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EXCHANGE RATE FLUCTUATION AND INFLATION TARGETING IN AN OPEN ECONOMY: ECONOMETRIC APPROACH

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ABSTRACT: *The study empirically evaluates the impact of exchange rate fluctuation on inflation targeting on the Nigerian economy. The study adopted annual times series data spanning a period of 43 years (1970 to 2012). The finding of our results suggests that the theoretical modelling requirements for all the variables used in the regression satisfy the statistical requirements that determine the choice of the statistical model. The result from the estimated long–run model shows that all the variables [interest rate (INTR) and exchange rate (EXCHR)] were statistically significant. The INTR positively influence the growth of INFR in the Nigerian economy while EXCHR negatively impact on the economy. Therefore, more concerted effort should employed by the federal government to stabilize the exchange rate as this will in turn lead to a positive impact of EXCHR on the economy. This will boost the country's export as well as reduce import their by reduction inflation in the economy. In the light of the foregoing, we state that the financial sector does not operate in ambiance but in a macroeconomic environment. It is therefore necessary that the environment should be one that is amenable to contemporary market situations. We therefore recommend that in order to curb inflation through inflation targeting, efforts must be made towards gathering financial data at a more precise level such that majority of financial transactions is captured in the database. Also, lending rates in Nigeria should be made flexible while other means should be employed towards raising the value of the naira as this will reduce greatly the inflation rate in the country.*

KEYWORDS: Exchange Rate Volatility, Inflation Targeting, Open Economy, Economic Growth

***JEL Classification Code**: C22, E31, E43, F31, F41*

INTRODUCTION

It is widely accepted that the pursuit of price stability is primary to long-run growth and development and should be the core of monetary policy. Several factors are responsible for this: high and variable inflation rate is socially and economically costly because it affects perspective planning, distorts prices, lowers voluntary savings and investment and orchestrates flight to values. Given this scenario therefore when the focus of monetary policy is primarily narrowed to the deliberate pursuit of low inflation, rather than output or unemployment, it is regarded as inflation targeting. It contrasts with alternative monetary policy strategies such as money targeting or exchange rate targeting. Although the latter money and exchange rate, still seek to

achieve low and stable inflation, their targets includes intermediate variables such as the growth rate of money aggregates or the levels of the exchange rate of an anchor currency, in the case of exchange rate targeting (Oluba, 2008). Therefore, inflation targeting is a policy in which an estimated inflation target is made public and deliberately pursued using the instruments of monetary management such as interest rate to steer actual inflation towards the desired policy target. For instance, the Central Bank of a country could raise interest rates when actual inflation is getting above the target. This monetary policy strategy started in New Zealand in the early 1990s and by the mid-1990s, Canada, United Kingdom, Sweden, Israel, Australia, and Spain adopted this policy while Japan announced its intention to adopt this regime (Dutkowsky, 2000). Presently, Egypt, South Africa, Brazil, South Korea, etc have all adopted the mechanism. This is so because the mechanism represents the core of new Keynesian monetary policy thrust. The main features of this policy framework include the followings:
(a) Announcement of an official numerical inflation target for a specified period of time;
(b) Designing monetary policy which is centred on inflation forecast in recognition of the fact that a low and stable inflation rate should be the foremost goals of the central bank; as well as
(c) Perceived transparency and accountability (Oluba, 2008).

Inflation-targeting mechanisms have been implemented with a view to bridle the well-known consequences of high inflation uncertainty which generally results in inefficient resource allocation and low productivity growth. According to Oluba (2008) the characteristics of the framework tend to strengthen transparency and coherency of monetary policy thereby eliminating uncertainties concerning future inflation rates. Overall it heightens the confidence level among households and other economic agents which the central bank is fighting inflation for aw well as for future inflation expectations. Its proponents believe that the flexibility of the framework and the accompanying cautious but discretionary manipulation of monetary policy instruments such as interest rate to tame inflation is an advantage in as much as it presents the central bank in the eyes of the public as fulfilling its statutory aim of price stability. This view is in consonance with the notion that in the absence of long-run (but only a short-run trade-off between variability's and not their levels in inflation and output) trade-off between inflation and output, it only makes more sense to aim at very low inflation rates. This trade-off between variability of inflation and the variability of output dominates current mainstream thinking in this respect. For instance, it is expected that the impact of an adverse macroeconomic shock such as oil price collapse or inflationary expectations thus increases inflations. Therefore, policy action in this instance will depend on how fast inflation is quickly brought back to the target level. If it is quickly brought back to the target level, it will be less variable and output will fluctuate around the trend. However, if on the contrary the central bank is slow to bring inflation back to the target level, output will fluctuate less, while inflation will be more variable.

