Macroeconomic Effects of Scheduled and Unscheduled Monetary Policy Surprises

Karthik Narayan A.S.*

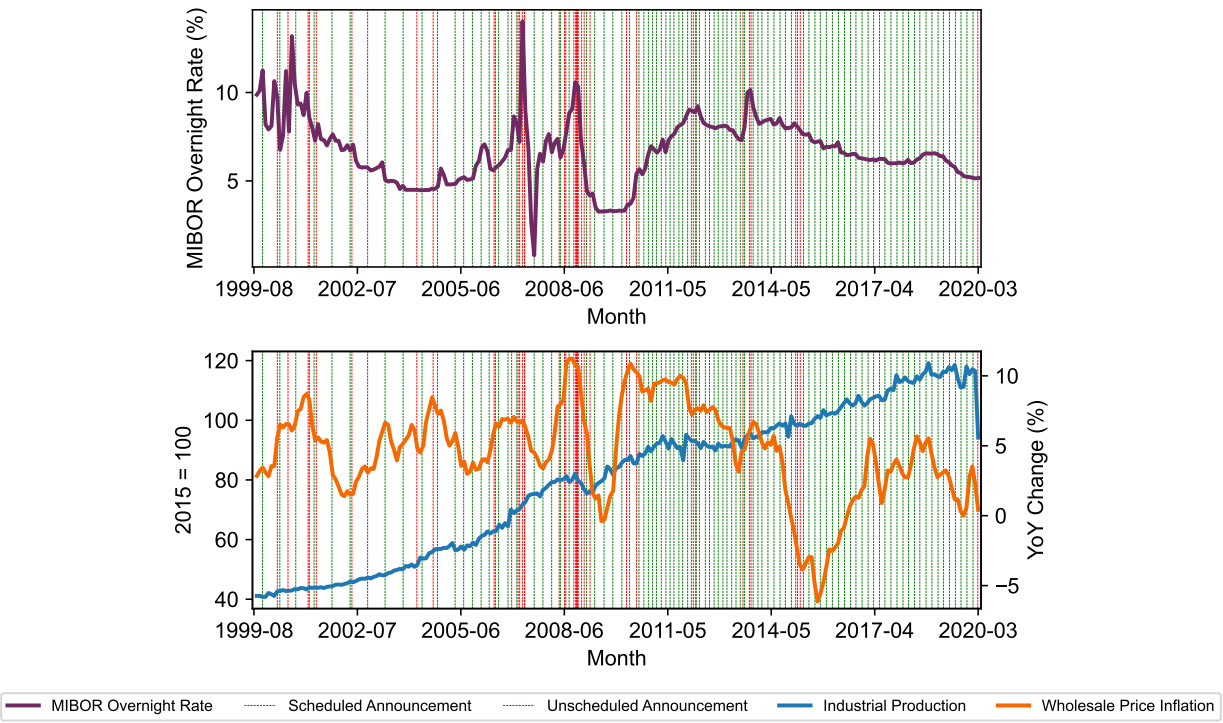
August 26, 2024

Abstract

Using measures of monetary policy surprises identified from the Overnight Indexed Swap market in India, this paper documents heterogeneity in the effects of monetary policy surprises on scheduled and unscheduled announcement dates. Higher interest rates on scheduled announcement dates lower stock prices, reduce forecasted and actual output as well as inflation. In contrast, unscheduled monetary policy surprises are predictable by past macroeconomic conditions, raise stock prices, output and inflation on impact. These results are consistent with less precise identification of exogenous changes in monetary policy on unscheduled announcement dates compared to scheduled announcement dates. Monetary policy transmission in India, identified using monetary policy surprises from scheduled announcement dates, is found to be significantly stronger than previously documented.

*Nuffield College and Department of Economics, University of Oxford. ✉: karthik.abhiramapuramsridhar@economics.ox.ac.uk.
I am indebted to Chris Adam, Steve Bond, John Muellbauer and Bent Nielsen for their constant guidance and support. I also thank Sergio de Ferra, Andrea Ferrero, Gabriel Pombal Fritsch, Chris Hyland, Rustam Jamilov, Aeimit Lakdawala, Michael McMahon, Silvia Miranda-Agrippino, Emi Nakamura, Golaka C Nath, Adrian Pagan, Rajeswari Sengupta, Gautham Udupa and William Witheridge as well as seminar participants at Oxford and Warwick for their helpful comments and suggestions. I am grateful to Philip Hubbard and Consensus Economics for providing access to the Consensus Forecasts data. I gratefully acknowledge financial support from the Clarendon Fund and Nuffield College during the period when this research was conducted. All errors are my own.

Figure 1: Key macroeconomic indicators in India, August 1999 to March 2020



Notes: The upper panel plots the monthly average of the overnight Mumbai Interbank Outright Rate (MIBOR) from August 1999 to March 2020. The lower panel plots the monthly Index of Industrial Production (IIP) and Year-on-Year percentage change in the Wholesale Price Index (WPI) for India between August 1999 and March 2020. Scheduled and unscheduled announcement dates of the Reserve Bank of India are marked in green and red respectively in the two panels. Data on overnight MIBOR is sourced from the Bloomberg Terminal with ticker: IN00O/N Index. The data on IIP is obtained from FRED with ticker: INDPROINDMISMEI and the data on WPI is obtained from FRED with ticker: WPIATT01INM661N.

1 Introduction

Central banks typically review their monetary policy at regular, pre-determined intervals. This allows financial market participants to price in their expectations for monetary policy in anticipation of these scheduled announcements. However, central banks also occassionally make announcements about monetary policy outside of these scheduled intervals in response to changing economic conditions. These unscheduled announcements are typically unanticipated by financial market participants and hence provide an opportunity to identify much larger surprise changes in monetary policy.

This paper argues that this opportunity comes at the cost of imprecise identification of exogenous changes in monetary policy. It does so by considering the response of key macroeconomic variables to monetary policy surprises identified using changes in Overnight Indexed Swap (OIS) rates in a narrow time window around monetary policy announcements of India's central bank, the Reserve Bank of India (RBI). India is presently the world's most populous country and its third-largest economy (UN, 2023; IMF, 2023). Furthermore, it presents an unqiue opportunity to study the differential effects of scheduled and unscheduled monetary policy surprises due to the large number of unscheduled monetary

policy announcements undertaken by the RBI in the last two decades. Figure 1 documents the time series of key macroeconomic variables in India and highlights the frequent occurrence of unscheduled monetary policy announcements in India during the time period under study.

Using measures of monetary policy surprises identified from changes in the fixed rates of OIS contracts tied to the Mumbai Interbank Outright Rate (MIBOR), the benchmark overnight interbank interest rate, during a two-day time window around monetary policy announcements of the RBI, this paper investigates the causal effects of monetary policy in India. [1] Applying this approach to 1-month MIBOR-OIS contracts, this paper documents significant heterogeneity in the effects of monetary policy surprises on scheduled and unscheduled announcement dates.

On scheduled announcement dates, higher interest rates lead to higher bond yields, lower stock prices, lower output and inflation. Following a 100 basis points increase in the 1-month MIBOR-OIS rate, the 1-year government bond yield increases by 20 basis points and stock market indices decline by about 3%. Higher interest rates are also associated with a flatter yield curve as evidenced by smaller responses of longer horizon interest rates to the monetary policy surprise.

Furthermore, such policy tightening on scheduled announcement dates also leads to downward revisions in consensus forecasts for real GDP growth for the current and next year by between 12 and 20 basis points, providing new evidence on the effects of RBI monetary policy announcements on forecast revisions of private sector economic agents.

A 100 basis point increase in the 1-month MIBOR-OIS rate on scheduled announcement dates also has persistent contractionary effects on actual output with a maximum effect of 2.5% on industrial production 12 to 18 months after the announcement. Inflation also declines following a monetary policy tightening on scheduled announcement dates, but starts to do so only after a lag of about one year, with a maximum effect of 2.5% occurring 19 months after the initial impulse.

In contrast, following unscheduled announcements, higher interest rates while still leading to higher bond yields, lead also to higher stock prices, output and inflation on impact. Further, the responses of consensus forecasts revisions of key macroeconomic variables appear biased in the opposite direction to the effects on scheduled announcement dates. While the effects on inflation and output are statistically significant on impact, they are not statistically significant for stock prices.

The paper accounts for the differences in the macroeconomic effects of scheduled and unscheduled monetary policy surprises by providing explicit evidence about differences in the endogeneity of measured monetary policy surprises to past macroeconomic conditions on scheduled and unscheduled announcement dates. Scheduled monetary policy surprises are not found to be predictable by past macroeconomic conditions while unscheduled monetary policy surprises are predictable by such conditions, in particular by recent economic growth and rainfall conditions.

[1] MIBOR is closely linked to the Weighted Average Call Rate (WACR), which is a trade-weighted average of the overnight interbank interest rate. WACR has been the operating target of monetary policy for the RBI since May 2011 (RBI, 2011). However, unlike WACR, which is based on actual trades, MIBOR which is used as the reference rate for interest rate derivatives, was calculated until 2014 based on polls conducted every weekday morning of 30 banks and primary dealers by the National Stock Exchange of India. Since 2014, MIBOR has also been calculated based on actual market trades (Nath, 2018).

There are three potential explanations for the endogeneity of unscheduled monetary policy surprises to past macroeconomic conditions. Firstly, if the central bank is reacting to high-frequency information about changing economic conditions, the use of a two-day window could confound the effects of the news and the central bank's systematic reaction to it with a monetary policy surprise. The choice of a two-day window is however necessitated by the lack of intra-day data on MIBOR-OIS contracts and the practice of the RBI to make many monetary policy announcements after trading hours. These problems are not unique to India but are a feature of other large emerging economies too (Witheridge, 2024). With the increased availability of intra-day data in emerging markets, it would be possible to isolate monetary policy surprises even on unscheduled announcement dates with greater precision by using narrower time windows around monetary policy announcements during which the effects of other information revelations have already been priced in. This would further allow for a better understanding of the sources of the different effects of unscheduled monetary policy surprises.

A second explanation for the lack of proper identification on unscheduled announcement dates has to do with the Hirshleifer (1971) effect. Since unscheduled announcements are completely unanticipated by market participants, they preclude the possibilities for risk-sharing activity in the financial markets in anticipation of these monetary policy announcements. As a result, swap contracts may not be properly priced to reflect market expectations of monetary policy actions at the time of the unscheduled announcements leading to poor identification of monetary policy surprises.

Finally, the endogeneity of monetary policy surprises on unscheduled announcement dates could reflect differences between the market percieved central bank policy reaction function and the actual policy reaction function used by the central bank when it is acting outside its regularly scheduled meetings. Acosta (2023) points out that the endogeneity of measured monetary policy surprises to past macroeconomic conditions in the US could be due to an emphasis on non-standard variables in central bank communications that the markets did not anticipate. Relatedly, this paper provides evidence consistent with the endogeneity of unscheduled monetary policy surprises in India being due to a non-standard emphasis on standard variables in the central bank policy reaction function relative to market expectations.

Regardless of the source of the information component of the identified surprises on unscheduled announcement dates, the results suggest that monetary policy surprises are not well identified on unscheduled announcement dates under relatively standard data availability conditions in emerging countries. Relative to scheduled announcement dates, central banks are biased towards action on unscheduled announcement dates. While the central bank may choose to keep monetary policy unchanged on scheduled announcement dates, unscheduled monetary policy announcements are always associated with a change in monetary policy. This bias towards action on unscheduled announcement dates manifests itself as a *power-identification tradeoff* for the econometrician. Measured monetary policy surprises on unscheduled announcement dates are likely to be typically larger than on scheduled dates, thereby providing more statistical power to detect the effects of monetary policy. However, they are also more likely to be endogenous to other contemporaneous developments,

confounding the identification of the effects of monetary policy actions. Therefore, for assessments of monetary policy transmission in developing countries which require reliance on high-frequency identification, it would be important to either exclude unscheduled monetary policy surprises altogether or exercise caution in controlling for the endogeneity of these surprises before using them for monetary policy analysis.

Existing evidence on the effects of monetary policy on aggregate demand suggest that it is very weak in India (Mishra et al., 2016). This paper also argues that the absence of evidence on the effectiveness of monetary policy transmission in India is not necessarily evidence of its absence. Instead, it is likely to be a result of the endogeneity of identified monetary policy surprises to other contemporaneous developments. Monetary policy transmission to aggregate demand in India, identified using monetary policy surprises on scheduled announcement dates, is found to be significantly stronger than previously documented. In contrast, monetary policy surprises on unscheduled announcement dates are found to be endogenous to prevailing macroeconomic conditions, thereby confounding the identification of their effects on macroeconomic variables.

1.1 Related literature

This paper makes a contribution to three main strands of the literature: (i) monetary policy transmission in India, (ii) monetary transmission in emerging economies and (iii) high-frequency identification of monetary policy surprises.

Monetary Policy Transmission in India: There is a large body of research studying monetary policy transmission in India. An extensive literature review of these studies was conducted by Mishra et al. (2016). The standard approach in the literature has involved using Structural Vector Auto-Regressions (SVARs) to estimate the effects of monetary policy on macroeconomic variables. The identification of exogenous changes in monetary policy in these studies has typically been based on the Cholesky decomposition of the reduced form VAR.

These studies have generally not been able to find statistically significant and economically meaningful effects of monetary policy on inflation and output, or in other words, aggregate demand in India. The lack of significant effects of monetary policy on output and inflation in India have been commonly attributed to a wide range of factors ranging from fiscal dominance of monetary policy (Acharya, 2020) to governmental interventions in setting price floors for key agricultural products (Rajan, 2014).

Given the limitations of restricting the contemporaneous interaction between variables at a monthly or quarterly frequency, which a SVAR imposes, attempts have been made in recent times to use changes in high-frequency swap rates around monetary policy announcements to identify monetary policy surprises. This paper is most closely related to Lakdawala and Sengupta (2024), who use high-frequency changes in MIBOR-OIS to measure monetary policy surprises in India.

Following Gürkaynak et al. (2005), they decompose changes in the OIS rates on monetary policy announcement dates up to 1 year ahead into target and path factors, capturing respectively the contem-

poraneous and forward guidance components of monetary policy announcements. They do not provide any evidence on the effects of the target factor on macroeconomic variables, due to the target factor being a weak instrument for the 1-year interest rate in a SVAR-IV model and find that the path factor tightening leads to an increase in output, which they attribute to information effects of monetary policy.

This paper extends the work of Lakdawala and Sengupta (2024) along three dimensions. Firstly, this paper uses a longer time series of monetary policy announcements going back to 1999 to measure monetary policy surprises in India. This is presently the longest available time series of monetary policy surprises for India.

Further, the paper just considers the 1-month MIBOR-OIS rate to measure changes in contemporary monetary policy and finds significant effects in the theoretically expected direction on output and inflation once unscheduled announcement dates have been excluded from the estimation. Monetary policy transmission in India is found to be much stronger than previously documented.

Finally, the paper uses novel monthly data on private sector economic forecasts, to understand and document the effect of monetary policy surprises on private sector expectations of future output and inflation. This is an important contribution to the literature as it provides evidence on the effects of monetary policy on the expectations of economic agents, which can be an important channel through which monetary policy affects macroeconomic variables.

Monetary Transmission in Emerging Economies: Monetary policy transmission in developing countries has received renewed attention in recent years with the increased availability of high-frequency financial market data (Witheridge, 2024; Pirozhkova et al., 2024). This has made it possible to identify surprise changes in monetary policy in emerging economies using high-frequency changes in prices of financial instruments, particularly from the futures and swap markets, around monetary policy announcements. In the process, it has allowed for a methodological advance over earlier studies which had to rely on identification assumptions imposed on much lower frequency data (Mishra and Montiel, 2013). As Adam et al. (2016) point out, the traditional VAR-based identification approach is ill-suited for reliable identification of monetary policy shocks in low income countries characterised by short time series and measurement error in the data. This paper contributes to the high-frequency identification literature by providing evidence on the effects of monetary policy on both the financial markets and macroeconomic outcomes in India, adding to the evidence from other emerging economies.

Adam et al. (2016) and Mishra et al. (2012) point to two competing explanations for the observed weakness of the effects of monetary policy in developing countries. The first 'facts on the ground' view suggests that formal financial markets are small and poorly arbitraged in low income countries leading to weak monetary policy transmission. The other 'limitations of the method' view suggests that the monetary transmission mechanism itself is not weak but that traditional methods of identification are unable to capture the effects of monetary policy appropriately due to data deficiencies in low income countries. This paper provides evidence in favour of the latter view using high-frequency identification of monetary policy surprises.

The focus of the literature on monetary policy transmission in emerging economies has recently been on the transmission of foreign, particularly US, monetary policy shocks to emerging economies (Rey, 2015; Chari et al., 2021). In addition, it has been common practice to use data on financial instruments with relatively longer maturities (e.g., 3-month, 1-year) to measure monetary policy surprises which could confound signals about monetary policy with signals about the future path of economic conditions and policy. This paper, on the other hand studies *domestic monetary policy*, measured using monetary policy surprises from a *much shorter maturity (1-month) financial asset* which helps to isolate the contemporaneous monetary policy component of the surprise.

High-frequency Identification of Monetary Policy Surprises: There is an extensive literature on the high-frequency identification of monetary policy surprises which was inaugurated by Kuttner (2001). Recent surveys of this literature can be found in Ramey (2016) and Bauer and Swanson (2023b). It has been common practice in this literature to use high-frequency changes in futures and swap rates on *both* scheduled and unscheduled announcement dates to identify monetary policy surprises. While Nakamura and Steinsson (2018) note that monetary policy surprises on unscheduled announcement dates may not be well identified due to their endogeneity to other contemporaneous developments, no systematic evidence exists to document this. This paper provides evidence on the differential effects of measured monetary policy surprises on scheduled and unscheduled announcement dates in India, which has a significant number of unscheduled monetary policy announcements. It shows that while measured monetary policy surprises on scheduled announcement dates have the expected effects on asset prices and macroeconomic outcomes, they do not do so on unscheduled announcement dates.

There is an emerging literature trying to document and account for the puzzling effects of measured monetary policy surprises on macroeconomic outcomes. Nakamura and Steinsson (2018) point out that the upward revisions of GDP growth forecasts in the US following measured monetary policy surprise tightenings is due to the revelation of information about the economic outlook in Fed monetary policy communications. On the other hand, Miranda-Agrippino and Ricco (2021), Bauer and Swanson (2023a) and Bauer and Swanson (2023b) argue that the puzzling effects of measured monetary policy surprises on macroeconomic forecasts are driven by omitted variables bias in the estimation of the effects of monetary policy surprises. Recent work by Acosta (2023) suggests that this endogeneity reflects central bank communications that emphasize non-standard variables that markets do not expect. This paper contributes to this literature by pointing out differences in the endogeneity of measured monetary policy surprises on scheduled and unscheduled announcement dates. Central bank communications with a non-standard emphasis on standard variables, relative to market expectations, rather than an emphasis on non-standard variables appear to be responsible for the endogeneity of measured monetary policy surprises on unscheduled announcement dates to past macroeconomic data. On the other hand, monetary policy surprises on scheduled announcement dates are not found to be endogenous to past macroeconomic conditions.

1.2 A reader's guide

The rest of the paper is structured as follows. Section 2 outlines the theory underlying the identification of monetary policy surprises from the OIS market. Section 3 describes the MIBOR-OIS data and the monetary policy surprises on scheduled and unscheduled RBI announcement dates. Section 4 provides evidence on the sources of monetary policy surprises in India. Section 5 presents event-study evidence on transmission of monetary policy to financial market variables and macroeconomic forecasts. Section 6 documents the effects of monetary policy surprises on macroeconomic variables, particularly output and inflation. Section 7 concludes.

2 Identification of monetary policy surprises

In order to analyse the transmission of monetary policy, it is necessary to first obtain a measure of monetary policy 'surprises', which are unanticipated and exogenous changes in the monetary policy actions of the central bank. The need for such monetary policy 'surprises', which are uncorrelated with other contemporaneous macroeconomic developments, to analyse the monetary transmission mechanism is well recognised in the literature (Christiano et al., 1999; Ramey, 2016).

If changes in monetary policy that are endogenous to developments in macroeconomic conditions (or perceived as such by economic agents) are used as part of a regression specification to estimate the effects of monetary policy on macroeconomic variables, any such estimates are likely to be biased and inconsistent. This is on account of the *dynamic inter-dependencies* that are likely to exist between different macroeconomic variables. A recent survey of methods developed to calculate monetary policy shocks can be found in Ramey (2016).

The standard empirical approach, which is followed here, attempts to use monetary policy surprises as an instrument to identify monetary policy transmission. An important limitation of this approach, as pointed out by McKay and Wolf (2023), is that it is subject to the Lucas Critique (Lucas, 1976). It will not be possible to learn about the effects of different monetary policy counterfactuals from the effects of monetary policy surprises estimated in this study. As a result, recent work has focused instead on identifying the effects of systematic monetary policy on macroeconomic conditions (Hack et al., 2023; Barnichon and Mesters, 2023; McKay and Wolf, 2023). This is an important area for future research in the Indian context.

In line with the established empirical approach, the monetary transmission mechanism in India is analysed using monetary policy 'surprises' derived based on high-frequency data on interest rate swap contracts around monetary policy announcement dates of the Reserve Bank of India. This is similar in spirit to recent work on high-frequency identification in the United States by Nakamura and Steinsson (2018). A further advantage of this method of identification is that it allows for a separate analysis of the transmission mechanism for contemporaneous monetary policy and information about the future path of monetary policy.

Monetary policy surprises are derived from the Overnight Indexed Swap (OIS) market for India. This is following the work of Lakdawala and Sengupta (2024), Das et al. (2020) and Mathur and Sengupta (2019). In particular, MIBOR-OIS contracts are used in the analysis. These contracts have a market-determined fixed coupon rate as their fixed leg and a floating leg tied to the Mumbai Interbank Outright Rate (MIBOR), which is the benchmark interest rate on unsecured loans in the interbank market.

MIBOR is the price of liquidity in the banking system and is hence closely tied to the RBI's monetary policy operations, which impart a significant control over liquidity conditions in the financial system. Changes in current monetary policy as well as in the stance of monetary policy for the future will hence reflect in MIBOR-OIS contracts of different maturities. A detailed description of MIBOR-OIS contracts can be found in FIMMDA (2016).

A brief consideration of the suitability of using OIS contracts to construct monetary policy surprises is now in order. There is a vast literature, inaugurated by Kuttner (2001), which uses high frequency financial market data to identify monetary policy surprises. It has been standard practice in this literature to use high frequency changes in yields on government securities or futures contracts. An application to the Indian context, using changes in the yield on 91-day Treasury Bills, can be found in Prabu A. et al. (2016).

However, as Lloyd (2018) notes, OIS contracts have many important advantages over government securities and futures contracts which make them a more suitable instrument for identification of monetary policy surprises. Firstly, OIS contracts involve no exchange of principal and consequently have *lower counterparty risk*.

In addition, OIS contracts do not lead to any initial cash flows thereby *reducing liquidity risk*. Many OIS contracts are also collateralized which *reduces credit risk*. Finally, as Choy (2003) notes, OIS contracts have lower *basis risk* (the risk of policy interest rate changes not reflecting in the contract interest rate) as they are directly indexed to an overnight interest rate influenced by the central bank's monetary policy actions.

On the other hand, as Gürkaynak et al. (2007) point out, government securities are subject to these risks to a greater extent, making it difficult to isolate monetary policy surprises from other contemporaneous developments, particularly during periods of heightened uncertainty. Furthermore, in contrast with typical futures contracts, OIS contracts have time horizons that align well with other financial instruments and hence their movements in response to monetary policy are less sensitive to the timing of the policy announcements. Their global usage also makes them more comparable across geographies than futures contracts which are not traded in many developing economies.

A two-day window (one day before and after the monetary policy announcement) is used to compute monetary policy surprises in this study, for reasons explained in greater detail below. In this context, identification of monetary policy surprises requires the following three identification assumptions, following Lloyd (2018):

Assumption 1: *no-arbitrage pricing* of the fixed leg of the MIBOR-OIS;
Assumption 2: *rational expectations* about the *expected future path* of the MIBOR-OIS floating interest rate and,
Assumption 3: Changes in the MIBOR-OIS fixed rate during the two-day window around monetary policy announcement dates reflect responses *only to monetary policy communication from the RBI.*

Under these assumptions, any anticipated change in monetary policy would already have been priced in to the MIBOR-OIS contract and reflected in the fixed leg interest rate in advance of the monetary policy announcement. Therefore, any movement in the fixed leg interest rate in response to the monetary policy announcement on the announcement date is a result of monetary policy actions *not anticipated* by financial market participants. In other words, it reflects a monetary policy surprise.

Suppose there is a n-day MIBOR-OIS contract starting at date t. The monetary policy surprise on monetary policy announcement date t, $\epsilon^m_{n,t}$, is then identified as the difference between the fixed rate on the MIBOR-OIS contract on the day after the announcement and the day before the announcement.

Proposition: *Under Assumption 1, Assumption 2 and Assumption 3, a surprise change in monetary policy up to n days ahead, on monetary policy announcement date t ($\epsilon^m_{n,t}$) is identified as*[2]:

$$\epsilon^m_{n,t} = \frac{365}{n}\left[\mathbb{E}_{t+1}\left(\prod_{j=t+1}^{t+1+n}\left(1+\frac{MIBOR_{j+1}}{365}\right)\right) - \mathbb{E}_{t-1}\left(\prod_{j=t-1}^{t-1+n}\left(1+\frac{MIBOR_{j+1}}{365}\right)\right)\right]$$

Proof: Let $i^{fixed}_{t,t+n}$ and $i^{float}_{t,t+n}$ be the fixed and floating rates on a n-day MIBOR-OIS contract at time t. *Assumption 1* is a statement of the expectations hypothesis of the term structure of interest rates (Fisher, 1930; Hicks, 1939). As Cochrane (2005) notes, the fixed interest rate on a swap is equivalent to the yield on a coupon bond of identical maturity and hence is also priced in the same fashion.[3] This requires that the return from investing a given sum at the fixed rate should equal the expected return from the floating leg and a term premium $\lambda_{t,t+n}$:

$$i^{fixed}_{t,t+n} = \mathbb{E}_t\left[i^{float}_{t,t+n}\right] + \lambda_{t,t+n} \qquad (Assumption\ 1)$$

Assumption 2 requires rational expectations for the expected future path of the MIBOR-OIS floating interest rate in the sense implied by Muth (1961) and Sargent (2013). Specifically, the subjective expectations of the return on the floating leg of the MIBOR-OIS contract are assumed to be consistent with its

[2] In case the monetary policy announcement was made during the weekend, the surprise is obtained by subtracting the rate on the preceding Friday from the rate on the Monday following the announcement. MIBOR-OIS trades with a one-day spot lag, so an n-day MIBOR-OIS contract starting at date t matures in $t+n+1$. For monetary policy announcements which occur on Monday or Friday, a two working day window is used to calculate the surprise i.e., the rate on the working day before the announcement is subtracted from the rate on the working day after the announcement. A similar approach is also used if there are any trading holidays during the two-day window around a monetary policy annoucement.

[3] A fuller exposition of this idea can be found in Cochrane (2005), Chapter 19.

contractual terms. $\mathbb{E}_t\left[i^{float}_{t,t+n}\right]$ is determined as the expected cumulative return from continually rolling over a given sum (principal and interest) yielding MIBOR everyday:[4]

$$\mathbb{E}_t\left[i^{float}_{t,t+n}\right] = \frac{365}{n}\left[\mathbb{E}_t\left(\prod_{j=t}^{t+n}\left(1+\frac{MIBOR_{j+1}}{365}\right)-1\right)\right] \qquad (\textit{Assumption 2})$$

Under *Assumption 3*, on monetary policy announcement dates, only information about changes to the sequence of MIBOR rates during the period of the contract is revealed. When a two-day window is used to identify the monetary policy surprises, this requires that the risk premia are not changing during this time period around the monetary policy announcement:[5]

$$\lambda_{t-1,t-1+n} = \lambda_{t+1,t+1+n} \qquad (\textit{Assumption 3})$$

With the above assumptions, the monetary policy surprises $\epsilon^m_{n,t}$ can be expressed as follows:

$$\begin{aligned}
\epsilon^m_{n,t} &\equiv i^{fixed}_{t+1,t+1+n} - i^{fixed}_{t-1,t-1+n} = \left(\mathbb{E}_{t+1}\left[i^{float}_{t+1,t+1+n}\right] + \lambda_{t+1,t+1+n}\right) - \left(\mathbb{E}_{t-1}\left[i^{float}_{t-1,t-1+n}\right] + \lambda_{t-1,t-1+n}\right) \\
&= \frac{365}{n}\left[\mathbb{E}_{t+1}\left(\prod_{j=t+1}^{t+1+n}\left(1+\frac{MIBOR_{j+1}}{365}\right)-1\right) - \mathbb{E}_{t-1}\left(\prod_{j=t-1}^{t-1+n}\left(1+\frac{MIBOR_{j+1}}{365}\right)-1\right)\right] \\
&= \frac{365}{n}\left[\mathbb{E}_{t+1}\left(\prod_{j=t+1}^{t+1+n}\left(1+\frac{MIBOR_{j+1}}{365}\right)\right) - \mathbb{E}_{t-1}\left(\prod_{j=t-1}^{t-1+n}\left(1+\frac{MIBOR_{j+1}}{365}\right)\right)\right]
\end{aligned}$$

□

As of March 2020, the MIBOR-OIS market was the largest over-the-counter derivatives market in India.[6] This market draws participation from a wide range of financial intermediaries like commercial banks and primary dealers who use it to insure their returns on government bond holdings. As a result, no-arbitrage pricing, which follows as a consequence of profit-maximising behaviour of buyers and sellers in this market, is more likely to hold than in traditional markets for consumer goods with behaviourally-biased agents.

