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Analysing monetary policy statements of the Reserve Bank of India

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Abstract

In this paper we quantitatively analyse monetary policy statements of the Reserve Bank of India (RBI) from 1998 to 2017, across the regimes of five governors. We first ask whether the content and focus of the statements have changed with the adoption of inflation-targeting as a framework for conducting monetary policy. Next, we study the influence of various aspects of monetary policy communication on financial markets. Using natural language processing tools, we construct measures of linguistic and structural complexity that capture governor-specific trends in communication. We find that while RBI's monetary policy communication is linguistically complex on average, the length of monetary policy statements has gone down and readability has improved significantly in the recent years. We also find that there has been a persistent semantic shift in RBI's monetary policy communication since the adoption of inflation-targeting. Finally, using a simple regression model we find that lengthier and less readable statements are linked to both higher trading volumes and higher returns volatility in the equity markets, though the effects are not persistent.

JEL classification: E52, E58, G12, G14

Keywords: Monetary policy, central bank communication, linguistic complexity, financial markets, textual analysis, natural language processing.

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1 Introduction

The primary aim of monetary policy is to influence the inflation expectations of economic agents. Future economic decisions of agents depend on expectations of long-term real interest rates, while the central bank only controls the short-term nominal interest rates (Hansen and McMahon, 2016). Consequently, a change in monetary policy through a change in the short-term rate, by itself, may not affect the economic decisions of agents in a significant manner (Blinder *et al.*, 2008). In order to form their own views about future economic developments and the likely responses of the central bank to these developments, agents must look at the entire set of information conveyed by the central bank, both through changes in the short rate, as well as through public communication.

Accordingly, when the central bank announces its monetary policy decision, it uses various instruments of communication to explain its rationale for the policy decision, revealing simultaneously its macroeconomic forecasts, as well as potential future courses of action. This gives economic agents an idea about both the current as well as future economic outlook of the central bank or of the monetary policy committee (MPC) members, and helps form their expectations, thereby effecting long-term rates.[1] Communication is especially important under inflation targeting because the success of such a regime hinges on the effectiveness of transmission of monetary policy announcements.

In this paper, we ask how the monetary policy communication of the Reserve Bank of India (RBI) has changed from 1998 to 2017, across the regimes of five different governors, specially after the adoption of inflation targeting (IT). To do this, we use techniques from computational linguistics to convert the raw text of monetary policy statements into quantitative indicators that measure different aspects of RBI's communication. We then use these measures to study the effects of communication on financial markets.

Specifically, we ask three questions. First, does the *de-jure* move to inflation targeting get reflected in the manner in which RBI communicates its monetary policy decision?[2] We look for the most frequently used words in the monetary policy statements of each governor's regime and visualise them in wordclouds. Our analysis indicates that there has been a persistent semantic shift in the content of RBI's monetary policy statements since the official implementation of inflation targeting and setting up of the MPC in October 2016. Since then there has been a clear shift to the word 'inflation' as well as words related to inflation such as 'fuel', 'food' etc, from words frequently used in the pre-IT years when monetary policy followed a multiple-indicator approach (such as 'exchange rate', 'exports' etc). This shift is also apparent in the manner in which macroeconomic developments in the global and domestic arena are discussed in the statements, with an explicit focus on upside or downside risks to inflation. Our finding may not be surprising given India's move to inflation targeting, but it does reinforce the intuitive appeal of our technique.

Second, how has the linguistic complexity of monetary policy statements of RBI evolved over the last two decades? To explore this we use two indicators: length and readability of monetary policy statements. Length is the number of words used in the statement. It may be regarded as a simple indicator of complexity, less prone to measurement error, and easily replicable. On the other hand, lengthier statements might still be easy to read, so we complement our analysis by using a standard index of readability (the Farr-Jenkins-Paterson, henceforth FJP, index), which

[1] See Woodford (2005) for an overview on the role of central bank communication.

[2] In a similar vein, Masayuki and Yosuke (February 2017) evaluate how Governor Kuroda's communication strategy changed in 2016 after the introduction of negative interest rate policy, and Acosta and Meade (2015) show how unusual the December 2008 meeting of the FOMC was, when it added discussions on balance sheet and asset purchase programs.

counts the number of one syllable words per 100 words. Lower values of the index indicate lower readability.

Prior to the adoption of IT, RBI's monetary policy statements were on average lengthier and less readable, compared to those issued in the post-IT era. In the pre-IT regime, the average monetary policy statement was roughly 13,000 words; since IT adoption, this has fallen by three-quarters to 3084 words.[3] By comparison, since 2000, the average Federal Open Markets Commitee (FOMC) statement in the US has been roughly 500 words. Readability of RBI's statements, as measured by the FJP index, is fairly low on average, but has improved with the advent of the IT regime. There is some evidence that the improvement in readability and shortening of statements may have partly been a function of governor-specific factors, and not just of the shift to IT alone.

Finally, what is the effect of RBI's monetary policy statements on the financial markets? Communication about the central bank's or the MPC's current and future economic outlook can have an important effect on financial markets – provided that communication is clear. We econometrically analyse the association between linguistic complexity of monetary policy statements and equity market activity, using an ordinary least squares regression framework. We hypothesise that lengthier or more complex statements are cognitively more taxing on the readers and hence increase equity market trading volumes as well as returns volatility.[4] This is because there is a greater likelihood for market participants to diverge in their interpretation of the information conveyed in lengthier and complex statements (Jansen, 2011). Our hypothesis is supported by theoretical research on the topic, for example by Atmaz and Basak (2018), who show in the context of a dynamic general equilibrium model with CRRA investors that dispersion of beliefs increases stock price volatility. In general, communication may be undesirable if it is of bad quality or noisy enough to increase stock market volatility (Geraats, 2002; Ehrmann and Fratzscher, 2007) or to crowd out private information (Shin and Morris, 2000).

There are two confounding factors that might effect our results. First, a statement containing a monetary policy surprise might end up driving equity market volumes or volatility. If we do not control for this announcement effect, or interest rate surprise, we would end up mistakenly attributing any observed relationship to complexity or length of the statement. Therefore, we calculate monetary policy surprise for each meeting using the methodology of Kamber and Mohanty (2018), and control for that in all our analysis. Another issue may be that statements may themselves be longer or more complicated when the overall macroeconomic situation is more complex or uncertain. However, our results hold when we account for governor regimes, year shocks, previous week's returns volatility or trading volumes, global and domestic economic uncertainty, and domestic macroeconomic fundamentals.

We find that a 1% increase in the length of a statement (which translates to roughly 115 words) is correlated with 0.37% increase in equity market volatility over the week following the monetary policy announcement, and 0.21% increase in trading volumes. We also find that an improvement in readability of statements lowers the volatility of returns. The strength of this transmission seems to have declined since 2013 when variation in statement length and readability reduced significantly.

Our work relates to two main strands of literature: (i) quantification of central bank communication using tools from computational linguistics, and (ii) analysis of how central bank commu-

[3]For context, an average Masters thesis in economics is roughly 10,000 words; an average financial disclosure (10-K) filing a non-financial firm in the US is 38,000 words (Loughran and McDonald, 2014).

[4]This is echoed by central bankers themselves. For example, in a speech on 02 May, 2018, Jens Weidmann, President Deutsche Bundesbank & Chairman of Board of Directors of the BIS, said: *"Central banks should communicate as precisely as possible, because if their signals are not clear enough, the result can be unwanted volatility in the markets, which can also spread to developments in the real economy."* (Weidmann, 2018)

nication affects financial markets. There is a burgeoning literature that sits at the intersection of these two fields.[5]

Acosta and Meade (2015) find that the over time FOMC statements have become longer, and more complex and the semantic content of the statements is quite variable across the years. In Smales and Apergis (2017), the authors analyse the complexity and readability of FOMC statements. Using information on returns and trading volumes in three futures markets (S&P 500 Index, 10-year Treasuries and the USD Index), they find that lengthier and more complex statements result in greater volatility and trading volumes. They additionally find that financial markets are more responsive to monetary policy language and decisions during recessions. Our study is closely related to their paper.

Rosa (2016) analyses the effects of different Federal Reserve communications on intra-day asset prices. He finds that in particular, FOMC statements and minutes significantly increase both the volatility and trading volume of asset prices. Picault and Renault (2017) develop their own field specific lexicon to measure the monetary policy stance of the European Central Bank (ECB), and find that their indicator explains future monetary policy decisions. They find that stock markets are more volatile following an ECB conference with a negative tone. Other important contributions include those by Ranaldo and Rossi (2010), who use intra-day asset price data and find significant price effects of Swiss National Bank communication on bond, currency, and equity markets and Hendry and Madeley (2010), who investigate the kind of information from Bank of Canada's monetary policy statements that moves markets., They find an increase in volatility of short-term interest rate returns and futures whenever there is a discussion of major shocks hitting the economy.

Depending on whether the focus is on content or tone, the literature finds differences in persistence of communication effects and their impact on real economic variables. Hansen and McMahon (2016) extract information on the content of FOMC statements, in particular on the state of the economy and forward guidance. They find that forward guidance has historically been more important than other types of information (similar to the finding of Conrad and Lamla (2010) for the EU). Using a factor augmented vector autoregression model, they confirm that none of the categories of communication has very strong or persistent effects on real economic variables. In contrast, Hubert and Labondance (2017) find that positive exogenous sentiment shocks increase private short-term interest rate expectations, and that the effect is persistent, helps predict next policy decisions, and impacts inflation and industrial production.[6]

There also exists a large literature which looks at readability and complexity of financial disclosures, and the implications for the stock market. Loughran and McDonald (2014) demonstrate that traditional readability indices - such as the Fog index - when applied to financial disclosure (10-K) forms by US firms do not perform well in explaining abnormal firm returns or volatility after filing. This is because they penalise the use of multisyllabic words, which may be commonly used (and therefore not likely to be misunderstood) by a specialist audience. They argue for using the size of the 10-K file as a better proxy for readability. They find that after controlling for all other factors, larger 10-K files have significantly higher post-filing abnormal

[5]There are also papers that use text mining and computational linguistics to study other aspects of central bank communication that we do not consider here. For example, Ehrmann and Fratzscher (2007) study optimal monetary policy communication for Bank of England, Federal Reserve, and the ECB. Bennani and Neuenkirch (2017) study the determinants of the tone of speeches by ECB Governing Council members. They find that the most important factors are home inflation and growth and differences in these variables across countries. In addition, governor preferences seem to matter too.

[6]Other papers that study the tone of CB statements include Lucca and Trebbi (2009) for the US, and Galardo and Guerrieri (2017); Tobback *et al.* (2017) for the ECB. As argued in Rosa (2011), focusing more on equity market volatility allows us to abstract from the tone of the statement, but the drawback is that we cannot determine whether markets moved as intended.

return volatility.[7] This is similar to our finding that longer the monetary policy statement of the RBI, the more volatile the stock market returns in the post-announcement period.

Our paper is similar to the above-mentioned studies in that we undertake quantitative analysis of central bank communication and analyse its impact on financial market variables. However instead of conducting a sentiment analysis which is dependent on the use of existing dictionaries developed in the advanced economies, we focus on other aspects of central bank communication such as linguistic complexity. This seems to be a good starting point for our technical analysis, especially for India where English is not the native language.[8]

To the best of our knowledge, ours is the first study that quantitatively analyses the RBI's monetary policy communication. India provides an interesting case study to analyse the effectiveness of central bank communication, for atleast two reasons. First, it is a major emerging market economy that has only recently adopted inflation targeting. This marks a significant departure from the multiple-indicators approach (see, for example, Mohan (2008)) that governed the conduct of monetary policy in the pre-IT era. In this context, it is interesting to study how the adoption of IT may have shaped communication and how linguistic complexity of the statements may be affecting the financial markets, if at all. Second, the relevant literature on India finds that monetary policy transmission from the short term policy rate is generally weak (see, for example, Mishra *et al.* (2016); Das (2015a); Sengupta (2014); Bhattacharya *et al.* (2011); Aleem (2010)). Nothing however is known about monetary policy communication in India, or the role played by it in the process of transmission of monetary policy (see, for example, Weidmann (2018); Hildebrand (2006)). Our paper sheds light on the possibility that transmission might be further impeded or affected adversely by poor monetary policy communication.

To understand the influence of RBI's communication on monetary transmission, one would ideally study the impact on the bond market, which reflects the long-term rates, and the currency market, which captures the exchange rate channel of transmission. In the case of India however, we do not have access to high frequency, daily data on the bond market. In addition, the Indian bond market is not a very liquid market, especially when we consider our 20-year sample period. In case of the currency market, the RBI regularly and actively intervenes in this market which could distort our estimates of the effect of RBI's communication on the currency market. Therefore, we look at the effect on equity market, also because it maybe considered the clearest channel of monetary transmission on account of being very liquid and reacting quickly to information.

Our analysis yields important policy implications. The RBI seems to be using a lot of inputs for its monetary policy decision, but there are significant benefits from clear and concise communication. We find that part of this has already been achieved through the legal mandate of IT. As mentioned earlier, our study is also relevant in the context of monetary policy transmission. A study of the linguistic complexity of RBI's communication and its effect on financial markets can help understand the importance of the *manner* in which RBI conveys information in its monetary policy statements. For example, if the statements are on average too long or too complex to comprehend, then the transmission to financial markets is likely to be weak, which is what we find in our empirical analysis. This in turn may adversely affect the pursuit of monetary policy objectives by RBI.

The rest of the paper is organised as follows. In section 2, we trace the evolution of monetary

[7] Other papers along the same lines include Lawrence (2013); Lehavy *et al.* (2011); Li (2008). Just like in our work, these papers rely on readability indices and length of disclosure statements and number of sentences as measures of complexity. A notable recent exception is Hwang and Kim (2017), who measure readability against the guidelines published by the SEC.

[8] In our future work we plan to conduct sentiment analysis of RBI's monetary policy statements by constructing an India-specific dictionary.

policy in India across the tenures of different governors and highlight the manner in which communication is now conducted under the new IT regime. In section 3, we discuss the data and provide a comprehensive descriptive analysis. In section 4 we analyse the possible effect of various aspects of RBI's communication on India's equity markets. Finally, in section 5, we conclude by delineating ideas for future research and policy recommendations.

2 Monetary policy in India: From governor to MPC

Communication about future policy rates can take two forms (Campbell *et al.*, 2012; Moessner *et al.*, 2017): one where the central bank forecasts macroeconomic performance and likely monetary policy actions, keeping forward guidance as either open-ended, or time or state-contingent and the second where the central bank commits itself to some future monetary policy actions. The RBI has traditionally followed the former.