Inflation targeting is a monetary policy regime, which is characterized by public announcement of official target ranges or quantitative targets for price level increases and by explicit acknowledgement that low inflation is the most crucial long-run objective of the monetary authorities. According to Savensson (1999), inflation targeting framework sets out very clear the goals for monetary policy, defines responsibilities, and establishes measures of accountability and transparency. However, in an open economy(ies), exchange rate fluctuations affect the

behaviour of domestic inflation. This is referred to as exchange rate pass-through effect. The magnitude of this effect is a key for monetary policy as it determines whether the central bank should devote efforts to control nominal depreciatory pressures that may jeopardise price stability. Moreover, recent studies such as Flamini (2007) and Adolfson (2007) pointed out that the characteristics of the pass-through may even affect the choice of the measure of inflation the central bank should target: either inflation involving exclusively locally produced goods or total inflation that includes imports. After the currency crashes of the late 1990s and early 2000, a growing number of emerging economies moved away from exchange rate rigidity and adopted a combination of flexible exchange rates policy as well as inflation targeting. This is so because of this move, the exchange rate has become less central in economic policy debate in most emerging markets. This, however, does not imply that the exchange rate has disappeared from policy discourse. Indeed, with the adoption of inflation targeting a number of important exchange rate-related questions, many of them new have emerged. The remainder of the paper is divided into: theoretical framework and review of literature, discusses source of data and the model, analyzes the results and derives conclusion and policy implication.

THEORETICAL FRAMEWORK

Two major goals of interest to economic policy makers are low inflation and low unemployment, but quite often, these goals conflict. The adoption of monetary and/or fiscal policy moves the economy along the short-run aggregate supply curve to a point of higher price level. As higher output is recorded, this is followed by lower unemployment, as firms need more workers when they produce more and vice-versa. This trade-off between inflation and unemployment is described as the Phillips curve. Phillips (1958), showed the existence of an inverse relationship between wage and unemployment rates, using United Kingdom data plotted over the period 1862-1957. The discovery is strengthened by the fact that movement in the money wages could be explained by the level and changes of unemployment. An argument in favour of the Phillips curve is the extension that establishes a relationship between prices and unemployment. This rests on the assumption that wages and prices move in the same direction. The strength of the Phillips curve is that it captures an economically important and statistically reliable empirical relationship between inflation and unemployment.

The monetarists following the Quantity theory of money (QTM), have propounded that the quantity of money is the main determinant of the price level, or the value of money, such that any change in the quantity of money produces an exactly direct and proportionate change in the price level. The QTM is traceable to Irving Fisher's famous equation of exchange:

$$MV = PQ \quad \text{.....(1)}$$

where M stands for the stock of money; V for velocity of circulation of money; Q is the volume of transactions which take place within the given period; while P stands for the general price level in the economy.

Transforming the equation by substituting Q for Y (i.e. the total amount of goods and services exchanged for money), the equation for exchange becomes thus:

$$MV = PY \text{.....(2)}$$

The introduction of Y in equation (2) provides the linkage between the monetary and the real side of the economy. In this framework, however, **P, V,** and **Y** are endogenously determined within the system. The variable **M** is the policy variable, which is exogenously determined by the monetary authorities. The monetarists emphasize that any change in the quantity of money affects only the price level or the monetary side of the economy, with the real sector of the economy totally insulated. This indicates that changes in the supply of money do not affect the real output of goods and services, but their values or the prices at which they are exchanged for only. An essential feature of the monetarists' model is its focus on the long-run supply-side properties of the economy as opposed to short-run dynamics (Dornbush, et al, 1996). Therefore economic policies aimed at controlling inflation should focus on the monetary sector controlling variables such as the quantity of money in circulation, interest and exchange rates.

On the other hand, the Keynesian opposed the monetarists' view of direct and proportional relationship between the quantity of money and prices. According to them, the relationship between changes in the quantity of money and prices is non-proportional and indirect, through the rate of interest. The strength of the Keynesian theory is its integration of monetary theory on the one side and the theory of output and employment through the rate of interest on the other side. Thus, when the quantity of money increase, the rate of interest falls, leading to an increase in the volume of investment and aggregate demand, thereby raising output and employment. In other words, the Keynesians see a link between the real and the monetary sectors of the economy an economic phenomenon that describes equilibrium in the goods and money market (IS-LM). Equally important about the Keynesian theory is that they examined the relationship between the quantity of money and prices both under unemployment and full employment situations. Therefore, as long as there is unemployment, output and employment will change in the same proportion as the quantity of money, but there will be no change in prices. At full employment, however, changes in the quantity of money will induce a proportional change in price. According Olafin (2001), this approach has the virtue of emphasizing that the objectives of full employment and price stability may be inherently irreconcilable.

The Neo-Keynesian theoretical exposition combines both aggregate demand and aggregate supply. It assumes a Keynesian view on the short-run and a classical view in the long-run. The simplistic approach is to consider changes in public expenditure or the nominal money supply and assume that expected inflation is zero. As a result, aggregate demand increases with real money balances and, therefore, decreases with the price level. The Neo-Keynesian theory focuses on productivity, because, declining productivity signals diminishing returns to scale and, consequently, induces inflationary pressures, resulting mainly from over-heating of the economy and widening output gap.

