Institutions and Economies
Vol. 11, No. 1, January 2019, pp. 23-43

What Causes India's High Inflation? A Threshold Structural Vector Autoregression Analysis

Arundhati Mallick[a], Narayan Sethi[b]

Abstract: *Inflation is a chronic problem for India since the last few decades. The existence of mild inflation is necessary for the growth of an economy. Mild inflation in the economy always has a positive or neutral effect on the growth rate. When inflation upswings certain level, it affects growth negatively and ultimately affects the other macroeconomic variables such as interest rate, exchange rate, and money supply. That level of inflation is known as a threshold level of inflation. This paper estimates the threshold level of inflation for India from the period of April 2006 to May 2015. The threshold level of inflation is treated as a regime point and the whole sample is divided into two different regimes, from April 2006 to March 2013 and April 2013 to May 2015. This paper also focuses on the interaction of inflation with other macroeconomic variables in two different regimes separately by using the non-linear Structural Vector Autoregression (SVAR) model. We find that high inflation in the economy is the result of shocks in the interest rate, oil price, and Nominal Effective Exchange Rate (NEER) and which ultimately affects the economic growth in India.*

Keywords: Economic growth; India; Inflation; Non-linear SVAR; Threshold level
JEL Classification: E31, C32

Article Received: 6 December 2017; Article Accepted: 14 November 2018

1. Introduction

Inflation is a chronic problem for India since the last few decades. The central bank of India, Reserve Bank of India (RBI) always tries to manage the trade-off between inflation and growth to maintain the economic stability of the country. The general notion of a layman is, inflation always affects economic growth negatively, but this is not true always. The existence of mild inflation is necessary for the growth of an economy. Mild inflation in the economy always has a positive or neutral effect on the growth rate. When inflation upswings certain level, it affects growth negatively and ultimately affects the other macroeconomic variables such as interest rate, exchange

[a] Department of Economics (H.D.J.C), Veer Kunwar Singh University, Bihar, India. *Email: arundhatimallick42@gmail.com.*
[b] Corresponding Author. Department of Humanities and Social Sciences, National Institute of Technology (NIT) Rourkela, Odisha, India. *Email: nsethinarayan@gmail.com.*

rate, and money supply. This relation of economic growth and inflation are nonlinear. The level of inflation beyond which inflation affects the growth negatively is known as the threshold level of inflation. To maintain the stability of an economy, the central bank of every country aims to maintain the threshold level of inflation. Sarel (1995) demonstrates the possibility of a nonlinear relationship between economic growth and inflation. This threshold level of inflation can be justified through the presence of structural breaks. When these structural breaks are ignored, the estimated effect of high level of inflation on growth decreased. Even many studies try to find out the role of a threshold level of inflation in developing and developed countries. Jha and Dang (2012) examine the effect of inflation variability and economic growth for both developing and developed countries. The study considers 182 developing countries and 31 developed countries from the period of 1961 to 2009 and as a result, found that in developing countries there is significant evidence for the adverse effect of inflation variability on growth when the inflation rate is high especially when the inflation is higher than 10 percent. In the case of developed countries, there is no significant evidence of inflation variability detrimental to growth. Ibarra and Trupkin (2011) try to find out the existence of a threshold level of inflation for both developed and developing countries and the speed of transition between one inflation regime to another inflation regime. The study uses a panel of 124 countries from the period of 1950 to 2007. The threshold level of inflation for industrialised countries is 4.1 percent, while for non-industrialised countries is 19.1 percent and the speed of transition is relatively smoother in industrialised countries than non-industrialised countries. According to the earlier studies, the threshold level of inflation is generally higher in developing countries than in developed countries.

As a whole, we can say that there is no linear relationship between inflation and growth. Other than inflation and growth; many macroeconomic variables also have nonlinear relations. Guo (2013) examines the asymmetric effect of macroeconomic variables in different inflation regimes. We can get through the inflation regime via the threshold level of inflation. The study finds that macroeconomic variables are more responsive to inflation in a high inflation regime than a low inflation regime.

In this paper, we analyse the nonlinear relationship between economic growth and inflation. After getting the threshold level of inflation, we examine the nonlinear relationship between inflation and other macroeconomic variables like interest rate, oil price, and Nominal Effective Exchange Rate (NEER). This paper is organised into five sections: Section 1- Introduction, Section 2- Literature Review. Section 3- Data and Methodology, Section 4- Empirical Results and Analysis. Section 5- Conclusion and some Policy Implication.

2. Literature Review

There are numerous studies conducted on the context of a threshold level of inflation across the world. Nasir and Nawaz (2009) try to find out inflation and economic growth nexus for Pakistan from the period of 1961 to 2008. As a result, the study finds the existence of two threshold level for inflation. That means inflation is divided into three sections. Firstly, inflation rises from 0 to 6 percent; affecting growth negligibly or positively. Secondly, inflation crosses the first threshold level (6%), which affects the growth of the economy negatively. Finally, when inflation crosses the second threshold level (11%), the marginal effect of inflation on growth starts to decline. The study also tries to find out the nonlinear relationship between investment and economic growth. The threshold level of investment for growth is 7 percent. Jayaraman, Chen and Bhatt (2013) study the threshold level of inflation for growth in Fiji. The study found that the threshold level of inflation for Fiji is 3.6 percent, which depends on the past trends of growth and inflation. Inflation below threshold level affects growth positively and inflation above threshold level affects growth adversely.

Other than focusing on the interaction between monetary policy and inflation many studies even concentrate on the effect of fiscal policy on macro and financial variables. Afonso, Baxa and Slavik (2011) try to study the non-linear relationship between fiscal policies and different financial market stress regimes. The study uses a quarterly dataset for the U.S., the U.K., Germany, and Italy from the period of 1980:4 to 2009:4 The study finds that in case of U.S. the difference between high and low financial stress regimes is lowest, but for Germany and Italy, both have an impact on output of fiscal policy shocks. Aleem and Lahiani (2014) estimate the exchange rate pass-through to domestic prices for Mexico by using a threshold vector autoregression (TVAR) model. From the analysis, the study gets 0.79% as the threshold value of inflation with two different regimes. Domestic prices of Mexico react strongly to any positive changes in exchange rate when the inflation rate is above the threshold level of inflation. Calza and Sousa (2005) investigate the response of output and inflation to credit shocks of euro areas over the period of 1981:2 to 2002:3. The threshold value for quarter-on-quarter growth for real loans is 0.78%. The real GDP and inflation both react to any positive shocks in the real economy in low credit growth regime.

