

Working Paper

No. 42

Inflation Targeting in India

Altamash Aiman and Shiva Reddy

June 2017

Gokhale Institute of Politics and Economics
(Deemed University)
Pune 411 004 (India)

Inflation Targeting in India

Altamash Aiman and Shiva Reddy

Gokhale Institute of Politics and Economics
Pune 411004
Maharashtra, India

Abstract

This paper seeks to examine the effect of supply shocks on the goals of inflation targeting as a monetary policy strategy. A VAR model was employed using New Keynesian Phillips Curve (NKPC) to capture impulse responses of supply shocks on CPI inflation. The result suggests that the effect of shocks to fuel and oil on CPI is strong and but short-lived, while that of food and beverages is very strong and persistent. This could be detrimental for Inflation targeting as it would shoot up CPI inflation resulting in an increase in household inflation expectations and huge disinflationary cost to bring it down under target range. Some lessons are drawn from international experiences to tackle supply shocks in time of crisis.

JEL Classification: E31, E42, E52

Keywords: Inflation Targeting; India

I Introduction

Inflation targeting became a dominant monetary policy strategy in early 1990's in advanced economies. The policy has the short term objective of maintaining low and stable inflation as an overriding goal of central banks while accommodating for growth and employment. It provided nominal anchors to track and control inflation and led to greater macroeconomic stability in those countries. This is because inflation targeting increases communication with the public by announcing clear targets and objectives of the central bank in the short and long term. This not only increases transparency in the framework and accountability of central banks but also helps in controlling and bringing down high inflation expectations of the households and private sectors.

The formation of high inflation expectations by private sectors due to long period of sustained and high inflation is a major problem that has been facing post the global financial crisis of 2008. That led to the adoption of Inflation targeting as a new monetary policy strategy (Urjit Patel Committee Report, 2014). In February 2015, in line with advanced economies, Reserve Bank of India (RBI) adopted flexible Inflation targeting with four per cent inflation as its long term target to be achieved by 2021 and maintain the medium term to be in the bandwidth of two to six per cent. Headline consumer price index (CPI) works as a nominal anchor to control inflation that gives the weight to different items. Among others, food and fuel are given a total weight of 57.07 that represents significant part of consumer basket (See appendix 1). However,

they are highly susceptible to supply shocks in case of monsoon failure or shooting up of international crude oil price. This could drive up the inflation out of the tolerance level of inflation bandwidth for a substantial amount of time making it extremely difficult for RBI to control as it was seen in the case of 2009 food supply shock. Bernanke and Mishkin (1997) evidenced that the inflation target itself can be and typically is defined to exclude at least first round effects of some important supply shock such as changes in prices of food and energy. Central bank should be completely autonomous and independent in achieving long-run inflation target. Both of these cases are missing in the case of India as the headline CPI (Consumer Price Index) contain items that are highly susceptible to supply shock and the independence of RBI is jeopardized by introducing MPC (Monetary Policy Committee) to decide on repo rate. Though until now the committee has taken a unanimous decision on repo rates but in the time of crisis there could be a situation of deadlock and the decisions could be manipulated for vested political interests.

According to Beckworth (2014) the Inflation-targeting regimes have two major shortcomings: (i) they have difficulty in coping with large supply and demand shocks, and (ii) they do not promote financial stability and a negative supply shocks, such as a decrease in the supply of oil, would cause an increase in prices overall and lead to higher inflation. This would require an inflation-targeting central bank to tighten monetary policy. Doing so, however, would constrain economic activity, inflicting more harm on an economy already grappling with the effects of higher commodity prices. Inflation targeting can be a powerful framework, even against supply shock in addition to demand shocks.

As per the Bernanke (1997), there is another strategy to tackle supply shocks is the removal of volatile components or its second round effect from the nominal anchor. However, food and fuel constitute more than 50 per cent of consumer basket in emerging market economies. In this case, Rahul, *et. al.* (2014) suggest that second round effects (in India) are robust and persistent due to the high share of food in households' expenditure and highly persistent supply shocks. Thus, their removal from nominal anchor will blur the true picture of consumer inflation.

