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An Estimation of Inflation Threshold for Nigeria 1970-2008

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Motivated by the movement of most developing countries and emerging countries towards inflation targeting and the concern that high level of inflation is inimical to economic growth, this paper uses the threshold model developed by Khan and Senhadji (2001) to estimate inflation threshold level for Nigeria. The study uses annual time series data spread over two periods 1970-2008 and 1980-2008 to determine the inflation threshold for Nigeria and to establish whether there is significant change in the threshold level for the two periods. Using a non linear inflation-growth model control variables such as growth in the ratio of broad money supply to GDP (GLM2/GDP) and growth in term of trade (GLTOT), we established an inflation threshold of 8 percent for Nigeria over the sample period 1970-2008. For the period 1980-2008 we estimate an inflation threshold of 7 percent although failing the test of significance. This result is essential for monetary policy formulation given that the Central Bank of Nigeria has been targeting single digit inflation over the past decades without necessarily targeting the optimum point in which inflation becomes inimical to growth.

Field of Research: Macroeconomics, Economic Policy, Monetary Economics

1. Introduction

The debate among scholars on inflation and economic growth is one that has taken a long route in the empirical literature with the issues coming alive in the twenty first century following increasing movement of monetary authorities in developing and emerging economies towards perfecting inflation targeting. According to a recent IMF staff survey of 88 nonindustrial countries, it was found that more than half the countries expressed a desire to move to explicit or implicit quantitative inflation targets and nearly three-quarters of these countries expressed an interest in moving to full-fledged inflation targeting by 2010. The implications of targeting inflation poses some fundamental questions, that inquires the level at which inflation threatens economic growth? Or at what level of inflation does the relationship between inflation and growth become positive or negative? And is the threshold level of inflation similar for developing, emerging and developed countries? Also at exactly what point is inflation inimical to economic growth?

The answer to these questions obviously depends upon the nature and structure of the economy and will vary from country to country. Various studies however, have been put forward in the literature ranging from studies that believes that inflation is inimical to

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economic growth (Barro 1991; Fischer 1993; Gomme 1993; Bullard and Keating 1995; Jones and Manuelli (1995); Mallik and Chowdhury 2001), to studies that believes that substantial amount of inflation is required for growth to take place in an economy (Tobin 1969 and De Gregorio 1993). Although, early studies (Fischer 1993; Barro 1995; Sarel 1996; Bruno and Easterly 1998 Ghosh and Phillips 1998) used various ad hoc methods to determine the threshold level of inflation which all together were limited in scope and application. Recent studies however, used relatively new econometric methods for threshold estimation as proposed by Hansen (1996).

This study attempts an estimation of the inflation threshold using country specific time series data to estimate the precise threshold level of inflation for Nigeria over the sample periods 1970-2008. The study will address the following research questions; does an inflation threshold level exist for Nigeria? In the affirmative, it will also consider the precise level at which inflation is inimical to growth? And probe further to detect if the threshold level changed over different time periods? The other part of the study is structured as follows. Section II is the literature review and section III is the method adopted in estimating the precise threshold levels for inflation rate. Section IV provides the discussion of findings and discussions while section V is the conclusion and policy implications of the study.

2. Literature review

The foremost macroeconomic policy objective most developing countries policy makers tend to attain is sustainable economic growth driven basically by low levels of inflation. It has been widely covered in most economic literatures that high persisting levels of inflation has a negative effect on economic growth (Fischer 1993, Sbordones and Kutter 1994, Bruno and Easterly 1998, Kremer, Bick and Nautz 2009). Also, the relationship between low rates of inflation and high levels of economic growth has been confirmed to elicit positive impacts (De Gregorio 1992, Hedgimichael, Ghura, Mhleisen, and Nord 1995, Khan and Senhadju 2000).

Darrat (1985) empirically analyzed the levels of inflation in Nigeria, Libya and Saudi Arabia using the role of money as a pivot to explain the source and types of inflation in these countries. He disclosed that higher money supply and lower real income growth are associated with higher inflation in these economies.

