of the higher frequency data on the lower frequency values; and
- $\beta, \lambda, and \theta$ are vectors of parameters to be estimated.

Against the backdrop of the challenges associated with mixed frequency regression, some recent studies have proposed some techniques of dealing with these challenges. The work of Ghysels et al. (2006) proposed regressions that directly accommodate variables sampled at different frequencies without making use of equal weights. MIDAS represents a simple, parsimonious and flexible class of time series models that allow the dependent and independent variables of time series regressions to be sampled at different frequencies. To enable us determine the most appropriate algorithm, we apply different weighting options as stated below.

#### IV.3.1 Step Weighting MIDAS

This simple approach of weighting employs the step function:

$$y_t = X_t^{'}\beta + \sum_{\tau=0}^{k-1} X_{(t-\tau)/S^{'}\varphi_\tau+\varepsilon_t}^{H} \quad (2)$$

Where

- K is a chosen number of lagged frequency periods to use (where *k* may be less than or greater than *S*).
- $\eta$ is a step length
- $\varphi_m = \theta_i$ for $k = \text{int}(m/\eta)$

Under this method, a step function is used to restrict the coefficients on the high frequency data, with high frequency lags within a stipulated step, having values for $\varphi$. For instance, when $\eta$ is equal to 4, the first four lagged higher frequency lags $X_{(t-\tau)/S}^{H}$, $\tau = 0,1,2,3$, make use of the same coefficient $\theta_0$, and the following four lags employ $\theta_1$, up until the maximum lag of $k$. As the number of high frequency lags increases, the number of high frequency coefficients, in the step weighing model, increases. However, in comparison to the individual coefficient approach, the number of coefficients is lowered by a factor of about $^1/_\eta$.

#### IV.3.2 Almon (PDL) Weighting MIDAS

This approach, which can also be referred to as polynomial distributed lag, is used extensively to place restrictions on lag coefficients in AR models and is employed as one of the mixed frequency weighting techniques. In this approach, for every high frequency lag up to $k$, the coefficients of the regression are modelled as a p dimensional lag polynomial in the MIDAS parameters θ. The restricted regression model is specified as follows:

$$y_t = X_t^{'}\beta + \sum_{\tau=0}^{k-1} X_{(t-\tau)/S^{'}}^{H}\left(\sum_{j=0}^{p}\tau^j\theta_j\right) + \varepsilon_t \quad (3)$$

Where p is the almon polynomial order, and the chosen number of lags k may be less than or greater than S.

Notably, the polynomial order, and not the number of high frequency lags, determines the number of coefficients to be estimated. This can be seen more clearly after rearranging the terms and rewriting the model, using a constructed variable.

$$y_t = X_t^{'}\beta + \sum_{i=0}^{p} Z_{i,t}{'}\theta_i + \varepsilon_t \quad (4)$$

$$Z_{i.t} = \sum_{\tau=0}^{k-1}\tau^i X_{(t-\tau)/S}^{H} \quad (5)$$

The distinct coefficient $\theta_i$, associated with each of the p sets of constructed variables $Z_{i.t}$

### IV.3.3 Exponential Almon Weighting MIDAS

The normalised exponential Almon weighting method uses exponential weights and a lag polynomial of degree 2, this can be represented as:

$$y_t = X_t^{'} + \sum_{\tau=0}^{k-1} X_{(t-\tau)/S^{'}}^{H} \left( \frac{\exp\left(\tau\theta_1 + \tau^2\theta_2\right)}{\sum_{j=0}^{k} \exp\left(j\theta_1 + j^2\theta_2\right)} \right) \lambda + \varepsilon_t \tag{6}$$

Where k represents the chosen number of lags, $\lambda$ is a slope coefficient that is common across lags, and the differential response comes via the exponential weighting function and the lag polynomial which depends on the two MIDAS coefficients $\theta_1 and \theta_2$.

In constructed variable form, this approach can be written as:

$$y_t = X_t^{'}\beta + \sum_{i=0}^{k} Z_{i.t}^{'} \lambda + \varepsilon_t \tag{7}$$

$$Z_{i,t} = \left( \frac{\exp\left(i\theta_1 + i^2\theta_2\right)}{\sum_{j=0}^{k} \exp\left(j\theta_1 + j^2\theta_2\right)} \right) X_{(t-i)/S}^{H} \tag{8}$$

It should, however, be noted that this regression model is highly nonlinear in the parameters of the model.

### IV.3.4 Beta Weighting MIDAS

This approach, which is based on the normalised beta weighting function, was introduced by Ghysels et al. (2006). The regression model is specified as follows:

$$y_t = X_t^{'}\beta + \sum_{\tau=0}^{k-1} X_{t-\tau}^{H} \left( \frac{\omega_\tau^{\theta_1-1}\left(1-\omega_\tau\right)^{\theta_2-1}}{\sum_{j=0}^{k} \omega_j^{\theta_1-1}\left(1-\omega_j\right)^{\theta_2-1}} + \theta_3 \right) \lambda + \varepsilon_t \tag{9}$$

In (9), k is the number of lags, $\lambda$ is the slope coefficient that is the same across lags, and

$$\omega_i = \begin{cases} \delta & \mathrm{i} = 0 \\ i/(k-1) & \mathrm{i} = 1,\ldots,\mathrm{k} - 2 \\ 1-\delta & \mathrm{i} = \mathrm{k} \end{cases} \tag{10}$$

Where δ is a small number, approximately about $2.22e^{-16}$.
The constructed variable form is written as

$$y_t = X_t^{'}\beta + \sum_{i=0}^{k} Z_{i,t}^{'} \lambda + \varepsilon_t$$

$$Z_{i,t} = \left( \frac{\omega_i^{\theta_1-1}\left(1-\omega_i\right)^{\theta_2-1}}{\sum_{j=0}^{k} \omega_j^{\theta_1-1}\left(1-\omega_j\right)^{\theta_2-1}} + \theta_3 \right) X_{(t-i)/S}^{H} \tag{11}$$

This beta function is very flexible and can be transformed into numerous shapes, such as flat, U-shaped, humped, gradually increasing or decreasing, based on the values of the three MIDAS parameter ($\Theta_1$, $\Theta_2$, $\Theta_3$). The parameters of the beta function are further restricted by imposing ($\Theta_1 = 1$, $\Theta_3 = 0$, or $\Theta_1 = 1$ and $\Theta_3 = 0$. The restriction $\Theta_1 = 1$ implies that the shape of the weight function depends on a single parameter, exhibiting slow decay when $\Theta_1$>1 and slow increase when $\Theta_2$<1. The restriction $\Theta_3$ = 0 implies that there are zero weights at the high frequency lag endpoints (when $\tau = 0$ and $\tau = k - 1$). The restriction $\Theta_1$ = 1 and $\Theta_3$ = 0 imposes both the shape and the zero endpoint weight restrictions.

It should be noted that for specifications with a small number of MIDAS lags, the zero endpoint restrictions is quite restrictive and may generate significant bias. While the number of parameters of the beta weighting model is at most 3 so that it does not increase with the number of lags, estimation does involve optimisation of a highly non-linear objective.

### IV.4 Models Specification
### IV.4.1 The FAMIDAS Framework

This study applied only the Almon/PDL weighting technique in the FAMIDAS models. The model is, therefore, in the form of a simple regression model of real GDP growth with its independent variables (in this context, PCs) measured at different frequencies. It is denoted as:

$$ry_t = \alpha_0 + \alpha_1\left(1 - d_t^{\pi^*}\right)I(m\pi_t)) + \alpha_2\left(d_t^{\pi^*}\right)I(m\pi_t) + \sum_{i=1}^{5}\alpha_{2i}qPC_t^i + \sum_{i=1}^{5}\alpha_{3i}mPC_t^i + e_t \quad (12)$$

where $ry_t$ is RGDP growth in quarterly frequency at period *t*, $m\pi_t$ represents year on year inflation rate in monthly frequency, $qPC_t^i$ is the quarterly PC at period *t* for PC1 to PC5, $mPC_t^i$ are the monthly PCs at period t for PC1 to PC5, and $e_t$ the error term. $\mathrm{I} = \begin{cases} 1 \text{ if } \mathrm{m\pi_t} > \pi^* \\ 0 \text{ if } \mathrm{m\pi_t} < \pi^* \end{cases}$ $\pi^*$is a potential value of inflation threshold chosen at a given time $\alpha_{0-3}$ are paprameters to be estimated. Equation 12 is a modified version of that of Chan (1993), in that it incorporates many control variables in different frequencies, in the form of PCs.

### IV.4.2 The Factor Augmented Least Squares (FALS) Regression Models

The factor augmented least squares regression model is similar to the FAMIDAS. However, in the FALS models all the variables are in the same frequency; in this case, all the variables, PCs inclusive, are in quarterly frequency. This study applied the modified versions of the threshold models outlined by Chan (1993), Khan and Senhadji (2001), Sarel (1996), and David *et al* (2005), within the framework of the FALS model, to determine the turning point in the relationship between inflation and economic growth. The models of these approaches are specified in the subsections below.

#### IV.4.2.1 The Threshold Model of Chan (1993)

Chan 1993, cited in Enders et al (2004), specified a threshold autoregressive distributed lag model of the form:

$$ry_t = c + \alpha_1\left(1 - d_t^{\pi^*}\right)(\pi_t) + \alpha_2\left(d_t^{\pi^*}\right)(\pi_t) + \theta X_t + \alpha_3 ry_{t-1} + e_t \quad (13)$$

$$d_t^{\pi^*} = \begin{cases} 1 \; if \; \pi_t > \pi^* \\ 0 \; if \; Otherwise \end{cases} t = 1, \dots, T$$

All variables and parameters are as defined in equation 12. $X_t$ is the vector of principal components, $\theta$ is the vector of coefficients of principal components, and $\alpha_3$ captures the autoregressive process. $\alpha_1$ and $\alpha_2$ capture the impacts of inflation on growth when inflation is below and above a given threshold, respectively.

### IV.4.2.2 The Threshold Model of Sarel (1996)

The modified version of the threshold model of Sarel (1996) specified in this study is of the form:

$$ry_t = c + \alpha_1 log(\pi_t) + \alpha_2\left(d_t^{\pi^*}\right)[\log(\pi_t) - \log(\pi^*)] + \theta X_t + \alpha_3 ry_{t-1} + e_t \quad (14)$$

$$d_t^{\pi^*} = \begin{cases} 1\ if\ \pi_t > \pi^* \\ 0\ if\ Otherwise \end{cases} t = 1, \dots, T$$

All the variables and parameters are as defined in earlier. However, in line with Sarel, in taking the log of inflation rate, all its observations below one were replaced with 0.1. Finally, while the parameter $\alpha_1$measures the impact of inflation on growth when inflation is low ($\pi_t < \pi^*$), the sum of $\alpha_1$ and $\alpha_2$ measures the impact of inflation on growth when inflation is high ($\pi_t < \pi^*$). $\alpha_2$ specifically measures the difference in the inflation effect on growth across the two regimes.

### IV.4.2.3 The Threshold Model of Khan and Senhadji (2001)

This study also employs a modified version of the threshold model of Khan and Senhadji (2001) in its estimation. This version is of the form:

$$ry_t = c + \alpha_1\left(1 - d_t^{\pi^*}\right)\{(\pi_t - 1)I(\pi_t < 1) + [\log(\pi_t) - \log(\pi^*)]I(\pi_t > 1)\} + \alpha_2\left(d_t^{\pi^*}\right)\{(\pi_t - 1)I(\pi_t < 1) + [\log(\pi_t) - \log(\pi^*)]I(\pi_t > 1)\} + \theta X_t + \alpha_3 ry_{t-1} + e_t \quad (15)$$

$$d_t^{\pi^*} = \begin{cases} 1\ if\ \pi_t > \pi^* \\ 0\ if\ Otherwise \end{cases} t = 1, \dots, T$$

Again, the variables of this model are the same as those in previous equations. However, $I(\pi_t < 1)$ and $I(\pi_t < 1)$ are dummies which take 1 for all observations of $\pi_t$ less than one and greater one, respectively, and zero for otherwise.

### IV.4.2.3 The Threshold Model of David et al (2005)

The threshold model of David *et al* (2005) attempts to determine the range of possible values of turning points in the relationship between inflation and economic growth. The modified version of their model applied here is in the form of Equation 16.

$$ry_t = c + \alpha_1\left(d_t^{\pi^*}\right)[log(\pi_t)] + \theta X_t + \alpha_2 ry_{t-1} + e_t \quad (16)$$

$$d_t^{\pi^*} = \begin{cases} 1\ if\ \pi^* < \pi_t < or = \pi^* \\ 0\ if\ Otherwise \end{cases} t = 1, \dots, T$$

Where the variables are as defined in previous equations, $\alpha_1$ therefore measures the impact of inflation, within a given range of possible thresholds, on real GDP growth. The log transformation of inflation rate here is such that all observations of the inflation rate less than one per cent are replaced with $\pi_t - 1$, while those above one are replaced with their natural logs.

### IV.4.2.4 Determining the Threshold Inflation level

To determine the threshold level of inflation from the models specified thus (equation 12 and 16), each model would be simulated at different levels of threshold of inflation rate ($\pi^*$) and their resulting sum of squared residuals (SSR) would be recorded and evaluated. A graphical plot of all the SSRs from each should reveal several troughs (minimal points), which correspond to the different levels of selected potential threshold values of inflation rate. The optimal threshold is that which corresponds to the minimum point of the least trough (Enders et al, 2004).

### IV.4.3 The Optimisation Technique

The optimisation technique involved estimating a structural model of real GDP growth as a polynomial function of inflation, and optimising the function with respect to inflation. The structural model employed in this case is of the form:

$$ry_t = c + \alpha_1(\pi_t) + \alpha_2(\pi_t)^\wedge 2 + \alpha_2(\pi_t)^\wedge 3 + \theta X_t + e_t \qquad (17)$$

The first and second order conditions for an optimum are $\frac{d(ry)}{d(\pi)} = 0$ and $\frac{d^\wedge 2(ry)}{d(\pi)^\wedge 2} < 0$. In this connection, the estimated model (Equation 17), was subjected to the first and second order tests to determine the value of inflation rate that maximises real GDP growth.

### IV.5 Preliminary Estimations

In addition to the aforementioned threshold estimations, a simple regression model of real GDP growth was estimated over the full-sample. Inflation and the key drivers of real GDP growth, captured by the principal components, were regressed against the growth of real output. This was necessary to determine the relationship between growth and inflation over the full-sample.

## V. Results and Interpretation

### V.1 Preliminary Estimation Results

### V.1.1 Correlation

The correlation between real GDP growth and inflation was estimated across different scopes to highlight the time varying nature of the nexus between the inflation and output. The correlation coefficients between the variables were also estimated when inflation recorded single digits and double digits, as seen in Table 1.

**Table1: Correlation between Real GDP Growth and Inflation**

| Period | Correlation |
|---|---|
| **2001Q1 – 2007Q1** | 0.077 |
| **2001Q1 – 2018Q2** | -0.058 |
| **2004Q1 – 2018Q2** | -0.205 |
| **2008Q1 – 2018Q2** | -0.406 |
| **2010Q1 – 2018Q2** | -0.505 |
| **2012Q1 – 2018Q2** | -0.863 |
| **2014Q1 – 2018Q2** | -0.878 |
| **2016Q1 – 2018Q2** | -0.627 |
| **Inflation>10%** | -0.045 |
| **Inflation<10%** | 0.026 |

Source: Staff Estimate

The correlation coefficient between inflation and output growth from 2001Q1 – 2007Q4 was positive but low (0.077), suggesting that, during this period, higher inflation was associated with higher output growth. For the period 2008Q1–2018Q2, however, a negative correlation coefficient of -0.41 was established. The correlation coefficient from the other sub-samples also established negative but increasing correlation between output growth and inflation, as the starting sample period approached 2018. Considering the correlation coefficient between the period of double digit inflation and output growth (that is -0.045), the results suggested that high rates of inflation were associated with low economic growth. The correlation coefficient of 0.026 further reinforced positive co-movement between inflation and real GDP growth, when inflation was single digit.

### V.1.2 Regression Results between Real GDP Growth and Inflation

To highlight the relationship between output growth and the different levels of inflation, a dynamic factor-augmented model was first specified and estimated with real GDP growth as the dependent variable and five principal components, inflation rate and one period lag of real GDP growth as explanatory variables. The coefficient of inflation was negative (-0.012), suggesting an inverse relationship between output growth and contemporaneous inflation (See Appendix I). This result is consistent with the findings of Fabayo and Ajilore (2006), Salami and Kelikume (2010) and Omotosho and Doguwa (2012), who found the inflation threshold for Nigeria to be less than 10 per cent, beyond which inflation is inimical to growth.

## V.2 Estimation of Inflation Threshold Using FALS

In order to determine the inflation threshold for Nigeria, the FALS model (Equation 13) was estimated and simulated for varying potential threshold levels of inflation, adopting various approaches as presented in the literature[3] and using data spanning 1987Q1 – 2018Q2. The results are presented in Table 2, and Figures 3 (a - c). The empirical results from the FALS model suggested a non-linear relationship between inflation and economic growth, with a 6.0 per cent threshold level of inflation when the Sarel (1996) and Khan and Sehandji (2001) approaches were utilised.

This result is consistent with the findings of Fabayo and Ajilore (2006). In addition, a 7.0 per cent threshold level was observed when the Chan (1993) approach was employed. Evidently, the threshold values estimated are lower than values found in recent empirical studies focused on Nigeria, which ranged between 8.0 and 13.0 per cent. For example, CBN (2017) calculated a threshold of about 12 per cent and Tule et al (2013) also found a threshold value of 10 per cent. Moreover, we arrived at a threshold band of 2 – 7 per cent when the Drukker et al (2005) approach was adopted, after which inflation would be inimical to economic growth. This result also supported earlier mentioned results, implying that inflation impedes growth significantly when it exceeds 7 per cent.

