INFLATION TARGETING IN AN EMERGING MARKET VAR AND IMPULSE RESPONSE FUNCTION APPROACH

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Abstract

This study examines the inflation targeting in developing countries, using Nigeria as a case study. Methodologically, an Auto-Regression (VAR) and impulse response function (IRF) model were used to analysis the nature of the impacts, where consumer price index (CPI) is presumed to depend upon changes in its determinants. The Auto-Regression process including the consumer price index, broad money supply, exchange rate, gross domestic product and government expenditure is estimated over the period 1970-2010. The model ascertained the extent in which policy target of these macroeconomics variables does lead to changes in inflation. The results show that, money supply and past level of inflation have the potentials of causing significant changes in inflation in Nigeria. This study therefore suggests that more policy attention should be given these variables in other to have stable inflation rate in Nigeria.

Keywords: Inflation, VAR

1. INTRODUCTION

The application of monetary policy strategies toward achieving macroeconomic objectives has been a dominant feature of economic management over the years. In this regard, the two main strategies of monetary policy- monetary aggregates target and inflation targeting, has been adopted at different point in time across different countries. However, the adoption of inflation targeting (IT) has grown in acceptance ever since it was first adopted by New Zealand in 1989, as quite a number of industrial countries has follow suit in the early 1990s, in addition to a growing number of emerging market and developing countries. As of late 2006, 24 countries are classified as inflation targeters, including8 industrial countries and 16 emerging market and developing countries. Prominent among the IT developed economies are United Kingdom, New Zealand, Canada, Sweden, Norway , Switzerland, Iceland and Austria; while early adopters of IT in emerging market economies include South Korea, Brazil, Mexico, Poland, Czech Republic, Thailand, South Africa, Colombia, Hungary, Chile, Israel, and Peru**.**

Erratic government spending, which often led to large budget deficits, as witnessed in Emerging Market Economies (EMEs), also may lead to significant changes in inflation. Thus small movements in government spending may trigger disproportionately large movements in inflation expectations and, ultimately, inflation (Mishkin and Schmidt-Hebbel 2000). Poor government finances may also lead to increases in regulated prices in order to limit public deficits. Such prices are quite important in EMEs, where many governments determine prices for transportation, electricity, fuel, etc. Changes in government-controlled prices and subsidies can therefore have a large and immediate impact on inflation. Since monetary policy affects inflation with a long lag, this may raise the volatility of inflation and render it more difficult for the central bank to establish credibility.

Also, large government debts are also problematic since they provide incentives to reduce the real value of the debt through inflation or by forcibly converting the maturity structure of the debt. This raises inflation and risk premia, and therefore nominal interest rates. If the central bank in fact maintains low inflation, ex-post real interest rates will be high, reducing growth and leading to unstable debt dynamics

Inflation-targeting regimes put great stress on the need to make monetary policy transparent and to maintain regular channels of communication with the public; in fact, these features have been central to the strategy's success in industrialized countries. As observed by (Mishkin and Posen 1997; and Bernanke, Laubach, Mishkin, and Adam Posen 1999), inflation-targeting central banks have frequent communications with the government, and their officials take every opportunity to make public speeches on their monetary policy strategy. The most important issues on inflation targeting centered on the notion of preconditions for adopting inflation targeting across countries in the literature. It is implicit in the argument that, unless the prerequisites are satisfied, the central bank should refrain from targeting inflation. Yet a closer look suggests that the preconditions typically specified are necessary for any monetary policy strategy to be successful - be it inflation, exchange rate or monetary targeting.

Arestis and Sawyer (2003) refer inflation targeting to be the ‘New Monetary Policy’, which is characterized by: a numerical and official inflation target; monetary policy exercised through interest rates; an independent central bank; and no other objectives of monetary policy. However, inflation targeting is considered to entails much morethan a public announcement of numerical targets for inflation for the year ahead, particularly as regards developing countries and emerging market economies, who routinely reported numerical inflation targets or objectives as part of the government's economic plan for the coming year, and yet their

monetary policy strategy should not be characterized as inflation targeting, which requires the other four elements for it to be sustainable over the medium term.

The main objective of this paper is to examine inflation targeting in emerging country, a case study of the Nigerian economy and discuss the relationship between inflation and some key macroeconomic variables in Nigeria. The paper is divided into six sections, following this introduction, is section two which focus on brief review of relevant literature of the relationship between inflation and some key macroeconomic variables. Section three focused on the study'stheoretical framework and model specification, while estimationstrategies are describe in section four. Section 5 discusses the empirical results in the study and section 6 is the conclusions and policy implication.

2. BRIEF REVIEW OF LITERATURE

Conceptually, inflation targeting has been defined in different way by different authors. However, those suggested by Mishkin (2000) and Mishkin and Savastano (2000) are considered a representative of those found elsewhere in the literature. According to them,inflation targeting is a monetary policy strategy that encompasses five main elements: First, the public announcement of medium-term numerical targets for inflation; Second, an institutional commitment to price stability as the primary goal of monetary policy, to which other goals are subordinated; Third, an information inclusive strategy in which many variables, and not just monetary aggregates or the exchange rate, are used for deciding the setting of policy instruments; Four, increased transparency of the monetary policy strategy through communication with the public and the markets about the plans, objectives, and decisions of the monetary authorities; and fifth, increased accountability of the central bank for attaining its inflation objectives