Chimobi (2010) used the cointegration method and the Granger causality test to examine a relationship between inflation and economic growth in Nigeria. From these empirical tests, there were no cointegrating relationship between inflation and economic growth in Nigeria within the period of the study. To justify this assertion, the Granger causality test at the second and fourth lags were used to further analyze this view. The result obtained revealed unidirectional causality moving from inflation to economic growth. He resolved that higher inflation is and has never been favourable to economic growth and that inflation has an impact on economic growth.

Obviously, most literatures insist that high persisting rates of inflation alter the innate potential of the levels of economic growth in the long-run in any given economy (Goncalves and Salles 2008, Lin and Ye 2009). These authors also acknowledge the fact that it is most essential to empirically prove the validity of a stated percentage level at which inflation is accepted to be inimical to economic growth in any economy.

In order to examine the issue of the existence of threshold effects in relation between inflation and economic growth Khan and Senhadju (2000) design a new empirical approach by using a range of econometric test. They evaluate the existence of threshold effects and ascertain robustness by estimating the impact of sensitivity to the estimated method, high inflation observation, the location of the threshold, date frequency and the sensitivity to additional explanatory variables. They discovered that the pace at which the rates of inflation significantly slow growth is estimated at one to three percent for developed countries and seven to eleven percent for developing countries. Also, the study reveals some levels of negative but statistically significant relationship between the rates of inflation and the levels of economic growth in the economies studied and the associated results were robust. Although the estimated thresholds were statistically significant at the one percent level, their stated confidence intervals were relatively wide. This empirical concern cast some levels of doubt over the exact location of the threshold level. Subsequently, with a ninety percent confidence interval, the researchers set an agreed band of one to four percent for developed countries and one to twenty percent for developing countries.

Also, Mubarik (2005) estimated a threshold model of inflation and output growth. He test for Granger Causality and found a unidirectional relationship between the existing rates of inflation and the levels of economic growth. He established that the threshold inflation was at nine percent for economic growth in Pakistan within the period of the observation tested. To justify this result, he introduced sensitivity analysis with more robust outcomes. The result also suggested the same level of threshold inflation for a health domestic output level.

From a broader perspective, Kremer, Bick and Nautz (2009) in other to expository capture the inflation threshold levels of in both developed and developing countries, established a dynamic panel threshold model to confirm the impact of inflation on long-run economic growth. They arrive at the view that developed economies empirical test results confirm the fact that inflation targeting is about 2 percent. Further, they stated that the observed level at which inflation would not affect economic growth for developing countries is below 17 percent. Although below these thresholds, the impact of inflation on economic growth remains insignificant. They suggested that the empirical results did not reveal any indication of growth-enhancing effects of inflation in developing countries.

From these studies on the relationship between the rates of inflation, inflation threshold and economic growth, it was noticed that the rates of inflation has a significant negative effect on economic growth for developing countries if it exceeds its threshold band (Khan and Senhadji 2000). Relatively, most of these studies did not express any

indication in view of positive effects of the rates of inflation on economic growth in situations where the level of inflation is within the specified threshold band. In this light Drukker, Gomis and Hernandez (2005) establish the fact that there are clearly defined relationship between inflation threshold and economic growth but the impact of the rates of inflation was noticed to be insignificant on economic growth. Subsequently, Lin and Ye (2009) after examining the effect of inflation targeting on economic growth, reveal that the performance of inflation targeting in developing countries can be affected positively by these countries specific characteristics which is due to the behavior and performance of other key macroeconomic variables in these economies. Furthermore, they stated that the inflation thresholds in developing countries and the appropriate levels of the inflation target are most likely country specific.

3. Methodology

To estimate the inflation threshold for Nigeria, we set out first to examine the causal relationship between inflation and economic growth. Also, we evaluate if it is economic growth that is fueling inflation? Or, whether it is inflation that is driving economic growth? And determine what exactly the direction of causation is?