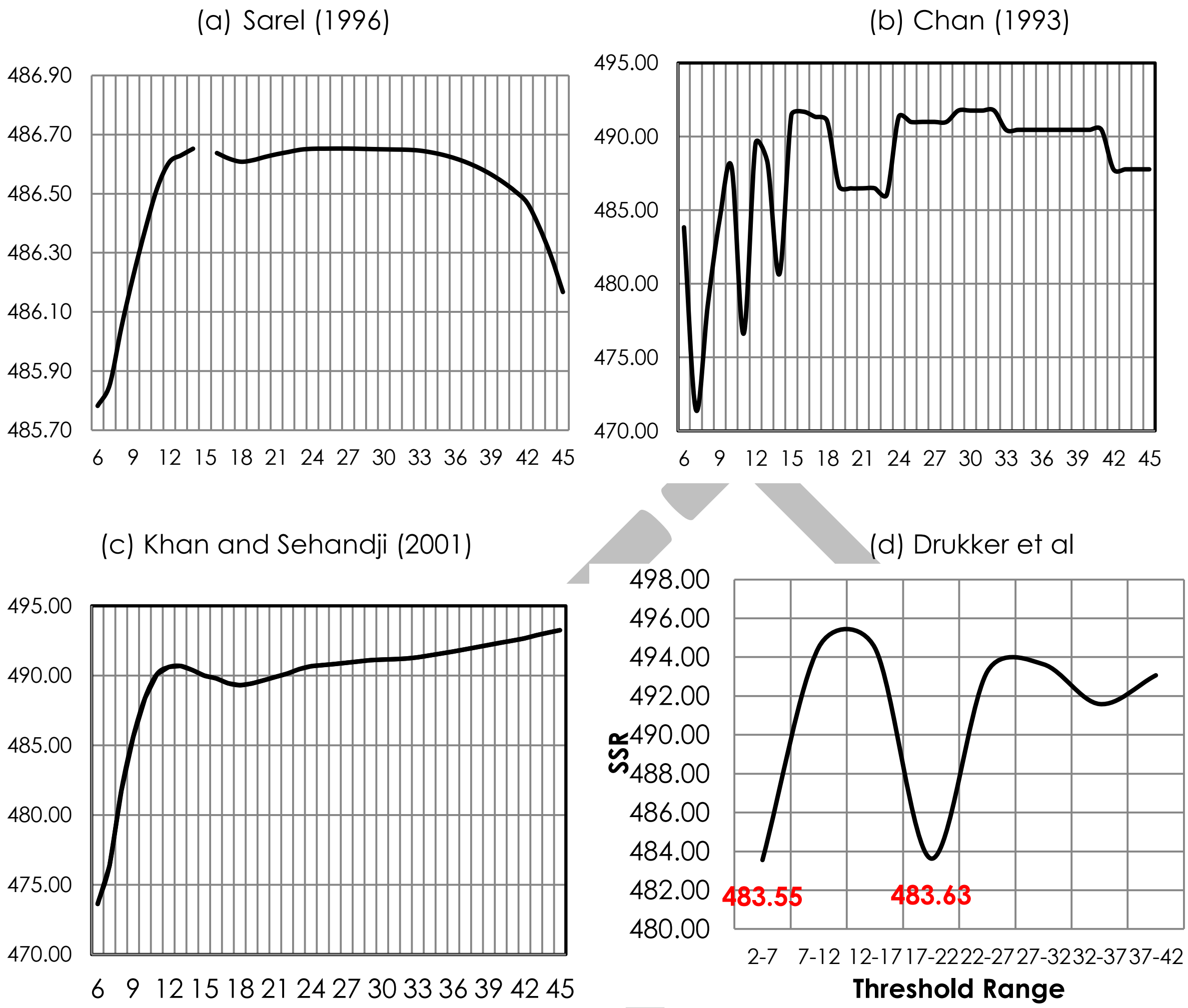
[3] Khan and Sehandji, 2001; Chan, 1993; and Sarel, 2000

**Table 2: Summary of Results (Sum of Squared Residual)**

| Threshold Levels | Sarel_SSR | Chan_SSR | Khan_SSR |
|---|---|---|---|
| 6 | **485.78** | 483.83 | **473.64** |
| 7 | 485.85 | **471.45** | 476.38 |
| 8 | 486.05 | 478.58 | 481.76 |
| 9 | 486.22 | 484.42 | 485.61 |
| 10 | 486.38 | 487.88 | 488.41 |
| 11 | 486.52 | 476.60 | 490.11 |
| 12 | 486.61 | 489.50 | 490.62 |
| 13 | 486.63 | 488.23 | 490.70 |
| 14 | 486.65 | 480.65 | 490.40 |
| 15 | | 491.44 | 490.00 |
| 16 | 486.64 | 491.69 | 489.81 |
| 17 | 486.62 | 491.33 | 489.46 |
| 18 | 486.61 | 491.05 | 489.32 |
| 19 | 486.61 | 486.62 | 489.45 |
| 20 | 486.62 | 486.48 | 489.67 |
| 21 | 486.63 | 486.48 | 489.91 |
| 22 | 486.64 | 486.48 | 490.15 |
| 23 | 486.65 | 486.05 | 490.47 |
| 24 | 486.65 | 491.33 | 490.68 |
| 25 | 486.65 | 490.99 | 490.76 |
| 26 | 486.65 | 490.99 | 490.84 |
| 27 | 486.65 | 490.99 | 490.93 |
| 28 | 486.65 | 490.99 | 491.02 |
| 29 | 486.65 | 491.76 | 491.11 |
| 30 | 486.65 | 491.76 | 491.15 |
| 31 | 486.65 | 491.76 | 491.19 |
| 32 | 486.65 | 491.76 | 491.23 |
| 33 | 486.65 | 490.45 | 491.32 |
| 34 | 486.64 | 490.45 | 491.45 |
| 35 | 486.63 | 490.45 | 491.59 |
| 36 | 486.62 | 490.45 | 491.74 |
| 37 | 486.60 | 490.45 | 491.89 |
| 38 | 486.59 | 490.45 | 492.04 |
| 39 | 486.56 | 490.45 | 492.20 |
| 40 | 486.54 | 490.45 | 492.36 |
| 41 | 486.51 | 490.45 | 492.52 |
| 42 | 486.47 | 487.77 | 492.68 |
| 43 | 486.39 | 487.77 | 492.89 |
| 44 | 486.29 | 487.77 | 493.09 |
| 45 | 486.17 | 487.77 | 493.26 |

**Source:** Staff Estimate

**Figure 3: Sum of Squared of Residual from the FALS model using the various approaches.**




**Source:** Staff Estimate

### V.3 The Growth-Maximising Level of Inflation

Following the established asymmetric relationship between inflation and real output growth in Nigeria, it was imperative to also determine, over the growth-inducing regime (all values of inflation above 7 per cent), the value of inflation for which growth rate would be at its maximum. This was done by optimising the estimated Equation 17. Both the first and second order conditions of the slope coefficients indicated that growth is maximised at 9 per cent level of inflation. From the estimate of the Chan threshold model at 7 per cent level of inflation (see Appendix 2), inflation levels above 7 per cent, captured by the slope coefficient FA2, is negative but lower than that of inflation levels below 7 per cent in absolute terms. It is, therefore, preferable to lie above 7 per cent level of inflation; as, above 7 per cent, the negative impact of inflation on growth is lower than the negative impact of growth ,when inflation is below 7 per cent. This justifies why the optimal point lies above 7 per cent.

### V.4 Robustness Check

To further highlight the nature of the relationship between real GDP growth and inflation, a FAMIDAS model was specified and estimated, using the Khan and Sehandji approach. Although similar to the FALS model, the FAMIDAS caters for mixed frequencies of macroeconomic data, thus, enhancing the information content in the analysis, through the incorporation of monthly inflation into the model. The results reveal that, over the full sample of the study, a threshold value of 7 per cent, was found to have the least sum of squared residual, suggesting that the turn-off point in the relationship between inflation and growth exists at an inflation value of 9 per cent. Beyond this value, the impact of inflation on economic growth is expect to reduce significantly, either in size or sign.

## VI. Summary, Policy Implications and Recommendations

This study was set to determine the threshold or turning point value of inflation rate in the relationship between inflation and economic growth in Nigeria. More specifically, this study sought to establish the point, over the historical observations of inflation in Nigeria, for which there is a significant switch in magnitude, size or both, in the relationship between inflation and economic growth. In view of the fact that most economic variables are key drivers of economic growth, and that these variables come in different frequencies, the study applied two models; the factor augmented mixed frequency (FAMIDAS) and the factor augmented least squares regression (FALS). Both models aggregate the many drivers of economic growth into smaller number of variables, using the technique of principal component analysis. However, while the FALS requires all variables to be of same frequency, the FAMIDAS improves on the FALS by specifying relationship between variables of mixed frequencies.

To determine the turning point, several versions of both models were estimated for different levels of potential threshold values of inflation between 1991 and 2018, and each result was evaluated to determine the value of inflation that corresponds with the model with the least sum of squared residual (SSR). The results indicate that, while monthly inflation has a turning point value of 9 per cent, quarterly inflation, from the FALS model, has a range of turning points between 6 and 7 per cent. Beyond this point, inflation is expected to assert negative impact on economic growth. In addition, the study found that, over the region below the turning point, the impact of inflation on growth is positive and peaking at 9 per cent inflation rate. That is, at an inflation of 9 per cent, the positive impact of inflation on economic growth is maximised.

It is, therefore, recommended that monetary policy should target the inflation rate of 9 per cent, which maximises the impact of inflation on economic growth in Nigeria. However, while this point is hardly attainable, considering the systemic rigidities and peculiarities of the Nigerian economy, keeping inflation rate within the band of 6 and 7 per cent is desirable and should be a continuous goal. In addition, due to the fact that it was earlier established that a double-digit inflation is inimical to growth, it is, thus, recommended that Management should:

1. Aim at inflation rate of 9 per cent to maximise growth;
2. Be at rest when inflation rate lies within the band of 6 and less than 10 per cent; and

Take decisions to possibly tighten monetary policy, when inflation rate gets to 10 per cent and beyond.

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# Appendix I

Dependent Variable: RYR
Method: Least Squares
Sample: 1991Q1 2018Q2
Included observations: 110

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 1.470323 | 0.540339 | 2.721112 | 0.0077 |
| PC1A | -0.022869 | 0.128945 | -0.177352 | 0.8596 |
| PC2A | -0.182281 | 0.152872 | -1.192371 | 0.2359 |
| PC3A | 0.110046 | 0.163860 | 0.671582 | 0.5034 |
| PC4A | -0.012294 | 0.186183 | -0.066033 | 0.9475 |
| PC5A | -0.462709 | 0.208516 | -2.219053 | 0.0287 |
| INF | -0.011697 | 0.015252 | -0.766868 | 0.4449 |
| RYR(-1) | 0.727853 | 0.066934 | 10.87422 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.698736 | Mean dependent var | 4.810973 |
| Adjusted R-squared | 0.678061 | S.D. dependent var | 3.870537 |
| S.E. of regression | 2.196129 | Akaike info criterion | 4.481217 |
| Sum squared resid | 491.9442 | Schwarz criterion | 4.677615 |
| Log likelihood | -238.4669 | Hannan-Quinn criter. | 4.560877 |
| F-statistic | 33.79625 | Durbin-Watson stat | 1.904123 |
| Prob(F-statistic) | 0.000000 | | |

**The model from the CHAN estimation that minimised the SSR**

Dependent Variable: RYR
Method: Least Squares
Sample: 1991Q1 2018Q2
Included observations: 110

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 1.805062 | 0.555054 | 3.252049 | 0.0016 |
| PC1A | 0.050668 | 0.131618 | 0.384966 | 0.7011 |
| PC2A | -0.199644 | 0.150620 | -1.325478 | 0.1880 |
| PC3A | 0.118869 | 0.161257 | 0.737140 | 0.4627 |
| PC4A | -0.076578 | 0.185714 | -0.412343 | 0.6810 |
| PC5A | -0.425320 | 0.205908 | -2.065580 | 0.0414 |
| F2 | -0.264476 | 0.121553 | -2.175818 | 0.0319 |
| FA2 | -0.022171 | 0.015816 | -1.401852 | 0.1640 |
| RYR(-1) | 0.734257 | 0.065919 | 11.13880 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.711290 | Mean dependent var | 4.810973 |
| Adjusted R-squared | 0.688422 | S.D. dependent var | 3.870537 |
| S.E. of regression | 2.160503 | Akaike info criterion | 4.456836 |
| Sum squared resid | 471.4451 | Schwarz criterion | 4.677784 |
| Log likelihood | -236.1260 | Hannan-Quinn criter. | 4.546454 |
| F-statistic | 31.10396 | Durbin-Watson stat | 1.999594 |
| Prob(F-statistic) | 0.000000 | | |

## Appendix II

**Table 2: Summary of Estimation Techniques Using the Sum of Square of Residual**

| Threshold | FAMIDAS1 2007-2018 | FAMIDAS2 2008-2018 | FAMIDAS3 2009-2018 | FALS1 2012-2018 | FALS2 2012-2018 |
|---|---|---|---|---|---|
| 3 | 0.001608 | 0.000963 | 0.000963 | | |
| 4 | 0.003031 | 0.001698 | 0.001698 | | |
| 5 | 0.001388 | 0.000961 | 0.000961 | | |
| 6 | 0.000799 | 0.000774 | 0.000774 | | |
| 7 | **0.000797** | 0.000726 | 0.000726 | | |
| 8 | 0.000853 | **0.000659** | **0.000659** | 0.00605 | **0.00481** |
| 9 | 0.0001043 | 0.000932 | 0.000932 | **0.00383** | 0.01905 |
| 10 | 0.001020 | 0.001028 | 0.001028 | 0.00535 | 0.00524 |
| 11 | 0.001412 | 0.001207 | 0.001207 | 0.00726 | 0.00618 |
| 12 | 0.001705 | 0.001409 | 0.001409 | 0.00726 | 0.00702 |
| 13 | 0.001608 | 0.000963 | 0.000963 | 0.00962 | 0.0123 |
| 14 | 0.001608 | 0.000963 | 0.000963 | 0.00962 | 0.01088 |
| 15 | 0.002369 | 0.001591 | 0.001591 | 0.00593 | 0.01866 |

# Does The Taylor Rule Influence Monetary Policy Formulation In Nigeria?

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***Abstract***

*This paper adopts the Vector autoregressive (VAR), model to empirically estimate the backward and forward-looking Taylor rule using quarterly time series data spanning 2000Q1 to 2018Q2. The study examined whether the formulation of Monetary Policy Rate (MPR) by the Central Bank of Nigeria (CBN) follows an augmented Taylor rule. In doing this, the study included exchange rate and crude oil price in analysing the CBN's monetary policy reaction function to determine the interaction between the MPR and other economic variables. The results revealed that the CBN's MPR follows the extended Taylor rule. The paper therefore recommended that the CBN should maintain the MPR at 14 per cent, to attract inflow of foreign capital, maintain stability in the foreign exchange market, boost reserves and stabilise the domestic interest rate.*

**Keywords:** Economic Growth, Inflation, Monetary Policy Rate (MPR)

**JEL Classification:** *C3, E3, E31, E32, Q48*

## I. Introduction

The mandate of price stability as the overriding objective of monetary policy is common to both developed and emerging market economies. The commitment to price stability, by most central banks, is seen as the key to achieving broader economic stability. Price stability entails the ability of the central bank to moderate inflation, maintain stable interest and exchange rates for economic growth. Thus, giving central bank a clear mandate of maintaining price stability, and holding it accountable, is seen as an essential requirement for a credible monetary policy regime. However, there is no consensus among economists and academia whether or not monetary policy formulation should be based on rule rather than discretion. This debate has provoked the search for models to determine and forecast the possible future path of monetary policy that is consistent with economic growth and inflow of foreign capital.

Some economists believe that the implementation of monetary policy rule enhances economic growth and price stability by reducing uncertainty, making monetary policy predictable and transparent. They also argued that discretionary monetary policy leads to policy error, including "time inconsistency" problem[1], economic instability, and political pressure (Taylor, 1995; McCallum, 1984; Barro and Gordon, 1983; Calvo, 1978; Kydland and Prescott, 1977; Sargent and Wallace, 1975; Friedman, 1968; Simons, 1946, 1936). Stiglitz (1998), a proponent of discretion, noted that the "decisions made by the central bank are not just technical decisions, they involve trade-offs, judgments. (pp 201)" The concern, however, remain that would such judgments be a clever choice? In view of this, Kahneman (2011) noted that expert decisions could be inferior to simple rules (like the Taylor Rule). He concluded that "to maximise predictive accuracy, final decisions should be left to formulas (Pp 4)"

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*[1]The problem is that, although a discretionary central bank might promise not to allow the inflation rate to rise above zero or some ideal value, the fact that an inflation "surprise" can enhance employment and output in the short-run will prompt it to break its promise. Realising this, market participants will anticipate higher inflation, which will lead to higher inflation rate in the long-run with no improvement in either employment or output.*

Taylor (2015) believes that following a rule makes monetary policy predictable and transparent. As agents are able to predict the actions of the monetary authority, they plan their consumption and investment decisions and are more likely to act the way the monetary authority desires. He noted that the performance of the US economy was characterised by high unemployment and inflation rates during the period in which the Federal Reserve Bank (Fed) pursued discretionary policies (from the late 1960s to the 1970s). Nevertheless, economic performance improved greatly from 1985 to 2002, as the Fed shifted to a "rule-based" policy, focused on price stability. During this period, inflation and nominal interest rates, and their volatilities. stabilised, the rate of unemployment declined and the volatility of GDP was cut by half, relative to the 1970s when Fed pursued discretionary policies. Also, recession became shorter and narrower, while cyclical expansion became longer and stronger (Taylor, 2012). However, as the Fed returned to a more discretionary monetary policy, it held the interest rate well below the level supported by a rule-based policy and, thus, laid the foundation of the subsequent mortgage-market bubble and financial market excesses, which culminated in the global economic recession that occurred in 2007 (Taylor, 2012).

It is unclear whether CBN's MPR is determined by policy rule or discretion. As such, the broad objective of the study is to ascertain whether the CBN monetary policy formulation is influenced by the Taylor rule. To achieve this, the paper adopted the augmented Taylor rule methodology by Clarida et al, (2000 and 1998) to model both the backward- and forward-looking versions of the rule to ascertain how CBN should adjust its monetary policy rule in response to inflation expectations and macroeconomic shocks. Simulations on the augmented Taylor rule for quarters two, three and four of 2018 were then performed to ascertain if the CBN's MPR follows the Taylor rule.

The remainder of the paper is structured into five parts. Following the introduction, Section 2, presented the theoretical and empirical literature as well as a critique of the Taylor rule. Section 3, focused on the methodology and model assumptions. Section 4, provided the analysis and discussion of results, while Section 5, gave the summary, conclusion and policy recommendations.

## II. Theoretical Literature, Empirical Literature and Critique

### II.1 Theoretical Literature

The theoretical literature on monetary policy rules separate the instrument rules into two important categories: interest rate based instrument rules, known as Taylor (1993) rule and monetary-based instrument rules known as the McCallum (1988) rule. McCallum's rule requires that policymakers adjust money growth when nominal GDP growth goes above or below a predetermined growth rate ceiling, using monetary base, as instrument:

$$b_t - b_{t-1} = \Delta x + {}^{1}/_{16} * [(b_{t-1} - x_{t-1}) - (b_{t-17} - x_{t-17})] - a * \left(x_{t-1} - x^{*}_{t\,t-1}\right) \qquad (1)$$

Where:

- $b_t$ is the logarithm of monetary base
- $x_t$ is the logarithm of gross national product in that period or quarter
- $\Delta x$ is the target set for nominal GDP growth, and $x_t = x_{t-1} + \Delta x$ is the path set for the GDP
- $a$ is a coefficient with the value > 0

Taylor's specification was a variant of policy rules or frameworks that were well examined in Bryant et al., (1993). Taylor(1993) demonstrated that the Federal Reserve (Fed) had been following a remarkably simple rule of reacting to gaps in inflation and output relative to a target, and that this rule performed quite well in terms of both output and price stability (as demonstrated during the period of Great Moderation). The Taylor rule serves as a guideline for monetary policy by prescribing that the policy rate should be raised when the output gap is positive or inflation is above the target level. The function for Fed is written as follows;

$$r = p + 0.5(y_t - \bar{y}_t) + 0.5\,(p - 2) + 2 \qquad (2)$$

Where *r* = the Federal funds rate, *p*= the rate of inflation, $(y_t - \bar{y}_t)$ is the output gap. The original Taylor rule predicts that for each percentage point that inflation rises, relative to the Bank's target or for each percentage point that output rises relative to its potential, the central bank will tighten monetary policy (raise the interest rate) by one-half percentage point. The rule also predicts that when inflation is at target and output is at potential, the central bank will set the interest rate at 2 per cent. The aim of including the output gap in the Taylor rule is to stabilise output in the short-run around the level that corresponds to the natural rate of unemployment (Hall and Taylor, 1997).

The original Taylor rule considers the deviation of inflation over the last four quarters from its target. Nevertheless, this is not practicable because central banks only target the expected inflation and not the past or current inflation. Consequently, Clarida et al. (1998) propose the use of a forward-looking version of the Taylor rule, which allows the central bank to take various relevant variables into consideration when forming its inflation forecasts. Thus, according to Clarida et al. (2000, 1998,), the central bank's desired level for interest rate (i*) depends on the deviation of expected inflation *k* periods ahead (in annual rates) from its target value and the expected output gap *p* periods ahead, which yields the following forward-looking Taylor rule:

$$i_t^* = \bar{r} + \pi^* + B\left[E_t\left(\frac{\pi_{t+k}}{\Omega_t}\right) - \pi^*\right] + yE_t\left[\frac{y_{t+p} - y_{t+p}^*}{\Omega_t}\right] \qquad (3)$$

Where $E$ is the expectations operator and $\Omega_t$ is a vector, including all the available information for the central bank at the time it sets the interest rate. Several authors have extended the forward-looking Taylor rule by taking into account the effect of other variables affecting the implementation of monetary policy, such as asset prices and financial variables (Tahir, 2013; Malik and Ahmad, 2010; Castro, 2011; Clarida, et al, 2000, 1997). For example, Tahir (2013), employed the forward- and backward- looking Taylor rules and found that monetary policy behaviour of State Bank of Pakistan was not very different under forward– and backward- looking Taylor rules.

Woodford (2001) argued that a Taylor rule consistent with inflation and output gap stabilisation requires the knowledge about the Wicksellian natural real rate of interest (NRRI) and the natural output. Woodford (2003) defined the NRRI ($r_t^n$) as the equilibrium real rate of interest that guarantees price stability by aligning saving with investment and demand with the flexible price level of output, but the monetary policy literature found both to be unobservable. Also, estimates of a time-varying NRRI suffer from an endogeneity problem and are imprecise when a non-model based approach is used (Laubach and Williams, 2003; Mesonnier and Renne, 2007). However, Kuhn and Muysken (2012) argued that employing a Taylor rule with fixed intercept and trend output target meets the theoretical requirements of Woodford (2001). They employed an Ak type endogenous growth model, which allows direct identification of the NRRI and its relation to the flexible price output, and found that the concern of central banks about inflation stability seem to follow a Standard Taylor rule.

### II.2 Critique of the Taylor Rule

Bernanke (2015) maintained that while the Taylor rule provided a good description of the way monetary policy was made in the past, it did not prescribe the way monetary policy should be made. Bernanke (2015) modified the measure of inflation (the rate of increase in consumer prices) used in the original Taylor rule by adopting the core personal consumption expenditures deflator, rather than the GDP deflator. He argued that the GDP deflator incorporated not only the prices of domestically-produced consumer goods and services, but also other categories of prices, such as the prices of capital goods and government spending (e.g. government spending on defense). He also noted that GDP deflator excluded the prices of imports, especially imported consumer goods.