The power of the inflation targeting framework is that the public trust central bank. Therefore, the frame work is to maintain inflation expectations of the public even if the central bank deviates from the targeted inflation rate. The public believes that central bank will go back in the medium-run to the target inflation rate so that they regard this partial accommodation will be temporary. Therefore, inflation expectations do not change and have time to adjust real economy side and thus the inflation rate will go down in the medium-run. For example, Bundesbank has been able to maintain low and stable inflation due to its high credibility. In particular, the public's confidence in the Bundesbank's commitment to low inflation has allowed it the flexibility to pursue short-term objectives, such as stabilization of output or the exchange rate, without increasing the inflation expectations of the public (Roger 2009). The inflation target doesn't have to strictly abide by the target in the time of crisis. It should be more pragmatic. When the bad supply shock comes, the central bank should allow inflation to go up slightly and moderate output loss. They should emphasize on the framework credibility and partial accommodation against adverse supply shock.

Historically, RBI commitment to control inflation has been exemplary which could foster public trust on its credibility. High dependence on monsoon for irrigation in India is the prime reason for the recurrent negative supply shocks. Government adequate response by building a robust infrastructure for irrigation, creating well-managed buffer stocks and importing food items could go a long way in curbing the effects of supply shocks and making inflation targeting a success.

The arguments presented above raises the question of suitability of Inflation targeting to the Indian economy that is being hit by recurrent negative supply shocks. This paper analyzes this situation by tracing out the effects of supply shocks on CPI inflation by employing New Keynesian Phillips Curve (NKPC) framework which can be augmented by introducing proxies for supply shocks in the model (Singh 2012 and Woodford 2001) and employs VAR model to find out the impulse response of CPI inflation to the supply shocks. The results suggest that the effect of supply shock on inflation persists for around eight quarters that could be detrimental to inflation targeting that can lead to loss of credibility of RBI, capital flight, and substantial loss of output. The remaining of the paper is structured as follows: Section II deals with methodology and data. Section III provides results and discussion. Section IV concludes.

II Methodology and Data

The New Keynesian Phillips Curve (NKPC) framework is written as follows

$$\Pi_t = \alpha (Y_t - Y_p) + \beta E(\pi_{t+1}) + \varepsilon_t \quad \dots(1)$$

To accommodate for supply shocks which an economy typically experiences over the period, the above equation can be modified to (Woodford, 2003)

$$\Pi_t = \alpha (Y_t - Y_p) + \beta E(\pi_{t+1}) + U_t + \varepsilon_t \quad \dots(2)$$

Where

Π_t = Inflation rate at time t

Y_t = Output at time t

Y_p = Potential Output

$E(\pi_{t+1})$ = Inflation expectation

U_t = Proxy for supply shocks at time t

ε_t = Normally distributed error term

Inflation is defined as a year-on-year percentage in Consumer Price Index-Industrial Worker (CPI-IW) with the base 2001-2002=100. The sole reason for choosing CPI-IW as a proxy for CPI is that its weights to volatile items like food and beverages and fuel and light is closest to that of CPI combined¹. Therefore, it justifies its use as a proxy for CPI combined. The output gap is measured as the difference between the Index of Industrial production (IIP) and its Hodrick-Prescott trend. Following, Srinivasan et al (2006), two proxies for supply shocks have been considered: (i) The year-on-year percentage change in the CPI-IW index for food group relative to the

¹ For instance, food and beverage has weightage of 46.19 per cent and fuel and light has 6.43 per cent weightage in CPI-Industrial Worker which are closest to that of CPI combined with food and beverage 47.58 per cent and fuel and light 9.49 per cent.

respective price index; and (ii) The year-on-year percentage change in the CPI-IW for fuel and light relative to the respective price index. Vector Auto Regression (VAR) model is employed to estimate the above model. Monthly data from 2001:1 to 2015:12 has been used for the analysis. CPI (IW) data has been taken from Ministry of Labour. Food and Fuel inflation has been obtained from Database of Indian economy, RBI. Data on IIP is taken from Ministry of Finance.