Further, existing studies have shown that the MIBOR-OIS fixed rates are good predictors of the future evolution of MIBOR particularly at the 1-month, 9-month and 1-year tenors, with ex-post excess re-

[4] The MIBOR rate from the next trading day applies on trading holidays which occur during the contract, but without compounding.

[5] In an environment where monetary policy is conducted using open market operations and repurchase agreements ('corridor system') rather than a reserve abundant regime where interbank interest rates are controlled by varying the interest paid on central bank reserves ('floor system'), as was the case with India, there is the possibility that the interbank interest rate also contains a potentially time-varying liquidity premium which should also not vary around monetary policy announcements for precise identification. A more detailed discussion of the 'corridor' and 'floor' systems of implementing monetary policy can be found in Borio (2023).

[6] Data from the Clearing Corporation of India Limited (CCIL) as of March 2020.

turns on these swaps being close to zero (Kumar and Rituraj, 2021). This suggests that the rational expectations assumption is a plausible one in the context of the MIBOR-OIS market, particularly at the shorter end of the maturity spectrum.

The third assumption is necessitated by data limitations. In an ideal setting, where time stamps are available for monetary policy statements and MIBOR-OIS data is available at an hourly frequency or higher, it is possible to isolate the monetary policy surprise by comparing MIBOR-OIS fixed rates just before and after a monetary policy announcement is made. However, high-frequency time-stamped data is not available in a consistent fashion for the full time period under study.

Further, because of the lack of time stamps for monetary policy announcements, it is not possible to ascertain whether the monetary policy announcements were made during or after market trading hours for a number of announcement dates in the study. Therefore, in what follows, a two-day window is used to compute the monetary policy surprises to ensure consistency. As a result, *Assumption 3* is necessary for identification of monetary policy surprises in this setting.

Assumption 3 is more likely to hold when tighter time windows around monetary policy announcements are considered and when the monetary policy announcement is uncorrelated with other contemporaneous developments in the economy. As succeeding sections will show, and as Nakamura and Steinsson (2018) have anticipated, *Assumption 3* is more likely to be satisfied on scheduled announcement dates than on unscheduled announcement dates.

An important limitation of assessing monetary policy surprises using OIS data is that it is not possible to say anything about the distribution of this surprise amongst economic agents. Identifying the cross-sectional distribution of monetary policy surprises is an important avenue for future research given the importance of the distribution of marginal propensities to consume for the strength of monetary policy transmission (Kaplan et al., 2018).

3 Monetary policy surprises from the MIBOR-OIS market

Monetary policy announcement dates were collected from the online archive of monetary policy statements of the Reserve Bank of India. Data on Overnight Indexed Swaps was collected from Bloomberg Terminal. This section describes in detail the procedures adopted for identification, collection, classification and construction of monetary policy surprises from the MIBOR-OIS market.

3.1 Identifying monetary policy announcement dates

Monetary policy announcements of the Reserve Bank of India were identified based on the online archive of press releases and monetary policy statements of the Reserve Bank of India. All monetary policy statements and any press release or circular which contained a discussion of the stance of the RBI towards its principal monetary policy instruments: (i) Bank Rate/Marginal Standing Facility (MSF)

Rate, (ii) Repo Rate, (iii) Reverse Repo Rate, (iv) Cash Reserve Ratio (CRR) and (v) Statutory Liquidity Ratio (SLR) were included in the sample of monetary policy announcements.

Dates of open market operations and speeches by the Governor of the RBI were not considered in constructing this sample but is a potential area for future research (Swanson, 2023; Swanson and Jayawickrema, 2023). A total of 133 monetary policy announcements were identified between August 1999 and March 2020. We start the series in August 1999 as the data on MIBOR-OIS is only available from then. This is the longest sample of monetary policy announcements in India to date.

3.2 Scheduled and unscheduled announcement dates

Monetary policy announcement dates are classified into scheduled and unscheduled announcement dates. Scheduled announcement dates are those announcement dates for which prior public notice was given by the RBI. All other announcements dates were classified as unscheduled announcement dates.

The frequency of scheduled monetary policy announcements has varied over the time period under study. The frequency of scheduled monetary policy announcements is as follows:

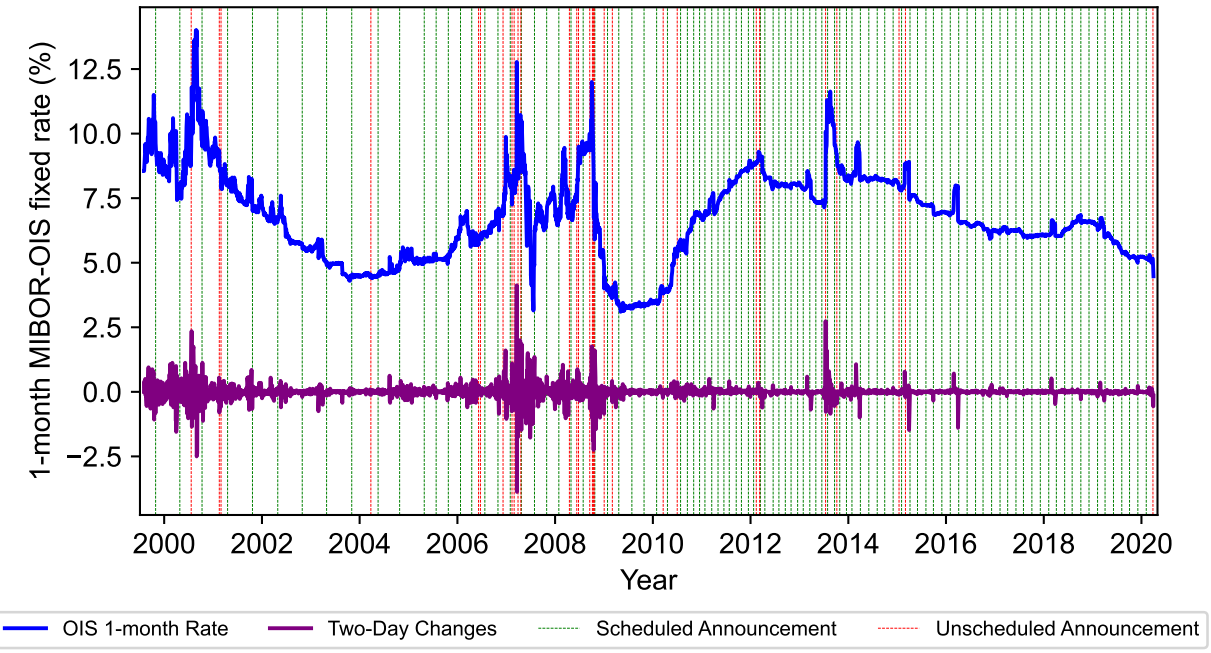
- 1999 - 2004: **2 times a year** (April/May and October/November)
- 2006 - 2009: **4 times a year** (Once every quarter)
- 2011 - 2013: **8 times a year** (Middle and end of every quarter)
- 2014 - 2020: **6 times a year** (Once every two months)

2005 (**3**) and 2010 (**6**) were transition years where the frequency of scheduled announcements changed. A two-day window (a day before and a day following the monetary policy announcement) is used to compute the surprise change in monetary policy. This is on account of a lack of time-stamps for a number of announcements in our sample.

Using a two-day window comes with its own identification challenges. The typical time window that is used in high-frequency identification studies is a much narrower 30-minute time window around a monetary policy announcement. Nakamura and Steinsson (2018) point out that identification of monetary policy surprises may be less robust with a one-day or two-day window than a 30-minute window.

An appealing feature of using narrower time windows is that it rules out reverse causality in event study regressions with financial market variables as monetary policy decisions are usually communicated with a non-trivial time lag after the decisions have been taken (Bauer and Swanson, 2023b). Furthermore, narrower time windows allow for more precise identification of monetary policy surprises by isolating financial market responses to monetary policy actions from other contemporaneous developments. Evaluating the robustness of the identified monetary policy surprises to the choice of a narrower time window is an important avenue for future research.

Figure 2: 1-month MIBOR-OIS fixed rate and its two-day change, August 1999 to March 2020



Notes: This figure plots the 1-month MIBOR-OIS fixed rate and its two-day change between August 1999 and March 2020. The vertical dashed lines represent monetary policy announcement dates of the RBI, with green lines representing scheduled announcement dates and red lines representing unscheduled announcement dates. The data on 1-month MIBOR-OIS rates is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Out of 133 announcement dates, 97 were scheduled announcement dates and 36 were unscheduled announcement dates. Table 1 documents the 36 unscheduled announcement dates and the reasons cited by the RBI for these announcements. The most common reasons cited for unscheduled announcements were developments in financial markets (including the foreign exchange market) and the need to provide liquidity support. Moreover, a few unscheduled announcements were also undertaken in response to fiscal policy and incoming macroeconomic data.

3.3 MIBOR-OIS data

The data on MIBOR-OIS contracts are collected from Bloomberg. The shortest maturity MIBOR-OIS contract with a tenor of 1 month is used to construct the monetary policy surprises. In particular, the *Bloomberg Generic Composite* (BGN) mid-rate for the 1-month MIBOR-OIS contract (Ticker: *IRSWOA BGN Curncy*) is used as the OIS fixed rate in the analysis. The BGN quote from Bloomberg Terminal is "based on bid and ask quotes that are derived from hundreds of quality sources, including indicative and executable price quotes from money-center and regional banks, broker-dealers, inter-dealer brokers, and trading platforms" (Bloomberg, 2023).

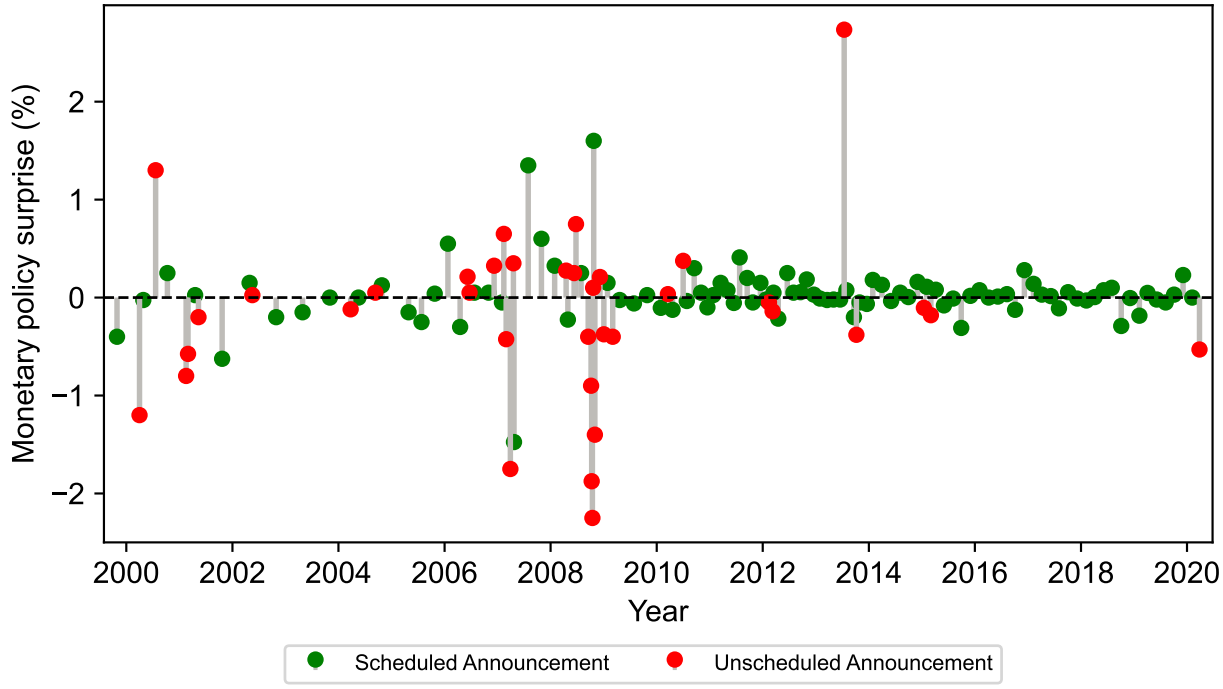
Since the MIBOR-OIS contracts are traded over-the-counter, there is no centralised repository of time-

Table 1: Unscheduled monetary policy announcements of the RBI, October 1999 to March 2020

Announcement Date	Reason	Monetary Surprise	Notes
1 April, 2000	Liquidity/Market Conditions; Fiscal Policy	-1.2	100 basis points cut in Bank Rate, CRR and Repo Rate; Announcement made a day after the Union Budget
21 July, 2000	Forex Market/Financial Markets	1.3	100 basis points increase in Bank Rate; 50 basis points increase in CRR; Responding to Rupee depreciation against US Dollar
16 February, 2001	Financial Markets; Fiscal Policy	-0.8	50 basis points cut in Bank Rate and CRR; Pre-Budget announcement as government expected to exceed borrowing targets
1 March, 2001	Fiscal Policy	-0.575	50 basis points cut in Bank Rate; Post-budget announcement
12 May, 2001	Liquidity/Financial Markets; Fiscal Policy;	-0.2	50 basis points cut in CRR; In anticipation of expected fresh issue of government bonds
18 May, 2002	Liquidity	0.025	CRR cut advanced by a fortnight; Liquidity conditions cited as reason
25 March, 2004	Administrative	-0.12	Reverse Repo Rate reduced by 50 basis points; Rationalisation of Liquidity Adjustment Facility
11 September, 2004	Macroeconomic Conditions	0.05	50 basis points increase in CRR; To curb inflation which had reached 8.33%
8 June, 2006	Macroeconomic Conditions	0.2125	25 basis points increase in Repo Rate and Reverse Repo Rate; Responding to strong economic growth, inflation and global monetary tightening
22 June, 2006	Administrative	0.05	Amendment to RBI Act regarding CRR
8 December, 2006	Macroeconomic Conditions	0.325	50 basis points increase in CRR; Responding to strong economic growth, credit growth and inflation
13 February, 2007	Macroeconomic Conditions	0.65	50 basis points increase in CRR; Responding to strong economic growth and inflation with a view to curbing inflation expectations
1 March, 2007	Administrative	-0.425	Amendment of laws governing CRR maintenance
30 March, 2007	Macroeconomic Conditions	-1.75	25 basis points increase in Repo Rate and 50 basis points increase in CRR; Responding to strong economic growth and inflation with a view to curbing inflation expectations
20 April, 2007	Administrative	0.35	Changes to CRR administration
17 April, 2008	Macroeconomic Conditions	0.275	50 basis points increase in CRR; Responding to high inflation with a view to curbing inflation expectations
11 June, 2008	Macroeconomic Conditions	0.25	25 basis points increase in Repo Rate; Responding to high inflation with a view to curbing inflation expectations
24 June, 2008	Macroeconomic Conditions	0.75	50 basis points increase in Repo Rate and CRR; Responding to high inflation with a view to curbing inflation expectations
16 September, 2008	Financial Crisis	-0.4	100 basis points reduction in SLR; To improve liquidity in the financial system post-Lehman Brothers bankruptcy
6 October, 2008	Financial Crisis	-0.9	50 basis points decrease in CRR; Aimed at increasing liquidity due to rising financial market volatility
10 October, 2008	Financial Crisis	-1.875	100 basis points decrease in CRR; Aimed at increasing financial system liquidity
15 October, 2008	Financial Crisis	-2.25	100 basis points decrease in CRR; Aimed at increasing financial system liquidity
20 October, 2008	Financial Crisis	0.1	100 basis points decrease in Repo Rate; Aimed at increasing financial system liquidity
1 November, 2008	Financial Crisis; Macroeconomic Conditions	-1.4	50 basis points decrease in Repo Rate, 100 basis points decrease in CRR, SLR; Aimed at supporting economic growth and improving liquidity
6 December, 2008	Financial Crisis; Macroeconomic Conditions	0.21	100 basis points decrease in Repo and Reverse Repo Rate; Aimed at supporting economic growth
2 January, 2009	Financial Crisis; Macroeconomic Conditions	-0.375	100 basis points decrease in Repo and Reverse Repo Rate; 50 basis points decrease in CRR; Aimed at supporting liquidity and economic growth
4 March, 2009	Financial Crisis; Macroeconomic Conditions	-0.4	50 basis points decrease in Repo and Reverse Repo Rate; Aimed at supporting liquidity and economic growth
19 March, 2010	Macroeconomic Conditions	0.035	25 basis points increase in Repo and Reverse Repo Rate; Aimed at controlling inflation and inflation expectations
2 July, 2010	Macroeconomic Conditions	0.375	25 basis points increase in Repo and Reverse Repo Rate; Aimed at controlling inflation and inflation expectations
13 February, 2012	Administrative	-0.05	Bank Rate increased by 350 basis points to align with MSF Rate;
9 March, 2012	Macroeconomic Conditions	-0.14	75 basis points decrease in CRR; To increase liquidity in the financial system
15 July, 2013	Forex Market	2.735	MSF/Bank Rate increased by 200 basis points; To stem Rupee depreciation following Fed tapering
7 October, 2013	Forex Market	-0.38	MSF/Bank Rate reduced by 50 basis points; Unwinding extraordinary measures taken to stem rupee depreciation
15 January, 2015	Macroeconomic Conditions	-0.105	Policy Rate reduced by 25 basis points; Easing policy rates in light of falling inflation and inflation expectations
4 March, 2015	Macroeconomic Conditions; Fiscal Policy	-0.18	Policy Rate reduced by 25 basis points; Easing policy rates in light of low growth and higher than expected fiscal deficit
27 March, 2020	COVID-19	-0.53015	Policy Rate reduced by 75 basis points; Reverse Repo Rate reduced by 90 basis points; Easing policy in response to COVID-19 related lockdowns

Notes: Unscheduled monetary policy announcements of the RBI were identified from the archive of RBI press releases available at https://rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx and the monetary policy surprises were computed using the two-day change in the 1-month MIBOR-OIS fixed rate on these dates. The 1-month MIBOR-OIS fixed rate was obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure 3: 1-month MIBOR-OIS fixed rate changes on monetary policy announcement dates of the RBI



Notes: This figure plots the monetary policy surprises derived as the two-day change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. The scheduled monetary policy surprises are shown in green and the unscheduled announcement surprsies are shown in red. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Table 2: Summary statistics for monetary policy surprises on scheduled and unscheduled dates

Announcement Date	Period	*N*	*Mean*	*Std.Dev*	*min*	25%	50%	75%	*max*
Scheduled	1999 - 2004	11	0.177	0.255	-0.625	-0.175	0.000	0.075	0.250
	2005 - 2009	19	0.396	0.638	-1.475	-0.105	0.040	0.287	1.600
	2010 - 2020	67	0.094	0.129	-0.310	-0.035	0.015	0.075	0.410
Unscheduled	1999 - 2004	8	0.534	0.743	-1.200	-0.631	-0.160	0.031	1.300
	2005 - 2009	19	0.681	0.889	-2.250	-0.662	0.050	0.263	0.750
	2010 - 2020	9	0.503	0.985	-0.530	-0.180	-0.105	0.035	2.735

Notes: This table shows the summary statistics for the monetary policy surprises on scheduled and unscheduled announcement dates during periods with different frequencies of scheduled announcements. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The *Mean* column shows the mean of the absolute change in the 1-month MIBOR-OIS fixed rate on the announcement dates.

stamped data on OIS trades for a number of years in the time period under study.[7] A more detailed description of the MIBOR-OIS market in India, including details about its liquidity and market structure, is provided in Appendix A.1. It is therefore important to note, while interpreting the results, that the monetary policy surprises are identified using the daily market quotes rather than actual market trades.

Figure 2 plots the evolution of the one-month OIS fixed rate and its change over a two-day window around monetary policy announcement dates of the RBI.[8] This further documents the increase in the proportion and frequency of scheduled monetary policy announcements during the time period under study. Furthermore, unscheduled announcements occurred with greater frequency during periods of greater macroeconomic uncertainty, such as during the 2007-2009 financial crisis.

Figure 3 plots the monetary policy surprises calculated using a two-day window around monetary policy announcement dates of the RBI. Table 2 shows the summary statistics for OIS rate changes on scheduled and unscheduled announcement dates during periods with different frequencies of scheduled announcements. Throughout the time period under study, scheduled monetary policy announcements outnumber unscheduled announcements in each of the regimes considered. However, the average absolute size of the surprise change in monetary policy is larger on unscheduled announcement dates than on scheduled announcement dates. Further, the dispersion in the size of the surprises is also much greater on unscheduled announcement dates. As Lakdawala and Sengupta (2024) have already noted, the movements in the one-month OIS rates were particularly large during the 2007-2009 period coinciding with the financial crisis.

[7] There is a trade repository of all interest rate swap contracts maintained by the Clearing Corporation of India (CCIL) since 2007. Intraday tick-by-tick data on RBI announcement dates is available for the BGN quote beginning in July 2011.

[8] There are a few instances of large movements in the 1-month MIBOR-OIS fixed rate on days without a monetary policy announcement. A notable example is the 4.125% points increase in the MIBOR-OIS rate on 20th March 2007 which was due to an unexpected increase in liquidity needs for banks following higher than expected advance tax payments by taxpayers leading up to the end of the financial year (Sinha, 2007).

Table 3: Auto-correlation of monetary policy surprises on RBI Announcement Dates

Monetary Surprise	Pooled	Scheduled	Unscheduled
Intercept	–0.012	0.046	–0.159
	(0.045)	(0.036)	(0.143)
Monetary Surprise$_{t-1}$	0.073	–0.097	0.115
	(0.152)	(0.218)	(0.173)
Monetary Surprise$_{t-2}$	–0.067	–0.162	0.093
	(0.143)	(0.129)	(0.133)
F-statistic	0.222	0.831	0.401
p-value	0.801	0.439	0.673
R^2	0.009	0.034	0.025
N	131	95	34

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of MIBOR-OIS monetary policy surprises on its first and second lags on RBI monetary policy announcement dates. Estimation is done separately for pooled, scheduled and unscheduled announcement dates. MIBOR-OIS monetary policy surprises are calculated as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcements of the RBI. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The F-statistic and p-value corresponding to a joint test of the significance of all coefficients being zero is reported.

Monetary policy shocks are traditionally conceived in macroeconomic models to be random disturbances to the system which are typically not auto-correlated.[9] To check the autocorrelation properties of the monetary policy surprises derived in this section, the monetary policy surprises on RBI announcement dates are regressed on their first and second lags in a event study context.

However, Miranda-Agrippino and Ricco (2021), Melosi (2017) as well as Coibion and Gorodnichenko (2015) point out that in the presence of asymmetric information between the central bank and the private sector, news about economic conditions revealed through central bank policy actions can filter into private sector expectations gradually, leading to auto-correlation in monetary policy surprises. In effect, as Miranda-Agrippino and Ricco (2021) suggest, the test for auto-correlation in monetary policy surprises is a test for the presence of asymmetric information between the central bank and the private sector.

Table 3 displays the results of a regression of the monetary policy surprise on its own first and second lags on scheduled and unscheduled announcement dates. There seems to be no statistically significant auto-regressive relationship between the monetary policy surprises on RBI announcement dates. This suggests that it is reasonable to view the monetary policy surprises as potentially random disturbances which are not systematically related to each other. Table A.1 further confirms that even when the monetary surprises are aggregated to a monthly frequency, there is no statistically significant auto-correlation in the monetary policy surprises on scheduled and unscheduled announcement dates.

[9] For instance, Ramey (2016), in a more general context of macroeconomic shocks, states that their characteristic feature lies in their exogeneity with respect to current and lagged endogenous variables and other shocks.

4 Sources of monetary policy surprises

What are the causes of monetary policy surprises? Monetary policy is typically understood to follow predictable rules, following the work of Taylor (1993) and Woodford (2003) which demonstrated potential welfare improvements from central banks committing to a policy rule. The identified monetary policy surprises, to the extent that economic agents are aware of the central bank's policy rule, should be uncorrelated with the various sources of incoming data to which the central bank reacts in formulating monetary policy. However, a recent literature surveyed in Bauer and Swanson (2023b) suggests that monetary policy surprises identified from financial markets are predictable by some key macroeconomic indicators to which the central bank reacts. The leading explanation for this phenomenon has been that market participants have imperfect information about the central bank's reaction function, thereby causing past macroeconomic variables to be predictive of monetary policy surprises (Bauer and Swanson, 2023a). This poses a threat to the identification of the effects of monetary policy, if these sources of monetary policy surprises are not controlled for in regression specifications.

To test whether monetary policy surprises identified from the MIBOR-OIS market are predictable by key macroeconomic indicators, the monetary policy surprises are regressed on key macroeconomic and financial indicators that would be available to the RBI at the time of each monetary policy announcement. Following Bauer and Swanson (2023b), the monetary policy surprises are first regressed on the following key macroeconomic and financial indicators:

1. **Index of Industrial Production:** 3-month log-change in the IIP until two months before the monetary policy announcement. The IIP data for each month is usually released two months later on the 12th of the month or the working day immediately preceding the 12th. Hence, for monetary policy announcements made before the IIP release date for the month, the 3-month change in IIP until 3 months before the monetary policy announcement is used.

2. **Wholesale Price Index:** 3-month log-change in the WPI until the month before the monetary policy announcement. WPI was released on a weekly basis with a two-week time lag until January 2012 and on a monthly basis thereafter. The WPI data for the previous month is usually announced on the 14th of the month or the working day immediately following the 14th. Hence, for monetary policy announcements made before the WPI release date for the month, the 3-month change in WPI until two months before the monetary policy announcement is used.

3. **Rainfall:** 3-month cumulative rainfall deviations from their 20th century average until the month before the monetary policy announcement. Separate coefficients are estimated for excess and deficient rainfall.

4. **Yield Spreads:** 91-day change in the spread between the 10-year and 1-year GSec yields until the day before the monetary policy announcement.

5. **Stock Market Returns:** 91-day log-change in the BSE SENSEX stock market index until the day before the monetary policy announcement.

6. **Exchange Rate:** 91-day log-change in the USD/INR exchange rate until the day before the monetary policy announcement.

During much of the time period under study, the RBI did not have an explicit inflation target, and its policy approach relied on monitoring and stablising 'multiple indicators'. It was only in 2014 that the RBI moved towards a flexible inflation targeting framework. Hence, the specification of the regression with the variables listed above is consistent with the RBI's approach to monetary policy taking into consideration a wide variety of macroeconomic and financial indicators. A more detailed description of the monetary policy framework in India during the period under study can be found in Dua (2020) and Roy (2022).

The results from this regression are presented in Table 4. The reported F-statistics for the pooled and scheduled samples results suggest that the monetary policy surprises are not predictable by some of the key macroeconomic indicators that would typically enter a Taylor rule, like proxies for output and inflation. In the pooled specification, periods of drought, increasing term premia and stock market returns are predictive of contractionary monetary policy surprises. Considering just the scheduled announcement dates, none of the macroeconomic variables have a statistically significant relationship with the monetary policy surprises individually or jointly. On unscheduled announcement dates, past macroeconomic variables, particularly the growth in industrial production and excess rainfall in the past few months are predictive of larger contractionary monetary policy surprises. Further, the associated F-statistic also points to the predictability of monetary policy surprises on unscheduled announcement dates.

This adds to the evidence presented in Table 1 which documents the reasons cited by the RBI for unscheduled monetary policy announcements. The most common reasons cited, as previously discussed, related to liquidity conditions in various financial markets. These are likely to be highly correlated with both aggregate demand, as proxied by IIP, and aggregate supply, which is affected by the amount of rainfall due to the rainfall dependence of Indian agriculture. Acosta (2023) points out that one reason for the endogeneity of measured monetary policy surprises to past macroeconomic data is an emphasis on non-standard variables in the monetary policy reaction function. The evidence in Table 4 however suggests a non-standard emphasis on standard macroeconomic variables in the monetary policy reaction function on unscheduled announcement dates. The endogeneity to past macroeconomic variables makes measured monetary policy surprises on unscheduled announcement dates less suitable for identification of the effects of monetary policy.

