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Qualitative and Quantitative Central Bank Communications and Professional Forecasts: Evidence from India

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Abstract

We analyze the influence of qualitative and quantitative communications of the Reserve Bank of India on inflation expectations of professional forecasters, and draw out implications for the impact of policy variables on expectations. Estimating Carroll-type epidemiological models of expectation formation, we find large speed of adjustment of professional forecasters' expectations. Analysis of the determinants of inflation forecasts, inflation surprises and forecaster disagreement reveals significant influence of quantitative RBI communications in the form of inflation projections. This effect is prominent for shorter horizon forecasts and after the adoption of flexible inflation targeting regime. Macroeconomic fundamentals like lagged inflation and Repo rate too play a significant role in influencing inflation forecasts. Choice of words in the RBI monetary policy statements has more impact since October 2016, after monetary policy committee became the decision-making body.

Keywords: Inflation Expectations; Survey of Professional Forecasters; Central Bank Communications; Text Analysis.

JEL Code: E31, E52, E58

1. Introduction:

Private sector expectations influence various macroeconomic aggregates, as emphasized by most macroeconomic models. Management of private sector expectations via central bank communications and actions is important for monetary policymaking (Hubert, 2015b). Given lagged real effects central bank actions, communications provides a way to shorten transmission lags by influencing expectations. Analysis of central bank communications effects on short-term inflation expectations explains the monetary policy transmission mechanism (Hubert, 2017).

This study analyzes the effects of qualitative and quantitative Reserve Bank of India (RBI) communications on survey-based inflation expectations of professional forecasters (SPF). Analysis is conducted across two periods due to the change in frequency of the survey from quarterly to bi-monthly in March 2014. This division coincides with a change in the monetary policy regime to flexible inflation targeting (FIT) from the erstwhile multiple indicator approach (MIA).[1] RBI inflation projections capture quantitative communications while qualitative ones are estimated using text analysis techniques.

We first conduct a preliminary analysis to test the response of SPF forecasts to RBI projections by incorporating information rigidities using Carroll-type epidemiological models of expectations formation (Carroll, 2003). SPF forecasts display high adjustment speeds to news in the form of RBI projections, but with the presence of information rigidities.

We then examine the role of RBI qualitative and quantitative communications in influencing SPF inflation expectations using three variables: forecast levels, surprises in SPF inflation forecasts and disagreements across forecasters. RBI projections, oil prices and lagged inflation come out as significant drivers of levels of SPF forecasts. Oil prices, which were high and volatile before 2014, influence quarterly SPF forecasts. Lagged inflation has positive and significant effects on forecast levels for both quarterly and bi-monthly surveys. Quantitative communications drive SPF forecasts, predominantly shorter-horizon ones. Qualitative communications and monetary policy stance prove insignificant in influencing SPF forecasts.

[1] The adoption of FIT regime began after the release of Patel Committee Report (January 2014). But it was officially adopted in 2015.

Shorter-horizon SPF inflation surprises are mainly driven by RBI projection surprises. Tighter monetary policy stance reduces inflation surprises pre- and post-FIT. Lagged inflation, oil prices and qualitative communications are insignificant both pre- and post-FIT.

Analysis of forecaster disagreement conveys significant positive influence of RBI projections post-FIT. Qualitative communication fails to significantly affect forecaster disagreement in both periods. However, interaction dummy analysis for the bi-monthly surveys show significant improvement in the influence of qualitative communications on dispersions after the monetary policy committee (MPC) became the decision-making body of the RBI in October 2016, indicating gradual improvement in the choice of words in monetary policy statements. Tighter monetary policy stance increases forecaster disagreements of 1-year-ahead forecasts for quarterly surveys.

This paper is structured as follows: Section 2 provides a brief review of literature followed by the descriptive analysis of data in Section 3. Section 4 describes properties of SPF forecasts. Section 5 gives results for Carroll-type epidemiological model-based estimations. Section 6 provides methodology and empirical analysis followed by discussion in Section 7. Section 8 concludes the analysis.

2. Brief Review of Literature:

Literature examines inflation expectations formation, its properties and influence of news and communication variables for the professional forecasters. We divide our reviewed literature into two categories based on the quantitative and qualitative communications.

2.1. Quantitative Communications:

Levin et al (2004), Cerisola and Gelos (2009), Carrasco and Ferreiro (2013) and del Carmen Ramos-Herrera and Sosvilla-Rivero (2013) model the determinants of survey-based inflation expectations, with a special emphasis on inflation targeting. Levin et al discover that inflation targeting anchors inflation expectations, particularly in advanced economies. Cerisola and Gelos find inflation targeting and fiscal policy stance to be important indicators of inflation expectations in Brazil since 1999. Lagged inflation and persistence in expectations do not play a significant role. Carrasco and Ferreiro find inflation targeting, interest rates and exchange rates influence inflation expectations in Mexico. del Carmen Ramos-Herrera and Sosvilla-

Rivero observe high persistence of Spanish inflation expectations and negative effect of ECB inflation target.

Hubert (2015a, 2015b, 2015c), Kotlowski (2015), Pedersen (2015), Hattori et al (2016), Hubert (2017) and Łyziak and Paloviita (2017a, 2017b) examine the effects of central bank projections on private sector inflation forecasts. All of them discover significant signaling effects of central bank projections on private sector forecasts. Carroll (2003), Coibion and Gorodnichenko (2012, 2015) and Andrade and LeBihaan (2013) provide empirical evidence for the presence of information frictions in inflation expectations formation of private agents. Fujiwara (2005), Ehrmann et al (2012), Hubert (2014) and Ehrmann (2015) examine the effects of central bank forecasts on cross-sectional dispersions across professional forecasters. They find central bank forecasts significantly reduce forecaster disagreement.

2.2. Qualitative Communications:

Literature focuses largely on qualitative communications in the form of central bank statements, minutes or speeches (Blinder et al, 2008). Effects of these communications are observed on various macro-financial variables like interest rate, exchange rates, stock prices, bond prices, etc. Studies also focus on examining these effects on survey-based forecasts of various macroeconomic variables.

Guthrie and Wright (2000) discover changes in interest rates across all maturities because of 'open mouth operations' (central bank statements) for New Zealand. Following this analysis, Rosa and Verga (2007), Ehrmann and Fratzscher (2007), Hendry and Madeley (2010), Apel and Blix-Grimaldi (2012), Moniz and De Jong (2014), and Carvalho (2014) discover similar communication effects for interest rates. Gurkayanak et al (2005), Rosa and Verga (2007), and Oshima and Matsubayashi (2018) find significant influence of qualitative communications on financial markets. Acosta (2015), Kahveci and Odabas (2016) and Bruno (2017) analyze characteristics of central bank statements like transparency, optimism, certainty, complexity, etc. Hubert and Labondance (2018) find significant influence of qualitative communications of ECB on interest rate expectations.

Jansen and De Haan (2007), Ullrich (2008), Montes et al (2016), Hubert (2017), Galvis Ciro and Anzoategui Zapata (2019) and Arango et al (2020) discover significant effects of qualitative communications on inflation expectations. Jansen and De Haan, Ullrich, Hubert and

Arango et al use the levels of private sector inflation expectations while Montes et al, and Galvis Ciro and Anzoategui Zapata use cross sectional dispersions.

In the Indian context, Goyal and Arora (2012) analyze communication effects on exchange rate and its volatility using dummy variable-based communications. Mathur and Sengupta (2020) examine the properties of RBI monetary policy statements across various Governor regimes.

This study contributes to the scarce communications literature for developing economies: First, we analyze SPF forecasts' properties and accuracy in comparison to RBI inflation projections. Second, we estimate Carroll-type epidemiological models to assess information frictions in the SPF data using RBI projections as the news variable. Third, we analyze the effects of central bank communications on three variables measuring SPF forecasts: (i) Median forecast values (ii) Deviation of forecasts from the realized inflation (iii) Dispersions across forecasts. Qualitative communications are estimated using text analysis dictionary methods. None of the earlier studies model RBI communications using text analysis and machine learning techniques. Our analysis of the effect of qualitative and quantitative RBI communications on SPF forecasts covers this literature gap. A comparative analysis of qualitative and quantitative RBI communications gives insights for better communication strategies to manage expectations.

3. Data and Descriptive Statistics:

3.1. Survey of Professional Forecasters (SPF):

RBI conducts SPF since September 2007. Data is available since March 2008 (2008Q1) on a quarterly basis. SPF frequency was changed to bi-monthly after the release of the Patel Committee Report (RBI, 2014), o wing to the change in frequency of the RBI monetary policy meetings. The flexible inflation targeting (FIT) regime was officially adopted in February 2015. However, FIT was implemented de facto after the release of Patel Committee Report (RBI, 2014). Hence, the episodes of analysis are pre-FIT (March 2008 to December 2013) and post-FIT (March 2014 to November 2019).

RBI circulates the questionnaire across many institutions like investment banks, commercial banks, stock exchanges, international brokerage houses, select educational institutions, credit rating agencies, securities firms, asset management companies, etc. More than 25 forecasters respond every time. Unlike household surveys, only aggregate values of all the forecasters'

expectations are provided owing to the clause of anonymity. Forecasts are available for macroeconomic variables like headline and core inflation (both CPI and WPI), exchange rate, oil prices, GDP growth rate (aggregate and sector-wise: agriculture, industries and tertiary), index of industrial production (IIP) growth rate, private final consumption expenditure (PFCE) growth rate, gross fixed capital formation (GFCF) as a percentage of GDP, imports, exports, Repo rate and corporate profits.

This study focuses on inflation forecasts by the professional forecasters. Quarterly forecasts are compiled at the end of every quarter (March, June, September and December), and formulated for four subsequent quarters. These forecasts are 'fixed-horizon' forecasts. They provide possible analysis through multiple time horizons and are not contaminated by varying leads (Hubert, 2015a).

Forecasts since March 2014 are bi-monthly forecasts. They are conducted in January, March, May, July, September and November. However, forecasts are given for every quarter end. For instance, forecasts in March and May are conducted for the same four quarters: June, September and December of the same calendar year and March of the next calendar year. They are not fixed-horizon forecasts and hence run the risk of being contaminated by varying leads. Along with quarterly forecasts, SPF forecasters forecast for two succeeding financial year-ends, i.e., in July 2015 forecasters formulate expectations for March 2016 and March 2017. These are 'fixed-event' forecasts; different surveys provide forecast values for the same event (financial year-end).

A major concern here is varying forecast horizons. Following Dovern et al (2012), we approximate 1-year-ahead forecasts using weighted averages of financial year-end values and 3-month-ahead forecasts using the forecast values of two quarters. Annual forecasts are approximated as follows:

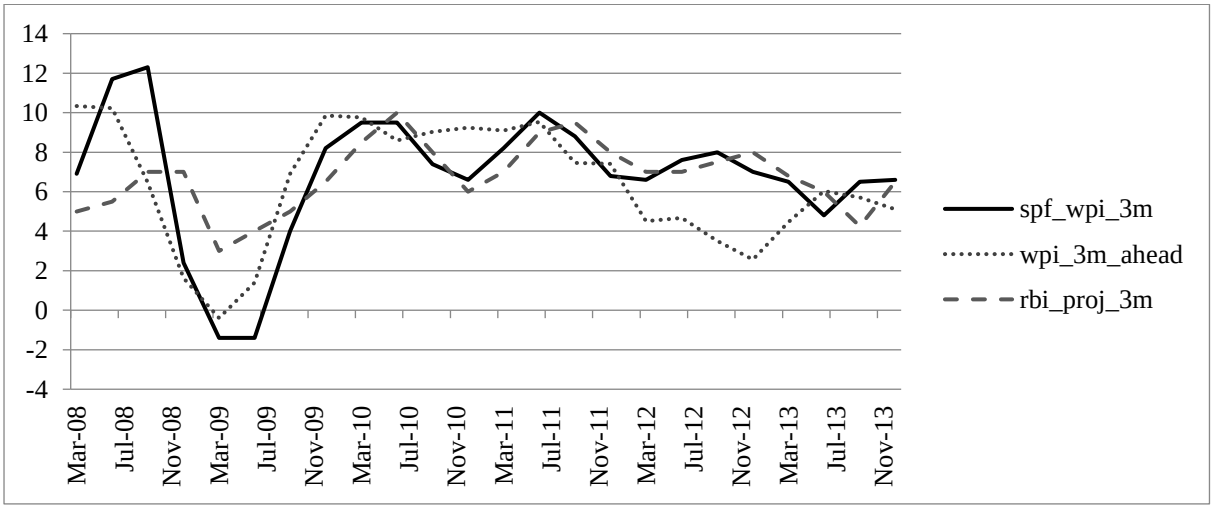
$$\tilde{\pi}_{t+12|t} = \frac{k}{12}\hat{\pi}_{t+k|t} + \frac{12-k}{12}\hat{\pi}_{t+k+12|t} \quad \text{.....(1)}$$

where $k \in \{1,3,\dots,11\}$ gives forecast horizon values at the time of survey. For example, the November 2015 1-year-ahead forecasts are approximated using the forecast values for March 2016 and March 2017 by assigning the weights of 5/12 and 7/12 to $\hat{\pi}_{Mar,2016|Nov,2015}$ and $\hat{\pi}_{Mar,2017|Nov,2015}$ respectively.