The aim of this paper is to trace out the effects of supply shocks on the consumer price index, their intensity and time persistence which will determine the feasibility with which RBI can bring down the inflation in its target zone of two-six per cent by using the policy rate (repo rate). Therefore, impulse response functions have been estimated from the VAR model. An impulse-response function describes movement of the variable of interest along a specified time horizon after a shock in a given moment.²

III Results and Discussion

VAR model was specifically chosen to model inflation as it is possible to trace the effects of shocks on inflation through impulse responses derived from it. The VAR model was statistically validated by checking for stationarity, stability, and the lag length. To determine number of lags for the VAR model, various information criterion was estimated and the results are reported in Table 1. Thirteen lags for each variable is included in the model as suggested by most of the information criterion. All the variables were checked for stationarity using Augmented Dickey-Fuller (ADF) test and were found to be non-stationary of integrated process of order one i.e. I (1) except for output gap which was found to be stationary in level form. Therefore, we checked the first difference of the variables CPI, Shock Food, and Shock Energy and

² Consider a stationary AR[1] process

$$x_t = \phi x_{t-1} + u_t$$

where x_t is a scalar, $\phi < 1$ and u_t is a (scalar) random disturbance with mean 0. In MA terms the AR process can be written as

$$x_t = u_t + \phi u_{t-1} + \phi^2 u_{t-2} + \phi^3 u_{t-3} + \dots$$

Suppose now that x_t , instead of being a scalar is a column vector with dimensions $n \times 1$, i.e., we have now a VAR(1) instead of an AR(1). We are, however, interested in the evolution of x_t after a structural shock, rather than after an innovation in u_t . If we think of u_t as reduced-form innovations that are mixed combination of some structural shocks ϵ_t , we can assume the following relationship: $u_t = B\epsilon_t$ where B is a $n \times n$ matrix and ϵ_t is a column vector ($n \times 1$) containing the n structural shock (the relationship between this B matrix and the A_0 matrix that we see in the problem sets is $B = A^{-1}0$).

We can then write the above moving average representation as

$$x_t = B\epsilon_t + \phi B\epsilon_{t-1} + \phi^2 B\epsilon_{t-2} + \phi^3 B\epsilon_{t-3} + \dots$$

$$x_t = C_0\epsilon_t + C_1\epsilon_{t-1} + C_2\epsilon_{t-2} + C_3\epsilon_{t-3} + \dots \quad (1)$$

The coefficients of the moving average representation (which is defined as $C_i = B\phi^i$) are the responses of variables contained in x to impulses in these structural shocks. The response of x_t to a shock for different time periods are computed as follows

What is the response of variables in x in period t to a shock in time t ? 1 (contemporaneous impact): $\partial x_t / \partial \epsilon_t = B$

What is the response of variables in x in period $t + 1$ to a shock in time t ? If we forward Equation 1 one period, we obtain: $\partial x_{t+1} / \partial \epsilon_t = \phi B$

What is the response of variables in x in period $t + j$ to a shock in time t ? Following the same procedure: $\partial x_{t+j} / \partial \epsilon_t = \phi^j B$

An impulse-response function will be a plot of $\partial x_{t+j} / \partial \epsilon_t$ for all $j = 0, \dots, H$ (where H is the time horizon of our plot). This function will depict the response of variables x_{t+j} for all j after a shock at time t (Alloza 2017).

found them stationary. For stationarity, the modulus of all the roots of the characteristic equation (framed under VAR) should be less than one. All the roots should lie inside the unit circle of unit radius with its Centre at the origin. The variables are found to be stationary at the levels with all the unit roots lying under unit circle and they are reported in Figure 1.