Next, the predictability of monetary policy surprises by forecasts of key macroeconomic indicators is tested in Table 5. The reported F-statistics suggest that macroeconomic forecasts of real GDP growth and WPI inflation are not very predictive of monetary policy surprises on either scheduled, unscheduled or pooled announcement dates. However, on scheduled announcement dates, the current year forecast for WPI inflation does have a positive, statistically significant relationship with monetary policy surprises. Contractionary monetary policy surprises on scheduled announcement dates appear, at least in part, to be unanticipated responses to heightened inflation expectations. However, only a

Table 4: Predictability of Monetary Policy Surprises by Macroeconomic Data

	Pooled	Scheduled	Unscheduled
Intercept	–0.064	0.056	–0.441**
	(0.063)	(0.055)	(0.203)
Δln (IIP) (3m)	2.351	0.336	9.283**
	(1.560)	(1.570)	(4.279)
Δln (WPI) (3m)	1.689	–2.047	5.168
	(2.504)	(1.580)	(5.885)
Drought (3m)	0.021*	0.014	0.018
	(0.011)	(0.009)	(0.062)
Excess Rain (3m)	0.026	–0.005	0.717***
	(0.018)	(0.008)	(0.141)
Δ (10Y-1Y GSec Spread) (3m)	0.173**	0.039	0.276
	(0.083)	(0.068)	(0.230)
Δln (*SENSEX*) (3m)	0.989**	0.210	0.480
	(0.483)	(0.379)	(0.896)
Δln (*USD – INR*) (3m)	2.442	1.991	0.243
	(1.775)	(1.230)	(2.962)
F-statistic	1.253	1.237	6.222
p-value	0.279	0.291	0.000
R^2	0.099	0.074	0.531
N	133	97	36

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of monetary policy surprises on various macroeconomic variables on all, scheduled and unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Δln (IIP) is calculated as the 3-month log-change in the Index of Industrial Production using data up to two months before the monetary policy announcement in the case of announcements made after the IIP release date for the month and up to three months before otherwise. Data on IIP release dates are obtained from Bloomberg Terminal and for months when such information was missing, the IIP release date was taken to be the 12th (or the latest working day preceding it). The data on IIP is obtained from FRED with ticker: INDPROINDMISMEI. Δln (WPI) is calculated as the 3-month log-change in the WPI using data up to the month before the monetary policy announcement of the RBI in the case of monetary policy announcements made after the WPI release date for the month or two months before otherwise. Data on WPI release dates are obtained from Bloomberg Terminal and for months where such information is missing, the release date is set to be the 14th of the month (or the working day immediately following it). The data on WPI is obtained from FRED with ticker: WPIATT01INM661N. Working days are defined as trading days in the foreign exchange market as found in Bloomberg Terminal with ticker: INR REGN Curncy. Monthly rainfall deviations from their 20th century average for three months (in 10 cms) before each monetary policy announcement of the RBI are calculated. The *Drought* variable is then defined as being equal to the rainfall deviation during three-month periods when the rainfall deviation is less than 0 and is defined as 0 otherwise. Similarly, the *Excess Rain* variable is defined as being equal to the rainfall deviation during three-month periods when this value is greater than 0 and is set equal to 0 otherwise. The data on Rainfall is obtained from annual issues of the *Rainfall Statistics of India*. Δ (*10Y-1Y GSec Spread*) is defined as the 91-day change in the difference in yields between the 10-year and 1-year GSecs until the day before the monetary policy announcement. The data on 1-year and 10-year GSec yields are obtained from investing.com. Δ*ln* (*SENSEX*) is defined as the 91-day log-change in the BSE SENSEX until the day before the monetary policy announcement. The data on BSE SENSEX is obtained from Yahoo Finance with ticker: ^BSESN. Δ*ln* (*USD-INR*) is defined as the 91-day log-change in the USD-INR exchange rate until the day before the monetary policy announcement. The data on USD-INR is obtained from Bloomberg Terminal with ticker: INR REGN Curncy. The F-statistic and p-value corresponding to a joint test of the significance of all coefficients being zero is reported.

Table 5: Predictability of Monetary Policy Surprises by Macroeconomic Forecasts

	Pooled	Scheduled	Unscheduled
Intercept	–0.380	–0.118	–0.170
	(0.280)	(0.204)	(1.022)
Current FY Growth Forecast	–0.057	0.026	–0.087
	(0.096)	(0.091)	(0.237)
Next FY Growth Forecast	0.112	0.003	0.191
	(0.106)	(0.099)	(0.237)
Current FY WPI Inflation Forecast	–0.024	0.043*	–0.114
	(0.037)	(0.024)	(0.086)
Next FY WPI Inflation Forecast	0.015	–0.053	–0.000
	(0.058)	(0.036)	(0.181)
F-statistic	1.149	1.248	1.354
p-value	0.337	0.296	0.273
R^2	0.019	0.061	0.118
N	132	97	35

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of monetary policy surprises on macroeconomic forecasts on all, scheduled and unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are regressed on the latest available survey forecasts before the day of the monetary policy announcement. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The Current FY Growth Forecast is the consensus forecast for real GDP growth in the present financial year and is obtained from Consensus Economics. The Next FY Growth Forecast is the consensus forecast for real GDP growth in the next financial year and is obtained from Consensus Economics. The Current FY WPI Inflation Forecast is the consensus forecast for WPI inflation for the current financial year and is obtained from Consensus Economics. The Next FY WPI Inflation Forecast is the consensus forecast for WPI inflation for the next financial year and is obtained from Consensus Economics. The F-statistic and p-value corresponding to a joint test of the significance of all coefficients being zero is reported. Coefficients less than 0.001 in absolute value are reported as 0.000. Monetary policy announcements which occurred on the same day as the forecast survey are excluded from the analysis.

negligible proportion of the variation in the monetary surprises is explained by the forecasts on scheduled announcement dates. On unscheduled announcement dates, there are no statistically significant predictors of monetary policy surprises in the macroeconomic forecasts considered. They appear to represent responses to more backward looking information rather than forward looking information.

Finally, the predictability of the monetary policy surprises by US monetary policy surprises is considered in Table 6. There were 19 instances, documented in Appendix Table C.1, where there was an FOMC announcement within a two-day window around RBI announcements. Due to the paucity of tick-by-tick data for MIBOR-OIS rates, it is not possible to comment directly on the correlations between FOMC and RBI monetary policy surprises on these dates. On the rest of the announcement dates, the FOMC surprises do not seem to explain much of the variation in the RBI announcement surprises even though the estimated coefficients are positive and close to 1. This suggests that the monetary policy surprises in India, particularly those not occurring simultaneously with FOMC announcements, are not systematically related to those in the US.

Table 6: FOMC surprises and RBI monetary policy surprises

	Pooled	Scheduled	Unscheduled
Intercept	–0.015	0.021	–0.118
	(0.051)	(0.038)	(0.169)
FOMC Surprise	1.180	1.271	0.738
	(0.775)	(1.358)	(1.113)
R^2	0.014	0.021	0.005
N	112	80	32

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of 1-month MIBOR-OIS monetary policy surprises on monetary policy surprises of the US Federal Reserve on all, scheduled and unscheduled announcement dates of the RBI. Monetary policy surprises of the RBI are regressed on the latest FOMC announcement surprise occurring immediately before each RBI announcement. FOMC announcements which occur in a two-day window around RBI announcement dates are excluded from the analysis. The data on FOMC surprises is obtained from Bauer and Swanson (2023b). The Indian monetary policy surprises are calculated as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Only data up to the end of 2019 is used in the analysis as the FOMC surprises from Bauer and Swanson (2023b) are only available until then.

5 High-frequency monetary policy transmission

5.1 Event study evidence from financial markets

In order to understand the high frequency response of financial market variables to monetary policy surprises, 'event study' regressions of the following form, in the sense implied by Black (1986), are estimated:

$$\Delta_2 y_t = \alpha + \beta \epsilon^m_{1M,t} + \kappa_t$$

where $\Delta_2 y_t$ is the two-day *percentage* change in the financial market variable y_t around the monetary policy announcement date t and $\epsilon^m_{1M,t}$ is the monetary policy surprise, derived from 1-month MIBOR-OIS, on date t.

A number of important indices in the government bond market, equities market and foreign exchange market are considered for the event studies. Standard asset pricing theory suggests that asset prices should decline and yields should rise in response to a surprise monetary policy tightening. Therefore, the event studies serve as a useful test of the quality of identification of monetary policy surprises.

Table 7 shows the mean of the absolute percentage changes and the standard deviation of the percentage changes in financial market variables used in the event study regressions on scheduled and unscheduled announcement dates as well as a corresponding set of selected non-announcement dates. Data on government bond yields was obtained from investing.com. Exchange rate data was obtained from Bloomberg and data on the Bombay Stock Exchange indices were obtained from Yahoo Finance. Data on the NSE NIFTY 50 index was obtained from the online archive of the National Stock Exchange of India.

Table 7: Summary statistics for daily financial market variables

In %	Statistic	Non-announcement	Scheduled	Unscheduled
Δ (1Y GSec Yield)	*Mean*	0.079	0.109	0.227
	Std. Dev	0.118	0.154	0.323
Δ (5Y GSec Yield)	*Mean*	0.061	0.107	0.147
	Std. Dev	0.102	0.131	0.204
Δ (10Y GSec Yield)	*Mean*	0.060	0.102	0.126
	Std. Dev	0.104	0.132	0.175
Δ (NIFTY)	*Mean*	1.733	1.737	2.385
	Std. Dev	2.360	2.781	3.156
Δ (SENSEX)	*Mean*	1.670	1.716	2.672
	Std. Dev	2.368	2.672	3.596
Δ (BSE200)	*Mean*	1.695	1.828	2.677
	Std. Dev	2.368	2.835	3.473
Δ (USD/INR)	*Mean*	0.530	0.444	0.486
	Std. Dev	0.782	0.618	0.679
N		133	97	36

Notes: This table documents the mean (of absolute values) and standard deviation of the two-day percentage change in selected financial market variables on scheduled and unscheduled monetary policy announcement dates of the RBI as well as a corresponding set of non-announcement dates. The non-announcement dates are chosen as non-policy dates occurring 30 days (or earliest working day prior to these 30 days) before a policy announcement date. The source for the data series used in this table can be found in Appendix E.

Table 8: Event Study Regressions for Financial Market Variables: All Announcement Dates

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	0.000	0.257***	133	0.425
	(0.014)	(0.048)		
Δ (5-Year GSec Yield)	0.011	0.171***	133	0.360
	(0.011)	(0.032)		
Δ (10-Year GSec Yield)	0.016	0.137***	133	0.260
	(0.011)	(0.029)		
Δ (NIFTY)	–0.222	–0.386	133	0.005
	(0.252)	(0.852)		
Δ (SENSEX)	–0.177	–0.366	133	0.005
	(0.256)	(0.860)		
Δ (BSE200)	–0.238	–0.252	133	0.002
	(0.264)	(0.826)		
Δ (USD/INR)	–0.043	–0.088	133	0.006
	(0.053)	(0.157)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises on all monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Values less than 0.001 in absolute value are reported as 0.000.

Compared to non-announcement dates, the variance of the percentage changes in financial market variables, except the exchange rate (discussed in more detail below), are higher on both scheduled and unscheduled monetary policy announcement dates. The mean absolute percentage changes are also broadly higher on announcement dates compared to non-announcement dates. In particular during unscheduled announcement dates, the mean and variance of the percentage changes in financial market variables are much higher than on both scheduled announcement dates and non-announcement dates.

The larger magnitudes of the changes in both the size of the monetary policy shock and the financial market variables on unscheduled announcement dates should provide more statistical power to identify the effects of monetary policy surprises. However, as the empirical results which follow will document, there is potentially a trade-off between statistical power and the quality of identification of monetary policy surprises on unscheduled announcement dates.

Table 8 shows the results of the event study regressions for selected financial market variables. The

monetary policy surprises are strongly positively correlated with changes in government bond yields at maturities of 1 year, 5 years and 10 years. The exchange rate response, however, is very weak and not statistically significant. The response of stock market indices of the Bombay Stock Exchange and the National Stock Exchange, while negative, is also not statistically significant. This points either to relatively weak transmission of monetary policy surprises or weak identification of monetary policy surprises from the OIS market.

To test the latter hypothesis, the event study regressions are re-estimated separately for scheduled and unscheduled announcement dates. While it is common practice to pool scheduled and unscheduled announcement dates in event study regressions, the results below will suggest that this may not be appropriate in the Indian context. Recent examples of studies which pool scheduled and unscheduled dates in their baseline analysis include Swanson and Jayawickrema (2023) and Miranda-Agrippino and Ricco (2021). A notable exception in this literature is the work of Nakamura and Steinsson (2018), and papers following in its footsteps, which are careful to study the effects of monetary policy in the United States while excluding certain announcement dates, including in particular unscheduled announcements, which they indicate may be less well identified.

Table 9 shows the results of the event study regressions for scheduled announcement dates. The corresponding event study regressions for unscheduled announcement dates are shown in Table 10. On both scheduled and unscheduled announcement dates, the yield curve flattens in response to a surprise increase in interest rates. This is in line with previous evidence from India and other emerging economies (Lakdawala and Sengupta, 2024; Solís, 2023). The responses of longer-term interest rates to short-term interest rates are found to be statistically robust. Since it is the longer-term interest rates which matter for investment and consumption decisions, this points to the effective transmission of monetary policy through the financial system. While the response of government bond yields to monetary policy surprises is very similar on scheduled and unscheduled announcement dates, the response of stock market indices is very different. In particular, the response on scheduled announcement dates is statistically significant and negative while the point estimates on unscheduled announcement dates are positive.

It is a well established proposition in monetary economics that asset prices, reflecting the present discounted value of their expected future financial flows, should decline (and yields should rise) in response to tighter monetary policy, which *ceteris paribus* increases the rate at which these future financial flows are discounted (Lucas, 1978; Castillo-Martinez and Reis, 2024). In addition, Bernanke and Kuttner (2005) suggest two additional channels through which higher interest rates affect asset prices: (i) reducing expected future dividends due to tighter liquidity conditions and (ii) increasing the risk premium demanded by investors due to increased perceived riskiness and reduced risk appetites. Both of these channels too have the effect of reducing asset prices and increasing yields in response to higher interest rates.[10]

[10] In fact, more recent research suggests that the transmission of monetary policy actions to the real economy are significantly enhanced by the effect of interest rate changes on risk premia as surveyed in Bauer et al. (2023)

Table 9: Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	–0.013	0.279***	97	0.32
	(0.014)	(0.098)		
Δ (5-Year GSec Yield)	0.000	0.188***	97	0.202
	(0.012)	(0.050)		
Δ (10-Year GSec Yield)	0.005	0.160***	97	0.143
	(0.013)	(0.050)		
Δ (NIFTY)	–0.095	–3.152*	97	0.126
	(0.258)	(1.703)		
Δ (SENSEX)	–0.046	–3.009*	97	0.124
	(0.250)	(1.529)		
Δ (BSE200)	–0.053	–2.933*	97	0.105
	(0.270)	(1.580)		
Δ (USD/INR)	–0.052	0.133	97	0.005
	(0.066)	(0.280)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Note: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises on scheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Values less than 0.001 in absolute value are reported as 0.000.

Table 10: Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ(1-Year GSec Yield)	0.031	0.258***	36	0.503
	(0.040)	(0.056)		
Δ(5-Year GSec Yield)	0.039*	0.173***	36	0.565
	(0.022)	(0.037)		
Δ(10-Year GSec Yield)	0.046**	0.137***	36	0.483
	(0.020)	(0.033)		
Δ(NIFTY)	–0.162	0.526	36	0.022
	(0.537)	(0.781)		
Δ(SENSEX)	–0.145	0.499	36	0.015
	(0.609)	(0.850)		
Δ(BSE200)	–0.354	0.587	36	0.023
	(0.592)	(0.769)		
Δ(USD/INR)	–0.052	–0.162	36	0.045
	(0.093)	(0.170)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Note: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises on unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

The event study regressions on scheduled announcement dates are consistent with this proposition while the event study regressions on unscheduled announcement dates are not. This suggests that the monetary policy surprises identified from the OIS market on unscheduled announcement dates may not be a good proxy for monetary policy surprises in the Indian context.

A useful framework to understand why identification may be less robust on unscheduled announcement dates is the literature on the information effects of monetary policy surprises (Bauer and Swanson, 2023b; Miranda-Agrippino and Ricco, 2021; Jarociński and Karadi, 2020; Nakamura and Steinsson, 2018).

A key insight from the work of Jarociński and Karadi (2020) is the fact that information revealed on monetary policy announcement dates contains not just the central bank's monetary policy stance but also its assessments of present and future economic conditions. This is likely to be true both on scheduled and unscheduled announcement dates, but is likely to be particularly problematic on unscheduled announcement dates.

Scheduled monetary announcements follow a regular, pre-announced calendar and can be calibrated to respond to economic information released by the national statistical authority. This is helpful from the standpoint of identification because the lag between the release of economic information and the monetary policy statement allows financial market participants to build in expectations while also allowing the econometrician to interpret the changes in the OIS rate on announcement dates as coming mainly from a policy surprise rather than an information surprise.

In contrast, unscheduled announcement dates, because they are not pre-announced, are likely to be very highly correlated with unforeseen developments in indicators that can be observed by the central bank at a very high frequency. This is confirmed in Table 1, which suggests that most unscheduled announcements are undertaken in response to sudden developments in financial markets. As a result, changes in OIS rates on unscheduled announcement dates are likely to contain a lot more information about economic conditions compared to the policy stance compared to scheduled announcement dates. This point, which was anticipated by Nakamura and Steinsson (2018), also suggests that while undertaking a decomposition of the monetary surprises into policy and information shocks as in Jarociński and Karadi (2020), it is important to use different weights for scheduled and unscheduled announcement dates.

The response of the US dollar exchange rate is weak and not statistically significant in the event study regressions. This is in line with evidence from other emerging economies where the effects of monetary surprises measured using daily changes have had weak effects on the exchange rate, which has been characterised as an *exchange rate puzzle* (Kohlscheen, 2014). Recent research suggests that this is on account of substantial noise in the measurement of exchange rate changes using wide time windows and not because of noise in measuring monetary policy surprises (Solís, 2023). The use of intra-day data on financial market variables around monetary policy announcements is likely to provide a more precise estimate of the effects of monetary policy surprises on the exchange rate.

The relatively low R^2 values in these event study regressions, particularly for the stock market indices, can also be attributed to the use of a 2-day window around the monetary policy announcement to measure the monetary policy surprise. However, the background noise is a bit lower for these variables compared to the exchange rate, thereby allowing for a more precise estimation of the efffects of monetary policy surprises on these variables. The explained variation on scheduled announcement dates is similar in magnitude to event studies in other countries using one-day window around monetary policy announcements (Bernanke and Kuttner, 2005).

5.2 Evidence from consensus forecasts

What effects did the monetary policy surprises have on expectations for growth and inflation? To answer this question, the response of the consensus forecasts of professional forecasters to monetary policy surprises is now considered. The data, available at a monthly frequency, is from the archive maintained by the professional forecasting firm Consensus Economics. Descriptive statistics about the main forecast variables used in the analysis are presented in Appendix D.1. The revision in the consensus forecast, defined as the mean of the individual professional forecasts, is used as the dependent variable in the regressions which follow. In particular, a model of the following form is estimated:

$$\Delta f_{t+1,t} = \alpha + \beta \epsilon^*_{1M,t} + \kappa_t$$

where $\Delta f_{t+1,t}$ is the change in the consensus forecast for the variable of interest from the survey date in month t to the survey date in month $t+1$ and $\epsilon^*_{1M,t}$ is the aggregated monetary policy surprise, derived from 1-month MIBOR-OIS, which occurs between the survey dates of months t and $t+1$. This specification is estimated using months when all monetary policy announcements occur and also just using months with scheduled or unscheduled announcements.

Since the forecasts are made on a financial year basis, monetary policy surprises occurring earlier in the financial year are likely to have mechanically larger effects on the forecasts for the current financial year than those occurring later. To adjust for this, the monetary surprises in month t are weighted by a factor (or time weight) capturing the number of months remaining in the financial year for the regressions on the current year forecast revisions:

$$TW_t = \frac{\text{Months remaining in FY}_t}{12}$$

and the *weighted monetary surprise* is then defined as: $\epsilon^*_{1M,t} = \hat{\epsilon}^m_{1M,t} \times TW_t$, where $\hat{\epsilon}^m_{1M,t}$ is the sum of monetary policy surprises which occur between survey dates in months t and $t+1$. The weighting procedure is similar in spirit to the adjustment undertaken by Ottonello and Winberry (2020) to the monetary policy surprises derived from Fed Funds futures in the United States. For regressions on the next year forecast revisions, TW_t is set to 1. For the specification with all announcement dates, $\hat{\epsilon}^m_{1M,t}$ is the sum of all monetary policy surprises which occur between two consecutive forecast surveys.

In the regression specifications using just scheduled or unscheduled announcements, the sum of the scheduled or unscheduled monetary policy surprises during the period between two consecutive forecast surveys are respectively projected onto the sum of the unscheduled or scheduled monetary policy surprises and the residuals, represented by $\hat{\epsilon}^{m}_{1M,t}$, are used as the measure of monthly monetary policy surprises. This is done to control for any estimation bias that may occur due to the correlation between scheduled and unscheduled monetary policy surprises during periods during which both types of announcements take place.[11]

Furthermore, the financial year basis for the forecasts means that it is not possible to calculate the current year forecast revisions for March, which is the last month of the financial year. Hence, the regressions for the current year foreacast revisions omit the observations for March. The regressions for the next year forecast revisions, however, include all observations.

There is an emerging literature analysing the impact of central bank communications on professional forecasts of key macroeconomic variables in India (Goyal and Parab, 2021; Garga et al., 2022). This literature mainly uses professional forecasts data from the Survey of Professional Forecasters (SPF), conducted by the RBI on a quarterly basis since 2008 and on a bi-monthly basis since 2014.

In contrast, this paper uses consensus forecasts data from Consensus Economics which has three distinct advantages over the SPF data: the forecasts data are available (i) at a monthly frequency, (ii) since the 1990s and (iii) for every individual forecaster. An early use of the consensus forecasts data for India was by Patra and Ray (2010) and a more recent example is Garga et al. (2022).

Table 11 plots the response of revisions of the consensus real GDP growth forecast, real investment growth forecast and WPI inflation forecast in the present and next financial years to monetary policy surprises on all announcement dates. In the pooled sample, while the point estimate for the current year growth forecast revision is negative, it is positive for all other forecast variables. However, none of these responses are statistically significant.

As with the event study regressions, the pooled sample results mask important differences in the effects of monetary policy surprises on scheduled and unscheduled announcement dates. The results for scheduled announcement dates are shown in Table 12 and for unscheduled announcement dates in Table 13.

There is a statistically significant negative response of current and next year GDP growth forecasts to monetary policy surprises on scheduled announcement dates. On unscheduled announcement dates, the point estimates are economically negligible (revisions of less than 5 basis points) and not statistically significant. On scheduled announcement dates, a 100 basis point surprise increase in interest rates is associated with about a 20 basis points decrease in growth forecasts for the current financial year and about a 12 basis points decrease in growth forecasts for the next financial year. This provides

[11] The possibility for such correlation is examined in further detail in Appendix G.2. Since the regressions which follow test the null hypothesis of a zero effect, following Pagan (1984), no changes are made to the standard errors to correct for the inclusion of generated regressors. This specification yields estimates that are very similar in direction and magnitude to the estimates obtained in specifications where the monetary policy surprises from the other type of announcement are directly controlled for in the regressions, as shown in Appendix D.4.

Table 11: Consensus Forecast Revisions and Monetary Policy Surprises: All Announcements

	Intercept	**Monetary Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.037***	–0.049	104	0.017
	(0.014)	(0.056)		
Δ (Current FY Investment Growth)	–0.219***	0.031	104	0.000
	(0.051)	(0.133)		
Δ (Current FY WPI Inflation)	0.004	0.226	104	0.047
	(0.036)	(0.158)		
Δ (Next FY Output Growth)	–0.065**	0.082	118	0.02
	(0.030)	(0.060)		
Δ (Next FY Investment Growth)	–0.205***	0.213	118	0.027
	(0.066)	(0.134)		
Δ (Next FY WPI Inflation)	–0.055*	0.092	118	0.021
	(0.033)	(0.062)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of key macroeconomic indicators for the current and next financial years on monetary policy surprises on all announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All monetary surprises which occur between two consecutive surveys are summed. For the regressions for the current year forecasts, these surprises are also weighted by the fraction of months remaining in the financial year. Data on the consensus forecasts of real GDP growth, real investment growth and WPI inflation is sourced from Consensus Economics. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Values less than 0.001 are displayed as 0.000. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

Table 12: Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements

	Intercept	**Monetary Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.036**	–0.204**	88	0.107
	(0.014)	(0.080)		
Δ (Current FY Investment Growth)	–0.192***	–0.144	88	0.004
	(0.057)	(0.321)		
Δ (Current FY WPI Inflation)	–0.009	0.019	88	0.000
	(0.035)	(0.091)		
Δ (Next FY Output Growth)	–0.024	–0.122**	97	0.033
	(0.019)	(0.060)		
Δ (Next FY Investment Growth)	–0.119**	–0.290	97	0.026
	(0.049)	(0.302)		
Δ (Next FY WPI Inflation)	–0.033	–0.055	97	0.004
	(0.026)	(0.056)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of key macroeconomic indicators for the current and next financial years on monetary policy surprises on scheduled announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All scheduled surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled surprises which occur during the same period. For the regressions for the current year forecasts, these surprises are also weighted by the fraction of months remaining in the financial year. Data on the consensus forecasts of real GDP growth, real investment growth and WPI inflation is sourced from Consensus Economics. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Values less than 0.001 are displayed as 0.000. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

Table 13: Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements

	Intercept	**Monetary Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.072**	–0.027	23	0.017
	(0.034)	(0.058)		
Δ (Current FY Investment Growth)	–0.406***	0.000	23	0.000
	(0.092)	(0.100)		
Δ (Current FY WPI Inflation)	0.064	0.202	23	0.073
	(0.119)	(0.180)		
Δ (Next FY Output Growth)	–0.213*	0.064	28	0.015
	(0.105)	(0.049)		
Δ (Next FY Investment Growth)	–0.514**	0.174	28	0.025
	(0.212)	(0.112)		
Δ (Next FY WPI Inflation)	–0.139	0.081	28	0.024
	(0.114)	(0.079)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of key macroeconomic indicators for the current and next financial years on monetary policy surprises on unscheduled announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All unscheduled surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of scheduled surprises which occur during the same period. For the regressions for the current year forecasts, these surprises are also weighted by the fraction of months remaining in the financial year. Data on the consensus forecasts of real GDP growth, real investment growth and WPI inflation is sourced from Consensus Economics. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Values less than 0.001 are displayed as 0.000. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

the first systematic evidence for India that higher policy interest rates are associated with a decline in private sector expectations of economic prospects.[12]

The point estimates of investment growth forecast revisions to monetary policy surprises are negative on scheduled announcement dates and for the next financial year, they are larger than the response of GDP growth. The real investment growth forecast revisions on unscheduled announcement dates are very small for the current financial year but larger and positive for the next financial year. However, the investment growth forecast revisions are not statistically significant at the 10% level.

The point estimate of the WPI inflation forecasts to monetary policy surprises is negligible, with point estimates less than or equal to 5 basis points, on scheduled announcement dates but positive and quite large for the current financial year on unscheduled announcement dates. However, these estimates too are not statistically significant at the 10% level.

These results are consistent with the evidence from financial market variables and the growth forecasts that monetary policy surprises on unscheduled announcement dates react differently compared to surprises on scheduled announcement dates. Importantly, even on scheduled announcement dates, the ability of higher interest rates to lower inflation expectations is quite weak, suggesting that the effects of monetary policy surprises on inflation expectations are not very strong.

The statistically significant negative intercepts for the revisions of the growth and investment forecasts tends to suggest that professional forecasters have consistently more optimistic views of macroeconomic conditions than the RBI as these forecasts get revised downwards following monetary policy communication from the RBI even in the absence of a monetary policy surprise.

This section provides further evidence about the heterogeneity in the effects of the measured monetary policy surprises on scheduled and unscheduled announcement dates. Monetary policy surprises measured on scheduled announcement dates do appear to have effects in the theoretically expected direction on output and investment expectations even though the effect on inflation expectations is quite weak. In contrast to the evidence in Nakamura and Steinsson (2018), the effects of interest rate surprises identified using scheduled announcement dates on output and investment growth expectations are negative, suggesting a much smaller role for the information or response to news components of monetary policy surprises in India.

The responses of the forecast variables to unscheduled monetary policy announcements appear to be biased in the opposite direction, suggesting that the monetary policy surprises on unscheduled announcement dates may not be a good proxy for monetary policy surprises in the Indian context. The concerns about confounding the information effects, response to news channels and other correlated shocks with monetary policy surprises are much stronger on unscheduled announcement dates compared to scheduled announcement dates. This is also consistent with the evidence from the event study regressions presented in Section 5.1.

[12] Goyal and Parab (2021) make a related, but distinct, point that increases in the RBI's repo rate are associated with a decline in the forecast errors for inflation.

6 Monetary policy transmission to output and inflation

What are the effects of the identified RBI monetary policy surprises on output and inflation, the end goals of monetary policy? This section provides empirical evidence on this question in the form of Impulse Response Functions (IRFs) using macroeconomic data at a monthly frequency. The IRF analysis is limited to considering the effects of monetary policy up to 24 months ahead. Given the relatively small magnitudes of the high-frequency identified monetary policy surprises, they lack the statistical power to identify the long-run effects of monetary policy (see Table 2). Nakamura and Steinsson (2018) refer to this as the *power problem* of high-frequency identification. Given the small magnitudes of the monetary policy surprises, the signal-to-noise ratios in regressions on variables very far into the future would be very low, thereby precluding reliable inference.

This is an important limitation of using high frequency identification of monetary policy surprises to study monetary policy transmission, as recent research suggests that these long-run effects of monetary policy may be quantitatively large and theoretically interesting (Jordà et al., 2020). But the search for more precise identification does often come at the expense of lower statistical power. Therefore, the empirical analysis in this section is mainly limited to a consideration of the effects of monetary policy surprises on macroeconomic variables up to 24 months ahead.

At a monthly frequency, the best available measure of economic activity in India is the Index of Industrial Production (IIP). This index measures the volume of production in the industrial sector and is hence a reliable source of information on real economic performance.

The best available measure of prices, for the whole time period under study in India, is the Wholesale Price Index (WPI). The WPI, unlike measures of consumer prices, places less weight on volatile commodities like food and fuel and more weight on manufactured goods prices. CPI data, for a nationally representative basket of consumption, is available only from 2011 onwards and hence the WPI is used as the measure of inflation.[13] Furthermore, for much of the time period under study, until 2014, WPI inflation was the official headline inflation measure against which the RBI evaluated its monetary policy.