Similarly, we approximate 3-month-ahead forecasts using forecast values of two adjacent quarters. Weights are assigned based on their distance from the period to be forecasted. Nearer forecast value is given weight 2/3 and farther forecast is given the value 1/3. For example, two shorter-horizon forecasts given in November 2015 are made for December 2015 and March 2016. 3-month-ahead forecast are formulated for February 2016. Weights are assigned based on the proximity to February 2016 forecast value. 2/3rd of weight is assigned to the March 2016 forecast ($\hat{\pi}_{March,2016|Nov,2015}$) and 1/3rd is assigned to the December 2015 one ($\hat{\pi}_{Dec,2015|Nov,2015}$).[2]

Figures 1(a)-1(d) plot SPF forecasts, RBI projections for the forecasted period, with realized WPI for the period upto end 2013 and CPI-C inflation after that. We conduct a comparative analysis for 3-month-ahead and 1-year-ahead forecasts for quarterly and bi-monthly surveys. SPF forecasts and RBI projections move in line with the 3-month-ahead realized WPI inflation. 1-year-ahead inflation diverges from both SPF forecasts and RBI projections, but converges around the mean of 6% showing higher predictability of both SPF and RBI forecasts for shorter forecast horizons. As with the bi-monthly surveys, SPF forecasts co-move with RBI projections but with over-prediction till December 2018. The key takeaway from this analysis, however, is the co-movement of SPF forecasts and RBI projections.

Figure 1(a) – SPF, Inflation and RBI Projections (Quarterly 3-month-ahead)



[2] We estimate 6-month-ahead forecasts and 9-month-ahead forecasts using similar techniques. Results are qualitatively similar and can be provided upon request.

Figure 1(b) – SPF, Inflation and RBI Projections (Quarterly 1-year-ahead)

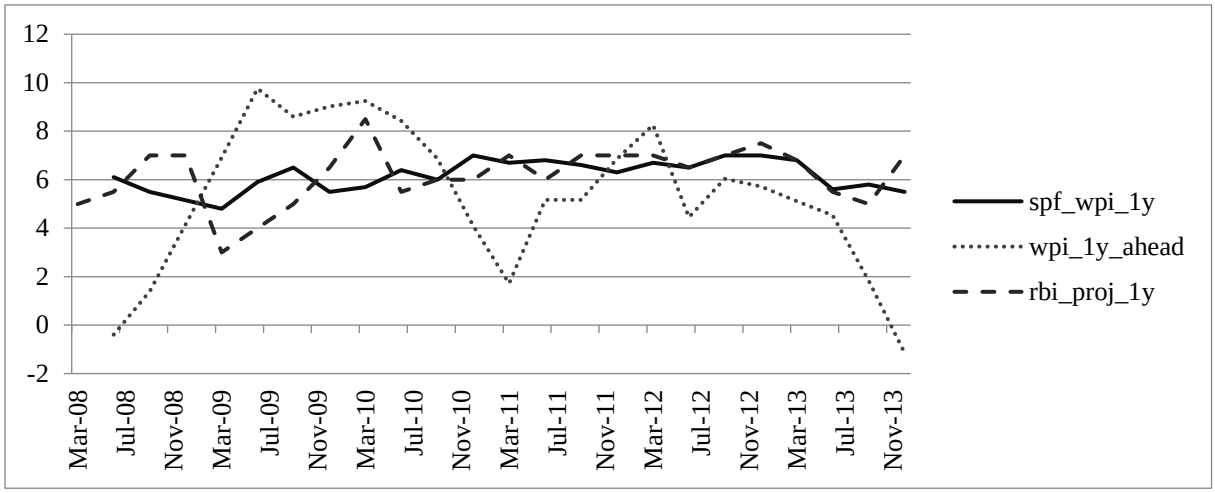


Figure 1(c) – SPF, Inflation and RBI Projections (Bi-monthly 3-month-ahead)

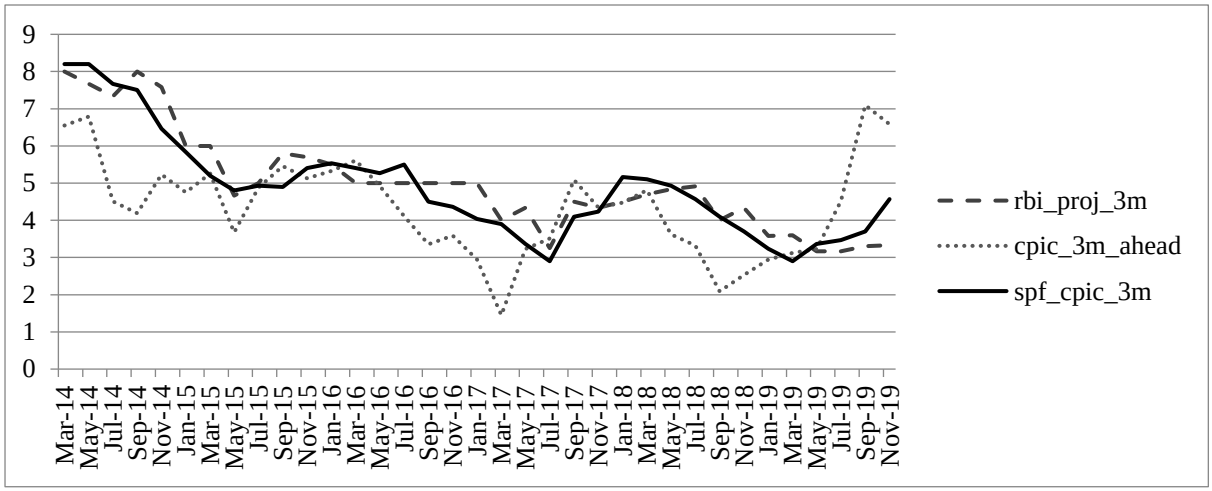
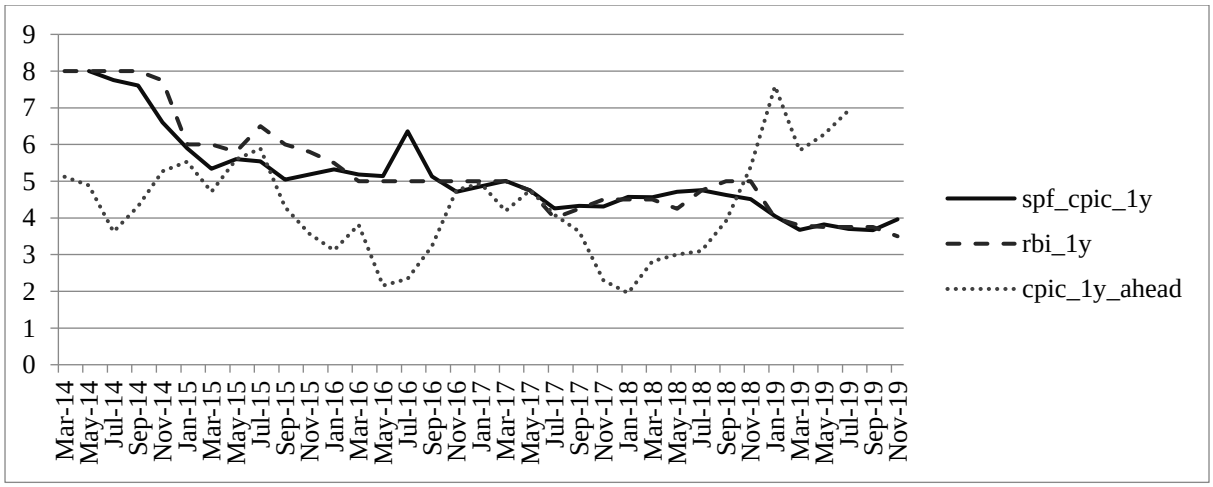


Figure 1(d) – SPF, Inflation and RBI Projections (Bi-monthly 1-year-ahead)



***Source**: RBI SPF, DBIE, MP Statements*

Means and standard deviations of quarterly and bi-monthly SPF forecasts and realized inflation are given in Table 1. Both forecasts and realized values of WPI (quarterly) are higher than their CPI-C counterparts (bi-monthly). 3-month-ahead forecasts and realized values of WPI are higher than their 1-year-ahead counterparts. Standard deviations of WPI realized inflation are higher than those of the CPI-C inflation for shorter horizon forecasts. Volatility of 3-month-ahead SPF forecasts declined post-FIT while that of 1-year-ahead forecasts increased.

Table 1 – Descriptive statistics of SPF forecasts and realized inflation (3-month and 1-year)

	Quarterly		WPI		Bi-monthly		CPI-C	
	3-month-ahead	**1-year-ahead**	**3-month-ahead**	**1-year-ahead**	**3-month-ahead**	**1-year-ahead**	**3-month-ahead**	**1-year-ahead**
Mean	6.80	6.21	6.11	5.35	4.89	5.08	4.35	4.33
Standard Deviation	3.33	0.62	3.14	3.12	1.39	1.10	1.33	1.39

***Source**: Authors' estimates*

3.2. Macroeconomic Variables:

Following Easaw et al (2013) and Ehrmann (2015) we use 1-month lagged realized inflation (π_t) as a control variable. Quarterly forecasts use WPI-based headline inflation while bi-monthly surveys use CPI-C-based headline inflation as these variables are intermediate targets during their respective periods of analyses.[3] We control for oil price volatility by incorporating month-on-month growth rate in crude oil prices ($\Delta_m OIL_t$).[4] Another control variable commonly used in literature is monetary policy stance (MS_t). It highlights the role of central bank actions in influencing SPF forecasts. It is defined as follows:

$$MS_t = \begin{cases} -1, if\ monetary\ policy\ stance\ is\ loose\ (Repo\ rate\ is\ reduced\ from\ the\ previous\ period) \\ 0, if\ monetary\ policy\ stance\ is\ neutral\ (Repo\ rate\ is\ unchanged\ from\ the\ previous\ period) \\ 1, if\ monetary\ policy\ stance\ is\ tightened\ (Repo\ rate\ is\ increased from\ the\ previous\ period) \end{cases}$$

[3] Inflation is estimated as year-on-year logarithmic growth rate using WPI and CPI-C indices.

[4] International crude oil prices in US $ are used for this analysis. Month-on-month growth rate is one of the estimates of measuring volatility of data represented in levels.

3.3. Communications variables:

Monetary policy statements are important for estimating communications for three reasons. (1) They announce policy decisions; (2) They act as a focal point for all the private agents who formulate expectations about the economy in general. They also provide detailed analysis of the current economic situation and future outlook of the economy. (3) The precise timings of monetary policy meetings make it possible to accurately identify communication effects on macroeconomic aggregates (Hubert and Labondance, 2018). Central bank communications are broadly classified as qualitative and quantitative. We use RBI inflation projections as quantitative communications to investigate their importance in stabilizing short-run fluctuations in inflation expectations.

Unlike households who are informed indirectly about the RBI projections via newspapers and television media, professional forecasters directly track RBI actions and speeches. Projections appear in the RBI speeches during monetary policy meetings as follows, *"…the Reserve Bank will endeavor to condition the evolution of inflation to a level of 5.0 percent by March 2014…"* (RBI May, 2013). These statements also contain fan charts of inflation and GDP growth rate for different quarters. Professional forecasters incorporate this information while formulating expectations.

Qualitative communications are estimated based on the choice of words used by the central bankers in the monetary policy speeches. RBI Governor's speeches had a quarterly frequency till January 2014 and bi-monthly from April 2014. SPF was changed to bi-monthly frequency following this change in the monetary policy meetings; which coincides with the de facto adoption of FIT. Quarterly RBI projections are fixed-horizon forecasts. We convert bi-monthly projections to fixed-horizon forecasts using similar data-conversion techniques to those of SPF forecasts. Data used for quarterly analysis ranges from January 2008 to January 2014 and extends from April 2014 to October 2019 for the bi-monthly analysis.

3.3.1. Construction of Qualitative Communications: Cleaning of MP statements

Unstructured text data from monetary policy speeches are analyzed using sophisticated text analysis techniques. 24 quarterly statements and 35 bi-monthly statements are used for analysis. We pre-process and clean the text files by getting rid of the unwanted information in the introductory statements, and then, by stripping spaces and removing punctuation marks, numbers and special characters. Unwanted words known as *"stopwords"* in linguistic terms are removed to make the text compact. Remaining words are converted to lower case for a

robust analysis. Any text analysis software reads upper-case and lower-case words as two different elements (e.g. "Inflation" and "inflation" are considered as two different words).. Conversion of all the words to lower cases eliminates the possibility of these errors. Next, a step called *'stemming'* or *'lemmatization'* uses *'Part-of-Speech'* tagging to identify stem words. This transforms all the words like "decrease", "decreasing" and "decreases" to the same stem word "decreas". We then arrange all the words in the form of a term-document matrix (TDM). Each term forms one row of the matrix while each column is denoted by the source document. We use *'bag-of-words'* approach for the analysis. An illustrative example of a TDM is given in Table 2. The word 'inflation' appears 15 times in the first document and 10 times in the third. 'finance' appears 6 times in the second document while 11 times in the fourth.