Furthermore, Bernanke (2015) argued that the Taylor rule was based on numerical values of coefficients that may not reflect the behaviour of the monetary authorities. He noted that the relative weights on the output gap and inflation should depend, among other things, on the extent to which policymakers were willing to accept greater variability in inflation in exchange for greater stability in output specifically, he suggested an output gap coefficient of 1.0 rather than 0.5 used in the original Taylor rule)[2]. Bernanke's view was in tandem with Yellen (2012) who opined that the Federal Open Market Committee's (FOMC's) "balanced approach" to inflation and unemployment was consistent with an output gap coefficient of 1.0, rather than 0.5[3]. Bernanke (2015) further noted that both the output gap and the equilibrium real interest rate were unobserved variables and, as such, introduced arbitrariness into the conduct of monetary policy since they could not be quantified. Finally, he pointed that measures, such as the output gap, were often subject to significant revisions, which were therefore, prone to substantial judgment of the monetary authorities. Bernanke concluded that the Taylor rule should serve as a "constrained discretion" in which the forward-looking nature of policy rules constrained central banks from systematically engaging in policies with undesirable long-run consequences, and that rigid policy rules could not manage shocks and changes in the structure of the economy[4].

Romer (2001) also made several comments on the Taylor rule that relatively large values of the coefficients for inflation and output gaps would cause the actual inflation rate and output to decline faster than expected. He argued that it would be proper to use the lagged inflation and output gaps. He further opined that to deal with an open economy, the exchange rate needed to be considered and that the Federal funds rate should be incorporated to capture partial adjustment.

### II.3 Empirical Review

A brief synopsis of major studies relating to the monetary policy reaction function and the Taylor rule is examined. The original Taylor rule assumes that central banks use past or current values of inflation and output gap to set up the interest rate. However, Clarida et al, (2000, 1998) suggest the use of a forward-looking type of the Taylor rule where central

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[2]Bernanke, B. S. (2015). *The Taylor Rule: A benchmark for monetary policy?*
[3]Yellen, J. L. (2012). *The Economic Outlook and Monetary Policy*.
[4]Bernanke, B. S. (2015). *The Taylor Rule: A benchmark for monetary policy?*

banks target expected inflation and output gap, rather than past or current values of these variables to take into account various relevant variables when forming its forecasts. Clarida et al, (1998) estimated the reaction function for G3 (Germany, Japan, and the U.S.) and E3 (France, Italy, and the U.K.) countries. They found that in G3 countries', central banks followed indirectly inflation targeting and were forward-looking, thereby reacting to the expected inflation, rather than the past inflation. However, E3 countries central banks relied significantly on the German monetary policy and kept interest rates higher than the levels required for the domestic economy. They proposed that targeting inflation might be better than fixing the exchange rate. Sauer and Sturm (2007) emphasised the importance of considering a forward-looking Taylor rule in the analysis of the ECB's monetary policy.

Several studies have extended the original Taylor rule by considering the role of other relevant variables, such as exchange rate, asset price and money supply in the conduct of monetary policy. Chadha et al., (2004), presented some evidence of the Fed, Bank of England and Bank of Japan response to the exchange rate deviations from its target. A similar result was found by Lubik and Schorfleide (2007) for the central banks of Canada and England; and Francans and Vranceanu (2004) for the ECB. In the same vein, Fendel and Frenkel (2006) and Surico (2007) in considering the role of money supply in the ECB's reaction function, found that the Taylor rule did not affect the ECB's behaviour directly, but it was a good instrument to predict future inflation. Using samples from the US and Japan, Bernanke and Gertler (1999) emphasised the role of asset prices in monetary policy since it would affect the balance sheet and the cost of borrowing. They found that the Fed responded, in advance, to inflation and did not respond to asset prices, individually and criticised Japan's monetary policy in dealing with asset prices and inflation, during the 1980s and 1990s. They suggested that a central bank should respond to asset prices only if rising asset prices would raise inflation expectations. Similarly, Rigobon and Sack (2003) revealed that monetary policy reacted significantly to stock market performance because there was a 50 per cent probability that the Fed would decrease the Federal funds rate by 25 base points if the S&P index dropped by 5 per cent. However, Bullard and Schaling (2002) observed that including asset prices in the Taylor rule would result in an indeterminate equilibrium and more unpredictable volatility, and suggested that asset prices should not be included in Fed's reaction function.

Some researchers have estimated Nigeria's monetary policy reaction function. Notable are the studies by Asogu (1996), Doguwa (2002), Iklaga (2009), and Kelikume et al., (2016). Asogu (1996) specified the reaction functions of the CBN, with a monetary base and a discount rate as dependent variables. He found a significance and stability of the coefficients of the reaction function, but noted that in a number of cases, the signs of such coefficients ran counter to theoretical postulations, which was due to policy distortions, discontinuities and instability in the sample period (1960 to 1993). Doguwa (2002) followed the Taylor specification to capture the monetary policy reaction function in Nigeria, based on actual policy performance of a real MRR and the monetary base. In the study, the sample period was divided according to three distinct regimes (the Babangida, Abacha-Abdulsalam and Obasanjo administrations). The study found that the implied paths of the reaction functions fit the actual paths of the policy variables (MRR and base money) quite closely.

Iklaga (2009) estimated a Taylor-type reaction function for the CBN under various scenarios to assess the efficacy of monetary policy in influencing macroeconomic variables. The results suggested that inflationary pressures played a significant role in the decisions taken by the Bank during the review period. Agu (2007) specified two simple models of monetary policy reaction functions for Nigeria: A tracking model based on the revealed preference at the CBN, and an alternate model, which closely followed the Taylor rule. The results confirmed the primacy of inflation and credit to the private sector in the CBN's monetary policy reaction function, which was consistent with the literature.

Kelikume et al.,(2016) examined the CBN's monetary policy reaction function and how the CBN responded to the dynamic and evolving macroeconomic environment. The monetary policy response function was developed following the basic structure of the Taylor's rule using secondary time series data covering1998:Q1-2014:Q2 and employing the ARDL technique. The result provides a strong evidence that monetary policy reaction function for Nigeria was influenced greatly by the price gap in both the short-run and the long-run period, and exchange and interest rates. However, output gap variable was found to be statistically insignificant in influencing the CBN monetary policy decisions.

From the literature reviewed, the findings point to the increasing need for more in-depth analysis of whether the CBN monetary policy rate follows the extended Taylor rule or not. The snap-shot of key issues from the review of literature are summarised as follows. Most studies focus on the extended Taylor rule, but none with particular reference to Nigeria. Some empirical studies on the extended Taylor rule (Lubik *et* al, 2007; Francans *et* al, 2004; Chadha et al., 2004) used exchange rate, asset price and money supply. To the best of our knowledge, this presents an innovative attempt to apply the extended Taylor Rule in Nigeria. A number of studies have estimated Nigeria monetary policy reaction function, using the original Taylor rule (Alabi, et al., 2016; Agu, 2007; Iklaga, 2009; Doguwa, 2002). These studies used time series data and GDP that were based on 1990 base year. However, this paper employed 2010 base year and specifically focused on whether CBN monetary policy follows the Taylor rule. The study carried out scenario simulation analysis of decline and rise in the selected macroeconomic variables, which were not included in the earlier studies on reaction function in Nigeria. They were, therefore, incapable of explaining whether CBN monetary policy follows Taylor rule or not, which this study attempted to address.

## III. Methodology

### III.1 Analytical Framework

The framework for analysing the backward- and forward-looking Taylor-typed rules is achieved by decomposing interest rate rule, which allowed for the inclusion of crude oil price, exchange rate, output gap and monetary policy targets.

### III.1 Backward-Looking Taylor Rule

The backward-looking Taylor rule is the baseline model that anchored the known predicted value(s) of the parameter(s) in the model to mimic the exact value or a value close to the actual monetary policy rate (MPR). Thus, if the backward-looking Taylor model mimics the actual value of MPR, it means that the model is robust and accurate and can be employed to predict the future value of MPR. This is in consonance with the views of Taylor, (2015), Aleem (2011) and Castro (2011).

### III.2 Forward-Looking Taylor Rule

Clarida, et al., (2000) assumed that within each operating period the central bank has a target for the nominal short-term interest rate, $r_t^*$ which is a function of the state of the economy represented by the gaps between expected inflation and output from their respective targets:

$$r_t^* = v(r^*) + f(\pi_t - \pi_t^*) + g(y_t - y_t^*) \qquad (5)$$

where$v(r^*)$ refers to the desired nominal interest rate when both inflation and output are at their target levels; $f(\pi_t - \pi_t^*)$, and $g(y_t - y_t^*)$. $f\ and\ g$ depict the expectations of inflation at time $\pi_t - \pi_t^*$ and the output gap at time $y_t - y_t^*$. Given the peculiarity of the Nigerian economy, Equation (5) is modified to include exchange rate and crude oil price, as shown in equation (6)

$$r_t^* = v(r^*) + f(\pi_t - \pi_t^*) + g(y_t - y_t^*) + h(e_t - e_t^*) + j(\delta_t^*) \qquad (6)$$

where $v(r^*), f(\pi_t - \pi_t^*)\ and\ g(y_t - y_t^*)$ are as explained in Equation (5), while $h(e_t - e_t^*)$ and $j(\delta_t^*)$ refer to the desired nominal exchange rate and crude oil price, respectively. Similarly, $h\ and\ j$ represent the expected exchange rate at time $e_t - e_t^*$, while $\delta_t^*$ is the prevailing crude oil price in the international market.

Equation (6) is too restrictive to interpret the behaviour of short–term rates. Thus, in the spirit of Goodfriend and Robert (1997), Equation (6) is re-specified by assuming that the current short-term interest rate $r_t$ adjusts to its target rate $r_t^*$ , subscribing to partial adjustment mechanism. Therefore, the adjustment mechanism in Equation (6), results in an interest rate rule where, in each period, central banks react to the short-term interest rate, thereby reducing the gap between the current target rate and its past value, as given in Equation (7).

$$r_{\mathrm{t}}^* = \beta_0 + \beta_1\pi_t + \beta_2 e_t + \beta_3 y_t + \beta_4\delta_t + \mu_t \qquad (7)$$

In Equation (7), the unobserved conditional expectations in equation (6) were eliminated in terms of realised variables. The selected variables were used to forecast both the backward- and forward-looking Taylor rule, which was in line with Svensson (1997) and

Bernanke et al., (1999),. These authors opined that the evaluations of the parameters in Equation (7) could be employed to obtained a framework when the central bank faced a quadratic loss function over inflation, output, exchange rate and oil price. Therefore, the estimates of the parameters, in the backward- and forward-looking Taylor rule in Equation (7), were used to recover the implied estimates of the variables. The inclusion of oil price and exchange rate, in the model, reflected the fact that 85 per cent of government revenue comes from crude oil receipt, while exchange rate mirrors the openness of the Nigerian economy and her interaction with rest of the world.

The data employed for this study were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin and the Annual Report Statement of Accounts, and the National Bureau of Statistics (NBS).

***Interest rates*** were calculated, following the initial Taylor rule in Equation (3). In this papers, we assumed that the CBN observed the Taylor rule, and thus the Nigerian Money Market interest rates were equal to the calculated rates.

***Equilibrium interest rate (the target interest rate)*** can be calculated with different methods, depending on the structure of the economy. Sibi (2002) used a golden rule which states that the equilibrium interest rate is equal to the growth rate of the economy, while Sachs (1999) recommended that equilibrium interest rate should be equal to the average of the previous short-term interest rates. In the case of the Nigerian economy, the Sachs approach was used by calculating the equilibrium interest rate during the period 2001:1 – 2017:1, and found equilibrium interest rate to be 18.40 per cent.

***Output Gap*** $(y_t)$: This is the difference between the actual GDP and its potential. It was calculated by Taylor (1993) as follows:

$$y_t = \frac{(GDP_{Actual} - GDP_{Potential})}{GDP_{Potential}} * 100 \quad (8)$$

***Crude oil price:*** This is the price of the preference crude (the Bonny light) in the international market. It is expected that the price of crude oil should impact money market interest rates, being a veritable source of foreign exchange earnings. When crude oil price rises in the international market, it will increase foreign exchange inflow, thereby moderating both exchange and domestic interest rates, and vice versa.

### III.3 Model Assumptions

Given the relative peace in the Niger Delta region and coupled with the agreement to cut oil supply over a period of nine months (July 2017 - March 2018), by the Organisation of Petroleum Exporting Countries (OPEC) members and non–OPEC members, the price of oil in the international market is projected to be stable at US$51. Also, Nigeria was given a waiver by the OPEC and Non-OPEC from the oil production cut. The benchmark for the Nigerian crude oil (the Bonny light) used in the 2018 budget was also pegged at US$51 per barrel. In the light of the foregoing, the following assumptions were made with respect to the forecast of various growth rates in the parameters. These included:

- That inflation rate is expected to decrease by a percentage point in quarter two and then increase for the rest of the quarters in 2018 by the same margin;
- Exchange rate of the naira to dollar will appreciate in the second quarter by 1.5 per cent and thereafter depreciate in the 3rd and 4th quarters of 2018 by the same magnitude;
- The economy is expected to grow and exit from recession. Therefore, we assume that it will improve by one per cent every quarter in 2017 through quarters' 1, 2, 3 and 4 of 2018; and
- The price of the country's reference crude, the Bonny Light is expected to remain stable in quarter 1 and 2, 2018 and increase thereafter by a percentage point in quarters' 3 and 4 2018, following the US exiting from Iran's nuclear deal and placing further sanction on Iran.

## IV. Analysis and Discussion of Results

### IV.1 Trend Analysis

In this Section, attempt was made to determine the potential GDP using the rebased quarterly GDP data from 2000:1 to 2018:4. The potential GDP was calculated using the Hodrick-Prescott filter approach, while Eviews was used to generate the quarterly GDP data for the period 2000 – 2009. The output gap was calculated, following the modified Taylor rule in Equation (7) and presented in Figure 1.

**Figure 1: Output Gap**

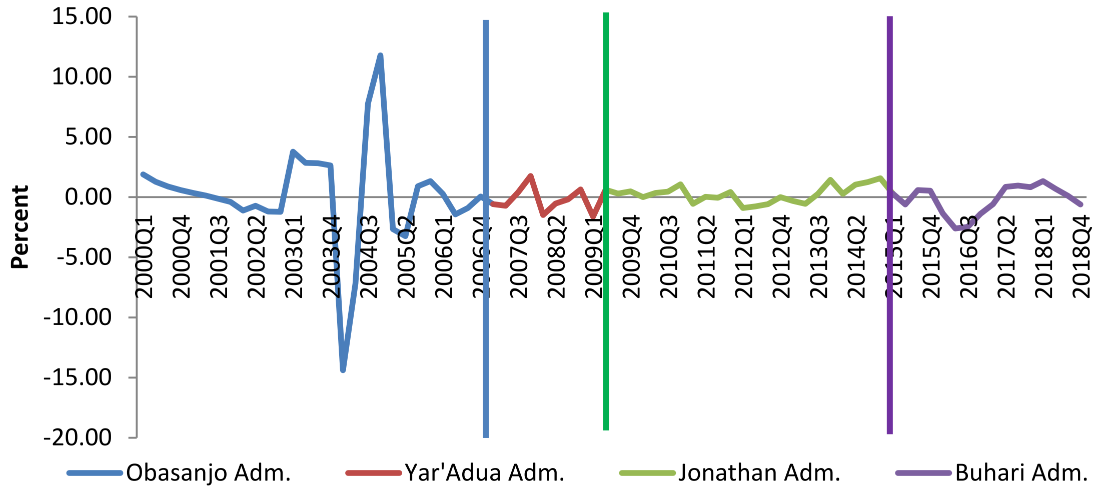
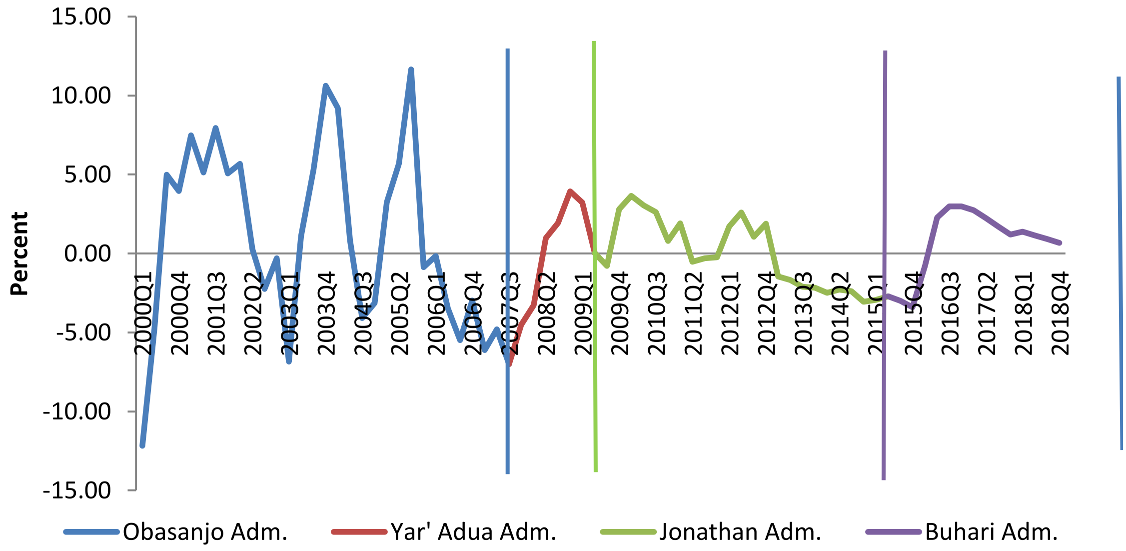


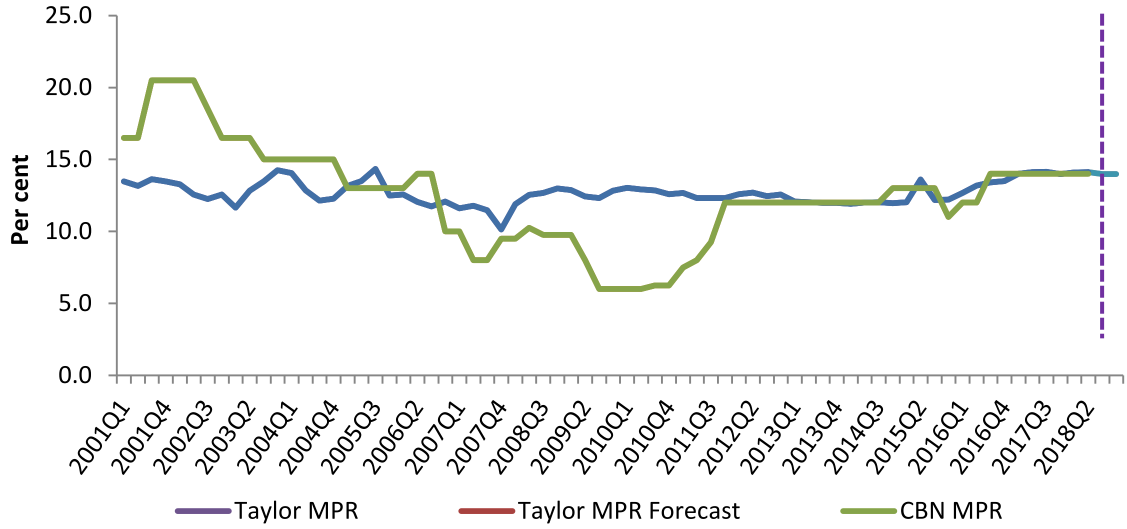

Figure 1 revealed significant instabilities in output gap between 2003 quarter 1 and 2009 quarter 2, as well as, between 2013 quarter 4, and 2018 quarters' 3 and 4 were forecasted from Equation (7). Thus, these fluctuations influenced the determination of the interest rates, using the Taylor's rule. Inflation generally is measured as the variation of the price level. Since the CBN does not express an explicit objective on inflation neither does it announces the target inflation, the study employed the HP filter to calculate the potential inflation, as shown in Figure 2.

**Figure 2: Variance in Inflation**




The comparative analysis of the calculated Taylor's interest rates for the Nigerian economy, as depicted in Figure 3, showed a significant difference between the nominal interest rate of the CBN and the calculated Taylor interest rate. The calculated Taylor interest rate took into account price stability and economic growth, with the original weights clearly demonstrate that these parameters could not fixed by the CBN.

**Figure 3: Comparative Analysis of CBN's MPR and Taylor Rule MPR**




## IV.2 Descriptive Analysis

In conducting the descriptive statistics, all the variables were in their nominal form. The result of the descriptive statistics were presented in Table 1. The evaluation of the results showed that MPR ($r_t$),INFR ($\pi_t$), GDP ($y_t$), EXCHR ($e_t$)and OILP ($\delta_t$) had average values of 13.05, 11.51, 20.30, 79.79 and 42.85, respectively. The result revealed evidence of significant variation in all the variables. This was shown by the large difference between the maximum and minimum values over the period covered, except in $r_t$ that was very small (20.00).

