

Choose your words wisely: Analysing RBI's monetary policy communication

Aakriti Mathur (IHEID, Geneva)
Rajeswari Sengupta (IGIDR, Mumbai)

Preliminary. Please do not cite.

Contents

- Motivation and Objective
- Questions
- Data and methodology
- Preliminary results
- Next steps

Part I

Motivation

- **An algorithm to track Australia's central bank (Bloomberg, Aug 29, 2017)** *"The latest index for Australian market watchers do not track stocks, bonds or currencies. It uses an algorithm to track the tone of central bank Governor Philip Lowe's words."*
- LSE and BOE released a handbook of textmining for central banks in June 2015.
- In the US, minutes of FOMC meetings are closely watched and analysed by researchers.

Central bank communication: Why is it important?

- The aim of monetary policy conducted by a central bank is to influence agents' **inflation expectations**.
- The central bank controls the short term nominal interest rate.
- A change in the short term rate by itself does not affect economic decisions of agents in a significant manner.
- Agents form their views about future economic developments and responses of the central bank to these developments.
- They look at **CB communication**: information made publicly available by the CB about its current and future policy objectives, current economic outlook and likely path of future monetary policy decisions.

Central bank communication: Why is it important?

Information content of monetary policy changes

$$i_t = \phi f(\Gamma_t, \Gamma_{t+j|t}^e) + \epsilon_t \quad (1)$$

- The CB reveals i_t , the nominal rate at time t when it announces its monetary policy decision.
- i_t is based on ϕ reaction function to the current state (Γ_t) and future expectations (Γ_t^e) of economic inputs.
- The reaction function ϕ itself is quantitatively unobserved.
- Γ_t are revealed in several ways, mostly through monetary policy statements or press conference held by Governor immediately after the decision.
- Forecasts of economic inputs (Γ_t^e) are also revealed through the same fora.

Central bank communication: Why is it important?

Information content of monetary policy changes

- CB informs the agents' inflation expectations through the following:
 - 1 Its decision of i_t
 - 2 Its belief about current and future economic outlook (Γ_t and Γ_t^e)
 - 3 Forward guidance: Its expected deviations from the average rule (ϵ_t) due to risks to various forecasts.
- Our objective is to analyse the last two aspects of RBI's communication using NLP tools.

Objective

- 1 To quantify the **content of RBI's MP communication** using techniques from computational linguistics.
 - 2 To quantify the **impact of RBI's MP communication** on financial market variables.
- **Advantage:** automated tools enable scaling up across a large database of texts in a consistent manner.
 - **Challenge:** converting raw communication, in words, into meaningful quantities which can be analysed.
 - **Importance:** broader applications beyond monetary policy analysis; brings economics close to the world of 'big data'.

Monetary Policy in India

Brief background

- From 1998 to 2015, RBI looked at **multiple indicators** to decide the interest rate (such as exchange rate, trade balance, inflation, output, unemployment etc).
- Governors Bimal Jalan, YV Reddy, Subbarao and Rajan belonged to this era.
- In 2015 February RBI shifted to an **inflation targeting** framework under Rajan.
- The formal operating procedure of IT was not in place for a year.
- The **monetary policy committee** was formed and met for the first time in October 2016.
 - **April 1998-October 2016**: RBI communication was through Governor's statements.
 - **October 2016 onward**: RBI communication has been through MPC's statements.

Part II

Questions

Quantification of content: Question 1

Testing the move to IT/ MPC

- 1 **Is the move to inflation targeting reflected in the RBI's communications?**
 - Has there been a semantic shift in the statements after **inflation targeting** was adopted and **MPC** started functioning in October 2016?

Quantification of content: Question II

Testing Governor fixed effects

- 1 **How has the tone of communication of RBI's monetary policy strategy changed across regimes?**
 - How much has been the **forward looking element** of the communication of respective governors and the MPC vis-a-vis the emphasis on current economic outlook?
 - Is it possible to discern the respective **hawkish vs. dovish Governors and MPC members** from the statements?

Quantification of impact: Question III

Testing effects of communication on asset prices

- 1 **Are there significant and/or persistent quantitative effects of RBI's statements on asset prices?** Effect on yields in the **bond** market, returns and volatility in the **equity** market.

Part III

Data and methodology

No. of regimes

Governor/ Regime	Term
Dr. D. Subbarao	2008-09 to 2013-09
Dr. Raghuram Rajan	2013-09 to 2016-09
Monetary Policy Committee	2016-10 to Present

Table: Governors of the RBI, 2008-2017

Data sources: Subbarao

Subbarao: Sep 2008 - Sep 2013

Quarterly statements July (1st qtr), October (2nd qtr), January (3rd qtr)

Annual policy statement April/May

Mid quarter press releases Started Sep 2010; June, September, December, March.

