Are there Asymmetric Effects of Monetary Policy in India?

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Reserve Bank of India

December 2013

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Abstract

The paper attempts to analyse asymmetric effects of monetary policy in India using quarterly data from 1996-97Q1 to 2011-12Q4. It finds that an unanticipated hike and an unanticipated cut in policy rate have a symmetric impact of on real GDP growth, but differentially impact the components of real aggregate demand. While the impact on real investment is symmetric, it is asymmetric on real private and government consumption in that while an unanticipated cut in policy rate leads to their increase, an unanticipated hike in policy rate has no impact on them. The impact on inflation is also symmetric. An anticipated policy rate change also has a negative impact on real GDP growth as well as on the components of real aggregate demand, except for real government consumption. However, there are ranges where anticipated policy rate changes become neutral to components of aggregate demand and, thus, on inflation, ranging from 6.25 per cent to 7.0 per cent.

JEL Classification: C32, C51, E31, E52

Key Words: Monetary Policy, Asymmetry, Inflation, Policy Rate

Introduction

In recent times, a number of studies have analysed different aspects of the monetary policy transmission in India (for example, Al-Mashat, 2003; Singh and Kalirajan, 2008; Aleem, 2010; Bhaumik *et al*, 2010; Patra and Kapur, 2010; Pandit and Vashisht, 2011; Mohanty, 2012; Khundrakpam and Jain, 2012; Kapur and Behera, 2012; and Khundrakpam, 2013). The broad consensus emerging in these efforts is that monetary policy in India works with a lag of about 2-3 three quarters on output and about 3-4 quarters on inflation, with the impact persisting for 8 to 12 quarters. Among the channels of transmission, interest rate is indicated to be the strongest channel. The underlying assumption in all of them is of symmetric impact of monetary policy and, therefore, no differentiation is made between positive and negative monetary policy changes. Further, no distinction has been made between an anticipated and an unanticipated monetary policy changes.

Economic theories have, however, emphasised that monetary policy could have asymmetric impact on the economy. For the more recent period, there are at least two main strands of theories explaining the asymmetric impact of monetary policy. First is the credit-rationing hypothesis wherein agents in credit markets face credit constraints due to information asymmetry. This credit constraint becomes more binding during recessionary phase than expansionary phase of business cycle. Thus, policy actions will be more effective when implemented in recessionary situations, as increase in cost of capital and tighter liquidity conditions will lead to decline in investment demand (Gertler, 1988; Bernanke and Gertler, 1989). The other theory is founded on asymmetry in price flexibility in terms of downward stickiness. Due to this downward inflexibility of prices, fall in aggregate demand due to a contractionary monetary policy leads to only reduction in real output. In contrast, rise in aggregate demand due to expansionary monetary policy moderates the increase in real output due to accompanying price rise. Thus, a contractionary monetary policy has a stronger impact on real output than an expansionary monetary policy (Tsiddon, 1993; Ball and Mankiw, 1994).

Empirically, several studies have examined the asymmetric impact of monetary policy on output and inflation in different countries. Many of them support the view that a contractionary monetary policy is more effective than an expansionary monetary policy, which include Cover (1993), Morgan (1993) and Thoma (1994) for the US and Karras (1996a and 1996b) for the European economies. However, some studies have contested the above findings arguing that asymmetric effects of money supply on real output is largely influenced by inflation regimes (Rhee and Rich, 1995 and Shen, 2000). Some studies even argue that the above hypothesis either does not hold or the opposite in fact holds. Rhee (1995) finds that in Korea there is little empirical support on inflation responding more to positive monetary shocks than negative shocks. And in the case of Australia, Bodman (2006) provide the opposite evidence that while an unanticipated expansionary monetary policy raises GDP growth rate significantly, an unanticipated monetary policy tightening appear to have no effect.

The asymmetric effect discussed above, however, pertains to unanticipated monetary policy, as it is based on the premise that only an unanticipated monetary policy has an impact on the real economy. However, there are others who argue that an anticipated monetary policy can also affect the real economy (for example, Boschen and Grossman, 1981; and Mishkin, 1982). While an anticipated monetary policy can affect real economy, the question is whether there exist some threshold level which separates between its effectiveness and ineffectiveness? In the case of Australia, considering the average policy rate over the sample period as the threshold level, Bodman (2006) found that while lower interest rate than the average contributes to output growth, higher than the average interest rate has no impact.

In the case of India, barring a recent one, there is hardly any study analysing the asymmetric impact of either an unanticipated or an anticipated monetary policy on the economy. Even this study, which employs a non-linear VAR, analysed the asymmetric impact of unanticipated change in money supply, and not interest rate, though in the post-LAF period, interest rate became the main signalling instrument of monetary policy. It finds that expansionary money supply shocks have a bigger effect on output than contractionary money supply shocks, but the asymmetric effect last only for few quarters. On the other hand, negative shocks have a much greater and persistent impact on inflation than positive shocks (Aye and Gupta, 2012).

In the above backdrop, this paper attempts to provide answers to the following questions in the Indian context:

i) Does an unanticipated change in the policy rate impacts real GDP and inflation, and is the impact the same on various components of aggregate demand? If so, is the impact asymmetric between an unanticipated hike and cut in the policy rate?

ii) Does an anticipated change in policy rate also impact real GDP, inflation and various components of aggregate demand? If so, is there some threshold level distinguishing its effectiveness and ineffectiveness?

The rest of the paper is organised as follows. Section II briefly describes the methodology. The empirical estimates and their interpretations are contained in section III. Concluding remarks are offered in the final section.

II. Methodology

We draw on the literature, but with necessary adaptation, to analyse i) the impact of an unanticipated change in the policy rate and its asymmetric effect, and ii) impact of an anticipated change in policy rate and its threshold level on real GDP growth, components of aggregate demand and inflation in India.

a. Impact of an Unanticipated Change in Policy Rate and its Effect

The method adopted is similar to the two step OLS approach as in Cover (1992), Morgan (1993), Ravn and Sola (2004) and Florio (2005). First, we define an unanticipated change in policy rate by the residuals of an estimate defining the interest rate setting process. Second, the residuals are included in the estimate of models for output, components of aggregate demand and inflation to assess the impact of an unanticipated change in policy rate. Third, to analyse the asymmetric impact, the residuals are segregated into negative and positive components representing negative and positive unanticipated change in policy rate, respectively, and are included in the estimate of models for output, components of aggregate demand and inflation.

In Cover (1992), money supply was considered to analyse the asymmetric impact of monetary policy on output. Morgan (1993) modified the money supply process by an interest rate setting process, which was subsequently employed by several others (e.g., Florio, 2005; MacDonald et al, 2011). The argument was that it was more appropriate to consider interest rate as the monetary policy instrument rather than money supply for most advanced economies. Studies covering EMEs such as Korea, however, use money supply as the monetary policy instrument, but analysed its asymmetric impact on inflation rather than output (e.g., Rhee, 1995).