**Table 1: Descriptive Statistics**

| Statistics | $r_t$ | $y_t$ | $\pi_t$ | $e_t$ | $\delta_t$ |
|---|---|---|---|---|---|
| Mean | 13.05 | 1.51 | 20.30 | 79.79 | 42.85 |
| Median | 13.00 | 1.05 | 13.67 | 21.99 | 29.12 |
| Max | 26.00 | 59.75 | 89.57 | 310.00 | 127.35 |
| Min | 6.00 | 0.08 | -4.98 | 0.54 | 11.36 |
| SD | 4.10 | 4.90 | 18.91 | 82.63 | 31.82 |
| CV | 0.31 | 3.24 | 0.93 | 1.04 | 0.74 |
| Kurtosis | 3.81 | 3.74 | 4.74 | 3.45 | 3.29 |
| Skewness | 0.61 | 11.56 | 1.57 | 0.95 | 1.24 |

*Source:* Author's computation

The standard deviation (Std. Dev.), which measured the variability within a single sample, provided an indication of how far an individual series distribution varies or deviates from its mean. From Table 1, the $r_t$,$\pi_t$ and $\delta_t$ had higher mean than their standard deviation (SD), meaning that, on the average, SD were 8.95, 1.40 and 11.03 point, respectively, below their different means. Conversely, a cursory look at Table 1, revealed that even though the mean of $y_t$ and $e_t$ were 1.51 and 79.79, their standard deviations were 3.39 and 2.84 points away from their mean.

The statistical distribution of $r_t$, $\pi_t$, $y_t$, $e_t$ and $\delta_t$ variables indicated the evidence of positive skewness for all the variables, which implied that they were all right tail. The kurtosis, which describe the peakedness and tailedness of the probability distribution of a normal distributed series, showed that all the variables were moderately peaked and tailed (mesokurtic). In addition, $y_t$ and $\pi_t$ has a high (leptokurtic), suggesting that the tails were fatter than the normal distribution.

### IV.3 Correlation Matrix

All the variables employed in the correlation analysis were not statistically significant at both 1, 5 and 10 per cent levels, respectively (see Table 2). However, a cursory evaluation of the result revealed that a positive relationship existed between $r_t$ and $\pi_t$, $\delta_t$, while a negative correlation existed between $r_t$ and $y_t$, $r_t$ and $e_t$, as well as $y_t$ and $\pi_t$; $\pi_t$ and $e_t$; $\pi_t$ and $\delta_t$. A positive correlation was found between rt, $\pi_t$ and $\delta_t$; yt and et; $e_t$ and $\delta_t$, as well as between $\pi_t$ , $e_t$ and $\delta_t$ which were significant at 5 per cent levels; while that between rt and $y_t$; $y_t$ and $\delta_t$ were significant at 10 per cent. Some of the variables had low correlation coefficient, as shown in Table 2. For instance, the lowest was minus 7.6 per cent between $r_t$ to $e_t$ and the highest was at 84 per cent between $r_t$ and $\delta_t$.

**Table 2: Correlation Matrix**

| | $r_t$ | $y_t$ | $\pi_t$ | $e_t$ | $\delta_t$ |
|---|---|---|---|---|---|
| $r_t$ | 1 | | | | |
| $y_t$ | -0.1475<br>0.0746 | 1 | | | |
| $\pi_t$ | 0.2228*<br>0.0065 | -0.0567<br>0.4953 | 1 | | |
| $e_t$ | -0.0761<br>0.3581 | 0.2470*<br>0.0026 | -0.3264*<br>0.0001 | 1 | |
| $\delta_t$ | 0.8400*<br>0.0000 | 0.2085<br>0.0113 | -0.3653*<br>0.0000 | 0.6237*<br>0.0000 | 1 |

*Source: Author's Computation*

### IV.4 Unit Root for Breakpoint Analysis

The result of Phillips - Perron unit root test for breakpoint with trend and intercept was presented in Table 3. The estimated break years were presented in rows 3, 4, 5, 6 and 7. The estimated trend breaks date in the $r_t$ model coincided with the eras of banking consolidation, bank bailout and continuation with the regular open market operation in Nigeria in 2007, as we as, the Global financial crisis. This finding illustrates the significance of the added generality of the I(1) model.

**Table 3: Phillips–Perron (PP) Unit Root test for Breakpoints**

| Variables | PP(Trend & Intercept) | | | | Order of Integration |
|---|---|---|---|---|---|
| | Break Date | Levels | Break Date | 1st Diff | |
| $r_t$ | 2004 Q2 | –2.208183 | 2007 Q4 | –7.561120 | I(1) |
| $\pi_t$ | 2009 Q4 | –1.639120 | 2004 Q3 | –5.811652 | I(1) |
| $y_t$ | 2013 Q1 | –1.225737 | 2013 Q4 | –9.537699 | I(1) |
| $e_t$ | 2016 Q1 | –4.793949 | 2016 Q2 | –19.21237 | I(1) |
| $\delta_t$ | 2003 Q4 | –3.216459 | 2013 Q4 | –12.53950 | I(1) |
| *Critical Value* | *1% = 5.347598; 5% = 4.859812; 10% = 4.607324* | | | | |

*Source*: Authors computation

A cursory evaluation of Table 3 showed that 2009Q4 was carefully chosen as the most expected break date. The t–statistic value of –5.812 indicated that we could reject the hypothesis that $\pi_t$ had a unit root. The trend breaks of $\pi_t$ result was highly informative as it coincided with the eras of post bank mergers and acquisition, corporate governance reforms for banks in Nigeria, sustained liberalisation of the foreign exchange market and the decrease in MPR to 15 per cent, from 16.5 per cent. This result proved the significance of the added generality of an I(1) model.

Further analysis of Table 3 showed that 2013Q4 was cautiously picked as the utmost break date. The t–statistic value of –9.538 revealed that we could reject the hypothesis that $y_t$ had a unit root. The trend breaks of $y_t$ result was quite revealing as MPR remained the same all year round at 12 per cent, while the non-oil sector remained the major engine of growth. The relatively strong domestic growth in an environment of sluggish global growth reflected the continuing favourable conditions for increased agricultural production and incentives for strong macroeconomic management. This findings corroborated the significance of the added generality of the I(1) model.

Table 3 revealed that 2016Q2 was identified as the utmost break date. The t–statistic value of –19.2123 indicated that the hypothesis that the $e_t$ had a unit root could be rejected. The trend breaks of $e_t$ estimation was quite informative as EXCHR was floated, due to widening gap between the unofficial and the official rates coupled with the country's declining reserves, as a result of decline in oil production, owing to youth restiveness in the Niger Delta region and the glut in oil supply that kept oil price low. This judgment authenticated the significance of the added generality of the I(1) model.

The break date of crude oil price of 2013 quarter four was presented in Table 3. The t–statistic value of –12.5395 showed that the hypothesis that the $\delta_t$ had a unit root could be rejected. The trend breaks of $\delta_t$ estimation was quite revealing as the period reflected the peak in oil prices that averaged US$100. This observation coincided with the significance of the variables in the model, which were stationary at first difference [I(1)].

### IV.5 Baseline/Forward-looking Forecast for Taylor Rule

As at the time of this study, the Nigerian economy was in recession, attributed to the decline in the international price of oil. This formed the foundation for the evaluation of whether or not the MPR followed Taylor rule in Nigeria. The hypothesis from this line of thought is that, the Taylor rule would lead to harmonisation of the CBN policy rate, as it provided the anchor rate for the financial system. Three major likely policy scenarios were considered:

- Baseline Scenario: Simulation to ascertain the validity of the hypothesis under the assumption of projecting current CBN's MPR stance.
- Alternative Scenario 1: Simulation on the validity of the hypothesis under the assumption of achieving a projected 5 per cent gradual growth in macroeconomic variables of the model between 2018 Q2 and 2018 Q4.
- Alternative Scenario 2: Simulation on the validity of the hypothesis projected under the assumption of achieving a 5 per cent drastic decline in macroeconomic variables of the model within the same time period.

The projections of each of the aforementioned possible MPR scenarios were presented in Table 4

**Table 4: Model Projection**

| Quarter | Baseline | Scenario 1 | Scenario 2 |
|---|---|---|---|
| 2016Q4 | 14.00 | 14.00 | 14.00 |
| 2017Q1 | 14.00 | 13.95 | 14.01 |
| 2017Q2 | 14.00 | 14.00 | 14.10 |
| 2017Q3 | 14.00 | 14.17 | 14.35 |
| 2017Q4 | 14.00 | 13.99 | 14.02 |
| 2018Q1 | 14.00 | 14.01 | 14.29 |
| 2018Q2 | 14.00 | 13.91 | 14.15 |
| 2018Q3 | 14.00 | 13.98 | 14.07 |
| 2018Q4 | 14.00 | 14.04 | 13.89 |

Source: Author's own computation

Table 4, presented the model results from the various Taylor rule options considered. From the 2nd to the 3rd columns of the Table, were MPR projections from the 1st to 4th quarters' of 2017. The 5th row columns two and three of the table were forecasts for Taylor interest rates across the two possible CBN's MPR policy options for the year.

Fugure 4 showed the baseline forecast result, which revealed that the CBN anchor rate and the Taylor rule interest rate were moving in the same direction. This implied that the CBN's anchor rate followed the Taylor rule.

**Figure 4: Comparison of CBN's MPR and Taylor Interest rate (Baseline)**

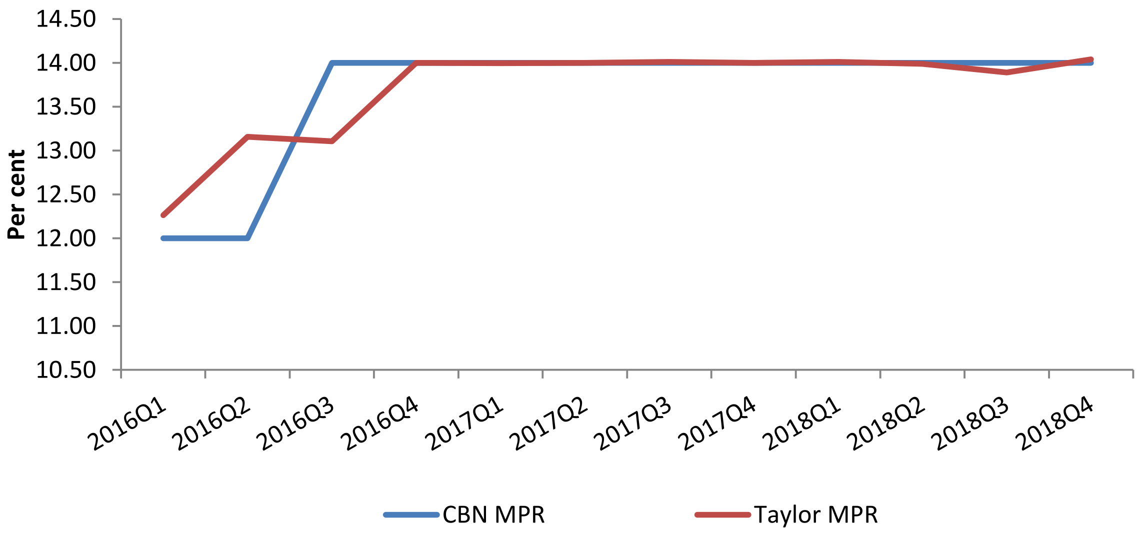
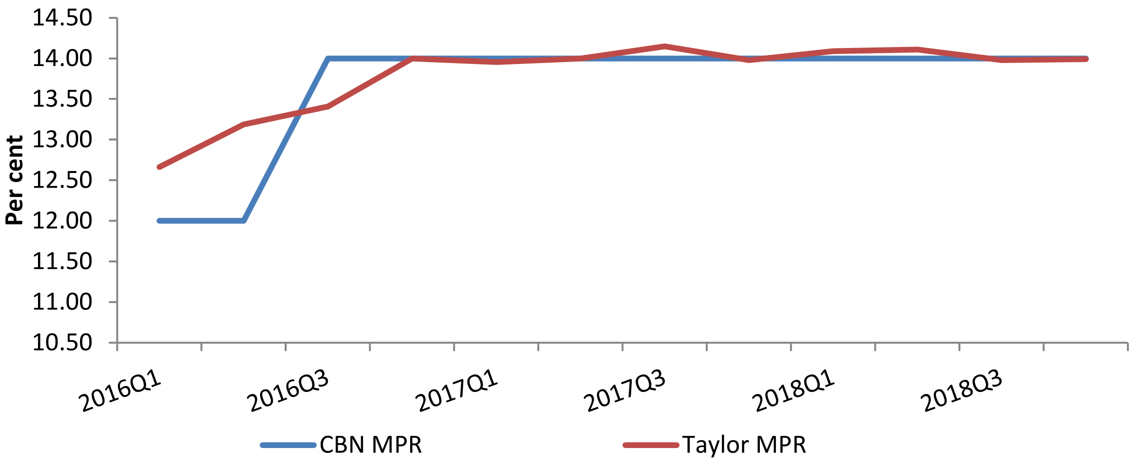


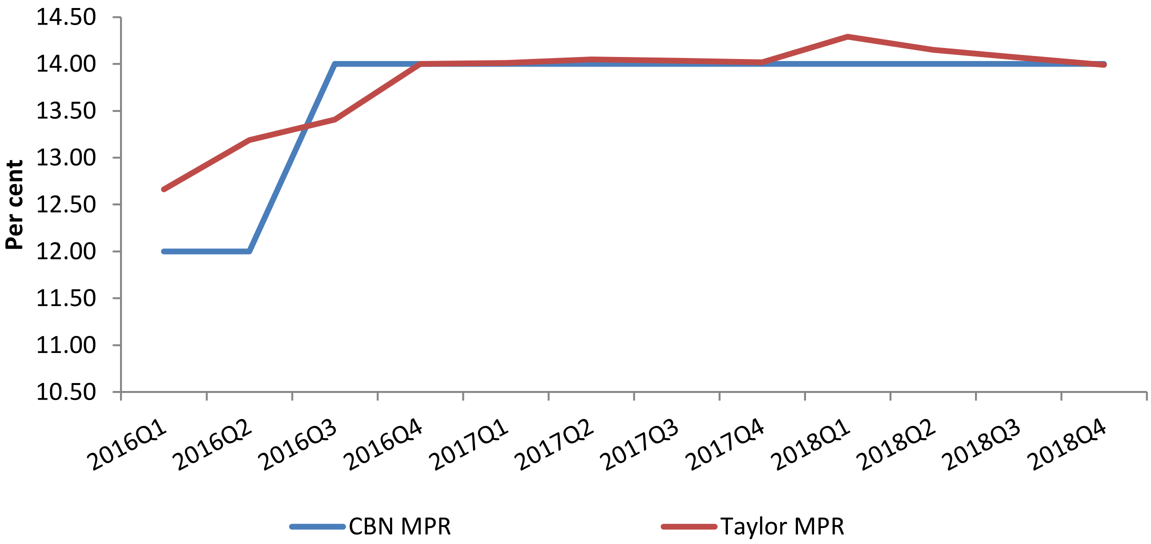

Figure 5 exemplified the relationship between CBN's MPR and the Taylor rule interest rate, using scenario 1 to validate the assertion that the CBN's MPR follows the Taylor interest rate, relative to the baseline result. The magnitude of the Taylor rule interest rate was marginally higher in 3rd quarter 2018 and the likelihood of a relative higher MPR (14.07%), in relation to decrease in other variables, was shown in Figure 5.

**Figure 5: Comparison of CBN's MPR and the Taylor Interest rate (Scenario 1)**




The  result indicated that the CBN anchor rate and the Taylor rule interest rate had the tendency to  co-move, if the current FG recovery and growth plan, as well as, the CBN's foreign exchange policies, were sustained without any significant modifications until the end of fourth quarter of 2018.

**Figure 6: Comparison of CBN's MPR and the Taylor Interest rate (Scenario 2)**




All things being equal, the hypothesis that the CBN MPR follows Taylors' rule to bring about convergence in the anchor rate appeared to be valid. The simulation result of CBN anchor rate was projected and showed that, convergence is possible in fourth quarter of 2018. The indication in Figure 6, clearly suggests that the CBN's MPR followed the Taylor interest (convergence). Therefore, the CBN should hold its anchor rate in the 3$^{rd}$ and 4$^{th}$ quarters of 2018 at 14 per cent.

## V. Summary, Conclusion and Policy recommendation

This paper investigated whether the Taylor rule influenced monetary policy formulation in Nigeria using quarterly data spanning 2000Q1 to 2018Q2. The augmented Clarida, et al., (2000 and 1998) vector autoregressive (VAR) model was employed to empirically evaluate the backward and forward- looking Taylor rule to ascertain how the CBN adjusts its monetary policy rule in response to inflation expectations and macroeconomic shocks. Using the augmented model, we forecast the monetary policy rate for the third and fourth quarters of 2018.

The backward and forward-looking Taylor rule simulations revealed that the CBN's MPR followed the Taylor rule. The study therefore, recommends that the rate be maintained at 14 per cent, to attract inflow of foreign capital, maintain stability in the foreign exchange market, boost reserves and stabilise the domestic interest rate.

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# A Re-Appraisal of the Savings-Growth Nexus in Nigeria

*Eboreime, I. M., Adigun, A. M., Adegbe, O., Elisha, D. J., and Oji-Okoro, I.**

***Abstract***
*The relationship between savings and economic growth has received considerable attention from economists worldwide. The debates have been centered, largely, on determining the nature and direction of the relationship, as well as, the extent of influence of the variables on one another. This study empirically re-appraised the savings-growth nexus in Nigeria, within the context of the business and financial cycles, using quarterly series of the rebased gross domestic product (GDP) data. Output-gap was used to proxy business cycle, while savings-gap proxied financial cycle to investigate how the business cycle interacts with the financial cycle. The analysis showed that output-gap Granger-caused savings-gap, implying that the current level of savings rate in Nigeria arises from the low economic growth. The findings emphasised the need for managers of the financial system, particularly the banking sector, to always be proactive by instituting countercyclical measures at the onset of economic crisis to safeguard the stability of the financial system against the possible aftereffects of economic downturn, as evidenced in the history of business and financial cycle in Nigeria.*

**Keywords:** Gross Domestic Product, Economic Growth, Business Cycle, Financial Cycle, Output Gap, Savings Gap

**JEL Classification Numbers:** E32, F43

## I. Introduction

The relationship between savings and economic growth has received considerable attention in the literature. This has been driven by the increasing need for policymakers to better understand the dynamics of the interactions between savings and economic growth, especially as economies evolve and become more complex. Consequently, the debates have been centered, largely, on determining the nature and direction of the relationship, as well as, the impact of savings on economic growth, and vice versa.

Different theories postulated close relationship between savings and growth. Financial liberalisation theorists identify savings as a basis for investment and catalyst for economic growth. Financial repression theorist, however, argues that rising savings do not necessarily lead to high growth, due to leakages, even in a developed financial sector. Moreover, empirical studies have established that the direction of influence between savings and growth could be bi-directional. This is because peculiarities of economies strongly affect possible dynamics, policy opportunities and outcomes. In general, there is strong support for the importance of savings in the process of achieving sustainable growth and development. More recently, probe into the interactions among the various economic cycles has further provided robust framework for

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understanding the nature and extent of the interactions between economic growth (business cycle) and savings, as an element of financial cycle.

Over the years, Nigeria has been grappling with major disequilibrium in both the domestic and external sectors. The mono-product nature of the economy and high propensity to import has continuously widened the savings-investment gap and made the economy dependent on external financing for growth-enhancing investment. Adebiyi (2005) explicitly noted that balance of payment problems in Nigeria had resulted, largely, from high saving-investment gap. Though results of studies on the savings-economic growth nexus in Nigeria have been mixed, there is general consensus in support of relationship between savings and economic growth in the short- and long-run. It is, however, pertinent to provide more evidence to effectively guide policy, as policymakers intensify effort to achieve sustainable economic development in the face of an increasingly sophisticated economy.

This study intends to re-appraise the savings-economic growth relationship in Nigeria, within the context of the interactions between business and financial cycles. It, therefore, attempts to expand existing literature in this direction by highlighting the pro-cyclicality between savings and economic growth. To the best of the authors' knowledge, no study in the past on Nigeria has investigated the savings-economic growth nexus within the context of business or financial cycles.

The rest of the paper is organised as follows. In Section 2, a brief review of theoretical and empirical literature was presented, while Section 3 contained developments and trend analysis on savings and economic growth in Nigeria. Data and methodology was discussed in Section 4, while Section 5 focused on major findings and the policy issues. Section 6 concluded the paper.

## II. Literature Review

### II.1 Theoretical Literature

#### II.1.1 Financial Liberalisation and Financial Repression

The theoretical literature on the savings-growth nexus broadly consist of the classical economists' view that the direction of association runs from savings to investment to growth and the Keynesians, who maintained that the direction of influence runs from investment to growth and savings. The classical economists hold that savings is a necessary and sufficient condition for investment, which ultimately drives productive activities and economic growth. An extension of this view is the position of the financial liberalisation theorists[8], which believes that financial liberalisation facilitates the accumulation of savings for the acquisition of physical capital or money balances. They further considered money balances (working capital) as a factor of production on which production depends, like physical capital, and therefore argued that savings compliments investment in the development process. Thus, Levhari & Patinkin (1968) and McKinnon (1973) conclude that, as a factor of production, money (working capital) facilitates the move to a higher level of per capita output than would otherwise have been possible.