Press conference transcripts 2009, 2010 (April: annual policy statements); July 2010 onward for every quarterly MP review.

Teleconference with researchers Started Jan 2010 for every quarterly review; April 2010 unedited and edited versions.

Data sources: Rajan

Rajan: Sep 2013 - Sep 2016

Only press release and transcripts Sep 2013 only

Quarterly statements Oct 2013 - Jan 2014

Bi-monthly statements Started April 2014; April, June, Aug, Sep, Dec, Feb

Mid quarter press releases Dec 2013 only

Press conference transcripts Sep 2013 (missing in June 2014)

Teleconference with researchers Sep 2013 onward (missing in June 2014)

Governor's statement on MP Jan and March 2015

Data sources: MPC

MPC: Oct 2016 - Present

[Resolution of MPC](#) Started Oct 2016

[Press conference transcripts](#) Started Oct 2016

[Minutes of meetings](#) Started Oct 2016 (released after 2 weeks)

Data sources

We use:

- All monetary policy *statements* by **Subbarao** and **Rajan**: October 2008 to August 2016.
- All *statements* and *minutes* of meetings of the **MPC**: October 2016 to August 2017.

We do not use:

- Mid quarter press releases (Subbarao), press conferences (Subbarao, Rajan, MPC), teleconference with analysts (Subbarao, Rajan).

No. of regimes

Governor/ Regime	Duration of MP reviews	Statements	minutes
Dr. D. Subbarao	2008-10-24 to 2013-07-30	20	-
Dr. Raghuram Rajan	2013-10-29 to 2016-08-09	17	-
Monetary Policy Committee	2016-10-04 to 2017-08-02	6	5

Table: Governors of the RBI, 2008-2017

Data sources and cleaning

- We read the PDF files as text files.
- We create a corpus for each set of statements.
- We eliminate:
 - punctuations (eg. !, .)
 - stop words (eg. 'the', 'that', 'this')
 - numbers (eg. 0-9)
 - other non-informative words (eg. 'another', 'bank', 'per cent')

Descriptives

Present analysis:

Complexity No. of words (raw counts)

Trends Word clouds

Associations Pairwise correlations across commonly occurring pairs of words

Going forward:

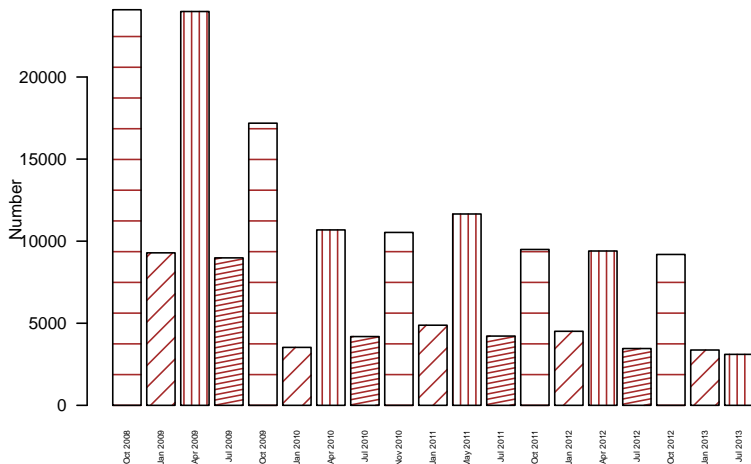
Visualisation Graphs with dates of domestic and external shocks

Part IV

Descriptives

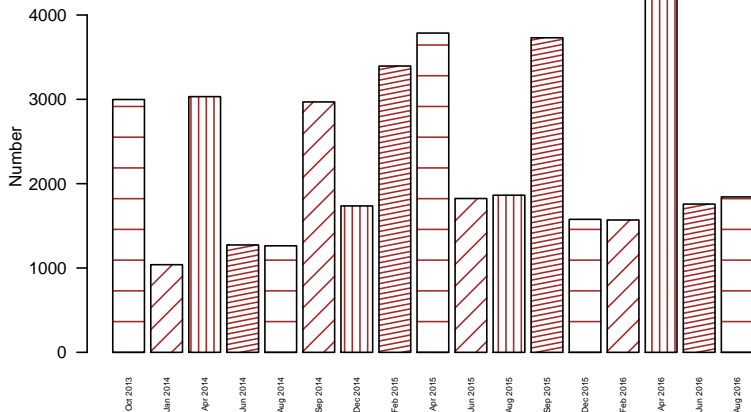
No. of words in Subbarao's statements

Complexity I (post-cleaning)