Table 2 – Illustrative Term-Document Matrix (TDM)

Term/Document	D1	D2	D3	D4
inflation	15	12	10	17
growth	9	15	6	12
finance	8	6	10	11
credit	10	8	7	5

3.3.2. Quantification of Monetary Policy Statements:

Ehrmann and Fratzscher (2007) and Ehrmann et al (2012) analyze qualitative communications of the European Central Bank. Their approach does not deal with the choice of words in the central bank statements. Apel and Blix-Grimaldi (2012), Hubert and Labondance (2018) estimate the tone of central bank communications using sophisticated text analytical techniques. A brief overview of the quantification of text data using advanced machine learning techniques is provided by Bholat *et al.* (2015).

We construct the communications variables as follows:

$$\tau_{i,t} = \frac{P_{i,t} - N_{i,t}}{P_{i,t} + N_{i,t}} \qquad \text{……..(2)}$$

where $\tau_{i,t}$ measures the qualitative communications (tone) using the dictionary 'i' for the speech t. $P_{i,t}$ and $N_{i,t}$ denote the number of positive words and negative words from dictionary 'i' used in speech t.

Dictionary methods are applied on the pre-processed TDM. Our study uses a specific dictionary constructed primarily for central bank communications by Apel and Blix-Grimaldi (2012).[5] We call this dictionary AB henceforth. The values of qualitative RBI communications lie between [-1, 1]. We augment the words in the AB dictionary to suit the Indian monetary policy statements incorporating words that are lacking. For example, AB dictionary does not incorporate any information of food and fuel prices, which are the major drivers of headline inflation in India.[6] In addition, some words occurring frequently in the RBI monetary policy statements are: rise, improve, pick, uptick, mute, augur, elevate, slowdown, subdued, benign, flatten, fall, surge, shrink, firm etc. Augmenting the original AB dictionary thus gives better understanding of the sentiments conveyed by RBI. Hence, qualitative communications are estimated using two dictionaries: the original AB dictionary (ab_org) and the augmented AB dictionary (ab_aug).

The TDM uses each word as a separate element. Classifying words based on positive and negative sentiments can be tricky. For instance, the word "rise" conveys a positive sentiment but "price rise" or "inflation rise" conveys a negative sentiment. This issue is resolved using a technique is called *'n-gram tokenization'* which clubs adjacent words to form a separate element in the TDM. We use 3-gram tokenization for our analysis. Our sample matrix contains a minimum of one word and a maximum of three words per row. Suppose a sentence contains the phrase "crude oil prices firmed", then using a maximum of 3-gram tokenization we get the following list of words as the elements of the matrix: "crude", "oil", "prices", "firmed", "crude oil", "oil prices" and "prices firmed" "crude oil prices" and "oil prices firmed". Of these, the phrase "oil prices firmed" conveys a negative sentiment.

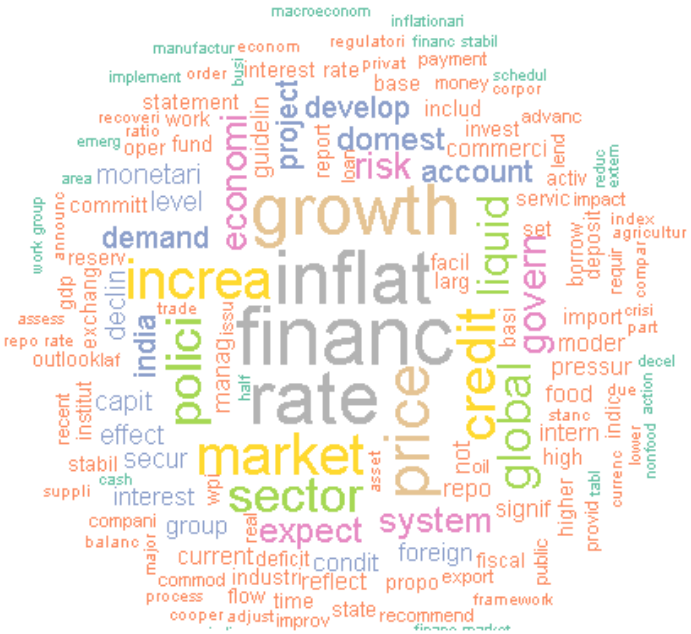
3.4. Word Clouds:

This sub-section presents a brief picture of the words used in the monetary policy statements pre- and post-FIT. Figures 2(a) and 2(b) give the word clouds of most commonly used words in the monetary policy statements for the quarterly and bi-monthly statements respectively. Along with inflation and growth, other words like finance, liquidity, credit and market were given high importance in the quarterly monetary policy statements indicating the multiple indicator approach at work. Word clouds of bi-monthly statements show that maximum

[5] List of all the words used in AB dictionary is available in Apel and Blix Grimaldi (2012).
[6] They comprise of 62.77% of the total weight in CPI-C (Goyal and Parab, 2020).

importance is given to inflation, followed by growth which indicates a gradual movement towards the flexible inflation targeting approach.

Figure 2(a) – Word Clouds for quarterly monetary policy statements



Source: Authors' estimates

Figure 2(b) – Word Clouds for bi-monthly monetary policy statements

Source: Authors' estimates

3.5. Timeline of variables:

The analysis is conducted using the information available at the time of formulating forecasts. Figures 3(a) and 3(b) give a clear picture of the time of release of dependent and explanatory variables for both quarterly and bi-monthly surveys.

Figure 3(a) – Time frame for Quarterly Surveys

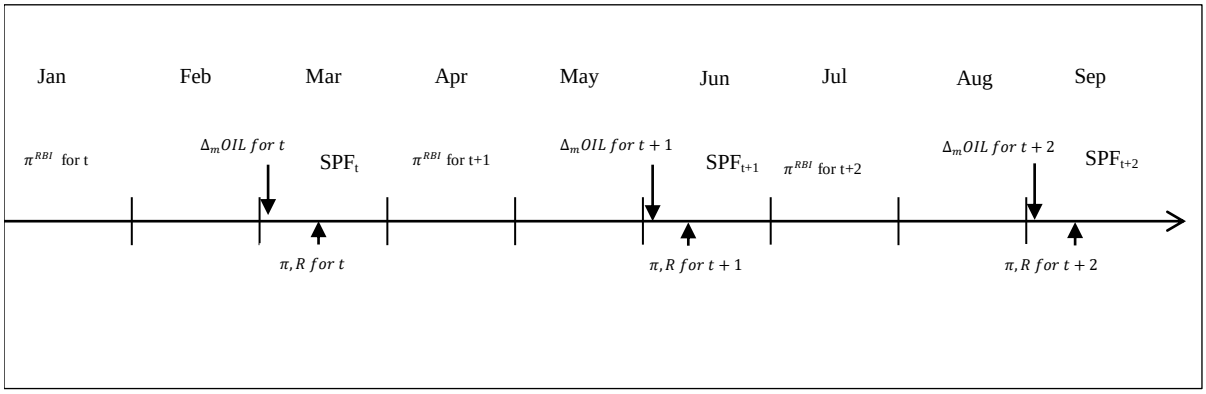
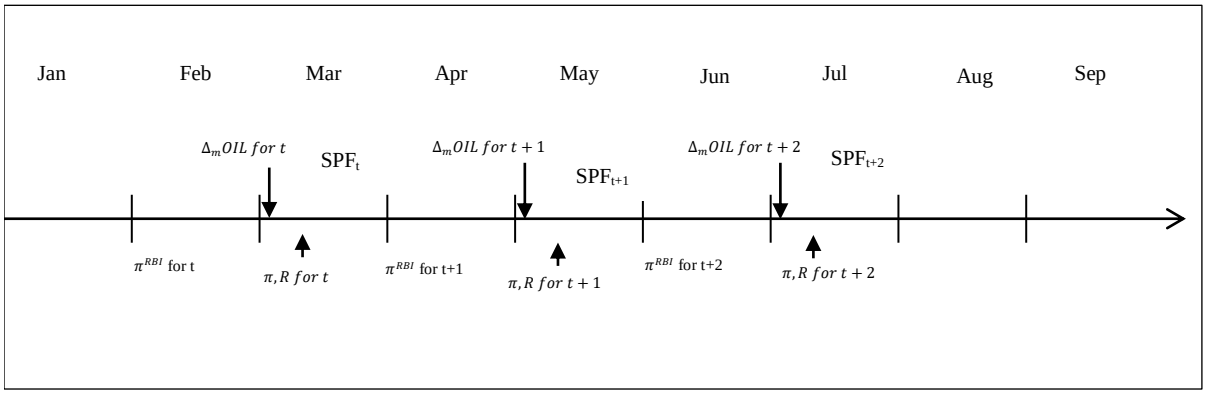


Figure 3(b) – Time frame for Bi-monthly Surveys



***Source**:* RBI SPF, DBIE, FRED Stats

where SPF gives the forecasts by the professional forecasters, π is inflation, π^{RBI} gives the inflation projections by the RBI, R is the Repo rate, $\Delta_m OIL$ is the month-on-month change in oil prices. Repo rate and inflation for March surveys are taken at the time of forecasts and oil prices are taken from the beginning of the month. RBI projections are taken from the latest available monetary policy statement in January. Similarly, macroeconomic variables are taken at the time of forecasts for the bi-monthly surveys conducted in May. RBI projections are taken from the latest available monetary policy statement in April.

4. Properties of Inflation Expectations:

Bi-monthly surveys have a maximum of 35 observations each for 3-month-ahead and 1-year-ahead forecasts. Quarterly forecasts on the other hand have a maximum 24 observations for every forecast horizon (3-month-ahead, 6-month-ahead, 9-month-ahead and 12-month-ahead). We club two forecast horizons to increase the sample size and control for the forecast horizon effects using dummy variables. We club 3-month-ahead and 6-month-ahead forecasts into one and 9-month-ahead and 12-month-ahead into another. For the sake of simplicity and convenience, we address these forecasts as shorter-horizon and longer-horizon forecasts respectively.

Augmented Dickey Fuller (ADF) unit root tests examine the stationarity of all the variables used for analysis.[7] Variables in the quarterly analysis are I(0) except oil prices which are I(1). On the other hand, 6-month-ahead and 1-year-ahead SPF forecasts, 3-month-ahead, 6-month-ahead and 9-month-ahead RBI projections and oil prices are I(1) for the bi-monthly analysis. As for the properties, we examine rationality, efficiency and accuracy of the forecasts for quarterly and bi-monthly surveys.

Rational Expectations:

Literature gives three forms of rationality namely weak rationality, sufficient rationality and strict rationality. The current study follows the analyses by Sharma and Bicchal (2018) and Goyal and Parab (2019) to test weak rationality of SPF forecasts using unbiasedness and efficiency tests. Equations (3) and (4) test unbiasedness of quarterly and bi-monthly forecasts respectively.

$$\pi_{i,t} = \alpha + \beta\pi_{i,t|t-j}^{e,SPF} + \delta_i DumFCH_i + \varepsilon_{i,t} \quad \text{……..(3)}$$

where 'j' is the number of lags of inflation expectations and 'i' is the forecast horizon. $\pi_{i,t}$ is the realized inflation at time t and $\pi_{i,t|t-j}^{e,SPF}$ denotes professional forecasters' expectations made at time 't-j' for the period t. 'i' gives the forecast horizon and DumFCH is the forecast horizon dummy.

$$\pi_t = \alpha + \beta\pi_{t|t-j}^{e,SPF} + \varepsilon_t \quad \text{……..(4)}$$

Acceptance of the combined null hypothesis of $\alpha = 0$ and $\beta = 1$ indicates unbiasedness of the

[7] Results for ADF tests are given in Table A1 in the appendix.

SPF forecasts. Equations (5) and (6) test the efficiency of quarterly and bi-monthly SPF forecasts respectively.

$$\pi_{i,t} - \pi^{e,SPF}_{i,t|t-j} = \alpha + \sum_{k=1}^{K} \beta_k \{\pi_{i,t-k} - \pi^{e,SPF}_{i,t-k|t-j-k}\} + \delta_i DumFCH_i + \varepsilon_{i,t} \quad \text{……..(5)}$$

where 'k' stands for the number of optimal lags chosen using the Bayesian Information Criterion (BIC).

$$\pi_t - \pi^{e,SPF}_{t|t-j} = \alpha + \sum_{k=1}^{K} \beta_k \{\pi_{t-k} - \pi^{e,SPF}_{t-k|t-j-k}\} + \varepsilon_t \quad \text{……..(6)}$$

Combined null hypothesis of $\alpha = 0$ and β_k's $= 0$ should be accepted for inflation expectations to be efficient. Efficiency of forecasts rejects the null of autocorrelation across error terms.