LITERATURE REVIEW

Ball and Sheridan (2003) in their study of twenty OECD economies, out of which seven have adopted inflation targeting in the 1990s which was not responsible for low inflation or its volatility. They concluded that there is no evidence that inflation targeting improves economic performance as measured by the behaviour of inflation, output and interest rates. Other studies have also shown that the much mouthed beneficial claims do not necessarily derive from adopting inflation targeting mechanism. Example is the study of Honda (2000), who opined that inflation targeting had no effect on either inflation or any other variable in Canada, New Zealand and the UK. Also, studies focusing on advanced economies mainly showed insignificant and small effects of inflation targeting on the various performance measures used. Ball and Sheridan (2005), us

ing a difference-in-difference approach, indicated that there is no significant effect of inflation targeting on inflation, inflation variability, output growth, output variability and long-term interest rates. Furthermore, inflation persistence is very similar between the targeting and non-targeting group. Using the same method with more data as well as taking into account the establishment of the European Monetary Union, Ball (2010) findings was in consonance with finding of earlier studies. Lin and Ye (2007) in their study adopted the propensity score matching method that gives room for controls for self-selection bias, revealed that inflation targeting does not have any significant impact on the level and volatility of inflation. The Study by Vega and Winkelried (2005) found the exact opposite results while adopting the same method but with an expanded sample which included both advanced as well as emerging economies. Their study also analysed the impact of inflation targeting on inflation persistence. They concluded that inflation targeting lowers the persistence of inflation, although its impact is very small. Wu (2004) adopted the panel estimations method and found a contrasting result. Using a panel dataset of 22 OECD countries, he found that inflation targeting significantly reduces inflation. However, Willard (2006) using the same dataset as Wu (2004), but different methods, found only small and insignificant effects. This is in consonance with the study by Mishkin and Schmidt-Hebbel (2007) who found that, although inflation targeting economies have improved their macroeconomic performance in terms of reducing inflation, inflation volatility, and output volatility over time, compared to non-inflation targeting economies, the difference is insignificant.

Analysing inflation expectations in industrialized countries, Johnson (2002) found that after the announcement of inflation targeting the level of inflation expectations were significantly reduced in inflation targeting countries, whereas the effect on uncertainty and forecast errors was not significant. Levin, Natalucci and Piger (2004) suggested that inflation targeting has a significant role anchoring long-run inflation expectations. Whereas empirical evidence for industrialized countries reveals the irrelevance of inflation targeting for macroeconomic improvement compared to non- inflation targeting countries, empirical evidence for emerging economies indicated a more favourable picture of the effects of inflation targeting. This may be due to a stronger degree of performance heterogeneity in the sample of emerging markets that adopted inflation targeting (Batini and Laxton, 2006) and the weaker credibility of emerging countries face when implementing macroeconomic policies (Goncalves and Salles, 2008). Most studies focusing on emerging economies found that inflation targeting significantly reduces average

inflation. This result is robust to country selections, time periods and estimation methods although the magnitude of the impact differs and performance of an inflation targeting regime is very heterogeneous across countries. There are fewer consensuses on the impact of inflation volatility. Batini and Laxton (2006), Li and Ye (2009), and Vega and Winkelried's (2005) results showed a significant dampening effect of IT on inflation volatility, whereas the effects in Goncalves and Salles (2008) and Brito and Bysted (2010) are insignificant. Similarly, the impact of inflation targeting on the real economy is not unanimous. Brito and Bystedt (2010) found a significant negative effect of inflation targeting on average growth suggesting that inflation targeting and the associated lower average inflation come at the cost of lower growth. Naqvi and Rizvi (2009) find an insignificant effect of inflation targeting (IT) on growth, but their country sample is very small and restricted to Asian economies. Theoretically, output volatility might fall or increase following IT adoption, however, empirically the effect found, if at all significant, is one of falling output volatility. Goncalves and Salles (2005) found that IT reduces output volatility, whereas Batini and Laxton (2006) did not find a significant effect for output volatility. Also, there are only a few studies that have assessed the performance of IT during the recent crisis. Filho (2010) found that the monetary policy of IT countries appears to have been more suited to dealing with this crisis. He found that relative to other countries, IT countries lowered nominal policy rates by more and this loosening translated into an even larger differential in real interest rates. With this monetary stimulus, IT countries on average seem to have dodged the deflation bullet better than other countries. Based on macroeconomic forecasts, Roger (2010) also found that inflation-targeting countries may be less adversely affected by the financial crisis. Gemayel, Jahan, and Peter (2011) found that inflation targeting appears to be associated with lower inflation and inflation volatility. At the same time, there is no robust evidence of an adverse impact on output. This may explain the appeal of IT for many LICs, where building credibility of monetary policy is difficult and minimizing output costs or reducing inflation is imperative for social and political reasons.