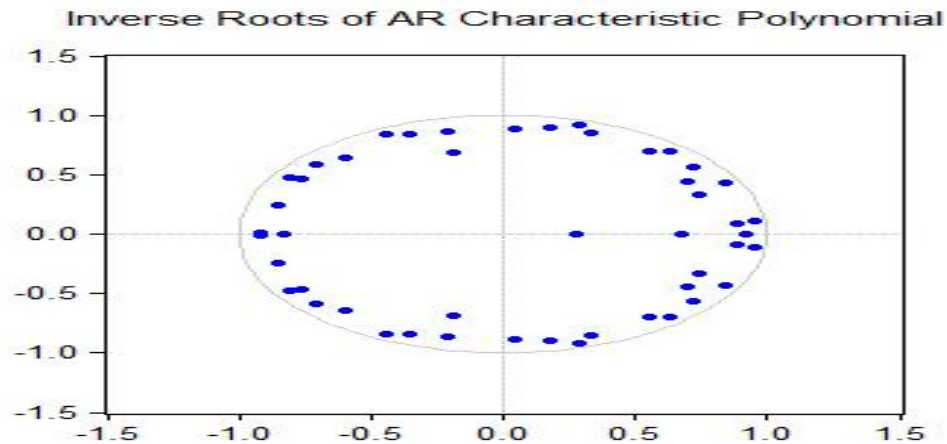
Table 1: Tests for Lag Selection

Lag	logL	LR	FPE	AIC	SC	HQ
1	-1832.906	784.59	1519.931	18.67	19.070*	18.837*
2	-14727.52	23.96	1586.282	18.72	19.426	19.007
3	-1414.81	32.01	1558.034	18.70	19.722	19.11
4	-1397.336	21.73	1639.373	18.75	20.085	19.29
5	-1385.13	12.24	1845.080	18.86	20.514	19.53
6	-1378.044	17.39	1993.316	18.93	20.901	1973
7	-1367.671	18.28	2133.151	18.99	21.270	19.92
8	-1356.424	19.94	2246.032	19.04	21.633	20.09
9	-1343.753	19.15	2373.532	19.08	21.990	20.26
10	-1331.171	10.35	2701.927	19.20	22.420	20.509
11	-1324.131	38.92	2372.205	19.05	22.580	20.489
12	-1296.709	31.76	2206.847	18.96	22.800	20.524
13	-1273.488	66.74*	1445.939*	18.51*	22.670	20.204

Notes: * indicates lag suggested by the respective criterion. LogL= Loglikelihood, LR; sequentially modified LR test statistic (each at five per cent level), FPE= Final prediction Error; AIC=Akaike Information Criterion; SC=Schwartz Criterion; HQ= Hannan Quinn Information criterion.

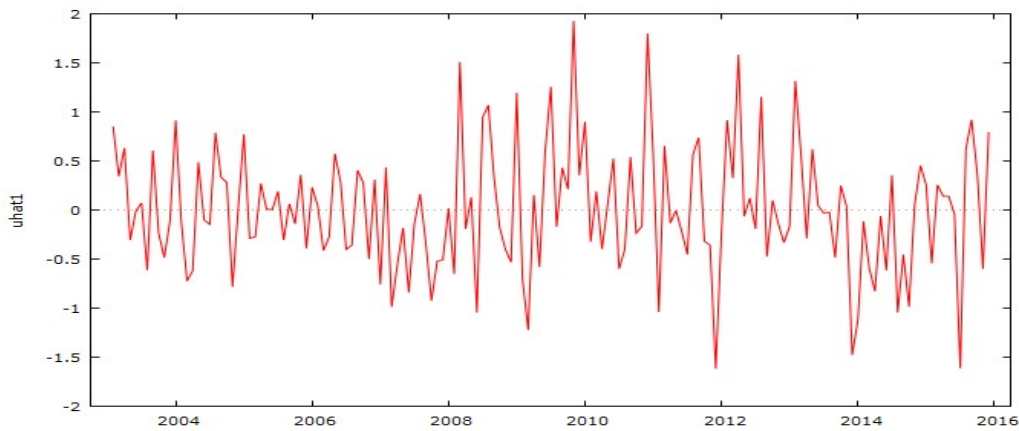
This could be an indication that the variables are co-integrated, under which Vector Error Correction Model (VECM) would be better suited. However, the necessary condition for variables to be co-integrated is that all of them should be an integrated process of order one. In present case, the variable, output gap is stationary and is an integrated process of order zero. Therefore, we adopted a VAR frame work for the analysis.