According to Mishkin (1999) the adoption of IT is considered to offer some benefits to the adopting countries, some shortcomings were also observed to be linked to its implementation. In this vein, critics of IT have identified seven disadvantages of this monetary policy. The first four of those disadvantages explained that inflation targeting is too rigid, that it allows too much discretion, that it has the potential to increase output instability, and that it will lower economic growth. The fifth disadvantage, that inflation targeting can only produce weak central bank accountability because inflation is hard to control and because there are long lags from the monetary policy instruments to the inflation outcome, is an especially serious one for emerging market countries. The sixth and seventh disadvantages, that

inflation targeting cannot prevent fiscal dominance, and that the exchange rate flexibility required by inflation targeting might cause financial instability, are also very relevant in the emerging market country context (Bernanke, et al., 1999)

In line with the recommendation of Masson et al. (1997), inflation targeting is likely to be a more effective strategy if it is phased in only after there has been some successful disinflation. According to them, one factor affecting inflation targeting (controllability) that is especially relevant in the emerging market context is the (at times large) incidence of government-controlled prices on the index used to compute headline inflation. And this shortcoming it may not be sufficient to ensure fiscal discipline or prevent fiscal dominance. Governments can still pursue irresponsible fiscal policy with an inflation targeting regime in place. In the long run, large fiscal deficits will cause an inflation targeting regime to break down: the fiscal deficits will eventually have to be monetized or the public debt eroded by a large devaluation, and high inflation will follow

In the same vein, Arminio et al (2003) and Alberto et al (2002) assesses inflation targeting in EMEs, and develop applied prescriptions for the conduct of monetary policy and inflation-targeting design in EMEs. They verified that EMEs have faced more acute trade-offs – higher output and inflation volatility – and worse performance than developed economies. They argued that these results thus stem from more pronounced external shocks, lower credibility, and lower level of development of institutions in these countries. Therefore, they suggest that high levels of transparency and communication with the public and the development of more stable institutions are required in order to improve their performance. In addition, at an operational level, they propose a procedure that a central bank under inflation targeting can apply and communicate when facing strong supply shocks, and suggest a monitoring structure for an inflation-targeting regime under an IMF program.

However, FitzGerald (2004) examined inflation targeting with reference to stabilisation policy in emerging market economies from two critique perspectives: The Keynesian and The Structuralist. He thus, developed two frameworks: First, from the Keynesian perspective, the IMF 'basic monetary programming framework's for developing countries which uses government borrowing and the exchange rate as policy instruments in order to achieve specific inflation and balance of payments targets was adapted. This standard model was adapted in order to include short-term capital flows and the floating exchange rate arising from financial liberalisation. In this way, the macroeconomic consequences of the current Fund focus on inflation targeting and the use of a single monetary policy instrument (the

interest rate, combined with rigid fiscal and reserve 'rules') in emerging market economies was demonstrated.

Rogers (2006) examined the macroeconomic performance of emerging market economies under IT and alternative monetary policy regimes. Statistical analyses of the benefits of adopting inflation targeting are based on a "difference in differences" approach, comparing how performance for key macroeconomic variables has changed in countries adopting inflation targeting with performance in other countries under alternative monetary regimes over the same period. The results obtained suggest that that inflation targeting has been associated with better macroeconomic performance than under alternative other monetary policy frameworks. Also, a comparison of macroeconomic performances of emerging market inflation targeters and non-targeters shows that emerging marketinflation targeters, on average, achieved a reduction in the median inflation rate from over10 percent prior to adopting IT to around 4 percent subsequently, while non-IT countries hada smaller decline in the median inflation rate to around 7 percent. Both groups of countrieswere able to achieve this at the same time as increased median growth. Industrial countryinflation targeters, in contrast, experienced little change, on average, in either inflation orgrowth between the 1990s and the mid-2000s. And Ball and Sheridan (2003) applied similar approach to industrial countries, finding no significant benefit from adoption of inflation targeting. However, using similar methodology, subsequent research by Mishkin and Schmidt-Hebbel (2005), IMF (2005), and Vega and Winkelried (2005) finds clearer evidence of a favorable outcome that inflation targeting in emerging market economies has been associated with better macroeconomic performance than alternative policy regimes.

3. THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

The pioneer work of Phillips (1958) on the relationship between unemployment and the rate of change of money wage rate provided the foundation on which theories on inflation has been developed over the last four decades. The basic tenet of the original version of the Phillips curve, postulated an inverse and stable curvelinear relationship between money wage rate as a proxy for inflation rate and the rate of unemployment. This tenet thus throws up the famous inflation-unemployment trade-off in macroeconomic management, as it assumed that the achievement of low inflation rate is conditioned on the tolerance of high unemployment rate and vice versa.

However, the subsequent challenge of this philosophy by the Milton Friedman-led Monetarist sequel to the empirical finding that reveals a contradiction of the trade-off postulate underlying the curve, using the 1900-1958 U.S. data; as the trade-off relationship was hardly as stable as that postulated originally by Phillips using data on Britain. Beside the observed absence of a systematic inverse relationship between both variables, there was also an observed simultaneous increase in both variables overtime. Hence, due to the absence of a long run trade off between inflation and unemployment, this school of thought asserts that any observed trade off was at best a short run phenomenon. In addition, the Monetarist asserts that there must be some level of unemployment that is consistent with a cleared labour market (full employment situation), a level which was subsequently termed as "the natural rate of unemployment" as well as "non-accelerating inflation rate of unemployment) (NAIRU).