We consider interest rate as the main monetary policy instrument, as monetary targeting in India was given up by the late 1990s, and use of interest rate as the monetary policy instrument was increasingly emphasised since the implementation of LAF in the beginning of 2000s. The impact of an unanticipated change in policy rate is analysed on both real output growth and inflation, and extend the analysis further to various components of aggregate demand.

The interest rate process is defined as,

$$r_t = \alpha_0 + \sum_{i-1}^{n} \alpha 1_i r_{t-i} + \sum_{i-0}^{p} \alpha 2_i \pi_{t-i} + res_t \qquad (1)$$

In other words, interest rate (r_t) is a function of its own lags and lags of inflation (π_t). In (1), 'res_t' represents the unanticipated change in policy rate, which can be segregated into positive and negative components, as *pos = max [res, 0]* and *neg = min [res, 0]*, respectively.

To analyse the overall impact of unanticipated change in policy rate, the lags 'res_t' are included among the factors explaining real GDP growth, components of aggregate demand and inflation. For analysing asymmetric impact, the lags of *'pos'* and *'neg'* are considered separately in the same set of equations. For overall impact of an unanticipated change in policy rate, real GDP growth (y_t) is expressed as a function its own lags, inflation (π_t), government deficit (FD) and the lags of 'res_t' as,

$$y_t = \gamma_0 + \sum_{i-1}^{n} \gamma 1_i y_{t-i} + \sum_{i-0}^{m} \gamma 2_i \pi_{t-i} + \sum_{i-0}^{p} \gamma 3 FD_i + \sum_{i-0}^{s} \gamma 4_i res_{t-i} + \epsilon_t \qquad (2)$$

As regards the impact of positive and negative interest rate shocks, it is defined as,

$$y_t = \gamma_0 + \sum_{i-1}^{n} \gamma 1_i y_{t-i} + \sum_{i-0}^{m} \gamma 2_i \pi_{t-i} + \sum_{i-0}^{p} \gamma 3 FD_i + \sum_{i-0}^{s} \gamma 4_i pos_{t-i} + \sum_{i-0}^{q} \gamma 5_i neg_{t-i} + \epsilon_t \qquad (3)$$

The sum of the coefficients of 'pos' and 'neg' viz., $\sum_{i-0}^{s} \gamma 4_i$ and $\sum_{i-0}^{q} \gamma 5_i$, are the respective impact of an unanticipated negative and positive change in policy rate. The asymmetry in the impact between an unanticipated negative and positive change in policy rate is confirmed by a Wald test that the sum of the coefficients is not equal i.e., $\sum_{i-0}^{s} \gamma 4_i \neq \sum_{i-0}^{q} \gamma 5_i \neq 0$.

To analyse the similar impact on components of real aggregate demand, 'y_t' in (2) and (3) is replaced by the respective components of real aggregate demand, viz., real investment (I_t), real private consumption (PC_t) and real government consumption (GC_t). However, FD was excluded, while for GC inflation was also excluded, as they were found to be statistically insignificant.[1]

A similar exercise was carried out for inflation by defining inflation 'π_t' i) as a function of its own lags, lags of GDP gap '$OGAP_{t-i}$' and lags of 'res_t' for the overall impact and ii) own lags, lags of GDP gap '$OGAP_{t-i}$' and lags of *'pos'* and *'neg'* for asymmetric impact, respectively, *as*,

$$\pi_t = \delta_0 + \sum_{i-1}^{n} \delta 1_i \pi_{t-i} + \sum_{i-0}^{p} \delta 2_i res_{t-i} + \sum_{i-0}^{q} \delta 3_i OGAP_{t-i} + \epsilon_t \quad (4)$$

$$\pi_t = \delta_0 + \sum_{i-1}^{n} \delta 1_i \pi_{t-i} + \sum_{i-0}^{p} \delta 2_i pos_{t-i} + \sum_{i-0}^{q} \delta 3_i neg_{t-i} + \sum_{i=1}^{s} \delta 4_i OGAP_{t-i} + \epsilon_t \quad (5)$$

b. Impact of Anticipated Change in Policy Rate and its Threshold Level

An anticipated change in policy rate is defined by the fitted values in (1), as they are components that are predictable through the defined policy rate function. Thus, to examine the corresponding impact of an anticipated change in policy rate, this fitted component, instead of *'res'*, is included in equation (2) and (4), and its respective variants representing each components of aggregate demand. These estimates are the average impact of an anticipated change in policy rate which, however, could vary substantially at different levels.

Thus, to examine the existence of any differential impact of an anticipated change in policy rate at different levels, the anticipated changes in policy rate are categorised into two viz., higher than and lower than relative to a threshold level as,

$high = r_t$ *if* $r_t >$ *threshold*
0 *otherwise*

$low = r_t$ *if* $r_t <$ *threshold*
0 *otherwise*

The high and low policy rates are obtained for various assumed threshold levels. We start from a threshold level of 5.0% and raise it by 25 basis points each time till 8.0%, as there are few observations outside this range. The high and low policy rate series so defined are then included in (3) and (5), and their variants for components of aggregate demand. We primarily focus on the behaviour of the sign and the statistical significance of the coefficient of the series representing high policy rate as the threshold level rises. This follows, since the estimated average impact also represents the

[1] Inclusion of these variables, however, did not make any significant difference to the results.

coefficient of high policy rate relative to a threshold level which is lower than all the observed data. Thus, as we raise the threshold level, the number of observations representing high policy rate decreases, while that of low policy rate increases that the impact could differ substantially from the average impact.

III. Data and Results

All the relevant quarterly data for the period 1996-97Q1 to 2011-12Q4 were culled from Real Time Handbook of Statistics on Indian Economy, RBI. Weighted average call rate was used as a proxy for policy interest rate. All the relevant variables, except for call rate, were seasonally adjusted, and found to be stationary by ADF and PP tests.[2]

a. Impact of an Unanticipated change in Policy Rate and its Effect

The estimate for policy rate process is as in the following.

$$Call_t = \underset{(1.23)}{0.71} + \underset{(10.1)}{0.80}\, Call_{(-1)} + \underset{(3.20)}{0.462}\, \pi_{(-1)} + \underset{(7.90)}{8.97}\, D98Q1 - \underset{(-5.47)}{7.42}\, D98Q2 + res_t$$

R-bar Square = 0.74 D.W. = 1.89

In the above estimate, only one lag of the relevant variables were considered, as statistically insignificant lags were progressively dropped from the starting maximum of four lags. Two dummies were included to remove an extreme positive and an extreme negative outlier in call rate in 1998Q1 and 1998Q2, respectively. As defined above, the respective unanticipated positive and negative changes in policy rate were then obtained from the residuals of this estimate.