To further underscore the importance of savings in the development process, McKinnon (1973) opines that economic agents engage in savings, not just for itself but, for the ultimate goal of

[8] *Proponents of this view include: Levhari & Patinkin  McKinnon (1973), Shaw (1973)]*

investment. He argued that given the usual large size of investment expenditure and the fact that self-finance is the first option for financing business enterprise, money needs to be accumulated for investment to take place. Hence, to encourage savings and facilitate investment, real interest rates must not just be positive, but also remain below the real rate of return on investment. Thus by facilitating savings, financial liberalisation drives investment and growth process (Shaw, 1973).

Financial repression theorists, on the other hand, believe that savings are simply a leakage from the production process. They added that with a developed financial sector, economic agents need to make a choice between buying physical capital and holding stock of purchasing power (money balance). This increases the chances of such funds not being channeled to productive investment, a situation that eventually leads to lower equilibrium growth path. Hence, Tobin (1965) argued that the development of a monetary sector could be damaging because savings are not necessarily committed to investment.

Overall, the classical theorists consider savings as a prerequisite for investment and growth, while the Keynesians identify the opportunities for profit and availability of credit to the private sector as the key driver of investment and growth. According to Solimano(1997), there are two leading theoretical perspectives on savings, investment and growth: the''Marx, Schumpeter and Keynes view'' and Mill, Marshall and solow's view''. The ''Marx, Schumpeter and Keynes view'' posited that innovation and investment are critical for growth and savings will only adjust to meet required investment. On the other hand, , Mill, Marshall and Solow's view is that all savings are automatically invested and translated to output growth.

#### II.1.2 Growth Models

A number of growth theories have attempted to explain the specific interactions between savings and growth, and how one affects the other. The Harrod-Domar Growth Model is one of the simplest growth models based on the Keynesian savings-investment analysis. It is the direct outcome of projection of the Keynesian short-run analysis into the long-run and stresses the importance of savings and investment as key determinants of growth. The model assumes that the average propensity to save is equal to the marginal propensity to save (S/Y = ∆S/∆Y). In other words, absolute change in savings is equal to the relative change in savings. The model adds the notion of a capital-output ratio {k/y = ($\theta$)} to the general concepts of income, saving and consumption, and capital accumulation to form a framework of growth. It also assumed that there are no lags in adjustment and that the marginal propensity to save and capital coefficient are constant. The capital-output ratio is basically the efficiency of production for an economy, measured in terms of capital, such that low capital-output ratio implies the economy produce more with less capital and vice versa. Also, high quality capital will be very productive and have a low capital-output ratio. In its simplest form, the Harrod-Domar equation for growth is:

$$gw = \frac{s}{\theta} \qquad (1)$$

Where gw is the natural growth rate of the economy, s is the savings rate and $\theta$ is the capital-output ratio. The growth of the economy is therefore positively related to its savings ratio and negatively related to the capital-output ratio. Increasing the savings ratio, the amount of investment or the rate of technological progress are vital for the growth process. The model, therefore, holds that low economic growth in developing countries is due to low savings rate which creates vicious cycle of low investment, low output and low savings. It recommended deliberate increase in savings, domestically or from across borders, to boost growth.

The neoclassical growth model identified capital and labour as the two major determinants in an endogenous production function, which also recognised technology as an exogenous factor that ultimately leads to shifts in the total production function. It explains economic growth through capital accumulation (i.e., saving and investment) and how this growth process ends in steady state equilibrium. Steady state equilibrium implies growth rate of output equals growth rate of labour force and growth rate of capital (i.e., $\Delta Y/Y = \Delta L/L = \Delta K/K$) so that per capita income and per capita capital are no longer changing. At steady state equilibrium, therefore is

$$\Delta Y/Y = \Delta K/K = \Delta N/N = n. \quad (2)$$

The theory considers saving as a constant fraction of income theory Thus,

$$S = sY \quad (3)$$

Further, since national income equals national product, we can also write Equation (1) as

$$sY = sF\,(K, L) \quad (4)$$

With planned investment assumed to always equal planned saving, net addition to the stock of capital (K) or investment (I), can be obtained by deducting depreciation of capital stock from the planned saving. Thus,

$$\Delta K = I = sY\text{-}D \quad (5)$$

Where $\Delta K$ = net addition to the stock of capital, I stands for investment and D for depreciation. Depreciation occurs at a certain percentage of the existing capital stock. The total depreciation (D) can be written as:

$$D = dK \quad (6)$$

Substituting dK for D in Equation (3) we have:

$$sY= \Delta K+ dK \quad (7)$$

Now dividing and multiplying the first term of the left hand side of Equation (7) by K we have

$$sY = K.\ \Delta K/K + dK \quad (8)$$

Hence, for the steady state equilibrium, growth of capital ($\Delta K/K$) must be equal to growth of labour force ($\Delta L/L$), so that capital per worker, and therefore income per head, remains constant. If we denote growth rate of labour force ($\Delta L/L$) by n, then is steady state $\Delta K/K = n$. Substituting n for $\Delta K/K$ in Equation (7) we have:

$$sY = K.n + dK \text{ or } sY=(n + d)K \quad (9)$$

Equation (9) is a fundamental growth equation of the neoclassical growth model that states the condition for the steady state equilibrium when capital per worker, and therefore income per capita, remains constant even though population or labour force is growing. Written in per capita terms, the growth equation is divided by L to give

$$sY/L = (n + d)\ K/L \qquad (10)$$

where Y/L represents income per capita and K/L represents capital per worker (i.e. capital-labour ratio). Writing y for Y/L and k for K/L we have

$$sy = (n + d)k \qquad (11)$$

Equation (9) represents fundamental neoclassical growth equation in per capita terms. An important economic implication of the above neoclassical growth process is that higher saving rate leads to a higher growth rate, especially in the short-run. The increase in the saving rate raises the growth rate of output, due to faster growth in capital and, therefore, in output. However, as more capital is accumulated, growth rate decreases due to the diminishing returns to capital and eventually falls back to the population or labour force growth rate (n).

Another important contribution to the theory of economic growth is the Solow model, which presents a simplified picture of the economy as a whole and provides insight into the causes of the economic growth. Solow and Swan postulates that the saving rate, the population growth rate and the rate of the technological progress are the main determinants of the economic growth. It is a more dynamic model that is built on the neoclassical aggregate production function:

$$y_t = \{A(t) + K\,(t) + L\,(t)\} \qquad (12)$$

Where $y_t$ is the aggregate output, generally measured as real GDP and presented as function of A, which is the measure of productivity or the level of technology at time; K is the capital input at time t; and L is the labour input at time. The supply of labour from the household is assumed inelastic and, as a result, the labour force grows exogenously at a constant given rate. Technology is also assumed to change only in the long-run but remain constant in the short-run, because it takes time for technological progress to mature. In line with the assumptions of the Solow model, therefore labour and the factor of technology will grow at constant exogenous rates in the short-run, so that:

$$L\,(t) = L(0) \text{ and } A\,(t) = A\,(0) \qquad (13)$$

Thus, in the Solow model, the main source of economic growth in the short-run is capital accumulation from investment, which depends on the level of savings, since every income is assumed to be partly consumed or partly saved for investment. In the short-run, the change in capital (investment) leads to the change in level of total income. An exogenous technological growth rate is the main driver of the long-run economic growth.

### II.1.3 Theoretical Framework

As a result of changes in employment levels and productivity, every economy fluctuates between periods of expansion and contraction. These changes are reflected as recession or expansion in the short-run; but in the long-run, the resultant economic growth allows for increase in the potential output level of the economy. Thus, prior to the achievement of the long-run potential output, every short-run output level represents a deviation (positive or negative, otherwise output gap) from the long-run potential output level. This fluctuation from one short-run output level to another, around a long-run potential output, is generally referred to as business cycle. The business cycle describes the increase and decrease in an economy's GDP over time. There are four distinct phases in a business cycle, including expansion, peak, contraction and trough. Features of expansion stage are rising employment, economic growth and inflationary pressure, and vice versa. Though business cycles are generally considered unobservable, a number of indicators rely on the decomposition of output level (GDP) into trend (long-run potential level) and cyclical (fluctuating short-run levels) components. The cyclical components of the GDP (otherwise known as the output gap) is the difference between potential and actual level, which proxied an economy's business cycle as variously used by different authors[9]. As noted by Kastrati et. al., (2017), conventional theory defines the business cycle as fitting a mean trend to the actual output, while the cycle, as proxied by the output gap, will symmetrically fluctuate above or below that mean over time.

An approximate definition characterises financial cycle as self-reinforcing interactions between perception of value and risk, attitudes towards risk and financing constraints, which translates into boom followed by busts (Borio, 2012). This analytical definition also coincides with the procyclicality perspective of the financial system to policy making around the new focus on business fluctuations and financial crises. Whereas a number of authors established that the concept of financial cycle predates the much more common and popular business cycle[10], it had only featured in the works of the outside mainstream authors like Minsky, (1982) and Kindleberger (2000). In the past two decades, there is an imperative for understanding financial cycle in the task of ensuring effective macroeconomic analysis and corresponding policy response to the challenges of business and economic fluctuations.

Savings gap is the difference between the current level of savings in the domestic economy and the savings level required to achieve the optimal long-run economic activity level. It is generally the deficit between current aggregate savings and the level of savings required to provide funds for business investment, along the path of natural rate of economic growth. Though co-movement of credit and property prices provides the most parsimonious description of the financial cycle, particularly in the developed economies[11], the underdevelopment of the state of financial markets and property sector limits this interaction in developing economies. Hence, the state of savings mobilistaion, as the impetus for capital accumulation, could be a good approximation for describing indication of the state of the financial cycle in developing economies. This study adopts savings gap as proxy for financial cycle.

[9] Duval R., Elmeskov, J. and Vogel, L. (2007); Kastrati A., Pugh, G. and Toci, V. (2017)
[10] Zarnowitz (1992), Laidler (1999) and Besomi (2006)
[11] Dremann at. Al (2012)

### II.2 Empirical Literature

Three broad strands of studies exist in the literature on the savings-growth nexus across advanced and developing economies. A strand of the literature found unidirectional causality from savings to economic growth, supporting the works of Solow (1956). On the other hand, some of the other studies have shown the reverse relationship where economic growth determines growth in savings, as postulated by Keynes (1936) and in Saltz (1999). Though generally inconclusive, outcomes of empirical exercises have been, dependent largely, on the macroeconomic peculiarities of the economies investigated. Hence, a third strand of the literature established bi-directional relationship such that each can influence the other at different times. In addition, there have been a number of cross-sectional studies that examined the savings-growth nexus to identify and isolate the functional peculiarities. Table 1 contains highlights of selected studies, the methodologies and findings. Notably, Ganioglu and Yalcin (2013), in a cross-country analysis found compelling evidence that countries, on average, financed a larger fraction of their capital with domestic savings. They found that international financial integration increased domestic savings rate to finance domestic capital (higher self-financing ratio), thereby contributing to growth performance of countries. They emphasised that the findings were more pronounced for low-middle income countries and that economies with low or declining self-financing ratios had been more affected during the recent global financial crisis.

In one of the pioneer studies to investigate the savings and growth nexus in Nigeria, Adebiyi (2005) employed Granger causality tests and impulse response analysis of vector auto regressive models (VAR) to assess the relationship in Nigeria, using quarterly time series between 1970 and 1998. The study found that per capita income was sensitive to the saving-GDP ratio. High but negative correlation coefficient was found between savings and economic growth. The impulse response analysis andthe result of the Granger causality test showed that saving-GDP ratio Granger-caused per capita income.

Abu (2010) analysed savings and economic growth in Nigeria between 1970 and 2007. The Johansen co-integration results established long-run equilibrium co-integration. He also found that Granger causality ran from economic growth to savings, implying that economic growth precedes savings. The study recommended policies that accelerate economic growth to increase savings. Bankole and Fatai (2013) employed the Granger-causality and Engle-Granger co-integration techniques to analyse annual data on savings and economic growth in Nigeria from the period 1980 to 2010. The results revealed that causality runs from savings to economic growth in Nigeria. Similarly, in a study to examine the causal relationship between domestic private savings and economic growth in Nigeria from 1980 to 2013, Odionye et. al., (2016) adopted the augmented Granger causality test approach developed by Toda and Yamamoto (1995). Outcome of the Johansen co-integration test indicated a positive long-run relationship between savings and economic growth. The study proposed appropriate policies mix to enhance savings for economic growth.

The summary of relevant studies is contained in Table 1

**Table 1: Selected Studies on Savings-Economic Growth Nexus**

| Author | Jurisdiction(s) | Methodology | Findings |
|---|---|---|---|
| Rahman and Uddin (2012) | **Bangladesh** (Annual data covering the period from 1974 to 2005) | Simultaneous equation to examine the role of savings in accelerating economic growth | • Growth rate and real rate of interest had a positive impact on savings rate. Financial savings, foreign direct investment and literacy rate positively affect the growth rate of the economy.<br>• Findings confirmed positive savings-growth simultaneity effects. |
| Tang (2013) | **Malaysia** (Annual data from 1961 to 2000) | Generalised Variance Decomposition Analysis, using the Bounds testing approach to co-integration. Generalised forecast error variance decomposition technique | • Stable relationship between economic growth and savings in Malaysia and coalescing in the long-run<br>• Economic growth in Malaysia was dominated by domestic savings<br>• Impact of foreign savings was relatively insignificant |
| Najarzade, Reed and Tasan (2014) | **Iran** (Annual data for the period 1972- 2010) | Autoregressive Distributed Lag Model | • Positive and significant two-way impact of savings on total and non-oil economic growth and vice-versa<br>• Two-way long-run causal relationship between savings and economic growth and between saving and non-oil economic growth. |
| El-Seoud (2016) | **Bahrain** (Data over the period of 1999-2014) | Co-integration, vector error correction and Granger Causality | • Stable long-run equilibrium relationship between household savings and economic growth, and Significant unidirectional causality, running from economic growth to household saving |
| S.K. Patra et al. (2017) | **India** (Annual time series data for 1950-2012) | Vector error correction Granger causality/block Erogeneity Wald Tests, Bai-Perron, Brown's PLS-based CUSUM test | • Savings and economic activity had long-run relationships with causality, running from savings to economic growth. |
| Odhiambo (2009) | **South Africa** (Period 1950–2005) | Co-integration-based error–correction mechanism | • Bi-directiona l causality between savings and economic growth in the short-run<br>• Distinct unidirectional causal flow from economic growth to savings dominated in the long-run<br>• Predominance of Growth-led savings |
| Chrispin (2010) | **Zambia** | Vector auto regression | • Economic growth 'Granger'-caused domestic savings |
| Jagadeesh | **Botswana** (Time series data for | Auto Regressive Distributed Lagged (ARDL) applied to Harrod– | • Significant relationship existed between Savings and Economic growth. |

| | | | |
|---|---|---|---|
| (2015) | the period of 1980 to 2013) | Domar growth model for Botswana. | |
| Siaw et al.,(2017) | **Ghana** (Annual data from 1970-2013) | Johansen co-integration and vector error correction model | In the long-run, consumer price index, trade openness, foreign direct investment, and domestic savings had positive significant impact on economic growth. In the short-run, lags in domestic savings had negative but insignificant effects on economic growth. |
| Mohan (2006). | **25 selected countries** (low-income (LIC), low-middle-income (LMC), upper-middle income (UMC) & high-income countries (HIC) (Annual data from 1960 to 2001) | Granger-causality test on annual time series data to examine the savings-growth nexus in the countries | • Mixed outcomes in the LIC,<br>• Economic growth influenced savings growth in LMCs.<br>• Bi-directional relationship was prevalent in the UMCs,<br>• Nexus in the HICs were generally from savings to economic growth. |
| Tang and Ch'ng (2012) | **ASEAN-5 Economies** (Annual data from 1970 to 2010) | Multivariate analysis of savings and economic growth and Bartlett-corrected trace test for co-integration | savings and its determinants were co-integrated in the five ASEAN founding countries bootstrapping approach indicated that savings Granger-caused economic growth in all ASEAN-5 economies; savings was a prominent source of economic growth and development, at least for the five ASEAN countries investigated |
| Aghion et. al (2009) | **118 countries** (series for 1960 to 2000) | Regression Analysis | • lagged savings was positively associated with productivity growth in poor countries but not in rich countries |
| Bolarinwa and Obembe (2017) | **Six sub-Saharan fastest growing African economies** (1981 and 2014) | Autoregressive distributed lag (ARDL) and the Toda and Yamamoto causality test between gross domestic savings and economic growth | • Unidirectional causality from economic growth to gross domestic savings for Ghana and Burkina Faso and<br>• Unidirectional causality from gross domestic savings to economic growth in Liberia, Niger and Sierra Leone<br>• No causality was recorded for Nigeria.<br>• Study concluded that the direction of causality was mixed and country-specific among the sub-Saharan African fastest growing economies. |

Authors' Compilation

A clear fall-out of these studies, including in Nigeria, is the need to further appraise the dynamics of the relationship, as the economy evolves, and complexity of interactions among economic variables. This way, policymakers are able to better track emerging interdependencies and effectively diagnose the economic situation to guide policy.

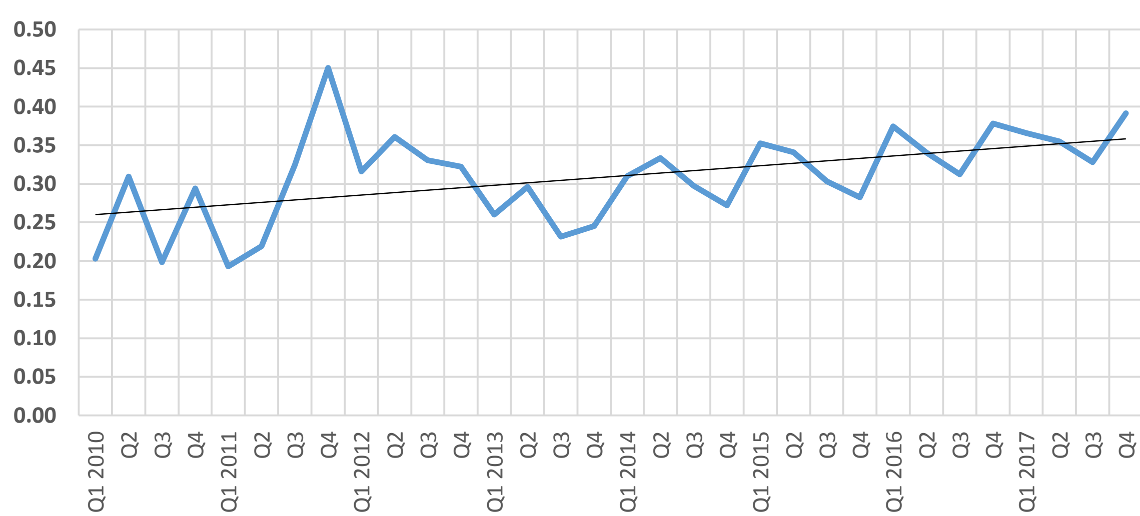
## III. Savings and Economic Growth in Nigeria

### III.1 Developments and Trend Analysis on Savings and Growth

One of the major macroeconomic goals in Nigeria is the achievement of sustainable economic growth. However, the country's endowment in natural resources, particularly oil and gas, has been more of a curse than blessings. The cyclical windfall from crude oil export has exposed growth and development activities to the vulnerabilities of international oil price. Over time, the foreign exchange revenue from oil has shifted focus from domestic production to high propensity to import. Consequently, there is perennial domestic savings-investment gap. Moreover, the non-reliability and inconsistent nature of financing across borders have limited the funding opportunities for growth enhancing activities.

Figure 1 shows the trend in the annual savings to GDP rate from 2010Q1. The gross domestic savings rate has fluctuated and varied along episodes of boom and burst in the fortunes of the global oil industry. Though savings rate increased in the immediate post-rebase period, reaching 0.45 per cent in 2011Q4, it has been a mixed trend from 2012Q1 to 2017Q3. The mixed trend in the savings ratio not only mimics the dynamics of the global economy industry but also, coincides with the period when government was running significantly higher budget deficits.