Regarding the measurement of inflation, quite a number of measures has been suggested and widely employed as measures of inflation in theory and practice. Prominent among these measures are consumer price indices (CPIs) which measure the price of a selection of goods purchased by a "typical consumer"; Cost-of-living indices (COLI) which often adjust fixed incomes and contractual incomes based on measures of goods and services price changes; producer price indices (PPIs) which measure the price received by a producer. This differs from the CPI in that price subsidization, profits, and taxes may cause the amount received by the producer to differ from what the consumer paid. There is also typically a delay between an increase in the PPI and any resulting increase in the CPI. Producer price inflation measures the pressure being put on producers by the costs of their raw materials.

Also, Wholesale price indices (WPI), which measure the change in price of a selection of goods at wholesale, prior to retail mark ups and sales taxes; commodity price indices (CPI), which measure the change in price of a selection of commodities that are weighted by the relative importance of the components to the "all in" cost of an employee; and GDP Deflators, which measures price increases in all assets rather than some particular subset. The term "deflator" in this case means the percentage to reduce current prices to get the equivalent price in a previous period.

Aron and Muellbauer (2007) note that a large body of economic theory suggests that high uncertainty impedes investment, and there is a negative link between inflation volatility and growth. Therefore, if monetary policy can lower volatility and uncertainty, this could support long-run growth, productivity and welfare. There is, however, a short-run trade-off between inflation and output (or deviations from potential output).

The academic literature generally characterizes inflation targeting as the assignment of an objective function of the following form, which illustrates this trade-off between inflation and output variability (Walsh, 2003 and Svensson, 2002):

$$L_t = E_t \sum_{t=0}^{\infty} \beta^i \left[\left(\pi_{t+i} - \pi^T \right)^2 + \lambda \left(y - y^* \right)^2_{t+1} \right] \quad (1)$$

The loss function, *L*, to be minimised reflects expected deviations of inflation ($\boldsymbol{\pi}$) from the inflation target ($\boldsymbol{\pi}^T$) and the expected deviation of output *(y)* from potential output *(y*)* (the output gap). The greater the deviation from the inflation target, the more costly it will be and the more strongly monetary policy is likely to react. λ represents the weight assigned to achieving the output gap objective *relative* to the inflation objective. If output = 0, then one has a 'strict' inflation targeter, where all weight is put on the inflation objective and therefore one would expect increased output variability. Any weight on output (> 0) describes what is referred to as a flexible inflation-targeting regime. It is generally agreed that there are very few central banks, if any that act in the strict sense. In other words, there is a concern about the amplitude and length of the business cycle.

Meanwhile, inflation-targeting banks do not usually use such a loss function in practice. But, as noted by Svendsen et al. (2004) and Smets (2000), the choice of the monetary policy horizon implicitly provides an indication of the size. Strict inflation targeters would choose as short a time horizon as possible within the constraints of the lag of monetary policy, while more flexible central banks would have a longer target horizon. The target horizon may also be extended in the face of shocks that would have a strong negative output effect.

Specifically, in order to plan monetary policy and to measure its success an objective function is used that accounts for the rate of inflation and economic output:

$$F(\mu^*, Y^*) = [(\mu_{t+1} - \mu^*)^2 + \lambda(Y_{t-1} - Y^*)^2] \quad (2)$$

μ* describes the targeted rate of inflation, μ_{t-1} the achieved rate of inflation in one year. Monetary policy's effects are time-shifted, the real effects are perceived later, that is why the rate of inflation in one year is of importance. The same way Y_{t+1} is the economic output in one year whereas *Y** is the targeted economic output. The difference of both is squared to get a positive result. That assures that there is no interpretative difference between a deviation downwards or a deviation upwards, both are not desired. For the sake of simplicity 1/2 is written in front of the formula because it simplifies the first mathematical derivative. λ has a special meaning: If it is equal to 0 then economic output does not matter to monetary policy, but if it is larger than 0, then economic output matters. The value of λ describes in how far the

economic output matters relative to the rate of inflation. The two cases can be distinguished as follows: $\lambda = 0$: *strict inflation targeting;* $\lambda > 0$: *flexible inflation targeting.*

It is the central bank's task to find values for π^* and Y^* that create stability for the economy. Empirical evidence suggests that the rate of inflation should be between 0% and 3%. The target value for Y^* should be equal to the economy's natural level of output Y^n. As a low rate of inflation, in the most cases, should be first priority, λ has a small value, which gives the economic output a slight significance, but does not exceed the rate of inflation in importance.

The theoretical background for $Y^* = Y^n$ is the assumption that in the long-run the economy will equilibrate and the output of an economy in its equilibrium is called the natural level of output. Money cannot influence the natural level of output because in the long-run changes in the money supply only result in corresponding price changes. This is called the *neutrality of money*: prices will adjust to the quantity of money in circulation. Another important concept is the *superneutrality of money*: the growth rate of the money supply does not affect economic output. Therefore sustained economic growth is no goal of monetary policy as such, but, as in the short-run monetary policy has an effect on real variables, stabilization around the natural level of output. The central bank needs to give a target for μ^* because inflation is a monetary phenomenon: there exists no natural level of inflation, but inflation is depended on the money supply and the central bank controls the money supply. Consequently inflation is the result of the central bank's way of proceeding and therefore the central bank needs to give a target value.

Institutional weaknesses, lack of credibility, fiscal dominance, lack of technical capabilities, structural rigidities, and external vulnerabilities has been considered to be the major attributes responsible for the divergent outcomes of inflation targeting on macroeconomic performance across countries, particularly between developed and developing countries (Masson et al 1997; Fraga et al 2003; Schaechter et al 2000; Mishkin 2004; Batini and Laxton 2007; and Frankel et al 2007).