Adaptive Expectations:

Equations (7) and (8) test adaptive expectations property of quarterly and bi-monthly SPF forecasts respectively.

$$\pi^{e,SPF}_{i,t+j|t} - \pi^{e,SPF}_{i,t|t-j} = \mu + \lambda(\pi_{i,t-j} - \pi^{e,SPF}_{i,t|t-j}) + \delta_i DumFCH_i + \eta_{i,t} \quad \text{……..(7)}$$

$$\pi^{e,SPF}_{t+j|t} - \pi^{e,SPF}_{t|t-j} = \mu + \lambda(\pi_{t-j} - \pi^{e,SPF}_{t|t-j}) + \eta_t \quad \text{……..(8)}$$

Rejection of the null hypothesis of $\lambda = 0$ indicates that the expectations are adaptive.

Accuracy:

Since professional forecasters are well-versed with the market conditions and use sophisticated forecasting techniques for expectations formation, we compare the accuracy of their forecasts with that of the RBI projections. Following Romer and Romer (2000) and Łyziak and Paloviita (2017b) forecast accuracy is estimated using the following equations:

$$\left(u^{SPF}_{i,t|t-n}\right)^2 - \left(u^{RBI}_{i,t|t-n}\right)^2 = \alpha_0 + \delta_i DumFCH_i + \varepsilon_{i,t} \quad \text{……..(9)}$$

$$\left(u^{SPF}_{t|t-n}\right)^2 - \left(u^{RBI}_{t|t-n}\right)^2 = \alpha_0 + \varepsilon_t \quad \text{……..(10)}$$

where u^{SPF} *and* u^{RBI} are forecast residuals of the inflation forecasts by professional forecasters and the RBI respectively. A significant negative (positive) value of the constant implies better (worse) forecast accuracy of professional forecasters than that of the RBI.

Table 3 presents the results for rational and adaptive expectations properties and accuracy of SPF forecasts in comparison to RBI projections. Rejection of the null of unbiasedness and efficiency indicates non-rationality of SPF forecasts. Both quarterly and bi-monthly forecasts are adaptive. 3-month-ahead forecasts have larger co-efficients of the adaptive components

than their 1-year-ahead counterparts for the bi-monthly surveys. Shorter horizon forecasts of the quarterly surveys are highly adaptive in nature. Tests for forecast accuracy show SPF forecasts are more accurate than the RBI projections for the quarterly surveys, albeit insignificantly. 3-month-ahead forecasts for bi-monthly surveys have significantly larger accuracy than the RBI projections. This result resembles the results obtained for the developed nations (Hubert, 2015a).

Table 3 – Rational expectations, Adaptive expectations and Accuracy of SPF forecasts

Variables	Unbiasedness	Efficiency	Adaptive Expectations	Accuracy
spf(wpi)–shorter horizon	0.00***	0.00***	0.48***	-2.64
			(0.16)	(2.38)
spf(wpi)–longer horizon	0.00***	0.00***	0.12	-0.62
			(0.08)	(2.42)
	Unbiasedness	**Efficiency**	**Adaptive Expectations**	**Accuracy**
spf(cpic)–3m	0.00***	0.00***	0.35***	-0.96***
			(0.05)	(0.29)
spf(cpic)–1y	0.00***	0.00***	0.14***	-0.13
			(0.04)	(0.36)

Notes: p-values are given for unbiasedness and efficiency, coefficient values are given for adaptive expectations and accuracy tests with robust standard errors in parentheses.
Level of significance - *** - 1%, ** - 5%, *- 10%.
***Source**: Authors' estimates*

5. Do epidemiological models fit SPF forecasts well?

As in Mankiw and Reis (2002) and Carroll (2003), private agents update their information based on some source of news and their own past experiences. In the sticky information (SI) models, private agents do not update their expectations every period as they face costs of information processing. Carroll (2003) shows that professional forecasters update their forecasts with the latest information available to them as they pay attention to news. Their expectations formation can be modeled using the epidemiological models given below:

$$\pi^{e}_{t+1|t} = \rho N_{t+1|t} + (1-\rho)\pi^{e}_{t|t-1} \quad \text{……..(11)}$$

where ρ is the speed of adjustment of professional forecasters to the news received. $N_{t+1|t}$ captures the source of news. We use RBI projections as the news variable in equation (11), modifying it for the quarterly forecasts as follows:

$$\pi^{e,SPF}_{i,t+h|t} = \beta + \rho\pi^{RBI}_{i,t+h|t} + (1-\rho)\pi^{e,SPF}_{i,t+h-1|t-1} + \delta_i DumFCH_i + \varepsilon_{i,t} \quad \text{……..(12)}$$

where $\pi_{i,t+h|t}^{e,SPF}$ denotes 'h' periods ahead median inflation expectations of professional forecasters. $\pi_{i,t+h|t}^{RBI}$ captures RBI inflation projections with the same forecast horizon as that of the dependent SPF forecast.

In line with Carroll (2003), we augment equation (12) by adding recently published prices. In our case, this is realized inflation figures of the previous month. The augmented equation is:

$$\pi_{i,t+h|t}^{e,SPF} = \beta + \alpha_1 \pi_{i,t+h|t}^{RBI} + \alpha_2 \pi_{i,t+h-1|t-1}^{e,SPF} + \alpha_3 \pi_{i,t\,(m-1)} + \delta_i DumFCH_i + \varepsilon_{i,t} \quad \text{.....(13)}$$

where we impose the restrictions $\alpha_1 + \alpha_2 + \alpha_3 = 1$. $\pi_{i,t\,(m-1)}$ is one-month lagged inflation to account for the delays in publication of official figures.[8]

These epidemiological models for the bi-monthly analysis can be written as follows:

$$\pi_{t+h|t}^{e,SPF} = \beta + \rho \pi_{t+h|t}^{RBI} + (1-\rho)\pi_{t+h-1|t-1}^{e,SPF} + \varepsilon_t \quad \text{.....(14)}$$

$$\pi_{t+h|t}^{e,SPF} = \beta + \alpha_1 \pi_{t+h|t}^{RBI} + \alpha_2 \pi_{t+h-1|t-1}^{e,SPF} + \alpha_3 \pi_{t\,(m-1)} + \varepsilon_t \quad \text{.....(15)}$$

Results of equations (12)-(15) estimated using ordinary least squares (heteroscedasticity and autocorrelation adjusted) are given in Tables 4 and 5. The speeds of adjustment are higher than those of professional forecasters for developed nations. Carroll (2003) suggests suppressing the constant term as professional forecasters incorporate most of the information and do not rely on social communication for information transfer (captured by the constant). Hence, the coefficients of RBI projections with and without constant should not differ significantly. Speeds of adjustment are high and significant for the shorter-horizon quarterly forecasts (around 0.65). They become insignificant for their longer-horizon counterparts. Lagged inflation does not influence quarterly forecasts but drives bi-monthly forecasts. Bi-monthly models show significant effects of all the variables used. Persistence effects are high for shorter- and longer-horizon forecasts (around 0.5). Speed of adjustment is lower than the quarterly SPF forecasts but significant for both 3-month-ahead and 1-year-ahead forecasts (around 0.4). Thus, Carroll-type epidemiological models fit well for our analysis and show that

[8] Quarterly SPF forecasts are formulated in March, June, September and December. Data on realized inflation is available with a lag of one month. For instance, realized inflation figures for February are available in March. These figures become a part of the information set of the professional forecasters forming their expectations in March. Hence, inflation variable in equation (3) is given as $\pi_{i,t\,(m-1)}$, where m indicates the month. However, for the sake of simplicity, we address this variable as $\pi_{i,t}$. Similarly we use lagged inflation for bi-monthly analysis.

professional forecasters use the information in the form of RBI inflation projections, especially post-FIT.

Table 4 – Speeds of adjustment (Quarterly SPF)

	SPF WPI Forecasts (shorter horizon)				**SPF WPI Forecasts (longer horizon)**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
$\pi^{e,SPF}_{i,t+h-1\|t-1}$	0.29	0.29	0.17	0.17	0.64**	0.64**	0.68***	0.67***
	(0.24)	(0.23)	(0.27)	(0.27)	(0.25)	(0.24)	(0.23)	(0.23)
RBI Projections	0.71***	0.71***	0.62**	0.62**	0.36	0.36	0.41	0.41
	(0.24)	(0.23)	(0.24)	(0.23)	(0.25)	(0.24)	(0.26)	(0.25)
WPI Inflation			0.21	0.21			-0.08	-0.08
			(0.20)	(0.19)			(0.07)	(0.07)
Constant	-0.03		0.07		-0.02		-0.00	
	(0.54)		(0.56)		(0.31)		(0.31)	
Observations	46	46	45	45	43	43	43	43

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

Table 5 – Speeds of adjustment (Bi-monthly SPF)

	SPF CPIC Forecasts (3-month-ahead)				**SPF CPIC Forecasts (1-year-ahead)**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
$\pi^{e,SPF}_{i,t+h-1\|t-1}$	0.59***	0.60***	0.28**	0.33**	0.58***	0.57***	0.51***	0.53***
	(0.17)	(0.16)	(0.13)	(0.14)	(0.16)	(0.19)	(0.18)	(0.16)
RBI Projections	0.41**	0.40**	0.30**	0.32**	0.42**	0.43**	0.23	0.27*
	(0.17)	(0.16)	(0.12)	(0.14)	(0.16)	(0.19)	(0.20)	(0.16)
CPI-C Inflation			0.43***	0.35***			0.26***	0.20***
			(0.06)	(0.04)			(0.07)	(0.04)
Constant	-0.11		0.14*		-0.12*		0.12	
	(0.08)		(0.07)		(0.07)		(0.09)	
Observations	34	34	34	34	33	33	33	33

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

6. Estimation of Forecast Determinants:

While the epidemiological models provide a basic understanding of the role of RBI projections in influencing the levels of SPF forecasts, we further investigate the impact of qualitative and quantitative RBI communications on SPF forecasts in three ways. First, we examine the direct effect of communications on SPF forecasts by analyzing the expectations formation process. Second, we analyze the effect of communications on the difference between inflation expectations and realized inflation (also called inflation surprises). Finally, we investigate how RBI communications drive dispersions/disagreements across SPF forecasts. In all the models, we control for international crude oil price volatility, lagged inflation and RBI's monetary policy stance.

The estimation is done for two time periods. Quarterly estimation from March-2008 to December-2013 uses headline WPI forecasts and bi-monthly estimation from March-2014 to November-2019 uses headline CPI-C forecasts as the RBI changed its intermediate target from WPI before 2014 to CPI-C after the de facto adoption of FIT. The estimation uses OLS with heteroscedasticity and autocorrelation adjusted (HAC) standard errors.

6.1. Inflation Expectations Formation:

Central bank communications influence professional forecasters' expectations in advanced economies (Ehrmann, 2015; Hubert, 2015a, 2015c; Hattori, 2016). This sub-section analyzes the effects of RBI communications on the levels of SPF forecasts. We estimate the following equation with quarterly data:

$$\pi_{i,t+h|t}^{e,SPF} = \gamma_0 + \gamma_1 \pi_{i,t+h-1|t-1}^{e,SPF} + \gamma_2 \pi_{i,t(m-1)} + \gamma_3 \Delta_m OIL_{i,t} + \gamma_4 MS_{i,t} + \gamma_5 RBIComm_{i,t(m-2)} + \delta_i DumFCH_i + \varepsilon_{i,t} \quad \text{.....(16)}$$

where $\pi_{i,t+h|t}^{e,SPF}$ denotes median inflation expectations of professional forecasters forecasted 'h' periods ahead. γ_1 controls for persistence in SPF forecasts. Lagged inflation $[\pi_{i,t(m-1)}]$ has a subscript of t(m-1) indicating that these values are taken for one month prior inflation but available at the time of forecast. The variable $RBIComm_{i,t(m-2)} = \{\pi_{i,t(m-2)}^{RBI}, \tau_{i,t(m-2)}\}$ captures RBI quantitative and qualitative communications used interchangeably.[9] It has a

[9] This subscript is used for the sake of understanding. All the equations henceforth will have subscripts denominated as 't'.

subscript of t(m-2) as these values were taken from the monetary policy statements released two months prior to the SPF surveys. $MS_{i,t}$ gives the monetary policy stance at the time of forecast. We control for forecast horizons using dummies as the analysis is conducted for two separate periods- shorter horizons (3-month-ahead and 6-month-ahead forecasts) and longer horizons (with 9-month-ahead and 12-month-ahead forecasts). Results of the quarterly analysis are given in Table 6.