Hu, (2003) empirically investigated issues associated with inflation targeting using a dataset of 66 countries for the 1980–2000 period. The paper focused on two issues. First, which factors are systematically associated with a country's decision to adopt inflation targeting as its monetary framework? Second, does inflation targeting improve the performance of inflation and output? Does the trade-off between inflation and output variability change under such a framework? The empirical results are informative and encouraging. A number of economic conditions, structure, and institution variables were found to be significantly associated with the choice of inflation targeting. Both descriptive statistics and regression results suggested that inflation targeting does play a beneficial role in improving the performance of inflation and output. The paper explores an evident and positive relationship between inflation and output variability, but a limited support for the proposition that the adoption of inflation targeting improves the trade-off between inflation and output variability.

Englema and Aliyu (2010) evaluated whether Nigeria is ready to adopt inflation targeting (IT). The paper reviewed literature on selected conditions for successful implementation of IT and then focused on whether one specific precondition of an empirically stable monetary transmission mechanism is tenable. A vector autoregressive (VAR) model was applied using

selected monetary policy and other macroeconomic variables to explore the various channels using the Granger causality tests, impulse responses, and variance decompositions. Results showed that inflation in Nigeria is impassive to monetary transmission variables in the model. Specifically, weak link between prices and credit and interest rate channels were established. However, evidence of strong inverse link between exchange rate and prices was found in the model. They suggested exchange rate pass-through on the level of prices in the economy. The paper, therefore, recommends the pursuance of IT in Nigeria.

Ecevit and Kayham (2011) examined the Turkish economy by the beginning of inflation targeting era using monthly data for the period 2002 to 2009 to establish Taylor type monetary policy reaction function and to test whether exchange rate has a place in reaction function by using structural VAR methodology. They found that exchange rate has no weight on short term nominal interest rate decisions of the Central Bank of Republic of Turkey. However, Calvo and Reinhart (2000) reported that although there is an increase in the number of countries practicing floating exchange rate system, emerging countries intervene exchange rate instead of leaving it floating. They named intervention policy of central banks as “fear of floating”. Indeed fear of floating is only one part of a more general fear of large exchange rate swings. According to Mohanty and Klau (2005), exchange rate is likely to assume special importance for monetary policy when the pass through of the exchange rate is high because it will affect real and financial sector directly and indirectly. It means that pass through effect is important for central bank even if it does not target inflation. According to Amato and Filardo (2005), in small open economies, in particular emerging markets, capital inflows can fuel the expansion of domestic credit. In turn, a tightening of monetary policy might encourage those inflows further. This makes these economies vulnerable to a sudden withdrawal of foreign capital.

Zettelmeyer (2004) examined effects of monetary policy on exchange rate for Canada, New Zealand and Australia. He used three months market interest rate as monetary policy to measure it by using OLS regression methodology. At the end of the study, he concluded that a 1 percentage increase in the three month interest rates will appreciate the exchange rate by 2 to 3 percent. Kearns and Manner (2006) has also examined intraday data of Canada, New Zealand, Australia and United Kingdom to determine effects of monetary policy on exchange rate. They used an event study and they found that monetary policy change is exogenous to the exchange rate. According to them an unanticipated tightening of 25 basis points leads to a rapid appreciation of around 0.35 percent. Another important conclusion is that expectations about monetary policy actions affect degree of appreciation. Calvo and Reinhart (2000) examined 39 countries which chose floating exchange rate regime for years between 1970 and 1999 and found that most of these countries’ central banks weigh exchange rate in the reaction function, although they choose floating exchange rate regime. Mohanty and Klau (2004) investigated monetary policy shocks to introduce effects on output gap, inflation and exchange rate and examined emerging economies including India, Korea, Philippines, Taiwan, Thailand, South Africa, Brazil, Chile, Mexico, Peru, Czech Republic, Hungary and Poland. They implied that interest rate responds strongly to the exchange rate in most of emerging economies. In some of them the response is higher than responses to inflation and output gap. In this respect their results supported the “fear of floating” hypothesis.

Brojnland and Halvorsen (2008) analysed Australia, Canada, New Zealand, Norway, Sweden and United Kingdom economies to understand relationship between monetary policy actions and exchange rate. They found that the impact of monetary policy shocks on exchange rate to be non-trivial and consistent with Dornbusch overshooting hypothesis. A contractionary monetary policy shock that increases the interest rate by one percentage, appreciates the exchange rate on impact by 2,5 – 4 percent. As a result of analysis they concluded that countries have taken exchange rate into their policy reaction functions. Isik and Duman (2008) took on Turkey, Israel, Chile, Brazil, Poland, South Korea and Czech Republic those target inflation and choose floating exchange rate regime to understand behaviours of governments and central banks in the case of exchange rate appreciation. They concluded that all these central banks do not intervened exchange rate markets unless there is high volatility in the market. Also, they implied that The Central Bank of Republic of Turkey does not weigh into the exchange market to affect long term equilibrium. As another sequence of this analysis they emphasized that credibility is an important point, while central banks, target inflation and allow exchange rate to float.