The conventional model for testing causality is that proposed by Granger (1969). This test which utilizes the concept of Vector Auto regression (VAR) model is presented in the two variables Vector Auto regression (VAR), represents the threshold of inflation (k) equations 1 and 2 as follows;

$$GLRGDP_t = \alpha_{10} + \sum_{j=1}^{k} \alpha_{1j}\, GLCPI_{t-j} + \sum_{j=1}^{k} \beta_{1j}\, GLRGDP_{t-j} + \in_{1t} \qquad (1)$$

$$GLCPI_t = \alpha_{20} + \sum_{j=1}^{k} \alpha_{2j}\, GLCPI_{t-j} + \sum_{j=1}^{k} \beta_{2j}\, GLRGDP_{t-j} + \in_{2t} \qquad (2)$$

To test the direction of causality the null hypothesis and alternative hypothesis is;
Null hypothesis $H0: \sum \alpha_i = 0$, that is lagged CPI does not belong to in the regression.

To test this hypothesis referring to the significance of the set of coefficients of equations 1 and 2, the usual Wald F-statistic is utilized give by equation (3)

$$F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)} \qquad (3)$$

Where, m and (n-k) is the degree of freedom for the numerator and denominator. RSSR and RSSUR are both the restricted residual sum of squares and the unrestricted residual sum of squares.

To establish a threshold model that explains the relationship between inflation and economic growth, for the Nigerian economy, we adapt the threshold model developed by Khan and Senhadji (2001) for the analysis of threshold level of inflation for industrialized and developing countries and the recent threshold model for Ghana by Frimpong and Oteng-Abayie (2010). The data used for this study are annual data

covering the period 1970-2009. The data are obtained from the Central Bank of Nigeria Statistical Bulletin 2008 and from the World Bank's World Development Indicator (2009). The choice of this period is based on the fact that between 1960 and 1970, the Nigerian economy was highly volatile-a period that the country experienced severe political instability that culminated into the 1967-1969 civil war. In addition to this, witnessed the first volatility in the early 1970s hence the study period started from 1970.

In order to capture significant variables in the growth-inflation model (Solow and Swan 1956; Tobin 1965; Barro 1991; Fischer 1993; King and Levine 1993; Bullard and Keating 1995; Boyd, Levine and Smith 2001), we include variables such as the growth rate of real GDP (GRGDP) growth rate of consumers price index (GCPI), the growth rate of the ratio of broad money supply to GDP ($^{GM2}/_{GDP}$)-a measure of financial depth and the growth rate in term of trade (GTOT).

The threshold model is expressed in estimation form as follows;

$$GLRGDP_t = \alpha_0 + \alpha_1 GLCPI_t + \alpha_2 * D_t(GLCPI_t - k) + \alpha_3 GL(M2/GDP)_t + GLTOT_t + U_t \quad (4)$$

On a priori, $\alpha_1 > 0$, $\alpha_3 > 0$, $\alpha_4 > 0$, $\alpha_5 > 0$, and $(\alpha_1 + \alpha_2) < 0$,

Where;
GLRGDP=Log transformation of growth rate of real GDP
GLCPI= Log transformation of growth rate of inflation
GL ($^{M2}/_{GDP}$) = Log transformation of growth rate the ratio of broad money supply to GDP.
GLTOT= Log transformation of growth in term of trade
K= threshold level of inflation

$D_t = \begin{Bmatrix} 1:100 * LogINFL_t > k \\ 0:100 * LogINFL_t \le k \end{Bmatrix}$ = Dummy variable

The null hypothesis to be tested in this model is;
$H_0 : k \le 10\%$, at inflation levels $\le$ 10%, inflation is not inimical to growth in the Nigerian economy.

The threshold value k in the dummy variable has a property that expresses α_1 as low inflation and $(\alpha_1 + \alpha_2)$ as high inflation in the inflation growth model. The k in the dummy variable is given arbitrarily by estimating the optimal k (k*) which is obtained by finding the value that minimizes the residual sum of square (RSS) and maximizes the coefficient of determination (Mubarik 2005).