Figure 1



Further, we checked if the model is correctly specified by checking whether the error terms are white noise process. The process is said to be white noise if $E(U_t) = 0$ and $Cov(U_t, U_{t-k}) = 0$. The mean of the residuals is zero as evident from the graph given below (Figure 2).

Figure 2:



Further, auto correlations among residuals have been checked by using LM test. The results are given in Table 2. The result clearly indicates that there is a problem of autocorrelation at lag one and twelfth at five per cent level of significance, justifying the choice of selecting thirteen lags from the results of different information criterion and why the usual twelve lags were not chosen for the monthly data. After thirteen lags the problem of autocorrelation vanishes and the null hypothesis of no autocorrelation could not be rejected at any number of lags after thirteen at five per cent level of significance.

Table 2: VAR Residual Serial Correlation Test (LM test)

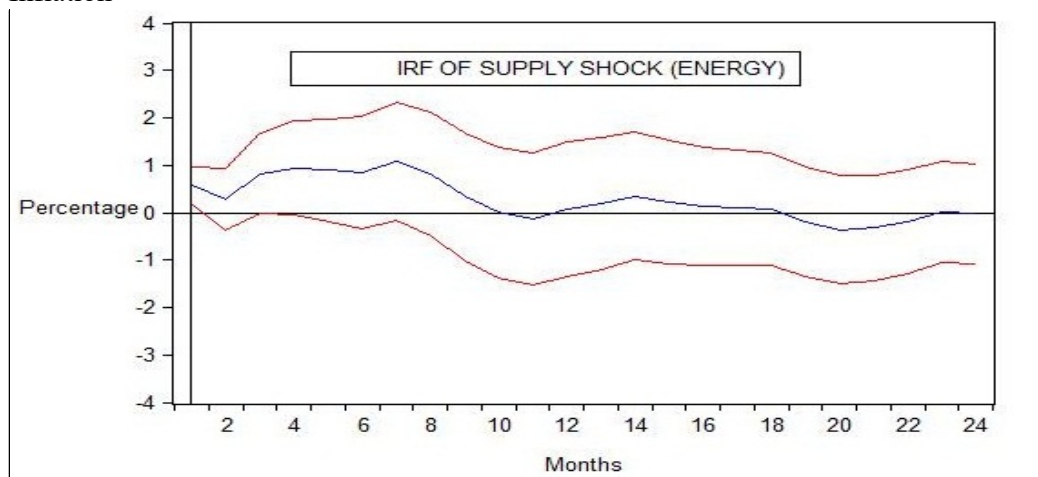
Lags	LM- Stat	Prob
1	54.46	0
2	35.88	0.0030
3	32.51	0.0086
4	16.74	0.4029
5	38.14	0.0014
6	25.47	0.0620
7	10.34	0.8484
8	27.55	0.0358
9	14.84	0.5361
10	14.92	0.5300
11	17.84	0.3332
12	33.39	0.0066
13	19.86	0.2263
14	24.98	0.0703
15	16.02	0.4517
16	19.29	0.2535
17	20.21	0.2110
18	19.16	0.2605
19	21.17	0.1721
20	14.46	0.5645
21	18.36	0.3034
22	24.27	0.0838
23	6.54	0.9762
24	25.24	0.0657
25	15.69	0.4750

To summarize, the diagnostic results show that all the roots of the characteristic equation lie under the unit circle and the residuals are white noise, i.e., their mean is zero and there is no autocorrelation. Thus, the VAR model constructed is stable and stationary and the impulse responses obtained from the model are reliable.

