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# NON–LINEAR RELATIONSHIP BETWEEN INFLATION AND ECONOMIC GROWTH IN INDIA

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**KEYWORDS:**

*Inflation, Economic Growth, Threshold Autoregressive (TAR) Model, Augmented - Expected Philphs Curve, Threshold Inflation*

## ABSTRACT

*This study examine the relationship between economic growth and inflation, various empirical studies have been reviewed, a robust theoretical framework is build base on the monetarist Augmented – Expectation Philips Curve, data of inflation and GDP is source from world bank data base, Perron (1997) and Zivot and Andrew (1992) Unit root test with break is used, the variables shows evidence of stationarity with the presence of break in both level and slope. A Self-exiting Threshold Autoregressive (TAR) model with 3 regime is used; the evidence is for a longrun positive relationship between inflation and economic growth with a threshold value of 1.32, 5.45 and 5.44 for first, second and third regime. Therefore the conclusion reach is that the 5.45 inflation value will translate to economic growth*

## 1.0 INTRODUCTION

High and sustained output growth coupled with a low level of inflation is the desired outcome of every economy, the relationship between inflation and economic growth and the existence of low inflation and high economic growth is a matter of debate, but what is the possibility of this combination? Do we need to have a trade – off between the two? realistically the inflation – growth nexus is vehemently dependent upon the level of inflation in most cases, low level inflation results to high output growth while higher level of inflation is detrimental to growth, as such there is the need to determine the threshold value of inflation that will translate to growth. Base on some empirical studies inflation – growth nexus have negative relationship (Fischer, 1983, De Gregorio, 1992, Barro, 1995)

Bruno and Easterly (1998) assert that the inflation – growth resultis stronger with high frequency data, but even the high frequency relationship is mostly driven by inflation series, growth falls during high inflation periods and recovers rapidly when inflation falls.In their approach they featured output growth before, during and after discrete high inflation crises; using a non – parametric approach and a threshold level of 40% to describe countries with inflation crises, they find no robust evidence of inflation – growth relationship at all frequencies with the exception of discrete high inflation crises and also find a robust evidence that growth become significantly negative during the discrete high inflation crises, likewise at the end of the crises inflation revert back to its normal level and a significant growth is achieved.

The fundamental questions to ask here is that, if inflation is un favorable to growth then how low should inflation be, is it zero percent, single digit or double digit? What should be the rate of inflation that will translate to economic growth? At what level of inflation does inflation and economic growth relation became negative?

These questions have become a basis for discussion and argument among scholars, but the main focus is the nonlinear relationship between inflation and economic growth. Nonlinearrelationship between inflation and economic growth was first exploited by Fischer (1993), while Sarel (1996) test for the presence of a structural break in the inflation growth relation and found a statistically significant break of 8%, this implies that a rate of inflation below 8% would not yield significant growth, while above 8% would yield significant growth. Some studies found a threshold level below Sarel's 8% while some found a threshold value of more than 8% (Gosh and Philliphs, 1998, Christoffersen and Doyle, 1998).

Some studies have compared two countries and try to find the threshold value, for example Lee and Wong (2005) find 7.25% and 9.6% for Taiwan and Japan respectively, while some used a panel threshold regression model, for example Vinayagathasan (2013) find 5.43% for Asia, Gullapalli(2013) took 214 countries and found 20% threshold value, wheras he find different values as he grouped the countries into categories.

There is scanty literature with regard non linear relationship between inflation and economic growth, the few include Veni and Choudhury (2007) used cointegration and causality approach and find that the variables are independent. V. Salian and Gopakumar (2013) used an correction model approach and found longrun negative relationship, N. Bhaduri (2013) uses a wavelet multi resolution analysis with varying time scale decomposition and found a persisitence negative relationship in the shortrun.

## 2.0 THEORETICAL AND EMPIRICAL MODELS

In his famous 1967 presidential address Freidman criticize the widely known Phillips curve as being miss – specified. Money wages are determined as result of a contractual agreement between the labour union and the manufacturers for a discrete period of time; as such both employees and employers are more interested in real wages over the contract period and what affects the expected real wage over the contract period is the expected inflation. Freidman argued that the Philips curve should be specified in terms of the rate of change of real wages, he thereby augment the Phillips curve by including variable that will account for the rate of change in money wages i.e. expected inflation and hence the name expectations – augmented Phillips curve, given as

$$\dot{W} = f(U) + \dot{P}^{e} \quad \text{.....(1.0)}$$

Where $\dot{W}$ is the rate of money wages as an increasing function of unemployment $f(U)$ and expected inflation $\dot{P}^{e}$ .Introducing theexpected rate of inflation in the Phillips curve above (1.0) with excess demand proxied by unemployment level which determine the rate of change in money wages suggest that instead of a unique Phillips curve, we will have a group of philiphs curve each with an expected inflation rate.