Yabu and Kessy (2015) empirically estimate the impact of a threshold level of inflation on growth for three founding EAC countries Kenya, Tanzania and Uganda from the period of 1970 to 2013. Other than focusing on inflation the study also focuses on other macroeconomic variables such as population growth, investment to GDP ratio, credit to GDP ratio, the degree of openness and foreign direct investment to GDP ratio. The study finds 8.46% as a threshold level of inflation beyond which inflation has a

negative impact on growth. However, the other macroeconomic variables have a positive effect on growth. Pahlavani and Ezzati (2011) explore the relationship between the threshold level of inflation and growth for Iran from the period of 1959 to 2007. The threshold level of inflation for Iran is between 9-12%, beyond this inflation affects growth rate negatively. So, the author strongly recommended maintaining the inflation level below this. Mubarik (2005) estimates the threshold level of inflation for Pakistan using an annual dataset from the period of 1973 to 2000. As a result, the study finds 9% as the threshold level of inflation. The study also tries to find out the impact of population and total investments on growth.

Avdjiev and Zeng (2014) examine the relationship between credit market condition, monetary policy and economic activity of the U.S from the period of 1955:1 to 2012:4. The study uses the following variables to analyse the above mention relations, i.e real GDP growth, inflation, federal funds rate, real credit growth rate, the spread between Baa-rated corporate bonds and 10-year treasury bond. To analyse the interaction between these variables the study uses structural TVAR and, as a result, finds that, when economic growth is below par output growth has the impact on it. When economic activity is sluggish, monetary policy has the most substantial effect, and output growth is sensitive to credit risk when the economy is booming. Mandler (2010) examines the relationship between macroeconomic variables and inflation in the U.S. by dividing the study period into high and low inflation regimes. The study finds that in a low inflation regime, monetary policy is predictable and more systematic.

Table 1: Estimates of Threshold Inflation from Past Empirical Studies of India

Study	**Period**	**The threshold level of inflation (percent)**	**Methodology**
Rangarajan (1998)		6	Macro-Econometric Model
Kannan and Joshi (1998)	1981 - 1996	6 - 7	
Vasudevan, Bhoi and Dhal (1998)	1961 - 1998	5 - 7	Correlation/regression
Samantaraya and Prasad (2001)	1970 - 1999	6.5	
Report on Currency and Finance (2001)	1970 - 2000	5	Sarel's Spline Method
Singh and Kalirajan (2003)	1971 - 1998	No threshold	Spline regression
Bhanumurthy and Alex (2010)	1975 - 2005	5 - 5.5	Spline regression
Singh (2010)	1970 - 2009	6	Spline regression

Table 1: (Continue)

Study	Period	The threshold level of inflation (percent)	Methodology
RBI Annual Report 2010-2011		4 - 6	Spline regression, non-linear least squares and Logistic Smooth Transition Regression (LSTR) model.
Pattanaik and Nadhanael (2013)	1972 - 2011	6	Spline regression, non-linear approach, Vector Autoregression (VAR).
IMF (2012)	1996 - 2012	5 - 6	
Mohanty et al (2011)	1996 - 2011	4 - 5.5	Spline regression, non-linear least squares and Logistic Smooth Transition Regression (LSTR) model.
Subbarao (2013)	1996 - 2012	4.4 - 5.7	Spline regression, non-linear least squares and Logistic Smooth Transition Regression (LSTR) model.

Source: Reserve Bank of India

Inflation in India is a serious and chronic problem because production depends on monsoon in agriculture sector, poor infrastructure facilities for transport of food items to the market and lack of proper storage facilities and energy import. The government has also historically heavily borrowed to finance its spending which leads to a high level of inflation due to high fiscal deficit. These are the main reasons of high inflation in India. The annual CPI from 1960 to 2016 has averaged at 7.6% in 16 of those years; CPI has been in double digits and above 6% in 35 of 56 years. Even in the post 1991 reform era, CPI has averaged above 6% for 17 of 25 years. India has been following the multiple objectives approach to conduct monetary policy. Recently, it has shifted to inflation targeting monetary policy framework. However, India is ready to adopt inflation targeting approach whereby India has to focus on a single objective to maintain low inflation. To do this, it will focus on core inflation while ignoring the supply side problem of inflation. However, for India the supply side problem is a more serious problem due to its poor infrastructure and traditional practice of farming. Given the above reasons, India adopted a flexible inflation targeting approach for a short period of time from 5th August 2016 to 31st March 2021 maintaining a flexible level of

inflation. Consequently, the central bank of India is made more accountable, transparent and improves the credibility of monetary policy.

3. Data and Methodology

To explore the effects of different macroeconomic variables in the different inflationary regimes we use monthly data from April 2006 to May 2015. We take monthly data of Wholesale Price Index (WPI) inflation, NEER, interest rate, changes in international crude oil price and Index of Industrial Production (IIP) as a proxy for GDP growth as monthly data GDP is not available. Instead of analysing the effect of all macroeconomic variables together, we divided the whole period into two categories, i.e. a low inflation regime and a high inflation regime. By using a threshold VAR to get the low and high inflation regime, and a nonlinear SVAR to get the effect of macroeconomic variables.