Since the main aim of this paper is to show the effect of shocks on inflation, we report only impulse responses from the VAR model. Figure 3 reports the result of Impulse Response Function (IRF) for the Effect of Fuel and Oil Supply Shock on CPI inflation. The results obtained from the effect of supply shock (fuel) on CPI inflation are consistent to that of UPCR (Urjit Patel Committee Report). One per cent (100 basis points) supply shock of fuel effects CPI inflation by 30 basis points that increase up to 50 basis points in the seventh month and its effects die down in twelve months and after that, the effect hovers around almost at zero per cent. The result obtained is consistent with many contemporaneous studies on Indian economy that suggest that effect of fuel supply shock though strong is not persistent. This could be explained by the fact that fuel and oil is an extremely important commodity for household hence any shock to fuel and oil through variation in global prices is bound to have its immediate effect on CPI inflation.

However, the weight given to fuel and oil in Consumer price index (IW) basket is 7.49 per cent. Thus, its effect transpired to CPI inflation doesn't lead to huge fluctuation, therefore, the effect is not time persistent and fades down after four quarters. Fuel shock inflation isn't found to be detrimental to inflation targeting and its effect on CPI inflation is temporary and could be controlled through strict monetary tightening by increasing repo rate.

Figure 3: Impulse Response Function for Effect of Fuel and Oil Supply Shock on CPI Inflation



Food and beverages constitute a substantial amount of CPI combined basket almost 48 per cent. Therefore, any shock to food basket will have a deep impact on CPI inflation. Figure 4 reports the result of Impulse Response Function (IRF) for Effect of Food supply shock on CPI (IW) inflation. The time period of our analysis, 2002-2015, contains a negative supply shock of 2009 due to monsoon failure and its effect is amply visible from the impulse response function. On average, a one per cent food

supply shock effect the CPI inflation by 50 basis points, though the initial immediate impact was 80 basis points but over the year the effect comes down to 50 basis points. The effect of food supply shock on CPI sustained for around eight quarters that is consistent with Urjit Patel's report. The effect is very robust and persistent and could bring a sustained increase in CPI inflation as evident from Figure 5. Before 2009 drought food and CPI inflation were almost at the same level moving in tandem with one another. As soon as the negative supply shock hit the economy prices of food commodities tossed up double digits, particularly pulses, reaching as high as 21.29 per cent in December 2009 and along with it CPI (IW) increased from five to six per cent to as high as 15 per cent by the end of December 2009.

Figure 4: Impulse Response Function -Effect of Food supply shock on CPI (IW) inflation