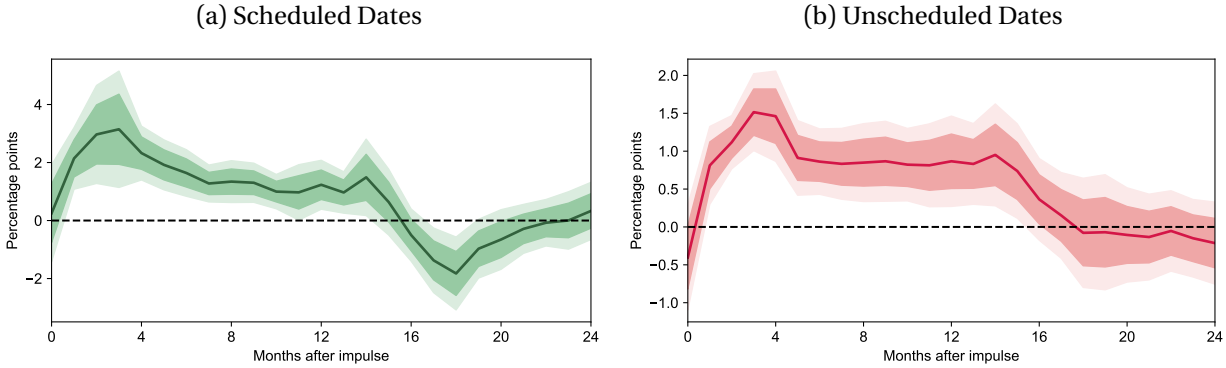
The data are obtained from the OECD's Main Economic Indicators database (accessed through FRED). Additional information on the data sources is provided in Appendix E. The IRFs are estimated using a Local Projection (LP) specification of the following form (Jordà, 2005):

$$y_{t+h} = \alpha^h + \beta_0^h \epsilon_{1M,t}^m + \sum_{k=1}^{12} \beta_k^h \epsilon_{1M,t-k}^m + \Gamma \mathbf{X_t} + \varepsilon_t$$

for $h = \{0, 1, 2, ..., 24\}$. $\left\{ \epsilon_{1M,t-k}^m \right\}_{k=0}^{12}$ represent the monthly sum of the changes in the 1-month MIBOR-OIS rates on monetary policy announcement dates in month $t-k$. $\mathbf{X_t}$ consists of a set of additional

[13] While separate CPI measures were available for Industrial Workers and Agricultural Workers before 2011, they were not nationally representative in the same way as the CPI-Combined measure introduced in 2011.

Figure 4: Impulse Response Functions of Overnight MIBOR to Monetary Policy Surprises



Notes: This figure shows the impulse responses of the overnight Mumbai Interbank Outright Rate (MIBOR) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the monthly average of the overnight MIBOR. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on overnight MIBOR is sourced from Bloomberg Terminal with ticker: IN00O/N Index.

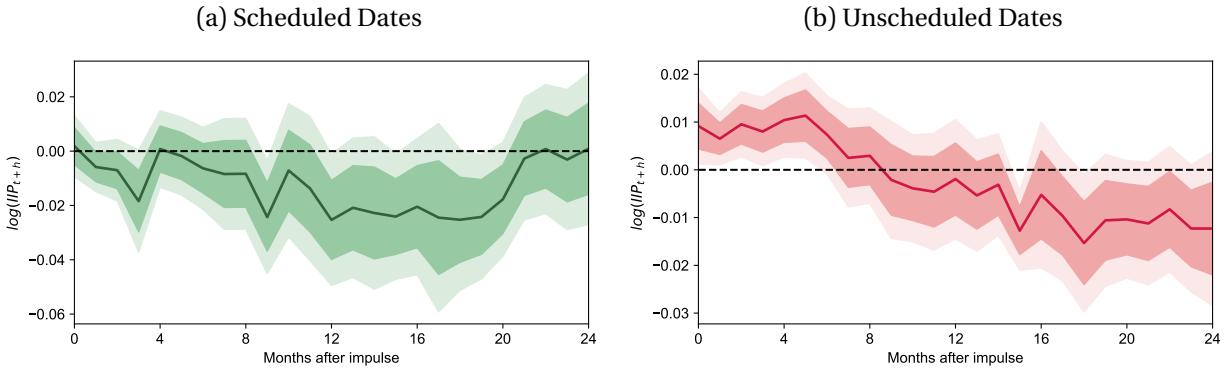
control variables: (i) A measure of MIBOR-OIS market liquidity, Liquidity_t, defined as the average bid-ask spread in month t, (ii) A measure of MIBOR-OIS market volatility, Volatility_t, defined as the average absolute change in the 1-month MIBOR-OIS rates during non-announcement dates in month t, (iii) the first-lag of the dependent variable (y_{t-1}) and (iv) the monthly sum of 1-month MIBOR-OIS based monetary policy surprises on unscheduled dates when the model is estimated for scheduled dates and vice-versa.

The IRFs are estimated separately for scheduled and unscheduled announcement dates. The IRF of interest is given by the series of regression coefficients: $\left\{\beta_0^h\right\}_{h=0}^{24}$. Following Montiel Olea and Plagborg-Møller (2021), heteroskedasiticty-robust confidence intervals are estimated after lag-augmentation of the LP specification.

Before considering the effects on output and inflation, Figure 4 first plots the Impulse Response Functions (IRFs) of the overnight MIBOR to the monetary policy surprises. The dependent variable in these regressions is the monthly average of the overnight MIBOR. On both scheduled and unscheduled announcement dates, higher interest rates lead to an increase in the overnight MIBOR and they persist in both cases for about 16 months. This suggests that the measured monetary policy surprises are reasonably persistent on average and are not immediately reversed by central bank actions.

Figure 5 plots the IRFs of the Index of Industrial Production (IIP) to the monetary policy surprises. The dependent variable in these regressions is the Index of Industrial Production (in log-levels). On scheduled announcement dates, a 100-basis point contractionary monetary policy surprise leads to a decline in the IIP which persists for close to 24 months, with a maximum effect of around 2.5%, occurring between 12 and 18 months after the initial impulse.

Figure 5: Impulse Response Functions of Industrial Production to Monetary Policy Surprises



Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the IIP is sourced from FRED with ticker: INDPROINDMISMEI. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

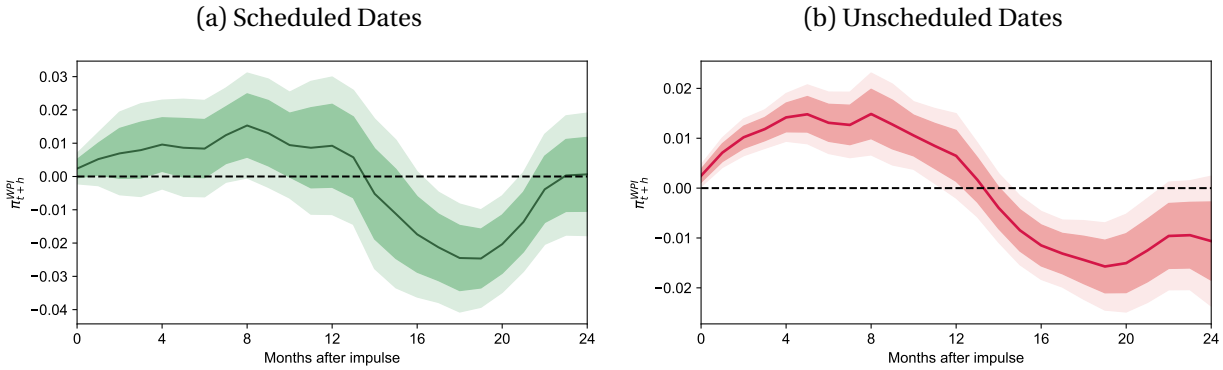
In contrast, on unscheduled announcement dates, the IIP tends to rise in the initial few months following a 100 basis points monetary policy surprise. The response of IIP on unscheduled announcement dates is consistent with the potential endogeneity of unscheduled surprises to lagged and contemporaneous developments in the economy, as documented in Section 4.

Figure 6 considers the response of wholesale price inflation to the monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable in these regressions is the year-on-year change in WPI (calculated as the logarithmic difference). On scheduled announcement dates, inflation declines following an increase in interest rates, but with a time lag of about one year. Following a 100-basis point contractionary monetary policy surprise, the response of inflation is positive but mostly not statistically significant for the first thirteen months and begins to decline thereafter, reaching a maximum effect of 2.5% around 19 months after the initial impulse. This suggests that there is a time lag before monetary policy starts affecting inflation.

The shape of the estimated impulse response function for inflation on unscheduled announcement dates is quite similar to that on scheduled announcement dates. However, there is a much stronger statistically significant increase in inflation in the first few months following an unscheduled monetary policy surprise than on scheduled announcement dates. The magnitude and estimated precision of the response of inflation in the months immediately following an unscheduled monetary policy announcement further confirm the potential endogeneity of unscheduled monetary policy surprises to lagged and contemporaneous developments in the economy.

It is important to note here that the responses of both IIP and WPI inflation beyond one year point to effects of monetary policy in the same direction, even though the magnitude of the responses on unscheduled announcement dates are much smaller. This similarity in the response of macroeconomic

Figure 6: Impulse Response Functions of WPI Inflation to Monetary Policy Surprises



Notes: This figure shows the impulse responses of the year-on-year change in the Wholesale Price Index (WPI) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year change in the WPI calculated as the logarithmic difference. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the WPI is sourced from FRED with ticker: WPIATT01INM661N. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

variables beyond the 12-month horizon suggests that the endogeneity of monetary policy surprises on unscheduled announcement dates to lagged and contemporaneous developments in the economy is particularly problematic in assessing the effects of monetary policy in the short-run.

This section provides evidence using MIBOR-OIS surprises on scheduled announcement dates that monetary policy transmission in India has been quite strong with the strength of the effects increasing considerably over time. The results suggest that the absence of existing evidence for strong monetary policy transmission in India is not necessarily evidence of its absence.

7 Conclusion

This paper studies monetary policy transmission in India using a newly constructed dataset of monetary policy surprises of the RBI. Using the longest available time series of RBI monetary policy announcement dates and surprise changes in monetary policy identified from the MIBOR-OIS market, this paper documents significant heterogeneity in the effects of monetary policy surprises measured following scheduled and unscheduled announcements on financial market variables, private sector expectations and macroeconomic variables.

The effects of scheduled monetary policy surprises are consistent with theoretical predictions about the effects of monetary policy. Following a surprise interest rate increase, asset prices, forecasted and actual output as well as inflation decline. The magnitude of the estimated effects suggests that monetary policy transmission in India is stronger than previously estimated.

In contrast, the effects of unscheduled monetary policy surprises are not well identified and are in-

consistent with the effects of scheduled monetary policy surprises. Asset prices, output and inflation appear to increase on impact following an unscheduled surprise increase in interest rates. The unscheduled monetary policy surprises are found to be strongly predictable by past macroeconomic conditions and are also potentially strongly correlated with other contemporaneous real shocks, making them unsuitable for direct use as measures of monetary policy surprises.

At this stage, it is important to note that this paper is limited in its scope. It is an attempt at more refined measurement of monetary policy surprises. The analysis is limited to identifying and quantifying the effects of monetary policy on aggregate macroeconomic variables in India. This does not enhance our understanding of the mechanics of how monetary policy transmits in India but is merely a contribution towards improving our understanding of the facts of monetary policy transmission.

The monetary policy surprises identified in this paper could serve as a useful input for future research aimed at understanding monetary policy transmission at a more granular level. Very little is known at present about the effects of monetary policy on households and firms in India, particularly towards those who are excluded from formal financial markets. With the increased availablility and frequency of household survey data and firm administrative data, an important avenue for future research would be to study how these groups respond to the monetary policy actions of the RBI.

The unscheduled monetary policy surprises identified in this paper are found to be endogenous to past macroeconomic conditions. Several possible reasons for this were discussed in the introduction. With the increased availability of intra-day financial market data in a larger number of emerging economies and the availability of transactions-level data on the trading of financial instruments, future research could focus on understanding the causes of the endogeneity of measured monetary policy surprises in these economies in greater detail.

References

Acharya, V. V. (2020). Fiscal dominance: A theory of everything in india. *Indian Public Policy Review*, 1(2):1–15.

Acosta, M. (2023). The perceived causes of monetary policy surprises. *Working Paper*.

Adam, C., Berg, A., Li, B. G., Montiel, P., and O'Connell, S. (2016). Var meets dsge: Uncovering the monetary transmission mechanism in low-income countries. *IMF Working Paper*, WP/16/90.

Barnichon, R. and Mesters, G. (2023). A sufficient statistics approach for macro policy. *The American Economic Review*, 113(11):2809–2845.

Bauer, M. D., Bernanke, B. S., and Milstein, E. (2023). Risk appetite and the risk-taking channel of monetary policy. *Journal of Economic Perspectives*, 37(1):77–100.

Bauer, M. D. and Swanson, E. T. (2023a). An alternative explanation for the "fed information effect". *The American Economic Review*, 113(3):664–700.

Bauer, M. D. and Swanson, E. T. (2023b). A reassessment of monetary policy surprises and high-frequency identification. *NBER Macroeconomics Annual 2022*, 37:87–155.

Bernanke, B. S. and Kuttner, K. N. (2005). What explains the stock market's reaction to federal reserve policy? *Journal of Finance*, 60(3):1221–1257.

Black, F. (1986). Noise. *Journal of Finance*, 41(3):528–543.

Bloomberg (2023). Bloomberg currency data disclaimers. https://www.bloomberg.com/notices/currency-data/. Accessed: 2023-12-28.

Borio, C. (2023). Getting up from the floor. *BIS Working Paper*, 1100.

Castillo-Martinez, L. and Reis, R. (2024). How do central banks control inflation? a guide for the perplexed. *Working Paper*.

Chari, A., Stedman, K. D., and Lundblad, C. (2021). Taper tantrums: Quantitative easing, its aftermanth, and emerging market capital flows. *The Review of Financial Studies*, 34(3):1445–1508.

Choy, W. K. (2003). Introducing overnight indexed swaps. *Reserve Bank of New Zealand Bulletin*, 66(1):34–39.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1999). Monetary policy shocks: What have we learned and to what end? In Taylor, J. B. and Woodford, M., editors, *Handbook of Macroeconomics*, volume 1A, pages 65–148. Elsevier, Amsterdam.

Cochrane, J. H. (2005). *Asset Pricing*. Princeton University Press, Princeton, revised edition.

Coibion, O. and Gorodnichenko, Y. (2015). Information rigidity and the expectations formation process: A simple framework and new facts. *The American Economic Review*, 105(8):2644–2678.

Das, S., Surti, J., and Tomar, S. (2020). Does inflation targeting help information transmission? *SSRN Electronic Journal*.

Dua, P. (2020). Monetary policy framework in india. *Indian Economic Review*, 55(1):117–154.

FIMMDA (2016). *Handbook of Market Practices*. Fixed Income Money Market and Derivatives Association of India.

Fisher, I. (1930). *The Theory of Interest: as determined by impatience to spend income and opportunity to invest it*. Macmillan, New York.

Garga, V., Lakdawala, A., and Sengupta, R. (2022). Assessing central bank commitment to inflation targeting: Evidence from financial market expectations in india. *Federal Reserve Bank of Boston Working Paper*.

Goyal, A. and Parab, P. (2021). Central bank communications and professional forecasts: Evidence from india. *Journal of Emerging Market Finance*, 20(3):308–336.

Gürkaynak, R. S., Sack, B. T., and Swanson, E. T. (2005). Do actions speak louder than words? the response of asset prices to monetary policy actions and statements. *International Journal of Central Banking*, 1(1):55–93.

Gürkaynak, R. S., Sack, B. T., and Swanson, E. T. (2007). Market-based measures of monetary policy expectations. *Journal of Business & Economic Statistics*, 25(2):201–212.

Hack, L., Istrefi, K., and Meir, M. (2023). Identification of systematic monetary policy. *Working Paper*.

Hicks, J. R. (1939). *Value and Capital*. Clarendon Press, Oxford.

Hirshleifer, J. (1971). The private and social value of information and the reward to inventive activity. *The American Economic Review*, 61(4):561–574.

IMF (2023). *World Economic Outlook: Navigating Global Divergences*. International Monetary Fund, Washington, D.C.

Jarociński, M. and Karadi, P. (2020). Deconstructing monetary policy surprises - the role of information shocks. *American Economic Journal: Macroeconomics*, 12(2):1–43.

Jordà, O. (2005). Estimation and inference of impulse responses by local projections. *The American Economic Review*, 95(1):161–182.

Jordà, O., Singh, S. R., and Taylor, A. M. (2020). The long-run effects of monetary policy. *NBER Working Paper*, 26666.

Kaplan, G., Moll, B., and Violante, G. L. (2018). Monetary policy according to hank. *The American Economic Review*, 108(3):697–743.

Kohlscheen, E. (2014). The impact of monetary policy on the exchange rate: A high frequency exchange rate puzzle in emerging economies. *Journal of International Money and Finance*, 44(C):69–96.

Kumar, A. V. and Rituraj (2021). Assessing the future path of monetary policy from overnight indexed swap (ois) rates. *Reserve Bank of India Bulletin*, 75(2):73–84.

Kuttner, K. N. (2001). Monetary policy surprises and interest rates: Evidence from the fed funds futures market. *Journal of Monetary Economics*, 47(3):523–544.

Lakdawala, A. and Sengupta, R. (2024). Measuring monetary policy shocks in emerging economies: Evidence from india. *Journal of Money, Credit and Banking*. forthcoming.

Lloyd, S. P. (2018). Overnight index swap market-based measures of monetary policy expectations. *Bank of England Staff Working Paper No. 709*.

Lucas, R. E. (1976). Econometric policy evaluation: A critique. *Carnegie-Rochester Conference Series on Public Policy*, 1:19–46.

Lucas, R. E. (1978). Asset prices in an exchange economy. *Econometrica*, 46(6):1429–1445.

Mathur, A. and Sengupta, R. (2019). Analysing monetary policy statements of the reserve bank of india. *IGIDR Working Paper*, 2019(012).

McKay, A. and Wolf, C. (2023). What can time-series regressions tell us about policy counterfactuals? *Econometrica*, 91(5):1695–1725.

Melosi, L. (2017). Signaling effects of monetary policy. *The Review of Economic Studies*, 84(2):853–884.

Miranda-Agrippino, S. and Ricco, G. (2021). The transmission of monetary policy shocks. *American Economic Journal: Macroeconomics*, 13(3):74–107.

Mishra, P. and Montiel, P. (2013). How effective is monetary transmission in low-income countries? a survey of the empirical evidence. *Economic Systems*, 37(2):187–216.

Mishra, P., Montiel, P., and Sengupta, R. (2016). Monetary policy transmission in developing countries: Evidence from india. *IMF Working Paper*, 16(167).

Mishra, P., Montiel, P., and Spilimbergo, A. (2012). Monetary transmission in low income countries. *IMF Working Paper*, WP/10/223.

Montiel Olea, J. L. and Plagborg-Møller, M. (2021). Local projection inference is simpler and more robust than you think. *Econometrica*, 89(4):1789–1823.

Muth, J. F. (1961). Rational expectations and the theory of price movements. *Econometrica*, 29(3):315–335.

Nakamura, E. and Steinsson, J. (2018). High-frequency identification of monetary non-neutrality: The information effect. *The Quarterly Journal of Economics*, 133(3):1283–1330.

Nath, G. C. (2018). Mumbai inter-bank overnight rate: Benchmark calculation and methodology. *CCIL Monthly Newsletter*, February 2018.

Ottonello, P. and Winberry, T. (2020). Financial heterogeneity and the investment channel of monetary policy. *Econometrica*, 88(6):2473–2502.

Pagan, A. (1984). Econometric issues in the analysis of regressions with generated regressors. *International Economic Review*, 25(1):221–247.

Patra, M. D. and Ray, P. (2010). Inflation expectations and monetary policy in india: An empirical exploration. *IMF Working Paper*, 10(84).

Pirozhkova, E., Ricco, G., and Viega, N. (2024). Trouble every day: Monetary policy in an open emerging economy. *Working Paper*.

Prabu A., E., Bhattacharyya, I., and Ray, P. (2016). Is the stock market impervious to monetary policy announcements: Evidence from emerging india. *International Review of Economics & Finance*, 46:166–179.

Rajan, R. G. (2014). Fighting inflation. *Reserve Bank of India Bulletin*, 68(3):11–20.

Ramey, V. (2016). Macroeconomic shocks and their propagation. In Taylor, J. B. and Uhlig, H., editors, *Handbook of Macroeconomics*, volume 2, pages 71–162. Elsevier, Amsterdam.

RBI (2011). Monetary policy statement, 2011-12. https://www.rbi.org.in/scripts/NotificationUser.aspx?Id=6376&Mode=0. Accessed: 2024-04-01.

Rey, H. (2015). Dilemma not trilemma: The global financial cycle and monetary policy independence. *NBER Working Paper*, 21162.

Roy, T. (2022). *The Reserve Bank of India, Volume 5: 1997 - 2008*. Cambridge University Press, Cambridge.

Sargent, T. J. (2013). *Rational expectations and inflation*. Princeton University Press, Princeton, third edition.

Sinha, P. (2007). Rates to harden further. *The Times of India*. 21st March 2007.

Solís, P. (2023). Does the exchange rate respond to monetary policy in mexico? solving an exchange rate puzzle in emerging markets. *Journal of Money, Credit and Banking*, 55(8):2093–2113.

Swanson, E. T. (2023). The macroeconomic effects of the federal reserve's conventional and unconventional monetary policies. *NBER Working Paper*, 31603.

Swanson, E. T. and Jayawickrema, V. (2023). Speeches by the fed chair are more important than fomc announcements: An improved high-frequency measure of u.s. monetary policy shocks. *Working Paper*.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, 39:195–214.

UN (2023). India overtakes china as the world's most populous country. *Department of Economic and Social Affairs Policy Brief*, 153.

Witheridge, W. (2024). Monetary policy and fiscal-led inflation in emerging markets. *Working Paper*.

Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press, Princeton.

Appendix

A MIBOR-OIS monetary policy surprises: additional results

A.1 MIBOR-OIS market in India: a brief overview

This section provides a brief overview of the key features of the Interest Rate Swap Market in India, and in particular, the MIBOR-OIS market. Interest Rate Swap (IRS) contracts were first introduced in India in July 1999, following the recommendations of the Advisory Committee on Derivatives in 1998. During much of the early period in the history of these contracts, trades were completed over the counter in a decentralised manner with no centralised clearing mechanism or repository of the deals that had been struck.

Beginning in 2007, the RBI mandated that all IRS contracts have to be reported to a trade repository maintained by the Clearing Corporation of India (CCIL), which paved the way for the development of centralised counterparty clearing of IRS contracts in 2014. In addition, in 2013, the RBI standardised MIBOR-OIS contracts, leading to the development of a liquid and transparent market for these contracts. A detailed timeline of the key developments in the IRS market in India can be found in Pawaskar and Ghose (2019).

MIBOR-OIS contracts are the largest segment of the IRS market in India, with a 91% market share by value and a 94% market share by volume in the financial year ending 2023. The total amount outstanding in this market has increased from ₹ 36.5 trillion in the financial year ending 2008 to ₹ 58.5 trillion in the financial year ending 2023 (Table 73, CCIL (2024b)). Anecdotal evidence suggests that the composition of banks participating in this market has remained relatively stable since its inception.

The largest participants on the buy-side in this market are Foreign Banks, Indian branches of commercial banks headquartered abroad, with a market share of 44%, followed by Primary Dealers (26%), Private Sector Banks (23%), Public Sector Banks (4%) and Mutual Funds (3%) (Table 11, CCIL (2024b)). On the sell-side, the market shares are Foreign Banks (45%), Private Sector Banks (29%), Primary Dealers (23%) and Public Sector Banks (3%) (Table 12, CCIL (2024b)).

The participation of banks in the OIS market is inversely related to their respective deposit shares. Public Sector Banks, which are the largest banks in India by deposit size, are a very minor participant in the MIBOR-OIS market. In contrast, Foreign Banks, whose deposits share is minimal, are the most active participants in this market.

This suggests that the MIBOR-OIS contracts are traded mainly to take a position on the evolution of policy interest rates rather than to hedge against interest rate risk, which makes them more suitable for the measurement of monetary policy surprises. However, this evidence is also consistent with the possibility that Public Sector Banks have other instruments at their disposal to manage interest rate risk

Table A.1: Monthly auto-correlation of monetary policy surprises

Monetary Surprise	Pooled	Scheduled	Unscheduled
Intercept	–0.011	0.013	–0.022
	(0.025)	(0.013)	(0.027)
Monetary Surprise$_{t-1}$	0.201*	–0.008	0.147
	(0.106)	(0.007)	(0.101)
Monetary Surprise$_{t-2}$	–0.054	0.002	–0.002
	(0.041)	(0.014)	(0.052)
F-statistic	1.902	0.605	1.122
p-value	0.152	0.547	0.327
R^2	0.039	0.000	0.022
N	246	246	246

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Heteroskedasticity-robust S.E.'s reported;

Notes: This table reports the results of OLS regressions of the monthly aggregated monetary policy surprises on their first and second lags. The monetary policy surprises are the monthly sum of the two-day change in 1-month MIBOR-OIS fixed rate on RBI monetary policy announcement dates. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The monthly monetary policy surprise is set to 0 in months without a RBI monetary policy announcement. Values less than 0.001 are displayed as 0.000.

on account of their implicit state-guarantees, which Foreign Banks and Private Sector Banks lack.[14]

In terms of the liquidity of these contracts across the term structure, the volume of trade is greatest in the 5-year and in general contracts with maturities above 1-year are more liquid than those with maturities below 1-year (CCIL, 2024a). However, the impact of less active trading in the 1-month MIBOR-OIS contracts is likely to have limited impact on our analysis as it uses data on quoted rates rather than traded rates.

A.2 Auto-correlation of MIBOR-OIS surprises at monthly frequency

Table A.1 reports the results of OLS regressions of the monthly aggregate of monetary policy surprises on their first and second lags. On both scheduled and unscheduled announcement dates, there seems to be no systematic auto-correlation in the monthly monetary policy surprises in this sample. While the first lag of the monetary surprise does seem to have some predictive capacity, this further confirms the results in Table 3 that the monetary policy surprises are not systematically auto-correlated across RBI announcement dates.

[14] Anecdotal evidence, based on conversations with regulators involved in this market, suggests that the high market shares of Foreign Banks is on account of a lot of trading which occurs between Foreign Banks on the basis of global agreements to take a position on the evolution of policy interest rate in each country in which they operate.

B Monetary policy surprises from longer-term OIS contracts

MIBOR-OIS contracts are available at a wide range of maturities. The shortest maturity OIS contract on which data is available is the 1 month contract which is used in the main analysis. This is a useful indicator of current central bank policy. However, we may want to consider monetary policy surprises derived from longer-term OIS contracts for two reasons. Firstly, the 1 month OIS rate is responsive not just to surprise changes in the policy rates but also changes in the timing of already anticipated policy rate changes. Monetary timing surprises may weaken identification as a lot of its effects may already have been anticipated and priced in (Gürkaynak et al., 2007). One way to check for the significance of this effect is to compare surprises from the 1 month rate with surprises derived from a slightly longer horizon OIS contract of 3 months, which is the next available maturity.

Moreover, on monetary policy announcement dates, information is revealed not just about the current policy rates but also about central bank assessments about future macroeconomic conditions and the path of future policy rates. In this context, it is useful to consider monetary policy surprises derived from longer-term OIS contracts to understand differences in the effects of current policy actions and central bank communication policy. Since central bank communications usually provide guidance only up to a year ahead, the 1 year OIS contract is a useful indicator of the market's expectations of the path of future policy rates.

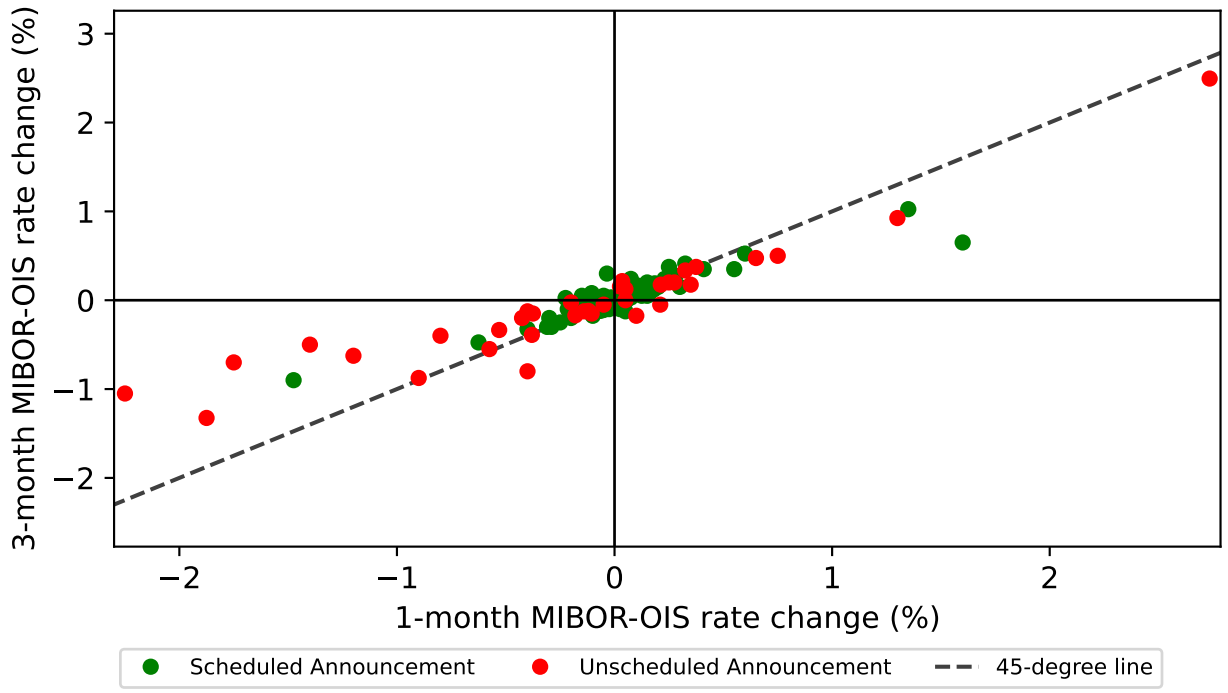
B.1 3-Month MIBOR-OIS

Figure B.1 plots the change in 3-month MIBOR-OIS contract on RBI announcement dates against the change in the 1-month MIBOR-OIS contract. On most instances, the two interest rates move in the same direction but the 3-month interest rates typically changes by a smaller amount, particularly during announcements when the magnitude of the monetary surprise is very large. This is confirmed in Table B.1, which shows the results from an event study regression of changes in the 3-month OIS rate on changes in the 1-month OIS rate.