The threshold VAR can be expressed as:

$$Y_t = A^1 Y_t + B^1(L) Y_{t-1} + (A^2 Y_t + B^2(L) Y_{t-1}) I[s_{t-d} > \gamma] + U_t \qquad (1)$$

Where Y_t is a vector of endogenous variables i.e, inflation, output, interest rate, oil price and NEER. $B^1(L)$ and $B^2(L)$ are lag polynomial matrices, $A^1 Y_t$ and $A^2 Y_t$ represent the contemporaneous term, because contemporaneous effects might also differ across the regimes. I represents the indicator function, it equals to 0 when s_{t-d} is less than the threshold value (γ) and 1 otherwise. U_t is the structural disturbance. Thus TVAR also can be written as:

$$Y_t = \begin{cases} A^1 Y_t + B^1(L) Y_{t-1} + U_t & if\ I = 0 \\ (A^1 + A^2) Y_t + [B^1(L) + B^2(L)] Y_{t-1} + U_t & if\ I = 1 \end{cases} \qquad (2)$$

After dividing time into two different regimes, now we can employ the nonlinear SVAR to analyse the effects of macroeconomic variables.

A VAR (p) model can be expressed as:

$$y_t = \mu + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t \qquad (3)$$

$$A(L) y_t = \mu + \varepsilon_t$$

Where A(L) matrix lags polynomial of order p and $\varepsilon_t \sim N\ (0, \Omega)$.

According to Wold Representation Theorem, under weak regularity conditions, a stationary process can be represented as an invertible distributed lag of serially uncorrelated disturbances. Thus equation (3) can be written as:

$$y_t = A^{-1}(L)\varepsilon_t$$

$$\Rightarrow y_t = B(L)\varepsilon_t \qquad B_0 = I \tag{4}$$

In the above representation, the elements of ε_t are contemporaneously correlated so, they cannot be represented as structural shocks. The elements of ε_t are orthogonalized by imposing restrictions. So the Wold representation can be written as

$$y_t = C(L)e_t \tag{5}$$

As B_0 is an identity matrix, from equation (2) and (3) we get $\varepsilon_t = C_0 e_t$ and $B_j C_0 = C_j$ so:

$$B(L)C_0 = C(L) \tag{6}$$

In this five-variable system the C_0 matrix contains twenty five elements and to orthogonalize the different innovations twenty restrictions are needed. From the normalization of var(e_t) it follows that:

$$\Omega = C_0 C_0' \tag{7}$$

It imposes fifteen restrictions on the elements of C_0 matrix because of the symmetry of the covariance matrix Ω. Ten more restriction is needed to identify C_0 i.e., long run restrictions of neutrality. So, the long run expression of equation (3) can be written in matrix form as:

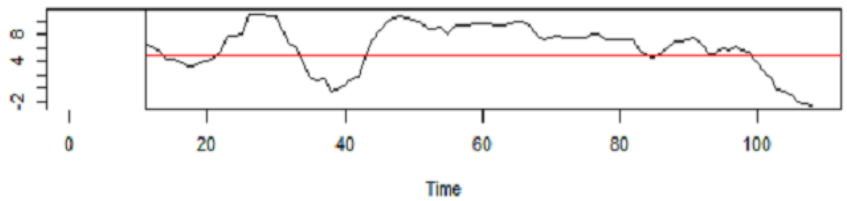
$$\begin{pmatrix} \Delta inf \\ \Delta interest\ rate \\ \Delta NEER \\ \Delta oil \\ \Delta output \end{pmatrix} = \begin{pmatrix} C_{11}(1) & C_{12}(1) & C_{13}(1) & C_{14}(1) & C_{15}(1) \\ C_{21}(1) & C_{22}(1) & C_{23}(1) & C_{24}(1) & C_{25}(1) \\ C_{31}(1) & C_{32}(1) & C_{33}(1) & C_{34}(1) & C_{35}(1) \\ C_{41}(1) & C_{42}(1) & C_{43}(1) & C_{44}(1) & C_{45}(1) \\ C_{51}(1) & C_{52}(1) & C_{53}(1) & C_{54}(1) & C_{55}(1) \end{pmatrix} \begin{pmatrix} e^{inf} \\ e^{interest\ rate} \\ e^{NEER} \\ e^{oil\ price} \\ e^{output} \end{pmatrix}$$

Where C(1) = $\sum_{j=0}^{\infty} C_j$ is the long run matrix of D(L). From our restrictions $C_{12}(1) = C_{13}(1) = C_{14}(1) = C_{15}(1) = C_{23}(1) = C_{24}(1) = C_{25} = C_{45}(1) = C_{53}(1) = C_{54}(1) = 0$.

4. Empirical Results and Analysis

Firstly, we try to get the threshold level of inflation to analyse the non-linear relation between inflation and different macroeconomic variables. By using the TVAR method, we get 4.7% as a threshold level of inflation presented in figure 1. Inflation below this threshold level may have a positive or non-negative impact on growth, but if inflation goes above this threshold level, then it has an adverse effect on growth. The TVAR method not only gives the threshold value but also divided the whole period into different regimes. In our study, we analyse the data with one threshold value and two separate regimes. After getting the threshold value, we divided our study into two regimes, i.e., from April 2006 to March 2013 and April 2013 to May 2015.

Figure 1: Threshold Level of Inflation



Source: Author's calculation

After getting two different regimes of inflation, we employ a non-recursive SVAR method to analyze the nonlinear relationship between inflation and other macroeconomic variables separately.

Before conducting any empirical analysis, it is necessary to know the nature of the variables used in the study, whether they are stationary or not. To test the stationarity, we have used an augmented dickey fuller test without trend and results as shown in table 2. Here we find that all the variables are non-stationary at the level, i.e., we cannot reject the null hypothesis of the presence of unit root. Then we converted all the variables to first difference and found all the variables are stationary at first difference and integrated of order one, i.e., I (1) process and now we can reject the null hypothesis of the presence of unit root.