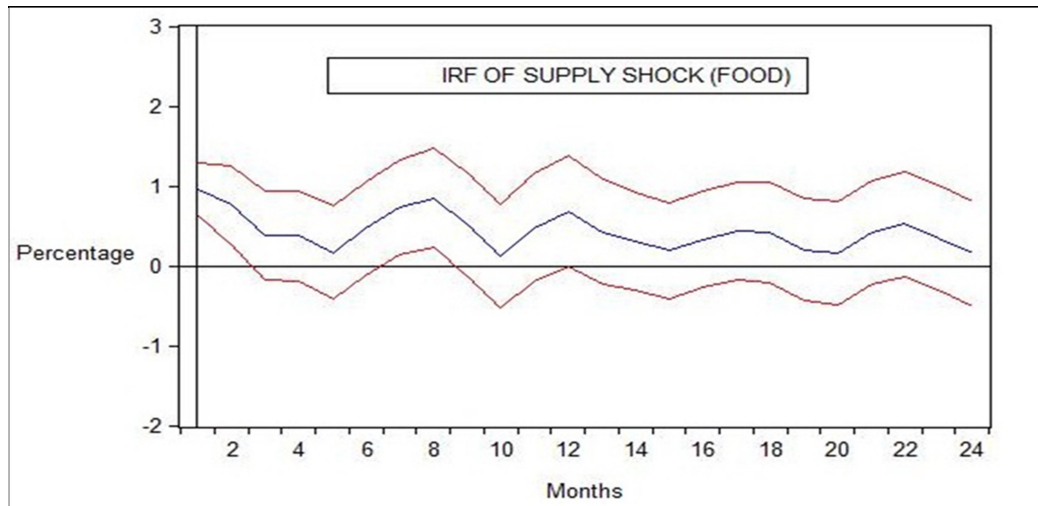


Figure 5: CPI (IW) Inflation and Food Inflation

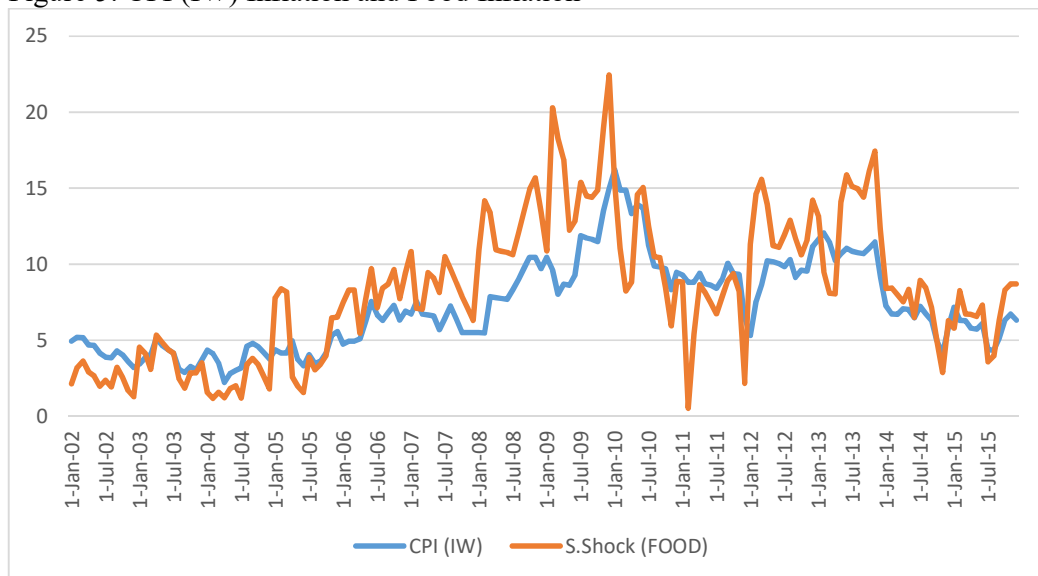
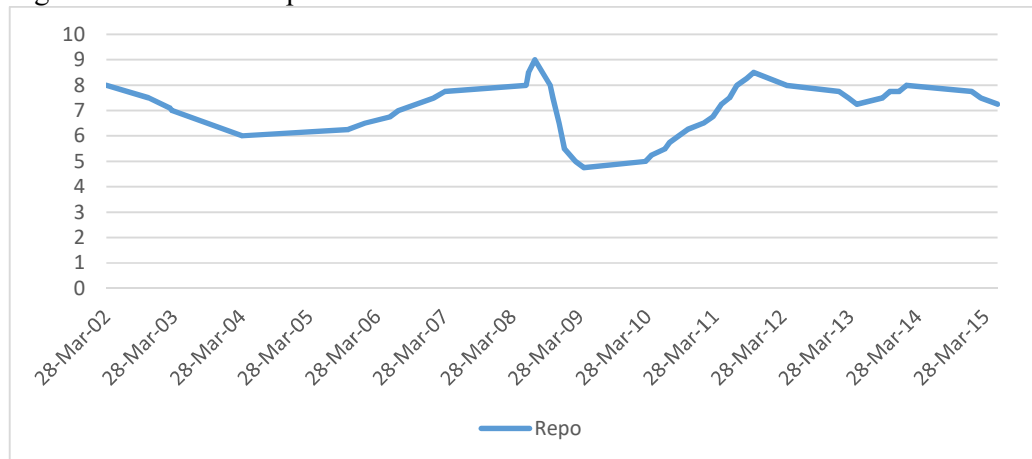


Figure 6 plots the historical repo rate from 2002 to 2015. Unfortunately, the year 2008 marked the period when the global economy started melting and there was a huge capital outflow from emerging economies. RBI started open market operations by

buying dollars and injected liquidity in the economy which can be seen from a sustained decline in repo rate right from the start of 2008 (March) to 2009 (March). After which there was a continuous increase in repo rate to tackle the negative supply shock of 2009. Strict Monetary tightening didn't succeed in containing inflation as the CPI inflation continued its upward rally to 2010, while food inflation average around 10% from FY 2008-2009 to 2012 that had huge disinflationary cost in loss of output and investment.