Table 6 – Determinants of SPF forecasts (Quarterly)

	SPF WPI Forecasts (shorter horizons)			**SPF WPI Forecasts (longer horizons)**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$\pi^{e,SPF}_{i,t+h-1\|t-1}$	0.59***	0.74***	0.76***	0.46**	0.52***	0.51**
	(0.18)	(0.17)	(0.18)	(0.17)	(0.19)	(0.21)
WPI Inflation	-0.00	0.05	0.00	0.08	0.13*	0.10
	(0.17)	(0.17)	(0.18)	(0.08)	(0.07)	(0.07)
Oil prices	0.16***	0.16***	0.16***	0.08***	0.08***	0.08***
	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Monetary Stance	1.29***	1.33***	1.25***	0.18	0.20	0.20
	(0.28)	(0.32)	(0.34)	(0.14)	(0.16)	(0.18)
RBI Projections	0.48*			0.12		
	(0.27)			(0.18)		
ab_org ($\tau_{i,t}$)		0.13			0.53	
		(0.91)			(0.59)	
ab_aug ($\tau_{i,t}$)			-0.62			0.26
			(0.93)			(0.62)
Constant	-0.69	1.22	1.12	1.60	1.64	1.78
	(1.35)	(1.12)	(1.12)	(1.76)	(1.40)	(1.52)
Observations	45	45	45	43	43	43
R-squared	0.72	0.70	0.70	0.53	0.55	0.53

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

Quarterly SPF forecasts (both shorter- and longer-horizon forecasts) display significant persistence effects, especially for shorter-horizon forecasts with qualitative communications. Lagged inflation displays insignificant influence in most of the models. Oil prices largely affect shorter-horizon forecasts. Monetary policy stance has positive influence on shorter-horizon forecasts indicating that SPF forecasters expect inflation to increase with monetary policy tightening. RBI projections too impact only the shorter-horizon forecasts. Qualitative communications fail to have any effect on the level of SPF forecasts. Significant positive effects of RBI projections support the hypothesis of larger influence of communication

variables on the shorter-horizon expectations (Badarinza and Buchmann, 2009; Goyal and Parab, 2020).

Bi-monthly surveys contain a maximum of 35 observations from March 2014 to November 2019. Monetary Policy Committee (MPC) became the decision-making body since October 2016. We analyze the effect of qualitative communications by incorporating an MPC dummy which takes the value 1 from November 2016 to November 2019 to segregate the effects of communications by an individual versus by a committee. Equations for bi-monthly analysis are given below.

$$\pi_{t+h|t}^{e,SPF} = \gamma_0 + \gamma_1 \pi_{t+h-1|t-1}^{e,SPF} + \gamma_2 \pi_t + \gamma_3 \Delta_m OIL_t + \gamma_4 MS_t + \gamma_5 RBIComm_t + \varepsilon_t \quad \text{.....(17)}$$

$$\pi_{t+h|t}^{e,SPF} = \gamma_0 + \gamma_1 \pi_{t+h-1|t-1}^{e,SPF} + \gamma_2 \pi_t + \gamma_3 \Delta_m OIL_t + \gamma_4 MS_t + \gamma_5 \tau_t + \gamma_6 DumMPC$$

$$+\gamma_7 DumMPC * \tau_t + \varepsilon_t \quad \text{.....(18)}$$

where $DumMPC = \begin{cases} 1, if\ t \geq November\ 2016 \\ 0, \qquad\qquad otherwise \end{cases}$

Communications variables are lagged by one month for bi-monthly analysis. Analysis is conducted separately for 3-month-ahead and 1-year-ahead SPF inflation forecasts. Results for 3-month-ahead and 1-year-ahead forecasts are given in Tables 7 and 8 respectively.

Table 7 – Determinants of SPF forecasts (Bi-monthly 3-month-ahead)

	(1)	(2)	(3)	(4)	(5)
$\pi^{e,SPF}_{t+h-1\|t-1}$	0.25*	0.51***	0.57***	0.48***	0.49***
	(0.14)	(0.07)	(0.08)	(0.08)	(0.11)
CPI-C Inflation	0.45***	0.43***	0.47***	0.47***	0.49***
	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Oil prices	-0.01***	-0.01**	-0.01**	-0.01**	-0.01**
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
MP Stance	-0.12	-0.14	-0.22**	-0.13	-0.17
	(0.08)	(0.09)	(0.11)	(0.08)	(0.11)
RBI Projections	0.36***				
	(0.12)				
MPC dummy			0.36		0.11
			(0.25)		(0.23)
ab_org (τ_t)		-0.04	-0.13		
		(0.10)	(0.21)		
Interaction dummy			0.16		
			(0.23)		
ab_aug (τ_t)				0.10	0.29
				(0.10)	(0.20)
Interaction dummy					-0.33
					(0.24)
Constant	0.16	0.34*	-0.32	0.37*	0.17
	(0.16)	(0.19)	(0.44)	(0.18)	(0.55)
Observations	34	34	34	34	34
R-squared	0.96	0.95	0.96	0.95	0.96

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

Table 8 – Determinants of SPF forecasts (Bi-monthly 1-year-ahead)

	(1)	(2)	(3)	(4)	(5)
$\pi^{e,SPF}_{t+h-1\|t-1}$	0.42**	0.64***	0.65***	0.63***	0.65***
	(0.17)	(0.07)	(0.10)	(0.07)	(0.10)
CPI-C Inflation	0.22***	0.27***	0.28***	0.28***	0.29***
	(0.08)	(0.07)	(0.06)	(0.06)	(0.06)
Oil prices	0.00	0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
MP Stance	0.06	0.04	0.03	0.05	0.05
	(0.06)	(0.06)	(0.12)	(0.06)	(0.10)
RBI Projections	0.26				
	(0.18)				
MPC dummy			0.06		0.07
			(0.40)		(0.25)
ab_org (τ_t)		0.07	0.03		
		(0.09)	(0.27)		
Interaction dummy			0.06		
			(0.32)		
ab_aug (τ_t)				0.12	0.00
				(0.09)	(0.19)
Interaction dummy					0.19
					(0.22)
Constant	0.61***	0.62***	0.51	0.63***	0.41
	(0.20)	(0.21)	(0.84)	(0.22)	(0.66)
Observations	33	33	33	33	33
R-squared	0.92	0.91	0.91	0.92	0.92

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Inertial effects are significant in both the models, but larger for longer-horizon forecasts. Lagged inflation has a larger influence on shorter-horizon forecasts. Oil price volatility adversely affects shorter-horizon forecasts, albeit smaller in magnitude. Monetary policy stance does not drive SPF forecasts. The influence of RBI projections is significant and positive for shorter-horizon forecasts but turns insignificant for the longer-horizon ones. Qualitative communications too fail to show any significant influence.

6.2. Influence of communications on inflation surprises

In line with the analysis by Ullrich (2008), we incorporate inflation surprises as a dependent variable. This variable is defined based on Andersen et al (2003) and Ehrmann (2015) as the difference between current realized inflation and inflation expectations formulated in the past about the current period ($\pi_t - \pi^e_{t|t-h}$).

Inflation surprises are often used as explanatory variables in the literature as they incorporate the news component of sudden unanticipated shocks. Very few studies use them as dependent variables (Ullrich, 2008). Analysis of inflation surprises helps to understand the shocks in theoretical inflation expectations models in the literature. The determinants of inflation surprises for quarterly surveys are estimated using the following equation.

$$\pi^{surp}_{i,t+h|t} = \gamma_0 + \gamma_1 \pi^{surp}_{i,t+h-1|t-1} + \gamma_2 \pi_{i,t} + \gamma_3 \Delta_m OIL_{i,t} + \gamma_4 MS_{i,t} + \gamma_5 RBIComm_{i,t}$$

$$+\delta_i DumFCH_i + \varepsilon_{i,t} \qquad \text{……..(19)}$$

where $\pi^{surp}_{i,t+h|t}$ captures inflation surprises at time 't'. The quantitative communication variable is replaced with RBI projection surprises [$\pi^{RBI,surp}_{i,t}$]. This variable is estimated as the difference between realized inflation and RBI projections for that period ($\pi_t - \pi^{e,RBI}_{i,t|t-h}$). A positive influence of RBI projection surprises on inflation surprises would indicate co-movement of SPF inflation forecasts with the RBI projections. We control for forecast horizon effects using dummy variables. Table 9 gives determinants of quarterly inflation surprises.

Table 9 – Determinants of Inflation surprises (Quarterly)

	SPF WPI Forecasts (shorter horizons)			SPF WPI Forecasts (longer horizons)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$\pi^{e,surp}_{i,t+h-1\|t-1}$	0.42***	0.47***	0.46**	0.63***	0.64***	0.65***
	(0.15)	(0.16)	(0.18)	(0.15)	(0.16)	(0.16)
WPI Inflation	-0.44***	-0.23	-0.30**	-0.08	-0.13	-0.15
	(0.14)	(0.17)	(0.15)	(0.15)	(0.23)	(0.20)
Oil prices	0.05	0.06	0.07*	0.04	0.07	0.07
	(0.04)	(0.04)	(0.04)	(0.06)	(0.05)	(0.05)
MP Stance	1.36**	1.34**	1.39**	1.13***	1.26***	1.18***
	(0.51)	(0.52)	(0.60)	(0.40)	(0.40)	(0.34)
RBI Projection Surprises	0.16			0.22		
	(0.21)			(0.15)		
ab_org ($\tau_{i,t}$)		1.75			-0.04	
		(1.26)			(1.38)	
ab_aug ($\tau_{i,t}$)			0.84			-0.53
			(1.17)			(1.30)
Constant	2.43**	1.60*	1.59*	2.43**	1.60*	1.59*
	(1.00)	(0.87)	(0.88)	(1.00)	(0.87)	(0.88)
Observations	41	42	42	35	35	35
R-squared	0.59	0.61	0.57	0.75	0.72	0.72

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

Inflation surprises are highly persistent. WPI inflation has negative and significant influence on shorter-horizon forecasts but an insignificant one for longer-horizon forecasts. Oil prices too fail to display any significant influence. Coefficients of monetary policy stance are positive and significant. Tighter monetary policy stance is associated with an increase in inflation surprises. This may be capturing food price or output gap shocks since these are not controlled for. RBI projection surprises as well as qualitative communications do not drive SPF forecast surprises.

Similar analysis is conducted for bi-monthly inflation surprises for both 3-month-ahead and 1-year-ahead SPF forecasts. We segregate the effects of qualitative communications post-MPC using interaction dummy. The equations for bi-monthly analysis are given below.

$$\pi_{t+h|t}^{e,surp} = \gamma_0 + \gamma_1 \pi_{t+h-1|t-1}^{e,surp} + \gamma_2 \pi_t + \gamma_3 \Delta_m OIL_t + \gamma_4 MS_t + \gamma_5 RBIComm_t + \varepsilon_t \quad \text{……..(20)}$$

$$\pi_{t+h|t}^{e,surp} = \gamma_0 + \gamma_1 \pi_{t+h-1|t-1}^{e,surp} + \gamma_2 \pi_t + \gamma_3 \Delta_m OIL_t + \gamma_4 MS_t + \gamma_5 \tau_t + \gamma_6 DumMPC$$

$$+\gamma_7 DumMPC * \tau_t + \varepsilon_t \quad \text{……..(21)}$$

Results of equations (20) and (21) for 3-month-ahead and 1-year-ahead forecasts are given in Tables 10 and 11 respectively.

Table 10 – Determinants of Inflation surprises (Bi-monthly 3-month-ahead)

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
$\pi_{t+h-1\|t-1}^{e,surp}$	-0.12	0.64***	0.55***	0.65***	0.47***
	(0.14)	(0.13)	(0.14)	(0.13)	(0.16)
CPI-C Inflation	-0.06	0.16	0.43**	0.18	0.53**
	(0.09)	(0.11)	(0.17)	(0.13)	(0.21)
Oil prices	0.01	0.03**	0.02	0.03**	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
MP Stance	-0.11	-0.44*	-0.52**	-0.47*	-0.52**
	(0.14)	(0.24)	(0.24)	(0.25)	(0.23)
RBI Projection Surprises	0.94***				
	(0.13)				
MPC dummy			0.78		1.27**
			(0.60)		(0.49)
ab_org (τ_t)		-0.24	-0.09		
		(0.24)	(0.55)		
Interaction dummy			-0.05		
			(0.61)		
ab_aug (τ_t)				-0.08	-1.11
				(0.54)	(0.83)
Interaction dummy					1.38
					(1.03)
Constant	0.26	-1.07**	-2.70**	-1.06**	-3.51***
	(0.36)	(0.40)	(1.00)	(0.48)	(1.16)
Observations	32	32	32	32	32
R-squared	0.83	0.54	0.59	0.53	0.63

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

Table 11 – Determinants of Inflation surprises (Bi-monthly 1-year-ahead)

	(1)	(2)	(3)	(4)	(5)
$\pi^{e,surp}_{t+h-1\|t-1}$	-0.12	0.62*	0.36	0.61*	0.34
	(0.22)	(0.32)	(0.36)	(0.32)	(0.32)
CPI-C Inflation	0.36**	0.08	0.57	0.11	0.55
	(0.15)	(0.29)	(0.45)	(0.30)	(0.35)
Oil prices	-0.03**	-0.02	-0.03*	-0.02	-0.03*
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Monetary Stance	-0.70***	-0.46*	-0.61**	-0.44*	-0.51**
	(0.13)	(0.23)	(0.27)	(0.23)	(0.23)
RBI Projection Surprises	0.61***				
	(0.11)				
MPC dummy			1.30*		1.29*
			(0.68)		(0.65)
ab_org (τ_t)		0.09	-0.48		
		(0.29)	(0.42)		
Interaction dummy			0.87		
			(0.63)		
ab_aug (τ_t)				0.20	-1.32
				(0.37)	(1.49)
Interaction dummy					1.75
					(1.53)
Constant	-1.53**	-0.68	-3.73	-0.81	-3.81**
	(0.73)	(1.36)	(2.32)	(1.40)	(1.64)
Observations	28	28	28	28	28
R-squared	0.80	0.43	0.50	0.43	0.51

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Lagged inflation surprises display persistent effects except for the models with RBI projections. Influence of lagged inflation is positive in some cases but predominantly insignificant. Shorter-horizon forecasts are influenced by oil prices in some scenarios. This effect vanishes for longer-horizon forecasts. Monetary policy stance displays desired negative effects on inflation surprises. Monetary policy tightening should drive down SPF forecasts in anticipation of lower inflation in the future. Unlike the quarterly analysis, RBI projection surprises have significant

and positive influence on inflation surprises for both shorter- and longer-horizon forecasts, the effect being higher for the former. We find no evidence for the influence of qualitative communications on inflation surprises.