The number of lags of the dependent variables in their respective estimates was decided by the statistical significance, with the maximum starting lag length of four, being quarterly data. As for the number of lags of an unanticipated change in policy rate, we considered three models using four, six and eight lags. This not only serves as robustness test, but also enables to indirectly observe in some sense on how long the transmission of monetary policy shocks remains effective. For example, if the sum of the coefficients is statistically significant for four and six lags but not for eight lags, one may interpret it as transmission effectively working only up to six quarters[3]. In the following, the summary of the results along with their analysis are presented, while the detail results are at Annex 1 to 15.

Impact on Real GDP Growth

An unanticipated change in policy rate has a statistically significant cumulative negative impact on real GDP growth. This is true for both unanticipated positive and negative change in policy rate i.e., while an unanticipated hike in policy rate dampens real GDP growth, an unanticipated cut in

[2] The results of the unit root tests have not been reported to conserve space.
[3] In this regard, a common observation made by most of the recent studies on monetary transmission based on VAR models in India is that a shock to policy rate on GDP growth and inflation last for about 8 to 10 quarters.

policy rate enhances real GDP growth. The two impact are also of statistically equal magnitude i.e., there is a symmetric impact (Table 1).[4]

Table 1: Impact of an Unanticipated Change in Policy Rate on Real GDP Growth

Variables	n=4	n=6	n=8
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-0.29***	**-0.36***	**-0.42***
	[0.00]	**[0.00]**	**[0.00]**
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	**-0.31***	**-0.38***	**-0.35****
	[0.01]	**[0.01]**	**[0.06]**
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	**-0.40***	**-0.37****	**-0.54****
	[0.01]	**[0.07]**	**[0.06]**
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$=$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	0.28	0.00	0.27
	[0.60]	[0.96]	[0.60]

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Impact on Real Investment Growth

An unanticipated change in policy rate also has a significant cumulative negative impact on real investment growth. And both unanticipated positive and negative change in policy rate has this negative impact of statistically equivalent magnitude. In other words, an unanticipated hike in policy rate leads to decline in real investment growth, while an unanticipated cut in interest rate induces an equivalent real investment growth. However, the impact last longer for an unanticipated hike than that of an unanticipated cut in policy rate, as in the case of the latter, statistical significant diminishes substantially by the eight quarter (Table 2).[5]

Table 2: Impact of an Unanticipated Change in Policy Rate on Real Investment Growth

Variables	n=4	n=6	n=8
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-2.61***	**-2.54***	**-2.84***
	[0.00]	**[0.00]**	**[0.00]**
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	**-3.00***	**-4.42***	**-4.42***
	[0.00]	**[0.00]**	**[0.00]**
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	**-3.37***	**-2.67***	**-1.95****
	[0.00]	**[0.01]**	**[0.08]**
$\sum_{i=1}^{n} \mathrm{pos}_{t-i}$=$\sum_{i=1}^{n} neg_{t-i}$	0.15	1.59	2.12
	[0.70]	[0.21]	[0.15]

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Impact on Real Private Consumption Growth

With regard to the overall impact of an unanticipated change in policy rate on real private consumption growth, the cumulative negative impact is statistically significant only with a lag of six quarters, and that too only for a negative shock (or an unanticipated cut in policy rate), indicating an asymmetric impact (Table 3). However, the estimates fail to pass the basic statistical diagnostic tests (Annex Table 5 and 6). Therefore, while a definitive conclusion may not be drawn, the inference

[4] The detail estimates presented in Annex Table 1 and 2 pass all the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

[5] The detail estimates presented in Annex Table 3 and 4 show that they pass all the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

would be that an unanticipated cut in policy rate induces real private consumption growth with a lag of about six quarters, but an unanticipated hike in policy rate has no impact on real private consumption growth.

Table 3: Impact of an Unanticipated Policy Shocks on Real Private Consumption Growth

Variables	n=4	n=6	n=8
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	-0.19	**-0.49***	-0.22
	[0.35]	**[0.02]**	[0.17]
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	-0.23	-0.14	-0.02
	[0.37]	[0.55]	[0.94]
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	-0.40	**-1.10***	**-0.45****
	[0.28]	**[0.00]**	**[0.10]**
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$=$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	0.14	**4.74***	1.26
	[0.71]	**[0.03]**	[0.26]

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Impact on Real Government Consumption Growth

An unanticipated change in policy rate, on an average, has no impact on real government consumption growth. However, when we segregate the impact between positive and negative change in policy rate, it is seen that while the former has no impact the latter has significant cumulative negative impact after six quarters, indicating asymmetric impact (Table 4).[6] It implies that while unanticipated cut in policy rate enhances real government consumption growth after about six quarters after the cut, a similar hike in policy rate has no significant impact.

Table 4: Impact of an Unanticipated Change in Policy Rate on Real Government Consumption Growth

Variables	n=4	n=6	n=8
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	-0.41	-0.04	0.19
	[0.60]	[0.97]	[0.84]
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	0.33	1.59	1.88
	[0.76]	[0.144]	[0.21]
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	-1.66	**-3.42***	-1.06
	[0.27]	**[0.03]**	[0.61]
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$=$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	1.04	**5.81***	1.05

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Impact on Inflation

As with real GDP growth, an unanticipated change in policy rate has a significant cumulative negative impact on inflation. The impact gets stronger as the number of lags increase from four to eight, indicating that the impact last more than eight quarters. The cumulative negative impact on inflation is true for both the unanticipated positive and negative change in policy rate. In other words, an unanticipated hike in policy rate lowers inflation, while an unanticipated cut in policy rate raises inflation of similar magnitude, indicating symmetric response. However, while inflation reducing

[6] The detail estimates presented in Annex Table 7 and 8 show that they pass all the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

impact of an unanticipated hike in policy rate last less than eight quarters, inflation inducing impact of unanticipated cut in policy rate last for more than eight quarters (Table 5).[7]

Table 5: Impact of an Unanticipated Change in Policy Rate on Inflation

Variables	n=4	n=6	n=8
$\sum_{i=1}^{n} res_{t-i}$	**-0.29***	**-0.46***	**-0.60**
	[0.02]	**[0.00]**	**[0.00]**
$\sum_{i=1}^{n} pos_{t-i}$	**-0.29***	**-0.43***	-0.44
	[0.05]	**[0.02]**	[0.14]
$\sum_{i=1}^{n} neg_{t-i}$	**-0.56***	**-0.60***	**-0.80***
	[0.01]	**[0.02]**	**[0.01]**
$\sum_{i=1}^{n} pos_{t-i}$=$\sum_{i=1}^{n} neg_{t-i}$	1.22	0.38	0.55
	[0.27]	[0.54]	[0.46]

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

b. Impact of an Anticipated Change in Policy Rate and its Threshold Level

An anticipated change in policy rate also has a significant cumulative negative impact on real GDP growth lasting for more than eight quarters.[8] It also has a similar cumulative negative impact lasting more than eight quarters on real investment growth.[9] An anticipated change in policy rate has a cumulative negative impact on private consumption growth only after six quarters,[10] but has no significant impact on real government consumption growth.[11] As regards inflation, an anticipated change in policy rate has a significant negative cumulative impact on inflation lasting more than eight quarters as in the case of real GDP and investment growth (Table 19).