Figure 6: Historical Repo Rate of RBI



IV Conclusion

The paper examines the effect of supply shocks on the goals of inflation targeting in India by employing VAR model under NKPC framework. Results from the analysis suggest that recurrent negative supply shocks due to monsoon failure could be detrimental for inflation targeting. Supply shocks to food may shoot up the inflation out of target range of two-six per cent resulting increase in inflation expectations of households and disinflationary cost in bringing down inflation that results in loss of output. The most recent food supply shock of 2009 showed that monetary tightening by increasing repo rate was inadequate in controlling inflation.

Strategies like the removal of volatile items or its second round effect from the consumer basket cannot work in emerging markets as it forms a substantial part of consumer basket and the second-round effects are robust in the Indian scenario. Thus, inflation could be brought under control by taking a more pragmatic approach in the time of supply shocks, like allowing inflation to be out of target for some period and concentrate on achieving medium-run target while moderating output loss. But, the most important step in making inflation targeting a success is the fiscal action, investment in irrigation infrastructure and adequate responses like importing food commodities and buffer stocks seem to be the ways of making inflation targeting a success in the long-run.

Appendix 1: Weights in Consumer Price Index

S.N	Item	Weight (%)
1	Food and beverage	47.58
2	Pan, tobacco, and intoxicants	2.19
3	Fuel and light	9.49
4	Housing	9.77
5	Clothing, bedding, and footwear	4.73
6	Miscellaneous	26.31

References

- Alloza, M. (2017), A Very Short Note on Computing Impulse Response Functions, University College, London, http://www.ucl.ac.uk/~uctp041/Teaching_files/Tutorial_IRF.pdf
- Beckworth, D. (2014), *Inflation Targeting: A Monetary Policy Whose Time has Come and Gone*, Working Paper, Mercatus Research Centre, George Mason university. <https://www.mercatus.org/system/files/Beckworth-Inflation-Targeting.pdf>
- Bernake, B.S and F.S. Mishkin (1997), Inflation Targeting: A New Framework for Monetary Policy?. *The Journal of Economic Perspectives*, 11(2): 97-116.
- Chand, R. (2010), Understanding Food inflation in India. EPW, 45(09): 10-13, <http://www.indiaenvironmentportal.org.in/files/food%20inflation.pdf>
- Rahul, A., D. Ding and T. Volodymyr (2014), *Food Inflation in India: The Role for Monetary Policy*, IMF Working Papers 14/178, International Monetary Fund, <https://www.imf.org/external/pubs/ft/wp/2014/wp14178.pdf>
- Reserve Bank of India (2014), *Urjit Patel Committee Report (2014)*.
- Roger S. (2009), Inflation Targeting at 20 - Achievements and Challenges. IMF Working Papers 09/236, International Monetary Fund, <https://www.imf.org/external/pubs/ft/wp/2009/wp09236.pdf>
- Sengupta, A. and R. Bhattacharya (2015), Food Inflation in India: Causes and Consequences, working paper, NIPFP, <http://www.nipfp.org.in/publications/one-pagers/food-inflation-india-causes-and-consequences/>
- Singh, B.K. (2012), *An Assessment of Inflation Modelling in India*, Working Paper, ICRIER, New Delhi.
- Srinivasan, N., M. Vidya and M. Ramachandran (2006), Modelling Inflation in India: A Critique of the Structuralist Approach, *Journal of Quantitative Economics*, 4(2): 45-58.
- Woodford, M. (2001), The Taylor Rule and Optimal Monetary Policy, *American Economic Review*, 9(2): 232-237.