The regression is estimated for the optimal value k by taking different values of k chosen in ascending order. The optimal value of k (k*), is obtained by choosing the estimate that minimizes the sum of squared residual.

4. Discussion of Findings

The result of the Granger causality test reported in Table 1 indicates that we cannot reject the null hypothesis that Inflation does not granger cause economic growth. The

same conclusion can be drawn from the growth-inflation relationship. Real GDP does not granger cause inflation. This is as indicated by the F-statistic value of 0.73 and 0.22 which failed the test of significance at 5% and 10% levels of significance.

To establish the inflation threshold for Nigeria, we observed two separate sample periods 1970-2008 and 1980-2008. The second sample period 1980-2008 is used as a control period to examine whether there has been a significant change in the threshold for Nigeria over the two sample periods. Using the methodology of Khan and Sendhaji (2001) the sample was grouped into 7 observations taking a range of inflation from a minimum level of less than or equal to 6 percent to a maximum level greater than or equal to 12 percent. Within each band of inflation rate, average real GDP growth rates are calculated against each linear level of inflation.

Estimating equation (4) with the least square procedure and utilizing the first order auto regression scheme AR(1), the regression results for the sample periods (1970-2008) and (1980-2008) is reported in Table 1 and 2 respectively. The result from Table 1, suggest a threshold level of 8 percent for Nigeria over the period 1970-2008. At this level, a maximum value of the coefficient of determination (R^2=0.81) and a minimum value of the residual sum of square (RSS=281.2) is obtained over the range of inflation values $k \leq 6$ to $k \geq 12$. Thus, we cannot accept the null hypothesis that at inflation levels greater that 10% for Nigeria, inflation is not inimical to growth.

Table 1: Granger causality test

Variables	GLCPI	GLRGDP
Constant	9.172992 [2.86378]	24.19011 [1.44941]
GLCPI(-1)	0.520180 [3.68297]	-0.345396 [-0.46934]
GLRGDP(-1)	-0.026473 [-0.85904]	-0.342707 [-2.13428]
R-squared	0.294844	0.123812
Adj. R-squared	0.253365	0.072272
F-statistic	7.108153*	2.402232

Source: Authors Estimation Using e-view 7.

Table 2: Pairwise Granger Causality

Tests. Sample: 1970 2008

Lag 1

Null Hypothesis:	Obs	F-Statistic	Prob.
GRGDP does not Granger Cause GCPI	37	0.73795	0.3963
GCPI does not Granger Cause GRGDP	0.22028	0.6418	

Source: Authors Estimation Using e-view 7.

At 8 percent level of inflation rate, the coefficient D(GLCPI-K) is statically significant at the 10 percent level of significant as shown by the p-value of (0.078). At 8 percent threshold level, inflation had a positive and significant impact on real GDP growth rate, increasing economic growth by the sum of the coefficients of GLCPI and D (GLCPI-K) (-0.821+4.149=2.329) above the threshold level of 8 percent, inflation depresses economic growth by 0.9148. Thus, we conclude inflation should be targeted at a minimal level of 8 percent for Nigeria. This is higher than the 6 percent rate suggested by Fabayo and Ajilore (2006) but falls within the 7-11 percent suggested by Khan and Senhadji (2001) for developing countries and lower than the 10 percent threshold level for oil producing countries by Espinoza, Leon and Prasad (2010).

To establish whether there have been significant changes in the inflation threshold level over different periods in Nigeria, the model was estimated over the sample period 1980-2008. The result of the estimate reported in Table 4, is not significantly different from that reported in Table 3, except that a threshold level of 7 percent was attained with the coefficient D(GLCPI-K) not statistically significant in explaining growth. This is as indicated by the p-value of -1.131.

We therefore conclude a threshold level of 8 percent for Nigeria beyond which inflation is inimical to growth.