This is laid out explicitly in the RBI's own communication strategy document (Page 2, RBI (2008), emphasis ours):

> This communication policy is best described as *principle-based* rather than *rule-based*.
>
> The RBI's approach to communicating the policy stance is to explain the stance with rationale, information and analysis but to *refrain from explicit forward guidance* with a preference for market participants and analysts to *draw their own inferences*.
>
> Where projections on the future path of key macroeconomic variables are provided, they *have to be set out in conditional forms and linked to incoming information* with an assessment of the balance of risks.

Until recently, the RBI followed a multiple indicator approach in the conduct of its monetary policy. This meant that the RBI would take into consideration a number of macroeconomic factors such as exchange rate, trade balance, unemployment etc, in addition to inflation and gross domestic product (GDP) growth, while deciding on the policy rate. Till the early 2000s, the bank rate was used as signaling rate to reflect the monetary policy stance. This was also the time when the cash reserve ratio (CRR) was actively used to manage liquidity in the system. From 2000 onwards, there was a shift towards using the repo rate (the rate at which the banks borrow from the RBI) and the reverse repo rate (the rate at which RBI borrows from the banks) and gradual phasing out of the CRR as a monetary policy instrument. A significant development in this period was an institutional innovation by the RBI to manage its own open-market operations. The new institution, termed the liquidity adjustment facility (LAF), was introduced in June 2000. It operates through repo and reverse repo auctions, thereby setting a corridor for the short-term interest rates, consistent with the policy objectives (Hutchison *et al.*, 2013).

Monetary policy stance during this pre-IT era was communicated primarily through governors' statements, but also often through circulars published on the RBI's website. For example, during governor Jalan's tenure, nearly 71% of communication was via circulars whereas with the MPC, this has gone down to zero (table 1). The schedule of statements or announcements was not usually announced in advance, and the interval between two consecutive statements was also not fixed. It changed across governor regimes and sometimes within the same governor regime as well. We discuss the communication of monetary policy in greater detail in section 3.

In February 2015, during the tenure of governor Raghuram Rajan, the RBI and the Indian

Ministry of Finance signed a monetary policy framework agreement, which paved the way for the implementation of a well-defined IT regime. The RBI Act was amended in 2016 to this effect (RBI, 2016). The amended Act mentions IT as an explicit objective of India's monetary policy. According to the law the RBI is now responsible for achieving a target consumer price index (CPI) inflation of 4% in the medium term, with a flexible band of 2% in both directions. The policy instrument to be used to achieve this objective is the repo rate alone. The decision on the repo rate is no longer taken just by the RBI governor but by an MPC chaired by the governor.

The formal operating procedure of IT was operationalised in October 2016 which is when the MPC met for the first time. The MPC consists of three members from outside the RBI, an executive director of RBI, a deputy governor of RBI who is in charge of monetary policy and the RBI governor. The policy rate is decided by a majority vote of the MPC members, with the RBI governor holding a casting vote in case of a tie. From October 2016 onwards, the official monetary policy communication consisted of a statement issued by the RBI, conveying the overall decision as well as current and future economic outlook of the MPC, along with supporting arguments by each of the six members and their votes.

The monetary policy communication strategy as a whole also got significantly streamlined under the new IT framework. The MPC meets six times a year.[9] Starting March 2018, the meeting schedule of the MPC for the entire year is put up on the RBI's website. The meeting lasts two days and on the second day at the end of the meeting, the governor of RBI conducts a press conference at 2pm where they announce the decision of the MPC. The monetary policy statement (called *Resolution of the Monetary Policy Committee*) containing the decision on the policy rate, as well as the accompanying analysis, is also published on RBI's website around the same time. The minutes of the MPC meeting are released after two weeks.

The resolution document is organised into three sections and is significantly more comprehensive compared to the pre-IT period when it used to be more detailed and verbose. The first part of a typical MPC resolution statement contains information regarding the monetary policy stance (accommodative, tightening, or neutral), and any changes to the policy repo rate, while reaffirming the medium term inflation target.

An example is given below, from the Oct 2016 meeting:

> *On the basis of an assessment of the current and evolving macroeconomic situation at its meeting today, the Monetary Policy Committee (MPC) decided to reduce the policy repo rate under the liquidity adjustment facility (LAF) by 25 basis points from 6.5 per cent to 6.25 per cent with immediate effect. (...) The decision of the MPC is consistent with an accommodative stance of monetary policy in consonance with the objective of achieving consumer price index (CPI) inflation at 5 per cent by Q4 of 2016-17 and the medium-term target of 4 per cent within a band of +/- 2 per cent, while supporting growth.*

The second part of the resolution contains an assessment of conditions that have gone into the committee's decision. This starts with a discussion of global macroeconomic conditions and the state of international financial markets in key advanced and emerging economies. For example, a key concern since 2016 has been spillovers from monetary policy normalisation and other policy uncertainties in advanced economies.

This is followed by discussion of the domestic economic conditions. In this part, the MPC discusses trends in agriculture, industry, and services, with emphasis on monsoon forecasts and sectoral performances, the external sector specially the current account imbalances as well as

[9] In the first year of its inception (2016-17) the MPC met three times (October, December and February). Thereafter in 2017-18 the MPC met six times (April, June, August, October, December and February).

liquidity conditions in the domestic banking system. Consider the following from Feb 2017, which was three months after demonetisation[10] (emphasis ours):

> *Agriculture and allied activities posted a strong pick-up, benefiting from the normal south-west monsoon, robust expansion in rabi acreage (higher by 5.7 per cent over the preceding year) and favourable base effects as well as the continuing resilience of allied activities. In contrast, the industrial sector experienced a sharp deceleration, mainly due to a slowdown in manufacturing and in mining and quarrying. Service sector activity also lost pace, concentrated in trade, hotels, transport and communication services, and construction, cushioned to some extent by public administration and defence. (...)*
>
> *The large overhang of liquidity consequent upon demonetisation weighed on money markets in December, but from mid-January rebalancing has been underway with expansion of currency in circulation and new bank notes being injected into the system at an accelerated pace. Throughout this period, the Reserve Bank's market operations have been in liquidity absorption mode.*

The final section is on the overall economic outlook, where forecasts of inflation and growth are provided, projected deviations from inflation target are discussed, and risks to the upside/ downside are laid out. From Feb 2018 (emphasis ours):

> *The MPC notes that the economy is on a recovery path, including early signs of a revival of investment activity. Global demand is improving, which should help strengthen domestic investment activity. The focus of the Union Budget on the rural and infrastructure sectors is also a welcome development as it would support rural incomes and investment, and in turn provide a further push to aggregate demand and economic activity. On the downside, the deterioration in public finances risks crowding out of private financing and investment. The Committee is of the view that the nascent recovery needs to be carefully nurtured and growth put on a sustainably higher path through conducive and stable macro-financial management*

The statement ends with the voting record of the MPC members. 6 out of the 10 MPC decisions in our sample have had at least one dissenting member.

A cursory glance reveals that with the adoption of IT, there have been substantial changes in RBI's monetary policy communication. The resolution statements contain a wealth of information about the current and expected state of the economy, which can be used by agents to formulate their expectations.[11]

3 Data and descriptive statistics

Our study covers the period October 1998 to June 2018. The sample is dictated by the availability of monetary policy statements on the RBI's website. During this period, the RBI followed a multiple-indicator approach from 1998 to 2016, and an IT regime between 2016-2018. Governors

[10] On November 8, 2016 the Government of India announced demonetisation of the Rs500 and Rs1000 banknotes, effectively withdrawing 86% of the cash in circulation at the time.

[11] For example, consider the following article written by the chief economist of a large Indian private sector bank in July 2017: "A repo rate cut is likely, but RBI's view on inflation will be of interest" (Saugata Bhattacharya, LiveMint, 26 July, 2017: https://bit.ly/2ORZl2F). The article discusses how markets had largely priced in a rate cut in for the next meeting in August 2017, which came to pass, and what inputs the MPC may use to make their decision.

Table 1 governors of the RBI, 1998-2018

Governor	Term	Instruments of communication	Statement intervals
Dr. Bimal Jalan	1997-11-22 to 2003-09-05	Statements (11); circulars (27)	6 months
Dr. Y.V. Reddy	2003-09-06 to 2008-09-05	Statements (17); circulars (5)	3, 4, 6 months
Dr. D. Subbarao	2008-09-05 to 2011-09-04 2011-09-05 to 2013-09-04 (COB)	Statements (20); circulars (11); mid-quarter reviews (8)	3 months
Dr. Raghuram Rajan	2013-09-04 to 2016-09-04	Statements (17); circulars (3); mid-quarter reviews (1)	2, 3 months
Dr. Urjit Patel (MPC)	2016-09-04 to 2018-06-06	Statements (12)	2 months

Bimal Jalan, Y.V. Reddy, D. Subbarao, Raguram Rajan belonged to the first era, while Urjit Patel belongs to the second era.[12]

The respective tenures of the governors during our sample period, and the instruments of monetary policy communication used by each of them are shown in table 1. In addition to monetary policy statements, the governors have often used circulars to convey monetary policy decision and/or stance. The periodicity of these instruments has also varied across governor regimes.

While different governors have resorted to different instruments of monetary policy communication at different frequencies, statements have been consistently used by each of them. Hence, we use the information content of the monetary policy statements for the purpose of our analysis. More details about monetary policy announcements in each governor's regime and the patterns of communication are given in appendix A.

3.1 Length: Indicator for statement complexity

We count the number of raw words (or tokens) and the number of sentences in each document for every governor regime, and treat these as rough proxies for the linguistic complexity of statements. The main idea is that longer statements are more deterring and require higher costs of information-processing (Li, 2008). Table 2 shows the average length of statements in each regime, as measured by the number of sentences and words.

As can be seen, the statements are usually longer and more complex the farther back we go back in time. We find that the statements during governor Reddy's time were the lengthiest and those of the MPC have been the least verbose. There was a marked decline in length of statements when Subbarao became the governor. The average length of statements came down from about 720 sentences to 440 sentences. We also find that while governor Rajan informally introduced IT in February 2015, there was a significant decline in the length of the statements from the time he took office in 2013. These patterns can be seen in figure 1 and table 2. These observations indicate the role played by governor-specific factors in guiding communication even before the formal adoption of IT.

The MPC statements are still roughly six times longer than both FOMC (average of just 22 sentences and 564 words each) (Acosta and Meade, 2015), and ECB monetary policy statements (average of 504 words each) (Tobback *et al.*, 2017).

[12]While inflation targeting was formally operationalised in October 2016 during the tenure of governor Urjit Patel, RBI has been implicitly following an IT framework from February 2015 onwards under the governorship of Raghuram Rajan.

Table 2 Average length of statements & readability, 1998-2018

Governor	Statements	Sentences	Words	Readability (mean FJP*)	Readability (SD of FJP*)
Dr. Bimal Jalan	10	571.60	16471.20	-56.712	0.858
Dr. Y.V. Reddy	17	719.82	20361.65	-56.276	1.193
Dr. D. Subbarao	20	440.25	13323.25	-51.990	2.550
Dr. Raghuram Rajan	17	134.47	3295.00	-53.533	2.057
Dr. Urjit Patel (MPC)	12	133.1	3072.10	-51.880	2.040

*: Based on Farr-Jenkins-Paterson readability index, discussed in section 3.2 .

We also find there is a governor-specific cylicality in the length of statements, which is often directly related to the *type* of statement. For example, for governors Reddy and Subbarao, the April statement (which set the monetary policy for the upcoming financial year), and the October statement (which presented a mid-year review), were 8000-12000 words lengthier on average. The other statements were considerably shorter in length, as can be seen in table 13, thereby leading to substantial heterogeneity within as well as across governors and statements.

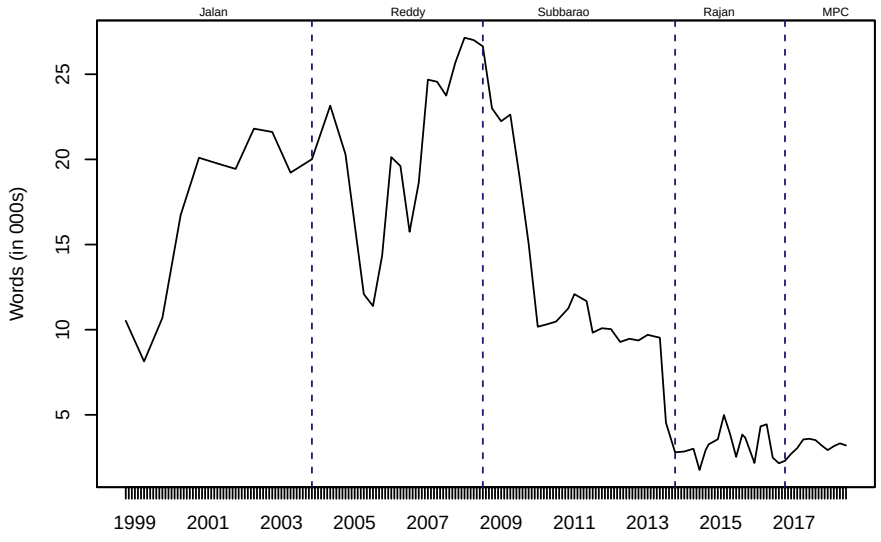
Table 3 Key variables pre and post-Governor Rajan

Note: This table shows a t-test of mean differences in length and readability between pre-governor Rajan and post-governor Rajan regimes, as well as before and after the move to inflation targeting.

Variables	Pre-Rajan	Post-Rajan	t-value	Pre-IT	Post-IT	t-value
No. of words	16479.29	3202.75	10.62***	14531.08	3323.05	8.72***
No. of sentences	604.50	131.61	11.58***	534.00	138.43	9.11***
Farr-Jenkins-Paterson	-54.31	-52.96	−2.21**	-54.37	-52.36	8.72***
Note: *p<0.1; **p<0.05; ***p<0.01						

Figure 1 Time series of statement length

Note: This graph shows the 2 statement rolling average of the length of statements as measured by the number of words across the five governor regimes.



3.2 Readability: Indicator for statement signal clarity

We are interested in capturing the clarity with which the information contained in each statement is conveyed to market participants. The hypothesis here is that when governors use complicated language to talk about current and future economic outlook, these participants are unable to clearly understand or interpret what they mean and therefore, unable to accurately

form their expectations. This creates a wider degree of dispersion in participants' beliefs, which gets reflected in higher financial market volatility (Atmaz and Basak, 2018).