**Figure 1: Gross Domestic Savings Rate in Nigeria (2010Q1-2017Q4)**

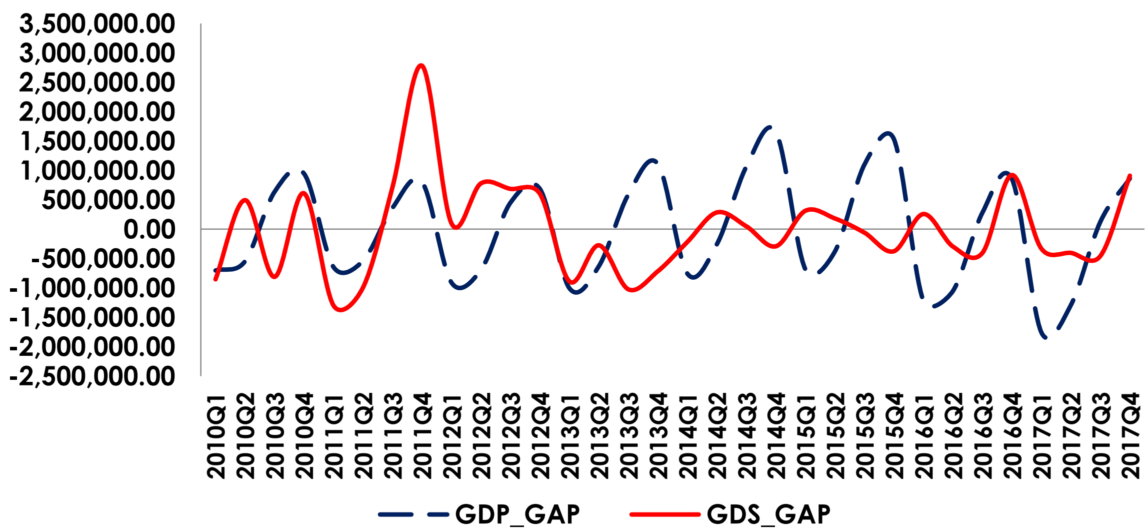



### III.2 Pro-Cyclicality of Savings and Output in Nigeria

The prevailing economic and business environment has highlighted the relationship between business and financial cycles. The 2007/2009 Global crisis underscored the imperative for policy makers to understand financial cycle as a requirement for effectively taking control of fluctuations in business cycles together with the analytical and policy challenges. The development has led to the need for a rethink of the modeling strategies and orientation for macroeconomic policy. Claessens and Terones (2012) established that there were strong linkages between the different phases of business and financial cycles. Specifically, they found that recessions were associated with financial disruptions, while recoveries coincided with rapid growth and, therefore, emphasising the importance of financial development to the real economy. Hence, they concluded that information about the financial cycle should be incorporated in measures of potential output (Borio et. al, 2012).

Figure 2 showed the interaction between the savings-gap (financial cycle) and output-gap (business cycle). The Hodrick–Prescott (HP) filter was used to de-trend both the GDP and gross domestic savings series to obtain the cyclical component. During the immediate eight (8) period post-rebase, both cycles co-move more closely. However, from Q2 of 2013, the co-movements had been divergent until Q3 2016 where cycle synchronisation was observed as the output gap appeared to lead the savings gap.

**Figure 2: Cyclicality of Output and Savings (HP Filter)**




## IV. Data and Methodology

### IV.1 Model Specification

This study adopts the short-run (abridged) version of the Solow neo-classical theory of economic growth, which attempted to identify the factors that determine the rate of economic growth. Its assumed that the household supply labour was inelastic and that technological know-how only progressed over the medium- to long-term, leaving the capital as the major determinant of output in the short-run. The theory was based on the simple aggregated production function, where output (Y) was a function of capital (K) and labour (L):

$$Y = AK^{\propto} L^{1-\propto} \quad (14)$$

This recognises that growth can come from using more capital, employing additional labour or adopting new technology. But in the short-run, technology and capital are assumed unchanging and so are fixed at 1. Ultimately because this study desire to elicit information strictly about the interactions between financial and business cycle, the abridged production function in year t becomes

$$Y_t = f(K_t^{\propto}) \tag{15}$$

Where $Yt$ is the GDP and $K_t$ is the capital, while $\propto$ is the elasticity of the capital. Consistent with the Solow model postulation that holding technology and labour constant in the short-run, sustained rise in capital investment (through increased savings) raises economic growth rate until the steady state is achieved, abridged production at steady state output (GDP):

$$\bar{Y} = \bar{K}^{\propto} \tag{16}$$

But income not consumed is saved and invested, such that:

$$S_t = I_t = Kt \tag{17}$$

This could be denoted as follows:

$$GDP_t = \alpha_0 + \alpha_1 \ GDS_t + \mu_t \tag{18}$$

Where GDP is gross domestic product to capture economic activity and GDS is the ratio of gross domestic savings to gross domestic product. On the contrary, the Keynesian model states that increase in income leads to growth in savings. The model can be expressed econometrically as:

$$GDS_t = \beta_0 + \beta_1 GDP_t + \varepsilon_t \tag{19}$$

Where $\alpha_0$ and $\beta_0$ are constant, and $\alpha_1$ and $\beta_1$ represent the slope coefficient and degree of responsiveness of savings to change in economic growth, as in the Solow model and economic growth to savings growth as in the Keynesian model. The $\mu_t$ and $\varepsilon_t$ are the stochastic disturbance terms in the respective equations.

### IV.2 Data Sources and Transformation

This study focused on the interaction between business and financial cycles, using quarterly series of gross domestic product (GDP) and gross domestic savings (GDS), based on 2010 rebased GDP. This captured the current development in the economy, as well as, provided opportunity for more current policy relevant outcomes. The GDS was computed as nominal GDP less final consumption expenditure (sum of private and government consumption expenditure). All data were sourced from the National Bureau of Statistics and the Central Bank of Nigeria's statistical database over the period 2010:Q1 – 2017:Q4.

Hodrick–Prescott (HP) filter was applied to de-trend the series and generate output and savings gaps. The cyclical components were needed to investigate interaction between business and financial cycles. This was intended to highlight preliminary evidence of the association between business and financial cycles and highlight the pro-cyclicality of the variables.

### IV.3 Methodology and Estimation Process

To validate the traditional assumptions for econometric estimation, the study conducted preliminary diagnostic checks, including unit root test, to determine the stationarity status of the variables (savings-gap and output-gap). A time series is stationary when the mean, variance and auto-variance are not time-dependent. Accordingly, the Augmented Dickey Fuller (ADF) unit root test was applied to determine the order of integration associated with the variables of interest.

Following the preliminary analysis of the data, the study adopted the Engle and Granger (1987) causality test based on the vector error correction mechanism (VECM). The procedure was employed due to its capability to assess direction of causality even where variables are non-stationary. Moreover, the procedure efficiently resolves the issue of endogeneity in time series analysis, through simultaneous determination of the estimates.

## V. Empirical Results

### V.1 Unit Root Test Result Analysis

Table 2 showed the extract of the result of the test of the time series behaviour of the variables. The results indicated that both GDP and GDS were stationary at levels (with or without trend). This outcome underscored the existence of long-run relationship between business (output gap) and financial (savings gap) cycles in Nigeria.

**Table 1: Results of the Augmented Dickey-Fuller (ADF) Unit Root Test**

| Variable | Integration | Exogenous | t-statistic | Critical Values | Prob.* |
|---|---|---|---|---|---|
| **GDS_GAP** | **Level** | **None** | **- 3.470529** | 1% level -3.699871<br>5% level -2.976263<br>10% level -2.627420 | **0.0170** |
| **GDP_GAP** | **Level** | **None** | **- 3.245768** | 1% level -3.699871<br>5% level -2.976263<br>10% level -2.627420 | **0.0281** |

### V.2 Vector Error Correction (VEC)Granger Causality and Estimation Analysis

With the confirmation that variables are stationary at levels with inherent presence of long-run relationship, a VEC Granger causality test was conducted to determine the existence and direction of cause and effect relationship between the output gap and savings gap. The causality test showed whether or not the past values of x ould predict with significant level of certainty the current values of y than without them, even with other information remaining unchanged. In which case, x is said to Granger-cause y otherwise stated in Granger sense as (x→y). It is expected that investigating the direction of cause and effect in the context of this study would assist the policy making process. Extracts of the results of the test are presented in the Table 3, while the detailed result was provided in Appendix 1.

The VEC Granger causality and block exogeneity Wald test suggest the existence of a short-run cause and effect relationship between the business cycle and financial cycle. It established a uni-directional causality that ran from the output gap (business cycle) to the savings gap (financial cycle).

**Table 3: VEC Granger Causality/Block Erogeneity Wald Test**

| **Sample: 2010Q1- 2016Q4** | | |
|---|---|---|
| Null Hypothesis | D(GDS_GAP) does not Granger cause D(GDP_GAP) | D(GDP_GAP) does not Granger cause D(GDS_GAP) |
| Chi-sq (X2) | 3.709707 | 7.865192 |
| P-value | 0.1565* | 0.0196 |
| Causal Relation | **D(GDP_GAP) → D(GDS_GAP)** | |

Note: *show the rejection of null hypothesis at 1% level

### V.3 Error Correction Estimates

To highlight the extent and strength of short-run relationship, the study generated error correction estimates of the interactions between the business and financial cycles. This shows how deviation from a long-run equilibrium, influences the short-run dynamics of the relationship. With the causality running from gdp_gap to savings gap, the process directly estimated the extent of influence of the business cycle on the financial cycle. The results of the process were presented in Table 4, while the detailed result is provided in Appendix 2. Result of the analysis show that business cycle is a strong lead indicator of financial cycle in Nigeria. Economic prosperity/downturn will precede boom/crisis in the financial cycle in time$_{t+n}$. Empirically, this finding underscores the recent trend of increased stress in the Nigerian banking sector in particular, following the 2016 economic recession.

**Table 4: Error Correction Estimates**

| **Error Correction:** | **D(LGDP_GAP)** | **D(LGDS_GAP)** |
|---|---|---|
| **D(LGDP_GAP1(-1))** | 0.382704 | **0.645376** |
| | (0.17806) | (0.23096) |
| **D(LGDP_GAP1(-2))** | -0.367410 | **0.450949** |
| | (0.17136) | (0.22227) |
| **D(LGDS_GAP(-1))** | **0.247979** | -0.073755 |
| | (0.19171) | (0.24867) |
| **D(LGDS_GAP(-2))** | **0.284652** | -0.022761 |
| | (0.14971) | (0.19419) |
| **C** | -4706.043 | 51491.13 |
| | (127094.) | (164858.) |
| R-squared | 0.765392 | 0.415315 |

### V.4 Lagged Correlation Analysis

To further validate the above outcomes and provide additional information to guide policy, the study conducted a lagged correlation analysis of the short-run relationship between the business cycle and financial cycle. The justification for this analysis stemmed from the realisation that in the real world, when a variable (Y) depends on another explanatory variable (X), such interactions, or cause and effect, are rarely instantaneous. Most times, the dependent variable (Y) responds to the value of the explanatory variable over a certain lapse of time, otherwise known as a lag. This procedure is conducted on the relationship GDP_GAP → GDS_GAP for time series of the same length and record. The exercise shows at what time lag, the two series have the highest correlation and further substantiates the outcome of the VEC Granger causality procedure. Result of the exercise was presented in Table 5:

**Table 5: Lagged Correlation Analysis of the Output Gap-Savings Gap Short-Run Relationship**

| TIME | INSTANTANEOUS | LAG1 | LAG2 | LAG3 | LAG4 |
|---|---|---|---|---|---|
| Corr. coef. | 0.174949 | 0.01001 | 0.13969 | 0.12192 | 0.265332 |

Result of the analysis showed the strongest cause and effect relationship with lag 4. This implied that the business cycle had a strong lag indicator of the financial cycle after four quarters. Economic prosperity/downturn in time *t* will lead to boom/crisis in the financial cycle in time *t+4*.

## VI. Discussion of Findings and Conclusion

### VI.1 Discussion of Findings

This paper investigated the savings-growth nexus in Nigeria within the framework of business and financial cycle. The study applied the Hodrick–Prescott (HP) filter to generate the cyclical components of output (output gap) and savings (savings gap). An abridged short-run version of the Solow growth model, which identified capital through investment as the major determinant of economic growth in the short-run, was adopted. The savings-gap was used to proxy financial cycle, while business cycle was proxied by the output-gap. Results of VEC Granger causality procedure revealed a unidirectional relationship from the business cycle to the financial cycle. This was consistent with the Keynesian tenets regarding savings-growth relationship and presupposes that the relationship in Nigeria follows Keynesian principles. To further guide policy, the lagged correlation analysis revealed the strongest cause and effect relationship after four lags (quarters). In other words, movements in the financial cycle are influenced largely and positively associated with movements in the business cycle four quarters ahead.

These findings support the fact that over the years, economic crises have not always coincided with, but in fact are lead indicators of financial crisis in Nigeria. For instance, the near systemic-banking crisis observed in 2009 followed the spill-over effect of the Global economic crisis of 2007-2008. Similarly, the challenged health of the banking system, which began to emerge from the last quarter of 2017 through 2018, might be attributed to the after-effect of the 2016 economic recession. More importantly, this findings call for proactive actions on the part of the regulators of the banking industry, in particular, and financial system in general, on the need to always ensure that appropriate countercyclical measures are taken for the industry at the onset of every economic crisis, irrespective of the origin of the crisis (financial/other sector).

Also, the trend may also be an indication of the unstable savings, base of the economy, which makes it vulnerable to the slightest change in the income flow. Furthermore, high propensity to import consumer goods drain the income of household and businesses, as the larger part of final consumption goes to foreign goods and services. Alternatively, this outcome may also highlight the low level of financial inclusion during the period under review, as well as, the absence of attractive financial products in the Nigerian financial system, which might serve as an incentive to grow the savings culture. In other words, to strengthen the financial system and make it possible to withstand the slightest shocks to output, government must vigorously pursue financial inclusion strategies to build a viable savings culture. This will improve significantly the savings culture and strengthen the stability of the financial system.

### VI.2 Conclusion

This study, empirically re-investigated the saving-growth nexus in Nigeria using quarterly series of rebased GDP of 2010. A major departure from past studies was the adoption of output-gap to savings-gap approach to investigate how the business cycle interacts with the financial cycle. The analysis showed that output-gap Granger-cause savings-gap, implying that the present low and unstable savings rate in Nigeria is as a result of the low economic growth.

To ensure that adequate level of investible fund is available for sustainable economic development, government must vigorously pursue policies that immediately expand the productive base and promote financial inclusion. Increased income level would promote higher savings, reinforced by high level of financial inclusion, and ensures that avenues for savings are readily available to the populace.

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## Appendix 1: Granger Causality

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 10/31/18 Time: 14:39
Sample: 2010Q1 2017Q4
Included observations: 29

Dependent variable: D(GDP_GAP)

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(GDS_GAP) | 3.709707 | 2 | 0.1565 |
| All | 3.709707 | 2 | 0.1565 |

Dependent variable: D(GDS_GAP)

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(GDP_GAP) | 7.865192 | 2 | 0.0196 |
| All | 7.865192 | 2 | 0.0196 |

## Appendix 2: Vector Error Correction Estimates

Included observations: 29 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| Co-integrating Eq: | Co-inteq1 | |
|---|---|---|
| LGDP_GAP1(-1) | 1.000000 | |
| LGDS_GAP(-1) | 0.584031 | |
| | (0.22254) | |
| | [ 2.62434] | |
| C | -2166.868 | |
| **Error Correction:** | **D(LGDP_GAP1)** | **D(LGDS_GAP)** |
| Co-inteq1 | -0.950348 | -1.010342 |
| | (0.28607) | (0.37107) |
| | [-3.32213] | [-2.72280] |
| **D(LGDP_GAP1(-1))** | **0.382704** | **0.645376** |
| | (0.17806) | (0.23096) |
| | [ 2.14935] | [ 2.79429] |

| | | |
|---|---|---|
| **D(LGDP_GAP1(-2))** | **-0.367410** | **0.450949** |
| | (0.17136) | (0.22227) |
| | [-2.14411] | [ 2.02879] |
| **D(LGDS_GAP(-1))** | **0.247979** | -0.073755 |
| | (0.19171) | (0.24867) |
| | [ 1.29352] | [-0.29659] |
| **D(LGDS_GAP(-2))** | **0.284652** | -0.022761 |
| | (0.14971) | (0.19419) |
| | [ 1.90141] | [-0.11721] |
| C | -4706.043 | 51491.13 |
| | (127094.) | (164858.) |
| | [-0.03703] | [ 0.31234] |
| R-squared | **0.765392** | **0.415315** |
| Adj. R-squared | **0.714390** | **0.288209** |
| Sum sq. resids | 1.07E+13 | 1.81E+13 |
| S.E. equation | 683583.8 | 886701.3 |
| F-statistic | 15.00714 | 3.267480 |
| Log likelihood | -427.4061 | -434.9507 |
| Akaike AIC | 29.89008 | 30.41040 |
| Schwarz SC | 30.17297 | 30.69328 |
| Mean dependent | 7919.442 | 59395.60 |
| S.D. dependent | 1279101. | 1050996. |
| Determinant resid covariance (dof adj.) | | 3.61E+23 |
| Determinant resid covariance | | 2.27E+23 |
| Log likelihood | | -862.0987 |
| Akaike information criterion | | 60.42060 |
| Schwarz criterion | | 61.08067 |

# Fiscal Theory of the Price Level (FTPL) in Nigeria: The Role of Private Sector Expectation

Mbutor, O. M., Evbuomwan, O .O. and Opiah, D. C.*

***Abstract***

*The paper investigated the dimension of private 'expectations' in explaining the FTPL proposition in Nigeria using the Toda-Yamamoto Approach to causality and annual time-series data spanning 1981 to 2016. The study revealed a unidirectional causality running from private sector expectation of fiscal operations to inflation. In addition, this relationship was found to only exist in the short-run. Furthermore, a positive relationship between private sector expectation on fiscal policy and inflation in Nigeria was established, affirming the theoretical link between expectations and inflation. The study, therefore, recommends the incorporation of such expectations into the monetary authority's decision-making framework via the expansion of the Bank's Consumer Inflation Expectation Survey. This would broaden policy outcomes; enhance inflation forecasts and the overall effectiveness of monetary policy through the provision of information on inflationary expectations on fiscal policy.*

**Keywords:** Fiscal Theory, Toda-Yamamoto, Price level, Causality
**JEL Classification:** C32, E3, E50, E62, H62

## I. Introduction

Inflation is understood as a monetary phenomenon, based on its supposed positive association with growth in money supply (Friedman 1974). The assertion holds to the extent that the monetary authority independently controls money supply. This perspective is, however, diluted by contributions by Sargent and Wallace (1975), among other works, who argued that irrespective of the stance of monetary policy, fiscal policy could determine the price level (Leeper, 1991; Sims, 1994; Woodford, 1994; Cochrane, 1998; and Tutino and Zarazaga, 2014). These views are consolidated in what has come to be known as the fiscal theory of the price level (FTPL). The strong version of the theory emphasises fiscal dominance. It hinges on the rational expectation theory and argues that fiscal policy could affect the price level and the path of inflation, regardless of monetary policy response (Sims, 1994). The 'soft' version, on the other hand, draws directly on Sargent and Wallace's (1975) original contribution, which posited that fiscal policy, by itself, could not drive inflation, except by inducing monetary policy response (via seigniorage). This version echoes Friedman's (1962) concern of excessive inflation being the outcome of states' manipulation of monetary policy (Ryan-Collins, 2015). The strength of the deficit-inflation transmission mechanism depends on the depth of institutional arrangements in countries and the form of deficit financing (Catao and Macro, 2001; Uwazie, et al., 2015).

* *The authors are staff of the Research Department, Central Bank of Nigeria. The usual disclaimer applies.*

In Nigeria, fiscal injections are pivotal in stimulating demand in both the private and public sectors with implications for the domestic price level. However, the capacity of government to spend depends characteristically on developments in the international crude oil market with more during oil booms. The pro-cyclicality of fiscal policy induces volatility in government finances, dragging the CBN into pseudo-fiscal activities like advancing the Ways and Means to support government. The concern is about inflationary effect of such interventions. Essentially, all economies are concerned, not just about the pace and level of inflation, but also, about its sources. This is consequent upon its potency in reducing real wages and living standards, in addition to the deviation of monetary policy from its targets, and a loss of political credibility. In Nigeria, the absence of a clear-cut monetary policy rule has rendered the existing monetary policy framework to fully accommodate the potential sources of inflation ineffective. The prolonged deviation of inflation from its single digit target has consistently fuelled curiosity on the possible explanations for the behaviour of the price-path in the Nigerian economy.

This study, therefore, derives its relevance, from the need to understand the sources of inflation in Nigeria and to avail policymakers with salient information that would enable them take proactive measures in achieving price stability. Although a considerable number of studies have examined the causal relationship between inflation and fiscal policy, this study establishes a niche by investigating the role of 'expectation' in the FTPL analytical framework. To the best of our knowledge, this is a new perspective for Nigeria. In addition, it takes into cognisance the cyclical nature of fiscal policy in Nigeria highlighting the prominence of oil prices. It adopted the Toda-Yamamoto Approach to causality given that the variables under study are of different orders of integration in the vector autoregression (VAR) system. The main objectives of this paper are to investigate the FTPL proposition for Nigeria and ascertain the causal relationship between private sector 'expectation' of fiscal policy and inflation in Nigeria.