6.3. Communication effects on dispersion across SPF forecasts:

Literature shows that dispersions across expectations are a key to macroeconomic dynamics (Mankiw et al, 2003). They can lead to the wrong investment decisions and affect resource allocation (Sims, 2003). Moreover, significant disagreements in the market resemble a demand shock with high unemployment (Beckmann and Czudaj, 2018). A necessary condition for successful policy intervention is that the cross-section dispersion of expectations be minimal (Dovern et al, 2012). Reduction in forecaster disagreements points to higher policy credibility.

We use range (maximum – minimum) as a measure of dispersion across SPF forecasts (Montes et al, 2016; Galvis Ciro and Anzoategui Zapata, 2019). Quarterly disagreements are constructed using the readily available fixed-horizon forecasts. Bi-monthly disagreements are converted to fixed-horizon using techniques similar to the SPF forecasts. Quarterly analysis is conducted by clubbing 3-month-ahead forecasts with 6-month-ahead and 9-month-ahead forecasts with 12-month-ahead ones. Unlike levels forecasts, dispersion values are not available for forecast horizons of 12 months and beyond. Hence, we analyze 3-month-ahead and 6-month-ahead dispersions. Table 12 gives the descriptive statistics of forecaster disagreements. There is a substantial decline in the mean and standard deviation of dispersions post-FIT.

Table 12 – Means and Standard Deviations of Forecaster Disagreements

	Quarterly Inflation dispersions		**Bi-monthly Inflation dispersions**	
	6-month-ahead	**1-year-ahead**	**3-month-ahead**	**6-month-ahead**
Mean	2.88	3.42	1.80	1.95
Standard Deviation	1.34	1.42	0.66	0.52

***Source**: Authors' estimates*

Quarterly disagreements are modeled using the following equation.

$$dis\left(\pi_{i,t+h|t}^{e,SPF}\right) = \gamma_0 + \gamma_1\, dis\left(\pi_{i,t+h-1|t-1}^{e,SPF}\right) + \gamma_2\pi_{i,t} + \gamma_3\Delta_m OIL_{i,t} + \gamma_4 MS_{i,t} + \gamma_5 RBIComm_{i,t}$$

$$+\delta_i DumFCH_i + \varepsilon_{i,t} \qquad \text{……..(22)}$$

where $dis\left(\pi_{i,t+h|t}^{e,SPF}\right)$ denotes dispersions across professional forecasters. γ_1 is the coefficient for inertia of dispersions.

Table 13 gives results for quarterly disagreements. Apart from the inertial effects of lagged disagreements, shorter-horizon forecasts are not influenced significantly by the macroeconomic controls. Oil prices display negative and significant effects while monetary policy stance has positive influence on 1-year-ahead dispersions. An increase in RBI projections decreases forecaster disagreement for shorter-horizon forecasts. Quarterly SPF forecasts tend to converge when RBI expects higher inflation in the near future. Qualitative communications do not display significant effects except for the one with original AB dictionary at longer horizons.

Table 13 – Determinants of Forecaster Disagreements (Quarterly)

	Dispersions across WPI forecasts (shorter horizons)			**Dispersions across WPI forecasts (longer horizons)**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
dis($\pi_{i,t+h-1|t-1}^{e,SPF}$)	0.28*	0.38**	0.35**	0.25*	0.39***	0.33***
	(0.15)	(0.15)	(0.15)	(0.12)	(0.10)	(0.10)
WPI Inflation	0.10	-0.04	-0.04	-0.06	-0.21	-0.18
	(0.11)	(0.11)	(0.10)	(0.10)	(0.12)	(0.13)
Oil prices	-0.02	-0.01	-0.02	-0.06***	-0.06**	-0.07**
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
MP Stance	0.20	0.15	0.11	0.53**	0.55**	0.59**
	(0.25)	(0.27)	(0.27)	(0.23)	(0.25)	(0.27)
RBI Projections	-0.32**			-0.38		
	(0.16)			(0.25)		
ab_org ($\tau_{i,t}$)		-0.47			-0.95*	
		(0.61)			(0.54)	
ab_aug ($\tau_{i,t}$)			-0.67			-0.44
			(0.71)			(0.57)
Constant	3.51***	1.76**	1.83**	5.30***	3.02***	3.32***
	(1.23)	(0.86)	(0.86)	(1.80)	(0.72)	(0.88)
Observations	42	42	42	40	40	40
R-squared	0.25	0.20	0.21	0.41	0.40	0.36

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Bi-monthly analysis is conducted for 3-month-ahead and 6-month-ahead dispersions By incorporating and MPC dummy to capture the interaction effects of qualitative communications variable. Equations for the analysis are given below.

$$dis\left(\pi_{t+h|t}^{e,SPF}\right) = \gamma_0 + \gamma_1\, dis\left(\pi_{t+h|t-1}^{e}\right) + \gamma_2\pi_t + \gamma_3\Delta_m OIL_t + \gamma_4 MS_t + \gamma_5 RBIComm_t + \varepsilon_t \quad \text{.....(23)}$$

$$dis\left(\pi_{t+h|t}^{e,SPF}\right) = \gamma_0 + \gamma_1\, dis\left(\pi_{t+h|t-1}^{e}\right) + \gamma_2\pi_t + \gamma_3\Delta_m OIL_t + \gamma_4 MS_t + \gamma_5\tau_t + \gamma_6 DumMPC$$

$$+\gamma_7 DumMPC * \tau_t + \varepsilon_t \quad \text{.....(24)}$$

Tables 14 and 15 give the results of equations (23) and (24) respectively. Persistence effects of lagged dispersions as well as the effects of lagged inflation are insignificant. Oil prices predominantly display negative effects for shorter-horizon forecaster disagreements. These effects are insignificant for the longer-horizon dispersions. Monetary policy stance too fails to influence forecaster disagreements.

Higher inflation projections by the RBI increase forecaster disagreements. These effects are higher for shorter-horizon forecasts. Qualitative communications fail to display desired negative effects. However, negative and significant coefficients of the interaction terms between the MPC dummy and qualitative communications with ab_aug dictionary for 3-month-ahead forecasts points out to the improvement in the choice of words used in the monetary policy statements post-MPC. The effects of qualitative communications on dispersions post-MPC are significantly different from its pre-MPC counterpart, with the desired negative sign. SPF forecasts converge significantly after MPC became the decision-making body in October 2016. Comparison of results across AB dictionaries shows significant differences. Insignificant influence of ab_org and significant one using ab_aug indicates that an appropriate choice of words is useful in reducing forecaster disagreements.

Table 14 – Determinants of Forecaster Disagreements (Bi-monthly 3-month-ahead)

	(1)	(2)	(3)	(4)	(5)
dis($\pi^{e,SPF}_{t+h-1\|t-1}$)	-0.09	0.15	0.20	0.14	0.09
	(0.20)	(0.16)	(0.17)	(0.17)	(0.15)
CPI-C Inflation	-0.22	0.05	-0.01	0.03	-0.11
	(0.15)	(0.09)	(0.13)	(0.08)	(0.12)
Oil prices	-0.02	-0.02*	-0.01	-0.02*	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
MP Stance	-0.08	-0.03	0.04	-0.01	0.02
	(0.19)	(0.20)	(0.20)	(0.20)	(0.20)
RBI Projections	0.35*				
	(0.18)				
MPC dummy			-0.36		-0.48
			(0.46)		(0.34)
ab_org (τ_t)		0.28	0.50		
		(0.21)	(0.35)		
Interaction dummy			-0.36		
			(0.49)		
ab_aug (τ_t)				0.21	0.67**
				(0.28)	(0.26)
Interaction dummy					-0.84*
					(0.45)
Constant	1.11***	1.36***	1.78**	1.37***	2.34***
	(0.38)	(0.45)	(0.79)	(0.48)	(0.74)
Observations	33	33	33	33	33
R-squared	0.25	0.18	0.20	0.15	0.24

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Table 15 – Determinants of Forecaster Disagreements (Bi-monthly 6-month-ahead)

	(1)	(2)	(3)	(4)	(5)
dis($\pi^{e,SPF}_{t+h-1\|t-1}$)	0.10	0.23	0.23	0.20	0.18
	(0.14)	(0.14)	(0.16)	(0.15)	(0.15)
CPI-C Inflation	-0.27***	-0.05	-0.09	-0.05	-0.11
	(0.09)	(0.06)	(0.10)	(0.05)	(0.09)
Oil prices	0.00	-0.00	-0.00	-0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
MP Stance	0.21	0.25	0.28	0.25	0.27
	(0.14)	(0.15)	(0.17)	(0.15)	(0.16)
RBI Projections	0.30***				
	(0.10)				
MPC dummy			-0.16		-0.20
			(0.37)		(0.30)
ab_org (τ_t)		0.04	0.08		
		(0.17)	(0.31)		
Interaction dummy			-0.07		
			(0.40)		
ab_aug (τ_t)				0.26	0.43
				(0.19)	(0.27)
Interaction dummy					-0.31
					(0.42)
Constant	1.42***	1.81***	2.05***	1.83***	2.24***
	(0.34)	(0.29)	(0.66)	(0.28)	(0.64)
Observations	33	33	33	33	33
R-squared	0.33	0.15	0.16	0.20	0.22

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

6.4. Robustness Checks:

To conduct robustness tests, we first substitute monetary policy stance with Repo rate for all the models.[10] Results are qualitatively similar for the levels of SPF forecasts. Some differences are observed for inflation surprises. While monetary policy stance has positive effect on

[10] Tables are provided in the appendix.

quarterly inflation surprises, this effect is negative for the models with Repo rate. The effects Repo rate are negative for bi-monthly surprises. Inertial effects increase for the bi-monthly models with Repo rate, especially for 1-year-ahead inflation surprises.

Robustness tests of disagreements show significant variations. While the monetary policy stance has insignificant influence in most of the cases and positive effects for 1-year-ahead dispersions in quarterly data; the influence of Repo rate is predominantly negative and significant for quarterly models and positive for the bi-monthly ones. In addition, lagged inflation positively affects inflation dispersions for the models with Repo rate. The influence of RBI projections, however, remains the same for both types of models, signifying their robust influence. The influence of qualitative communications turns insignificant for these models.[11]

7. Discussion:

Results from these estimations support the literature on expectations management using central bank forecasts. However, these findings do not undermine the role of monetary policy actions in driving these expectations. Inflation expectations can be anchored in two ways. First, align them with the projections of the central bank. Second, reduce cross-sectional disagreements across forecasts (Dovern et al, 2012). We find original evidence for both types of anchoring of SPF forecasts. RBI partly sets the future inflation rate influencing SPF inflation forecasts, which are the main determinants of future inflation. They are positively related to the dispersions indicating lower RBI forecasts reduce forecaster disagreements. Also qualitative communications reduce dispersions after MPC became the decision-making body. As for central bank actions, tighter monetary policy stance reduces inflation surprises. Comparing results across various forecast horizons shows a larger influence of RBI communications (both quantitative and qualitative) on the shorter-horizon forecasts.

Analysis conducted using Carroll-type epidemiological models shows the presence of information rigidities in inflation expectations formation. Rigidities are higher for longer horizon forecasts, suggesting their larger dependence on economic fundamentals. Robust analyses provide evidence for higher speed of adjustment in comparison to the developed nations.

[11] Another set of robustness tests consists of incorporating 50, 70 and 90 percent confidence intervals of RBI projections as given in the fan charts. This new variable measured as the range of the confidence intervals has insignificant influence on all the measures of inflation expectations (levels, surprises and disagreements) and does not affect the results obtained in this study. These results are available with the authors and can be provided upon request.