Table 3: Inflation Threshold Estimate Dependent Variable RGDP Growth Rate (1970-2008)

(%)	Variable	Coefficient	T-Stat	Prob.	R2	R2	F-Stat	DW	RSS
6%	**GLCPI**	-0.546655	-1.879775***	0.0846	0.78	0.68	8.364*	1.91	443.2
	D(GLCPI-K)	3.047973	0.721116	0.4847					
	[GL(M2/GDP)]	-0.347813	-4.222477*	0.0012					
	GLTOT	0.070898	2.018318***	0.0665					
	AR(1)	0.704767	5.013625*	0.0003					
	INT	26.44181	4.117194*	0.0014					
7%	**GLCPI**	-0.594065	-1.827504***	0.0976	0.75	0.62	5.89*	1.93	353.6
	D(GLCPI-K)	-1.771027	-0.549713	0.5946					
	[GL(M2/GDP)]	-0.313598	-3.623105*	0.0047					
	GLTOT	0.074071	2.158113***	0.0563					
	INT	29.00976	4.561611*	0.0010					
	AR(1)	0.705759	5.304837*	0.0003					
8%	**GLCPI**	-0.820956	-3.375670*	0.0062	0.81	0.72	9.39	1.35	281.2
	D(GLCPI-K)	4.149676	1.943410	0.0780					
	[GL(M2/GDP)]	-0.320393	-4.790887*	0.0006					
	GLTOT	0.080053	2.959019**	0.0130					
	INT	25.44726	3.126572*	0.0096					
	AR(1)	0.818195	6.658273*	0.0000					
9%	**GLCPI**	-0.518843	-3.428156*	0.0041	0.78	0.71	10.08	2.21	403.9
	D(GLCPI-K)	-0.396023	-0.177963	0.8613					
	[GL(M2/GDP)]	-0.302468	-4.213445*	0.0009					
	GLTOT	0.066254	2.424580	0.0294					
	INT	25.32515	4.950209*	0.0002					
	AR(1)	0.718012	6.105659*	0.0000					
10%	**GLCPI**	-0.603652	-4.955219*	0.0001	0.85	0.82	20.6	1.21	322.8
	D(GLCPI-K)	-4.556706	-2.653677**	0.0167					
	[GL(M2/GDP)]	-0.299706	-5.682872*	0.0000					
	GLTOT	0.081538	3.573737*	0.0023					
	INT	26.04650	5.944171*	0.0000					
	AR(1)	0.767279	8.551789*	0.0000					
11%	**GLCPI**	-0.512281	-3.573322*	0.0023	0.80	0.74	17.7	1.85	453.4
	D(GLCPI-K)	0.538122	0.310990	0.7596					
	[GL(M2/GDP)]	-0.272532	-4.417797*	0.0004					
	GLTOT	0.056939	2.294168**	0.0348					
	INT	22.74862	4.652392*	0.0002					
	AR(1)	0.752169	7.210806*	0.0000					
12%	**GLCPI**	-0.575400	-4.295856*	0.0005	0.823	0.78	16.49	2.03	389.8
	D(GLCPI-K)	-4.247660	-1.669014	0.1134					
	[GL(M2/GDP)]	-0.315375	-4.975549*	0.0001					
	GLTOT	0.047587	2.031273***	0.0582					
	INT	25.46308	5.378209*	0.0001					
	AR(1)	0.759538	7.298927*	0.0000					

Source: Authors Estimation Using e-view 7.
Note: *, ** and *** represents 1%, 5% and 10 percent levels of significance.