Table 6: Impact of an Anticipated Change in Policy Rate

Variables	n=4	n=6	n=8
Real GDP Growth	**-0.25***	**-0.37***	**-0.47***
	[0.00]	**[0.00]**	**[0.00]**
Real Investment Growth	**-2.19***	**-2.87***	**-3.47***
	[0.00]	**[0.00]**	**[0.00]**
Real Private Consumption	-0.26	-0.13	**-0.33***
	[0.15]	[0.49]	**[0.04]**
Real Government Consumption	-0.34	-0.19	-0.65
	[0.65]	[0.82]	[0.46]
Inflation	**-0.44***	**-0.48***	**-0.50***
	[0.00]	**[0.00]**	**[0.00]**

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

[7] The detail estimates presented in Annex Table 9 and 10 show that they pass all the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

[8] The detail estimates presented in Annex Table 11 show that they pass all the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

[9] The detail estimates presented in Annex Table 12 show that they pass all the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

[10] The detail estimates presented in Annex Table 13 show that only the model with eight lag pass the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

[11] The detail estimates presented in Annex Table 14 show that they pass all the basic diagnostic tests of normality, serial correlation and heteroskedasticity.

As for the threshold level of anticipated change in policy rate, it is seen that policy rate change between 6.25 to 7.0 per cent has no statistically insignificant negative impact on real GDP growth. Outside this range, higher policy rate than the threshold has a statistically significant negative impact. In other words, anticipated policy rate could be neutral to real GDP growth in the range of 6.25 to 7.0 per cent. In the case of real investment growth, this range where anticipated policy rate is neutral narrows down considerably to about 6.5 per cent with the increase in the number of lags to eight. With regard to real private consumption growth, anticipated policy rate is neutral at any level up to six quarters, but by the eight quarter after the change, it is neutral only in the range of 6.0 to 7.0 per cent. Unlike other components of aggregate demand, anticipated policy rate is neutral to real government consumption at any level and for any number of lags. As regards inflation, the range where anticipated policy rate is neutral is much narrower irrespective of the number of lags, and similar to that of real investment growth at about 6.5%.

Table 7: Threshold Levels of Anticipated Change in Policy Rate

Rate	Real GDP			Real Investment			Real Private Consumption			Real Government Consumption			Inflation		
	n=4	n=6	n=8	n=4	n=6	n=8	n=4	n=6	n=8	n=4	n=6	n=8	n=4	n=6	n=8
8.00%	**-0.26*** **(0.01)**	**-0.36*** **(0.00)**	**-0.41*** **(0.02)**	**-2.54** **(0.00)**	**-3.15** **(0.00)**	**-3.95** **(0.00)**	-0.30 (0.15)	-0.12 (0.60)	**-0.40*** **(0.04)**	-0.41 (0.64)	0.26 (0.79)	-0.52 (0.66)	**-0.41*** **(0.00)**	**-0.42*** **(0.01)**	**-0.42*** **(0.01)**
7.75%	**-0.24*** **(0.02)**	**-0.35*** **(0.01)**	**-0.42*** **(0.03)**	**-2.51*** **(0.00)**	**-3.07*** **(0.00)**	**-3.91*** **(0.00)**	-0.16 (0.46)	0.17 (0.47)	**-0.4**** **(0.08)**	0.15 (0.87)	0.69 (0.50)	0.53 (0.72)	**-0.40*** **(0.01)**	**-0.39*** **(0.02)**	**-0.4**** **(0.07)**
7.50%	**-0.27*** **(0.03)**	**-0.40*** **(0.00)**	**-0.43*** **(0.01)**	**-1.61*** **(0.06)**	**-2.27*** **(0.01)**	**-3.29*** **(0.00)**	-0.21 (0.38)	0.03 (0.91)	**-0.4*** **(0.07)**	-0.34 (0.75)	-0.02 (0.99)	-1.82 (0.24)	**-0.46*** **(0.00)**	**-0.43*** **(0.02)**	**-0.4**** **(0.09)**
7.25%	**-0.27** **(0.12)**	**-0.39*** **(0.00)**	**-0.50*** **(0.00)**	**-1.5**** **(0.07)**	**-2.24** **(0.01)**	**-3.17*** **(0.00)**	-0.18 (0.46)	-0.03 (0.90)	**-0.4**** **(0.06)**	-0.56 (0.62)	-0.71 (0.58)	-2.84 (0.16)	**-0.50*** **(0.00)**	**-0.48*** **(0.01)**	**-0.4**** **(0.06)**
7.00%	-0.21 (0.12)	-0.25 (0.13)	-0.28 (0.15)	-1.00 (0.26)	-1.33 (0.19)	**-2.50*** **(0.02)**	-0.46 (0.12)	-0.01 (0.98)	-0.25 (0.33)	-1.61 (0.19)	-0.80 (0.57)	-2.11 (0.22)	**-0.54*** **(0.00)**	**-0.60*** **(0.01)**	**-0.49*** **(0.05)**
6.75%	-0.12 (0.43)	-0.16 (0.41)	-0.18 (0.42)	-0.72 (0.46)	-0.88 (0.42)	**-2.16*** **(0.06)**	-0.33 (0.35)	0.31 (0.39)	-0.12 (0.70)	-1.63 (0.25)	-0.59 (0.72)	-1.92 (0.34)	**-0.52*** **(0.01)**	**-0.67*** **(0.01)**	**-0.5**** **(0.06)**
6.50%	0.16 (0.39)	-0.03 (0.91)	0.06 (0.87)	-0.40 (0.75)	-0.35 (0.83)	-1.72 (0.37)	-0.38 (0.37)	0.41 (0.46)	-0.30 (0.56)	-1.63 (0.34)	-1.50 (0.53)	-4.15 (0.12)	-0.22 (0.36)	-0.43 (0.25)	-0.70 (0.13)
6.25%	0.09 (0.59)	-0.15 (0.55)	-0.19 (0.55)	-1.89 (0.13)	-2.45 (0.14)	**-3.84*** **(0.02)**	-0.44 (0.29)	0.40 (0.44)	-0.46 (0.33)	0.00 (0.99)	-0.43 (0.86)	-2.69 (0.34)	-0.28 (0.18)	**-0.5**** **(0.10)**	**-0.89*** **(0.02)**
6.00%	-0.20 (0.20)	**-0.42*** **(0.03)**	**-0.62*** **(0.02)**	**-2.15*** **(0.04)**	**-2.98*** **(0.01)**	**-4.00*** **(0.00)**	-0.49 (0.17)	0.06 (0.87)	-0.40 (0.25)	0.55 (0.71)	0.41 (0.81)	-0.27 (0.90)	**-0.45*** **(0.02)**	**-0.63*** **(0.01)**	**-0.98*** **(0.00)**
5.75%	**-0.27*** **(0.06)**	**-0.49*** **(0.00)**	**-0.69*** **(0.00)**	**-1.85*** **(0.04)**	**-3.03*** **(0.01)**	**-3.98*** **(0.00)**	-0.41 (0.19)	-0.02 (0.94)	**-0.4**** **(0.08)**	1.46 (0.26)	0.83 (0.56)	0.76 (0.64)	**-0.45*** **(0.01)**	**-0.57*** **(0.01)**	**-0.71*** **(0.01)**
5.50%	**-0.24*** **(0.06)**	**-0.42*** **(0.00)**	**-0.59*** **(0.00)**	**-2.64*** **(0.00)**	**-3.63*** **(0.00)**	**-3.81*** **(0.00)**	-0.32 (0.27)	-0.10 (0.75)	**-0.4**** **(0.08)**	0.25 (0.83)	0.47 (0.73)	0.59 (0.66)	**-0.34*** **(0.06)**	**-0.4**** **(0.08)**	**-0.4**** **(0.10)**
5.25%	**-0.28*** **(0.01)**	**-0.40*** **(0.00)**	**-0.62*** **(0.00)**	**-2.51*** **(0.00)**	**-3.08*** **(0.00)**	**-3.97*** **(0.00)**	-0.24 (0.31)	-0.16 (0.52)	**-0.41*** **(0.04)**	0.16 (0.87)	0.19 (0.86)	0.42 (0.71)	**-0.43*** **(0.00)**	**-0.46*** **(0.01)**	**-0.41*** **(0.03)**
5.00%	**-0.28*** **(0.00)**	**-0.38*** **(0.00)**	**-0.51*** **(0.00)**	**-2.48*** **(0.00)**	**-3.09*** **(0..00)**	**-3.49*** **(0.00)**	-0.25 (0.22)	-0.22 (0.32)	**-0.37*** **(0.02)**	-0.36 (0.67)	-0.04 (0.96)	-0.40 (0.69)	**-0.49*** **(0.00)**	**-0.43*** **(0.00)**	**-0.46*** **(0.01)**