Table 2: Result of Unit Root Test without Trend

Variables	**Augmented Dickey-Fuller (t-statistics)**
Regime 1 (April-06 to March-13)	
At Level	
Inflation	-2.6
Interest rate	-1.1

Table 2: (Continue)

Variables	Augmented Dickey-Fuller (t-statistics)
Regime 1 (April-06 to March-13)	
At Level	
Oil price	-2.3
Output	-1.4
NEER	-0.4
1st Difference	
Inflation	-4.9*
Interest rate	-8.9*
Oil price	-10.3*
Output	-5.1*
NEER	-7.3*
Regime 2 (April-13 to May-15)	
At Level	
Inflation	-0.1
Interest rate	-2.4
Oil price	-2.3
Output	-2.1
NEER	-2.5
1st Difference	
Inflation	-3.0*
Interest rate	-12.8*
Oil price	-7.4*
Output	-8.7*
NEER	-3.5*

Notes: * denotes that the values are significant at the level of 5%.

4.1 Regime 1 (April 06 to March 13)

After dividing the whole period into two regimes, we used nonlinear SVAR model to know the effects of different macroeconomic variables in different inflationary regime period. The result of the impulse response function estimated from non-linear SVAR model is presented below in figure 2.

In figure 2, we analysed the impulse response function for up to 16 months. Inflation is highly reactive to any shock from interest rate, NEER and oil price. Any shock to interest rate and oil price leads to a sharp decline in inflation but in response to oil price it reacts with some time lag. While in the case of NEER it responds positively with time lag but after some period it shows a sharp decline. Inflation does not react much to shocks in output. NEER significantly responds only to interest rate and oil price. It reacts

Figure 2: Impulse Response Function derived from nonlinear SVAR Model for Regime 1 (April-06 to March 13)

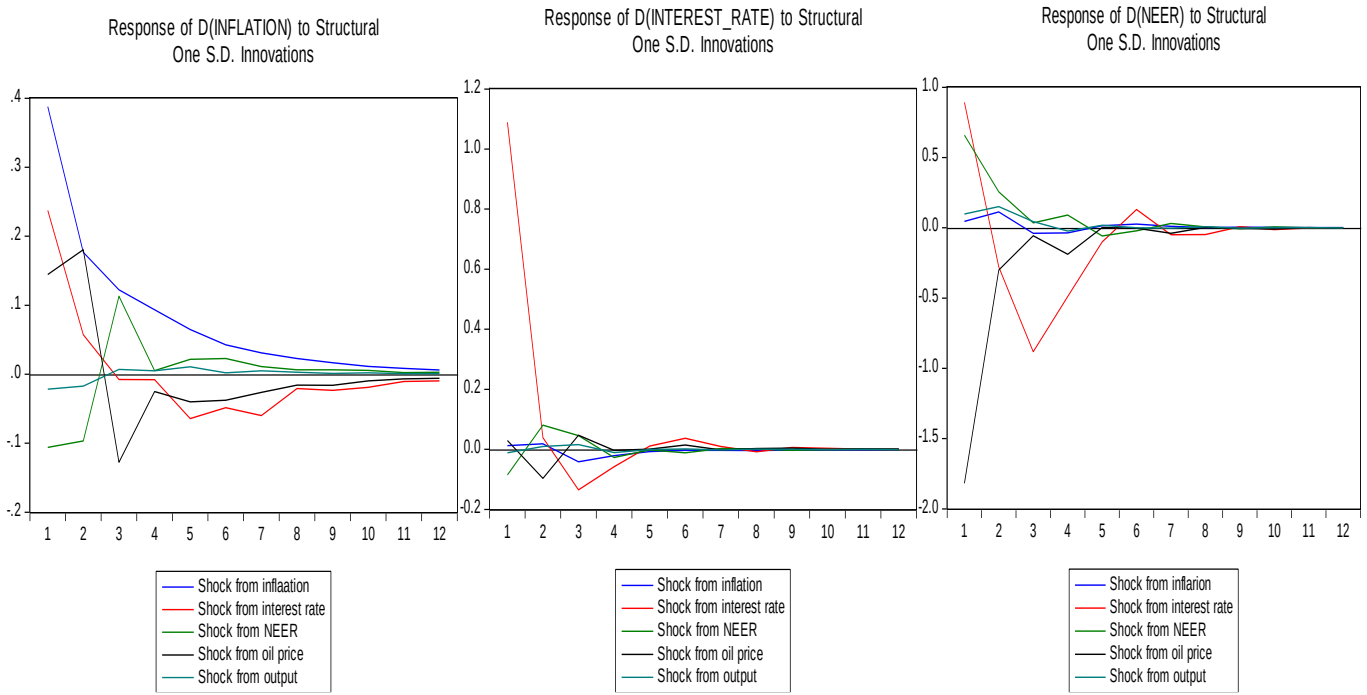
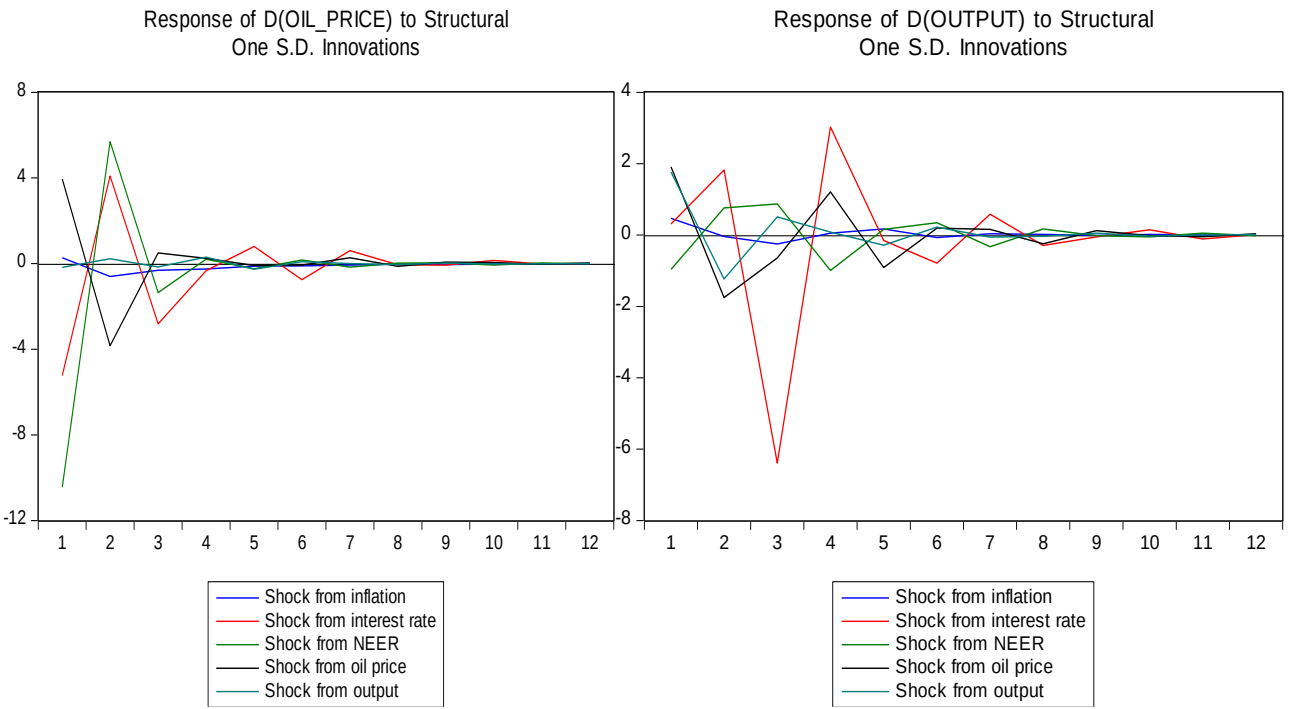