Precisely, the over-riding influences of political economy to subdue the central bank independence regarding instrument independence exacerbate the time inconsistency problem or political monetary policy cycle as well as institutional weakness and lack of credibility. Suppression of inflation targeting framework due to fiscal dominance debacle emanates from the persistency of budget deficits and the subsequent monetization of government debt which often undermine inflation targeting focus of monetary policy.

Also, economic regulatory structures that often influence overly sensitive commodity price and exchange rate changes largely render the administration of inflation targeting ineffective.

All these constitute endogenously-induced forces, in addition to the exogenous effect of supply shocks and external volatilities that often reduce the efficacy of inflation target. Therefore, as observed it would seem reasonable to expect that a focus on and inclusion of money supply condition, exchange rate movement, government expenditure, in addition to the age-long analysis of inflation through consumer price index and output through Gross Domestic Product, in the model becomes imperative (Calvo and Reinhart 2002; Ho and McCauley 2003; Swanepoel 2004; Du Plessis et al 2008; Stiglitz 2008; Blinder and Rudd 2008; Ajam and Aron 2009).

On the issue of specifying the inflation target, the adoption of IT requires that an appropriate price index be selected and that the exact level of the target be determined. Like more advanced economies, EMEs target the CPI because it is well understood by the public, is available quickly and is not revised. However, CPI baskets in EMEs tend to differ from those in more advanced economies on two accounts. First, food constitutes a greater part of the basket. Since food prices are highly variable as a result of their sensitivity to weather conditions, this translates to more volatile CPI inflation. Second, regulated prices are more important (Debelle et al. 1998). Large movements in regulated prices, which have a direct impact on the overall price level, may lead to poor control of inflation and damage the central bank's credibility. While poor inflation control resulting from the large weight of food in the CPI could be addressed by the central bank targeting a measure of core inflation, this strategy is also subject to problems (Feldstein 1999). A measure of core inflation that reduces the importance of food and regulated prices may reflect the actual cost of living quite poorly. Also, the use of core inflation may also lead to credibility problems.

Hence, transforming equation (2) to include the above variables results in the following equation:

$$f(\mu^*, Y^*, MS^*, EXRT^*, GOVEXP^*) = [(\mu_{t+1}-\backslash\ \mu^*)^2 + \lambda(Y_{t-1}- Y^*)^2 + (MS_{t-1}-MS^*)^2 + (EXRT_{t-1}-EXRT^*)^2 + (GOVEXP_{t-1}-GOVEXP^*)^2]$$

Removing the influence of expectation from equation (3), we derive:

$$\mu = f(Y, MS, EXRT, GOVEXP) = [(\mu_{t+1})^2 + \lambda(Y_{t-1})^2 + (MS_{t-1})^2 + (EXRT_{t-1})^2 + (GOVEXP_{t-1})^2] \quad (4)$$

Removing the lags and squares in equation (4), and making μ the subject of the equation, equation (3) is transformed in natural log form as follows:

$$In\mu = \beta_0 + \beta_1\, InY + \beta_2\, InMS + \beta_3\, InEXRT + \beta_4\, InGOVEXP + u \quad (5)$$

The symbol μ and *Y* is represented as: CPI and GDP in the model as follows:

$$InCPI = \beta_0 + \beta_1\, InGDP + \beta_2\, InMS + \beta_3\, InEXRT + \beta_4\, InGOVEXP + u \quad (6)$$

Following the theoretical background of this study, and using the autoregressive framework developed by Sims (1980) we specify a VAR model of order *p*. The general form of a VAR model is given by the following unrestricted (reduced form) system.

$$Z_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Z_{t-1} + u_t \qquad (7)$$

Equation (2) above specifies a VAR (P) process, Where Z_t is a vector of stationary endogenous Variables, α is an $n \times 1$ vector of constants, β is an (n*n) matrix of coefficients, p is the number of lag, U_t is an (n*n) vector of error term.

In addition, u is an independently and identically distributed with zero mean, i.e $E(u_t) = 0$ and $E(u_{tk}, u_{sk}) = 0 \quad for\ t \neq s$). The disturbance term, ut also has a covariance matrix.

In order to capture the impulse response function (IRF) in the model which also incorporates the above direct and indirect linkages, the model VAR is specified as follows:

$$CPI_t = \alpha_{it} + \sum_{j=1}^{n} \beta_j CPI_{t-j} + \sum_{j=1}^{n} \delta_j MS_{t-j} + \sum_{j=1}^{n} Y_{ij} EXRT_{t-j} + \sum_{j=1}^{n} \phi_{ij} GDP_{t-j} + \sum_{j=1}^{n} \Omega_{ij} GOVEXP_{t-j} + U_{1t} \quad --8$$

$$MS_t = \alpha_{it} + \sum_{j=1}^{n} \beta_j CPI_{t-j} + \sum_{j=1}^{n} \delta_j MS_{t-j} + \sum_{j=1}^{n} Y_{ij} EXRT_{t-j} + \sum_{j=1}^{n} \phi_{ij} GDP_{t-j} + \sum_{j=1}^{n} \Omega_{ij} GOVEXP_{t-j} + U_{2t} \quad --9$$

$$EXRT_t = \alpha_{it} + \sum_{j=1}^{n} \beta_j CPI_{t-j} + \sum_{j=1}^{n} \delta_j MS_{t-j} + \sum_{j=1}^{n} Y_{ij} EXRT_{t-j} + \sum_{j=1}^{n} \phi_{ij} GDP_{t-j} + \sum_{j=1}^{n} \Omega_{ij} GOVEXP_{t-j} + U_{3t} \quad --10$$

$$GDP_t = \alpha_{it} + \sum_{j=1}^{n} \beta_j CPI_{t-j} + \sum_{j=1}^{n} \delta_j MS_{t-j} + \sum_{j=1}^{n} Y_{ij} EXRT_{t-j} + \sum_{j=1}^{n} \phi_{ij} GDP_{t-j} + \sum_{j=1}^{n} \Omega_{ij} GOVEXP_{t-j} + U_{4t} \quad --11$$

$$GOVEXP_t = \alpha_{it} + \sum_{j=1}^{n} \beta_j CPI_{t-j} + \sum_{j=1}^{n} \delta_j MS_{t-j} + \sum_{j=1}^{n} Y_{ij} EXRT_{t-j} + \sum_{j=1}^{n} \phi_{ij} GDP_{t-j} + \sum_{j=1}^{n} \Omega_{ij} GOVEXP_{t-j} + U_{5t} \quad --12$$