* and ** denote significance at 5% and 10% level, respectively; Figures in parentheses are p-values of chi-square tests.

Conclusion

Several studies have analysed monetary policy transmission in India and have shown its effectiveness through the operation of most of the traditional channels. However, these studies have

either implicitly or explicitly assumed symmetric impact of tight and easy monetary policy. Economic theories, however, emphasise that tight and easy monetary policy could have an asymmetric impact on the economy. Unlike for several other countries, there is hardly any study analysing this aspect of asymmetric transmission of monetary policy particularly that of interest rate, for India. Further, the analysis on monetary policy transmission has been confined to an unanticipated change in monetary policy, though in the literature there are arguments supporting effectiveness of an anticipated change in monetary policy as well. Thus, the paper was an attempt to fill this gap using quarterly data from 1996-97Q1 to 2011-12Q4.

The paper finds that an unanticipated hike and an unanticipated cut in policy rate have a symmetric impact on real GDP growth lasting for more than eight quarters. However, they have a differential impact on various components of real aggregate demand. On real investment growth, though the impact is symmetric, real investment growth reducing impact of an unanticipated policy rate hike is more persistent than that of real investment growth enhancing impact of an unanticipated policy rate cut. In contrast, while an unanticipated hike in policy rate has no impact on the growth of real private consumption and real government consumption, an unanticipated cut in policy rate increases their growth after four quarters, but last no more than eight quarters.

Unanticipated hike/cut in policy rate has a symmetric impact of reducing/increasing inflation. However, inflation reducing impact of unanticipated policy rate hike is less persistent - last less than eight quarters - as compared to inflation inducing impact of unanticipated cut in policy rate – last more than eight quarters.

Anticipated policy rate hike also has a negative impact on real GDP growth as well as on the components of real aggregate demand, except for real government consumption. But, while the impact on real private consumption growth is felt only after six quarters, on real investment growth and real GDP growth it is felt within four quarters. However, at certain levels, anticipated policy rate is found to be ineffective or neutral. This neutral level ranges between 6.25 to 7.0 per cent for real GDP growth and real private consumption growth, but is much narrower at about 6.5 per cent for real investment growth and inflation.

A policy inference that can be drawn, particularly from the perspective of an emerging economy striving for higher economic growth, is that while policy rate shocks could effectively control aggregate demand, and therefore, inflation in the short-run, that the effect works primarily through growth in investment may have implications on real output growth beyond the short-run. Weak response of real private consumption growth to policy rate could be due to cash intensive nature of consumption. In that case, money supply could still be a relevant monetary policy instrument.

References:

Aleem, Abdul (2010), "Transmission Mechanism of Monetary Policy in India", Journal of Asian Economics, 21, 186-197.

Al-Mashat, R. (2003), "Monetary Policy Transmission in India: Selected Issues and Statistical Appendix, Country Report, No. 03/261, International Monetary Fund.

Aye Goodness C. And Rangan Gupta (2012), "Are the Effects of Monetary Policy Asymmetric in India? Evidence from a Nonlinear Vector Autoregression Approach", Working Paper 2012-02, Department of Economics, University of Pretoria, January.

Ball, L. and N.G. Mankiw (1994), "Asymmetric Price Adjustment and Economic Fluctuations", Economic Journal, 104, pp. 247-261.

Bernanke, B.S. and M. Gertler (1989), "Agency Costs, Net Worth, and Business Cycle Fluctuations", American Economic Review, 82, pp. 901-921.

Bhaumik, S. K., Vinh Dang and Ali M. Kutan (2010), "Implications of bank ownership for the credit channel of monetary policy transmission: evidence from India", *William Davidson Institute Working Paper Number 988*, University of Michigan.

Bodman Philip M. (2006), "Are the Effects of Monetary Policy Asymmetric in Australia?," School of Economics, The University of Queensland, Discussion Paper No. 4.

Boschen, J. F. and H. I. Grossman (1981), "Tests of Equilibrium Macroeconomics with Contemporaneous Monetary Data", Working Paper No. 558R, National Bureau of Economic Research.

Cover James Perry (1992), "Asymmetric Effects of Positive and Negative Money-Supply Shocks", Quarterly Journal of Economics, Volume 107, No.4, pp.1261-1282.