Figure 2: (Continue)



negatively to interest rate while positively to oil price. Oil price positively responds to any shocks in interest rate and NEER up to some periods; then it starts to decline. The output shows a highly significant reaction to changes in interest rates. It shows a cyclical response to the interest rate shock. In case of interest rate, it responds profoundly only to its own shock.

Variance decompositions are also analysed in table 3 of regime one up to 16 periods. Any shock to interest rate immediately makes 23% of fluctuation in inflation. In the fourth period, it decreases to 16% after one year and it causes 18% fluctuations in inflation. NEER in initial period makes 4% fluctuations in inflation then it increases to 8%. Similarly, oil price affects inflation only 8% initially and slowly the effect increases; it makes around 18% of fluctuations in the 8th period. In the case of output, any shock to interest rate makes only 1% fluctuations in output but later on the effect increases. A shock in interest rate makes around 74% of the variation of the fluctuation in output while in the case of shocks from NEER and oil price it is just the opposite. Shocks to NEER makes 11% variation of fluctuation in output in the initial periods and later on the effect decreases to 4%, In the case of shocks from oil price, it immediately makes around 45% of fluctuations in output and later on the effect decreases decay to 13%. In the case of interest rate, mostly the variation in fluctuation is mostly explained by interest rate itself (around 97%). In the case of NEER variations in fluctuation are mostly explained by oil price and interest rate. In initial periods, the effect of oil price was high and later on it decreases, while in the case of interest rate it is just the opposite.

Table 3: Variance Decomposition (April-06 to March-13)

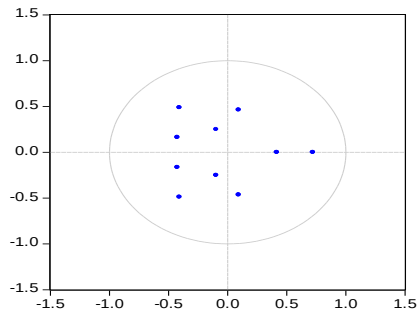
Variance decomposition of inflation					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	62.85591	23.53621	4.687188	8.724660	0.196032
4	55.56536	16.15644	9.011226	19.04041	0.226566
8	54.17990	17.87561	8.770029	18.92354	0.250918
12	54.01524	18.05939	8.743076	18.93095	0.251344
16	54.00452	18.07240	8.741078	18.93057	0.251433
Variance decomposition of interest rate					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	0.013209	99.29242	0.609784	0.072948	0.011642
4	0.214520	97.39612	1.337726	1.003581	0.048050
8	0.222392	97.36220	1.346946	1.019951	0.048510
12	0.223159	97.35923	1.347731	1.021328	0.048557

Table 3: (Continue)

Variance decomposition of interest rate					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
16	0.223218	97.35913	1.347735	1.021363	0.048559
Variance decomposition of NEER					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	0.045837	17.50952	9.553879	72.68060	0.210163
4	0.295643	32.12303	8.654920	58.33539	0.591016
8	0.311029	32.44746	8.678327	57.96990	0.593285
12	0.311898	32.44887	8.679138	57.96669	0.593407
16	0.311943	32.44921	8.679140	57.96630	0.593408
Variance decomposition of oil price					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	0.050790	17.95154	71.70288	10.27550	0.019292
4	0.263547	22.93788	63.19910	13.51368	0.085799
8	0.273691	23.43626	62.72510	13.44568	0.119262
12	0.275066	23.44271	62.71549	13.44691	0.119819
16	0.275119	23.44320	62.71499	13.44685	0.119834
Variance decomposition of output					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	2.731650	1.188648	11.57601	45.61756	38.88613
4	0.406818	75.86107	4.602179	12.18690	6.943031
8	0.441067	74.75876	4.830977	13.07433	6.894863
12	0.441227	74.74242	4.834695	13.08814	6.893526
16	0.441253	74.74225	4.834823	13.08824	6.893429

Figure 3 represents the graph of AR root test conducted to find the stability of the nonlinear SVAR model regime 1, and we found that no root lies outside the unit circle. So, our model satisfies the stability condition.

Figure 3: Result stability test of the SVAR



4.2 Regime 2 (April 2013 to May 2015)

We again conducted a nonlinear SVAR model to know the effects of different macroeconomic variables in second inflationary regime period from April 2013 to May 2015. The result of the impulse response function estimated from non-linear SVAR model is presented in figure 4.