As a result of Freidman criticism on the conventional Phillips curve, literature has evolved with regards to the Expectations – augmented Phillips Curve using the equation:

$$\dot{W} = f(U) + \dot{P}^{e} \quad \text{.....(1.1)}$$

If the value of is one it signifies no longrun trade – off, while if it is less than 1 but greater than 0, it signifies a longrun trade – off that is less favorable than in the shortrun. Assuming the growth rate of productivity is zero i.e. $\dot{W} = \dot{P}^{e}$ Equation (1.1) is written as:

$$\dot{P} = f(U) + \dot{P}^{e} \quad \text{.....(1.2)}$$

By rearranging equation (1.2) we have

$$\dot{P} - \dot{P}^{e} = f(U) \quad \text{.....(1.3)}$$

At the equilibrium unemployment is equals to $U^{*}$ while both the actual and expected inflation are equal, therefore equation (1.3) can be factorized and written as

$$\dot{P}(1 - \quad) = f(U) \quad \text{.....(1.4)}$$

If we divide both side of equation (1.4) by $(1 - \quad)$ we will have

$$\dot{P} = \frac{f(U)}{(1 - \quad)} \quad \text{.....(1.5)}$$

From equation (1.5) we can assume the value of to be either less than 1 or greater than 1, if it is less than 1, a positive relationship between inflation and unemployment will exist likewise, if it is greater than 1 the relationship will be positive.

The transmission channelis that increase in the level of inflation or prices ( $\dot{P}$ ) will lead to increase in labour, income, and output, as such the relationship can be rewritten as

$$eco\_grth = f(\text{inf}) \quad \text{.....(1.6)}$$

Where $eco\_grth$ is Economic growth as a function of Inflation. The above equation will be used in the analysis

## 2.1 DATA AND TECHNIQUE OF DATA ANALYSIS

Annual Inflation and economic growth data from 1964 to 2015 is used, the source of the data is the data base of the World Bank, growth rate of GDP is taking in order to arrive economic growth series.

The study utilizes test of unit root with breaks, Perron (1997) and Zivot and Andrew (1992). The debate on the stochastic properties of a time series dates back to Nelson and Plosser (1982). The focal point of the debate is current shock only have a temporary impact on the longrun behavior of a time series; Nelson and Plosser argued and used the Dickey and Fuller (1979, 1981) statistical technique to check for the stochastic properties of 14 times series; others include Shapiro and Watson (1988) and Christianoand Eichenbaum (1989).

Perron (1988, 1989) counter the degree of confidence of Nelson's and Plosser by using the great depression and post war oil crises of 1973 as a breaking point of the series and he was able to reject null for 11 out 14 series.

Zivot and Andrew provide a Further Evidence and Great Crash, the Oil Price Shock and Unit Root Hypothesis by criticizing Perron's methodology that the break points are based on prior observation of the data and hence the problem of *"Pre – testing"*(P 251), as such an endogenous break point is more preferable, dates like formation of OPEC, 196 tax cut, Vietnam war, 1980's financial deregulation are important. The null hypotheses are:

Model A: $y_t = « + dD(T_B)_t + y_{t-1} + e_t,$

Model B: $y_t = «_1 + y_{t-1} + («_2 - «_1)D«_t + e_t,$

Model C: $y_t = «_1 + y_{t-1} + dD(T_B)_t + («_2 - «_1)D«_t + e_t,$

Where $D(T_B)_t$ =1 if $t = T_B + 1$, 0 otherwise

$D«_t$ =1 if $t > T_B$, 0 otherwise

Perron (1997) provide a Further Evidence on Breaking Trend Functions in Macroeconomic Variable by assuming an endogenous break date occurring at most once. The additive outlier model that allows for change in the intercept is given as

$$y_t = « + \bar{}D«_t + \ _t + ¢D(T_b)_t + \sim y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-1} + e_t$$

Where $D«_t = 1 \ (t > T_b)$

$D«_t = 1(t = T_b + 1)$

The second model allows for change in both intercept and slope at time $T_B$ as

$$y_t = « + \bar{}D«_t + \ _t + ¥DT_t + ¢D(T_b)_t + \sim y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-1} + e_t$$

Where $DT_t = 1(t > T_b)$

The third model allows for segment of the trend function at the time of the break, it follows a double stage procedure, the first step de – trendthe series using the regression:

$DT_t = 1(t > T_c)(t - T_b)$ :

$$y_t = « + \ _t + ¥DT_t + \hat{y}_t$$

The test is then performed using the t – statistics for $\sim = 1$ in the regression

$$\hat{y} = \sim y_{t-1} + \sum_{i=1}^{k} \hat{ci}\Delta \hat{y}_{t-1} + e_t \ .$$