Where $\Omega, \phi, Y, \delta, \beta\ and\ \alpha$ are the unknown parameters, α is the constant or intercept *u's* is the stochastic error terms, *n* is no of lags and CPI, MS_2, EXRT, GDP, GOVEXP are as define above. More specifically, our interest is in equation (8)

$$CPI_t = \alpha_{it} + \sum_{j=1}^{n} \beta_j CPI_{t-j} + \sum_{j=1}^{n} \delta_j MS_{t-j} + \sum_{j=1}^{n} Y_{ij} EXRT_{t-j} + \sum_{j=1}^{n} \phi_{ij} GDP_{t-j} + \sum_{j=1}^{n} \Omega_{ij} GOVEXP_{t-j} + U_{1t}$$

4. ESTIMATION STRATEGY

Our estimation technique consists of three steps procedure. First, the unit root test using the unit root test of the individual root - ADF – Fisher unit root test. Second, a vector autoregression estimate, using Iterative Weighted Least Squares simultaneous regression method (including a constant term) is run over the sample period 1970-2010. The lag length

of one was chosen based on the Akaike Information. Finally, once the VAR was estimated, then we determine the impulse response function (IRF) of inflation targeting proxied by CPI, this is to describe how CPI react over time to exogenous impulses' (shocks) in the dependent variables. Impulse response factions are devices to display the dynamics of the variables tracing out the reaction of each variable to a particular shock at time‘t’.

The dynamic relationships between variable are modeled empirically as a vector autoregression (VAR) while a simple linear model based on economic theory is used to model the contemporaneous relationships. The advantage of using economic theory to model the contemporaneous relationships is that the impulse response functions will now have clear economic interpretations; this is to examine the dynamic response of inflation to shocks in its determinants. These variables under consideration are consumer price index (CPI), gross domestic product (GDP), money supply (MS), government expenditure (GOVEXP), Interest rate (INTR) and exchange rate (EXRT). The data set for this paper consists of annual time series from 1970 – 2010 and they were obtained from Central Bank of Nigeria (CBN) and National Bureau of Statistics (NBS).

To estimate the hybrid model, we estimate by an unrestricted VAR of the form, we recall equation (7) above $Z_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Z_{t-1} + u_t$

The (*n x 1*) vector Z_t contains *n* variable in the system, which is list of vector of endogenous variables that includes. The vector Z_t contains broad money supply (MS_t), exchange rate ($EXRT_t$), gross domestic product (GDP_t), government expenditure ($GOVEXP_t$), and consumer price index (CPI_t) a measures of inflation targeting. $\alpha_0$is a vector that contains the constant terms

To ensure stationarity of the data we employed the group unit root test of the individual root - ADF – Fisher unit root test. This test is to detect the order of integration of the variables before estimation. The unit root test is necessary because research has shown that non-stationary data leads to spurious regression. The study tested for co-integration using the Johansen approach which is suitable for VAR model. We employ the vector autoregressive model (VAR), which better explains a revolving door model. This choice of the estimation technique is as a result of the fact that Vector Auto Regression model best captures the relationship between CPI and its determinants variable using their related lags. A unique feature of the VAR model is that an endogenous variable in one equation of the system appears in another equation as an explanatory variable thereby becoming stochastic and correlated with the disturbance term (shock or impulse term) of the equation.

5. EMPIRICAL RESULTS

ADF – Fisher Unit Root Test Statistics

From the ADF – Fisher unit root test statistics in Table 1, the results show all the variables are in terms of first differences of logarithms (growth rates) and none at level (See Table 1).

Table 1: Summary of Results of Unit Root Tests (ADF – Fisher)

Exogenous variables: Individual effects, individual linear trends					
Automatic selection of lags based on SIC: 0					
Total (balanced) observations: 195					
Cross-sections included: 5					
Method			Statistic	Prob.**	
ADF - Fisher Chi-square			79.4847	0.0000	
ADF - Choi Z-stat			-7.30353	0.0000	
** Probabilities For Fisher Tests Are Computed Using An Asympotic Chi-Square Distribution. All Other Tests Assume Asymptptic Normality					
Series	**Prob.**	**OO I**	**ADF T-Stat**	**Max Lag**	**Observation**
D(LOGCPI)	0.0090	I(1)	-4.259406	1	38
D(LOGMS)	0.0096	I(1)	-4.237125	1	38
D(EXRT)	0.0003	I(1)	-5.556079	1	38
D(LOGGDP)	0.0007	I(1)	-5.230877	1	38
D(LOGGOVEXP)	0.0000	I(1)	-7.640723	1	38
Test critical values:		1% level		-4.219126	
		5% level		-3.533083	
		10% level		-3.198312	

Note: OOI – Order of integration

The results in the Table 1 showed that there is an existence of unit root. This implies that all the series are non stationary at levels except. Therefore the null hypothesis ($\rho = 1$) is accepted at levels. From the results, the ADF - Choi Z- test statistic (-7.640723) and various probabilities values show that CPI, MS, EXRT, GDP and GOVEXP were all integrated at order one, that is I(1). This implies that all the variables were statistically significant at 1%, 5% and 10% critical values at first difference. In other words, they were stationary at first difference. These are MacKinnon critical values for the rejection of hypothesis of a unit root.