Figure 4 represents the impulse response function of different variables in regime 2. From the above figures we can see, inflation shows a declining trend in response to shocks of NEER and an increasing trend to oil price, but it shows a cyclical trend in response to the shocks in the interest rate. Inflation does not react much to shocks in output. Interest rate significantly responds to only shocks from oil price and NEER but in opposite directions. It shows a declining pattern in responding to NEER and an increasing pattern in responding to oil price. NEER profoundly respond to shocks from oil price and output. For the initial two periods it declines in response to interest rate, but after that, it shows a sharply increasing trend. While in responding to oil price it shows a sharply increasing trend in initial periods than after the second period it starts falling. Oil price shows a cyclical pattern in responding to shocks in NEER and interest rate but in the opposite direction. Output also shows a cyclical pattern in responding to shocks in oil price, interest rate, and NEER but in the case for oil price and interest rate it shows a similar reaction, and in response to NEER, it moves just opposite as to oil price and interest rate.

Table 4 shows the variance decomposition of all variables in regime two up to 16 periods. Any shock to oil price immediately affects inflation. Oil price accounts for 27% variation of fluctuation in inflation in initial periods then it decreases to 16%. Any shock from NEER and interest rate negligibly affects inflation in initial periods, and later on, it increases. Initially interest rate explains 7 % of the variation in fluctuation of inflation, and then it rises to 38%, while in the case of NEER it was 0.7%, and later on, it rises to 15%. In the case of output, variation in fluctuations are mostly affected by shocks to the interest rate. Initially it explains 77% of changes in output, and later on, it explains 56% of variations. Initially, NEER presents 11% of variations in output and slowly it increases to 35%. A variation of interest rate is mostly explained by its own shock. Interest rate and NEER explain changes in NEER and oil price. NEER is also affected by oil price, in initial periods it explains 29% of the variation, slowly it decreases to 15%. Interest rate explains around 30% of fluctuations of oil price and NEER explains 66% of fluctuation. Interest rate explains around 43% of the variation in NEER in initial periods and then it increases to 71%, while NEER explains 26% of fluctuations and then it decreases to 11%.

Figure 4: Impulse Response Function derived from nonlinear SVAR model for Regime 2 (April 2013 to May 2015)

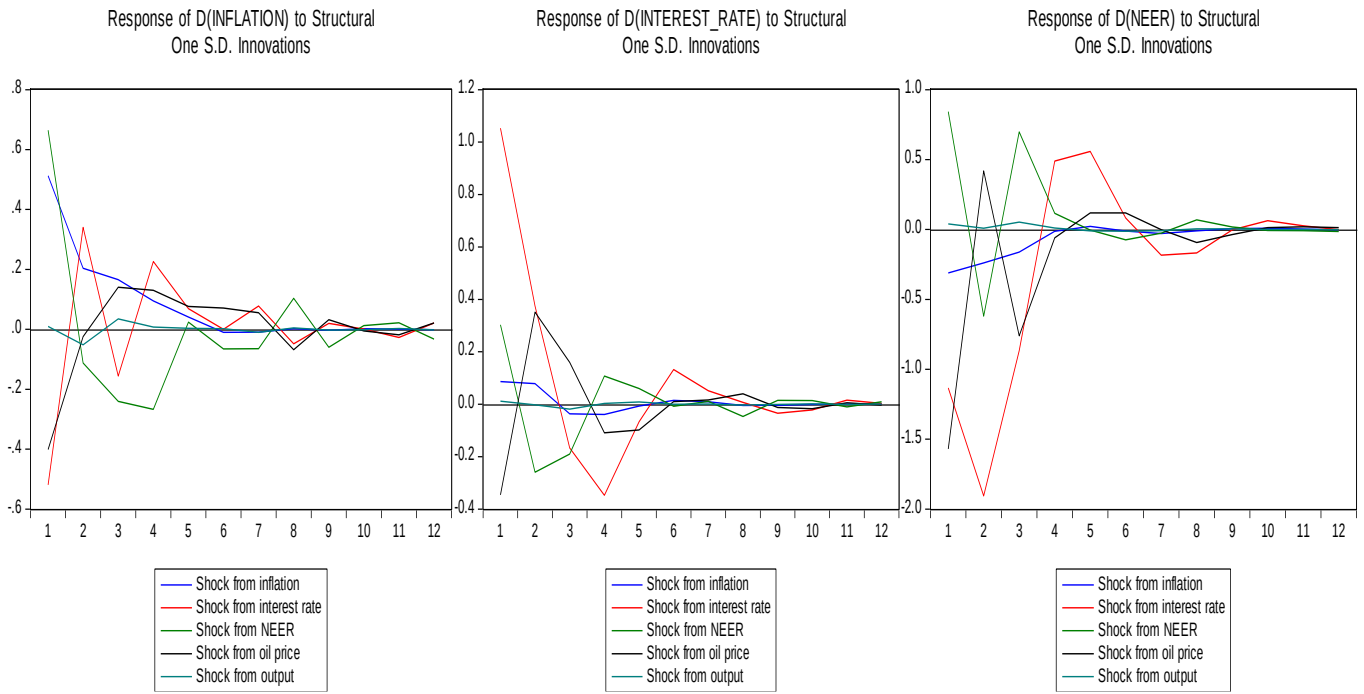


Figure 4: (Continue)