Florio, Anna (2005), "Asymmetric Monetary Policy: Empirical Evidence for Italy," Applied Economics, Taylor and Francis Journals, Vol. 37(7), pages 751-764.

Gertler, M. (1988), "Financial Structure and Aggregate Economic Activity: An Overview", NBER Working Paper No. 2559, National Bureau of Economic Research, Cambridge, MA.

Kapur Muneesh and Harendra Behera (2012), "Monetary Transmission Mechanism in India: A Quarterly Model", *RBI Working Paper No. WPS (DEPR): 9/ 2012.*

Karras, G. (1996a), "Are the Output Effects of Monetary Policy Asymmetric? Evidence from a Sample of European Countries", Oxford Bulletin of Economics and Statistics, 58, pp. 267-278.

Karras, G. (1996b), "Why are the Effects of Monetary-Supply Shocks Asymmetric? Convex Aggregate Supply or "Pushing on a String? ", Journal of Macroeconomics, 18, pp. 605-619.

Khundrakpam, Jeevan Kumar (2013), "Credit Channel of Monetary Policy Transmission in India - How Effective and Long is the Lag?", *The IUP Journal of Applied Economics,* Vol. XII, No.1, pp. 26-49 .

Khundrakpam, Jeevan Kumar and Rajeev Jain (2012), "Monetary Policy Transmission in India: A Peep Inside the Black Box ", *RBI Working Paper No. WPS (DEPR): 11/ 2012.*

MacDonald Garry, Andy Mullineux and Rudra Sensarma (2011), "Asymmetric Effects of Interest Changes: The Role of the Consumption-Wealth Channel," Applied Economics, Vol. 43, No.16.

Mishkin, F. (1982), "Does Anticipated Monetary Policy Matter? An Econometric Investigation," Journal of Political Economy, 10(1).

Mohanty, D. (2012), "Evidence on Interest Rate Channel of Monetary Policy Transmission in India", Paper Presented at the Second International Research Conference at the Reserve Bank of India, February 1-2.

Morgan, D.P. (1993), "Asymmetric Effects of Monetary Policy," Federal Reserve Bank of Kansas City Economic Review, Vol 2., pp.21-33.

Pandit, B. L and Pankaj Vashisht [2011], "Monetary Policy and Credit Demand in India and Some EMEs", *ICRIER Working Paper No.256*.

Patra, Debabrata Michael and Muneesh Kapur (2010), "A Monetary Policy Model Without Money for India", *IMF Working Paper No.10/183*, International Monetary Fund.

Reserve Bank of India (2005), Report on Currency and Finance, 2003-04.

Rhee Wooheon (1995), "Asymmetric Effects of Money on Inflation: Evidence from Korean Data," International Economic Journal, Vol. 9, No. 4. pp. 31-43.

Rhee, W. And R.W. Rich (1995), "Inflation and the Asymmetric Effects of Money on Output Fluctuations", Journal of Macroeconomics, 17, pp. 683-702.

Thoma, M.A. (19994), "Subsample Instability and Asymmetries in Money-Income Causality", Journal of Econometrics, 64, pp. 279-306.

Shen, C.H. (2000), " Are the Effects of Monetary Policy Asymmetric? The Case of Taiwan", Journal of Policy Modeling, 22, pp. 197-218.

Singh, Kanhaiya and Kaliappa Kalirajan [2007], "Monetary Transmission in Post-reform India: An Evaluation", Journal of the Asia Pacific Economy, 12, 158–187.

Tsiddon, D. (1993), "The Misbehaviour of the Aggregate Price Level", Review of Economic Studies, 60, pp. 889-902.

Weise Charles L. (1999), "The Asymmetric Effects of Monetary Policy: A Non-linear Vector Autoregression Approach", Journal of Money, Credit and Banking, Vol. 31, No.1, pp.85-108.

Annex 1: Average Impact of an Unanticipated Change in Policy Rate on Real GDP Growth

Variables	n=4	n=6	n=8
Constant	0.018*	0.019*	0.019*
	(5.98)	(5.51)	(5.05)
$\sum_{i=1}^{4} y_{t-i}$	0.20	0.13	0.09
	[0.24]	[0.51]	[0.68]
$\pi_{(t)}$	-0.19*	-0.19*	-0.21*
	(-2.60)	(-2.52)	(-2.49)
FD_{t-1}	-0.005*	-0.005*	-0.005
	(-2.80)	(-2.79)	(-2.57)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-0.29***	**-0.36***	**-0.42***
	[0.00]	**[0.00]**	**[0.00]**
Jarque-Bera	0.31	0.26	0.01
	[0.86]	[0.88]	[0.99]
LM-Test	0.08	0.07	0.02
	[0.93]	[0.93]	[0.99]
BPG	0.79	0.90	0.99
	[0.65]	[0.56]	[0.49]
R-bar Square	0.52	0.52	0.49

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. A dummy variable defined as 1 for 2002Q1 and 2004Q1 and zero otherwise was included in all the three models to remove outliers.

Annex 2: Asymmetric Impact of an Unanticipated Change in Policy Rate on Real GDP Growth

Variables	n=4	n=6	n=8
Constant	0.018*	0.019*	0.019*
	(5.78)	(4.95)	(4.56)
$\sum_{i=1}^{4} y_{t-i}$	0.15	0.10	0.014
	[0.38]	[0.62]	[0.96]
$\pi_{(t)}$	-0.19*	-0.19*	-0.17**
	(-2.43)	(-2.21)	(-1.83)
FD_{t-1}	-0.004*	-0.005*	-0.005
	(-2.21)	(-2.22)	(-2.43)
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	**-0.31***	**-0.38***	**-0.35****
	[0.01]	**[0.01]**	**[0.06]**
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	**-0.40***	**-0.37****	**-0.54****
	[0.01]	**[0.07]**	**[0.06]**
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}=\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	0.28	0.00	0.27
	[0.60]	[0.96]	[0.60]
Jarque-Bera	0.12	0.39	0.24
	[0.94]	[0.82]	[0.89]
LM-Test	0.04	0.18	0.32
	[0.96]	[0.75]	[0.73]
BPG	1.15	1.28	0.87
	[0.34]	[0.25]	[0.64]
R-bar Square	0.51	0.49	0.49

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. A dummy variable defined as 1 for 2002Q1 and 2004Q1 and zero otherwise was included in all the three models to remove outliers.