One dimension of complexity is, as discussed earlier, the number of words used. Longer statements are cognitively taxing on the reader. It is equally important to take into account the grammar and structure of the statements. To this end, we need to be able to quantify the readability and lexical diversity of the statements.[13]

We use the Farr-Jenkins-Paterson index (henceforth, FJP) (Farr *et al.*, 1951). It counts the number of one syllable words per 100 words.[14,15] In table 14, we show that the FJP index is highly correlated with other commonly used measures.

$$FJP\ reading\ ease \quad = \quad 1.599\frac{no.\ one\ syllable\ words}{100\ words} - 1.015\frac{total\ words}{total\ sentences} \\ -31.517 \tag{1}$$

The FJP index has a negative sign. The interpretation is that lower the index value (eg. −50), the less readable a statement is. As an example, consider the following sentences from the Feb 2018 MPC statement, in order from most to least readable sentences:

> *"Merchandise exports bounced back in November and December."* (FJP = -38.83)
> *"The MPC notes that the inflation outlook is clouded by several uncertainties on the upside."* (FJP = -45.78)
> *"On the downside, the deterioration in public finances risks crowding out of private financing and investment."* (FJP = -46.96)
> *"Accordingly, the MPC decided to keep the policy repo rate on hold and continue with the neutral stance."* (FJP = -48.72)
> *"After rising abruptly in November, food prices reversed partly in December, reflecting mainly the seasonal moderation, albeit muted, in prices of vegetables along with continuing decline in prices of pulses."* (FJP = -61.48)

Over the 20 year period under study, the statement-wise index has ranged between −48 and −59. It picks up inter-governor and intra-governor variation as well. Inter-governor variation is shown using averages from all the statements of each regime in figure 2. The statements during governor Jalan and governor Reddy appear to be the least readable going by the FJP index. These statements are also the lengthiest in the entire sample period as shown in table 2. The readability rises sharply during governor Subbarao and falls marginally during governor Rajan. This may be because governor Rajan used more complex words with lesser proportion

[13]The most commonly used readability indicator in the literature is the Flesch-Kincaid grade level index, which gives the number of years of US education required to read and understand a text. There are two drawbacks of this index that make it less useful for our case. India is not a native English speaking country. When we apply this index to the RBI's monetary policy statements, we find that it is unequipped to pick up the variation in communication strategies across the governors: the range of the index is only 1.8 years, from 14.7 years to 16.5 years, over a 20 year period. This tells us that the statements are complex on average, but not how their complexity has changed over the years, which is what we are primarily interested in.

[14]Note that in some cases using words with higher syllable counts might be a necessity. For example, *monetary* has 4 syllables while *liquidity* has 5 syllables, but both are unavoidable in a monetary policy statement. In other situations, there may be a choice. For example, consider the following synonyms: *rising*, which is 2 syllables; *increasing*, which is 3 syllables; and *accelerating* which is 5 syllables. This is echoed in Loughran and McDonald (2014).

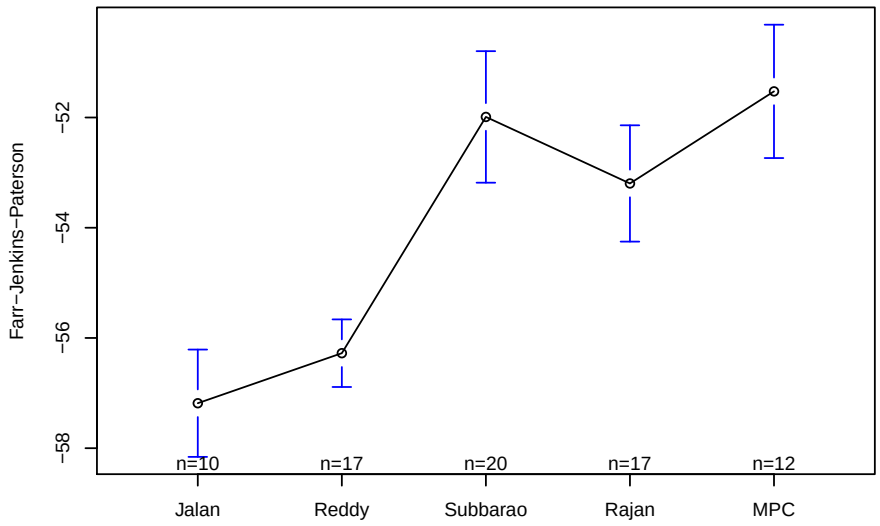
[15]Construction of the FJP index is the same in spirit to another commonly used index, Gunning-Fog (Gunning, 1952), which is used specially in the literature analysing complexity of financial disclosure forms. The two main differences are that first, the FJP considers words with more than one syllable "complex", whilst for the Gunning-Fog it is words with more than two syllables, and the second difference is on the weights.

of mono-syllabic words as compared to governor Subbarao. The readability of RBI's monetary policy statements improves with the shift of communication to the MPC.

Like in the case of the length, we find that readability of the monetary policy statements issued during Subbarao's time was on average higher than the previous two governors' regimes. In fact the average readability of Subbarao's monetary policy statements is very similar to that of the MPC's. This once again hints at the possibility that while the switch to IT may have improved monetary policy communication of the RBI, there are governor specific factors at play as well. Subbarao's regime appears to be an interesting one when statements were longer on average than the MPC's but almost equally readable, even though the variation in readability was higher (table 2). When we divide the sample between pre and post-IT periods (table 3), we find that the statements in the post-IT period are significantly shorter in length and also more readable.

Figure 2 Farr-Jenkins-Paterson (1951) readability index

Note: This graph shows the evolution of the average FJP readability index across the five governor regimes. The index is negative - and lower index values imply lower readability. The horizontal axis measures the number of statements per governor.

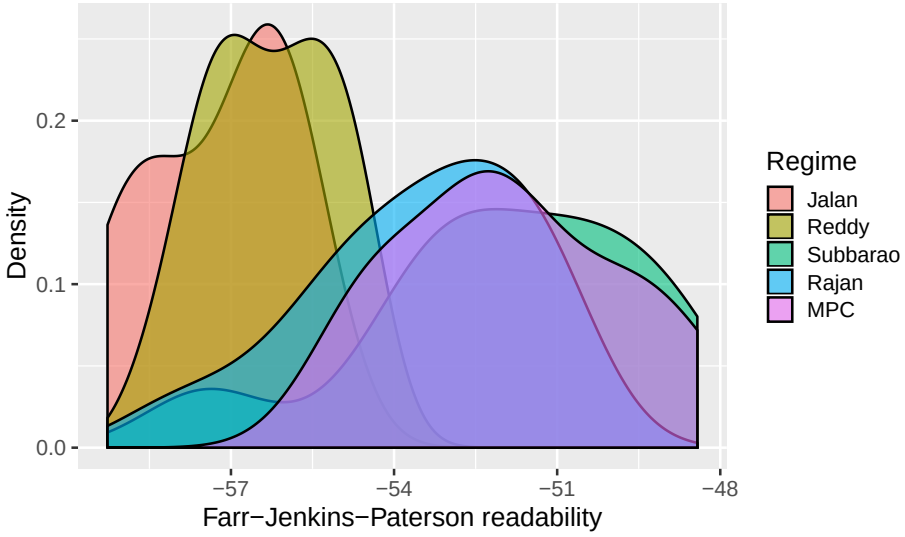


The extent of intra-governor variation is shown in figure 3. This graph shows the density plots of readability, measured by the FJP index, for each regime. Lower values of the FJP mean less readable statements, and so in this graph, the x-axis reads from *least readable* to *most readable* from left to right. We can see from this graph that even though the inter-governor averages are different, there is substantial overlap in the distributions of the FJP index across regimes. This implies that averages could be hiding the heterogeneity in readability within each regime. For example, within the MPC regime, we find that there is significant variation in the readability of the statements. While the MPC regime itself may exhibit a higher readability on average, some of the statements may be less so and may infact be similar to the less readable statements from other regimes.

Hence, to facilitate the use and interpretation of this readability indicator, in our subsequent empirical estimations, we use the FJP index to cluster our statements into three buckets of low, medium, and high readability. We exploit the inter- and intra- governor variation to create these clusters. The construction of these clusters is done as follows. First, we scale the FJP index series to have cross-sectional mean, $\mu = 0$ and standard deviation, $\sigma = 1$. After this, we

Figure 3 Density of FJP readability index for all governors

Note: This graph shows the density plots of readability, measured by the Farr-Jenkins-Paterson (1951) index, for each regime. Lower values of the FJP mean less readable statements, and so in this graph, the x-axis reads from *least readable* to *most readable* from left to right.



compute the standard euclidean distance between every pair of statements, i and j:

$$distance_{i,j} = \sqrt{(x_i - x_j)^2} \tag{2}$$

The final distance matrix measures the *similarity* of the statements to one another based on the readability index. We then use hierarchical clustering to get the final set of $k = 3$ clusters denoting low, medium, and high readability.[16] The algorithm starts off by treating each observation as a separate cluster and then repeatedly does the following two things: identifying the two closest clusters and then merging the two most similar clusters. This process continues until no more clustering is possible.

Table 4 shows the average values of the FJP for each cluster with some sample statements, while table 16 in the appendix shows the number of words, repo rate decision, and readability cluster for all the statements in the corpus. Note again that we are clustering so that the index can be used in the regressions. The advantages are two-fold. First, we can say clearly which statements are distinct from each other in terms of readability (eg. a -45 score may not be very different from one that is -43.5 when we consider the entire history of communication). Second, using these clusters greatly enhances interpretation of the results.

Table 4 Converting the raw FJP to low, medium, and high readability clusters

Cluster	Interpretation	Mean Farr-Jenkins-Paterson index	SD FJP	Eg. statement
1	Low readability	-56.19	1.38	Jalan (Apr 2003) Reddy (Oct 2006)
2	Medium readability	-52.50	0.59	Subbarao (Jan 2009) MPCS (Apr 2017)
3	High readability	-49.98	1.01	Subbarao (Jul 2013) Rajan (Dec 2014)

[16]The number of clusters k is chosen by the researcher. In our case, the choice of 3 clusters is motivated simply by ease of interpretability, i.e. low, medium, and high readability.

3.3 Word clouds

Next, we look at the variables that each governor gives emphasis to in their statements, through word clouds. The hypothesis is that the MPC's wordcloud would be dominated by the words "inflation/prices" and related words, while those of the previous regimes would not be. In the process, we aim to discover the implicit focal variables for the RBI over the past 20 years.

To construct word-clouds, we first process the raw statements, removing spaces, punctuation marks and other special notation, stopwords, numbers, and uninformative words (e.g. names of months or days, websites, Reserve Bank of India, verbs, etc) from our term-document matrices. We also bring all words down to lower cases and stem them using the Porter-stemming algorithm. The final matrix of words[17] is considerably smaller than before, containing approximately 81,100 words across 76 documents, and five Governor regimes. This is only about 9.5% of the total words in the raw corpus.

In the processed term-document matrix, we count the raw frequencies of each word, arrange it in descending order, and then narrow the set down to those words that occur atleast four times.[18] The word cloud is created with a limit of 40 words, purely based on space considerations.[19] We present the results from this exercise in Figure 4. The size and colour of the words is directly proportional to their frequencies.

The word *inflat** appears for the first time during Reddy's regime and does not appear for Jalan. It appears more frequently in Subbarao's statements compared to Reddy. This is intuitive given that India was experiencing high CPI inflation during Subbarao's tenure. The word *interest* appears to be most most frequently used by Jalan and does not appear in the word clouds for Rajan and the MPC. This could be because during Jalan's tenure, RBI's monetary policy would look at multiple interest rates (repo rate, reverse repo rate, bank rate etc.) whereas during the regimes of Rajan and the MPC the discussion centred around the repo rate.

There are several similarities across the regimes of Jalan and Reddy (such as the emphasis on *financial*, *markets*, and *monetary* conditions).[20] The word *gover** in both the first two regimes refers to either balance sheet discussions (eg. net RBI credit to central government), deficits, issuances of securities, or advanced estimates of growth or GVA by governmental agencies.

Both the first two regimes have mentions of the word *exchang** which is mostly related to the exchange rate, while this is not the case for Subbarao's regime. It reappears in Rajan's statements but is not found in the MPC word cloud. In the aftermath of the Asian Financial Crisis of 1997, which is when our sample starts and when Jalan was the governor, there was substantial discussion in RBI's monetary policy statements on the volatility of the exchange rate. This shows that possibly Jalan was more concerned about the exchange rate than inflation.

After 2004, India became a managed float with greater currency flexibility, but the RBI continued to intervene in the foreign exchange markets during Reddy's tenure (see Patnaik and Shah (2009); Zeileis *et al.* (2010)). In the aftermath of the Global Financial Crisis of 2008, RBI's intervention

[17] For a sample, please see table 15.

[18] In general, the literature on text mining of central bank communications usually does not use raw term frequencies, but weights them by their inverse document frequencies, in order to reduce the importance given to very frequent words. However, we do not use the *tf-idf* methodology here, as our focus is exactly on those frequent words. This is because we are trying to proxy for the de jure transition to an inflation targeting regime by measuring the number of times 'inflation' and associated words are mentioned in our statements. Using *tf-idf* would reduce their importance if they were mentioned more frequently in the post-MPC era and therefore, defeat the purpose of the exercise. One alternative is to only weight the words by the total words in each statement, and the results do not change materially when we do that.

[19] We experimented with different numbers here and got similar results.

[20] Since we have removed the verb 'operating's at the processing stage, the stem *oper** in regime 1 refers to open market operations, foreign exchange operations, or the operating target of monetary policy.

in the foreign exchange market declined substantially. This was also reflected in the lack of exchange rate related discussions in Subbarao's monetary policy statements.

The focus on the exchange rate reappeared in Rajan's statements. This could be linked to the fact that when Rajan came to office in September 2013, India was experiencing the fall out of the Taper Tantrum episode of May 2013, potential normalization of unconventional monetary policies in the US and sharp rupee depreciation (Eichengreen and Gupta, 2015; Mishra *et al.*, 2014). Since 2016, however, the RBI has been given a clear mandate to target the inflation and discussions on the exchange rate seem to have gone down.

One word that appears frequently in the statements of all four governors as well as the MPC is *liquid* referring to the liquidity conditions in the financial markets or system. It appears most frequently in statements issued during Rajan's tenure. This reflects the fact that in August 2014, the RBI revised its liquidity management framework significantly, with liquidity provision to banks shifting from overnight repos to (scheduled) term repos of different maturities (RBI, 2014; Das, 2015b).