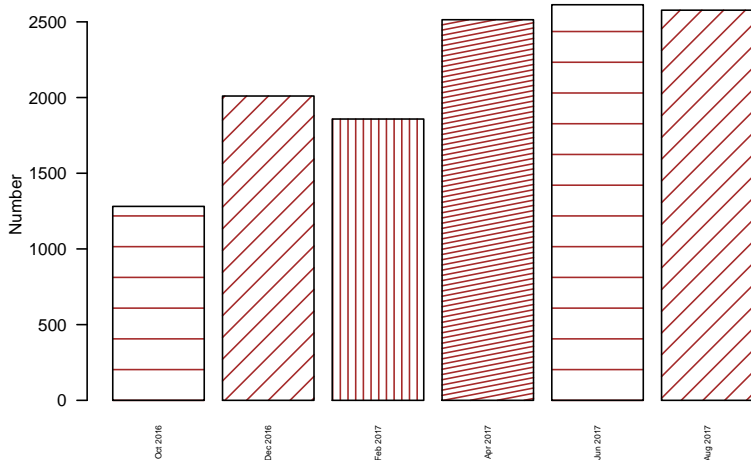
No. of words in Rajan's statements

Complexity II (post-cleaning)



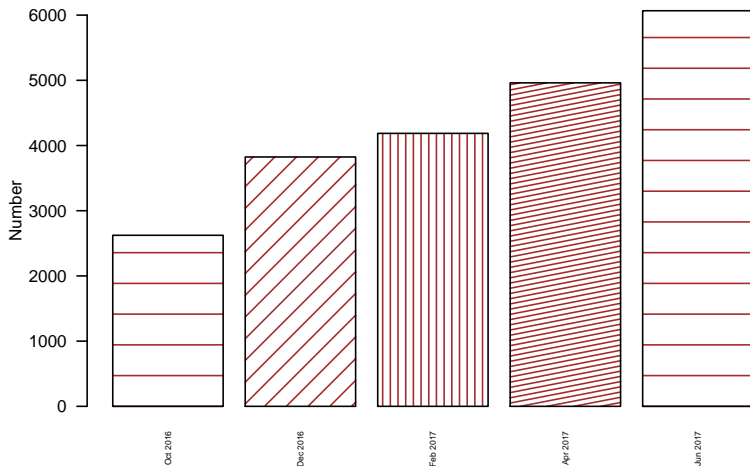
No. of words in MPC's statements

Complexity III (post-cleaning)



No. of words in MPC's minutes

Complexity IV (post-cleaning)



No. of words across regimes

Regime	Mean words
Dr. D. Subbarao	9251
Dr. Raghuram Rajan	2373
Monetary Policy Committee Statements	2142
Minutes	4332

Table: Summary statistics of document lengths, 2008-2017 - I

Most important words: Subbarao

Trends I (using raw frequencies)



Most important words: Rajan

Trends II (using raw frequencies)



Most important words: MPC's statements

Trends III (using raw frequencies)



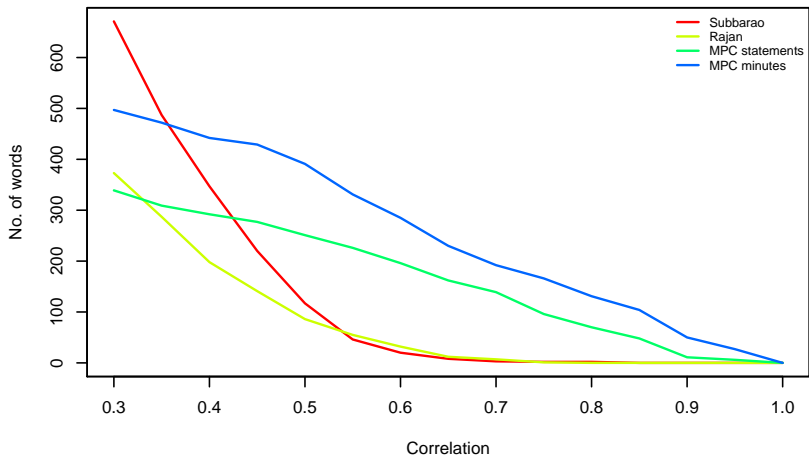
Most important words: MPC's minutes

Trends IV (using raw frequencies)



Associations with 'inflation'

How central is the word to the document?