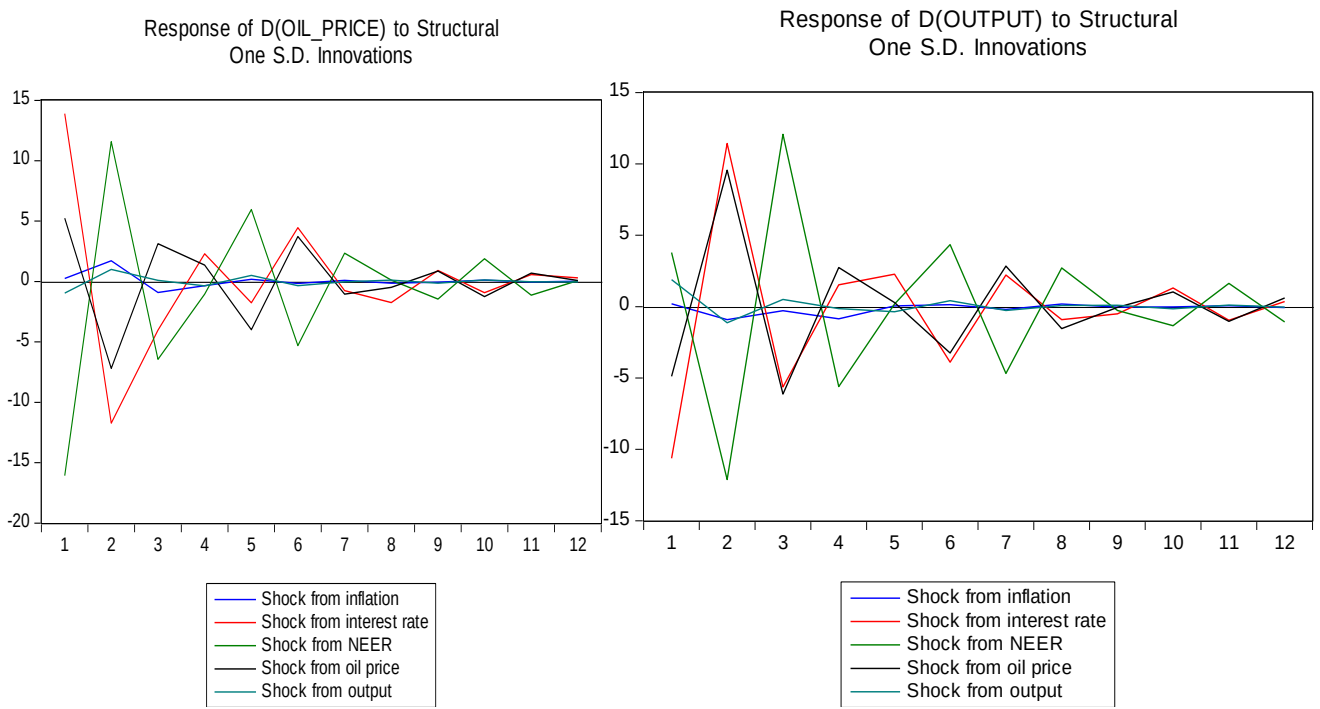


Table 4: Variance Decomposition (April 13 to May 15)

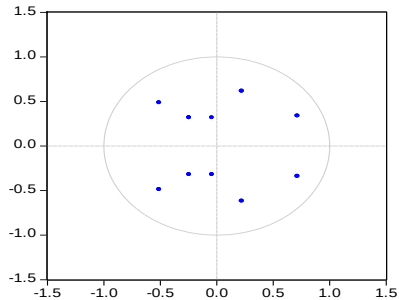
Variance decomposition of inflation					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	63.32564	7.840951	0.714578	27.86324	0.255591
4	33.80503	31.39167	16.49833	18.12288	0.182088
8	29.46178	38.07454	15.22885	17.04198	0.192856
12	29.55313	38.14510	15.14058	16.96961	0.191575
16	29.47937	38.30076	15.09777	16.93045	0.191655
48	29.47924	38.30697	15.09328	16.92886	0.191646
Variance decomposition of interest rate					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	0.092718	95.71590	0.380834	3.810244	0.000305
4	0.559518	90.45314	2.659867	6.323354	0.004121
8	0.554863	90.33392	2.711626	6.395382	0.004210
12	0.555569	90.33777	2.711274	6.391172	0.004215
16	0.555597	90.33741	2.711572	6.391203	0.004216
48	0.555603	90.33737	2.711601	6.391210	0.004216
Variance decomposition of NEER					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	1.461690	43.00632	26.36654	29.16041	0.005041
4	0.945780	71.09696	11.99350	15.95707	0.006684
8	0.949996	71.80797	11.69042	15.54438	0.007231
12	0.958270	71.86139	11.66346	15.50961	0.007272
16	0.958785	71.86142	11.66331	15.50920	0.007290
48	0.959032	71.86166	11.66308	15.50894	0.007291
Variance decomposition of oil price					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	0.146478	31.49453	66.62358	1.630841	0.104566
4	1.510092	30.22667	66.64638	1.496351	0.120502
8	1.601208	30.14635	66.61950	1.508713	0.124233
12	1.619130	30.11827	66.60988	1.528304	0.124413
16	1.621193	30.11909	66.60660	1.528717	0.124409
48	1.621273	30.11969	66.60583	1.528790	0.124411
Variance decomposition of output					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
1	10.00084	77.77222	11.94314	0.007912	0.275881
4	5.178336	58.07338	35.85856	0.665449	0.224273

Table 4: (Continue)

Variance decomposition of output					
Period	**Shock from inflation**	**Shock from interest rate**	**Shock from NEER**	**Shock from oil price**	**Shock from output**
8	6.243815	56.57639	35.86973	1.098564	0.211499
12	6.221039	56.72796	35.70890	1.130071	0.212029
16	6.241522	56.72978	35.67760	1.139210	0.211890
48	6.241881	56.73736	35.66904	1.139832	0.211887

Figure 4 represents the graph of AR root test conducted to know/find the stability of the nonlinear SVAR model for regime 2, and we found that no root lies outside the unit circle. So, our model satisfies the stability condition.

Figure 4: Result stability test of the SVAR model



5. Conclusion

In this study, we examine the nonlinear relationship between inflation, growth and other macroeconomic variables. By employing threshold VAR model, we get 4.77% as a threshold level of inflation for India. Earlier studies like Mohanty et al. (2011), Subbarao (2013) and RBI Annual Report, (2010-11) also find the threshold level of inflation for India around this range. Inflation below this threshold level does not have an adverse effect on growth, however, inflation above this threshold level impacts growth adversely. This threshold also works as a structural break, from which we get two different regimes of inflation, i.e. 1st regime from April 2006 to March 2013 and 2nd regime from April 2013 to May 2015. In the 1st regime, the output is more responsive to oil price while in the 2nd regime it is more sensitive to the interest rate. In the 1st regime, the interest rate does not have an immediate effect on output while in the 2nd regime it has a direct impact on output. Inflation responds equally to the oil price in both regimes and is more responsive to interest rate and NEER in the 2nd regime. A higher level

of inflation in the economy is the result of shocks to interest rate, oil price, and NEER and ultimately affects the economic growth.