From Reddy's regime onwards i.e. from 2003, the word *global* appears frequently in the statements of all the regimes. This hints at the growing integration of the Indian economy with the rest of the world and the recognition given by the RBI governors as well as the MPC to the influence of global factors on domestic economic conditions. It seems to have been used most frequently during Subbarao's tenure, which was the period after the Global Financial Crisis and coincided with the Eurozone soverign debt crisis.[21]

It is worth noting that while the word *wpi* appears in the word cloud describing Subbarao's regime, it does not appear again either for Rajan or for the MPC. Instead the word *cpi* appears in the word clouds for both Rajan and the MPC. This shows that from Rajan's tenure onwards monetary policy has been focusing more on CPI inflation which is also in sync with the official mandate of targeting CPI inflation.

Rajan's regime, which we consider the 'transition' regime from the multiple indicator era to the IT framework shares the emphasis on inflation and price levels with the MPC. This is perhaps because of the monetary policy framework agreement that was signed in February 2015 signalling the gradual shift of RBI towards an inflation centric regime. As expected, for the MPC statements, "inflation" is the most oft repeated word, which points to a de-facto IT regime, at least to the extent we can guage by analysing communication.

In the context of inflation, the word *food* starts appearing for the first time in the word cloud of Subbarao's regime and is found in the word clouds of Rajan's and MPC regimes as well. This shows that food inflation began featuring prominently in RBI's analysis of the macroeconomic outlook from 2008 onwards. This is intuitive because Subbarao's regime faced high food inflation which translated into high aggregate inflation (Bhattacharya and Sen Gupta, 2018). RBI continued to remain vigilant about food inflation from then on.

It is interesting to note that the word *support* appears for the first time in the MPC wordcloud. Given the IT mandate, it seems the MPC's analysis of the macroeconomic outlook has been focusing more on inflation related words. In that context *support* refers to the minimum support prices (MSP) at which the government procures crops from the farmers. MSP in India has always posed a risk to overall inflation and it seems to have become more prominent with the adoption of IT.

Other inflation related words that appear in the MPC word cloud are *oil* and *crude*. This highlights the role of oil price fluctuations on domestic inflation. Post GFC was also the period when

[21] On the literature of how India was effected during the two crises, see, for example, Patnaik and Shah (2010); Dua and Tuteja (2015).

India faced higher international crude oil prices. Once again under the MPC, risks from volatile or future increases in oil prices have been mentioned several times, as it is a key component of imported inflation, which might pose an upside risk to the MPC's CPI inflation target.

Figure 4 Word clouds by regimes, 1998-2018

This graph shows word clouds for all the five governors. Word colours and sizes are proportional to their raw frequencies, and the 40 most frequent words are plotted in each picture (see Section 3.3 for more details).

(a) Jalan

(b) Reddy

(c) Subbarao

(d) Rajan

(e) MPC

4 Estimating effect on financial markets

We next turn to studying the effect of linguistic complexity of RBI's monetary policy communication on the volatility of returns and trading volumes in the Indian equity market. In our analysis we control for the 'surprise' in the repo rate decision, as well as a host of other factors (discussed in sections 4.1, 4.2). As a proxy for equity markets, we use daily data on the Nifty 50 index, which captures the 50 most liquid stocks in India.[22] We obtain the price and trading volume data from the Centre for Monitoring Indian Economy (CMIE) database for our sample period.

We started our analysis with 76 statements, but for the regression analysis we use 70. We lose about 4 statements from the initial part of the sample as the data on the monetary policy surprise variable starts only in the second half of 2000. We also remove two outlier dates that coincided with days of high volatility on the Nifty due to either political reasons or the onset of the global financial crisis.[23]

4.1 Influence of RBI communication on equity market volatility

We first look at equity market volatility. We estimate the the following equation using ordinary least squares (3) and (4):[24]

$$\begin{aligned} logRVOL_{t:t+7} &= \alpha + \beta_1\ MPSurprise_t + \beta_2\ log(Words)_t + \beta_3\ D.Day \\ &\quad + \beta_4\ D.Quarter + \beta_5\ D.Regime + \epsilon_t \end{aligned} \tag{3}$$

where, $\text{RVOL}_{t:t+7}$ is the annualised 7-day ahead volatility of returns of the Nifty index.[25] We use the log of returns volatility as well as log of the total number of words ($log(Words)$) in the statement issued on day t, for ease of interpretation. Figure 6 shows the scatterplot of our dependent variable over the entire sample.

The length as captured by the number of words per statement acts as a proxy for the linguistic complexity of the statements.[26] Our hypothesis is that an increase in the length of a statement should increase the volatility of returns (i.e. $\beta_2 > 0$). To the extent that agents and market participants are expected to "draw their own inferences" from RBI's monetary policy communication (RBI, 2008), we hypothesise that the longer the statement, and lesser the clarity of information being conveyed, the greater the scope for market participants to diverge in their beliefs about the current and future path of policy based on their reading and understanding of the text. This in turn can induce greater volatility in returns (Geraats, 2002; Ehrmann and Fratzscher, 2007; Atmaz and Basak, 2018; Weidmann, 2018).

A statement containing a monetary policy surprise might end up driving equity market volumes or volatility. If we do not control for this announcement effect, we would end up mistakenly

[22] In the relevant literature, studies have looked at the effect of CB communication on bond, currency and equity markets. Unfortunately, we do not have access to daily data on the Indian bond market for our sample period. In our future work, we plan to investigate the effect on currency markets, data for which is available from 2008 onwards.

[23] These dates are 18 May 2004 and 24 Oct 2008. On these days, the Nifty returns were more than 3.5 standard deviations away from their average over the entire sample.

[24] In all our empirical estimations we report heteroskedasticity and autocorelation robust standard errors.

[25] This is calculated using the standard deviation of the daily returns for the seven days starting from the day of the monetary policy announcement (and hence issuance of the statement), i.e. $\sqrt{250} \times \sigma_{t:t+7}^{Returns}$

[26] Later on in the paper, we also present our analysis of the effect of the readability index.

attributing any observed relationship to complexity or length of the statement. To avoid this, we control for any unanticipated shocks to the repo rate; this is captured by the term $MPSurprise_t$. A commonly used variable in the literature to capture monetary policy surprise is the price of interest rate futures. However, this derivative product is not actively traded in Indian financial markets. Instead we adopt the approach of Kamber and Mohanty (2018) and use data on overnight index swaps (OIS) of 1 month maturity.

We use the absolute difference in the OIS rate, $|\Delta OIS|$ between t and $t-1$, with t being the day of the monetary policy announcement.[27] We find that even on days of no actual changes in the policy repo rate there can be monetary policy surprises as captured by changes in the OIS rate. The surprise can be non-zero even on days when the repo rate was not changed, if market participants expected a change, and the surprise need not be in the same direction as the repo rate change either (tables 8 and 9) (Rosa, 2011). Consequently, the coefficient β_2 captures the additional effect of linguistic complexity on returns volatility, over and above the annoucement itself.

In our baseline model, we incorporate a host of dummy variables to capture other dynamics. First, we control for the day-of-the-week effect ($D.Day$) to account for any cyclicality in equity market activity within the week (Rosa, 2011; Ehrmann and Fratzscher, 2007). Next, we include dummy variables for different quarters of the year ($D.Quarter$). This is because in some quarters, such as those following the festive season in India, equity market activity can be more intense as compared to the summer months, when the activity tends to be relatively more slack. Finally, we add dummy variables to control for any possible monetary policy or governor regime effects ($D.Regime$). This should pick up any changes in the operation of monetary policy or communication, as well as any governor-specific factors.

In addition to the baseline model specified in equation (3), we also account for the possibility that the response of equity market activity to monetary policy related news may depend on the stage of the business cycle (see for example, Smales and Apergis (2017) and Basistha and Kurov (2008)). Controlling for the stage of the business cycle should in part address the concern that a complex or deteroriating economic situation might simultaneously be driving both length of statements as well as equity market volatility.

We use dates of recession and expansion for India as computed by Pandey *et al.* (2017). The authors use growth-cycle approach to find three recessionary periods for India: 1999 Q4 to 2003 Q1, 2007 Q2 to 2009 Q3, and 2011 Q2 to 2012 Q4. We incorporate a dummy variable $D.Recession$, that takes a value of 1 for the recessionary quarter-years and 0 otherwise, in equation (3) below, which is otherwise same as equation (4).[28]

$$\begin{aligned} logRVOL_{t:t+7} &= \alpha + \beta_1\ MPSurprise_t + \beta_2\ log(Words)_t + \beta_3\ D.Day \\ &\quad +\beta_4\ D.Quarter + \beta_5\ D.Regime + \beta_6\ D.Recession + \epsilon_t \end{aligned} \tag{4}$$

We first estimate our baseline model on the full corpus of 70 statements, reported in table 5.

The monetary policy surprise, captured by the change in OIS rate, is positive and significant, which implies that larger MP surprises result in greater volatility in the equity market. This is consistent with the literature (see, for example, Gospodinov and Jamali (2015)). To the best of

[27] We don't use ΔOIS because there's no reason to expect any directional association between monetary policy surprise and trading activity or volatility.

[28] We also interact the recession dummy with the log of words to see whether length of the monetary policy statement has any additional effect on market volatility when the economy is in a recession. However, we don't find any interesting results and hence do not report them here.

Table 5 Volatility and length of statements, full sample data

Note: The dependent variable is *log volatility of Nifty returns* from $t : t+7$ in columns (1) - (3) and $t : t+6$ in columns (4) - (5). The main independent variable is *number of words* in the MP statement released on day t. ΔOIS rate (1 month) is the difference in the 1 month overnight indexed swap rate between $t-1$ and t. *D.Recessions* is a dummy for whether there is a recession that month. The dates are Dec 1999 to Mar 2003, Jun 2007 to Sep 2009, and Jun 2011 to Dec 2012, taken from Pandey *et al.* (2017). *Regimes* refer to RBI governor tenures. All specifications contain a constant, and regime and quarter dummies, while day of the week dummies are added from column (3) onwards. Heteroskedasticity and autocorrelation robust standard errors are reported in parentheses below the coefficients.

	Dependent variable:				
	log $RVOL_{t:t+7}$			log $RVOL_{t:t+6}$	
	(1)	(2)	(3)	(4)	(5)
ΔOIS rate (1 month)$_{t:t-1}$	0.037***	0.039***	0.029***	0.041***	0.032***
	(0.010)	(0.010)	(0.008)	(0.011)	(0.010)
log (no. of words)$_t$	0.384**	0.427**	0.368**	0.404**	0.349**
	(0.152)	(0.176)	(0.165)	(0.155)	(0.148)
D. Recessions$_m$			0.279**		0.255*
			(0.123)		(0.131)
Regime	All	All	All	All	All
Observations	70	70	70	70	70
Adjusted R^2	0.361	0.362	0.386	0.332	0.351
F Statistic	5.340***	4.005***	4.103***	3.633***	3.667***
Regime dummies	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes	Yes	Yes
Day dummies	No	Yes	Yes	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

our knowledge, our study is the first to explicitly control for monetary policy surprises using the OIS rate in an analysis of monetary policy transmission in India.

Columns (1) and (2) of table 5 show the results of estimating equation (3). In column (2) we add the day-wise dummy variables and in column (3) we control for recessions, as in equation (4). We find that volatility of stock market returns increases as the linguistic complexity of monetary policy statements, proxied by the number of words, increases. In particular, our baseline results indicate that after controlling for a host of factors, a 1% increase in the number of words (a rough increase of about 115 words) is strongly correlated with a higher stock market volatility of roughly 0.37% (column (3), table 5), ceterus paribus. We also find that stock market volatility goes up during recessions, as per expectations.

We use an alternate measure of the dependent variable to check the robustness of our result, i.e. standard deviation of daily returns over (t) and $(t+6)$ period, with t being the day of the monetary policy announcement.[29] We use this as the dependent variable in columns (4) and (5) of table 5, the difference between the two specifications being that we add the recession dummy in column (5). We find that the positive correlation of the length of the statements with volatility of returns holds and the estimated coefficients are statistically significant.

Next, we check for the possibility that an already complicated or worsening macroeconomic situation drives both equity market volatility as well as length of the monetary policy statement. In particular, this maybe true in the aftermath of negative shocks such as onset of the global financial crisis or demonetisation. To account for this, we first add a few more macroeconomic controls which could potentially drive volatility, such as domestic economic policy uncertainty (EPU)[30] from Baker *et al.* (2016), last available information on GDP growth and inflation, as

[29]Using volatility calculated over $(t+1)$ to $(t+6)$ gives similar results. The table 5 column (4) coefficient becomes 0.317** and the column (5) coefficient becomes 0.30*.

[30]To construct the India index, Baker *et al.* (2016) use 7 Indian newspapers: The Economic Times, the Times of India, the Hindustan Times, the Hindu, the Statesman, the Indian Express, and the Financial Express. For each paper, they count the number of articles belonging to three term sets, "economic", "policy", and"uncertainty". They first scale the monthly article counts by the number of all articles in the same newspaper and month. Next,

Table 6 Volatility and length of statements, controlling for other macro variables

Note: The dependent variable is *log volatility of Nifty returns* from $t : t+7$ in columns (1) and (2), and from $t : t+6$ in column (3). The main independent variable is *number of words* in the MP statement released on day t. ΔOIS rate (1 month) is the difference in the 1 month overnight indexed swap rate between $t-1$ and t. We control for CBoE global VIX, a proxy of global uncertainty and international market volatility, and a textual measure of economic policy uncertainty (EPU) for India, constructed by Baker *et al.* (2016). Since the data for EPU is only available from 2003, we lose a couple of observations. We also add the last available information on inflation and GDP growth (both from CMIE). "D.Post-Rajan" is a dummy that takes value 1 for period from Oct 2013 onwards (and 0 from Apr 2000 to Jul 2013). *Regimes* refer to RBI governor tenures. All specifications contain a constant, and regime, quarter dummies, and day of the week dummies. Heteroskedasticity and autocorrelation robust standard errors are reported in parentheses below the coefficients.