Part V

Measuring tone

Sentiment analysis

- Very preliminary. Three in-built dictionaries in *tidyr* package in *R*
 - 1 **AFINN** from Finn Arup Nielsen
 - 2 **bing** from Bing Liu and collaborators
 - 3 **nrc** from Saif Mohammad and Peter Turney
- We currently use *bing* as it is binary and each word is defined as “positive” or “negative”
- This reduces the number of words being analysed (on average to $1/10^{th}$)
- We obtain counts of each type of word and define *sentiment* of document d at time t as:

$$sentiment_{d,t} = n.positive_{d,t} - n.negative_{d,t} \quad (2)$$

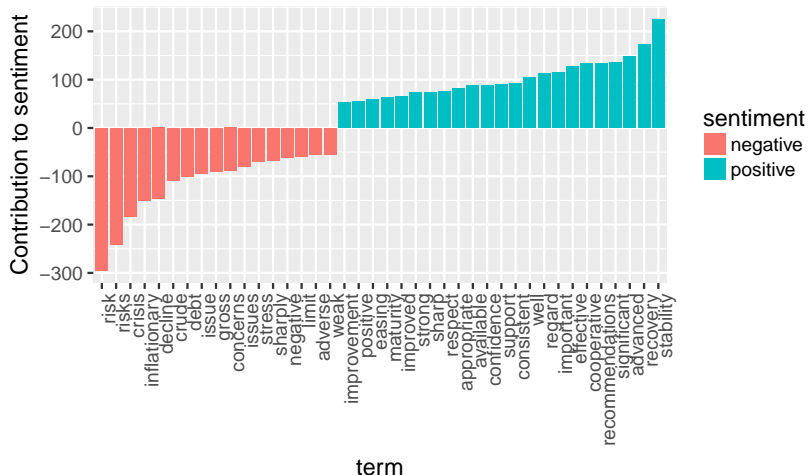
- We then plot these against various series reflecting the economic outlook

Subbarao I

	Document	Negative	Positive	Sentiment
1	2008Oct_Subbarao.pdf	501.00	491.00	-10.00
2	2009Jan_Subbarao.pdf	209.00	210.00	1.00
3	2009April_Subbarao.pdf	392.00	656.00	264.00
4	2009July_Subbarao.pdf	166.00	188.00	22.00
5	2009Oct_Subbarao.pdf	301.00	438.00	137.00
6	2010Jan_Subbarao.pdf	79.00	122.00	43.00
7	2010April_Subbarao.pdf	180.00	365.00	185.00
8	2010July_Subbarao.pdf	69.00	142.00	73.00
9	2010Nov_Subbarao.pdf	156.00	304.00	148.00
10	2011Jan_Subbarao.pdf	93.00	132.00	39.00
11	2011May_Subbarao.pdf	199.00	306.00	107.00
12	2011July_Subbarao.pdf	108.00	92.00	-16.00
13	2011Oct_Subbarao.pdf	186.00	263.00	77.00
14	2012Jan_Subbarao.pdf	127.00	109.00	-18.00
15	2012April_Subbarao.pdf	188.00	288.00	100.00
16	2012July_Subbarao.pdf	113.00	67.00	-46.00
17	2012Oct_Subbarao.pdf	187.00	281.00	94.00
18	2013Jan_Subbarao.pdf	102.00	95.00	-7.00
19	2013July_Subbarao.pdf	88.00	90.00	2.00