Annex 3: Average Impact of an Unanticipated Change in Policy Rate on Real Investment Growth

Variables	n=4	n=6	n=8
Constant	0.04*	0.04*	0.04*
	(5.02)	(4.49)	(4.49)
I_{t-1}	-0.39*	-0.37*	-0.27*
	(-6.18)	(-3.35)	(-2.59)
$\pi_{(t)}$	-0.69	-0.68	-0.86**
	(-1.45)	(-1.39)	(-1.82)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-2.61***	**-2.54***	**-2.84***
	[0.00]	**[0.00]**	**[0.00]**
Jarque-Bera	0.32	0.38	0.44
	[0.85]	[0.83]	[0.80]
LM-Test	0.15	0.42	0.74
	[0.86]	[0.66]	[0.48]
BPG	1.04	1.01	1.12
	[0.42]	[0.45]	[0.37]
R-Bar Square	0.86	0.86	0.89

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. Two dummy variables, the first defined as 1 for 1999Q2 and Q3 and zero otherwise, and the second defined as 1 for 2007Q4 and 2010Q1 and zero otherwise, were included in all the three models to remove positive and negative outliers, respectively.

Annex 4: Asymmetric Impact of an Unanticipated Change in Policy Rate on Real Investment Growth

Variables	n=4	n=6	n=8
Constant	0.044*	0.065*	0.071*
	(5.46)	(6.43)	(6.62)
I_{t-1}	-0.45*	-0.738*	-0.782*
	(-7.39)	(-5.54)	(-5.56)
$\pi_{(t)}$	-0.947*	-1.16*	-1.06*
	(-2.43)	(-3.03)	(-2.73)
	(-4.08)	(-4.27)	(-5.07)
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	**-3.00***	**-4.42***	**-4.42***
	[0.00]	**[0.00]**	**[0.00]**
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	**-3.37***	**-2.67***	**-1.95****
	[0.00]	**[0.01]**	**[0.08]**
$\sum_{i=1}^{n} \text{pos}_{t-i}$=$\sum_{i=1}^{n} neg_{t-i}$	0.15	1.59	2.12
	[0.70]	[0.21]	[0.15]
Jarque-Bera	2.06	0.26	0.33
	[0.36]	[0.88]	[0.85]
LM-Test	0.53	1.34	2.44
	[0.59]	[0.27]	[0.10]
BPG	0.54	0.56	0.67
	[0.88]	[0.89]	[0.83]
R-bar Square	0.91	0.92	0.93

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. Two dummy variables, the first defined as 1 for 1999Q2 and Q3 and zero otherwise, and the second defined as 1 for 2007Q4 and 2010Q1 and zero otherwise, were included in all the three models to remove positive and negative outliers, respectively.

Annex 5: Average Impact of an Unanticipated Change in Policy Rate on Real Private Consumption Growth

Variables	n=4	n=6	n=8
Constant	0.02*	0.02*	0.02*
	(8.35)	(9.11)	(5.14)
PC_{t-1}	-0.42*	-0.46*	0.08
	(-3.33)	(-3.86)	(0.65)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	-0.19	**-0.49***	-0.22
	[0.35]	**[0.02]**	[0.17]
Jarque-Bera	540.0*	108.0*	1.77
	[0.00]	[0.00]	[0.41]
LM-Test	0.89	12.7*	1.42
	[0.42]	[0.00]	[0.25]
BPG	1.17	2.10**	1.46
	[0.34]	[0.06]	[0.19]
R-bar Square	0.11	0.26	0.68

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Annex 6: Asymmetric Impact of an Unanticipated Change in Policy Rate on Real Private Consumption Growth

Variables	n=4	n=6	n=8
Constant	0.021*	0.016*	0.014*
	(5.60)	(4.68)	(5.14)
PC_{t-1}	-0.40*	-0.40*	0.02
	(-3.02)	(-3.71)	(0.18]
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	-0.23	-0.14	-0.02
	[0.37]	[0.55]	[0.94]
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	-0.40	**-1.10***	**-0.45****
	[0.28]	**[0.00]**	**[0.10]**
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}=\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	0.14	**4.74***	1.26
	[0.71]	**[0.03]**	[0.26]
Jarque-Bera	594*	11.8*	3.84
	[0.00]	[0.00]	[0.15]
LM-Test	2.07	2.17	0.94
	[0.14]	[0.13]	[0.40]
BPG	0.67	0.90	0.79
	[0.73]	[0.56]	[0.69]
R-bar Square	0.12	0.45	0.80

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Annex 7: Average Impact of Unanticipated Change in Policy Rate on Real Government Consumption Growth

Variables	n=4	n=6	n=8
Constant	0.02*	0.03*	0.03*
	(2.67)	(3.00)	(2.72)
$\sum_{i=1}^{4} GC_{t-i}$	-0.44	-0.78*	-0.71**
	[0.16]	[0.03]	[0.08]
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	-0.41	-0.04	0.19
	[0.60]	[0.97]	[0.84]
Jarque-Bera	0.40	0.26	0.55
	[0.82]	[0.88]	[0.76]
LM-Test	0.59	0.40	0.04
	[0.56]	[0.67]	[0.96]
BPG	0.82	0.62	0.76
	[0.59]	[0.79]	[0.69]
R-bar Square	0.35	0.38	0.38

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Annex 8: Asymmetric Impact of an Unanticipated Change in Policy Rate on Real Government Consumption Growth

Variables	n=4	n=6	n=8
Constant	0.016	0.001	0.01
	(1.24)	(0.09)	(0.59)
$\sum_{i=1}^{4} GC_{t-i}$	-0.63**	-1.04*	-0.43
	[0.09]	[0.01]	[0.35]
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	0.33	1.59	1.88
	[0.76]	[0.144]	[0.21]
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	-1.66	**-3.42***	-1.06
	[0.27]	**[0.03]**	[0.61]
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$=$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	1.04	**5.81***	1.05
	[0.31]	**[0.02]**	[0.31]
Jarque-Bera	0.47	0.18	3.50
	[0.79]	[0.92]	[0.17]
LM-Test	0.85	0.09	0.58
	[0.43]	[0.91]	[0.57]
BPG	0.77	0.88	0.69
	[0.68]	[0.60]	[0.81]
R-bar Square	0.32	0.44	0.47

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Annex 9: Average Impact of an Unanticipated Change in Policy Rate on Inflation

Variables	n=4	n=6	n=8
Constant	0.01*	0.01*	0.01*
	(6.34)	(6.51)	(6.43)
$\sum_{i=1}^{2} \pi_{t-i}$	0.16	0.07	0.04
	[0.17]	[0.59]	[0.78]
$OGAP_{(-3)}$	0.17	0.23**	0.28*
	(1.55)	(2.00)	(2.26)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-0.29***	**-0.46***	**-0.60**
	[0.02]	**[0.00]**	**[0.00]**
Jarque-Bera	2.24	3.36	2.66
	[0.33]	[0.19]	[0.27]
LM-Test	0.11	0.23	0.11
	[0.90]	[0.80]	[0.90]
BPG	0.66	0.60	0.77
	[0.74]	[0.82]	[0.68]
R-bar Square	0.48	0.50	0.52

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. Two dummy variables, the first defined as 1 for 2000Q4 and zero otherwise, and the second defined as 1 for 2008Q4 were included in all the three models to remove positive and negative outliers, respectively.