	Dependent variable:			
	log $\text{RVOL}_{t:t+7}$			log $\text{RVOL}_{t:t+6}$
	(1)	(2)	(3)	(4)
Δ OIS rate (1 month)$_{t,t-1}$	0.034**	0.034**	0.031**	0.035**
	(0.013)	(0.013)	(0.013)	(0.014)
log (no. of words)$_t$	0.314**	0.269**	0.399**	0.348*
	(0.121)	(0.128)	(0.177)	(0.177)
log $\text{RVOL}_{t:t-7}$		0.374**	0.354**	0.360**
		(0.149)	(0.143)	(0.147)
D. Recessions$_m$	0.053	−0.119	−0.117	−0.109
	(0.208)	(0.211)	(0.210)	(0.222)
log India EPU_m	0.024	0.045	0.018	0.032
	(0.139)	(0.136)	(0.143)	(0.151)
log Global VIX_m	0.127***	0.073**	0.074**	0.068*
	(0.036)	(0.036)	(0.035)	(0.038)
GDP_{q-1}	−0.038*	−0.016	−0.011	−0.004
	(0.020)	(0.024)	(0.026)	(0.026)
Inflation_{q-1}	−0.008	−0.019	−0.023	−0.011
	(0.023)	(0.026)	(0.028)	(0.029)
D.Post-Rajan$_t$			3.459	2.708
			(2.115)	(2.247)
log (no. of words)$_t$ × D.Post-Rajan$_t$			−0.315	−0.233
			(0.245)	(0.258)
Observations	64	64	64	64
Adjusted R^2	0.467	0.520	0.527	0.470
F Statistic	4.067***	4.588***	4.516***	3.794***
Regime dummies	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes	Yes
Day dummies	Yes	Yes	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

well as option-implied volatility on the S&P500 from Chicago Board Options Exchange (VIX), as a proxy for global uncertainty. Figure 7 shows the evolution of the Economic Policy Uncertainty index (EPU) India and global VIX over the sample.

From column (1) in table 6, we find that the main result on length of statements is robust to the inclusion of these variables. We also find that global VIX is also an important driver of equity market volatility.

Next, in column (2) onwards, we add previous week's equity market volatility ($log(rvol)_{t-1:t-7}$) in table 6. Unless the macroeconomic situation becomes suddenly more complex or worsens drastically between $t-1$ and t, including this variable should control for any pre-existing trends in returns volatility in an even more robust manner.

The coefficient on $log(rvol)_{t-1:t-7}$ is positive and significant, implying that if volatility is higher the week before the monetary policy statement, it is likely to persist into the following week as well. The interesting result to note is that the estimated coefficient on the number of words continues to be positive and significant. This means that even after controlling for pre-existing

they normalize the standard deviation of scaled article counts for each newspaper separately, and then sum across the 7 newspapers. Finally, they re-normalize the resulting sum to achieve a mean of 100 prior to 2011.

trends and a host of other macro variables, we find that the length of the monetary policy statement is positively associated with volatility. Magnitude of the effect is slightly smaller, at 0.27% (column (2), table 6).[31]

Next, we include an interaction term for post-Rajan period in table 6, *log number of words* × *D.Post Rajan*, along with all other previously discussed macroeconomic controls. The rationale of doing this is because we find a sharp decline in the length of the monetary policy statements from the tenure of Rajan onwards, as shown in figure 1. However, one issue that might complicate estimation here is that monetary policy statements since 2013 have looked fairly similar in their structure and length. For example, the variation in the number of words across the statements of the post-Rajan sample ($\sigma = 1175$ words) is roughly 1/8th that of the pre-Rajan sample ($\sigma = 8287.3$ words). Our reading of the statements also throws up similarities in structure and content of the statements post-2013.[32]

In columns (3) and (4) of table 6, we find that the estimated coefficient for the length of statement continues to be positive and significant, closer in magnitude to the baseline results.[33] While the interaction term has the incorrect sign, the estimated standard errors are very large. Therefore, the observed relationship between length and volatility of equity markets has declined since governor Rajan.

Finally, we find that the relationship we observe between length and returns volatility does not persist for a long period of time. We do not find any effect when we increase our observation window to 15 days post the monetary policy announcement (table 7).

Readability of statements and effect on equity market

In addition to exploring the effect of length of statements, we also look into the association between the readability of these statements and equity market volatility. For this we use the Farr-Jenkins-Paterson (FJP) readability clusters as described in section 3.2. We estimate the following equation:

$$\begin{aligned} logRVOL_{t:t+7} &= \alpha + \beta_1\ MPSurprise_t + \beta_2\ log(Words)_t + \beta_3\ D.Readability \\ &\quad +\beta_4\ D.Day + \beta_5\ D.Regime\ +\ \epsilon_t \end{aligned} \tag{5}$$

where, all variables are as in equation (3) and *D.Readability* is measured as categories. As discussed in section 3.2, we cluster the various statements into 3 groups of readability based on the euclidean distance between them for ease of interpretability. *D.Readability* takes value *low*, *medium*, *high* for low, medium, and highly readable statements. Our hypothesis is that

[31] In another specification, similar to Kohn and Sack (2003), we regress equity returns on monetary policy announcement days on a host of variables, include lagged returns, lagged GDP, inflation, and rainfall deviation from normal, along with days of the week, quarter, regime, and recession dummies. We then regress the squared residuals on its own lag, as well as the length of MP statement. The results do not change.

[32] We also follow Acosta and Meade (2015) and calculate the *cosine* similarity between the MPC's first statement in October 2016 and all others, and rank them in order of increasing similarity. We find that it is quite similar to the statements by Rajan from 2015 onwards, specially the ones from 2016, and of course, also to the ensuing statements by the MPC itself. This provides some indication that the MPC continued to use the main structure of the statements preceding it, but shortened and streamlined them.

[33] Splitting the sample pre and post inflation targeting, or pre and post Feb 2015 (when the inflation targeting agreement was signed), does not change the results. When we use pre and post IT, the coefficient on $log(no.of words)$ in the pre-Rajan period becomes 0.75^{***}, while that for post-Rajan becomes 0.074. When we use pre and post Feb 2015, the coefficients become 0.75^{***} and 0.23 respectively. The results in the sub-sample analysis are robust to using alternate variants of the returns volatility measure.

Table 7 Volatility of returns and persistence of effect

Note: The dependent variable is *log equity market volatility* measured over t to $t+15$, where t is the day of the monetary policy announcement. The main independent variable of interest is the *number of words* in the MP statement at day t. We control for CBoE global VIX, a proxy of global uncertainty and international market volatility, and a textual measure of economic policy uncertainty (EPU) for India, constructed by Baker *et al.* (2016). Since the data for EPU is only available from 2003, we lose a couple of observations. We also add the last available information on inflation and GDP growth (both from CMIE). All regressions contain constants, and control for regime, quarter, day, and recession effects. All other variables are as before. The standard errors reported below coefficients in parentheses are heteroskedasticity and autocorrelation robust.

	Dependent variable:	
	log $\text{RVOL}_{t:t+15}$	
	(1)	(2)
ΔOIS rate (1 month)$_{t,t-1}$	0.035**	0.041***
	(0.016)	(0.013)
log (no. of words)$_t$	0.215	0.135
	(0.143)	(0.160)
log $\text{RVOL}_{t:t-7}$		0.390***
		(0.125)
D. Recessions$_m$	0.102	−0.177
	(0.199)	(0.194)
log India EPU_m	0.015	0.056
	(0.134)	(0.129)
log Global VIX_m	0.078**	0.034
	(0.036)	(0.046)
GDP_{q-1}		−0.014
		(0.026)
Inflation_{q-1}		−0.032
		(0.021)
Observations	64	64
Adjusted R^2	0.401	0.474
F Statistic	3.640***	3.987***
Regime dummies	Yes	Yes
Quarter dummies	Yes	Yes
Day dummies	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

lower the readability of monetary policy statements, the higher will be the volatility of equity market returns, due to the dispersion in information among market participants.[34]

We report the baseline results of the readability analysis in table 8.[35] In addition to our baseline result on the length of statement, we find that the dummy for the medium readability cluster is negatively associated with volatility. This is intuitive because as readability improves (i.e. as we go from *low* to *medium* readability), clarity of the information improves. This in turn reduces the market participants' dispersion of beliefs and leads to a moderating effect on volatility.[36]

The high readability cluster has the expected negative sign but is not statistically significant. In other words, we find that while the switch from *low* to *medium* readability clusters lowers volatility we do not find the similar effect as we go from *low* to *high* readability clusters. This could be because there are fewer statements that are classified as 'highly' readable (15 out of 72). It could also indicate that most of the gains from improvement in monetary policy statement readability come from moving from *low* to *medium* readability. This may reflect the importance of governor specific factors in communication, as the first distinct improvement in readability came with governor Subbarao.

[34]However, as discussed in Loughran and McDonald (2014), there is also atleast one disadvantage of applying readability indices to financial or monetary policy statements. Their use may be limited, specially when they penalise unavoidable multisyllabic words, such as "liquidity" or "monetary", which are not very likely to be misunderstood by market participants.

[35]In this analysis we do not use the sub-samples because there is almost no variation in readability clusters for the first two governors (all their statements are ranked as 'low readable', see table 16)

[36]Using the raw index of Farr-Jenkins-Paterson gives us a the same negative coefficient, implying that an increase in the index – which is an improvement in readability – is associated with lower volatility, though it is not significant.

Table 8 Volatility, length and readability of statement, full sample data

Note: The dependent variable is *log volatility of Nifty returns* from $t : t + 7$. The main independent variable is *number of words* in the MP statement released on day t. ΔOIS rate (1 month) is the difference in the 1 month overnight indexed swap rate between $t - 1$ and t. *D.Medium readability* and *D.High readability* are dummies that take value 1 if the hierarchical clustering algorithm tags the statement at day t as such. Clustering is based on the Farr-Jenkins-Paterson index (more details are in section 3.2). *D.Recessions* is a dummy for whether there is a recession that month. The dates are Dec 1999 to Mar 2003, Jun 2007 to Sep 2009, and Jun 2011 to Dec 2012, taken from Pandey *et al.* (2017). All specifications contain a constant, and regime, quarter, and day dummies. Heteroskedasticity and autocorrelation robust standard errors are reported in parentheses below the coefficients.

	Dependent variable:	
	log $\text{RVOL}_{t:t+7}$	
	(1)	(2)
Δ OIS rate (1 month)$_{t,t-1}$	0.044^{***}	0.031^{***}
	(0.012)	(0.010)
log (no. of words)$_t$	0.366^{***}	0.313^{***}
	(0.107)	(0.112)
D. Medium readability$_t$	-0.195^{*}	-0.207^{*}
	(0.104)	(0.108)
D. High readability$_t$	-0.040	-0.080
	(0.135)	(0.149)
D. Recessions$_m$		0.295^{**}
		(0.128)
Observations	70	70
Adjusted R^2	0.368	0.397
F Statistic	4.346^{***}	4.492^{***}
Regime dummies	Yes	Yes
Quarter dummies	Yes	Yes
Day dummies	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

Overall, our results are consistent with our hypotheses that longer and more complex (or less readable) monetary policy statements of the RBI generate greater uncertainty and wider dispersion of information which in turn result in greater trading volume and heightened volatility in the Indian equity market. The results for India are in sync with the findings of Smales and Apergis (2017) for the US.

4.2 Influence of RBI communication on trading activity

Next, we explore the influence of RBI's monetary policy communication on trading activity in the equity market. We now estimate equations (6) and (7):

$$\begin{aligned} log(TradVol_t) &= \alpha + \beta_1\ MPSurprise_t + \beta_2\ log(Words)_t + \beta_3\ D.Day \\ &\quad + \beta_4\ D.Quarter + \beta_5\ D.Regime + \epsilon_t \end{aligned} \tag{6}$$

$$\begin{aligned} log(TradVol_t) &= \alpha + \beta_1\ MPSurprise_t + \beta_2\ log(Words)_t + \beta_3\ D.Day \\ &\quad + \beta_4\ D.Quarter + \beta_5\ D.Regime + \beta_6\ D.Recession + \epsilon_t \end{aligned} \tag{7}$$

where, $TradVol_t$ is the daily trading volume of the Nifty index on the day of the RBI's monetary policy decision and statement issuance (t), $MPSurprise_t$ is the monetary policy surprise resulting from the RBI's decision on day t (calculated using ΔOIS), and $log(Words)$ is the logarithm of the total number of words in the statement issued on day t. All other variables are as before.

Table 9 Trading volumes and length of statements, full sample data

Note: In columns (1) - (3), the dependent variable is *log trading volumes* on the day of the monetary policy announcement, while it is the *demeaned trading volume* in columns (4) - (5). The main dependent variable is *number of words* in the MP statement. *D.Recessions* is a dummy for whether there is a recession that month. The dates are Dec 1999 to Mar 2003, Jun 2007 to Sep 2009, and Jun 2011 to Dec 2012, taken from Pandey *et al.* (2017). ΔOIS rate (1 month) is the difference in the 1 month overnight indexed swap rate between $t-1$ and t. *Regimes* refer to RBI governor tenures. All specifications contain a constant, and regime and quarter dummies, while day of the week dummies are added from column (2) onwards. We additionally control for recessions in column (3) onwards. Heteroskedasticity and autocorrelation robust standard errors are reported in parentheses below the coefficients.

	Dependent variable:				
	$\log(\text{tv})_t$			tv_t - μ (in 000s)	
	(1)	(2)	(3)	(4)	(5)
ΔOIS rate (1 month)$_{t,t-1}$	0.006	0.007	−0.003	0.024	−0.707
	(0.017)	(0.015)	(0.013)	(1.544)	(1.353)
log (no. of words)$_t$	0.260***	0.264**	0.205**		
	(0.096)	(0.107)	(0.098)		
No. of words$_t$				0.004***	0.004***
				(0.001)	(0.001)
D. Recession$_m$			0.275*		18.701
			(0.153)		(11.604)
Regime	All	All	All	All	All
Observations	70	70	70	70	70
Adjusted R^2	0.789	0.789	0.806	0.742	0.746
F Statistic	29.662***	20.793***	21.465***	16.294***	15.459***
Regime dummies	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes	Yes	Yes
Day dummies	No	Yes	Yes	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

Our hypothesis is same as before: an increase in the length of a statement should be related to an increase in the trading volume (i.e. $\beta_2 > 0$). Lengthier statements lead to dispersion in market beliefs, which should play out in the equity market in the form of more elevated trading volumes.

The estimated cofficients are reported in table 9. We use our full corpus of 70 monetary policy statements, each of which mentions the RBI's decision regarding the repo rate. Columns (1), (2) and (3) show the results of the baseline model as specified in equations (6) and (7). In column (2) we add the dummy variables to capture the effect of days of the week. In column (3) we also add the recession dummy.