Subbarao II

Words contributing most to sentiment

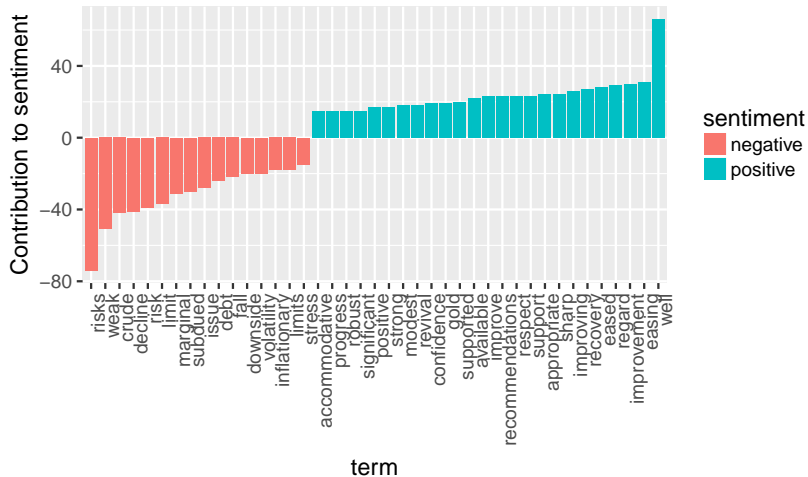


Rajan I

	Document	Negative	Positive	Sentiment
1	2013Oct_Rajan.pdf	37.00	82.00	45.00
2	2014Jan_Rajan.pdf	19.00	24.00	5.00
3	2014April_Rajan.pdf	51.00	103.00	52.00
4	2014June_Rajan.pdf	20.00	49.00	29.00
5	2014Aug_Rajan.pdf	26.00	42.00	16.00
6	2014Sep_Rajan.pdf	48.00	85.00	37.00
7	2014Dec_Rajan.pdf	50.00	63.00	13.00
8	2015Feb_Rajan.pdf	78.00	102.00	24.00
9	2015April_Rajan.pdf	70.00	126.00	56.00
10	2015June_Rajan.pdf	46.00	53.00	7.00
11	2015Aug_Rajan.pdf	43.00	61.00	18.00
12	2015Sep_Rajan.pdf	99.00	85.00	-14.00
13	2015Dec_Rajan.pdf	34.00	42.00	8.00
14	2016Feb_Rajan.pdf	53.00	54.00	1.00
15	2016April_Rajan.pdf	68.00	145.00	77.00
16	2016June_Rajan.pdf	56.00	62.00	6.00
17	2016Aug_Rajan.pdf	47.00	62.00	15.00

Rajan II

Words contributing most to sentiment

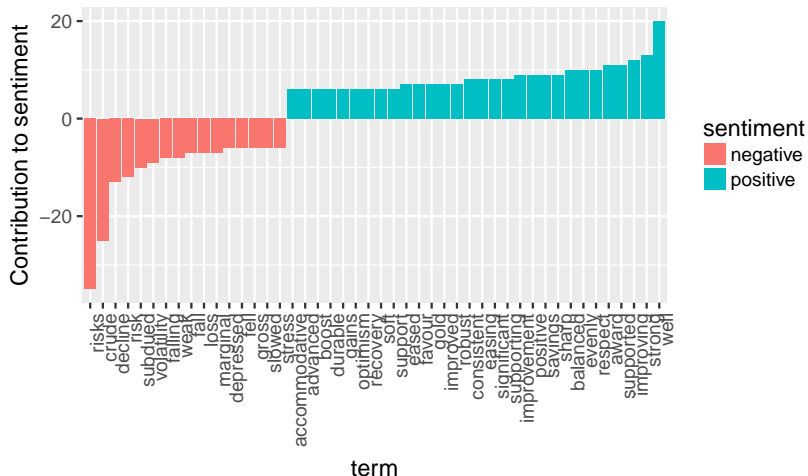


MPC statement I

	Document	Negative	Positive	Sentiment
1	Oct 16-17	23.00	42.00	19.00
2	Dec 16-17	44.00	45.00	1.00
3	Feb 16-17	26.00	50.00	24.00
4	Apr 17-18	46.00	62.00	16.00
5	Jun 17-18	47.00	61.00	14.00
6	Aug 17-18	46.00	55.00	9.00

MPC statement II

Words contributing most to sentiment



Weighting scheme

- Raw counts of words do not give us a sense of the “importance” of the word.
- There are words that may occur many times but are not informative: for e.g., 'the', 'is', 'of', 'that', 'although', 'along', 'statement', 'rather' etc.
- *tf-idf* tells us the frequency of a term adjusted for how rarely it is used.
- It decreases the weight for commonly used words/ terms, and increases the weight for other words that are not very much used
- *tf-idf* weighting is represented as follows:

$$tf - idf = (1 + \log f_{t,d}) \times \log\left(\frac{D}{df_t}\right) \quad (3)$$

- $f_{t,d}$: frequency of term t in document d ; D : No. of documents; df_t : number of documents. in which the term t appears.

Pooled common terms using tf-idf

Regime	Total	Average/ document
Dr. D. Subbarao	3411	180
Dr. Raghuram Rajan	1625	96
Monetary Policy Committee Statements	709	120
Minutes	921	5

Table: Summary statistics of documents, 2008-2017 - II

Part VI

Next steps

Measuring topics

Coverage Extend coverage of statements backwards to April 1998, covering **17 years and 5 Governors**.

Descriptives Repeat with the weighted count of words

Clustering Measuring economic topics using Latent Dirichlet Allocation (LDA)

Measuring tone

Sentiment analysis Measuring tone using central banking specific dictionaries

- Assigning words *positive* or *negative* connotations
- Use existing dictionaries to discern the tone of statements:
eg. **Apel and Blix-Grimaldi** 2012 (for CB communications)
Loughran and McDonald 2011 (for financial context)
General Inquirer's Harvard IV-4 Psychosocial dictionary
- Modify dictionaries to reflect India-specific terms

Forward guidance Measuring amount and direction of guidance

Thank you.