References

Afonso, A., Baxa, J., & Slavik, M. (2011). Fiscal developments and financial stress A threshold VAR analysis (No. 1319/April 2011). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.204.6044&rep=rep1&type=pdf.

Aleem, A., & Lahiani, A. (2014). A threshold vector autoregression model of exchange rate pass-through in Mexico. Research in International Business and Finance, 30, 24–33. https://doi.org/10.1016/j.ribaf.2013.05.001.

Avdjiev, S., & Zeng, Z. (2014). Credit growth, monetary policy and economic activity in a three-regime TVAR model. Applied Economics, 46(24), 37–41. https://doi.org/10.1080/00036846.201 4.916391.

Bhanumurthy, N. R., & Alex, D. (2008). Threshold Level of inflation for India (No. Institute of Economic Growth Discussion Paper Series No. 124/2008). Retrieved from http://iegindia.org/upl oad/pdf/dis124.pdf.

Calza, A., & Sousa, J. (2005). Output and inflation responses to credit shocks are there threshold effects in the euro area? (No. 481/April 2005). Retrieved from https://www.econstor.eu/bitst ream/10419/152915/1/ecbwp0481.pdf.

Guo, F. (2013). What causes china' s high inflation? A threshold structural vector autoregression analysis. China & World Economy, 21(6), 100–120. https://doi.org/10.1111/j.1749-124X.2013.12048.x.

Ibarra, R., & Trupkin, D. (2011). The relationship between inflation and growth: a panel smooth transition regression approach for developed and developing countries (No. 006-2011). Retrieved from https://ideas.repec.org/p/mnt/wpaper/1107.html.

IMF (2012). India: 2012 article IV consultation report. Box 5: The output-inflation trade-off in India: Implications for disinflation. (IMF Country Report No. 12/96). Retrieved from https://www.imf.org/external/pubs/ft/scr/2012/cr1296.pdf.

Jayaraman, T. K., Chen, H., & Bhatt, M. (2013). Inflation and growth in Fiji: a study on threshold inflation rate. The Empirical Economics Letters, 12(2), 163–171. Retrieved from https://repository. usp.ac.fj/id/eprint/7345.

Jha, R., & Dang, T. N. (2012). Inflation variability and the relationship between inflation and growth. Macroeconomics and Finance in Emerging Market Economies, 5(1), 3–17. https://doi.org/10.1080/17520843.2011.608371.

Kannan, R., & Joshi, H. (1998). Growth-inflation trade-off: Empirical

estimation of threshold rate of inflation for India. Economic and Political Weekly, 33(42/43), 2724–2728. Retrieved from https://www.jstor.org/stable/4407296.

Mandler, M. (2010). Macroeconomic dynamics and inflation regimes in the U.S. results from threshold vector autoregressions (MPRA Paper No. 21887). Retrieved from https://mpra.ub.uni-muenchen.de/21887/.

Mohanty, D., Chakraborty, A. B., Das, A., & John, J. (2011). Inflation threshold in India: an empirical investigation (No. WPS (DEPR): 18/2011). Retrieved from https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/18WPS071011F.PDF.

Mubarik, Y. A. (2005). Inflation and growth: An estimate of the threshold level of inflation in Pakistan. SBP-Research Bulletin, 1(1), 35–44. Retrieved from https://www.sbp.org.pk/research/bulletin/2005/Article-3.pdf.

Nasir, I., & Saima, N. (2010). Investment, inflation and economic growth nexus (MPRA Paper No. 27163). Retrieved from https://mpra.ub.uni-muenchen.de/27163/.

Pattanaik, S., & Nadhanael, G. V. (2013). Why persistent high inflation impedes growth? an empirical assessment of threshold level of inflation for India. Macroeconomics and Finance in Emerging Market Economies, 6(2), 204–220. https://doi.org/10.1080/17520843.2012.735248.

Rangarajan, C. (1998) "Development, Inflation and Monetary Policy" in I. S. Ahluwalia and I M D Little (eds), India's Economic Reforms and Development (Oxford University Press: New Delhi), 48–72.

Reserve Bank of India (2001). "Report on currency and finance". Retrieved from https://www.rbi.org.in/scripts/PublicationsView.aspx?id=10892

Reserve Bank of India (2011). "Annual report 2010-11". Retrieved from https://rbi.org.in/scripts/AnnualReportPublications.aspx?Id=999.

Samantaraya, A., & Prasad, A. (2001). Growth and inflation in India: detecting the threshold level. Asian Economic Review, 43(3), 414-20.

Singh, K., & Kalirajan, K. (2003). The inflation-growth nexus in India: an empirical analysis. Journal of Policy Modeling, 25(4), 377–396. https://doi.org/10.1016/S0161-8938(03)00011-5.

Singh, P. (2010). Searching threshold inflation for India. Economics Bulletin, 30(4), 3209–3220. Retrieved from https://core.ac.uk/download/pdf/6570957.pdf.

Vasudevan, A., B. K. Bhoi, and S. C. Dhal (1998). Inflation rate and optimal growth: Is there a gateway to nirvana? In A. Vasudevan (Ed.), Fifty Years of Developmental Economics: Essays in Honour of Prof. Brahmananda, 50-67. Himalya Publishing House.

Yabu, N., & Kessy, N. J. (2015). Appropriate threshold level of inflation for economic growth: evidence from the three founding EAC countries.

Applied Economics and Finance, 2(3), 127–144. https://doi.org/10.11114/aef.v2i3.966.