**Table 1 Unit Root Test**

| Inflation | | | | | | |
|---|---|---|---|---|---|---|
| **Perron(1997) Unit Root Test** | | | | **Zivot and Andrew(1992)** | | |
| | **Model A** | **Model B** | **Model C** | **Model A** | **Model B** | **Model C** |
| Test Statistics | -5.538577 | -5.611607 | -5.257258 | -5.993481 | -5.682415 | -6.108771 |
| Break Dates | (1974) | (1998) | (2005) | (1999) | (1974) | (1999) |
| Probability | | | | [0.052809] | [0.013024] | [0.029177] |
| CritValue: 1% | -5.92 | -6.32 | -5.45 | -5.34* | -4.80* | -5.57* |
| 5% | -5.23 | -5.59 | -4.83** | -4.93 | -4.42 | -5.08 |
| 10% | -4.92*** | -5.29 | -4.48 | -4.58 | -4.11 | -4.82 |

| Economic Growth | | | | | | |
|---|---|---|---|---|---|---|
| **Perron(1997) Unit Root Test** | | | | **Zivot and Andrew** | | |
| | **Model A** | **Model B** | **Model C** | **Model A** | **Model B** | **Model C** |
| Test Statistics | -2.934457 | -4.089767 | -5.012127 | -2.964787 | -3.536074 | -4.106689 |
| Break Dates | (1992) | (2006) | (2007) | (1993) | (2007) | (2006) |
| Probability | | | | [0.16325] | [0.000877] | [0.010874] |
| CritValue: 1% | -5.92 | -6.32 | -5.45 | -5.34 | -4.80 | -5.57 |
| 5% | -5.23 | -5.59 | -4.83 | -4.93 | -4.42 | -5.08 |
| 10% | -4.92 | -5.29 | -4.48 | -4.58 | -4.11 | -4.82 |

The tables 1 and 2 above shows the unit root test using Perron (1997) and Zivot and Andrew (1992) for inflation and economic growth series.From table 1 using Perron (1997) inflation series is trend stationary with a break (1974) at the level with 10% level of significance; the series is also trend stationary with the presence of an endogenous break in 2005 at 5% level of significance; as such the data generating process of the series follows model c. using Zivot and Andrew (1992) inflation series is also trend stationary with break in both level and the slope at 1% level of significance. Inflation series is trend stationary.

The series economic growth using Perron (1997) is trend stationary with a break at both level and slope at 5%, using the Zivot and Andrew test I was unable to reject the null hypothesis, this is due to the null hypothesis of drift and an alternative of stationary with break. The economic growth is also stationary.

The stability condition of the two series can allow me to use a bivariate Threshold Auto regressive (TAR) model.

## 2.2 DATA AND STRATEGY OF THE WORK

The Threshold model was first introduced by Tong (1980) in a paper titled *Threshold Auto - regression, Limit Cycles and Cyclical Data* at the royal statistical society meeting (Tong 2010).

A self-exiting threshold autoregressive (TAR) time series $Y_t$ is specified as:

$$Y_t = \Phi_0^{(j)} + \sum_{i=1}^{p} \Phi_0^{(j)} Y_{t-1} + a_t^{(j)}$$

$$r_{j-1} \le Y_{t-d} < r_j,$$

Where $j = 1,\ldots\ldots\ldots\ldots,k$ and is a positive integer, the thresholds variables are $-\infty = r_0 < r_1 < \ldots\ldots < r_k = \infty$ for each $j$

**Table 2 Estimates of the Threshold Var: Economic Growth and Unemployment**

| Variable | Regime 1 E(-3)<1.32 | Regime 2 1.32 ≤ E(-3)<5.45 | Regime 3 5.44 ≤ E(-3) |
|---|---|---|---|
| E(-1) | 0.2(0.01) | -0.79(0.25) | 0.14(0.28) |
| E(-2) | -0.40(0.04) | -2.25(0.15) | -0.08(0.65) |
| E(-3) | -0.94(0.00) | 24.14(0.00) | 0.49(0.12) |
| E(-4) | -0.29(0.07) | 6.39(0.00) | 0.15(0.69) |
| I | 1.78(0.00) | 17.49(0.00) | 0.03(0.91) |

The table above presents the estimate of the threshold Var model, the threshold variable is the third period lag of economic growth, the result is in favor of three regimes, and the model utilizes 4 period lags of economic growth. In all the regimes inflation is significant in influencing economic growth positively; while the lag values of economic growth are also significant in influencing economic growth in first and second regime with the exceptions of forth lag in the first regime, first and second lag in second regime.

## 3.0 CONCLUSION

This study examine the relationship between economic growth and inflation, various empirical studies have been reviewed, a robust theoretical framework is build base on the monetarist Augmented – Expectation Philips Curve, data of inflation and GDP is source from world bank data base, GDP is converted to economic growth by taking the growth rate of GDP. Perron (1997) and Zivot and Andrew (1992) Unit root test with break is used, the variables shows evidence of stationarity with the presence of break in both level and slope. The stochastic properties of the series allow for running a Self-exiting Threshold Autoregressive model with 3 regimes; the evidence is for a longrun positive relationship between inflation and economic growth with a threshold value of 1.32, 5.45 and 5.44 for first, second and third regime. Therefore the conclusion reach is that the 5.45 inflation value will translate to economic growth.

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