We find that in these three specifications, number of words is positively associated with the contemporaneous trading activity and the estimated coefficients are significant at the 1% level. The baseline results indicate that, holding all else constant, a 1% increase in the length of the statement (which represents roughly 115 words on average), is correlated with a 0.21% (column (3), table 9) increase in trading volume on the day of the announcement, all else equal.

Our main result holds when we use a different measure of the trading activity. In columns (4) and (5) of table 9, we define the dependent variable as the difference in trading volume between day t and the full sample average of trading volume, calculated in levels. For these two columns our main independent variable of interest is the absolute number of words. In other words, for these two columns, we estimate equations (6) and (7) in levels and not in logarithms.[37] We retain the day-wise, quarter-wise as well as the regime specific dummy variables in these two columns. Overall there appears to be a strong positive correlation between the length of the monetary policy statements and the trading activity in the equity market when we consider the full corpus of statements.

In column (1) of table 10, we add other macroeconomic variables to control for pre-existing

[37]This is because when we take demeaned trading volumes at day t are often negative. For consistency, we use number of words in levels too.

Table 10 Trading volumes and length, controlling for other macro variables

Note: The dependent variable is *demeaned log trading volumes*. The main independent variable of interest is the *number of words* in the MP statement at day t. We control for CBoE global VIX, a proxy of global uncertainty and international market volatility, and a textual measure of economic policy uncertainty (EPU) for India, constructed by Baker *et al.* (2016). Since the data for EPU is only available from 2003, we lose a couple of observations. We also add the last available information on inflation and GDP growth (both from CMIE). All regressions contain constants, and control for regime, quarter, day, and recession effects. All other variables are as before. The standard errors reported below coefficients in parentheses are heteroskedasticity and autocorrelation robust.

	Dependent variable:		
	tv - μ (in 000s)		
	(1)	(2)	(3)
Delta OIS rate (1 month)$_{t,t-1}$	−3.376*	−2.661***	−3.268***
	(1.684)	(0.776)	(0.840)
No. of words$_t$	0.004***	0.002	0.001
	(0.001)	(0.001)	(0.001)
log Mean trading volumes$_{t-1:t-7}$		93.448***	96.561***
		(12.896)	(13.044)
D. Recession$_m$	48.259**	16.201	20.994*
	(18.165)	(11.442)	(10.756)
log India EPU$_m$	−34.604**	−18.878**	−21.283**
	(14.703)	(8.411)	(9.815)
log Global VIX$_m$	4.895	2.976	3.422
	(3.028)	(1.982)	(2.075)
Infl$_{q-1}$	3.422	0.745	0.847
	(3.423)	(1.551)	(1.571)
GDP$_{q-1}$	3.796	0.718	1.537
	(2.921)	(1.888)	(1.736)
D. Medium readability$_t$		7.859	
		(9.013)	
D. High readability$_t$		18.468*	
		(9.877)	
D.Post-Rajan$_t$			−29.590
			(49.171)
log (no. of words)$_t$ × D.Post-Rajan$_t$			−0.001
			(0.004)
Observations	64	64	64
Adjusted R^2	0.708	0.888	0.883
F Statistic	9.504***	24.691***	24.723***
Regime dummies	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes
Day dummies	Yes	Yes	Yes

*p<0.1; **p<0.05; ***p<0.01

uncertainty in the environment that might lead to longer statements as well as higher stock market volatility. We find that the main result on the length of statements holds, and that other coefficients have expected signs. For example, India specific economic policy uncertainty is strongly negatively associated with trading volumes. In column (2), we further add the mean equity market trading volume from the previous week ($tv_{t-1:t-7}$). The coefficient on $tv_{t-1:t-7}$ is positive as expected, and statistically significant, implying that if trading volumes are higher the week before the monetary policy statement, they are likely to persist the following week as well. However, we find that our coefficient on length of the statement is not robust to the inclusion of this variable. It stays positive, but becomes insignificant (the p-value is 0.13). In addition, we find that a move from *low* to *high* readability of statements increases the trading volumes as well.

If we include an interaction term for post-Rajan period in column (3) of table 10, (*log number of words* × *D.Post Rajan*), along with average trading volumes of the previous week and all other previously discussed macro controls, we find that the main term for length of MP statement stays positive but becomes insignificant.

We next split the sample between pre-Rajan and post-Rajan statements (table 11). The specification here is the same as in equation (6).[38] We use the same two variants of trading volume

[38]We do not add the recession dummy here because all the recession quarters are in the pre-Rajan sample.

Table 11 Trading volumes and length of statements, sub-sample data

Note: In columns (1) - (4), the dependent variable is *log trading volumes* on the day of the monetary policy announcement, while it is the *demeaned trading volume* in (5) - (6). The main independent variable is *number of words* in the MP statement. ΔOIS rate (1 month) is the difference in the 1 month overnight indexed swap rate between $t-1$ and t. "Pre-Rajan" is the time period from Apr 2000 to Jul 2013, and "post-Rajan" is the time period from Oct 2013 onwards. *Regimes* refer to RBI governor tenures. All specifications contain a constant, and regime and quarter dummies, while day of the week dummies are added from column (3) onwards. Heteroskedasticity and autocorrelation robust standard errors are reported in parentheses below the coefficients.

	Dependent variable:					
	$\log(\text{tv})_t$				tv - μ (in 000s)	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔOIS rate (1 month)$_{t,t-1}$	0.002	−0.036	0.004	−0.036	0.141	−8.715
	(0.016)	(0.040)	(0.014)	(0.043)	(1.386)	(8.671)
log (no. of words)$_t$	0.504***	0.017	0.500***	0.028		
	(0.136)	(0.069)	(0.171)	(0.076)		
No. of words$_t$					0.005***	0.001
					(0.002)	(0.006)
Regime	Pre-Rajan	Post-Rajan	Pre-Rajan	Post-Rajan	Pre-Rajan	Post-Rajan
Observations	42	28	42	28	42	28
Adjusted R^2	0.705	0.479	0.693	0.438	0.601	0.480
F Statistic	15.005***	5.142***	9.399***	3.635***	6.620***	4.115***
Regime dummies	Yes	Yes	Yes	Yes	Yes	Yes
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Day dummies	No	No	Yes	Yes	Yes	Yes
Recession dummies	No	No	No	No	No	No

*p<0.1; **p<0.05; ***p<0.01

as in table 9.

We find that for the pre-Rajan sample, across different specifications, the number of words (both in log and in level) is positively correlated with trading volume and the effect is statistically significant at the 1% level. For the post-Rajan sample, while the estimated coefficient of the number of words variable has the expected positive sign, it is not significant. This may be because, as discussed earlier, monetary policy statements issued during the tenures of Rajan and the MPC are similar in terms of their length and hence have very little variation among them, as compared to the pre-Rajan sample.

5 Conclusion and further research

In this paper we quantify monetary policy communication of the Reserve Bank of India (RBI) and analyse its evolution across the regimes of five governors over a 20-year period starting from 1998. We measure the length and readability of the monetary policy statements over time and also estimate potential transmission to equity markets.

Our descriptive analysis shows that the move towards an inflation targeting (IT) regime gets reflected in the monetary policy communication of RBI. We throw light on the variables that different governors' communication seemed to have focused on, and how this has evolved with changes in the underlying macroeconomic environment. We uncover the possible presence of governor-specific factors in communication patterns that are distinct from the transition to an IT regime. Further we find that greater linguistic complexity of the statements as captured by their length or readability leads to higher volatility of returns in the Indian equity market, but the evidence on trading volumes is mixed.

The main contribution of our paper is twofold. We study monetary policy communication in India, a large emerging economy which has only recently transitioned to an IT regime. Clarity of communication maybe considered a cornerstone of any successful IT regime given its role in shaping the inflation expectations of economic agents. We find that with the advent of IT, RBI's

monetary policy communication has improved significantly. To the best of our knowledge no other study has explicitly studied the shift in a central bank's communication patterns in the aftermath of adoption of IT.

Second, monetary policy transmission in India remains weak and at best gradual, and our paper focuses on a less-studied aspect of it: the role of communication. We shed light on the possibility that transmission may get impeded if the RBI's monetary policy communication is not concise or clear.

As part of future research, we plan to explore the effect of various aspects of RBI's monetary policy communication on the currency markets as well. In addition we plan to undertake content analysis of the RBI's monetary policy statements, specifically on the sentiment expressed in the various monetary policy statements of the RBI and the transmission thereof to financial markets. We want to understand whether this transmission has strengthened as a result of improved communication in the post IT period.

The world over, considerable attention is being paid to analysing central bank communication in the aftermath of the global financial crisis. Monetary policy communication is regarded as an effective tool in the process of anchoring agents' inflation expectations and improving monetary policy transmission. This is especially true of countries that have adopted IT as a monetary policy framework because the success of such a regime hinges on the effectiveness of transmission of monetary policy announcements. As a new IT country where conventional channels of monetary transmission may not work well, India is an excellent case study for quantitatively analysing the central bank's monetary policy communication and exploring the transmission thereof to financial markets. This kind of a study will help throw light on the optimal communication strategy that the RBI can devise in order to effectively influence agents' inflation expectations and achieve its official objective of controlling inflation.

References

Acosta M, Meade E (2015). "Hanging on every word: Semantic analysis of the FOMC's postmeeting statement." *Feds notes*, Federal Reserve Board.

Aleem A (2010). "Transmission mechanism of monetary policy in India." *Journal of Asian Economics*, **21**(2), 186–197.

Atmaz A, Basak S (2018). "Belief dispersion in the stock market." *The Journal of Finance*, **LXXIII**(3), 1225–1279.

Baker SR, Bloom N, Davis SJ (2016). "Measuring economic policy uncertainty." *Quarterly Journal of Economics*, **131(4)**, 1593–1636.

Basistha A, Kurov A (2008). "Macroeconomic cycles and the stock market's reaction to monetary policy." *Journal of Banking & Finance*, **32**(12), 2606–2616.

Bennani H, Neuenkirch M (2017). "The (home) bias of European central bankers: New evidence based on speeches." *Applied Economics*, **49**(11), 1114–1131.

Bhattacharya R, Patnaik I, Shah A (2011). "Monetary policy transmission in an emerging market setting." *IMF Working Paper WP/11/5*, International Monetary Fund.

Bhattacharya R, Sen Gupta A (2018). "Drivers and impact of food inflation in India." *Macroeconomics and Finance in Emerging Market Economies*, **11**(2), 146–168.

Blinder AS, Ehrmann M, Fratzscher M, de Haan J, Tansen DJ (2008). "Central bank communication and monetary policy: A survey of theory and evidence." *Journal of Economic Literature*, **46**(4), 910–945.

Campbell J, Evans CL, Fisher J, Justiniano A (2012). "Macroeconomic effects of Federal Reserve forward guidance." *Brookings Papers on Economic Activity*, **43**(1 (Spring)), 1–80.

Conrad C, Lamla MJ (2010). "The high-frequency response of the EUR-USD exchange rate to ECB communication." *Journal of Money, Credit and Banking*, **42**(7).

Das S (2015a). "Monetary policy in India: Transmission to bank interest rates." *IMF Working Papers 15/129*, International Monetary Fund.

Das S (2015b). "Monetary policy in India: Transmission to bank interest rates." *Working Paper WP/15/129*, International Monetary Fund.

Dua P, Tuteja D (2015). "Global recession and eurozone debt crisis: Impact on exports of China And India." *Working papers 242*, Centre for Development Economics, Delhi School of Economics.

Ehrmann M, Fratzscher M (2007). "Communication by central bank committee members: Different strategies, same effectiveness?" *Journal of Money, Credit and Banking*, **39**(2-3), 509–541.

Eichengreen B, Gupta P (2015). "Tapering talk: The impact of expectations of reduced Federal Reserve security purchases on emerging markets." *Emerging Markets Review*, **25**(C), 1–15.

Farr JN, Jenkins JJ, Paterson DG (1951). "Simplification of Flesch reading ease formula." *Journal of Applied Psychology*, **35**(5), 333–337.

Galardo M, Guerrieri C (2017). "The effects of central bank's verbal guidance: Evidence from the ECB." *Temi di discussione (Economic working papers) 1129*, Bank of Italy, Economic Research and International Relations Area.

Geraats P (2002). "Central Bank Transparency." *Economic Journal*, **112**(483), 532–565.

Gospodinov N, Jamali I (2015). "The response of stock market volatility to futures-based measures of monetary policy shocks." *International Review of Economics & Finance*, **37**(C), 42–54.

Gunning R (1952). *The technique of clear writing*. McGraw-Hill, New York.

Hansen S, McMahon M (2016). "Shocking language: Understanding the macroeconomic effects of central bank communication." *Journal of International Economics*, **99**, S114–S133.

Hendry S, Madeley A (2010). "Text mining and the information content of Bank of Canada communications." *Working paper 2010-31*, Bank of Canada.

Hildebrand PM (2006). "Monetary policy and financial markets." Speech by Dr. Philip Hildebrand, Member of the Governing Board of the Swiss National Bank at 20th anniversary of the Swiss Society for Financial Market Research, Zurich, 7 April 2006. Accessed: 2019-07-01, URL https://bit.ly/2J1Q6gh.

Hubert P, Labondance F (2017). "Central bank sentiment and policy expectations." *Staff working paper No. 648*, Bank of England.

Hutchison MM, Sengupta R, Singh N (2013). "Dove or hawk? Characterizing monetary policy regime switches in India." *Emerging Markets Review*, **16**(C), 183–202.

Hwang BH, Kim HH (2017). "It pays to write well." *Journal of Financial Economics*, **124**(2017), 373–394.

Jansen DJ (2011). "Does the clarity of central bank communication affect volatility in financial markets? Evidence from Humphrey-Hawkins testimonies." *Contemporary Economic Policy*, **29**(4), 494–509.

Kamber Gü, Mohanty MS (2018). "Do interest rates play a major role in monetary policy transmission in China?" *BIS Working Papers No 714*, Monetary and Economic Department, Bank for International Settlements.

Kohn DL, Sack BP (2003). "Central bank talk: Does it matter and why?" *Finance and Economics Discussion Series 2003-55*, Board of Governors of the Federal Reserve System.

Lawrence A (2013). "Individual investors and financial disclosure." *Journal of Accounting and Economics*, **56**(1), 130–147.

Lehavy R, Li F, Merkley K (2011). "The effect of annual report readability on analyst following and the properties of their earnings forecasts." *The Accounting Review*, **86**(3), 1087–1115.

Li F (2008). "Annual report readability, current earnings, and earnings persistence." *Journal of Accounting and Economics*, **2008**(45), 221–247.