The rest of the study is organised as follows: Section 2 provides conceptual issues on the FTPL and undertakes a review of the literature. A description of the data and methodology are presented in Section 3; while Section 4 estimates the model and presents the findings. Section 5 concludes the paper with policy recommendations.

## II. Literature Review

### II.1 Conceptual Issues

From the quantity theory of money, inflation has been conceived as a monetary phenomenon. Consequently, the goal of price stability is assumed to be a reservation of monetary policy. However, the extent to which monetary policy can successfully managed inflation in different economies has been a subject of criticism (Ballabriga and Martineq-Mongay, 2003). The perceived failure of monetary policy to stabilise prices led to the emergence of the fiscal theory of price level, as an alternative explanation for inflation. The theory negates the strict perception of inflation being everywhere a monetary phenomenon. The fundamental assumption of the theory is the independence of monetary and fiscal policies with regard to their targets and instruments. These assumptions include: non-Ricardian fiscal policy, budget constraint equality, flexible nominal prices and an administrative interest rate.

Two versions of the theory exist – the strong and weak versions. The weak version is founded on the contribution of Sargent and Wallace (1981) under the assumption of an 'active' fiscal policy and a 'passive' monetary policy. According to this theory, the monetary authority finances government deficits by increasing money supply, which is consistent with the quantity theory of money that posits that growth in money supply, is inflationary. The inflationary outcome is such that increase in the quantity of money (above the growth rate of real output) reduces the value of money, inducing economic agents to switch to non-monetary assets. This reduces their real money balances and increases the velocity of money, and thus fueling inflation. This version of FTPL negates the independence of monetary policy and it is consistent with the conclusion of the 'theory of money disequilibrium'. It is against this backdrop of monetisation-induced inflation that Friedman (1962) proffered the capping of money supply by central banks.

The 'Strong' version of the theory, on the other hand, is buttressed by the rational expectation theory, suggesting that the dynamics of inflation are entirely determined by household expectations (Dorn, 2017). It states that regardless of the prevailing monetary policy rule, fiscal policy can dictate the path of inflation. The requirement is for economic agents to 'expect' future increase in the price level, based on the precedent of fiscal deficits. If individuals think fiscal deficits would increase in the future, they reduce their cash balances, which raise the velocity of money and inflation without the monetisation of government deficits. Thus, there is a possibility for hyperinflation though money supply is kept constant.

### II.1.1 FTPL: Soft Version – A Case for Fiscal-Monetary Policy Coordination

The FTPL evolves from the inter-temporal government budget constraint expressed as:

$$b_t = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r}\right)^{j+1} E_t S_{t+j+1} + \lim_{j\to\infty} \left(\frac{1+x}{1+r}\right)^{j+1} E_t\, b_{t+j+1} \qquad (1)$$

$b$ and s are government debt and primary surplus expressed as ratios of GDP (gross domestic product), respectively. $x$ and $r$ are real GDP growth rate and the real interest rate, respectively, which are assumed to be constant.

The solvency or fiscal sustainability condition requires:

$$\lim_{j\to\infty} \left(\frac{1+x}{1+r}\right)^{j+1} E_t\, b_{t+j+1} = 0 \qquad (2)$$

This is based on the 'Transversality' condition, which limits addition to debt to zero. Outside this condition, government continues to accumulate new debt to replace old ones (Ponzi scheme). Thus, in the long-run, government offsets its debt commitment, s, such that:

$$b_t = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r}\right)^{j+1} E_t S_{t+j+1} \qquad (3)$$

Equation 3 is the solvency condition, which equates the real debt to the expected present value of primary surplus. That is, the expected future government primary surplus to, at least, finance the present value of its debt.

Based on the conventional monetary approach, the price level is determined in the money market where the primary surplus adjusts endogenously to satisfy the inter-temporal budget constraint. It assumes some element of coordination between fiscal and monetary policies, such that, regardless of the price level, **s** can be set to equate **b.** Given this assumption, seigniorage is regarded as part of government revenue (that is revenue minus expenditure plus seigniorage). If government, for instance, wishes to reduce the primary surplus ,$\boldsymbol{s}$**,** to keep **s** equal to **b** and satisfy Equation 3, it must increase seigniorage. Given that seigniorage forms part of government revenue, its evolution must be compatible with that of the primary surplus for the condition to hold (Ballabriga and Martineq-Mongay, 2003). The solvency condition, thus, restricts monetary policy options and reduces the potency of rule-based monetary policy.

It was in this spirit that Sargent and Wallace (1981), in their 'Unpleasant Monetarist Arithmetic', provided insight into the implicit interaction between monetary and fiscal policy and the need for one of the institutions to 'blink' for the economy to satisfy the government solvency condition. Accordingly, they proposed a coordination scheme, where the fiscal policy sets an exogenous path for real spending and the monetary policy moves to accommodate it through monetisation.

Considering the Sargent and Wallace's coordination approach, Leeper (1991) argues that the determination of the price level depends on the sequence of policy action. He identifies two regimes, namely: (1) an active fiscal policy (FP) and a passive monetary policy (MP), on the one hand, and (2) an active MP and a passive FP, on the other. Under the first regime, a unique price level exists and shocks to the fiscal rule and changes in its coefficients have direct effects on inflation; while shocks to MP are inert. In the second regime, active MP and passive FP, shocks to MP rule and its coefficients affect the price level, while shocks to FP does not. However, the shocks to MP and its coefficients results in a saddle-path equilibrium rather than a unique equilibrium (price). Thus, a unique equilibrium price is only obtainable under an active FP and passive MP setting. This gives credence to the observation of Sargent and Wallace (1981) that so long as fiscal policy is fixed, monetary policy actions do not influence the price level.

### II.1.2 FTPL: Strong Version – Autonomous Fiscal and Monetary Policy

The FTPL forwards that fiscal policy may determine the price level even under an inflation targeting strategy. It holds where the government exogenously determines the primary surplus, regardless of the level of its debt stock. The dynamics of the relationships would induce an adjustment of the price level and ensure that Equation 3, the solvency condition, is satisfied.

For instance, by modifying Equation 3, we obtain:

$$b_t = \frac{B_t}{P_t y_t} = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r}\right)^{j+1} E_t s_{t+j+1} \qquad (4)$$

Such that $B_t$, $P_t$ and $y_t$ are nominal public debt, price level and real GDP, respectively.

Government could issue nominal debt, by raising $B_t$ without any future backing or commitment. To fulfil Equation 4, the price level ($P_t$) will 'jump' to restore parity between **b** and **s**. Alternatively, government might alter the path of **s**, regardless of the level of **b,** via the same mechanism, the price level will adjust to restore stability. Thus, under FTPL, Equation 4, rather than being a constraint, represents an equilibrium condition that satisfies by a unique price level path. This contrasts Sargent and Wallace (1981) where Equation 4 is seen as a resource-constraint that must be fulfilled. FTPL, therefore, interprets Equation 4 as a stock valuation equation that expresses the value of outstanding government debt as a function of future discounted surpluses (Ballabriga, 2004).

A major departure of the FTPL from the government solvency condition is that it assumes independent paths for fiscal and monetary policy. Monetary policy is not compelled or expected to provide seigniorage to bailout the fiscal authority. Secondly, interactions between monetary and fiscal policies, under the FTPL, occur through equilibrium channels in the economy, rather than being constrained by the solvency condition. For instance, the reduction of interest rate stimulates output or employment and thus induces a fiscal response.

Although the strong version of FTPL appears to be theorietical, the theory is, overall, more complementary than competitive. Sims (2016:5) is of the view that rather than replace the conventional thinking with the idea that it is the sequence of government debt, or deficits that determines the price level, the FTPL submits that the price level is jointly determined by interest rate, tax, and expenditure policies. Thus, FTPL's contention of inflation being everywhere a monetary phenomenon does not necessarily undermine the role of central banks in maintaining the long-run value of money. It only provides an alternative explanation for the determination of prices and, thus, broadens the instruments of macroeconomic policy in achieving price stability.

## II.2 Theoretical Issues

The contention in the fiscal dominance is whether or not inflation is explained by the actions of the fiscal authority. The conventional view, anchored on the quantity theory of money, is that 'current price movement reflects past and current changes in the quantity of money' (Cagan, 1956: 27). The implication is that the price level is determined by dynamics in the money market and nothing more. The argument of the FTPL is that fiscal behaviour may influence the path of inflation, regardless of existing monetary policy rule.

Preliminary explanation on the implication of government fiscal deficit on the price level is linked to Keynes (1934). By recommending fiscal injection as the panacea to unemployment and low demand, Keynes believes that inflation is driven by government spending, albeit, through seigniorage. Hayek (1941) accepted Keynes' fundamental discovery conclusion on the deficit-inflation causality, but refuted his assumption of 'no scarcity' in the economy. His analysis did not, however, reduce Keynes' conclusion on the impact of inflationary on fiscal actions. At the extreme spectrum of the FTPL literature are the proponents that deny its economic realism wholesale, and those that believe that

Keynes's discovery was given undue attention, by highlighting policy interdependence and the critical role of the monetary authority in 'monetising' fiscal deficits.

The Ricardians, for instance, refuted the inflationary effect of fiscal policy. According to the Ricardian Equivalence, economic agents are rational and forward–looking; as a result, they take into cognisance the deficit behaviour of the government in their inter-temporal decisions. Consequently, as government accumulate debts in the present period, economic agents anticipate higher taxes, in the future, and reduce their current consumption and increase savings to smoothen-out their consumption over time. These adjustments are argued to neutralise the effect of government deficits on either inflation or any other macroeconomic variable. The Ricardian position has, however, been punctured, severally, with regard to its assumption on the strategic behaviour of individuals and by a plethora of empirical evidence (Seater, 1993).

Sargent and Wallace (1981) and Drazen and Helpman (1990), on the other hand, believed that fiscal deficits drive inflation through central banks' monetisation of government debt, and that where increase in government deficits are expected to be financed by sources other than 'monetisation', prices are not expected to rise. He noted, however, that if government debt grows, unsustainably, deficits may eventually result in inflation, even when they are not financed by the central bank.

In addition, Sargent and Wallace (1981) further noted that there is a limit to which government can utilise fiscal instruments (taxes, expenditure, debt issuance) in realising its goals. Given this constraint, they opined that the central bank might have to expand its monetary base by financing additional borrowings through its purchase of new interest-bearing debt instruments issued by the government.

Similarly, Barro (1976) and McCallum (1982) observed that persistent bond-financed deficits are inflationary, if the growth rate of bonds exceeds the growth rate of output. Barro (1976) goes further to add that at any point in time, the value of the stock of public debt is limited to the present value of future taxing policy, in line with the government solvency condition. He stated that if bonds grow faster than the rate at which the economy grows, the Ricardian Equivalence argument breaks down, and government deficits would eventually be monetised. The author stated that bond issuance also has its limits, noting that when the market becomes saturated and the private sector can no longer absorb additional issuance, the monetary authority may be forced to step in to buy-over the bonds.

The FTPL school of thought, accepted the monetisation-inflation transmission process, but refused to concede it as a fiscal phenomenon. McCallum (2003), for instance, punctured the FTPL by noting that the price path generated in the bond market, as applied to the budget constraint, is different from that in the money market, as such, both predict different prices. He further argued in his work with Nelson (McCallum and Nelson, 2005), that it is only in cases where the price level path veers off the path of money stock that the FTPL can be considered to be a bona fide theory. According to them, this arbitrary divergence between money and prices only occur in equilibria that produce explosive behaviour of the nominal interest rate. They, therefore, concluded that the FTPL is simply a process in monetary accommodation of fiscal balance, rather than a distinct theory. Their criticism were, however, made within a Ricardian framework, whereas the FTPL assumes a non-Ricardian fiscal policy

Woodford (2003) assumed that the central bank implements an interest rate peg, that allows money and prices co-move. This discounts McCallum and Nelson's (2005) assertion on the possibility of an explosive interest rate that induces divergence in the price-level and money stock paths. Buiter (2005) was of the view that the FTPL was fallacious when it confused the budget constraint with an equilibrium condition. This view, although, has been long refuted by the FTPL adherents through the dynamics of the ominous inter-temporal budget constraint. He also challenged the assumption of the theory of a flexible price, identification with fiscal dominance, inconsistency with an exogenously determined nominal interest rate (or monetary rule) among other criticisms. He concluded that these shortcomings make the theory dangerous for policy purposes. Despite these divergent views, Sims et al., (2016) affirmed the validity and relevance of the theory.

Other proponents (Leeper, 1991; Sims, 1994; Woodford, 1994; and Cochrane, 1998 and 2005; Tutino and Zarazaga, 2014) have examined the FTPL within a coordination framework.

## II.3 Empirical Literature

Considerable efforts have gone into studying the relationship between fiscal policy and inflation, and the ensuing evidence have, however, been mixed. Keho (2016) investigated the effect of budget deficit and money supply on inflation in the West African Economic and Monetary Union (WAEMU), using dataset, ranging1970 to 2013 and adopting the Pesaran et al. (2001) methodology. He found evidence of long-run relationship among the variables in all the countries, except Mali. Inflation was positively related to budget in Niger and Togo, but negatively related in Benin and Senegal. Also, the inflation and money supply exhibited a positive relationship in Burkina Faso, Cote d'Ivoire and Senegal. The Granger causality analyses showed that deficits Granger-caused money growth in Cote d'Ivoire, Mali and Togo, but Granger-cause inflation only in Senegal. In the short-run, there was no causality running from money supply to inflation. Overall, the results revealed that neither budget deficits nor money supply was inflationary in the sub-region. The author, therefore suggested that policies on inflation management should focus on other macroeconomic and structural determinants of inflation in WAEMU.

Bajo-Rubio et al. (2006) investigated the prevalence of fiscal policy on inflation in the European Monetary Union (EMU) from 1970 to 2005 employing the Dynamic Least Square and Co-integration techniques. Their result showed the need for sustainability of fiscal policy in EMU countries, except in Finland where monetary policy was dominant.

A number of studies have been conducted on the monetary and fiscal policy determinants of inflation in Nigeria. The conclusions have, however, been inconclusive. What is, however, established in the literature is the existence of a long-run relationship among fiscal policy, monetary policy and inflation. Bayo (2005) examined the determinants of inflation in Nigeria based on a multiple regression framework using annual time series data between 1981 and 2003. He found that fiscal deficits and money supply, including interest and exchange rates, jointly accounted for 72.0 per cent of variation in inflation in Nigeria and suggested the need for fiscal prudence, among other recommendations, in taming inflationary pressure.

Olusoji and Oderinde (2011) explored the causal link between inflation and fiscal deficits in Nigeria using time series data for the period 1970-2006. They employed the Toda-Yamamoto Granger non-causality test, which allowed the Granger test in an integrated system. The result revealed no evidence of causality between fiscal deficits and inflation. Utilising co-integration and the vector error correction model, Dockery et al., (2012) examined the relationship between fiscal deficits and inflation in Nigeria, using annual time series data spanning 1970 - 2006. Although the authors established a long-run relationship between fiscal deficits and inflation, the short-run dynamics indicated a positive but insignificant relationship between the variables. The results also revealed that previous levels of fiscal deficits had no influence on current inflation in Nigeria, confounding theory.

Ezeabasili et al. (2012), using a blend of co-integration techniques and structural analysis, examined the relationship between inflation and fiscal deficits in Nigeria using data spanning 1970 to 2006. They found no evidence linking past levels of fiscal deficits with inflation but reported the existence of a positive long-run relationship between money supply and inflation in the Nigerian economy. However, the authors observed that money supply to grow faster than inflation due to the imbued pro-cyclicality in the former. The authors established the passivity of fiscal policy in driving inflation in Nigeria and noted that the fiscal deficit-inflation relationship depended, to a greater extent, on the method of financing the deficits (Uwazie et al., 2015).

Raji et al., (2014) examined the relationship among real money supply, price and fiscal deficit in Nigeria, using data from 1970 to 2010 and implementing the Granger causality test in an autoregressive distributed lag (ARDL) framework. The short-run analysis revealed unidirectional causality, running from real money supply to inflation, government deficit to price level, real output to inflation and interest rate to inflation, while the long-run analysis showed bidirectional causality running from real money supply to price level, and from interest rate to price level.

Bakare et al., (2014) investigated the long-run relationship between budget deficits, money supply and inflation in Nigeria using annual time series data, covering 1975 to 2012 and employing the co-integration and error correction model estimation techniques. They indicated a long-run relationship among budget deficits, external debt and money supply, while the short-run dynamics of their model revealed a positive but insignificant relationship between growths in budget deficits and money supply, at 5 per cent significant level. Their findings indicated that neither monetary nor fiscal policy was a significant driver of inflation in Nigeria during the period.

Inanm (2014) examined the long-run causality relationship between budget deficits and inflation in Nigeria, using a multivariate con-integration regression technique on time series data between 1970 and 2010. The result confirmed long-run causality running from budget deficits to inflation. Employing the co-integration technique and the Granger

Causality test, Ojonye et al. (2015) quantified the relationship between fiscal policy, monetary policy, exchange rate and inflation, using data, ranging from 1970-2013. They found money supply and exchange rate as the main determinants of inflation in Nigeria. The associated causality tests also indicated no causality between inflation and fiscal policy. They concluded that inflation in Nigeria was principally a monetary phenomenon.

Oseni and Ogunmuyiwa (2016) examined the direction of causality between fiscal policy and inflation volatility in Nigeria using quarterly data for the period 1981-2014. The study employed a pairwise granger causality test and its findings showed bidirectional causality between fiscal deficits and inflation volatility. The interrelationship between budget deficit, inflation and growth in money supply was also investigated by Ehinomen and Ugwu (2017). The authors employed data covering 1970 to 2014 and used the vector auto regression (VAR) and co-integration procedures. The results from the impulse response function (IRF) showed that shocks to money supply growth induced a significant positive response in inflation in the short-run with a decreasing effect over time. Conversely, shocks to deficits provoked a positive, but insignificant response in inflation over time. The authors subsequently recommended the use of budget deficit to finance capital projects, given its short-run non-inflationary effect.

In summary, the FTPL, which evolves from the budget constraint equation of the fiscal authority advances the critical role of fiscal policy in determining the path of inflation. This perspective is, however, contested by the monetarists who view the FTPL as a channel in the transmission mechanism of monetary policy rather than a stand-alone theory. Regardless, empirical findings regarding the theory have also been mixed with causality tests being the dominant estimation technique. While this paper employs the Toda-Yamamoto Non-Granger Causality Test in investigating the FTPL, it considers the role of private expectation, a consideration that is novel in the Nigerian literature.

## III. Methodolgy

### III.1 Analytical Framework

The theoretical framework for this study follows Seccareccia and Sood (2000) who modified the workhorse neoclassical budget constraint equation by incorporating the expectations-augmented Phillips curve to capture the supply-side constraint of the economy. As he noted, the extent to which government monetisation would accelerate inflation depends on the elasticity of the aggregate supply curve.

It begins with a one-period government budget constraint as follows:

$$(G - T) = Def = \Delta B + \Delta M \quad (5)$$

Where $G$ represents government expenditure (including interest payments on public debt), $T$ tax revenues and $Def$, government deficit. $\Delta B$ and $\Delta M$ are the change in the stock of government securities held by the public and the change in the stock of government debt held by the central bank, respectively.

Dividing Equation (5) by M and rearranging the same, we obtain the equation for the growth rate of money:

$$\frac{\Delta M}{M} = \frac{Def}{M} - \frac{\Delta B}{M} \tag{6}$$

Recall the standard quantity money equation:

$$MV = PQ \tag{7}$$

The velocity of money is defined as $V$, while P and Q represent the price level and output, respectively. The theory assumes a constant V because annual changes in the velocity of money in economies tend to be similar, owing to the fact that institutional structures are slow to change. Consequently, the equation can be expressed as:

$$M = PQ \tag{8}$$

Expressed in its rate form, Equation 8 becomes:

$$\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Q}{Q} \tag{9}$$

The growth rate of money is the sum of the inflation rate and the real growth of output in the economy. Substituting equation (6) into (9) and expressing in terms of the rate of inflation:

$$\frac{\Delta P}{P} = \left(\frac{Def}{M} - \frac{\Delta B}{M}\right) - \frac{\Delta Q}{Q} \tag{10}$$

When $\Delta B = 0$ and output is constant, from the above:

$$\frac{\Delta P}{P} = \frac{Def}{M} \tag{11}$$

So that:

$$Def = M\left(\frac{\Delta P}{P}\right) \tag{12}$$

Dividing both sides of equation (12) by P, we obtain:

$$\frac{Def}{P} = \frac{M}{P}\left(\frac{\Delta P}{P}\right) \tag{13}$$

$\frac{Def}{P}$ is the real value of government seigniorage, while $\left(\frac{\Delta P}{P}\right)$ represents inflation tax on real money balances $\left(\frac{M}{P}\right)$. The inflationary effect of government fiscal behaviour arises as a result of the inflation tax, $\left(\frac{\Delta P}{P}\right)$, it generates on the real money balances of individuals.