Key issues from the literature review are as follows: Few known studies examined inflation and exchange with particular reference to Nigeria. Some empirical studies on inflation targeting in developing countries (Edward *et al*, 2011; Brito *et al*, 2010; Lin *et al*, 2009) use panel data that may be difficult obtain in Nigeria; A number of studies have been conducted on inflation targeting (Oluba, 2009; Aliyu *et al*, 2008). These studies uses times series data and error correction specification, but are not specifically focussed on exchange rate fluctuation and inflation targeting in Nigeria. Others studies focussed on Sub –Saharan Africa, Industrialized countries, East Asian countries, etc. These studies are therefore incapable of explaining the impact of exchange rate fluctuation on inflation targeting in Nigeria. This paper therefore attempts to address these salient issues.

RESEARCH METHODOLOGY

This study adopted an econometric model to test the long-run relationship between exchange rate volatility and inflation targeting on the Nigerian economy. The study uses annual times series from 1970 to 2012. The sources of these data are Central Bank of Nigeria Statistical Bulletin as well as Statement of Account, National Bureau of Statistics, Penn World data, African Development Indicators and International Financial Corporation. A majority of the macroeconomic time series are characterized by a unit root so that their first differences are stationary (Engel and Granger, 1987; Nelson and Ploster, 1982). Ahmed and Harnhirun (1995) opined that is a statistical test like cointegration establishes co–movements in these times series, then the residuals from the regression can be used as error correction term in the dynamic difference equation. Thus, given two time series that are integrated of order one that is I(1) and cointegrated then there exists Granger Causality in at least one direction in the I(0) variables (Engel and Granger, 1987) and hence a VAR model can be set up with an error correction term for doubled cointegrated time series to cover the short-run dynamics and thus decrease the chance of observing *spurious regression* in terms of the level of the data or their first difference.

Therefore, after estimating the multiple regression models, the study tests for stationarity, cointegration and error correction model so as to know the long-run reliability of the model.

What we have tried to do under the methodology is to specify the multiple regression models that show the effect of exchange rate volatility and inflation targeting on the Nigerian economy. This study draws from that of Audu (2012) which tries to incorporate inflation and interest rate on consumer's spending into an estimable version of the life-cycle model for Nigeria. Also, Olusanya, et al, (2009) shows empirically the extent to which inflation rate and real exchange rate affects the growth of the Nigerian economy.

Therefore, this study specifies the following multiple regression equation using aggregate data thus:

$INFR = \beta_0 + \beta_1 INTR + \beta_2 EXCHR + \mu$

$\beta_1 < 0;\ \beta_2 \gtrless 0$

Where INFR = Inflation rate; INTR = Interest rate; EXCHR = Exchange rate; μ = Stochastic term

IV. Presentation, analysis of empirical result and policy implications

Descriptive statistics

The descriptive statistics of variables used in this estimation is presented in Table 1. Exchange rate (EXCHR), inflation rate (INFR) and interest rate INTR) averages 44.90, 18.75 and 16.99 respectively while they also ranges from 145.00 to 0.55, 78.80 to 3.20 and 36.09 to 6.00 for the respective parameters with a standard deviation of 56.55, 16.04 and 7.12. the variables also exhibit increasing return to scale given the JB statistics values of 7.12, 29.73 and 2.91 respectively.

Table 1: Descriptive statistics

	EXCHR	INFR	INTR
Mean	44.89897	18.75349	16.99453
Median	9.909492	13.00000	17.34000
Maximum	145.0000	72.80000	36.09000
Minimum	0.546781	3.200000	6.000000
Std. Dev.	56.54561	16.04165	7.118296
Skewness	0.748540	1.694195	0.622831
Kurtosis	1.683096	5.261690	2.732735
Jarque-Bera	7.122743	29.73527	2.908061
Probability	0.028400	0.000000	0.233627
Sum	1930.656	806.4000	730.7650
Sum Sq. Dev.	134291.0	10808.05	2128.146
Observations	43	43	43

Source: Author's computation using EViews7

Correlation matrix

A positive correlation exists among all the variables except between INFR and EXCHR that is negative; some with moderate correlation and some with very low correlation as shown in Table 2. For example, there is a moderate positive correlation between INTR and INFR (32.8%), while the correlation between INTR and EXCHR is relatively low (28.7%), and that between INFR and EXCHR is very low (–26.4).

Table 2: Correlation matrix

	EXCHR	INFR	INTR
EXCHR	1.000000		
INFR	-0.264163	1.000000	
INTR	0.286821	0.327838	1.000000

Source: Author's computation using EViews7

Unit root test

The regression for the purpose of clarifying the result for the Phillips–Perron test (PP) class of unit root test is presented in Table 1. The result reveals that all the variables used in the study exhibited unit root process at various critical levels but mostly at 5% level of significance. In other words, all the variables except INFR and ECM(-1) were found to be non–stationary at their levels but stationary at their first differences.