A monetary policy surprise, traditionally understood as a surprise change in the monetary policy instruments, would be expected to affect the 1-month OIS rate by the exact same amount as the 3-month OIS rate. A smaller change in the 3-month OIS rate than the 1-month OIS rate can be indicative of one of two things: (i) a *timing surprise* of an already anticipated monetary policy action or (ii) *release of information* about future macroeconomic conditions or the future path of monetary policy which affects the 3-month OIS rate but not the 1-month OIS rate.

It is possible to test which effect is dominant by checking the correlation of the differential change in the 3-month OIS rate on announcement dates with changes in asset prices in an event study specification following Bernanke and Kuttner (2005). If the timing surprise effect is dominant, the coefficient on the differential change variable should be negative, as if the longer horizon interest rate responds by a lesser amount, it implies that interest rate changes have already been anticipated and hence the negative

Figure B.1: 3-month MIBOR-OIS rate changes on RBI monetary policy announcement dates



Notes: This figure plots monetary policy surprises derived as the two-day change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI against the two-day change in the 3-month MIBOR-OIS fixed rates on the same dates. The scheduled monetary policy surprises are shown in green and the unscheduled monetary policy surprises are shown in red. The 1-month and 3-month MIBOR-OIS fixed rates are sourced from Bloomberg Terminal with tickers: IRSWOA BGN Curncy and IRSWOC BGN Curncy respectively.

Table B.1: 3-Month MIBOR-OIS and 1-month MIBOR-OIS rate changes on RBI announcement dates

3M MIBOR-OIS Change	Pooled	Scheduled	Unscheduled
Intercept	0.020	0.011	0.048
	(0.012)	(0.008)	(0.040)
1M MIBOR-OIS Surprise	0.659***	0.644***	0.672***
	(0.064)	(0.072)	(0.081)
R^2	0.869	0.836	0.880
N	133	97	36

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Heteroskedasticity-robust S.E.'s reported;

Notes: This table plots the results from OLS regressions of the two-day change in the 3-month MIBOR-OIS fixed rate on the corresponding change in the 1-month MIBOR-OIS fixed rate on all, scheduled and unscheduled monetary policy announcement dates of the RBI. Data on 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

effect of any surprise (as measured through the 1-month OIS rate) on asset prices should be lower to the extent to which it has been anticipated.

On the other hand, if the coefficient on the differential change variable is positive, then it suggests that the information effects are much more likely to be dominant. To the extent that monetary tightening surprises (as measured through the 1-month OIS rate) are accompanied by the revelation of information about economic conditions in the future, then a positive coefficient on the differential change variable would be expected. Positive (negative) news about future economic conditions would act as a positive (negative) demand shock for credit and lead to the longer horizon interest rates responding by larger (smaller) amounts than the short-term interest rates and mitigate (accentuate) the negative effects on asset prices.

Following Bernanke and Kuttner (2005), the *Timing Surprise* variable is defined as the difference between the change in the 3-month MIBOR-OIS rate and the change in the 1-month MIBOR-OIS rate on monetary policy announcement dates. The variable has a positive value when the 3-month OIS rate changes by a larger amoount than the 1-month OIS rate. While the nomenclature may suggest that the variable is a measure only of timing surprises, it is important to note that changes in this variable can also be driven by the release of information about future macroeconomic conditions and the future path of monetary policy.

Table B.2 present results from the event study specifications for various financial market variables controlling for the *Timing Surprise* variable on scheduled announcement dates. Unsurprisingly, government security yields co-move positively with both the *Monetary Surprise* and the *Timing Surprise* variables. The response of the exchange rate is weak in response to both variables and not statistically significant. However, the response of the stock market variables, while statistically insignificant, point to the *Timing Surprise* variable moving in the same direction as the stock market indices. This provides suggestive evidence that on scheduled announcement dates, the predominant effect of monetary announcements on longer horizon interest rates comes from the release of relevant information rather than from timing surprises.

By contrast, on unscheduled announcement dates, the event study regressions in Table B.3 show that the *Timing Surprise* variable is much stronger in its effect on stock market indices. The reaction of financial market indicators is similar to the reaction on scheduled announcement dates, but the exchange rate appreciation is now much stronger and statistically significant.

With the inclusion of controls from longer-horizon interest rates, there is a slight change in interpretation of the coefficient on the monetary surprise variable in the event study regressions. It now measures the effect of monetary surprises which change both the 1-month and the 3-month OIS rates by the same magnitude. Since, the point estimates in Table B.2 are now much smaller in magnitude and statistically insignificant compared to Table 9, this points in the direction of the information component of the timing surprise variable being much more dominant on scheduled announcement dates. Therefore, available evidence suggests that, at least on scheduled announcement dates, changes in the 1-month OIS rate are unlikely to simply reflect timing surprises.

Table B.2: Event Study Regressions for Financial Market Variables: Scheduled Dates (timing surprises)

In %	**Intercept**	**Monetary Surprise**	**Timing Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	–0.021*	0.548***	0.756***	97	0.512
	(0.012)	(0.092)	(0.128)		
Δ (5-Year GSec Yield)	–0.006	0.395***	0.584***	97	0.360
	(0.011)	(0.066)	(0.109)		
Δ (10-Year GSec Yield)	–0.001	0.361***	0.566***	97	0.290
	(0.012)	(0.069)	(0.125)		
Δ (NIFTY)	–0.152	–1.246	5.359	97	0.155
	(0.269)	(1.364)	(4.470)		
Δ (SENSEX)	–0.091	–1.536	4.140	97	0.143
	(0.260)	(1.334)	(4.199)		
Δ (BSE200)	–0.106	–1.180	4.927	97	0.129
	(0.281)	(1.416)	(4.318)		
Δ (USD/INR)	–0.051	0.102	–0.086	97	0.005
	(0.065)	(0.364)	(0.673)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises and timing surprises on scheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The *Timing Surprise* variable is calculated as the difference between the two-day change in the 3-month MIBOR-OIS fixed rate and the 1-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

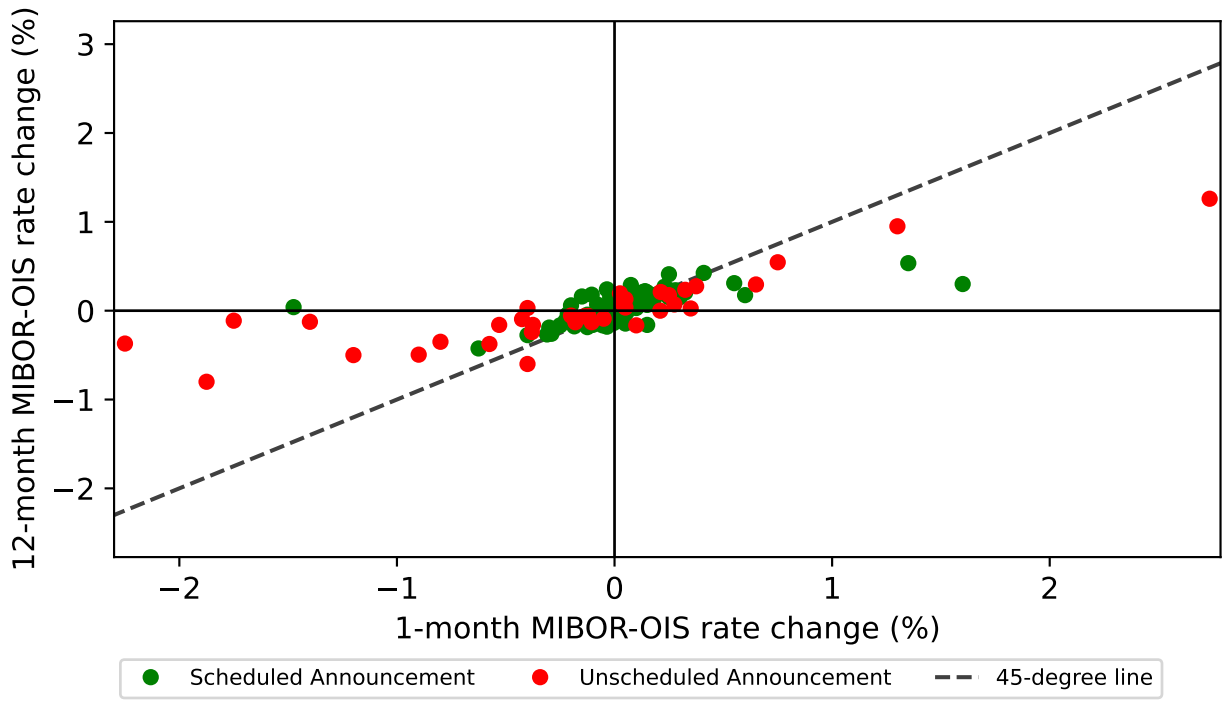
Table B.3: Event Study Regressions for Stock Market Variables: Unscheduled Dates (timing surprises)

In %	**Intercept**	**Monetary Surprise**	**Timing Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	0.005	0.432***	0.528**	36	0.633
	(0.039)	(0.080)	(0.205)		
Δ (5-Year GSec Yield)	0.021	0.294***	0.370***	36	0.724
	(0.018)	(0.027)	(0.089)		
Δ (10-Year GSec Yield)	0.033*	0.221***	0.255**	36	0.586
	(0.019)	(0.033)	(0.119)		
Δ (NIFTY)	–0.047	–0.256	–2.382	36	0.050
	(0.553)	(0.894)	(2.876)		
Δ (SENSEX)	–0.046	–0.174	–2.048	36	0.031
	(0.641)	(1.012)	(3.197)		
Δ (BSE200)	–0.292	0.163	–1.293	36	0.029
	(0.626)	(1.009)	(2.972)		
Δ (USD/INR)	0.000	–0.520**	–1.089	36	0.170
	(0.088)	(0.210)	(0.738)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises and timing surprises on unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The *Timing Surprise* variable is calculated as the difference between the two-day change in the 3-month MIBOR-OIS fixed rate and the 1-month MIBOR-OIS fixed rate on unscheduled monetary policy announcement dates. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Values less than 0.001 are displayed as 0.000.

Figure B.2: 1-year MIBOR-OIS rate changes on monetary policy announcement dates of the RBI



Notes: This figure plots monetary policy surprises derived as the two-day change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI against the two-day change in the 1-year MIBOR-OIS fixed rates on the same dates. The scheduled monetary policy surprises are shown in green and the unscheduled monetary policy surprises are shown in red. The 1-month and 1-year MIBOR-OIS fixed rates are sourced from Bloomberg Terminal with tickers: IRSWOA BGN Curncy and IRSWO1 BGN Curncy respectively.

B.2 1-Year MIBOR-OIS

Figure B.2 plots the change in 1-year MIBOR-OIS contract on RBI announcement dates against the change in the 1-month MIBOR-OIS contract. As with the 3-month MIBOR-OIS rate, the 1-year rate too changes in the same direction as the 1-month rate on monetary policy announcement dates.

Further, Table B.4 shows the results from an event study regression of changes in the 1-year MIBOR-OIS rate on changes in the 1-month MIBOR-OIS rate on RBI monetary policy announcement dates. The coefficient on the 1-month MIBOR-OIS rate is positive, statistically significant and roughly of similar magnitude on both scheduled and unscheduled announcement dates. However, the 1-year rate does not move one-for-one with the 1-month rate and the magnitude of its response is much smaller than that of the 3-month MIBOR-OIS rate.

Interestingly, the R^2 of the event study regression is significantly greater on unscheduled announcement dates than on scheduled announcement dates. On unscheduled announcement dates, close to three-fourths of the variation in both short and long term interest rates is driven by a common source. During the time period under study, the RBI had an explicit commitment to provide no forward guid-

Table B.4: 1-Year MIBOR-OIS and 1-Month MIBOR-OIS rate changes on RBI announcement dates

1Y MIBOR-OIS Change	Pooled	Scheduled	Unscheduled
Intercept	0.029**	0.024	0.050
	(0.013)	(0.014)	(0.032)
1-month MIBOR-OIS Change	0.355***	0.320***	0.372***
	(0.051)	(0.094)	(0.058)
R^2	0.612	0.375	0.729
N	133	97	36

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of the two-day change in the 1-year MIBOR-OIS fixed rate on the corresponding change in the 1-month MIBOR-OIS fixed rate on all, scheduled and unscheduled monetary policy announcement dates of the RBI. Data on 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

ance about the future path of monetary policy (RBI, 2018).[15] In the absence of a forward guidance policy, a lot of the variation in MIBOR-OIS rates on unscheduled announcement dates is likely to be driven by the market response to the release of information about present and future economic conditions, since such information surprises affect both short and long horizon interest rates.

In order to understand the information contained in the 1-year OIS rate about the future path of monetary policy and economic conditions, the *Path Surprise* variable (ε_t^{Path}) is defined as the residual from a regression of the 1-year MIBOR-OIS rate changes (ΔMIBOR-OIS$_t^{1Y}$) on 1-month MIBOR-OIS rate changes (ΔMIBOR-OIS$_t^{1M}$) on monetary policy announcement dates:

$$\Delta\text{MIBOR-OIS}_t^{1Y} = \alpha + \beta\Delta\text{MIBOR-OIS}_t^{1M} + \varepsilon_t^{Path}$$

This regression is estimated using the entire set of announcement dates as well as separately for scheduled and unscheduled announcement dates. The *Path Surprise* variable captures changes in the 1-year MIBOR-OIS rate on monetary policy announcement dates that are orthogonal to changes in the 1-month MIBOR-OIS rate. While *Path Surprise* is a generated regressor, standard inference procedures are consistent and valid for the null hypothesis of zero effect of the *Path Surprise* variable on financial market variables (Pagan, 1984; Coibion and Gorodnichenko, 2015).[16]

Table B.5 presents results from the event study specifications for various financial market variables on scheduled announcement dates while controlling for the *Path Surprise*. The coefficient on the *Path Surprise* is positive and statistically significant for all the government security yields and as with the

[15] The RBI communication policy of 2018, which is the relevant policy for the time period under study states that: "The Reserve Bank'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". This principle of providing no explicit forward guidance has been a part of the RBI's official communication policy since its very first edition in 2008.

[16] In particular, see Model 4 in page 232 of Pagan (1984) for a detailed proof of this result

Table B.5: Event Study Regressions for Financial Market Variables: Scheduled Dates (path surprise)

In %	**Intercept**	**Monetary Surprise**	**Path Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	–0.013	0.279***	0.619***	97	0.589
	(0.010)	(0.053)	(0.080)		
Δ (5-Year GSec Yield)	0.000	0.188***	0.679***	97	0.651
	(0.008)	(0.040)	(0.078)		
Δ (10-Year GSec Yield)	0.005	0.160***	0.651***	97	0.548
	(0.009)	(0.045)	(0.089)		
Δ (NIFTY)	–0.095	–3.152*	1.379	97	0.130
	(0.260)	(1.688)	(2.200)		
Δ (SENSEX)	–0.046	–3.009*	1.131	97	0.127
	(0.252)	(1.518)	(2.058)		
Δ (BSE200)	–0.053	–2.933*	1.538	97	0.110
	(0.272)	(1.559)	(2.160)		
Δ (USD/INR)	–0.052	0.133	–0.520	97	0.016
	(0.065)	(0.243)	(0.614)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises and path surprises on scheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The *Path Surprise* variable is calculated as the residual from a regression of the two-day 1-year MIBOR-OIS fixed rate changes on the corresponding changes in the 1-month MIBOR-OIS fixed rate on scheduled announcement dates. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

Table B.6: Event Study Regressions for Financial Market Variables: Unscheduled Dates (path surprise)

In %	**Intercept**	**Monetary Surprise**	**Path Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	0.031	0.258***	0.776***	36	0.739
	(0.028)	(0.034)	(0.229)		
Δ (5-Year GSec Yield)	0.039**	0.173***	0.473***	36	0.784
	(0.016)	(0.023)	(0.100)		
Δ (10-Year GSec Yield)	0.046***	0.137***	0.390***	36	0.685
	(0.016)	(0.023)	(0.139)		
Δ (NIFTY)	–0.162	0.526	–5.309	36	0.137
	(0.485)	(0.628)	(3.575)		
Δ (SENSEX)	–0.145	0.499	–5.945	36	0.127
	(0.555)	(0.684)	(4.025)		
Δ (BSE200)	–0.354	0.587	–4.509	36	0.091
	(0.555)	(0.658)	(3.845)		
Δ (USD/INR)	–0.052	–0.162	–1.137	36	0.159
	(0.091)	(0.175)	(0.812)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises and path surprises on unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate. The *Path Surprise* variable is calculated as the residual from a regression of the two-day 1-year MIBOR-OIS fixed rate changes on the corresponding changes in the 1-month MIBOR-OIS fixed rate on unscheduled announcement dates. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

monetary policy surprise, shorter horizon yields react more strongly than longer horizon yields. The exchange rate response is weak and not statstically significant. The stock market response has the opposite sign for the *Path Surprise* variable compared to the *Monetary Surprise*. The positive coefficient on the *Path Surprise* variable suggests that, on scheduled announcement dates, the communication of the RBI about future conditions contains less information about monetary policy and more information about economic conditions.

Table B.6 presents results from the event study specifications for various financial market variables on unscheduled announcement dates while controlling for the *Path Surprise*. The response of government bond yields and the exchange rate is very similar to the response on scheduled announcement dates. The *Path Surprise* variable however seems to have a contractionary effect on stock market indicies, but these effects are not statistically significant.

However, as Table B.4 suggests, on unscheduled announcement dates, a substantial proportion of the variation in both the 1-month and the 1-year MIBOR-OIS rates appear to be driven by a common source, which is likely to represent the release of information about economic conditions, given the correlation of the 1-month MIBOR-OIS rate changes with stock price indices. Hence, on unscheduled announcement dates, it is likely that the *Path Surprise* measure contains very little additional information which is not already captured by the 1-month MIBOR-OIS rate changes.

B.3 Timing surprises and endogeneity

An important concern in attributing the differences in the endogeneity of the measured monetary policy surprises, particularly on unscheduled announcement dates, documented in Table 4, is that these differences may be driven by the choice of the 1-month MIBOR-OIS contract as the measure of monetary policy surprises. The 1-month MIBOR-OIS rate is likely to capture not just information about monetary policy, but also information about timing surprises, which are likely to be sensitive to prevailing economic conditions. In order to address this concern and to check the robustness of the results, the 3-month MIBOR-OIS and 1-year MIBOR-OIS contracts are used as alternatives to measure monetary policy surprises and their endogeneity to past macroeconomic conditions is studied in this section.

Table B.7 presents the results of OLS regressions of the 3-month MIBOR-OIS rate changes on various macroeconomic variables on all, scheduled and unscheduled monetary policy announcement dates of the RBI. As with Table 5, the joint test of signficance suggests that even when monetary policy surprises are measured using 3-month MIBOR-OIS rates, they are highly predictable by past macroeconomic variables on unscheduled announcement dates, while they are not predictable in a statistically significant manner on scheduled announcement dates.

Similarly, Table B.8 presents the results of OLS regressions of the 1-year MIBOR-OIS rate changes on various macroeconomic variables on all, scheduled and unscheduled monetary policy announcement dates of the RBI. Here too, the joint test of signficance suggests that even when monetary policy surprises are measured using 1-year MIBOR-OIS rates, they are highly predictable by past macroeconomic

Table B.7: Predictability of Monetary Policy Surprises by Macro Data (3m MIBOR-OIS)

3-month MIBOR-OIS	Pooled	Scheduled	Unscheduled
Intercept	–0.004	0.060	–0.240**
	(0.039)	(0.037)	(0.114)
Δln (IIP) (3m)	1.065	–0.464	4.834*
	(1.134)	(1.222)	(2.401)
Δln (WPI) (3m)	0.719	–0.977	1.341
	(1.937)	(1.215)	(4.401)
Drought (3m)	0.018**	0.012	–0.006
	(0.009)	(0.007)	(0.038)
Excess Rain (3m)	0.018	–0.005	0.616***
	(0.016)	(0.007)	(0.127)
Δ (10Y-1Y GSec Spread) (3m)	0.120*	0.020	0.205
	(0.061)	(0.054)	(0.151)
Δln (*SENSEX*) (3m)	0.715**	0.188	0.327
	(0.361)	(0.221)	(0.552)
Δln (*USD – INR*) (3m)	1.518	1.030	–0.874
	(1.430)	(0.777)	(1.513)
F-statistic	1.405	1.303	5.959
p-value	0.209	0.258	0.000
R^2	0.105	0.065	0.634
N	133	97	36

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of monetary policy surprises on various macroeconomic variables on all, scheduled and unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 3-month MIBOR-OIS fixed rate. The 3-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Δln (IIP) is calculated as the 3-month log-change in the Index of Industrial Production using data up to two months before the monetary policy announcement in the case of announcements made after the IIP release date for the month and up to three months before otherwise. Data on IIP release dates are obtained from Bloomberg Terminal and for months when such information was missing, the IIP release date was taken to be the 12th (or the latest working day preceding it). The data on IIP is obtained from FRED with ticker: INDPROINDMISMEI. Δln (WPI) is calculated as the 3-month log-change in the WPI using data up to the month before the monetary policy announcement of the RBI in the case of monetary policy announcements made after the WPI release date for the month or two months before otherwise. Data on WPI release dates are obtained from Bloomberg Terminal and for months where such information is missing, the release date is set to be the 14th of the month (or the working day immediately following it). The data on WPI is obtained from FRED with ticker: WPIATT01INM661N. Working days are defined as trading days in the foreign exchange market as found in Bloomberg Terminal with ticker: INR REGN Curncy. Monthly rainfall deviations from their 20th century average for three months (in 10 cms) before each monetary policy announcement of the RBI are calculated. The *Drought* variable is then defined as being equal to the rainfall deviation during three-month periods when the rainfall deviation is less than 0 and is defined as 0 otherwise. Similarly, the *Excess Rain* variable is defined as being equal to the rainfall deviation during three-month periods when this value is greater than 0 and is set equal to 0 otherwise. The data on Rainfall is obtained from annual issues of the *Rainfall Statistics of India*. Δ (*10Y-1Y GSec Spread*) is defined as the 91-day change in the difference in yields between the 10-year and 1-year GSecs until the day before the monetary policy announcement. The data on 1-year and 10-year GSec yields are obtained from investing.com. Δ*ln* (*SENSEX*) is defined as the 91-day log-change in the BSE SENSEX until the day before the monetary policy announcement. The data on BSE SENSEX is obtained from Yahoo Finance with ticker: ^BSESN. Δ*ln* (*USD-INR*) is defined as the 91-day log-change in the USD-INR exchange rate until the day before the monetary policy announcement. The data on USD-INR is obtained from Bloomberg Terminal with ticker: INR REGN Curncy. The F-statistic and p-value corresponding to a joint test of the significance of all coefficients being zero is reported.

Table B.8: Predictability of Monetary Policy Surprises by Macro Data (1y MIBOR-OIS)

1-year MIBOR-OIS	Pooled	Scheduled	Unscheduled
Intercept	0.030	0.064***	–0.101
	(0.027)	(0.024)	(0.078)
Δln (IIP) (3m)	0.173	–0.844	2.484
	(0.816)	(0.942)	(1.522)
Δln (WPI) (3m)	1.159	–0.126	2.116
	(1.320)	(1.338)	(2.750)
Drought (3m)	0.015**	0.011*	0.001
	(0.006)	(0.006)	(0.028)
Excess Rain (3m)	0.014	0.000	0.351***
	(0.010)	(0.006)	(0.075)
Δ (10Y-1Y GSec Spread) (3m)	0.055	–0.018	0.156
	(0.041)	(0.036)	(0.094)
Δln (*SENSEX*) (3m)	0.287	0.056	–0.060
	(0.200)	(0.132)	(0.415)
Δln (*USD – INR*) (3m)	0.553	0.303	–1.136
	(0.736)	(0.498)	(1.112)
F-statistic	2.106	1.140	5.440
p-value	0.048	0.346	0.001
R^2	0.093	0.091	0.553
N	133	97	36

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of monetary policy surprises on various macroeconomic variables on all, scheduled and unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-year MIBOR-OIS fixed rate. The 1-year MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. Δln (IIP) is calculated as the 3-month log-change in the Index of Industrial Production using data up to two months before the monetary policy announcement in the case of announcements made after the IIP release date for the month and up to three months before otherwise. Data on IIP release dates are obtained from Bloomberg Terminal and for months when such information was missing, the IIP release date was taken to be the 12th (or the latest working day preceding it). The data on IIP is obtained from FRED with ticker: INDPROINDMISMEI. Δln (WPI) is calculated as the 3-month log-change in the WPI using data up to the month before the monetary policy announcement of the RBI in the case of monetary policy announcements made after the WPI release date for the month or two months before otherwise. Data on WPI release dates are obtained from Bloomberg Terminal and for months where such information is missing, the release date is set to be the 14th of the month (or the working day immediately following it). The data on WPI is obtained from FRED with ticker: WPIATT01INM661N. Working days are defined as trading days in the foreign exchange market as found in Bloomberg Terminal with ticker: INR REGN Curncy. Monthly rainfall deviations from their 20th century average for three months (in 10 cms) before each monetary policy announcement of the RBI are calculated. The *Drought* variable is then defined as being equal to the rainfall deviation during three-month periods when the rainfall deviation is less than 0 and is defined as 0 otherwise. Similarly, the *Excess Rain* variable is defined as being equal to the rainfall deviation during three-month periods when this value is greater than 0 and is set equal to 0 otherwise. The data on Rainfall is obtained from annual issues of the *Rainfall Statistics of India*. Δ (*10Y-1Y GSec Spread*) is defined as the 91-day change in the difference in yields between the 10-year and 1-year GSecs until the day before the monetary policy announcement. The data on 1-year and 10-year GSec yields are obtained from investing.com. Δ*ln* (*SENSEX*) is defined as the 91-day log-change in the BSE SENSEX until the day before the monetary policy announcement. The data on BSE SENSEX is obtained from Yahoo Finance with ticker: ^BSESN. Δ*ln* (*USD-INR*) is defined as the 91-day log-change in the USD-INR exchange rate until the day before the monetary policy announcement. The data on USD-INR is obtained from Bloomberg Terminal with ticker: INR REGN Curncy. The F-statistic and p-value corresponding to a joint test of the significance of all coefficients being zero is reported.

variables on unscheduled announcement dates, while they are not predictable in a statistically significant manner on scheduled announcement dates.

The results from this section confirm that the endogeneity of the measured monetary policy surprises to past macroeconomic conditions on unscheduled announcement dates is not driven by the choice of the 1-month MIBOR-OIS rate as the measure of monetary policy surprises. The results are robust to the use of alternative measures of monetary policy surprises, such as the 3-month and 1-year MIBOR-OIS rates. This suggests three potential explanations for the observed endogeneity of unscheduled monetary policy surprises.

Firstly, in the presence of rational inattention, economic agents may update their information sets about the state of the economy on the basis of central bank communication even though such information is already available. This could lead to repricing of MIBOR-OIS contracts on monetary policy announcement dates to 'ordinary but unexpected past news' (Reis, 2006).

Another possible explanation is that the central bank may contain private information about the state of the economy, as documented by Miranda-Agrippino and Ricco (2021), which may be more salient on unscheduled announcement dates. To the extent that this private information is correlated with past macroeconomic conditions, it could lead to the observed endogeneity of monetary policy surprises to past macroeconomic conditions on unscheduled announcement dates.

Finally, the central bank choosing to act on unscheduled announcement dates may be using a policy rule that is quite different from the market percieved policy rule. To the extent that the weights of the market percieved Taylor rule differ from the actual Taylor rule, the monetary policy surprises on unscheduled announcement dates may be endogenous to past macroeconomic conditions.

C Monetary policy surprises from exchange rate forwards

Monetary policy surprises identified from the 1-month MIBOR-OIS fixed rate were used in the main analysis. However, a leading alternative high-frequency identification strategy for monetary policy surprises, used particularly in the literature on emerging market economies without well developed interest rate swap markets, is to use exchange rate forwards. In order to check the robustness of the results to the choice of identification strategy, results based on this alternative identification strategy are presented in this section.

C.1 Identification strategy

The starting point for this identification strategy is the Covered Interest Parity (CIP) condition:

$$(1 + r_{t,t+n}) = (1 + r^{\$}_{t,t+n})\frac{F_{t,t+n}}{\mathcal{E}_t}$$

where $r_{t,t+n}$ is the risk-free interest rate between period t and $t+n$ in Indian Rupees, $r^{\$}_{t,t+n}$ is the corresponding risk-free interest rate in the U.S. Dollars, $F_{t,t+n}$ is the n-period forward exchange rate between the Indian Rupees and the U.S. Dollars and $\mathcal{E}_t$ is the spot exchange rate between the two currencies. Both $F_{t,t+n}$ and $\mathcal{E}_t$ are expressed in units of Indian Rupees per U.S. Dollar.