Vector Autoregression (VAR) Estimates

In Table 2 we use VAR estimate, we adopt a one lag VAR model. We did this to take in account the possibility of running into the problem of lost degree of freedom or the problem of multi-collinearity and in choosing the best order to give us a result that is manageable.

The examination of these results indicates that the past value of the endogenous variable, inflation (CPI) is significant in determining its own current value (0.916%). The result also shows that the past value of the explanatory variables MS (0.63%) and GOVEXP (0.21%) are significant in determining the current level of inflation in Nigeria. Though GDP (0.022%) is positively related, the result that it is not significant having observed the value of probability distribution. In the case of EXRT, the result shows that the lagged value of EXRT (-0.002%) has no significant effects (negative) in determining the current level of inflation in Nigeria, given their coefficient of determination (R^2)of (96%).

Table 2: Estimation Method: Vector Autoregression Estimates				
Total system (balanced) observations 195				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.915527	0.098903	9.256848	0.0000
C(2)	0.628511	0.085961	7.311583	0.0657
C(3)	-0.00196	0.001005	-1.95025	0.0528
C(4)	0.022359	0.141459	0.15806	0.8746
C(5)	0.20724	0.102895	2.014092	0.0436
C(6)	-0.817224	1.028156	-0.794845	0.4278
Determinant residual covariance		1.03E-05		
Equation: LOGCPI = C(1)*LOGCPI(-1) + C(2)*LOGMS(-1) + C(3)*EXRT(-1) + C(4)*LOGGDP(-1) + C(5)*LOGGOVEXP(-1) + C(6)				
Observations: 40				
R-squared	0.956484	Mean dependent var		1.987973
Adjusted R-squared	0.995951	S.D. dependent var		2.312048
S.E. of regression	0.147120	Sum squared resid		0.714266
Durbin-Watson stat	1.868000			

The result shows that past level of inflation and money supply seem to have the highest impacts, while and government expenditure seems to have less significant impact, considering the level of the coefficient. The Durbin-Watson (DW) test statistic *(d*)* shows the presence of weak positive serial correlation between the error terms in the model.

Table 3: Impulse Response of Consumer Price Index (CPI) to Structural one S.D. innovations					
Period Horizon	**LOGCPI**	**LOGMS**	**EXRT**	**LOGGDP**	**LOGGOVEXP**
1	0.14712	0.00000	0.00000	0.00000	0.00000
2	0.14277	0.11017	-0.02216	0.00416	0.00323
3	0.13752	0.20462	-0.04347	0.01241	0.00310
4	0.13211	0.28197	-0.06057	0.02034	0.00217
5	0.12682	0.34408	-0.07321	0.02692	0.00125

6	0.12177	0.39326	-0.08202	0.03213	0.00054
7	0.11704	0.43158	-0.08775	0.03617	5.91E-0
8	0.11266	0.46076	-0.09108	0.03924	-0.00023
9	0.10867	0.48229	-0.09256	0.04153	-0.00037
10	0.10507	0.49743	-0.09267	0.04319	-0.00040
Cholesky Ordering: LOGCPI LOGMS EXRT LOGGDP LOGGOVEXP					

Impulse Response Functions (IRF)

The estimated coefficients of the VAR and contemporaneous model indicate the direct effects on the measure of output. Yet, we are also interested in the total effects (direct and indirect effects) that these variables will have on inflation. An IRF traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. Thus, in Table 3, we present the results from the impulse response for the level of inflation. The actual impulse response function is based on the initially estimated model of the vector autoregression (VAR) estimate using the actual data.

The IRF results in Table 3 describe how inflation reacts over time to past inflation and exogenous impulses' (shocks) of its determinant variables. The results show that current inflation is affected contemporaneously by the shocks from it past and from other variables (columns one to five). The response is also portrayed graphically, with horizon (period) on the horizontal axis and response on the vertical axis (see Appendix A). The first column is the response of current inflation to past inflation, while the second column is the response of current inflation to money supply shock. The third column is the response of inflation to exchange rate shock, the fourth column is the response of inflation to growth in gross domestic product and the fifth column is the response of inflation to the increase in government expenditure. The results show that past value of inflation is significant in explaining current value of inflation. That is CPI is affected contemporaneously by the shock to it past (first column). The result in column one shows that past the positive impact seem to decrease effect in the long run

Inflation response to structural one innovation appears to be greater in money supply than other exogenous variables. Monetary policy shock to money supply effect is stronger on the inflation at longer horizon (from the firth to tenth years). One innovation in money supply show large percentages of inflation response. This shows that money policy innovations play an important role in variation of inflation in long run than they do in the short run. Indeed, for the seventh to the ten period horizons (43.2%, 46.1%, 48.2% and 49.7% at 7^{th}, 8^{th}, 9^{th} and

10th years' horizon, respectively) aggregate money supply shocks explain a greater proportion of the variation in inflation. This shows that inflation is monetary phenomena in Nigeria.

Innovations in gross domestic product explain relatively small proportions of inflation variance but its effect are larger after the 9th year's horizon, the long run. Thus, inflation appears to be less sensitive to the economic shocks to other exchange rate shock and government expenditure. In other words, it appears that both are not very important in explaining inflation in either the short or long run. Overall, it appears that an innovation in money supply is an important factor affecting inflation either the short or long.