8. Conclusions:

This paper provides original evidence on the influence of quantitative and qualitative RBI communications on survey-based inflation forecasts of professional forecasters. RBI projections represent quantitative communications while qualitative communications are captured using text analysis techniques (Apel and Blix-Grimaldi 2012). Analysis is conducted across two periods (pre-FIT – March 2008 to December 2013: Quarterly; post-FIT – March 2014 to November 2019: Bi-monthly) for three measures of inflation expectations namely inflation forecast levels, inflation surprises and forecaster disagreement. Results support the role of RBI communications, especially inflation projections, in anchoring SPF forecasts.

First, analysis conducted using Carroll-type epidemiological models display presence of information frictions in expectations formation of professional forecasters. Frictions are marginally lower for longer-horizon forecasts, indicating their larger dependence on macroeconomic fundamentals than the news components. High- speed of adjustment supports the use of communications to affect expectations.

Second, RBI projections influence levels of SPF forecasts, with higher magnitude for shorter-horizon forecasts. In addition, inertial effects of inflation expectations are significant during pre- and post-FIT. Oil prices affect SPF forecasts primarily in the pre-FIT period due to high volatility. This effect dampens post-FIT indicating better anchoring of expectations. Lagged inflation plays a vital role in driving SPF forecasts particularly post-FIT.

Third, inflation surprises display positive association with lagged inflation for the bi-monthly surveys. RBI projection surprises influence inflation surprises post-FIT, with a higher magnitude for shorter-horizon forecasts. Tighter monetary policy stance reduces inflation surprises.

Finally, RBI projections reduce forecaster disagreements for bi-monthly surveys. Qualitative communications were not significant before but their influence increased after MPC became the decision-making body. This study finds robust evidence for the impact of RBI communications on SPF forecasts. It finds a gradual improvement in RBI communications and credibility with more effective choice of words after October 2016. A longer time series analysis as more data becomes available would be more helpful to evaluate the communication effects during the times of uncertainty.

References:

Acosta, Miguel. 2015. "FOMC Responses to Calls for Transparency." *Available at SSRN 2647486*.

Andersen, Torben G., Tim Bollerslev, Francis X. Diebold, and Clara Vega. 2003. "Micro Effects of Macro Announcements: Real-Time Price Discovery in Foreign Exchange." *American Economic Review* 93 (1): 38–62.

Andrade, Philippe, and Hervé Le Bihan. 2013. "Inattentive Professional Forecasters." *Journal of Monetary Economics* 60 (8): 967–82.

Apel, Mikael, and Marianna Grimaldi. 2012. "The Information Content Of Central Bank Minutes." *Riksbank Research Paper Series*, no. 92.

Arango-Thomas, Luis Eduardo, Javier Pantoja, Carlos Alberto Velásquez, and Luis E Arango. 2020. "Effects of the Central Bank's Communications in Colombia: A Content Analysis." *Borradores de Economía; No. 1024*.

Badarinza, Cristian, and Marco Buchmann. 2009. "Inflation Perceptions and Expectations in the Euro Area: The Role of News." *European Central Bank Working Paper No. 1088*.

Beckmann, Joscha, and Robert L. Czudaj. 2018. "Monetary Policy Shocks, Expectations, and Information Rigidities." *Economic Inquiry* 56 (4): 2158–76.

Bholat, David, Stephen Hansen, Pedro Santos, and Cheryl Schonhardt-Bailey. 2015. "Text Mining for Central Banks." Bank of England.

Blinder, Alan S, Michael Ehrmann, Marcel Fratzscher, Jakob De Haan, and David-Jan Jansen. 2008. "Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence." *Journal of Economic Literature* 46 (4): 910–45.

Bruno, Giuseppe. 2017. "Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence." In The R User Conference, useR! 2017 July 4-7 2017 Brussels, Belgium, 253.

Carmen Ramos-Herrera, María del, and Simón Sosvilla-Rivero. 2013. "Inflation Expectations in Spain: The Spanish PwC Survey." *Cuadernos de Economía* 36 (101): 109–15.

Carrasco, Carlos A, and Jesus Ferreiro. 2013. "Inflation Targeting and Inflation Expectations in Mexico." *Applied Economics* 45 (23): 3295–3304.

Carroll, Christopher D. 2003. "Macroeconomic Expectations of Households and Professional Forecasters." *The Quarterly Journal of Economics* 118 (1): 269–98.

Carvalho, Carlos, Fernando Cordeiro, and Juliana Vargas. 2014. "Just Words? A Quantitative Analysis of the Communication of the Central Bank of Brazil," Rede de Economia Aplicada, Working Paper, No. 63, .

Cerisola, Martin, and Gaston Gelos. 2009. "What Drives Inflation Expectations in Brazil? An Empirical Analysis." *Applied Economics* 41 (10): 1215–27.

Coibion, Olivier, and Yuriy Gorodnichenko. 2012. "What Can Survey Forecasts Tell Us about Information Rigidities?" *Journal of Political Economy* 120 (1): 116–59.

———. 2015. “Information Rigidity and the Expectations Formation Process: A Simple Framework and New Facts.” *American Economic Review* 105 (8): 2644–78.

Dovern, Jonas, Ulrich Fritsche, and Jiri Slacalek. 2012. “Disagreement among Forecasters in G7 Countries.” *The Review of Economics and Statistics* 94 (4): 1081–96. https://www.jstor.org/stable/23355342.

Ehrmann, Michael. 2015. “Targeting Inflation from Below: How Do Inflation Expectations Behave?” *International Journal of Central Banking* 11 (4): 213–49.

Ehrmann, Michael, Sylvester Eijffinger, and Marcel Fratzscher. 2012. “The Role of Central Bank Transparency for Guiding Private Sector Forecasts.” *The Scandinavian Journal of Economics* 114 (3): 1018–52.

Ehrmann, Michael, and Marcel Fratzscher. 2007. “Communication by Central Bank Committee Members: Different Strategies, Same Effectiveness?” *Journal of Money, Credit and Banking* 39 (2-3): 509–41.

Fujiwara, Ippei. 2005. “Is the Central Bank’s Publication of Economic Forecasts Influential?” *Economics Letters* 89 (3): 255–61.

Galvis Ciro, Juan Camilo, and Juan Camilo Anzoátegui Zapata. 2019. “Disagreement in Inflation Expectations: Empirical Evidence for Colombia.” *Applied Economics* 51 (40): 4411–24.

Goyal, Ashima, and Sanchit Arora. 2012. “The Indian Exchange Rate and Central Bank Action: An EGARCH Analysis.” *Journal of Asian Economics* 23 (1): 60–72.

Goyal, Ashima, and Prashant Parab. 2019. “Modeling Heterogeneity and Rationality of Inflation Expectations across Indian Households.” *Indira Gandhi Institute of Development Research, Working Paper Series*, no. 2019–002.

Gürkaynak, Refet S, Brian Sack, and Eric T Swansonc. 2005. “Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements.” *International Journal of Central Banking*.

Guthrie, Graeme, and Julian Wright. 2000. “Open Mouth Operations.” *Journal of Monetary Economics* 46 (2): 489–516.

Hattori, Masazumi, Steven Kong, Frank Packer, and Toshitaka Sekine. 2016. “The Effects of a Central Bank’s Inflation Forecasts on Private Sector Forecasts: Recent Evidence from Japan.,” BIS Working Paper Series, No. 585, .

Hendry, Scott, and Alison Madeley. 2010. “Text Mining and the Information Content of Bank of Canada Communications.” *Available at SSRN 1722829*.

Hubert, Paul. 2014. “FOMC Forecasts as a Focal Point for Private Expectations.” *Journal of Money, Credit and Banking* 46 (7): 1381–1420.

———. 2015a. “Do Central Bank Forecasts Influence Private Agents? Forecasting Performance versus Signals.” *Journal of Money, Credit and Banking* 47 (4): 771–89.

———. 2015b. “ECB Projections as a Tool for Understanding Policy Decisions.” *Journal of Forecasting* 34 (7): 574–87.

———. 2015c. “The Influence and Policy Signalling Role of FOMC Forecasts.” *Oxford Bulletin of Economics and Statistics* 77 (5): 655–80.

———. 2017. “Qualitative and Quantitative Central Bank Communication and Inflation Expectations.” *The BE Journal of Macroeconomics* 17 (1): 1–41.

Hubert, Paul, and Fabien Labondance. 2018. “Central Bank Sentiment.” *URL: Https://Www. Nbp. Pl/Badania/Seminaria/14xi2018. Pdf. Working Paper*.

Jansen, David-Jan, and Jakob De Haan. 2007. “The Importance of Being Vigilant: Has ECB Communication Influenced Euro Area Inflation Expectations?,” CESIFO WORKING PAPER NO. 2134, .

Kahveci, Eyup, and Aysun Odabaş. 2016. “Central Banks’ Communication Strategy and Content Analysis of Monetary Policy Statements: The Case of Fed, ECB and CBRT.” *Procedia-Social and Behavioral Sciences* 235: 618–29.

Kotlowski, Jacek. 2015. “Do Central Bank Forecasts Matter for Professional Forecasters?” *National Bank of Poland Working Paper*, no. 204.

Levin, Andrew T, Fabio M Natalucci, and Jeremy M Piger. 2004. “The Macroeconomic Effects of Inflation Targeting.” *Review-Federal Reserve Bank of Saint Louis* 86 (4): 51–58.

Łyziak, Tomasz, and Maritta Paloviita. 2017a. “Anchoring of Inflation Expectations in the Euro Area: Recent Evidence Based on Survey Data.” *European Journal of Political Economy* 46: 52–73.

———. 2017b. *Formation of Inflation Expectations in Turbulent Times*. NBP Working Paper, No. 261.

Mankiw, N. Gregory, and Ricardo Reis. 2002. “Sticky Information versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve.” *The Quarterly Journal of Economics* 117 (4): 1295–1328.

Mankiw, N. Gregory, Ricardo Reis, and Justin Wolfers. 2003. “Disagreement about Inflation Expectations.” *NBER Macroeconomics Annual* 18: 209–48.

Mathur, Aakriti, and Rajeshwari Sengupta. 2019. “Analysing Monetary Policy Statements of the Reserve Bank of India.” *Indira Gandhi Institute of Development Research, Working Paper Series*, no. 2019–012.

Moniz, Andy, and Franciska de Jong. 2014. “Predicting the Impact of Central Bank Communications on Financial Market Investors’ Interest Rate Expectations.” In , 144–55. V. Presutti et al. (Eds.): ESWC Satellite Events 2014, LNCS 8798. Springer.

Montes, GC, LV Oliveira, A Curi, and RTF Nicolay. 2016. “Effects of Transparency, Monetary Policy Signalling and Clarity of Central Bank Communication on Disagreement About Inflation Expectations.” *Applied Economics* 48 (7): 590–607.

Oshima, Yusuke, and Yoichi Matsubayashi. 2018. “Monetary Policy Communication of the Bank of Japan: Computational Text Analysis,” Graduate School of Economics, Kobe University, Discussion Paper, No. 1816.

Pedersen, Michael. 2015. “What Affects the Predictions of Private Forecasters? The Role of Central Bank Forecasts in Chile.” *International Journal of Forecasting* 31 (4): 1043–55.

Rosa, Carlo, and Giovanni Verga. 2007. “On the Consistency and Effectiveness of Central Bank Communication: Evidence from the ECB.” *European Journal of Political Economy* 23 (1): 146–75.

Sharma, Narendra Kumar, and Motilal Bicchal. 2018. “The Properties of Inflation Expectations: Evidence for India.” *EconomiA* 19: 74–89.

Sims, Christopher A. 2003. “Implications of Rational Inattention.” *Journal of Monetary Economics* 50 (3): 665–90.

Ullrich, Katrin. 2008. “Inflation Expectations of Experts and ECB Communication.” *The North American Journal of Economics and Finance* 19 (1): 93–108.