Taking logs and allowing for CIP deviations λ_t, the CIP condition can be written as:

$$r_{t,t+n} - r^{\$}_{t,t+n} - \lambda_t = f_{t,t+n} - e_t \equiv fp_{t,t+n}$$

Then, in a narrow window around the monetary policy announcement date t, provided that $r^{\$}_{t,t+n}$ and λ_t are constant, the change in the forward premium $fp_{t,t+n}$ can be used as a proxy for the monetary policy surprise (Witheridge, 2024):

$$\Delta fp_{t,t+n} = \Delta r_{t,t+n}$$

In the Indian context, when two day windows are used for consistency with the MIBOR-OIS surprises, an alternative measure of the monetary policy surprise is given by:

$$\epsilon^{m}_{n,t} = fp_{t+1,t+n+1} - fp_{t-1,t-1+n}$$

The 1-month USD-INR forward contract price is used for the purprose of obtaining the monetary policy surprises to retain comparability with the MIBOR-OIS surprise series.

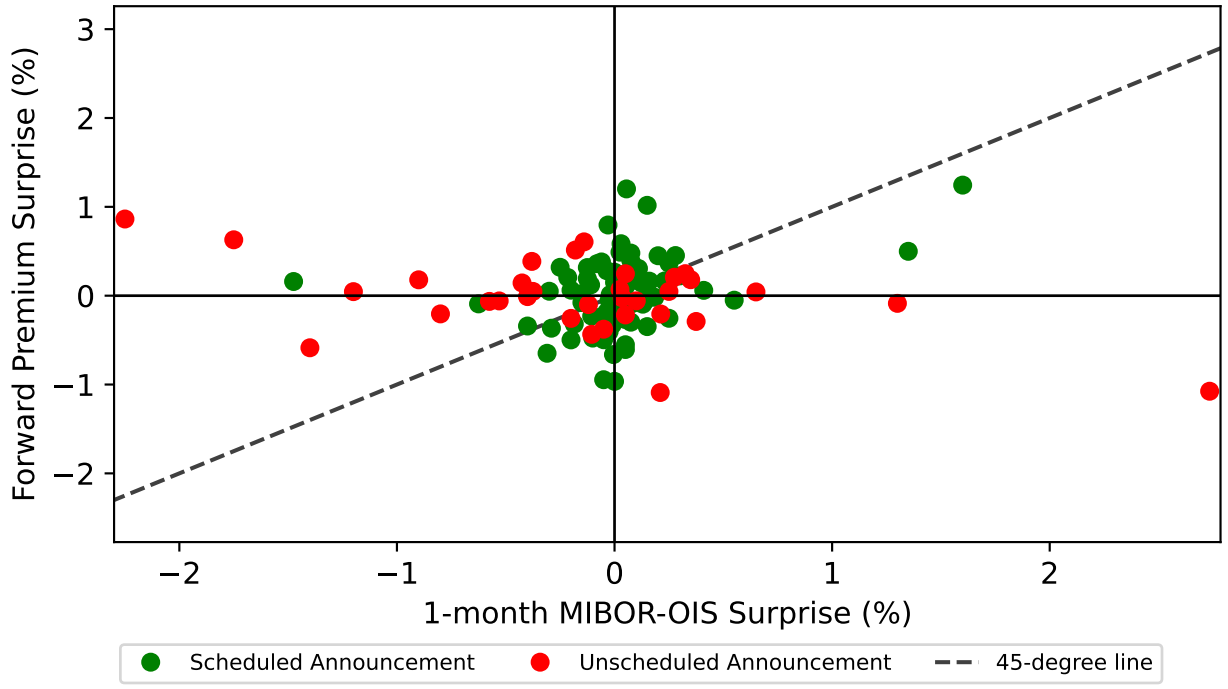
A key identification assumption in this strategy is that $r^{\$}_{t,t+n}$ is constant during the time window used for deriving the surprises. With the use of two day windows, this is unlikely to be satisfied during windows around RBI monetary policy announcements coinciding with FOMC announcements. In this

Table C.1: FOMC announcements during two-day window around RBI announcements

FOMC Announcement	FOMC Type	RBI Announcement	RBI Type
18 April 2001	Unscheduled	19 April 2001	Scheduled
31 January 2007	Scheduled	31 January 2007	Scheduled
31 October 2007	Scheduled	30 October 2007	Scheduled
30 January 2008	Scheduled	29 January 2008	Scheduled
30 April 2008	Scheduled	29 April 2008	Scheduled
25 June 2008	Scheduled	24 June 2008	Unscheduled
16 September 2008	Scheduled	16 September 2008	Unscheduled
08 October 2008	Unscheduled	10 October 2008	Unscheduled
28 January 2009	Scheduled	27 January 2009	Scheduled
03 November 2010	Scheduled	02 November 2010	Scheduled
25 January 2012	Scheduled	24 January 2012	Scheduled
01 August 2012	Scheduled	31 July 2012	Scheduled
30 January 2013	Scheduled	29 January 2013	Scheduled
20 March 2013	Scheduled	19 March 2013	Scheduled
31 July 2013	Scheduled	30 July 2013	Scheduled
30 October 2013	Scheduled	29 October 2013	Scheduled
18 December 2013	Scheduled	18 December 2013	Scheduled
29 January 2014	Scheduled	28 January 2014	Scheduled
01 August 2018	Scheduled	01 August 2018	Scheduled

Notes: This table shows the FOMC announcement dates (along with their type) which occur during a two-day window around RBI monetary policy announcement dates. The FOMC announcement dates are sourced from Bauer and Swanson (2023b) and https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm.

Figure C.1: Forward premium surprises and MIBOR-OIS surprises on RBI announcement dates



Notes: This figure plots the monetary policy surprises derived as the two-day change in the 1-month MIBOR-OIS fixed rate against monetary policy surprises derived from the two-day change in the 1-month USD-INR (log) forward premium expressed, in percentage points, following Witheridge (2024). The scheduled monetary policy surprises are shown in green and the unscheduled monetary policy surprises are shown in red. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The forward premium is calculated as the difference between the closing 1-month USD-INR forward rate and the spot rate in logarithms. The 1-month USD-INR forward rate is sourced from Bloomberg Terminal with ticker: INR+1M BGN Curncy, corresponding to the 1-month non-deliverable forward outright rate. The USD-INR spot rate is sourced from Bloomberg Terminal with ticker: INR REGN Curncy. RBI announcement dates, during whose windows there is also an FOMC announcement, are excluded from the sample.

sample, there are 19 instances, documented in Table C.1, where FOMC announcements coincide with RBI announcement windows. These instances are dropped from the sample to maintain consistency with the identification assumptions.

Figure C.1 plots the monetary policy surprises derived from the 1-month MIBOR-OIS fixed rate against the monetary policy surprises derived from the 1-month USD-INR forward premium. The two series are highly correlated and are of similar magnitude (as evidenced by observations close to the 45-degree line) for small surprise changes. However, for larger surprises and particularly on unscheduled announcement dates, the magnitudes and signs implied by the two series diverge.

Table C.2 presents the results of an event study regression of changes in the 1-month USD-INR forward premium on changes in the 1-month MIBOR-OIS rate on RBI monetary policy announcement dates. On scheduled announcement dates, the two series are positively correlated with each other in a statistically significant fashion. Furthermore, the R^2 is broadly in line with results reported for other advanced economies by Witheridge (2024) using 1-year forward rate data. However, on unscheduled announcement dates, the two series appear to be inversely related. There are two potential reasons

Table C.2: 1-month USD-INR forward premium and MIBOR-OIS changes on RBI announcement dates

1M Forward Premium Surprise	Pooled	Scheduled	Unscheduled
Intercept	0.011	0.016	–0.056
	(0.039)	(0.043)	(0.063)
Monetary Surprise	–0.061	0.400*	–0.242**
	(0.122)	(0.172)	(0.082)
R^2	0.007	0.109	0.255
N	114	81	33

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of the two-day change in the 1-month (log) USD-INR forward premium, expressed in percentage points, on the corresponding change in the 1-month MIBOR-OIS fixed rate on all, scheduled and unscheduled monetary policy announcement dates of the RBI. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The forward premium is calculated as the difference between the closing 1-month USD-INR forward rate and the spot rate in logarithms. The 1-month USD-INR forward rate is sourced from Bloomberg Terminal with ticker: INR+1M BGN Curncy, corresponding to the 1-month non-deliverable forward outright rate. The USD-INR spot rate is sourced from Bloomberg Terminal with ticker: INR REGN Curncy. RBI announcement dates, during whose windows there is also an FOMC announcement, are excluded from the sample.

for this behaviour of the two series on unscheduled announcement dates. It is possible that there are changes in CIP deviations on unscheduled RBI announcement dates, particularly as a few of the unscheduled RBI announcements were undertaken in response to developments in the foreign exchange market. The other possibility is that the 1-month MIBOR-OIS rate, which is subject to default risk, moves very strongly in the opposite direction to the official policy interest rate during unscheduled announcement dates which occur during periods of high uncertainity about macroeconomic conditions. In either case, the inverse relationship between the two series further points to the unsuitability of using surprises identified on unscheduled announcement dates for monetary policy analysis due to their sensitivity to the choice of instrument used for measurement.

C.2 Evidence from event studies in financial markets

Table C.3 presents the results of the event study regressions for financial market variables on scheduled announcement dates using the monetary policy surprises derived from the 1-month USD-INR forward premium. The results are broadly consistent with the results obtained using the 1-month MIBOR-OIS rate changes. The 1-year GSec yield responds positively to the monetary policy surprises, while the 5-year and 10-year GSec yield responses are not statistically significant. The exchange rate appreciates in response to tighter monetary policy in a statistically significant manner. This is in contrast to the MIBOR-OIS response of the exchange rate which was quite small and not statistically significant. The stock market indices decline in response to the monetary policy surprises, but these responses are not statistically significant. Compared to the 1-month MIBOR-OIS surprises, the responses of the government bond yields and the stock market indcies to the forward premium surprises are estimated to be much smaller in magnitude.

Table C.3: Event Study Regressions for Financial Market Variables: Scheduled Dates (forward rate)

In %	**Intercept**	**Forward Premium Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	–0.008	0.103**	81	0.065
	(0.017)	(0.051)		
Δ (5-Year GSec Yield)	0.007	0.031	81	0.009
	(0.015)	(0.038)		
Δ (10-Year GSec Yield)	0.012	0.009	81	0.001
	(0.015)	(0.034)		
Δ (NIFTY)	–0.321	–1.880	81	0.071
	(0.309)	(1.517)		
Δ (SENSEX)	–0.251	–1.964	81	0.085
	(0.292)	(1.362)		
Δ (BSE200)	–0.259	–1.862	81	0.066
	(0.321)	(1.483)		
Δ (USD/INR)	–0.033	–0.395**	81	0.068
	(0.067)	(0.184)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises on scheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month (log) USD-INR forward premium expressed in percentage points. The forward premium is calculated as the difference between the closing 1-month USD-INR forward rate and the spot rate in logarithms. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month USD-INR forward rate is sourced from Bloomberg Terminal with ticker: INR+1M BGN Curncy, corresponding to the 1-month non-deliverable forward outright rate. RBI announcement dates, during whose windows there is also an FOMC announcement, are excluded from the sample.

Table C.4: Event Study Regressions for Financial Market Variables: Unscheduled Dates (forward rate)

In %	**Intercept**	**Forward Premium Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	–0.017	–0.191	33	0.060
	(0.054)	(0.184)		
Δ (5-Year GSec Yield)	0.008	–0.155	33	0.098
	(0.033)	(0.129)		
Δ (10-Year GSec Yield)	0.025	–0.115	33	0.071
	(0.030)	(0.103)		
Δ (NIFTY)	–0.250	–2.377*	33	0.090
	(0.562)	(1.356)		
Δ (SENSEX)	–0.225	–2.492*	33	0.076
	(0.645)	(1.405)		
Δ (BSE200)	–0.417	–2.155	33	0.061
	(0.626)	(1.282)		
Δ (USD/INR)	–0.037	0.453	33	0.075
	(0.120)	(0.364)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises on unscheduled monetary policy announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month (log) USD-INR forward premium expressed in percentage points. The forward premium is calculated as the difference between the closing 1-month USD-INR forward rate and the spot rate in logarithms. The 1-year, 5-year and 10-year GSec yields are sourced from investing.com. Data on NSE NIFTY 50 is sourced from https://www.niftyindices.com/. Data on BSE SENSEX is sourced from Yahoo Finance with ticker: ^BSESN. Data on BSE200 is sourced from Yahoo Finance with ticker: BSE-200.BO. The USD/INR exchange rate is the spot exchange rate between the US Dollar and the Indian Rupee sourced from Bloomberg Terminal with ticker: INR REGN Curncy. The 1-month USD-INR forward rate is sourced from Bloomberg Terminal with ticker: INR+1M BGN Curncy, corresponding to the 1-month non-deliverable forward outright rate. RBI announcement dates, during whose windows there is also an FOMC announcement, are excluded from the sample.

Table C.4 presents the results for unscheduled announcement dates. The point estimates of the response of government security yields is in the opposite direction of what is predicted by the standard monetary transmission mechanism and existing evidence from 1-month MIBOR-OIS surprises on unscheduled announcement dates. While there are strong statistically significant responses of stock market indices to the forward premium surprise in the expected direction, the large estimated negative coefficient on the response of government bond yields suggests that the forward premium surprises are potentially capturing changes in the CIP deviation term λ_t along with actual changes in monetary policy. Hence, on unscheduled announcement dates, the identification of monetary surprises from forward premia appears to be very imprecise. Furthermore, the exchange rate appears to depreciate following a forward premium surprise on unscheduled announcement dates, in contrast to the results obtained on scheduled announcement dates.

D Consensus forecasts and monetary surprises: additional results

D.1 Descriptive statistics

Figures D.1, D.2 and D.3 plot the time series of the consensus forecasts for real GDP growth, real investment growth and WPI inflation in India for the time period under study. Since the primary focus of the analysis using consensus forecasts data has been on trying to understand the effects of monetary policy surprises on consensus forecast revisions, the plots also document the consensus forecast revisions following monetary policy announcements for the current and next financial year.

The occurrence of unscheduled monetary policy announcements, particularly once scheduled announcements became more frequent in the post-2005 period, is concentrated in periods following large revisions in the magnitude and direction of the consensus forecasts. This is particularly true for forecasts of real GDP growth and investment growth, which could be leading indicators of aggregate demand conditions in the economy.

These figures provide further suggestive evidence that the unscheduled announcement dates are potentially endogenous to other contemporaneous macroeconomic developments and were more likely to be undertaken during periods of greater macroeconomic uncertainty. This can constrain precise identification of monetary policy surprises on those dates.

The large number of unscheduled announcements are noticeably concentrated in late-2008 during the global financial crisis, which resulted in large downward forecast revisions for economic growth as well as WPI inflation and during the period of historically high oil prices in 2012 and in the months leading up to the 'Taper Tantrum' of 2013.

Table D.1 presents some descriptive statistics on the consensus forecast revisions following monetary policy announcements. The forecast revisions in months following unscheduled announcements are larger in magnitude than those following scheduled announcements. The forecast revisions in months with unscheduled monetary policy announcements are also larger in magnitude relative to months without any monetary policy announcements. However, the forecast revisions during months with scheduled announcements are not significantly different from those in months without any monetary policy announcements, suggesting that professional forecasters revise their forecasts by similar magnitudes in response to non-monetary news as well.

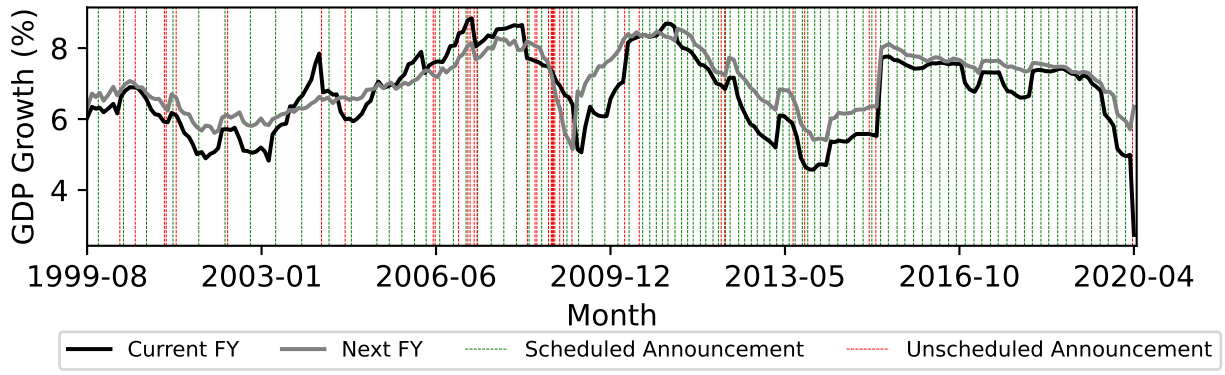
D.2 Consensus forecasts and path surprises

The responses of the consensus forecasts of GDP growth, investment growth and WPI inflation to the *Path Surprise* are now considered. Tables D.2, D.3 and D.4 document the results of these regressions on all, scheduled and unscheduled announcement dates of the RBI respectively.

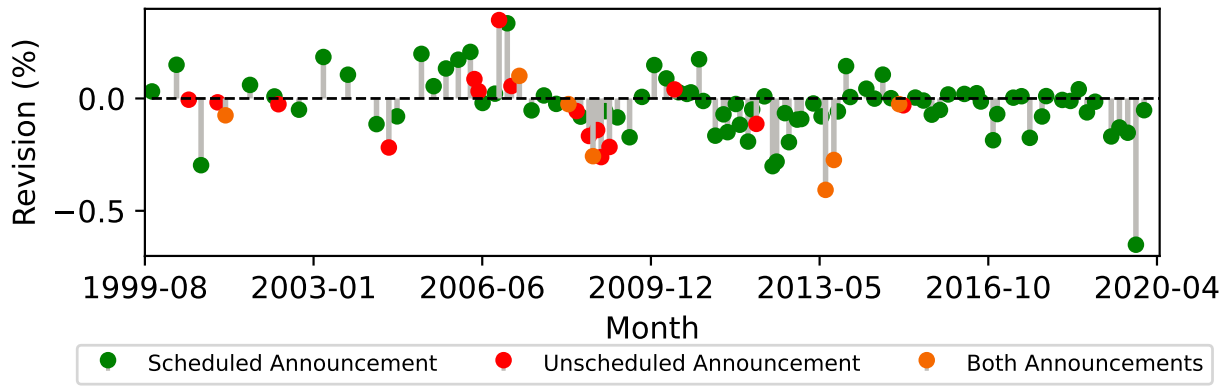
As in the main specifications for consensus forecast regressions, the time-weighted *Path Surprises* are used. On both scheduled and unscheduled announcement dates, the forecasts for inflation in the

Figure D.1: Consensus forecasts for real GDP growth in India, August 1999 to April 2020

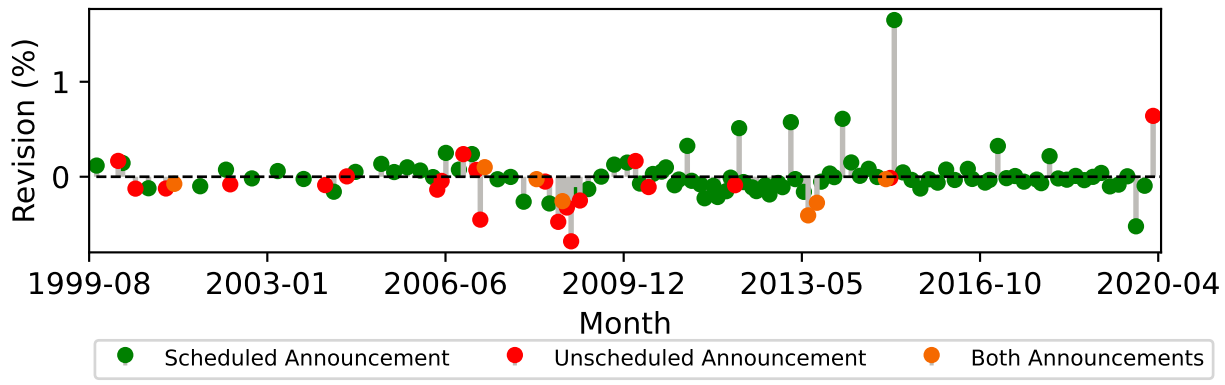
(a) Time series



(b) Current FY forecast revisions during announcement months



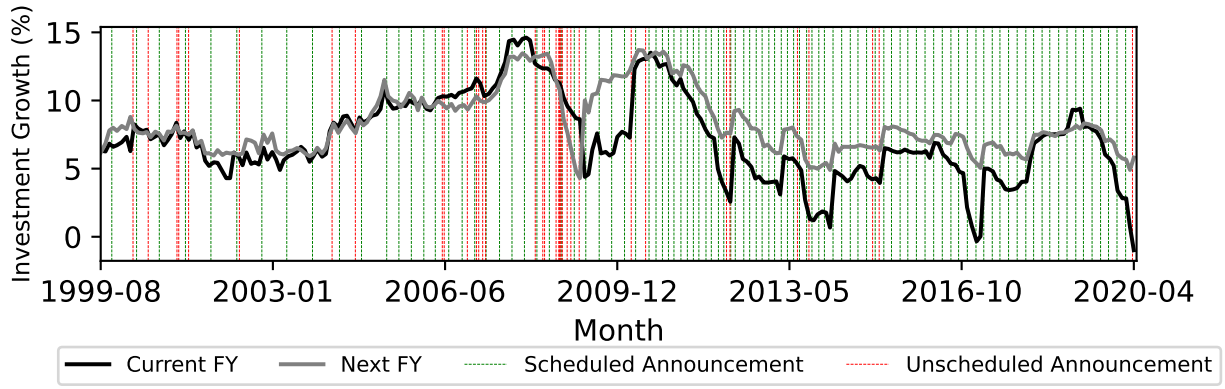
(c) Next FY forecast revisions during announcement months



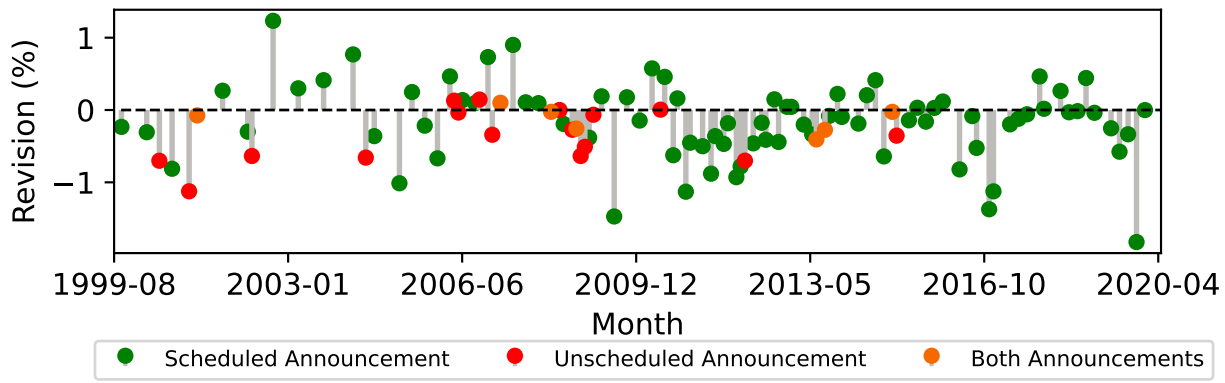
Notes: The first panel plots the time series of monthly consensus forecasts for real GDP growth in India for the current and next financial year. The second and third panels plot the revisions in the consensus forecasts for real GDP growth for the current and next financial year in India between months during which there was a monetary policy announcement of the RBI. Data on consensus forecasts is obtained from Consensus Economics. RBI announcements which occur on the same day as the forecast survey are excluded from the analysis. Consensus forecast revisions for the current financial year are not available for the same financial year between the months of March and April and are excluded from the sample.

Figure D.2: Consensus forecasts for real investment growth in India, August 1999 to April 2020

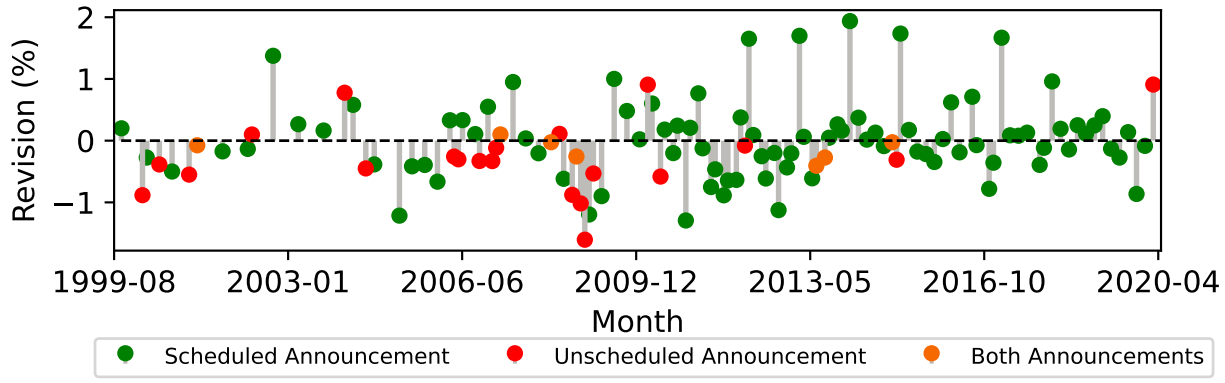
(a) Time series



(b) Current FY forecast revisions during announcement months



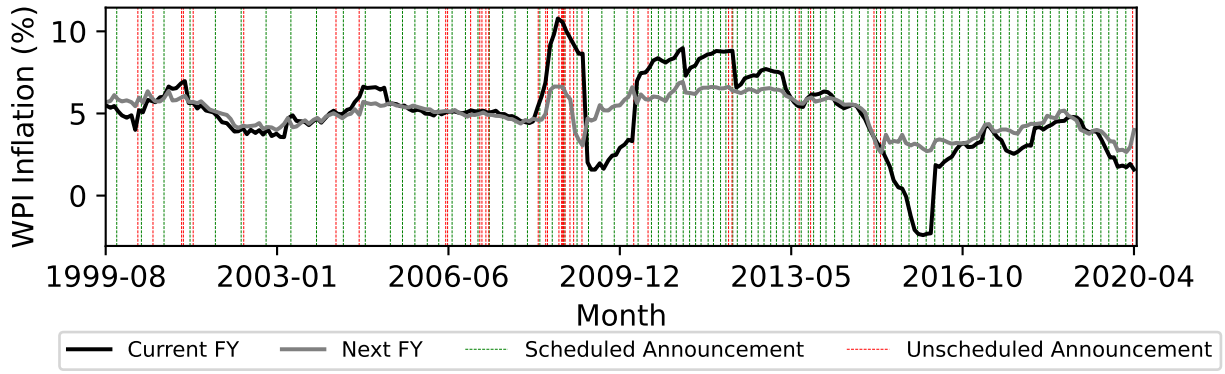
(c) Next FY forecast revisions during announcement months



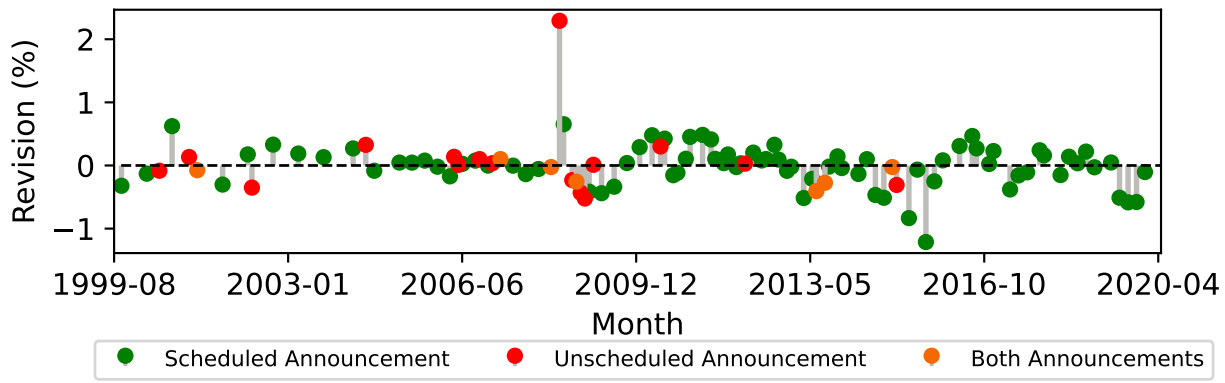
Notes: The first panel plots the time series of monthly consensus forecasts for real investment growth in India for the current and next financial year. The second and third panels plot the revisions in the consensus forecasts for real investment growth for the current and next financial year in India between months during which there was a monetary policy announcement of the RBI. Data on consensus forecasts is obtained from Consensus Economics. RBI announcements which occur on the same day as the forecast survey are excluded from the analysis. Consensus forecast revisions for the current financial year are not available for the same financial year between the months of March and April and are excluded from the sample.