In accommodating the supply-side dynamics of the economy, Seccareccia and Sood (2000) incorporated the Non-Accelerating Inflation Rate Unemployment (NAIRU) hypothesis, which postulates that if products and labour markets operate freely, the economy would gravitate towards a unique unemployment level that is consistent with steady state properties.

The authors introduced a variant of the Expectation Augmented Philip's Curve to capture the supply side constraint as follows:

$$\frac{\Delta P}{P} = \propto (u - u^{*}) + \frac{\Delta P^{e}}{P} \qquad (14)$$

$u$ and $u^{*}$ are the actual unemployment and natural unemployment rates. $\frac{\Delta P^{e}}{P}$ is the expected rate of inflation, while the coefficient, $\propto$, is assumed to be less than zero ($\propto < 0$).

Equation (14) suggests that variations in deficits are monetised to avoid borrowing from the private sector and thus, avert worsening unemployment. The rate of monetisation is related to the level of unemployment, That is:

$$(u - u^{*}) = \beta \left(\frac{\Delta M}{M}\right); \ \beta < 0 \qquad (15)$$

Substituting Equation (15) into Equation (14) the inflation path becomes:

$$\frac{\Delta P}{P} = \propto \beta \left(\frac{\Delta M}{M}\right) + \frac{\Delta P^{e}}{P} \qquad (16)$$

Recall from Equation (6) that $\frac{\Delta M}{M} \equiv \left(\frac{Def}{M} - \frac{\Delta B}{M}\right)$

When $\left(\frac{\Delta M}{M}\right) > 0; \frac{\Delta P}{P} > \frac{\Delta P^{e}}{P}$, inflation is accelerating. However, when $\left(\frac{\Delta M}{M}\right) < 0; \frac{\Delta P}{P} < \frac{\Delta P^{e}}{P}$, inflation is below its steady state. Thus, money creation induced by government spending moves inflation away from its steady state path.

Sargent and Wallace (1981) observed that the inflationary tendency of fiscal policy derives from agents' 'adaptive' expectation on government deficit behaviour based on precedents. Consequently, Seccareccia and Sood (2000) replaced the forward-looking inflationary expectation, $\frac{\Delta P^{e}}{P}$ in Equation (16) with expectation on future 'monetisation', $\frac{\Delta M^{e}}{M}$. Thus, Equation (16) becomes:

$$\frac{\Delta P}{P} = \propto \beta \left(\frac{\Delta M}{M}\right) + \frac{\Delta M^{e}}{M} \qquad (17)$$

So long as $\frac{\Delta M^{e}}{M} > 0$ whether the central bank monetises or not (i.e. if $\frac{\Delta M}{M} = 0$), inflation would be triggered by expectations of monetisation of fiscal deficits.

### III.2 Data

The study employed annual time-series data between 1981 and 2016, Comprising government debt stock (G), fiscal deficits (DEF), inflation (INFL), money supply growth (M), fiscal policy expectation (FEX) and oil prices (OP). OP was included in the model because fiscal policy in Nigeria mirrors historical trends in the international prices of crude petroleum. Three definitions of inflation were used in estimating the model – headline inflation, consumer price index and the implicit GDP deflator. The implicit GDP deflator was eventually selected on the basis of adaptability to the model. Debt stock was selected as the fiscal policy variable, due to its widely used as an indicator of government fiscal policy behaviour and secondly, to avoid the problem of serial correlation between measures of 'Fiscal Policy Expectation' and 'Fiscal Policy'. These variables were obtained from publications by the Central Bank of Nigeria, except OP, which was obtained from the International Energy Agency (IEA) publication.

The variables were all normalised by the nominal GDP apart from INFL and OP which were used in their original form. All the variables were endogenous in the estimated VAR models, except OP which was considered exogenous.

FEX is the fiscal expectation series. It was derived based on the 'Adaptive Expectation Hypothesis' that states that economic agents form expectations about an economic variable by taking a sample (geometric) mean of past observations. The concept of adaptive expectation builds on Friedman's (1957) Permanent Income Hypothesis and econometric evidence that supports the extrapolative process, abounds (Chow, 1989).

The adaptive expectation of an economic variable X can be expressed as:

$$X_p - X_{p_{t-1}} = \delta\left(X - X_{p_{t-1}}\right) \qquad (18a)$$

Where $X_p$ is the expected value of the variable and $\delta$, the coefficient of revised expectation ($0 < \delta \leq 1$). By algebraic substitution, Equation (18a) can be expressed thus:

$$X_p = \delta X_t + \delta(1-\delta)X_{t-1} + \delta(1-\delta)^2 X_{t-2} + \cdots + \delta(1-\delta)^n X_{t-k} + \varepsilon_t \qquad (18b)$$

The sample mean is a weighted average with smaller weights attached to past observations and declines geometrically as the lag (k) increases. FEX series were thus, derived from Equation (18b).

## III.3 The Model

The modified framework of Seccareccia and Sood (2000) was used in this analysis. Firstly, it captured both the demand and supply side factors of the economy and, secondly, accounted for the role of expectation in the evolution of inflation. This is important given that the FTPL thrives on the significance of private expectation of government fiscal behaviour (Sims, 1998). Thus, based on the path of inflation specified by their framework, the model was formulated as:

$$INFL_t = \beta_0 + \beta t + \beta_t M_t + \beta_2 G_t + \beta_3 FEX_t + OP_t + \varepsilon_t \qquad (19)$$

Where $INFL\ and\ M$ are inflation rate and the growth rate of money supply, respectively, while $G\ and\ FEX$ represented fiscal behaviour of government and private sector's expectation of fiscal policy. $\beta$ represented the parameter to be estimated and $\varepsilon$ was the disturbance term.

### III.4 Model Estimation - Toda-Yamamoto Granger Non-Causality Test

The main estimation technique adopted in this paper is the Toda-Yamamoto (TYM) approach. The approach is essentially a modified Wald test (MWALD) or an augmented Granger Causality test that fits a standard autoregressive model at the levels of the variables. It reduces the risk of wrongly identifying the order of integration in a series, particularly where the variables have mixed order of integration 1(0) and I(1) (Mavrotas and Kelly, 2001). It does this by augmenting the original VAR order, k, by the maximum order of integration, *d,* explaining why the TYM is sometimes referred to as an over-fitted VAR. The process thus, runs a VAR of (k+ d max)$^{th}$ order and the coefficient of the last *dmax* vector is ignored in the Wald test. The purpose of including extra lags in the model is to ensure an asymptotic $\chi^2$ distribution.

An important condition for this approach is that the optimum lag length must be greater than the maximum integration order in the system. The bivariate form of the model is expressed as:

$$y_t = \alpha_1 + \sum_{i=1}^{k} \beta_{1i}\, y_{t-i} + \sum_{i=k+1}^{k+d} \beta_{1i}\, y_{t-i} + \sum_{i=1}^{k} \gamma_{1i}\, x_{t-i} + \sum_{i=k+1}^{k+d} \gamma_{1i}\, x_{t-i} + \varepsilon_{1t} \qquad (20)$$

$$x_t = \alpha_2 + \sum_{i=1}^{k} \beta_{2i}\, y_{t-i} + \sum_{i=k+1}^{k+d} \beta_{2i}\, y_{t-i} + \sum_{i=1}^{k} \gamma_{2i}\, x_{t-i} + \sum_{i=k+1}^{k+d} \gamma_{2i}\, x_{t-i} + \varepsilon_{2t} \qquad (21)$$

Where $x \; and \; y$ are endogenous variables and $\alpha, \beta \; and \; \gamma$ the model parameters.

The test statistic, $\chi^2$, only estimates relevant parameters with a null hypothesis of asymptotic $\chi^2$ distribution (the sequence of distribution converges).

The TYD approach has three advantages: it can be used in integrated and co-integrated systems without necessarily needing to test for co-integration; it is simple to implement and can be run in an unrelated regression; and despite a deliberate over-fitting of the model, the MWALD test performs as similar test procedures and even better for sample sizes exceeding fifty observations (Zapata and Rambaldi, 1997). The inclusion of additional lags in this approach is at the cost of some degrees of freedom; hence, the estimation points in model must be sizeable.

### III.5 Pre-Estimation Tests

In the Toda-Yamamoto procedure, information on the maximum order of integration in the system must necessarily be obtained; informing the implementation of the ensuing stationarity and associated pre-estimation tests.

**Table 1: Unit Root/Stationarity Tests (Constant, @Trend)**

| Variable | Augmented Dickey-Fuller (ADF) | | Phillips-Perron (PP) | | Kwiatkowski-Phillips-Schmidt (KPSS) | |
|---|---|---|---|---|---|---|
| G | -4.1600* (-3.5485) | I(1) | -4.1550* (-3.5485) | I(1) | 0.1406** (0.4600) | I(0) |
| INFL | -5.1549* (-3.5578) | I(1) | -5.9542* (-3.5484) | I(1) | 0.1917*** (0.2160) | I(1) |
| M | -5.2343* (-3.5485) | I(0) | -5.3475* (-3.5485) | I(0) | 0.0819** (0.1460) | I(0) |
| FEX | -5.8526* (-3.5950) | I(0) | -7.3200* (-3.5530) | I(2) | 0.1980** (0.2160)*** | I(0) |
| OP | -5.0937* (-3.5485) | I(1) | -5.0788* (-3.5485) | I(1) | 0.1279** (0.1460) | I(1) |

Note: (a) the tests include constant with trend; (b) * Indicates rejection of the null hypothesis of unit root at 5% level; (c) ** and *** denote non-rejection of the null hypothesis of stationarity at 5% and 1% level, respectively; (d) the critical values at 0.05 are in parenthesis.

**Table 2: Confirmatory Analysis**

| | ADF | PP | KPSS | Decision |
|---|---|---|---|---|
| G | I(1) | I(1) | I(0) | **I(1)** → Non-Stationary |
| INFL | I(1) | I(1) | I(1) | **I(1)** → Non-Stationary |
| M | I(0) | I(0) | I(0) | **I(0)** → Stationary |
| FEX | I(0) | I(2) | I(0) | **I(0)** → Stationary |
| OP | I(1) | I(1) | I(1) | **I(1)** → Non-Stationary |

The outcomes of the three tests are summarised in Table 2. The variables M and FEX are stationary, while G, INFL and OP have unit roots. The maximum order of integration in the series is 1 (dmax=1). Consequently, in the implementation of the VAR causality test, the estimation model would be over-fitted by an extra lag of 1 {i.e. (k+ d max)}. The determination of the appropriate lag length for the VAR system based on different criteria at 5 per cent level is shown in Table 3.

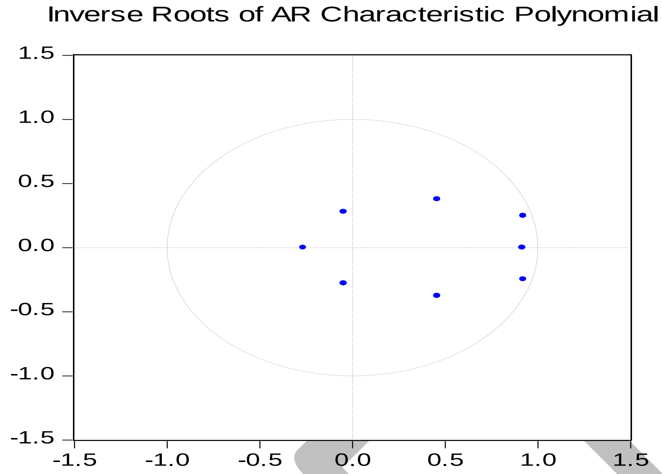
**Table 3: Lag Length Selection**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -632.9960 | NA | 8.75e+11 | 38.84824 | 39.21103 | 38.97031 |
| 1 | -508.0810 | 204.4064 | 1.21e+09 | 32.24733 | 33.33570* | 32.61353 |
| 2 | -485.0136 | 32.15452* | 8.38e+08* | 31.81901* | 33.63295 | 32.42934* |

*Indicates lag order selected by the criterion

As indicated by the LR test statistics, Final Prediction Error (FPE) and Hannan-Quinn Information Criterion (HQ) in Table 3, the lag length with the least sum of squares of residuals in the model was 2. In ensuring that the estimates of the models are unbiased, the residuals of the series were tested for normality, auto and serial-correlation (LM-test). The results revealed the series to be well-behaved. Also, the autoregressive (AR) test showed that all the inverse roots of the AR polynomial lie within the circle, thus, satisfying the stability condition.

**Figure 1: Model Stability Test**




## IV. Estimation and Results

### IV.1 Results: Toda-Yamamoto Non-Granger Causality Test

A major challenge of the TYM approach is its inability to distinguish between the short-run and long-run causality (Lin, 2008). Hence, in determining the relationship between FEX and INFL with respect to time, we ascertained the co-integrating properties of the model and tested for its short- and long-run properties.

**Table 4: Toda-Yamamoto Causality (Modified Wald) Test**

| Null Hypothesis | Chi-Square | Probability | Granger Causality |
|---|---|---|---|
| G does not Granger-cause INFL | 1.8331 | 0.3999 | No Causality |
| INFL does not Granger-cause G | 2.6891 | 0.4421 | |
| M does not Granger-cause INFL | 1.8494 | 0.3966 | No Causality |
| INFL does not Granger-cause M | 3.5951 | 0.1657 | |
| FEX does not Granger-cause INFL | 10.7336 | 0.0047 | Unidirectional Causality FEX → INFL |
| INFL does not Granger-cause FEX | 0.9400 | 0.6251 | |

### IV.2 Long- and Short-Run Estimation

As presented in Table 5, the trace and the maximum eigenvalues rejected the null hypothesis of 'no co-integration' at 5 per cent level, respectively. They indicated the existence of at least one co-integrating equation in the system, suggesting some long-run equilibrium relationship among the variables.

**Table 5: Johansen Co-integration Test Results**

| | Null Hypothesis | Test Statistic | Critical Values | Prob.* Value | No. of Co-integrating Vectors |
|---|---|---|---|---|---|
| Trace Statistic | r=0 | 77.2441 | 47.8561 | 0.0000 | |
| | r=1 | 29.7316 | 29.7971 | 0.0051 | 2 |
| Max-Eigenvalue | r=0 | 47.5125 | 27.5843 | 0.0000 | |
| | r≤1 | 18.6598 | 21.1316 | 0.1071 | 1 |

Note: The Null hypothesis is rejected at 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

### IV.2.1 Long-run Relationship Analysis

Having ascertained co-integration in the system, we estimated a co-integration regression of the model in its stationary form:

$$INFL_t = \beta_0 + \beta t + \beta_t M_t + \beta_2 G_t + \beta_3 FEX_t + OP_t + \varepsilon_t \qquad (22)$$

Table 6: Co-integrating Regression

| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |
|---|---|---|---|---|
| D(G) | -0.0729 | 0.0284 | -2.5645 | 0.0160 |
| M | -0.0197 | 0.0256 | -0.7707 | 0.4473 |
| FEX | 0.0018 | 0.0010 | -1.7094 | 0.0984 |
| D(OP) | 0.1130 | 0.0203 | 5.5585 | 0.0000 |
| C | -0.6354 | 0.7068 | -0.8989 | 0.3763 |
| @TREND | 0.2475 | 0.0465 | 5.3210 | 0.0000 |
| *R-squared* | 0.8420 | Mean dependent var | | 4.3647 |
| *Adjusted R-squared* | 0.8137 | S.D. dependent var | | 3.9590 |
| *S.E. of regression* | 1.7083 | Sum squared resid | | 81.719 |
| *Long-run variance* | 2.3884 | | | |

### IV.2.2 Short-run Relationship Analysis

To show the relationship between both variables in the short-run, an error-correction model (ECM) is formulated. First, we expressed equation (23) in terms of its residuals:

$$\varepsilon_t = INFL_t - \beta_0 - \beta t - \beta_t M_t - \beta_2 G_t - \beta_3 FEX_t - OP_t \qquad (23)$$

and used the same in estimating the simple ECM:

$$\Delta INFL_t = \gamma_0 + \gamma_1 \Delta M + \gamma_2 \Delta G_t + \gamma_3 \Delta FEX_t + \gamma_4 \Delta OP_t + \varphi \varepsilon ct_{t-1} \qquad (24)$$

The coefficient $\gamma$ captures the short-run effect of the explanatory variables on $INFL$, while $\varphi$ is the coefficient of the error-correction term (ect) which tied the model's long-run properties to the ECM. The estimation results of equation (24) were presented in Table 7.

**Table 7: Short-Run Estimation Results**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| **C** | 0.0688 | 0.3056 | 0.2250 | 0.8236 |
| **D(M)** | -0.0312 | 0.0193 | -1.6143 | 0.1181 |
| **D(D(OP))** | 0.1232 | 0.0153 | 8.0415 | 0.0000 |
| **D(D(G))** | -0.0612 | 0.0231 | -2.6454 | 0.0134 |
| **D(FEX)** | 0.0044 | 0.0022 | 1.9648 | 0.0498 |
| **ECM(-1)** | -1.0907 | 0.2000 | -5.4519 | 0.0000 |
| *R-squared* | 0.7864 | Mean dependent var | | 0.3878 |
| *Adjusted R-squared* | 0.7469 | S.D. dependent var | | 3.2309 |
| *S.E. of regression* | 1.6253 | Akaike info criterion | | 3.9722 |
| *Sum squared resid* | 71.326 | Schwarz criterion | | 4.2443 |
| *Log likelihood* | -59.542 | Hannan-Quinn criterion | | 4.0638 |
| *F-statistic* | 19.890 | Durbin-Watson stat | | 1.9521 |
| *Prob(F-statistic)* | 0.0000 | | | |

The short-run analysis indicated that FEX had a significant impact on inflation at the 5 per cent level.

## V. Discussion of Results

The major finding showed that the path of inflation in Nigeria was influenced by private sectors' expectations on fiscal policy, and this relationship was obtained in the short-run.

Specifically, as depicted in Table 4, the study revealed a unidirectional causality, running from the fiscal expectation (FEX) to inflation (INFL), with a probability value of 0.0047 (0.47%). This finding was consistent with the works of Sims (1998) and Seccareccia and Sood (2000), which highlighted the implicit effect of historical fiscal policy behaviour on private expectations, and how these expectations impacted on the price level. However, the paper found no causal relationships among the other variables of interest, including causality between government expenditure (G) and inflation (INFL). As such, it could not validate the preponderance of fiscal dominance in Nigeria, as Raji et al., (2014) and Olusoji and Oderinde (2011) did.

With regards to the time horizon of the expectation-inflation relationship, results from the short-run and long-run analysis indicated that the relationship FEX and INFL is only sustained in the short-run (see Tables 6 and 7). From Table 6, the co-integration regression indicated a positive relationship between FEX and INFL. However, the significance of this relationship was rejected at the 5 per cent level. In contrast, the short-run analysis, estimated by an ECM model, affirmed a positive relationship between both variables, and their significance at the 5 per cent level. This is intuitive, given that private expectations are not static; individuals review their expectations on government policy, from time to time.

The observed positive relationship between inflation and private expectation in both time horizons, was quite instructive. It suggests that if the private sector, for instance, expects government to raise spending in the future (based on precedence), theoretically, it conceives such action as inflationary, and a reduction of its monetary assets, if its expectation eventually materialises. Consequently, it reduces it monetary holdings, either by spending more or switching to non-monetary assets. These responses, based on the quantity theory of money, increase the velocity of money and triggers inflation.

A major limitation of this paper, however, is in its measurement of 'private expectation'. Although the use of the weighted geometric mean of an economic variable in generating expectation series, as adopted by this paper, is widely accepted in the literature (Chow, 1989; Svenden, 1993). However, survey-based data produces superior outcomes (Svenden, 1993; Manski, 2003). Also, the use of annual data does not capture adequately the transmission mechanism of monetary policy. Thus, further work can improve on these weaknesses and enhance the validity of results posted in this study.

## VI. Conclusion and Recommendations

A proper understanding of the evolution of the path of inflation is important in analysis of the factors that drive the price level. Although the FTPL, in its strongest form, does not upturn the conventional role of monetary policy, it provides cues that might enable the optimisation of policies on price stability.

Relying on the FTPL theory and the analytical framework of Seccareccia and Sood (2000), this paper explored the dimension of private 'expectations' in explaining inflation in Nigeria, and provided some empirical support. It found a positive relationship between private sector expectation on fiscal policy and inflation in Nigeria, affirming the theoretical link between expectations and inflation.

The findings are informative in the understanding of the sequence of monetary policy formulation, the robustness of existing monetary policy rule, and the management of inflation in Nigeria. Given the significance of private sector expectation, monetary authority should necessarily incorporate such expectations into its decision-making framework. Such information would broaden policy outcomes in accounting for price fluctuations in the economy. One way of achieving this is by expanding the Bank's Consumer Inflation Expectation Survey, to elicit information on inflationary expectations on fiscal policy. The enhancement of inflation forecasts and the overall effectiveness of monetary policy, would be the major gains.

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