Table 4: Inflation Threshold Estimate Dependent Variable RGDP Growth Rate (1980-2008)

(%)	Variable	Coefficient	T-Stat	Prob.	R2	R2	F-Stat	DW	RSS
6%	**GLCPI**	-1.044334	-3.559063**	0.0162	0.89	0.79	8.45*	2.558	117.3
	D(GLCPI-K)	0.762616	0.158823	0.8800					
	[GL(M2/GDP)]	-0.522380	-3.475920**	0.0177					
	GLTOT	0.145106	3.604385**	0.0155					
	AR(1)	0.649790	4.968163*	0.0042					
	INT	30.17351	4.191070*	0.0086					
7%	**GLCPI**	-0.959109	-2.632147**	0.0464	0.89	0.79	8.68	2.23	114.6
	D(GLCPI-K)	-1.131428	-0.366172	0.7292					
	[GL(M2/GDP)]	-0.521241	-3.764569**	0.0131					
	GLTOT	0.144192	3.697038**	0.0140					
	INT AR(1)	0.647614	4.977086*	0.0042					
	INT	30.44031	5.192367*	0.0035					
8%	**GLCPI**	-0.954238	-3.302157**	0.0164	0.87	0.77	8.55	2.06	142.8
	D(GLCPI-K)	0.031833	0.009995	0.9923					
	[GL(M2/GDP)]	-0.485247	-3.679586**	0.0103					
	GLTOT	0.131651	3.268054**	0.0171					
	INT AR(1)	0.622242	4.347087*	0.0048					
	INT	30.39054	4.867658*	0.0028					
9%	**GLCPI**	-0.571708	-3.586864*	0.0059	0.84	0.76	10.00	2.97	218.5
	D(GLCPI-K)	-1.437971	-0.562907	0.5872					
	[GL(M2/GDP)]	-0.397981	-3.451306*	0.0073					
	GLTOT	0.115506	3.156384**	0.0116					
	INT AR(1)	0.604374	4.437484*	0.0016					
	INT	24.54698	5.426373*	0.0004					
10%	**GLCPI**	-0.585686	-4.425458*	0.0008	0.86	0.80	14.87	1.58	241.7
	D(GLCPI-K)	-3.703573	-1.78496***	0.0995					
	[GL(M2/GDP)]	-0.304059	-3.923095*	0.0020					
	GLTOT	0.112284	3.654135*	0.0033					
	INT AR(1)	0.694986	5.469311*	0.0001					
	INT	23.52877	5.618762*	0.0001					
11%	**GLCPI**	-0.548998	-3.611992*	0.0036	0.83	0.75	11.33*	2.17	303.8
	D(GLCPI-K)	-0.472041	-0.229752	0.8222					
	[GL(M2/GDP)]	-0.315599	-3.484842*	0.0045					
	GLTOT	0.101932	2.911239**	0.0131					
	AR(1)	0.662952	4.923781*	0.0004					
	INT	21.11275	4.955878*	0.0003					
12%	**GLCPI**	-0.600544	-4.219096*	0.0012	0.85	0.79	13.79*	2.38	257.8
	D(GLCPI-K)	-4.589389	-1.475987	0.1657					
	[GL(M2/GDP)]	-0.372668	-4.157592*	0.0013					
	GLTOT	0.074667	2.136755***	0.0539					
	AR(1)	0.656808	5.071786*	0.0003					
	INT	0.656808	5.071786*	0.0003					

Source: Authors Estimation Using e-view 7.

Note: *, ** and *** represents 1%, 5% and 10 percent levels of significance.

5. Conclusion

Attempt have been made in this paper to explain the direction of causation between inflation and economic growth and the threshold level of inflation using country specific data for Nigeria over the sample period 1970-2008. The result of the granger causality test shows inflation does not granger cause economic growth and economic growth does not granger cause inflation. Using control variables such as growth in the ratio of broad money supply to GDP (GLM2/GDP) and growth in term of trade (GLTOT), we established an inflation threshold of 8 percent for Nigeria

This result is essential for monetary policy formulation given that the Central Bank of Nigeria has been targeting single digit inflation over the past decades without necessarily targeting the optimum point in which inflation becomes inimical to growth.

A major limitation of this study is the use of CPI to proxy inflation which majorly addresses variation in prices at the household level in the National Income framework. There is need for a broader definition of inflation that will factor in variation in price level in all the components of aggregate demand. In addition to this limitation is the use of annual time series data as against quarterly data. These issues will be addressed in sub sequent studies.

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