Figure D.3: Consensus forecasts for WPI inflation in India, August 1999 to April 2020

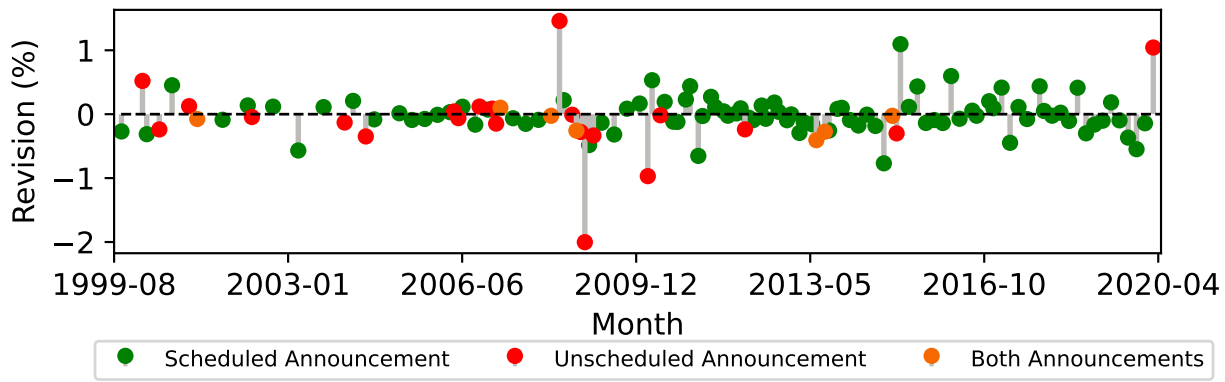
(a) Time series



(b) Current FY forecast revisions during announcement months



(c) Next FY forecast revisions during announcement months



Notes: The first panel plots the time series of monthly consensus forecasts for WPI inflation in India for the current and next financial year. The second and third panels plot the revisions in the consensus forecasts for WPI inflation for the current and next financial year in India between months during which there was a monetary policy announcement of the RBI. Data on consensus forecasts is obtained from Consensus Economics. RBI announcements which occur on the same day as the forecast survey are excluded from the analysis. Consensus forecast revisions for the current financial year are not available for the same financial year between the months of March and April and are excluded from the sample.

Table D.1: Summary statistics for consensus forecast revisions following RBI announcements

Variable	Statistic	Non-announcement	Scheduled	Unscheduled
Δ (Current FY Output Growth)	*Mean*	0.144	0.099	0.129
	Std. Dev	0.209	0.140	0.161
Δ (Current FY Investment Growth)	*Mean*	0.496	0.420	0.453
	Std. Dev	0.712	0.537	0.435
Δ (Current FY WPI Inflation)	*Mean*	0.206	0.234	0.316
	Std. Dev	0.284	0.322	0.568
N		123	88	23
Δ (Next FY Output Growth)	*Mean*	0.124	0.131	0.203
	Std. Dev	0.206	0.242	0.262
Δ (Next FY Investment Growth)	*Mean*	0.414	0.474	0.532
	Std. Dev	0.712	0.668	0.651
Δ (Next FY WPI Inflation)	*Mean*	0.178	0.194	0.352
	Std. Dev	0.280	0.277	0.592
N		130	97	28

Notes: This table presents the mean (of the absolute value) and standard deviation of the consensus forecast revisions for the current and next financial year for output growth, investment growth and WPI inflation for months without any monetary policy announcement and separately for months with scheduled and unscheduled RBI monetary policy announcements. For RBI announcements made before the current month's forecast survey, the revision from the previous month's survey is used and for announcements made after the current month's survey the revision in the following month's survey is used. RBI announcements which occur on the same day as the consensus forecast survey are excluded from the analysis. The consensus forecasts data is sourced from Consensus Economics. Data betwen August 1999 and April 2020 is used in the analysis. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

Table D.2: Consensus Forecast Revisions and Path Surprises: All Announcements

	Intercept	**Path Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.037***	–0.118	104	0.009
	(0.014)	(0.148)		
Δ (Current FY Investment Growth)	–0.216***	–0.606	104	0.017
	(0.050)	(0.382)		
Δ (Current FY WPI Inflation)	0.003	0.812	104	0.056
	(0.036)	(0.497)		
Δ (Next FY Output Growth)	–0.067**	0.027	118	0.000
	(0.031)	(0.135)		
Δ (Next FY Investment Growth)	–0.211***	–0.152	118	0.001
	(0.068)	(0.336)		
Δ (Next FY WPI Inflation)	–0.057*	0.169	118	0.006
	(0.033)	(0.190)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the consensus forecast revisions for real GDP growth, investment growth and WPI inflation for the current and next financial year on the path surprises on all monetary policy announcement dates of the RBI. The path surprises are computed as the residuals from a regression of the two-day change in the 1-year MIBOR-OIS fixed rate on the corresponding change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All path surprises which occur between two consecutive surveys are summed. For the regressions for the current year forecasts, these surprises are also weighted by the fraction of months remaining in the financial year. Data on consensus forecasts is sourced from Consensus Economics. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Values less than 0.001 are displayed as 0.000. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

Table D.3: Consensus Forecast Revisions and Path Surprises: Scheduled Announcements

	Intercept	**Path Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.037**	–0.239	88	0.027
	(0.015)	(0.210)		
Δ (Current FY Investment Growth)	–0.193***	–0.807	88	0.021
	(0.057)	(0.606)		
Δ (Current FY WPI Inflation)	–0.008	0.549	88	0.027
	(0.034)	(0.372)		
Δ (Next FY Output Growth)	–0.028	–0.076	97	0.003
	(0.020)	(0.134)		
Δ (Next FY Investment Growth)	–0.131**	–0.642*	97	0.025
	(0.052)	(0.383)		
Δ (Next FY WPI Inflation)	–0.035	0.084	97	0.002
	(0.026)	(0.163)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the consensus forecast revisions for real GDP growth, investment growth and WPI inflation for the current and next financial year on the path surprises on scheduled monetary policy announcement dates of the RBI. The path surprises are computed as the residuals from a regression of the two-day change in the 1-year MIBOR-OIS fixed rate on the corresponding change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All path surprises which occur between two consecutive surveys are summed. For the regressions for the current year forecasts, these surprises are also weighted by the fraction of months remaining in the financial year. Data on consensus forecasts is sourced from Consensus Economics. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

Table D.4: Consensus Forecast Revisions and Path Surprises: Unscheduled Announcements

	Intercept	**Path Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.073**	0.033	23	0.001
	(0.032)	(0.176)		
Δ (Current FY Investment Growth)	–0.405***	–0.002	23	0.000
	(0.093)	(0.401)		
Δ (Current FY WPI Inflation)	0.032	0.841	23	0.058
	(0.096)	(0.917)		
Δ (Next FY Output Growth)	–0.233**	0.160	28	0.005
	(0.112)	(0.136)		
Δ (Next FY Investment Growth)	–0.568**	0.387	28	0.007
	(0.229)	(0.443)		
Δ (Next FY WPI Inflation)	–0.167	0.264	28	0.014
	(0.109)	(0.364)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the consensus forecast revisions for real GDP growth, investment growth and WPI inflation for the current and next financial year on the path surprises on unscheduled monetary policy announcement dates of the RBI. The path surprises are computed as the residuals from a regression of the two-day change in the 1-year MIBOR-OIS fixed rate on the corresponding change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All path surprises which occur between two consecutive surveys are summed. For the regressions for the current year forecasts, these surprises are also weighted by the fraction of months remaining in the financial year. Data on consensus forecasts is sourced from Consensus Economics. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Values less than 0.001 are displayed as 0.000. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

Table D.5: Interest Rate Forecast Revisions and Monetary Policy: Scheduled Announcements

	Intercept	Path Surprise	Monetary Surprise	N	R^2
Δ(3M ahead 3M interest rate)	–0.043		–0.033	97	0.001
	(0.031)		(0.140)		
Δ(3M ahead 12M interest rate)	–0.030		–0.047	97	0.002
	(0.030)		(0.118)		
Δ(3M ahead 3M interest rate)	–0.042	0.398*		97	0.027
	(0.031)	(0.215)			
Δ(3M ahead 12M interest rate)	–0.028	0.675***		97	0.081
	(0.029)	(0.232)			

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of the 3-month interest rate 3-months ahead and 12-months ahead on monetary surprises and path surprises on scheduled announcement dates of the RBI. The monetary surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. The path surprises are computed as the residuals from a regression of the two-day change in the 1-year MIBOR-OIS fixed rate on the corresponding change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All monetary and path surprises which occur between two consecutive surveys are summed without any time weighting. Data on the consensus forecasts of the 3-month interest rate 3-months ahead and 12-months ahead are sourced from Consensus Economics. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis.

present and next financial years increase following a *Path Surprise*.

This suggests that *Path Surprises* are associated with a revelation of information by the central bank of higher than expected inflation in the future. The point estimates of GDP growth and investment growth rates to the *Path Surprises* are mostly negative and not statistically significant, on both scheduled and unscheduled announcement dates.

D.3 Interest rate forecasts and monetary policy surprises

Additional evidence is now considered on the response of interest rate forecasts. Unlike the forecasts for other macroeconomic variables, the interest rate forecasts are for fixed horizons rather than time periods and hence the regressions can be estimated without adjusting the monetary policy surprises for their timing in the financial year. Consensus Economics collects information about the forecast of the 3-month interest rate 3-months ahead and 12-months ahead. The response of these interest rate forecast revisions to the measured monetary policy surprises as well the path surprises following scheduled and unscheduled announcements are presented in Tables D.5 and D.6. The specification is identical to the one used in Section 5.2.

On scheduled announcement dates, the 3-month ahead and 12-month ahead interest rate forecasts are not revised upwards in response to a surprise monetary policy tightening. On unscheduled an-

Table D.6: Interest Rate Forecast Revisions and Monetary Policy: Unscheduled Announcements

	Intercept	Path Surprise	Monetary Surprise	N	R^2
Δ (3M ahead 3M interest rate)	0.013		0.213**	28	0.130
	(0.118)		(0.094)		
Δ (3M ahead 12M interest rate)	–0.028		0.196**	28	0.120
	(0.112)		(0.079)		
Δ (3M ahead 3M interest rate)	–0.064	0.793**		28	0.098
	(0.116)	(0.363)			
Δ (3M ahead 12M interest rate)	–0.097	0.691*		28	0.082
	(0.112)	(0.339)			

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of the 3-month interest rate 3-months ahead and 12-months ahead on monetary surprises and path surprises following unscheduled announcement dates of the RBI. The monetary surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. The path surprises are computed as the residuals from a regression of the two-day change in the 1-year MIBOR-OIS fixed rate on the corresponding change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All monetary and path surprises which occur between two consecutive surveys are summed without any time weighting. Data on the consensus forecasts of the 3-month interest rate 3-months ahead and 12-months ahead are sourced from Consensus Economics. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis.

nouncement dates, the forecast revisions are positive and statistically significant. On scheduled announcement dates, the surprise tightening of contemporary monetary policy does not seem to have a significant effect on the medium-term interest rate forecasts of the private sector.

It is known from Table B.4 that on unscheduled announcement dates, both short and long term interest rates are driven by a common source of variation which is likely to represent information revealed by the RBI about present and future economic conditions. This could be responsible for the strong positive forecast revisions on unscheduled dates and the lack of an effect on scheduled dates. To check if interest rate forecasts on scheduled dates respond more strongly to information, the response of interest rate forecast revisions to the *Path Surprise* (defined in Appendix B.2) is considered.

The response of the interest rate forecasts to the *Path Surprise* is positive and statistically significant on scheduled announcement dates. On unscheduled announcement dates, the effect of the *Path Surprise* variable is much more limited as a significant proportion of the information is already captured in the monetary surprises. This suggests that the private sector's interest rate forecasts are more responsive to information about present and future economic conditions than to the surprise tightening of contemporary monetary policy. Put simply, information which causes MIBOR-OIS market participants to increase their expectations of future interest rates, also causes the private sector to revise upwards their interest rate forecasts.

Table D.7: Consensus Forecast Revisions and Monetary Policy Surprises: Alternative Specification (Scheduled)

	Intercept	Scheduled MP Surprise	Unscheduled MP Surprise	N	R^2
Δ (Current FY Output Growth)	–0.036**	–0.202***	–0.083	88	0.109
	(0.014)	(0.075)	(0.075)		
Δ (Current FY Investment Growth)	–0.193***	–0.158	0.121	88	0.012
	(0.057)	(0.328)	(0.229)		
Δ (Current FY WPI Inflation)	–0.009	0.008	0.133	88	0.015
	(0.035)	(0.095)	(0.121)		
Δ (Next FY Output Growth)	–0.024	–0.122*	0.021	97	0.051
	(0.018)	(0.064)	(0.075)		
Δ (Next FY Investment Growth)	–0.116**	–0.291	0.251	97	0.117
	(0.048)	(0.296)	(0.191)		
Δ (Next FY WPI Inflation)	–0.033	–0.055	0.064	97	0.024
	(0.026)	(0.054)	(0.038)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of real GDP growth, investment growth and WPI inflation for the current and next financial year on scheduled and unscheduled monetary policy surprises during months with a scheduled monetary policy announcement of the RBI. The monetary policy surprises are computed as the two-day change in the 1-year MIBOR-OIS fixed rate around RBI monetary policy announcements. All monetary surprises of each type which occur between two consecutive surveys are summed. For the current year forecast regressions, the monetary policy surprises are weighted by the fraction of months remaining in the financial year. The unscheduled monetary policy surprise variable is set to 0 during months without an unscheduled monetary policy announcement. Data on the consensus forecasts is sourced from Consensus Economics. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

D.4 Robustness to an alternative specification

Tables D.7 and D.8 present the results of the consensus forecast regressions during months with scheduled and unscheduled monetary policy announcements using an alternative specification to the one considered in Section 5.2. The regressions directly control for the scheduled and unscheduled monetary policy surprises instead of using the residualised surprises.

As before, for the regressions for the current year forecast revisions, the regressors are weighted by the fraction of months remaining until the end of the financial year. The results for both scheduled and unscheduled announcement dates are consistent with the main specifications in terms of both the direction and magnitude of the consensus forecast revisions.

Table D.8: Consensus Forecast Revisions and Monetary Policy Surprises: Alternative Specification (Unscheduled)

	Intercept	Scheduled MP Surprise	Unscheduled MP Surprise	N	R^2
Δ (Current FY Output Growth)	–0.077**	–0.149**	–0.009	23	0.104
	(0.034)	(0.059)	(0.062)		
Δ (Current FY Investment Growth)	–0.424***	–0.405***	0.064	23	0.148
	(0.088)	(0.091)	(0.086)		
Δ (Current FY WPI Inflation)	0.050	–0.059	0.250	23	0.123
	(0.116)	(0.202)	(0.199)		
Δ (Next FY Output Growth)	–0.214*	–0.126*	0.064	28	0.038
	(0.106)	(0.069)	(0.045)		
Δ (Next FY Investment Growth)	–0.517**	–0.512***	0.174*	28	0.092
	(0.211)	(0.132)	(0.089)		
Δ (Next FY WPI Inflation)	–0.139	–0.080	0.081	28	0.042
	(0.115)	(0.104)	(0.079)		

* p < 0.1, ** p < 0.05, *** p < 0.01; Heteroskedasticity-robust S.E.'s reported;

Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of real GDP growth, investment growth and WPI inflation for the current and next financial year on scheduled and unscheduled monetary policy surprises during months with an unscheduled monetary policy announcement of the RBI. The monetary policy surprises are computed as the two-day change in the 1-year MIBOR-OIS fixed rate around RBI monetary policy announcements. All monetary surprises of each type which occur between two consecutive surveys are summed. For the current year forecast regressions, the monetary policy surprises are weighted by the fraction of months remaining in the financial year. The scheduled monetary policy surprise variable is set to 0 in months without a scheduled monetary policy announcement. Data on the consensus forecasts is sourced from Consensus Economics. The 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Announcement dates which occur on same day as the survey release are omitted from the analysis. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

E Data sources

E.1 Daily data

Table E.1: Sources of Daily Data

Variable	Source	Notes	Date Accessed
1-month MIBOR-OIS fixed rate	Bloomberg Terminal, Ticker: IRSWOA BGN Curncy	PX_MID BGN quote is used	13-10-2022
3-month MIBOR-OIS fixed rate	Bloomberg Terminal, Ticker: IRSWOC BGN Curncy	PX_MID BGN quote is used	19-01-2024
1-year MIBOR-OIS fixed rate	Bloomberg Terminal, Ticker: IRSWO1 BGN Curncy	PX_MID BGN quote is used	13-10-2022
1-year GSec yield	investing.com; India 1-year bond yield	Daily closing price is used	16-04-2024
5-year GSec yield	investing.com; India 5-year bond yield	Daily closing price is used	16-04-2024
10-year GSec yield	investing.com; India 10-year bond yield	Daily closing price is used	16-04-2024
USD-INR exchange rate	Bloomberg Terminal, Ticker: INR REGN Curncy	PX_LAST REGN quote is used	19-01-2023
BSE SENSEX Index	Yahoo Finance, Ticker: ^BSESN	Daily closing price is used	10-07-2024
NIFTY 50 Index	www.niftyindices.com/reports/historical-data	Daily closing price is used	29-12-2023
BSE 200 Index	Yahoo Finance, Ticker: BSE-200.BO	Daily closing price is used	10-07-2024

E.2 Monthly data

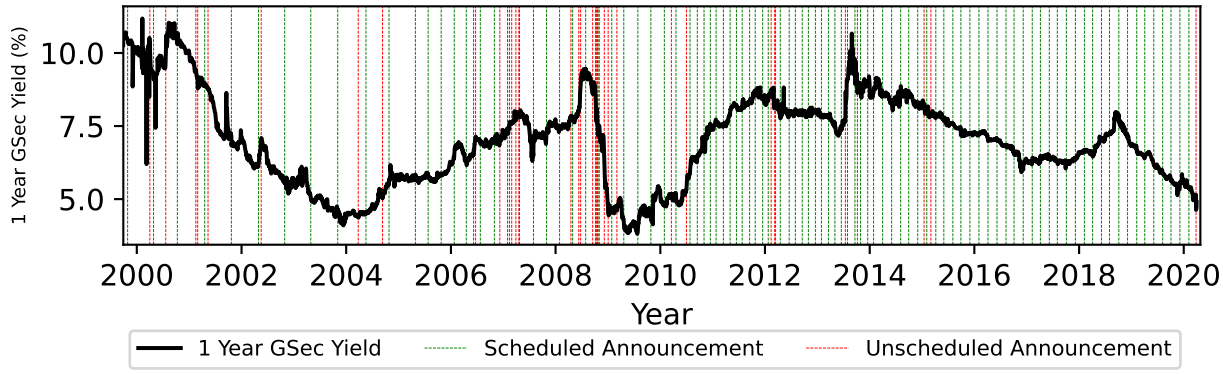
Table E.2: Sources of Monthly Data

Variable	Source	Notes	Date Accessed
Index of Industrial Production (IIP)	FRED, Ticker: INDPROINDMISMEI	Production of Total Industry in India (Index 2015 = 100, Seasonally Adjusted)	14-08-2023
Wholesale Price Index (WPI)	FRED, Ticker: WPIATT01INM661N	Total Wholesale Prices by Industry Aggregate for India (Index 2015=100, Not Seasonally Adjusted)	14-08-2023
Goods Exports	FRED, Ticker: XTEXVA01INM667S	Exports: Value Goods for India (USD, Seasonally Adjusted)	14-08-2023
Goods Imports	FRED, Ticker: XTIMVA01INM667S	Imports: Value Goods for India (USD, Seasonally Adjusted)	14-08-2023
Bank Credit	RBI, Database on Indian Economy (DBIE)	Domestic Credit by Commerical Banks, RBI Bulletin Commerical Bank Survey	07-08-2024
Current FY Output Growth Forecast	Consensus Economics India Forecast Database	Consensus forecast of current FY real GDP growth	03-11-2023
Next FY Output Growth Forecast	Consensus Economics India Forecast Database	Consensus forecast of next FY real GDP growth	03-11-2023
Current FY Investment Growth Forecast	Consensus Economics India Forecast Database	Consensus forecast of current FY real gross fixed investment growth	03-11-2023
Next FY Investment Growth Forecast	Consensus Economics India Forecast Database	Consensus forecast of next FY real gross fixed investment growth	03-11-2023
Current FY WPI Inflation Forecast	Consensus Economics India Forecast Database	Consensus forecast of current FY WPI inflation	03-11-2023
Next FY WPI Inflation Forecast	Consensus Economics India Forecast Database	Consensus forecast of next FY WPI inflation	03-11-2023

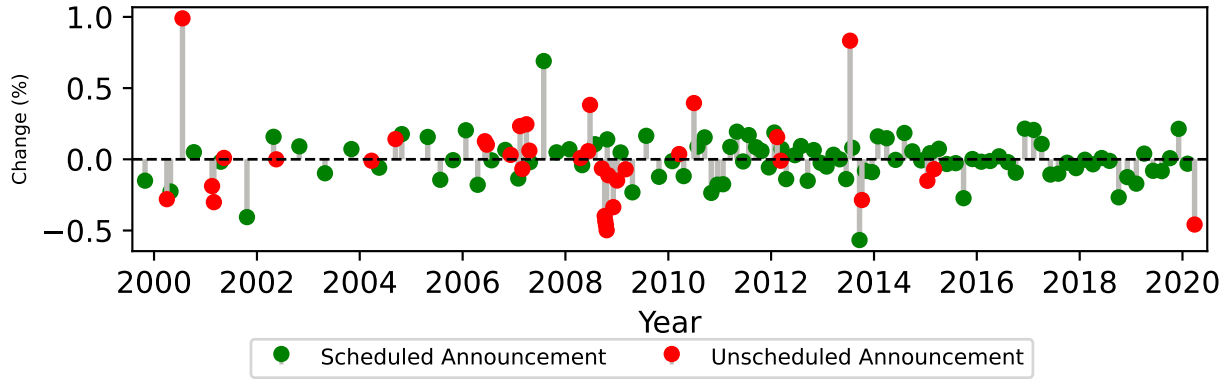
F Event studies: additional descriptive evidence

Figure F.1: 1-year government security (GSec) yield, August 1999 to March 2020

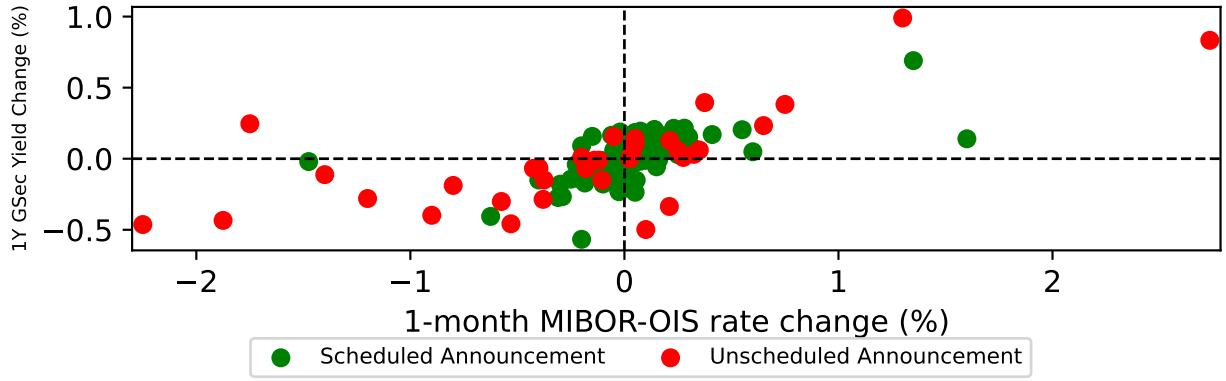
(a) Time series



(b) Changes on monetary policy announcement dates



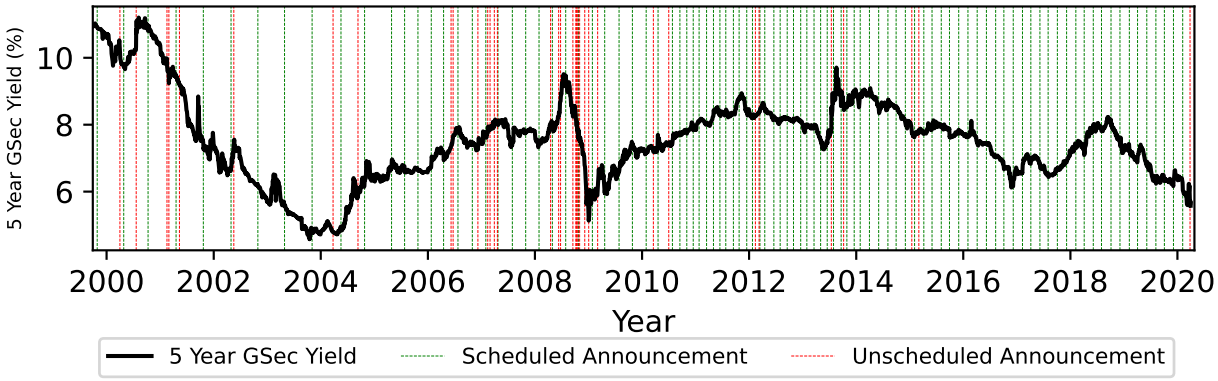
(c) Correlation with MIBOR-OIS surprises



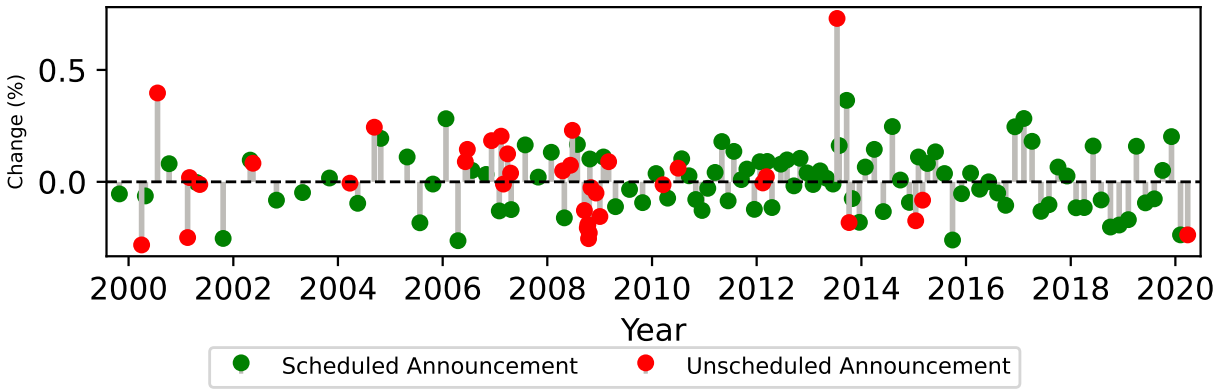
Notes: The first panel plots the time series of the 1-year government security (GSec) yield from August 1999 to March 2020. The second panel plots the two-day percentage change in the 1-year GSec yield on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the 1-year government security (GSec) yield against the corresponding change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Scheduled and unscheduled announcement dates are marked in green and red respectively. Data on 1-month MIBOR-OIS is from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on 1-year GSec yield is from https://in.investing.com/rates-bonds/india-1-year-bond-yield-historical-data.

Figure F.2: 5-year government security (GSec) yield, August 1999 to March 2020

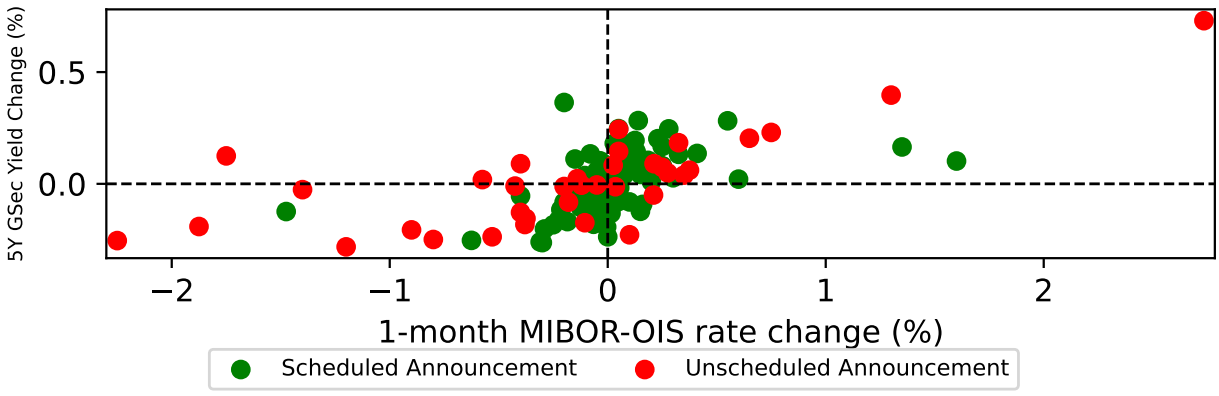
(a) Time series



(b) Changes on monetary policy announcement dates



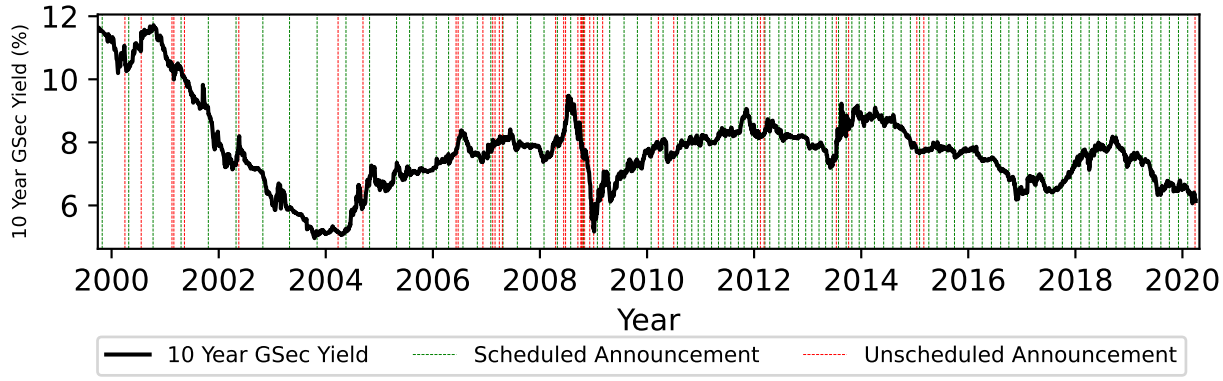
(c) Correlation with MIBOR-OIS surprises



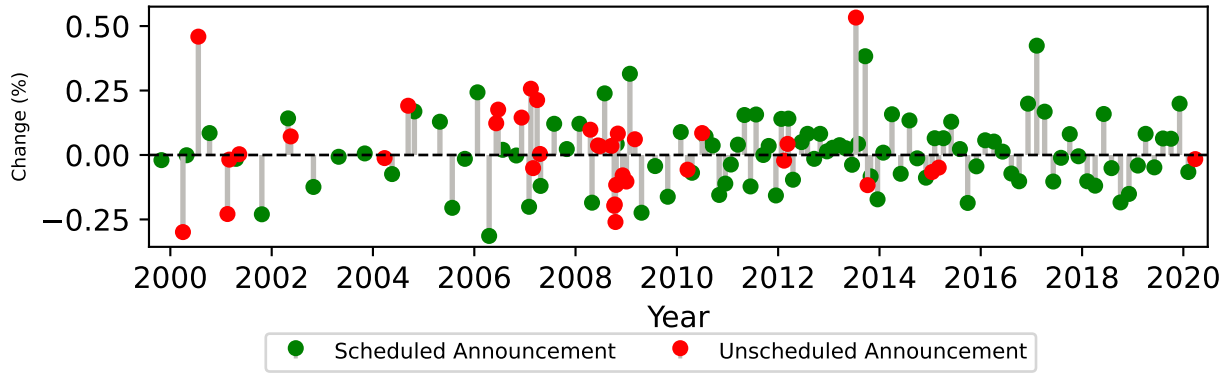
Notes: The first panel plots the time series of the 5-year government security (GSec) yield from August 1999 to March 2020. The second panel plots the two-day percentage change in the 5-year GSec yield on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the 5-year government security (GSec) yield against the corresponding change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Scheduled and unscheduled announcement dates are marked in green and red respectively. Data on 1-month MIBOR-OIS is from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on 5-year GSec yield is from https://in.investing.com/rates-bonds/india-5-year-bond-yield-historical-data.