Appendix:

Table A1 – Unit Root Tests

	Null Hypothesis: Series contains unit root			
	SPF Quarterly (Mar-2008 to Dec-2013)		SPF Bi-monthly (Mar-2014 to Nov-2019)	
Variables	**Level (p-values)**	**First Difference (p-values)**	**Level (p-values)**	**First Difference (p-values)**
SPF Forecasts (3-months)	0.02**		0.04**	
SPF Forecasts (6-months)	0.01***		0.25	0.00***
SPF Forecasts (9-months)	0.00***		0.04**	
SPF Forecasts (1-year)	0.00***		0.08*	0.00***
Inflation Surprises (3-months)	0.01***		0.01***	
Inflation Surprises (6-months)	0.01***		0.03**	
Inflation Surprises (9-months)	0.02**		0.02**	
Inflation Surprises (1-year)	0.02**		0.03**	
Dispersions (3-months)	0.01***		0.00***	
Dispersions (6-months)	0.00***		0.00***	
Dispersions (9-months)	0.02**		0.00***	
Headline Inflation	0.04**		0.01***	
Monetary Stance	0.01***		0.00***	
Oil Price	0.22	0.00***	0.21	0.00***
RBI Projections (3-months	0.01**		0.02**	
RBI Projections (6-months)	0.01***		0.27	0.00***
RBI Projections (9-months)	0.00***		0.05*	0.00***
RBI Projections (1-year)	0.00***		0.05*	0.00***
ab_org (τ_t)	0.00***		0.00***	
ab_aug (τ_t)	0.00***		0.00***	

Table A2 – Determinants of SPF forecasts (Quarterly)

	SPF WPI Forecasts (shorter horizons)			SPF WPI Forecasts (longer horizons)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$\pi^{e,SPF}_{i,t+h-1\|t-1}$	0.41*	0.65**	0.70***	0.42**	0.45**	0.46*
	(0.24)	(0.24)	(0.25)	(0.19)	(0.20)	(0.24)
WPI Inflation	0.33*	0.38*	0.26	0.12*	0.17**	0.13*
	(0.18)	(0.19)	(0.19)	(0.07)	(0.07)	(0.07)
Oil prices	0.19***	0.20***	0.19***	0.09***	0.09***	0.09***
	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)	(0.02)
Repo rate	0.39	0.27	0.26	0.11	0.14	0.12
	(0.33)	(0.34)	(0.31)	(0.11)	(0.10)	(0.12)
RBI Projections	0.60**			0.08		
	(0.29)			(0.18)		
ab_org ($\tau_{i,t}$)		0.03			0.53	
		(1.06)			(0.54)	
ab_aug ($\tau_{i,t}$)			-1.38			0.06
			(0.82)			(0.51)
Constant	-4.83*	-1.90	-1.86	1.60	1.64	1.78
	(2.55)	(2.46)	(2.24)	(1.76)	(1.40)	(1.52)
Observations	45	45	45	43	43	43
R-squared	0.65	0.62	0.63	0.53	0.55	0.52

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Table A3 – Determinants of SPF forecasts (Bi-monthly 3-month-ahead)

	(1)	(2)	(3)	(4)	(5)
$\pi^{e,SPF}_{t+h-1\|t-1}$	0.27*	0.49***	0.46***	0.44***	0.37**
	(0.15)	(0.13)	(0.15)	(0.15)	(0.17)
CPI-C Inflation	0.44***	0.45***	0.50***	0.50***	0.54***
	(0.05)	(0.08)	(0.11)	(0.08)	(0.11)
Oil prices	-0.01***	-0.01***	-0.01**	-0.01***	-0.01**
	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
Repo rate	-0.18*	-0.02	0.07	0.00	0.06
	(0.10)	(0.13)	(0.20)	(0.14)	(0.22)
RBI Projections	0.36***				
	(0.12)				
MPC dummy			0.20		0.01
			(0.33)		(0.31)
ab_org (τ_t)		-0.04	-0.05		
		(0.10)	(0.21)		
Interaction dummy			0.04		
			(0.22)		
ab_aug (τ_t)				0.13	0.40*
				(0.11)	(0.22)
Interaction dummy					-0.42*
					(0.24)
Constant	1.01**	0.53	-0.21	0.48	0.25
	(0.45)	(0.53)	(1.26)	(0.58)	(1.44)
Observations	34	34	34	34	34
R-squared	0.96	0.95	0.95	0.95	0.95

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

Table A4 – Determinants of SPF forecasts (Bi-monthly 1-year-ahead)

	(1)	(2)	(3)	(4)	(5)
$\pi^{e,SPF}_{t+h-1\|t-1}$	0.45**	0.55***	0.53***	0.52**	0.54***
	(0.19)	(0.18)	(0.17)	(0.19)	(0.19)
CPI-C Inflation	0.21**	0.28***	0.32***	0.29***	0.34***
	(0.09)	(0.07)	(0.08)	(0.07)	(0.08)
Oil prices	0.00	0.00	0.00	0.00	-0.00
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Repo rate	-0.05	0.15	0.24	0.17	0.26
	(0.20)	(0.24)	(0.31)	(0.25)	(0.33)
RBI Projections	0.28				
	(0.19)				
MPC dummy			0.21		0.28
			(0.37)		(0.28)
ab_org (τ_t)		0.08	0.07		
		(0.09)	(0.16)		
Interaction dummy			0.03		
			(0.19)		
ab_aug (τ_t)				0.14	-0.02
				(0.10)	(0.16)
Interaction dummy					0.25
					(0.18)
Constant	0.75	0.06	-0.73	-0.02	-1.05
	(0.74)	(0.83)	(1.79)	(0.83)	(1.65)
Observations	33	33	33	33	33
R-squared	0.92	0.92	0.92	0.92	0.92

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Table A5 – Determinants of Inflation surprises (Quarterly)

	SPF WPI Forecasts (shorter horizons)			SPF WPI Forecasts (longer horizons)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$\pi^{e,surp}_{i,t+h-1\|t-1}$	0.62***	0.68***	0.69***	0.82***	0.84***	0.84***
	(0.10)	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)
WPI Inflation	-0.26*	0.03	-0.01	-0.07	-0.20	-0.17
	(0.14)	(0.19)	(0.17)	(0.15)	(0.19)	(0.17)
Oil prices	0.08**	0.11***	0.12***	0.05	0.06	0.05
	(0.03)	(0.03)	(0.04)	(0.06)	(0.05)	(0.05)
Repo rate	-0.54**	-0.48*	-0.57**	-0.52	-0.79*	-0.67*
	(0.26)	(0.26)	(0.22)	(0.47)	(0.40)	(0.34)
RBI Projection Surprises	0.29			0.12		
	(0.24)			(0.21)		
ab_org ($\tau_{i,t}$)		1.70			-1.22	
		(1.47)			(1.44)	
ab_aug ($\tau_{i,t}$)			1.21			-1.43
			(1.24)			(1.21)
Constant	5.26***	3.60	4.12**	4.29	6.46*	5.61*
	(1.67)	(2.14)	(1.90)	(3.94)	(3.49)	(3.00)
Observations	41	42	42	35	35	35
R-squared	0.58	0.58	0.55	0.71	0.72	0.73

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
Source*: Authors' estimates*

Table A6 – Determinants of Inflation surprises (Bi-monthly 3-month-ahead)

	(1)	(2)	(3)	(4)	(5)
$\pi^{e,surp}_{t+h-1\|t-1}$	-0.16	0.08	0.03	0.06	0.00
	(0.12)	(0.14)	(0.15)	(0.16)	(0.14)
CPI-C Inflation	0.07	0.56***	0.44***	0.58***	0.49***
	(0.14)	(0.12)	(0.10)	(0.12)	(0.12)
Oil prices	0.00	0.00	0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Repo rate	-0.30	-1.21***	-1.55***	-1.24***	-1.47***
	(0.24)	(0.21)	(0.28)	(0.21)	(0.23)
RBI Projection Surprises	0.81***				
	(0.18)				
MPC dummy			-0.69*		-0.39
			(0.37)		(0.38)
ab_org (τ_t)		-0.19	-0.31		
		(0.20)	(0.38)		
Interaction dummy			0.08		
			(0.43)		
ab_aug (τ_t)				-0.17	-0.75
				(0.41)	(0.52)
Interaction dummy					0.71
					(0.63)
Constant	1.54	4.85***	7.90***	5.05***	7.04***
	(1.12)	(1.06)	(1.79)	(1.07)	(1.71)
Observations	32	32	32	32	32
R-squared	0.83	0.74	0.77	0.74	0.77

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Table A7 – Determinants of Inflation surprises (Bi-monthly 1-year-ahead)

	(1)	(2)	(3)	(4)	(5)
$\pi^{e,surp}_{t+h-1\|t-1}$	-0.29	-0.19	-0.04	-0.21	-0.07
	(0.34)	(0.35)	(0.33)	(0.35)	(0.29)
CPI-C Inflation	0.62**	0.77**	0.51	0.75**	0.48*
	(0.27)	(0.30)	(0.35)	(0.29)	(0.27)
Oil prices	-0.02	-0.02	-0.02	-0.02	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Repo rate	-0.61	-1.20***	-1.55***	-1.20***	-1.56***
	(0.46)	(0.41)	(0.45)	(0.42)	(0.41)
RBI Projection Surprises	0.35**				
	(0.16)				
MPC dummy			-0.51		-0.40
			(0.69)		(0.76)
ab_org (τ_t)		0.09	-0.39		
		(0.24)	(0.48)		
Interaction dummy			0.55		
			(0.60)		
ab_aug (τ_t)				-0.08	-1.29
				(0.34)	(1.23)
Interaction dummy					1.27
					(1.32)
Constant	0.99	3.71*	7.38**	3.72*	7.32**
	(2.08)	(1.94)	(2.88)	(2.00)	(2.91)
Observations	28	28	28	28	28
R-squared	0.66	0.59	0.64	0.59	0.65

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Table A8 – Determinants of Forecaster Disagreements (Quarterly)

	Dispersions across WPI forecasts (shorter horizons)			Dispersions across WPI forecasts (longer horizons)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
dis($\pi^{e,SPF}_{i,t+h-1\|t-1}$)	-0.05	0.09	0.08	0.06	0.20	0.14
	(0.18)	(0.16)	(0.16)	(0.15)	(0.12)	(0.13)
WPI Inflation	0.27**	0.08	0.09	0.10	-0.05	-0.01
	(0.11)	(0.08)	(0.09)	(0.10)	(0.10)	(0.10)
Oil prices	-0.02	-0.01	-0.02	-0.06***	-0.06**	-0.07**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Repo rate	-0.69***	-0.63***	-0.61***	-0.47**	-0.50**	-0.50**
	(0.20)	(0.19)	(0.19)	(0.20)	(0.20)	(0.22)
RBI Projections	-0.40**			-0.39		
	(0.15)			(0.25)		
ab_org ($\tau_{i,t}$)		-0.55			-1.08*	
		(0.55)			(0.60)	
ab_aug ($\tau_{i,t}$)			-0.52			-0.51
			(0.69)			(0.68)
Constant	8.55***	6.09***	6.01***	8.41***	6.22***	6.47***
	(1.83)	(1.59)	(1.56)	(2.37)	(1.65)	(1.85)
Observations	42	42	42	40	40	40
R-squared	0.47	0.39	0.39	0.45	0.45	0.39

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Table A9 – Determinants of Forecaster Disagreements (Bi-monthly 3-month-ahead)

	(1)	(2)	(3)	(4)	(5)
dis($\pi^{e,SPF}_{t+h-1\|t-1}$)	-0.14	-0.10	-0.11	-0.12	-0.16
	(0.16)	(0.12)	(0.16)	(0.12)	(0.14)
CPI-C Inflation	-0.20	-0.15	-0.09	-0.17*	-0.14
	(0.14)	(0.10)	(0.13)	(0.09)	(0.11)
Oil prices	-0.01	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Repo rate	0.58**	0.59***	0.76***	0.62***	0.76***
	(0.27)	(0.21)	(0.20)	(0.20)	(0.23)
RBI Projections	0.05				
	(0.22)				
MPC dummy			0.39		0.33
			(0.37)		(0.36)
ab_org (τ_t)		0.14	0.23		
		(0.18)	(0.26)		
Interaction dummy			-0.12		
			(0.36)		
ab_aug (τ_t)				0.01	0.12
				(0.20)	(0.25)
Interaction dummy					-0.26
					(0.43)
Constant	-1.26	-1.28	-2.88**	-1.41	-2.63*
	(1.27)	(1.06)	(1.24)	(1.02)	(1.52)
Observations	33	33	33	33	33
R-squared	0.37	0.38	0.42	0.37	0.41

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*

Table A10 – Determinants of Forecaster Disagreements (Bi-monthly 1-year-ahead)

	(1)	(2)	(3)	(4)	(5)
dis($\pi^{e,SPF}_{t+h-1\|t-1}$)	0.04	-0.00	-0.11	-0.01	-0.11
	(0.19)	(0.18)	(0.19)	(0.19)	(0.19)
CPI-C Inflation	-0.27**	-0.20**	-0.12	-0.18**	-0.10
	(0.10)	(0.09)	(0.10)	(0.08)	(0.09)
Oil prices	0.00	0.00	-0.00	0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Repo rate	0.09	0.42**	0.70***	0.39**	0.72***
	(0.30)	(0.17)	(0.17)	(0.16)	(0.21)
RBI Projections	0.27				
	(0.18)				
MPC dummy			0.70**		0.72**
			(0.32)		(0.34)
ab_org (τ_t)		-0.00	-0.04		
		(0.18)	(0.23)		
Interaction dummy			0.09		
			(0.37)		
ab_aug (τ_t)				0.17	-0.02
				(0.16)	(0.26)
Interaction dummy					0.20
					(0.44)
Constant	1.02	-0.03	-2.39**	0.12	-2.57*
	(1.06)	(0.71)	(1.14)	(0.71)	(1.46)
Observations	33	33	33	33	33
R-squared	0.28	0.23	0.35	0.25	0.36

Notes: Robust standard errors given in the parentheses. Level of significance - *** - 1%, ** - 5%, * - 10%
***Source**: Authors' estimates*