Table 3: Phillip –Perron unit root test

Variables	**Order of integration**	**Level of significance (%)**	**PP**	**Critical values**	**Lag**
INFR	I(0)	5	-3.126626	-2.933158	2
INTR	I(1)	5	-8.855843	-2.935001	2
EXCHR	I(1)	5	-5.530185	-2.935001	2
ECM(-1)	I(0)	5	-6.118034	-2.938987	2

Cointegration analysis

We use cointegration approach to test if there exist at least a linear combination of the variables with unit roots that are stationary. The Johansen cointegration analysis we adopted because it helps to clarify the long–run relationship between integrated variables. Johansen's procedure is the maximum likelihood for finite–order vector autoregressions (VARs) and is easily calculated for such systems, so it is used in this study. The Johansen's technique was chosen not only because it is VAR based but also due to evidence that it performs better than single–equation and alternative multivariate methods. The results of the cointegration test are presented in Table 4.

The max–eigenvalue tests shows that there are two cointegrating equation in the analysis. The PT–matrix of the beta coefficients from the Johansen cointegration analysis and the preferred cointegrating (CI) equation of the model are presented in Annex 1. Only one cointegrating relation was chosen among the two, based on statistical significance and conformity of the coefficient with economic theory. As shown in the chosen CI equation, which normalized the coefficient of INFR, all the explanatory variables is significantly influencing changes in INFR. The most significant of the determinants of INFR are EXCHR and INTR. The relationship depicted in Annex 1 suggests that in the long–run INTR exerts positive influences on INFR while EXCHR affects INFR negatively

Table 4: Johansen Max–Eigen statistics

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.999998	487.2740	27.58434	0.0001
At most 1 *	0.591974	33.16772	21.13162	0.0007
At most 2	0.200681	8.287818	14.26460	0.3502
At most 3	0.020879	0.780687	3.841466	0.3769

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's computation using EViews7

Having ascertained that the variables are non–stationary at their levels but stationary after first differencing once and that they are cointegrated, the stage is set to formulate an error correction model. The intuition behind the error correction model is the need to recover the long–run information lost by differencing the variables. The error correction model rectifies this problem by introducing an error correction term. The error correction term is derived from the long–run equation based on economic theory. The error term enables us to gauge the speed of adjustment of INFR to its long–run equilibrium. It gives us the proportion of the disequilibrium error accumulated in the previous period which is corrected in the current period. The results indicate that the speed of adjustment of INFR to the long–run equilibrium part is moderate. Specifically, about 47.9% of the disequilibrium errors, which occurred in the previous year, are corrected in the current year. It also shows a relatively high persistence of INFR (52.3.8%) thereby suggesting the existence of a strong inertia.

Preceding the dynamic analysis, the result of the estimated static model shows that interest rate and exchange rate are the long–run determinants of INFR in Nigeria. The results of the parsimonious ECM are in Table 5.

Table 5: Parsimonious error correction model

Dependent Variable: INFR
Included observations: 40 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFR(-1)	0.522553	0.131159	3.984119	0.0004
INFR(-2)	-0.561164	0.136004	-4.126087	0.0002
C	3.200535	4.828584	0.662831	0.5120
INTR	0.479088	0.182727	-2.621878	0.0715
INTR(-2)	1.944736	0.416034	4.674465	0.0000
EXCHR	-0.180946	0.039457	-4.585908	0.0001
ECM(-1)	-0.478578	0.150511	-3.179688	0.0038
R-squared	0.677684	Mean dependent var		19.33500
Adjusted R-squared	0.619081	S.D. dependent var		16.42426
S.E. of regression	0.873682	Akaike info criterion		3.627854
Sum squared resid	33.90920	Schwarz criterion		3.923408
Log likelihood	-145.5571	F-statistic		11.56401
Durbin-Watson stat	2.311488	Prob(F-statistic)		0.000001

Source: Author's computation using EViews7

The over–parameterized model from which the parsimonious ECM emanated is presented in Annex 2. The adjusted R^2 of the estimated model shows about 61.9% of the variation in INFR is explained by the combined effects of all the determinants while the F–statistics shows that the overall regression is significant at both 1% and 5% levels. Also, the equation's standard error of 0.8737 signifies that in about two–third of the time the predicted value of INFR would be within 87.37% of the actual value while given the DW value of 2.31 suggests the absence of serial correlation are presented in Table 5. The first and second lagged of INFR exerts a very high significant positive and negative influence on the growth of current INFR in Nigeria. In a similar vein, both the current and second lagged value of interest rate (INTR) impacted positively on INFR growth in the country. The current EXCHR was statistically significant in influencing INFR but the impact was negative.

Stability analysis

We examine the stability properties of the short–run dynamics model. In the graph of the recursive residual, in some periods, particularly between 2004 and 2010, the residuals either went outside the ±2 standard error bounds or become close to the bounds (Fig. 1). This period corresponds to the period of massive deregulation and liberalization of the financial system in terms of interest rate and entry so that SMEs can flourish and contribute meaningfully to GDP growth in Nigeria. The plot of the CUSUM test and CUSUM squares in figures 3 and 4 tends to corroborates this view. In fig 3, the plot was close to the 5% significance bound in 1985 and was actually outside the bound between 1986 and 2008. Further examination reveals that the main source of this instability over this period comes from the instability in the coefficients on the short–run HCD and BLSME as shown in figure 5. This collaborate our earlier view that the period of sustained deregulation of economy, interest rate and foreign exchange market which had some inflationary impact on the economy.