Loughran T, McDonald B (2014). "Measuring readability in financial disclosures." *The Journal of Finance*, **69**(4), 1643–1671.

Lucca DO, Trebbi F (2009). "Measuring central bank communication: An automated approach with application to FOMC statements." *NBER Working Paper No. 15367*, National Bureau of Economic Research.

Masayuki K, Yosuke T (February 2017). "A semantic analysis of monetary shamanism: A case of the BOJ's governor Haruhiko Kuroda." *RIETI Discussion Paper Series 17-E-011*, The Research Institute of Economy, Trade and Industry.

Mishra P, Montiel J P, Sengupta R (2016). "Monetary transmission in developing countries: Evidence from India." *IMF Working Papers 16/167*, International Monetary Fund.

Mishra P, Moriyama K, N'Diaye P, Nguyen L (2014). "Impact of Fed tapering announcements on emerging markets." *IMF Working Paper WP/14/109*, International Monetary Fund.

Moessner R, Jansen DJ, de Haan J (2017). "Communication about future policy rates in theory and practice: A survey." *Journal of Economic Surveys*, **31**(3), 678–711.

Mohan R (2008). "The role of fiscal and monetary policies in sustaining growth with stability in India." *Asian Economic Policy Review*, **3**, 209–236.

Pandey R, Patnaik I, Shah A (2017). "Dating business cycles in India." *Indian Growth and Development Review*, **10**(1), 32–61.

Patnaik I, Shah A (2009). "The difficulties of the Chinese and Indian exchange rate regimes." *European Journal of Comparative Economics*, **6**(1), 157–173.

Patnaik I, Shah A (2010). "Why India choked when Lehman broke." *India Policy Forum*, **6**, 39–73.

Picault M, Renault T (2017). "Words are not all created equal: A new measure of ECB communication." *Journal of International Money and Finance*, **79**, 136–156.

Ranaldo A, Rossi E (2010). "The reaction of asset markets to Swiss National Bank communication." *Journal of International Money and Finance*, **29**(3), 486–503.

RBI (2008). "Communication policy of RBI." Accessed: 2018-04-26, URL https://bit.ly/2V6sCIm.

RBI (2014). "RBI announces revised liquidity management framework." Press release: 2014-2015/381. Released 22.08.2014; Accessed: 2019-05-02, URL https://bit.ly/2vG5UN1.

RBI (2016). "Reserve Bank of India Act, 1934." As amended up to June 27, 2016, URL https://bit.ly/2VhaWPa.

Rosa C (2011). "Words that shake traders: The stock market's reaction to central bank communication in real time." *Journal of Empirical Finance*, **18**(2011), 915–934.

Rosa C (2016). "Fedspeak: Who moves US asset prices?" *International Journal of Central Banking*, **12**(4), 223–261.

Sengupta N (2014). "Changes in transmission channels of monetary policy in India." *Economic and Political Weekly*, **49**(49).

Shin HS, Morris S (2000). "Welfare effects of public information." *Discussion Paper Series 1: Economic Studies 2000,07*, Deutsche Bundesbank.

Singh B (2011). "How asymmetric is the monetary policy transmission to financial markets in India?" *RBI Occasional Papers 2 (Monsoon)*, Reserve Bank of India.

Smales L, Apergis N (2017). "Does more complex language in FOMC decisions impact financial markets?" *Journal of International Financial Markets, Institutions and Money*, **51**(2017), 171–189.

Tobback E, Nardelli S, Martens D (2017). "Between hawks and doves: Measuring central bank communication." *Working paper series No. 2085*, European Central Bank.

Weidmann J (2018). "Central bank communication as an instrument of monetary policy." Lecture by Dr. Jens Weidmann, President of the Deutsche Bundesbank and Chairman of the Board of Directors of the Bank for International Settlements at the Centre for European Economic Research, Mannheim, 2 May 2018. Accessed: 2019-05-01, URL https://bit.ly/2Lq52Xo.

Woodford M (2005). "Central bank communication and policy effectiveness." In *The Greenspan Era: Lessons for the Future*, Federal Reserve Bank of Kansas City, pp 399-474.

Zeileis A, Shah A, Patnaik I (2010). "Testing, monitoring, and dating structural changes in exchange rate regimes." *Computational Statistics & Data Analysis*, **54**(6), 1696–1706.

Appendices

A Data details

A.1 Number of monetary policy announcements

During the tenure of governor Bimal Jalan, two monetary policy statements were issued each year, one in April which outlined the monetary and credit policy for the year and one in October/November which provided a mid-term review of the monetary and credit policy. A new governor would typically commence his term in September of the year he was appointed.

When governor Reddy took over in September 2003, this communication strategy was continued for a while. In 2005-06 he initiated a new design under which four monetary policy statements were issued each year, in January, April, July and October. The April statement was always the annual policy statement for the year and the October one was the mid-term review. The statements were published on the RBI's website and were accompanied by shorter press releases that summarised the content of the statements.

Governor Subbarao's tenure began in September 2008. He continued the previous communication strategy (consisting of four statements a year and accompanying press releases) until 2010. In 2010 January he started teleconference with researchers and analysts right after announcing the monetary policy decision and simultaneously with the publication of the statement on the RBI's website. In 2010 April this was further accompanied by a press conference. The transcripts of both conferences were published on RBI's website with a lag of 1-2 days. In addition, he started issuing press releases seven times a year, which meant that three of these were issued even when there was no monetary policy statement. While the April/May statement continued to be the annual policy statement for the year, the mid-quarter review was instead communicated through a press release starting September 2010.

Governor Rajan's tenure began in September 2013. He changed the old design of communication starting April 2014. Instead of issuing four monetary policy statements a year, which was the practice during governors Reddy and Subbarao, during Rajan's tenure the RBI began issuing six statements a year. He continued the press conferences and teleconference with researchers and analysts but discontinued press statements/releases.

The IT regime was formalised and the MPC was appointed in Septmber 2016, when governor Urjit Patel took over. The MPC issues six monetary policy statements a year. These are published on the RBI's website around the time when the monetary policy decision is announced by the governor, in a press conference at 2pm on the scheduled date.

A.2 Monetary policy decision and communication

For majority of our sample period, an important policy rate was the repo rate, especially in the post inflation-targeting years and so we focus on this particular instrument of monetary policy. We first hand collect a time series of all repo rate announcements as well as the instruments used to communicate the rate between 1998-2018. During the pre-IT period, the monetary policy communication of RBI consisted of the governor announcing the policy rate through a statement. Often times the policy rate was also announced through off-cycle circulars, or press-releases. We club all rate announcements about policy rates, aside from statements, into the catchall term 'circulars', and use 'off-cycle' liberally to refer to any announcement date other than the scheduled date of the monetary policy statement.

There are 123 monetary policy events that are associated with changes in the repo rate. Roughly 37% of these since 2000 have been through circulars (19 for rate increases, and 25 for rate decreases).[39] These

[39]It is interesting to note that most rate cuts in India have been announced via circulars or press releases (not regularly scheduled statements). The most heavy usage of circulars has been during 2000-2002 and 2008-2011, both of which were turbulent periods in the global economy, which may have justified off-cycle rate cuts. It may further be because of asymmetric monetary policy transmission in India, where lending rates adjust faster to monetary tightening than to loosening (Das, 2015b; Singh, 2011). Therefore, it may be that to some extent,

are not usually accompanied by an explanation for why an off-cycle, rate-change has been made or a description of current and future economic conditions. [40]

Table 12 Summary of repo rate announcements in India, 1998-2018

Announcement	N	Repo change	Words	Sentences	Median readability*
No change	45	0.00	5475	234	Low
Rate hike	17	+0.25	11773	402	Medium
Rate cut	9	−0.25	5277	218	High

*: Based on the Farr-Jenkins-Paterson readability measure, discussed in more detail in section 3.2.

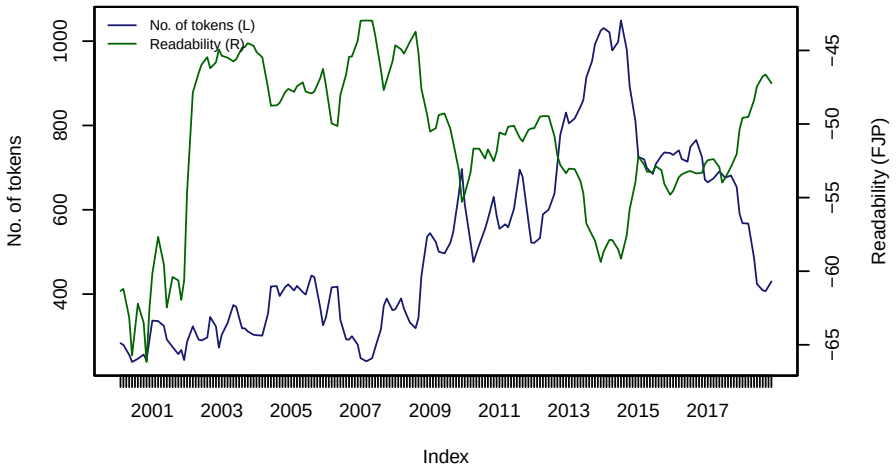
Monetary policy statements account for roughly 60% of the annoucements regarding the policy rate. Out of these, 45 events are of no rate changes, 17 events are of rate increases, and 9 events correspond to rate decreases.

One quirk of Indian monetary policy communication seems to be that a statement that announces a rate cut is shorter in length on average than one that announces a rate hike (table 12). This may be due to political economy considerations. Rate hikes transmit faster to tighter credit conditions (as shown in the relevant literature) and are relatively more unpopular in a growing economy than rate cuts, which is why they may need to be accompanied by greater explanation.

B Tables and figures

Figure 5 FOMC benchmark

Note: This graph reports the 2-meeting rolling average of length (measured by number of words) and readability (measured by Farr-Jenkins-Paterson readability score) for the FOMC. The two variables are significantly negatively correlated at the 1% level (−0.34). For India, the correlation is negative as well (−0.52) and highly significant at 1%.



the RBI relies on unanticipated or surprise decreases in interest rates to hasten this transmission process during times of stress. Also circulars or press releases containing repo rate changes were not issued close to a scheduled monetary policy announcement date. As a result their issuance will not affect our analysis as these were outside our observation window of 1 week after a scheduled announcement.

[40]There are, to the best of our knowledge, only two exceptions, 15 Jan 2015 and 4 Mar 2015, both under governor Rajan, which contain an explanation.

Table 13 Cyclicality of statement lengths: A sample

Note: This shows a sample of statement lengths between 2005-2009 (Reddy and Subbarao) to demonstrate the extent of variation between April (or October) statements with their intermediate follow-ups.

	No. of words	No. of sentences	Reddy	Subbarao
Apr 2005	**18,302**	**691**	1	0
Jul 2005	5,874	224	1	0
Oct 2005	**16,907**	**625**	1	0
Jan 2006	11,773	402	1	0
Apr 2006	**28,490**	**1,039**	1	0
Jul 2006	10,723	402	1	0
Oct 2006	**20,777**	**756**	1	0
Jan 2007	16,477	625	1	0
Apr 2007	**32,889**	**1,115**	1	0
Jul 2007	16,233	599	1	0
Oct 2007	**31,262**	**1,060**	1	0
Jan 2008	20,122	706	1	0
Apr 2008	**34,165**	**1,128**	1	0
Jul 2008	19,850	714	0	1
Oct 2008	**33,428**	**1,133**	0	1
Jan 2009	12,572	514	0	1

Table 14 Correlation between various readability indices

Note: This table shows the simple correlation between various measures of readability along with our preferred measure, the Farr-Jenkins-Paterson.

	Farr-Jenkins-Paterson	Flesch-Kincaid	Flesch-PSK	FOG
Farr-Jenkins-Paterson				
Flesch-Kincaid	-0.92****			
Flesch-PSK	-0.74****	0.94****		
FOG	-0.90****	0.99****	0.94****	
SMOG	-0.88****	0.99****	0.95****	1.00****

Table 15 Sample of the pre-processed term document matrix (excl. stemming)

Note: This table shows an example of the term-document matrix, before stemming, that is used to construct the word-clouds.

Word	**Document**	**Count**	**Regime**	**Quarter**
discuss	1998_10_Jalan	1	Jalan	Oct 1998
evergreening	1998_10_Jalan	1	Jalan	Oct 1998
non	1998_10_Jalan	1	Jalan	Oct 1998
abil	1998_10_Jalan	2	Jalan	Oct 1998
abroad	1998_10_Jalan	1	Jalan	Oct 1998
absenc	1998_10_Jalan	1	Jalan	Oct 1998
widen	2018_04_MPCS	1	MPCS	Apr 2018
wit	2018_04_MPCS	1	MPCS	Apr 2018
within	2018_04_MPCS	1	MPCS	Apr 2018
work	2018_04_MPCS	1	MPCS	Apr 2018
world	2018_04_MPCS	1	MPCS	Apr 2018
yield	2018_04_MPCS	2	MPCS	Apr 2018

Figure 6 Nifty50 annualised 7-day standard deviation

Note: This graph shows the the main dependent variable of interest $log\ RVOL_{t:t+7}$. The data is for 70 statements.