6. CONCLUSION AND POLICY IMPLICATION

This study examines the inflation targeting in developing countries using Nigeria as a case study. It pointed out that targeting inflation is a key factor for the policy makers in Nigeria in order to achieve her macro economic objectives. This study came out with empirical evidence that will help in understanding the relationships among variables used in the model drawing from the Nigerian experience.

The principal finding of this paper is that the money supply is more important in explaining variation in inflation in Nigeria than other variables in this model both in the short and long run. Also, from our analysis, it was discovered that past inflation rate has high significant impact on current CPI until the 10th year horizon. This discovery, further gives credit to the random walk hypothesis. The presence of high money supply shocks has adverse effects on inflation rate. The also revealed that, sudden changes or shocks in government expenditure and exchange rate tend to have no impact on inflation in Nigeria. However, gross domestic product shocks had little implication for inflation from the 2nd to 10th year.

The result of our analysis is relevant to the Nigerian policy makers who desire to understand how inflation hinders economic growth. Thus, the regulatory body (CBN) should do all it can to stabilize fluctuations in the supply of money in Nigeria in order to reduce inflation and boost confidence and attract investors into the economy. Thus, more policy attention should be given to regulation of inflation rate and a steady boost in money supply in Nigeria. The challenges of using sample data size suggest the need for further studies in this area as more published data is available in Nigeria. The resurgent rising inflation rate in Nigeria in the past few years is a pointer of the effects of at least one of these variables.

Lastly, policy measures that are capable of reducing degree of fluctuations in these variables should be welcomed by the Regulatory body (CBN). Furthermore, since past inflation have

effects on current inflation only in the short run; efforts should be made towards making CPI stable thus encouraging growth gross domestic product in the long run.

REFERENCES

Alberto et al (2002), Inflation Targeting in Emerging Market Countries, Too Much Exchange Rate Intervention? : A Test Goldman Sachs Economic Research.

Amato, J. D., and Gerlach, S. (2001) "Inflation Targeting in Emerging and Transition Economies: Lessons after a Decade; Hong Kong Institute for Monetary Research**.**

Arestis, P. And M. Sawyer (2002) "Can Monetary Policy Affect The Real Economy" Working Paper No 355. Annadela-on-Hudson, N.Y.: The Levy Economic Institute.

Ball, Laurence, and Niamh Sheridan, 2003,"Does Inflation Targeting Matter?" NBER Working Paper No. W9577 (Cambridge, Massachusetts: National Bureau of Economic Research).

Bernanke, B., F. Mishkin (1997), inflation targeting: A new framework for monetary policy? "journal of economic perspectives 11 (2): 97 – 116

Bernanke, B., T. Laubach, F . Mishkin, and A . posen, (1999), inflation targeting: lesson from the international experience, Princeton, NJ: Princeton university press.

Calvo, Guillermo A. And Carmen M. Reinhart (2002) "Fear of Floating", Quarterly Journal of Economics 117 (2):379-408.

Debelle, Guy and Stanley Fischer (1994) "How Independent Should a Central Bank Be" In Jeffrey C., Fuhrer, ed., Goals, Guidelines and Constraint Facing Monetary Policy Makers" Conference Series 38 (Boston: Federal Reserve Bank of Boston): 195-221.

FitzGerald, V. (2004) Monetary Models and Inflation Targeting in Emerging Market Economies, Department of Economics, Oxford University, Discussion Paper Series; N0 184.

Fraga, Arminio, Goldfaljn Ilan and Minella Andre Minelle (2003) Inflation Targeting in Emerging Market Economies" NBER Macro Annual, Forthcoming

IMF (2005) "Does Inflation Targeting Work in Emerging Market" IMF World Economic Outlook, September 2005/09/16, Washington D.C.: International Monetary Fund.

Leiderman, L. and G. Bufman (1996), "Searching for Nominal Anchors in Shock-Prone Economies in the 1990s: Inflation Targets and Exchange Rate Bands," in Securing Stability and Growth in Latin America: Policy Issues and Prospects for Shock-Prone Economies, ed. R. Hausman and H. Reisen, OECD, Paris.

Leiderman, L. And G. Bufman (2000), "Inflation Targeting under a Crawling Band Exchange Rate Regime: Lessons from Israel," in Inflation Targeting in Practice: Strategic and Operational Issues and Applications to Emerging Market Economies, ed. M. Blejer, A. Ize, A. Leone and S. Werlang, IMF, Washington.

Masson, P., M. Savastano, and S.Sharma (1997) "The Scope for Inflation Targeting in Developing Countries" IMF Working Paper 97/130, October.

Mishkin, F. S. And K. Schmidt-Hebbel (2000), "One Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know?" paper prepared for the Central Bank of Chile Conference on "Ten Years of Inflation Targeting: Design, Performance, Challenges", December 2000.

Mishkin, F.S. (2000) "Inflation Targeting in Emerging Economies", NBER Working Paper 7618.

Mishkin, Frederic and Klaus Schmidt-Hebbel, (2005), Does inflation Targeting Make a Difference In Klaus Schmidt-Hebbel and J, Frederic Mishkin, eds., 2005 Monetary Policy Under Inflation Targeting (Santiago: Central Bank Of Chile)

Mishkin, Frederic S. (1999) "Lessons from The Asian Crisis, Journal of International Money and Finance, 18(4): 709-723.