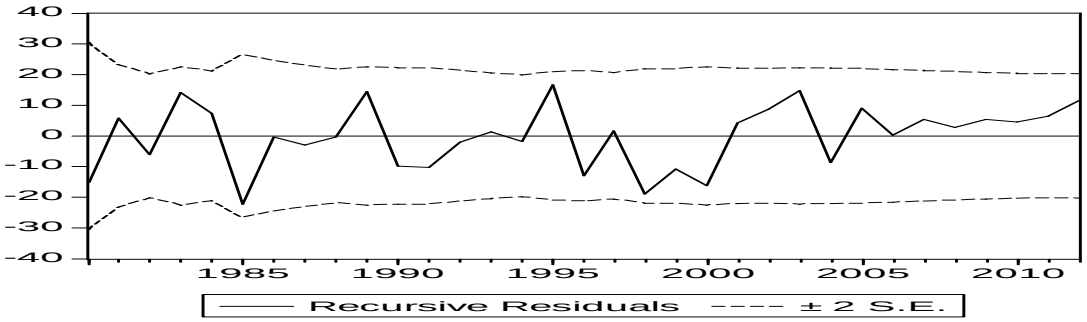

Figure 1: Recursive residual graph

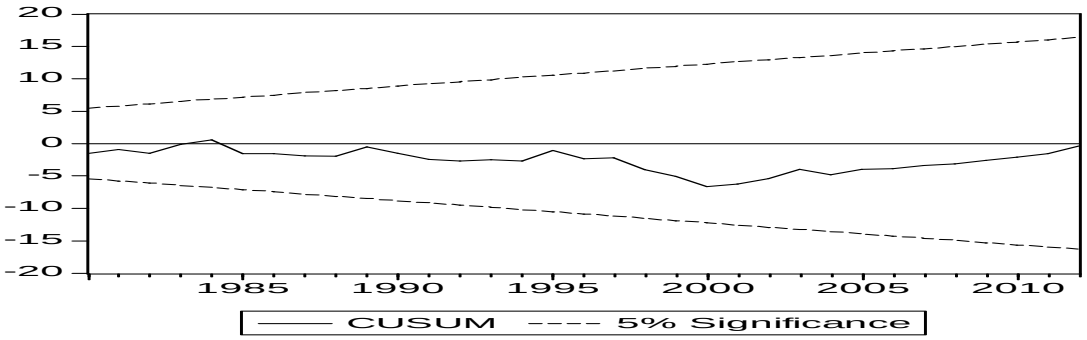

Figure 2: CUSUM test graph

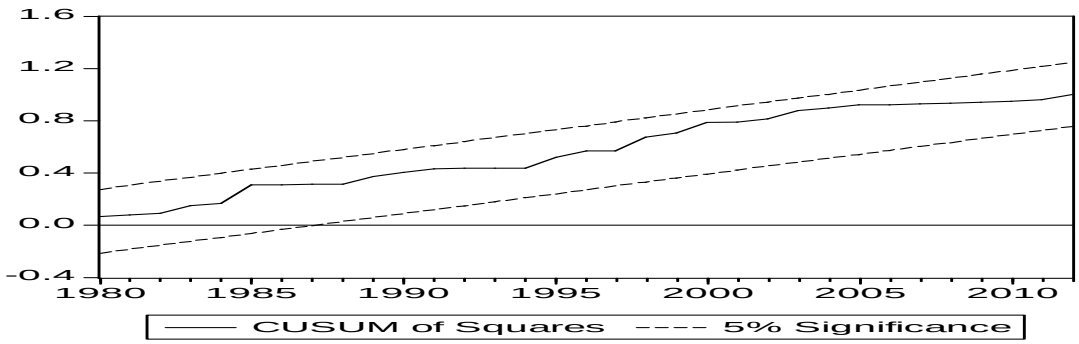

Figure 3: CUSUM of square test graph

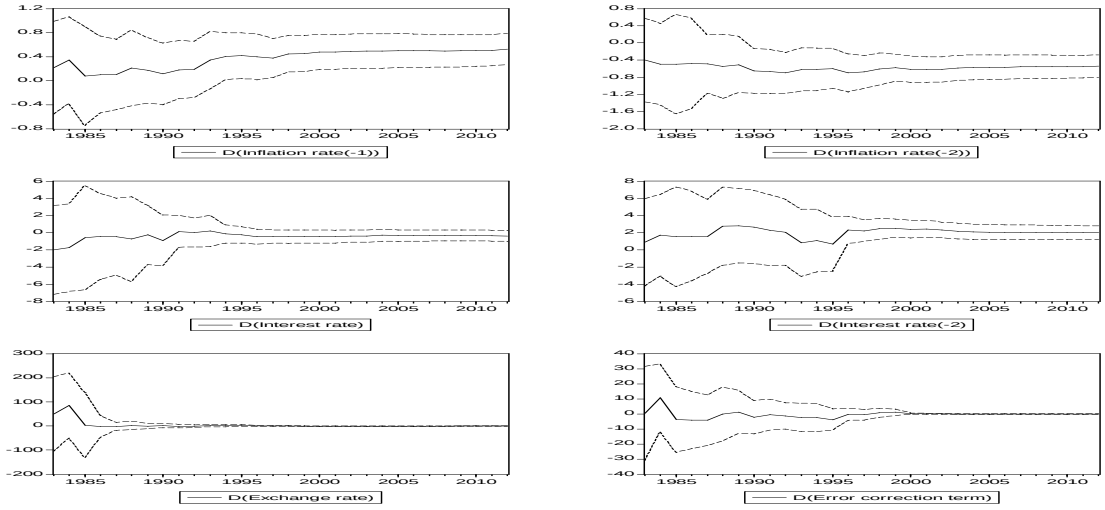

Figure 4: Recursive coefficients

Policy implications

The following policy implications emanate from the study.

i. Exchange and interest rates play a very significant role in explaining inflation targeting Nigeria between 1970 and 2012. However, this may be due to the prolong period of price control as against that of deregulation as well as the failure of the study to take into consideration structural breaks and regime shifts.
ii. The nominal effective exchange rate and interest rate are the only component that is relatively under the control of monetary authority in Nigeria, therefore, efforts must be intensified or made to ensure that exchange and interest rates stability in order to stem inflationary tendencies.
iii. To curb inflation, there is the need for high transparency in monetary policy making and inflation. Similarly, the fiscal posture of the government must also be made to regularly align with monetary targets.
iv. The policy linkage between exchange rate, interest rate and inflation targeting instruments in the country are very strong in the short–run.
v. The growth of inflation in Nigeria is more of inertia than exchange and interest rates.
vi. There is need to interpret the findings with cautions as the annual times series data span through different government with different exchange and interest rate regimes.

CONCLUSION

Having examined the impact of interest rate and exchange rate on inflation, we conclusion that both interest rate and exchange rate in Nigeria are good explanatory variables in explaining the changes in inflation on Nigerian economy. Inflation in Nigeria is caused by these two variables as well as other factors not included in our model such as low productivity, concentration of wealth in the hands of the minute few, financial dualism, among other. Therefore, efforts that are

geared towards curbing inflation should not just focus on interest rate and exchange rate policies but equally on those variables that are intertwined with them.