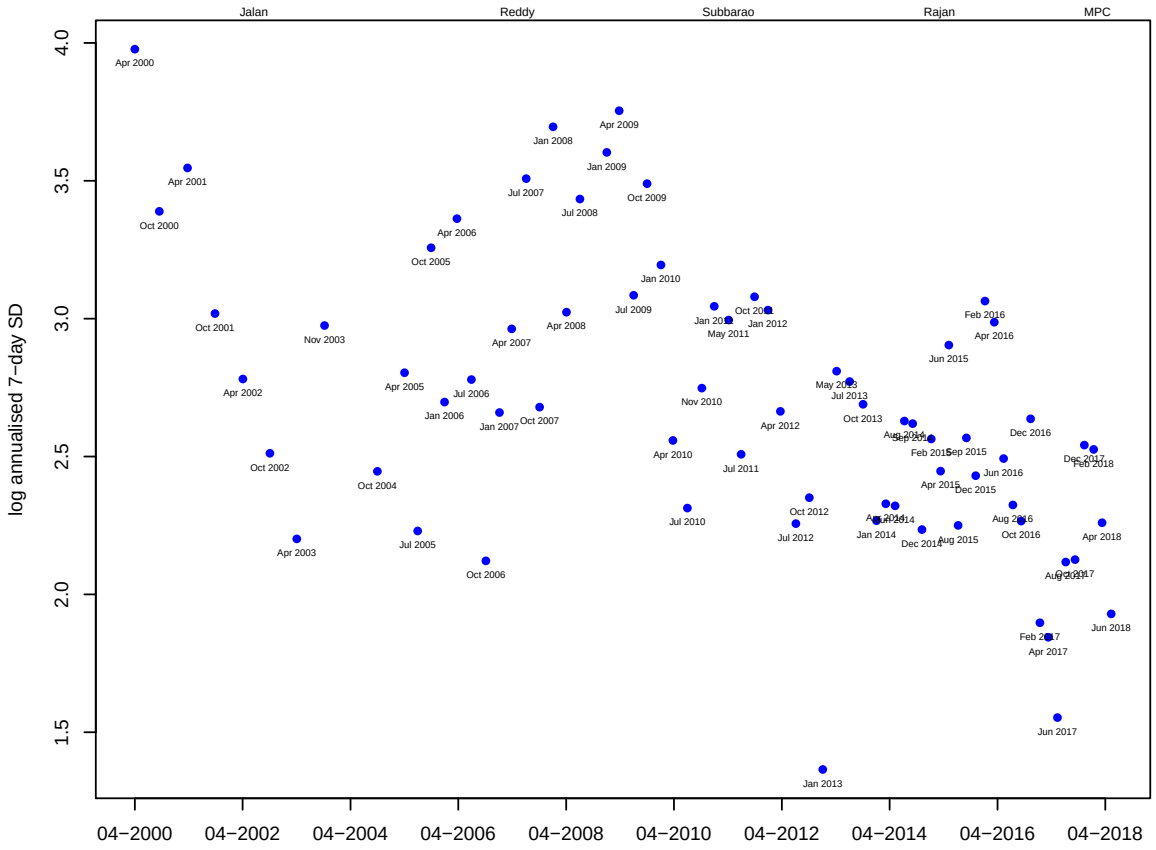


Figure 7 Global VIX and India EPU

Note: This graph shows the CBoE global VIX - a proxy global uncertainty and international market volatility in green, and a textual measure of economic policy uncertainty (EPU) for India, constructed by Baker *et al.* (2016). India EPU shows a jump in December 2016 and February 2017, post the Nov 2016 episode of demonetisation.

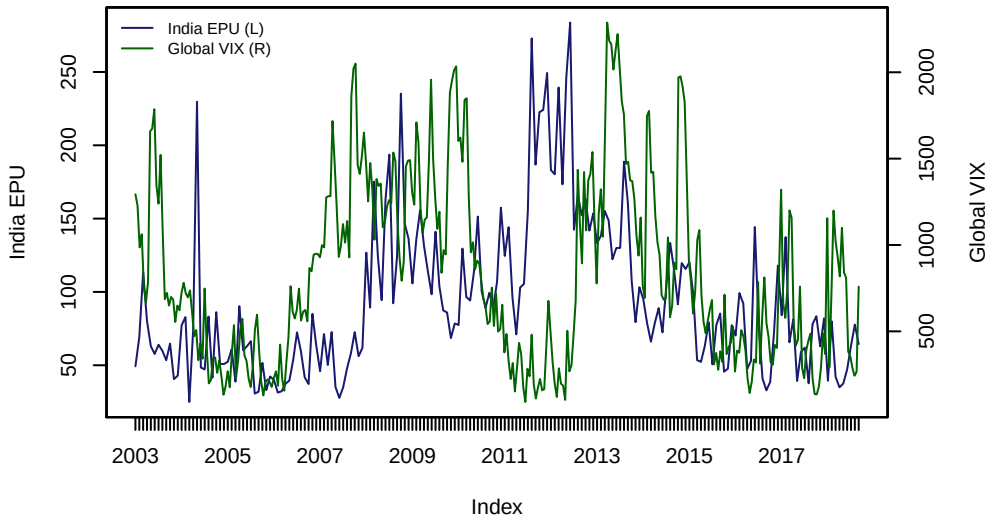
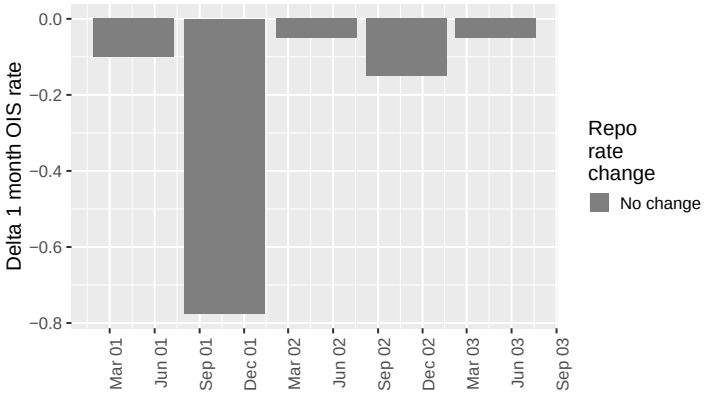
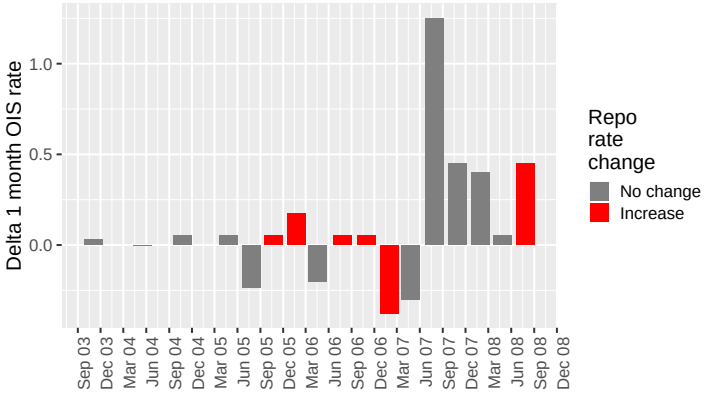


Figure 8 MP surprises: Jalan, Reddy, Subbarao

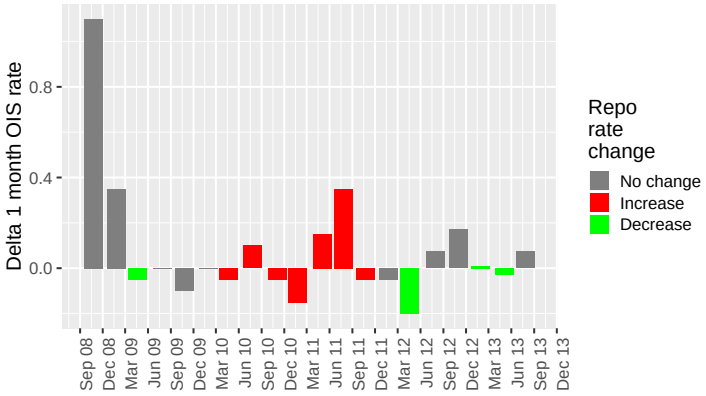
Note: This graph shows monetary policy surprises for three RBI governors (Jalan, Reddy, and Subbarao), as measured using the daily difference in the 1 month overnight indexed swap between t and $t-1$ (where t is the monetary policy announcement), as used in Kamber and Mohanty (2018). Green refers to an announcement where there was an actual repo rate decrease, red to an announcement where there was a repo rate increase, and grey refers to no repo rate change. As an example, there can be a monetary policy surprise even on days of rate increases when either (a) the market anticipated more tightening than what the RBI delivered or (b) the market anticipated monetary easing. The big surprise in Oct 2008 potentially refers to a market expectation that the repo rate would be lowered after the Lehman crisis broke in September.



(a) Jalan



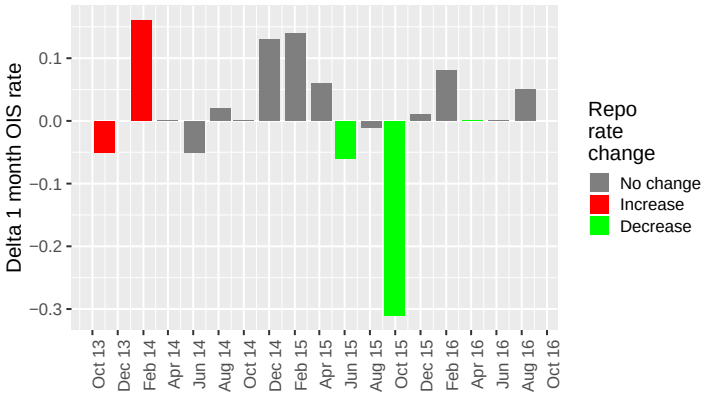
(b) Reddy



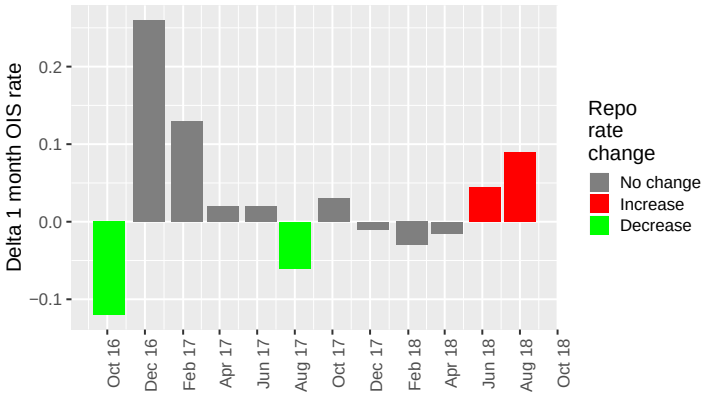
(c) Subbarao

Figure 9 MP surprises: Rajan, MPC

Note: This graph shows monetary policy surprises for two RBI regimes (Rajan and MPC), as measured using the daily difference in the 1 month overnight indexed swap between t and $t-1$ (where t is the monetary policy announcement), as used in Kamber and Mohanty (2018). As an example, there can be a monetary policy surprise even on days of rate increases when either (a) the market anticipated more tightening than what the RBI delivered or (b) the announcement was accompanied by other loosening measures. The surprise in Dec 2016 and Feb 2017 potentially refers to a market expectation that the repo rate would be lowered after demonetization.



(a) Rajan



(b) MPC

Table 16 Readability based clustering of all monetary policy announcements, 2000-2018

Note: This table shows the length, readability cluster, and repo rate decision of each of the monetary policy statements in India between 2000 and 2018. *Number of words* are the number of raw words in each statement, while there are three *readability* clusters: 1 is for low readability, 2 for medium readability, and 3 for high readability, as defined in detail in section 3.2.

	Regime	Year	Readability cluster	Δ Repo rate	No. of words
1	Jalan	Apr 2000	1		16,770
2	Jalan	Oct 2000	1		16,703
3	Jalan	Apr 2001	1	0	23,491
4	Jalan	Oct 2001	1	0	16,035
5	Jalan	Apr 2002	1	0	22,844
6	Jalan	Oct 2002	1	0	20,766
7	Jalan	Apr 2003	1	0	22,452
8	Reddy	Nov 2003	1	0	15,992
9	Reddy	May 2004	1	0	24,029
10	Reddy	Oct 2004	1	0	22,283
11	Reddy	Apr 2005	1	0	18,302
12	Reddy	Jul 2005	1	0	5,874
13	Reddy	Oct 2005	1	0.250	16,907
14	Reddy	Jan 2006	1	0.250	11,773
15	Reddy	Apr 2006	1	0	28,490
16	Reddy	Jul 2006	1	0.250	10,723
17	Reddy	Oct 2006	1	0.250	20,777
18	Reddy	Jan 2007	1	0.250	16,477
19	Reddy	Apr 2007	1	0	32,889
20	Reddy	Jul 2007	1	0	16,233
21	Reddy	Oct 2007	1	0	31,262
22	Reddy	Jan 2008	1	0	20,122
23	Reddy	Apr 2008	1	0	34,165
24	Reddy	Jul 2008	1	0.500	19,850
25	Subbarao	Oct 2008	1	0	33,428
26	Subbarao	Jan 2009	2	0	12,572
27	Subbarao	Apr 2009	1	−0.250	31,911
28	Subbarao	Jul 2009	2	0	13,351
29	Subbarao	Oct 2009	1	0	24,658
30	Subbarao	Jan 2010	3	0	5,456
31	Subbarao	Apr 2010	2	0.250	14,891
32	Subbarao	Jul 2010	3	0.250	5,743
33	Subbarao	Nov 2010	2	0.250	15,210
34	Subbarao	Jan 2011	3	0.250	7,288
35	Subbarao	May 2011	2	0.500	16,889
36	Subbarao	Jul 2011	3	0.500	6,458
37	Subbarao	Oct 2011	2	0.250	13,193
38	Subbarao	Jan 2012	3	0	6,977
39	Subbarao	Apr 2012	3	−0.500	13,084
40	Subbarao	Jul 2012	3	0	5,475
41	Subbarao	Oct 2012	2	0	13,459
42	Subbarao	Jan 2013	3	−0.250	5,277
43	Subbarao	May 2013	1	−0.250	14,121
44	Subbarao	Jul 2013	3	0	4,937
45	Rajan	Oct 2013	2	0.250	4,136
46	Rajan	Jan 2014	1	0.250	1,459
47	Rajan	Apr 2014	2	0	4,232
48	Rajan	Jun 2014	1	0	1,790
49	Rajan	Aug 2014	1	0	1,738
50	Rajan	Sep 2014	1	0	4,129
51	Rajan	Dec 2014	2	0	2,409
52	Rajan	Feb 2015	1	0	4,727
53	Rajan	Apr 2015	1	0	5,245
54	Rajan	Jun 2015	2	−0.250	2,519
55	Rajan	Aug 2015	2	0	2,547
56	Rajan	Sep 2015	2	−0.500	5,135
57	Rajan	Dec 2015	2	0	2,163
58	Rajan	Feb 2016	3	0	2,187
59	Rajan	Apr 2016	1	−0.250	6,460
60	Rajan	Jun 2016	3	0	2,426
61	Rajan	Aug 2016	3	0	2,531
62	MPCS	Oct 2016	1	−0.250	1,783
63	MPCS	Dec 2016	1	0	2,818
64	MPCS	Feb 2017	1	0	2,602
65	MPCS	Apr 2017	2	0	3,482
66	MPCS	Jun 2017	2	0	3,628
67	MPCS	Aug 2017	2	−0.250	3,559
68	MPCS	Oct 2017	2	0	3,468
69	MPCS	Dec 2017	3	0	2,941
70	MPCS	Feb 2018	3	0	2,917
71	MPCS	Apr 2018	2	0	3,403
72	MPCS	Jun 2018	3	0.250	3,243