Annex 10: Asymmetric Impact of an Unanticipated Change in Policy Rate on Inflation

Variables	n=4	n=6	n=8
Constant	0.011*	0.013*	0.011*
	(4.85)	(4.60)	(2.92)
$\sum_{i=1}^{2} \pi_{t-i}$	0.13	0.032	0.092
	[0.26]	[0.82]	[0.54]
$OGAP_{(-3)}$	0.264*	0.286*	0.265**
	(2.28)	(2.33)	(1.89)
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$	**-0.29***	**-0.43***	-0.44
	[0.05]	**[0.02]**	[0.14]
$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	**-0.56***	**-0.60***	**-0.80***
	[0.01]	**[0.02]**	**[0.01]**
$\sum_{i=1}^{n} \mathbf{pos}_{t-i}$=$\sum_{i=1}^{n} \boldsymbol{neg}_{t-i}$	1.22	0.38	0.55
	[0.27]	[0.54]	[0.46]
Jarque-Bera	2.70	3.10	2.03
	[0.26]	[0.21]	[0.36]
LM-Test	0.24	0.16	0.42
	[0.78]	[0.85]	[0.66]
BPG	0.54	0.50	0.55
	[0.89]	[0.93]	[0.92]
R-bar Square	0.51	0.49	0.49

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. Two dummy variables, the first defined as 1 for 2000Q4 and zero otherwise, and the second defined as 1 for 2008Q4 were included in all the three models to remove positive and negative outliers, respectively.

Annex 11: Average Impact of an Anticipated Change in Policy Rate on Real GDP Growth

Variables	n=4	n=6	n=8
Constant	0.04*	0.05*	0.05*
	(4.44)	(4.57)	(4.37)
$\sum_{i=1}^{4} y_{t-i}$	0.18	0.02	0.12
	[0.32]	[0.92]	[0.63]
$\pi_{(t)}$	-0.24*	-0.22*	-0.23*
	(-2.98)	(-2.74)	(-2.69)
FD_{t-1}	-0.005*	-0.006*	-0.005
	(-2.82)	(-3.09)	(-2.77)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-0.25***	**-0.37***	**-0.47***
	[0.00]	**[0.00]**	**[0.00]**
Jarque-Bera	0.17	0.49	0.52
	[0.92]	[0.78]	[0.77]
LM-Test	0.22	0.08	0.06
	[0.81]	[0.92]	[0.94]
BPG	0.22	1.39	1.24
	[0.30]	[0.20]	[0.28]
R-bar Square	0.50	0.52	0.52

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. A dummy variable defined as 1 for 2002Q1 and 2004Q1 and zero otherwise was included in all the three models to remove outliers.

Annex 12: Average Impact of an Anticipated Change in Policy Rate on Real Investment Growth

Variables	n=4	n=6	n=8
Constant	0.19*	0.24*	0.29*
	(4.57)	(5.72)	(7.22)
I_{t-1}	-0.44*	-0.58*	-0.57*
	(-5.80)	(-4.81)	(-5.26)
$\pi_{(t)}$	-1.00**	-1.17*	-1.42*
	(-1.92)	(-2.39)	(-3.27)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-2.19***	**-2.87***	**-3.47***
	[0.00]	**[0.00]**	**[0.00]**
Jarque-Bera	0.43	1.93	0.17
	[0.81]	[0.38]	[0.65]
LM-Test	1.58	1.27	1.68
	[0.22]	[0.29]	[0.20]
BPG	1.11	1.50	0.98
	[0.37]	[0.17]	[0.48]
R-Bar Square	0.84	0.87	0.90

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. Two dummy variables, i) 1 for 1999Q2 and Q3 and zero otherwise, and ii) 1 for 2007Q4 and 2010Q1 and zero otherwise, were included in all the three models to remove positive and negative outliers, respectively.

Annex 13: Average Impact of an Anticipated Change in Policy Rate on Real Private Consumption Growth

Variables	n=4	n=6	n=8
Constant	0.04*	0.03*	0.04*
	(3.16)	(2.39)	(3.42)
PC_{t-1}	-0.42*	-0.43*	-0.12
	(-3.41)	(-3.67)	(-0.83)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	-0.26	-0.13	**-0.33***
	[0.15]	[0.49]	**[0.04]**
Jarque-Bera	533.5*	42.1*	0.52
	[0.00]	[0.00]	[0.77]
LM-Test	2.15	14.2*	1.53
	[0.13]	([0.00]	[0.23]
BPG	0.41	2.85*	1.78
	[0.84]	[0.01]	[0.10]
R-bar Square	0.13	0.28	0.67

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Annex 14: Average Impact of an Anticipated Change in Policy Rate on Real Government Consumption Growth

Variables	n=4	n=6	n=8
Constant	0.05	0.04	0.07
	(0.93)	(0.75)	(1.21)
$\sum_{i=1}^{4} GC_{t-i}$	-0.45	-0.84*	-0.98*
	[0.20]	[0.02]	[0.02]
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	-0.34	-0.19	-0.65
	[0.65]	[0.82]	[0.46]
Jarque-Bera	0.85	1.56	1.25
	[0.65]	[0.46]	[0.54]
LM-Test	0.72	1.54	0.29
	[1.73]	[0.23]	[0.75]
BPG	0.49	0.55	0.65
	[0.86]	[0.84]	[0.78]
R-bar Square	0.23	0.29	0.33

Figures in round brackets indicate t-statistics while the figures in square brackets are probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively.

Annex 15: Average Impact of an Anticipated Change in Policy Rate on Inflation

Variables	n=4	n=6	n=8
Constant	0.04*	0.05*	0.05*
	(4.91)	(4.62)	(4.40)
$\sum_{i=1}^{2} \pi_{t-i}$	0.04	0.03	0.11
	[0.79]	[0.83]	[0.49]
$OGAP_{(-3)}$	0.27*	0.28*	0.35*
	(2.43)	(2.36)	(2.84)
$\sum_{i=1}^{n} \mathbf{res}_{t-i}$	**-0.44***	**-0.48***	**-0.50***
	[0.00]	**[0.00]**	**[0.00]**
Jarque-Bera	2.74	2.72	2.66
	[0.25]	[0.26]	[0.26]
LM-Test	0.19	0.06	0.40
	[0.83]	[0.94]	[0.67]
BPG	0.59	0.71	0.81
	[0.80]	[0.72]	[0.65]
R-bar Square	0.54	0.52	0.55

Figures in round brackets indicate t-statistics while the figures in square brackets probability of the respective tests. * and ** denote, significance at 5% and 10% level, respectively. Two dummy variables, the first defined as 1 for 2000Q4 and zero otherwise, and the second defined as 1 for 2008Q4 were included in all the three models to remove positive and negative outliers, respectively.