The financial sector does not operate in ambiance but in a macroeconomic environment. It is therefore necessary that the environment should be one that is amenable to contemporary market situations. We therefore recommend that in order to curb inflation through inflation targeting, efforts must be made towards gathering financial data at a more precise level such that majority of financial transactions is captured in the database. Also, lending rates in Nigeria should be made flexible while other means should be employed towards raising the value of the naira as this will reduce greatly the inflation rate in the country.

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Annex 1: Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I)

PT–matrix of the beta coefficients from the Johansen cointegrating analysis

INFR	INTR	EXCHR	ECM(-1)
7.45E-05	-0.000128	1.61E-05	74.99718
-0.168004	0.263901	-0.030061	-12.24030
0.008811	0.072363	0.020171	30.65460
-0.011574	-0.150815	0.011183	-1.169862

Unrestricted Adjustment Coefficients (alpha):

D(INFR)	2.624806	6.917101	1.234315	1.043368
D(INTR)	0.571677	1.128710	-1.339490	-0.104617
D(EXCHR)	1.653724	3.434268	0.952049	-1.412211
D(ECM(-1))	-0.013336	-3.51E-06	2.23E-06	2.30E-07

1 Cointegrating Equation(s): Log likelihood -30.64009

Normalized cointegrating coefficients (standard error in parentheses)

INFR	INTR	EXCHR	ECM(-1)
1.000000	4.618386	-7.941916	4649435.
	(1.67479)	(3.73043)	(1282.22)

Annex 2: Over–parameterized error correction model

Dependent Variable: INFR
Method: Least Squares Date: 06/03/13 Time: 14:45
Sample(adjusted): 1973 2012
Included observations: 40 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFR(-1)	0.494990	0.135227	3.660446	0.0010
INFR(-2)	-0.606866	0.145809	-4.162048	0.0002
C	4.848545	6.305989	0.768879	0.4480
INTR	-0.487400	0.442102	-1.102459	0.2790
INTR(-1)	0.169172	0.510819	0.331179	0.7428
INTR(-2)	2.007979	0.482533	4.161330	0.0002
EXCHR	-0.355130	0.163174	-2.176380	0.0375
EXCHR(-1)	-0.826654	1.472239	-0.561495	0.5786
EXCHR(-2)	1.000169	1.469883	0.680441	0.5014
ECM(-1)	0.887781	1.462857	0.606881	0.5485
R-squared	0.695787	Mean dependent var		19.33500
Adjusted R-squared	0.604523	S.D. dependent var		16.42426
S.E. of regression	10.32872	Akaike info criterion		7.720051
Sum squared resid	3200.472	Schwarz criterion		8.142271
Log likelihood	-144.4010	F-statistic		7.623897
Durbin-Watson stat	2.385827	Prob(F-statistic)		0.000010

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