Mishkin, Frederic S. And Miguel Savastano (2002)"Monetary Policy in Emerging Market Countries: Lessons from Latin America" Comparative Economic Studies Vol. XLIV. No 2(Summer 2002):45-83

Rogers, S. (2006) "An Overview of Inflation Targeting in Emerging Market Economies", In Challenges to Inflation Targeting in Emerging Countries; Bank of Thailand International Symposium**,** 13–14 November 2006 Bangkok, Thailand.

Svesson, L.E.O (1997) "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targeting, European Economic Review, 41: 1111-1146.

Vega, Marco, and Diego Winkelried (2005) "Inflation Targeting and Inflation Behaviour: A Successful Story" International Journal of Central Banking, pp. 153-175.

Vega, Marco, and Diego Winkelried, 2005, "Inflation Targeting and Inflation Behavior: A Successful Story?" *International Journal of Central Banking*, Vol. 1(3), 153–175.

Alberto et al (2002), Inflation Targeting in Emerging Market Countries, Too Much Exchange Rate Intervention? : A Test Goldman Sachs Economic Research.

Amato, J. D., and Gerlach, S. (2001) "Inflation Targeting in Emerging and Transition Economies: Lessons after a Decade; Hong Kong Institute for Monetary Research.

Arestis, P. And M. Sawyer (2002) "Can Monetary Policy Affect The Real Economy"

Working Paper No 355. Annadela-on-Hudson, N.Y.: The Levy Economic Institute. Ball, Laurence, and Niamh Sheridan, 2003,"Does Inflation Targeting Matter?" NBER Working Paper No. W9577 (Cambridge, Massachusetts: National Bureau of Economic Research).

Bernanke, B., F. Mishkin (1997), inflation targeting: A new framework for monetary policy? "journal of economic perspectives 11 (2): 97 – 116

Bernanke, B., T. Laubach, F . Mishkin, and A . posen, (1999), inflation targeting: lesson from the international experience, Princeton, NJ: Princeton university press.

Calvo, Guillermo A. And Carmen M. Reinhart (2002) "Fear of Floating", Quarterly Journal of Economics 117 (2):379-408. http://dx.doi.org/10.1162/003355302753650274

Debelle, Guy and Stanley Fischer (1994) "How Independent Should a Central Bank Be" In Jeffrey C., Fuhrer, ed., Goals, Guidelines and Constraint Facing Monetary Policy Makers" Conference Series 38 (Boston: Federal Reserve Bank of Boston): 195-221.

FitzGerald, V. (2004) Monetary Models and Inflation Targeting in Emerging Market Economies, Department of Economics, Oxford University, Discussion Paper Series; N0 184.

Fraga, Arminio, Goldfaljn Ilan and Minella Andre Minelle (2003) Inflation Targeting in Emerging Market Economies" NBER Macro Annual, Forthcoming IMF (2005) "Does Inflation Targeting Work in Emerging Market" IMF World Economic Outlook, September 2005/09/16, Washington D.C.: International Monetary Fund.

Leiderman, L. and G. Bufman (1996), "Searching for Nominal Anchors in Shock-Prone Economies in the 1990s: Inflation Targets and Exchange Rate Bands," in Securing Stability and Growth in Latin America: Policy Issues and Prospects for Shock-Prone Economies, ed. R. Hausman and H. Reisen, OECD, Paris.

Leiderman, L. And G. Bufman (2000), "Inflation Targeting under a Crawling Band Exchange Rate Regime: Lessons from Israel," in Inflation Targeting in Practice: Strategic and Operational Issues and Applications to Emerging Market Economies, ed. M. Blejer, A. Ize, A. Leone and S. Werlang, IMF, Washington.

Masson, P., M. Savastano, and S.Sharma (1997) "The Scope for Inflation Targeting in Developing Countries" IMF Working Paper 97/130, October.

Mishkin, F. S. And K. Schmidt-Hebbel (2000), "One Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know?" paper prepared for the Central Bank of Chile Conference on "Ten Years of Inflation Targeting: Design, Performance, Challenges", December 2000.

Mishkin, F.S. (2000) "Inflation Targeting in Emerging Economies", NBER Working Paper 7618.

Mishkin, Frederic and Klaus Schmidt-Hebbel, (2005), Does inflation Targeting Make a Difference In Klaus Schmidt-Hebbel and J, Frederic Mishkin, eds., 2005 Monetary Policy Under Inflation Targeting (Santiago: Central Bank Of Chile)

Mishkin, Frederic S. (1999) "Lessons from The Asian Crisis, Journal of International Money and Finance, 18(4): 709-723. Mishkin, Frederic S. And Miguel Savastano (2002)"Monetary Policy in Emerging Market Countries: Lessons from Latin America" Comparative Economic Studies Vol. XLIV. No 2(Summer 2002):45-83

Rogers, S. (2006) "An Overview of Inflation Targeting in Emerging Market Economies", In Challenges to Inflation Targeting in Emerging Countries; Bank of Thailand International Symposium, 13–14 November 2006 Bangkok, Thailand.

Svesson, L.E.O (1997) "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targeting, European Economic Review, 41: 1111-1146. http://dx.doi.org/10.1016/S0014-2921(96)00055-4

Vega, Marco, and Diego Winkelried (2005) "Inflation Targeting and Inflation Behaviour: A Successful Story" International Journal of Central Banking, pp. 153-175.

Vega, Marco, and Diego Winkelried, 2005, "Inflation Targeting and Inflation Behavior: A Successful Story?" International Journal of Central Banking, Vol. 1(3), 153–175.

Appendix A: Response of CPI to its Determinants

Response to Cholesky One S.D. Innovations ± 2 S.E.