Figure F.3: 10-year government security (GSec) yield, August 1999 to March 2020

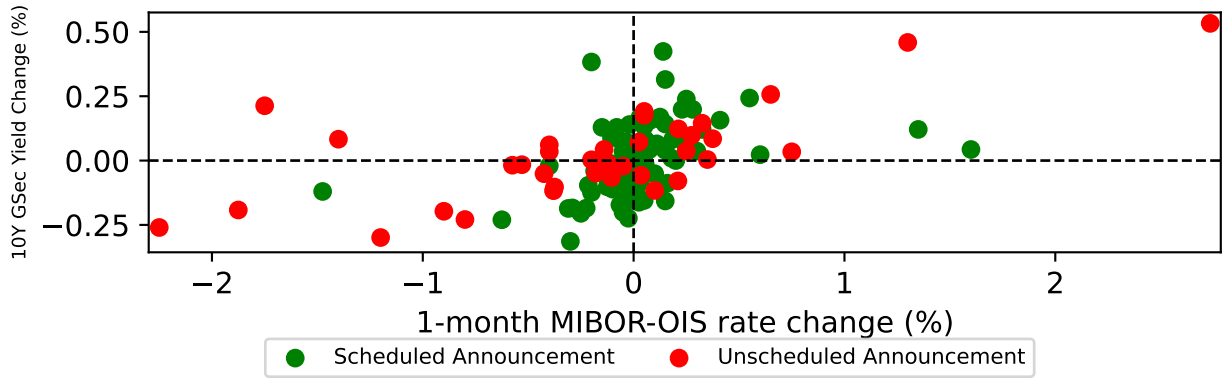
(a) Time series



(b) Changes on monetary policy announcement dates



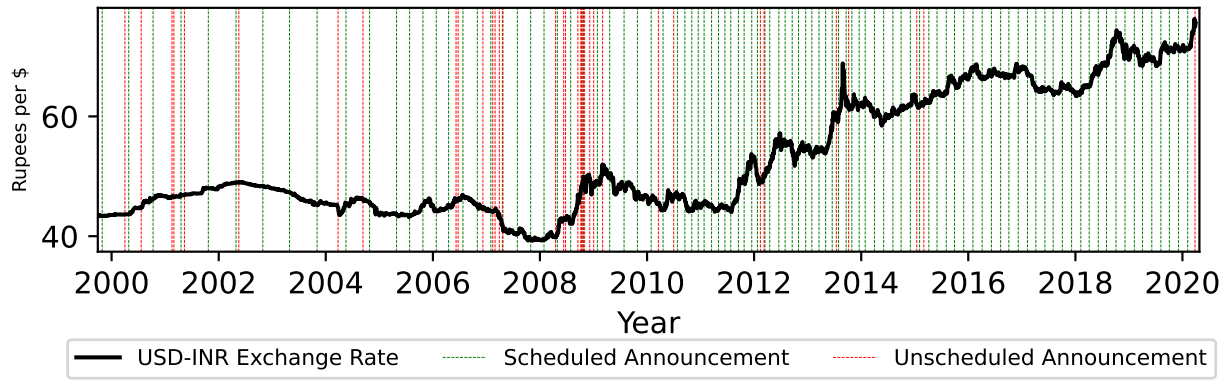
(c) Correlation with MIBOR-OIS surprises



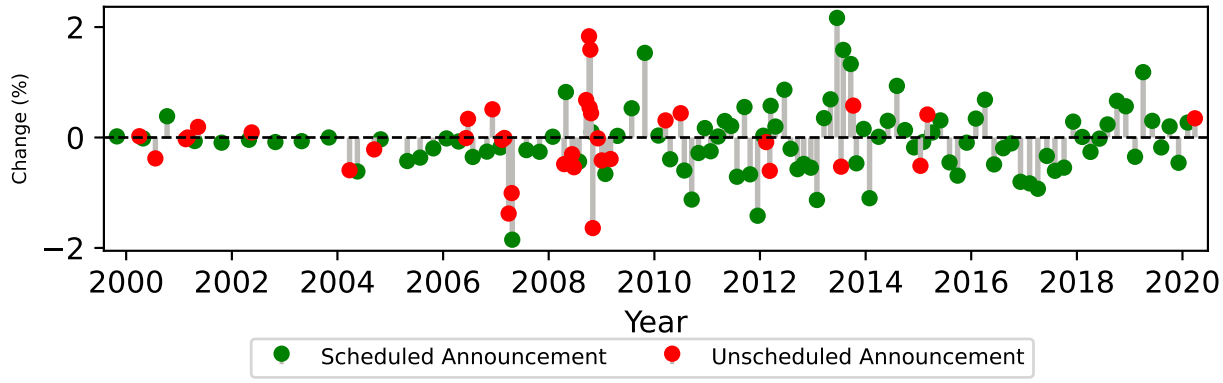
Notes: The first panel plots the time series of the 10-year government security (GSec) yield from August 1999 to March 2020. The second panel plots the two-day percentage change in the 10-year GSec yield on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the 10-year government security (GSec) yield against the corresponding change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Scheduled and unscheduled announcement dates are marked in green and red respectively. Data on 1-month MIBOR-OIS is from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on 10-year GSec yield is from https://in.investing.com/rates-bonds/india-10-year-bond-yield-historical-data.

Figure F.4: USD-INR exchange rate, August 1999 to March 2020

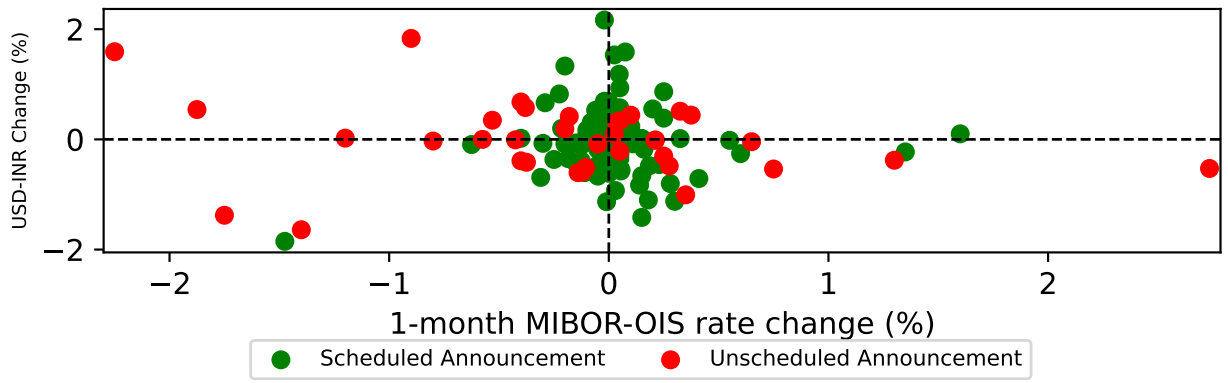
(a) Time series



(b) Changes on monetary policy announcement dates



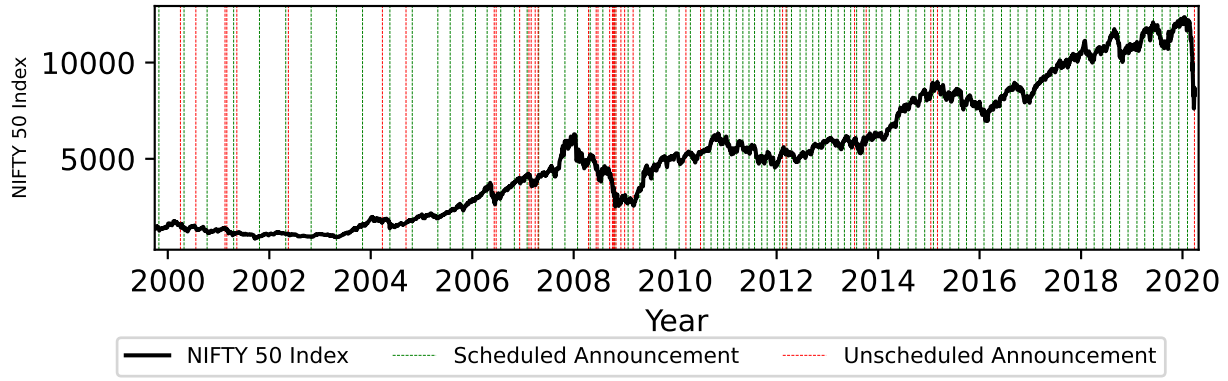
(c) Correlation with MIBOR-OIS surprises



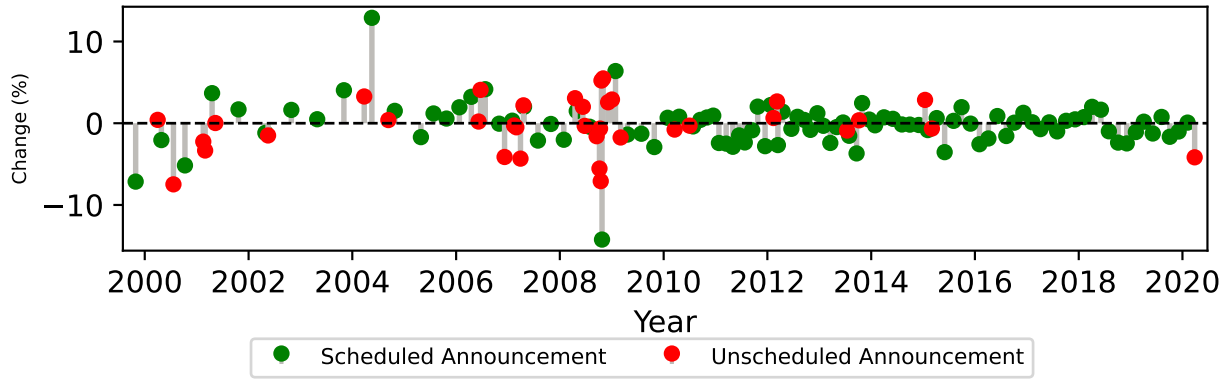
Notes: The first panel plots the time series of the USD-INR exchange rate from August 1999 to March 2020. The second panel plots the two-day percentage change in the USD-INR exchange rate on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the USD-INR exchange rate against the corresponding change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Scheduled and unscheduled announcement dates are marked in green and red respectively. Data on 1-month MIBOR-OIS is from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on USD-INR exchange rate is from Bloomberg Terminal with ticker: INR REGN Curncy.

Figure F.5: NSE NIFTY 50 Index, August 1999 to March 2020

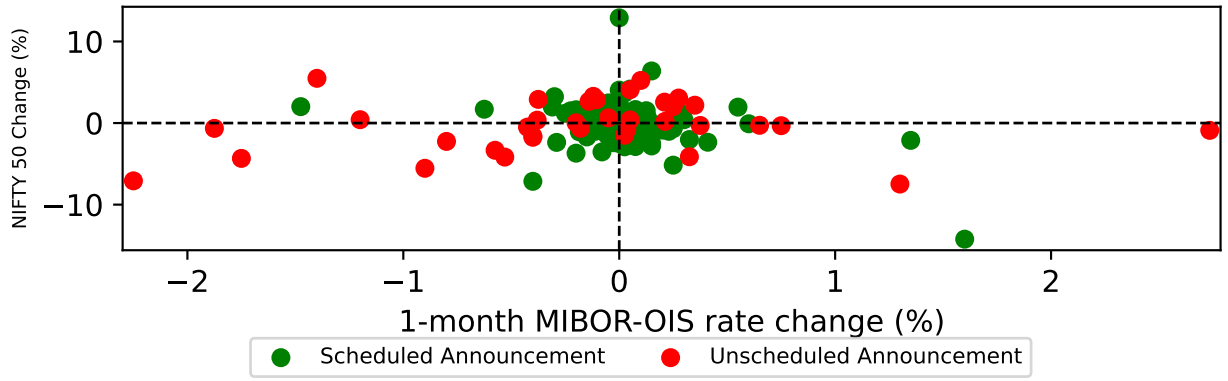
(a) Time series



(b) Changes on monetary policy announcement dates



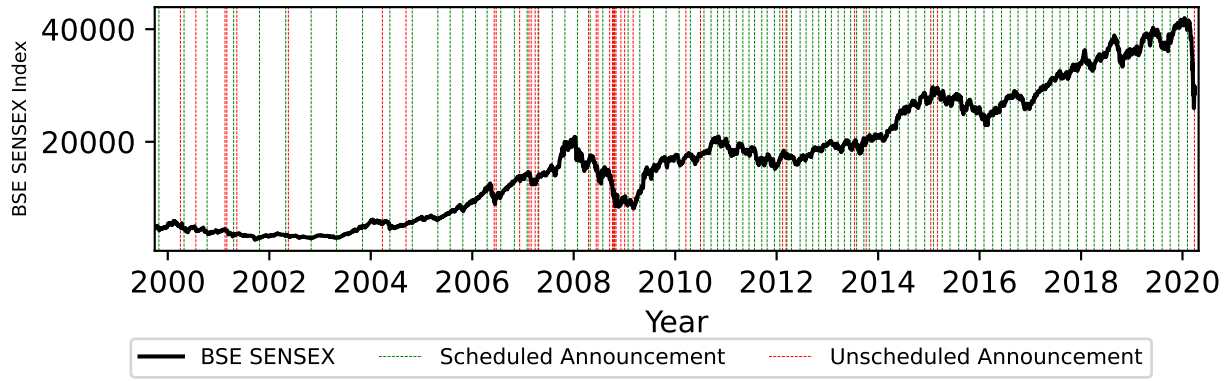
(c) Correlation with MIBOR-OIS surprises



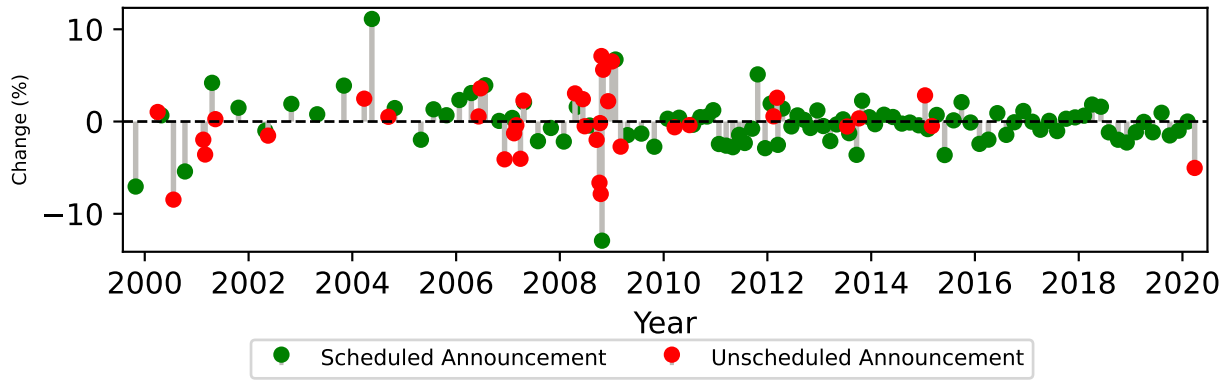
Notes: The first panel plots the time series of the NSE NIFTY 50 Index from August 1999 to March 2020. The second panel plots the two-day percentage change in the NSE NIFTY 50 Index on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the NSE NIFTY 50 Index against the corresponding change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Scheduled and unscheduled announcement dates are marked in green and red respectively. Data on 1-month MIBOR-OIS is from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on NIFTY 50 Index is from www.niftyindices.com/reports/historical-data.

Figure F.6: BSE SENSEX Index, August 1999 to March 2020

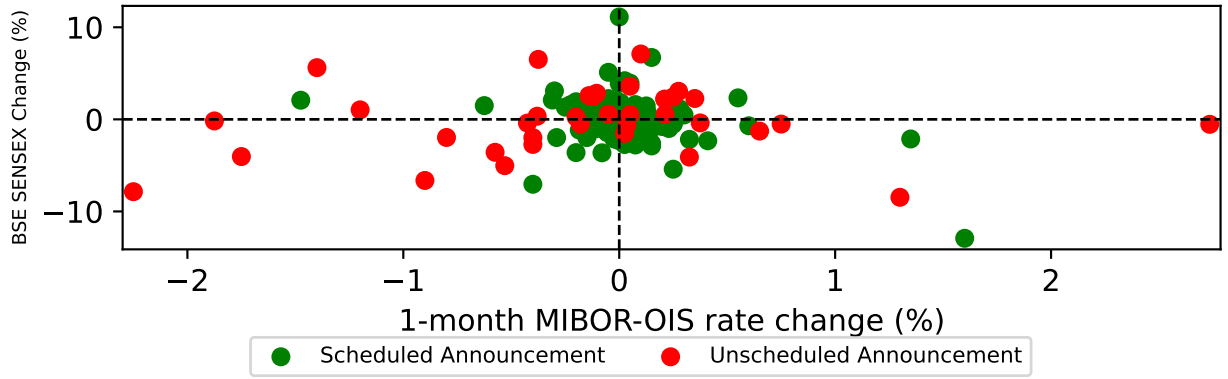
(a) Time series



(b) Changes on monetary policy announcement dates



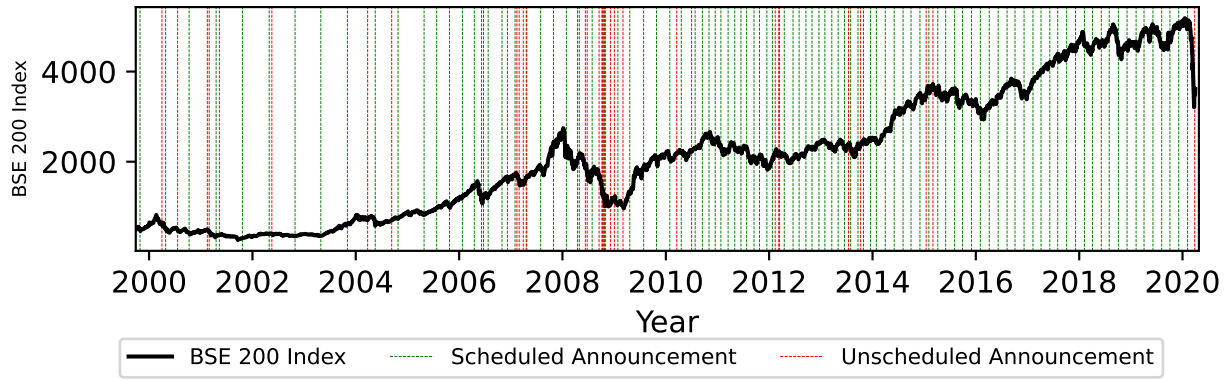
(c) Correlation with MIBOR-OIS surprises



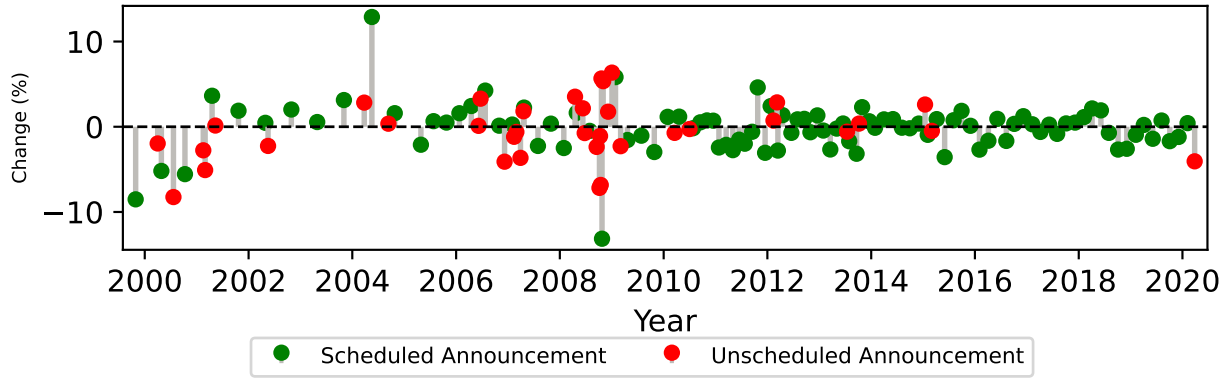
Notes: The first panel plots the time series of the BSE SENSEX Index from August 1999 to March 2020. The second panel plots the two-day percentage change in the BSE SENSEX Index on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the BSE SENSEX Index against the corresponding change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Scheduled and unscheduled announcement dates are marked in green and red respectively. Data on 1-month MIBOR-OIS is from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on BSE SENSEX Index is from Yahoo Finance, Ticker: ^BSESN.

Figure F.7: BSE 200 Index, August 1999 to March 2020

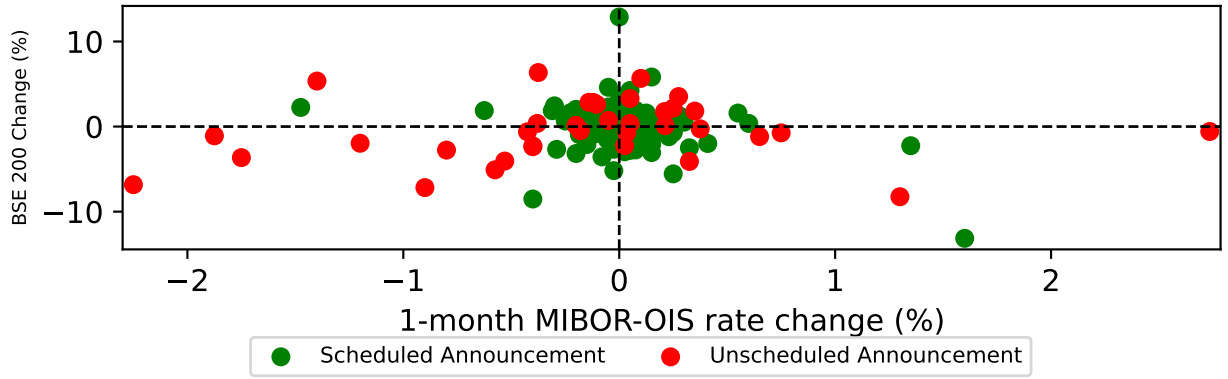
(a) Time series



(b) Changes on monetary policy announcement dates

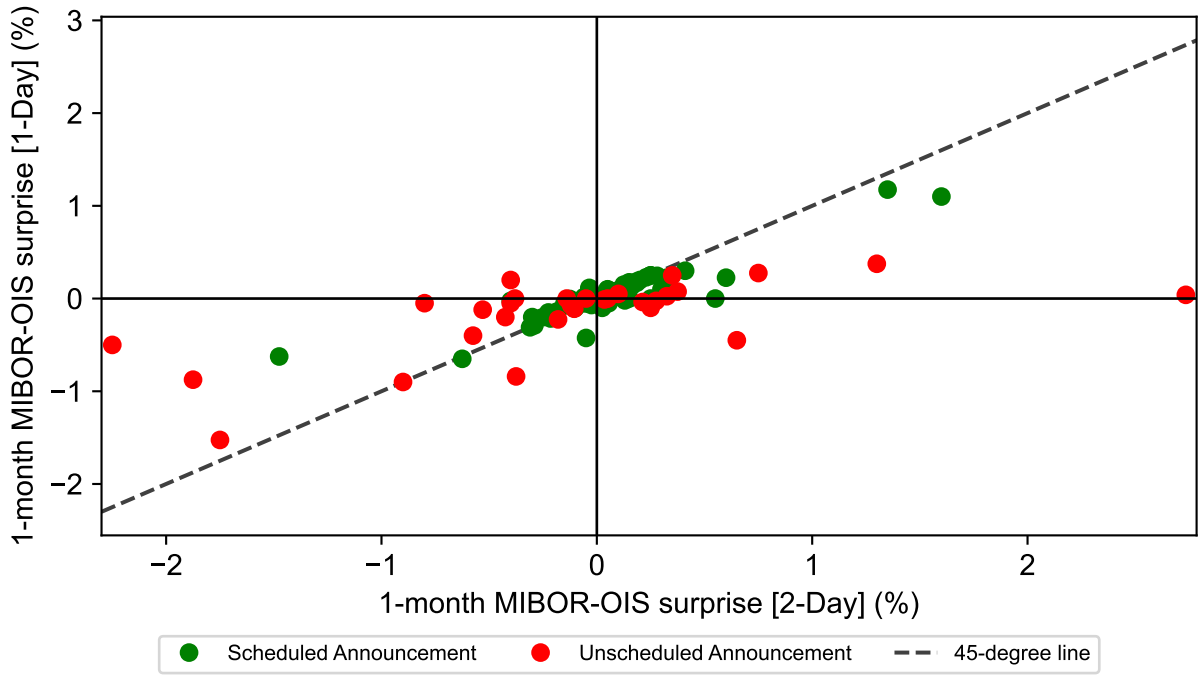


(c) Correlation with MIBOR-OIS surprises



Notes: The first panel plots the time series of the BSE 200 Index from August 1999 to March 2020. The second panel plots the two-day percentage change in the BSE 200 Index on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the BSE 200 Index against the corresponding change in the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Scheduled and unscheduled announcement dates are marked in green and red respectively. Data on 1-month MIBOR-OIS is from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on BSE 200 Index is from Yahoo Finance, Ticker: BSE-200.BO.

Figure G.1: MIBOR-OIS monetary policy surprises measured using one and two-day windows



Notes: This figure plots monetary policy surprises measured using two-day changes in the 1-month MIBOR-OIS fixed rate around monetary policy announcements of the RBI against their corresponding one-day change. The data on 1-month MIBOR-OIS contracts are sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Monetary policy surprises which occur on Saturdays are excluded from the sample.

G Some additional results on measured monetary policy surprises

G.1 Monetary policy surprises using one-day window

Figure G.1 plots the monetary policy surprises measured using the two-day window against surprises measured using a one-day window. The two-day window considers the change in the 1-month MIBOR-OIS rate from the day before to the day after the monetary policy announcement while the one-day window considers the change from the day before to the day of the announcement. Monetary policy surprises which occur on Saturday are not included in the sample as it is not possible to measure surprises using one-day windows for these announcements. There were six such instances during the time period under consideration and all of them were unscheduled announcements.

On most scheduled announcement dates, when monetary policy announcements were usually made during market trading hours, there is not much difference between the measured surprises using the two-day and one-day windows. However, on unscheduled announcement dates, when the announcements were more likely to be made outside market trading hours, the measured surprises using the two-day window are typically larger than those using the one-day window.

This is confirmed by the summary statistics presented in Table G.1. The mean of the absolute dif-

Table G.1: Summary statistics for the difference between one-day and two-day MIBOR-OIS surprises

Announcement Date	Period	*N*	*Mean*	*Std.Dev*	*min*	25%	50%	75%	*max*
Scheduled	1999 - 2004	11	0.091	0.152	-0.250	-0.025	-0.025	0.025	0.375
	2005 - 2009	19	0.188	0.297	-0.550	-0.137	-0.025	0.063	0.850
	2010 - 2020	67	0.029	0.053	-0.200	-0.016	0.000	0.010	0.150
Unscheduled	1999 - 2004	4	0.475	0.695	-0.925	-0.194	0.112	0.319	0.750
	2005 - 2009	17	0.446	0.645	-1.100	-0.300	-0.050	0.225	1.750
	2010 - 2020	9	0.452	0.948	-2.695	-0.045	-0.005	0.140	0.410

Notes: This table shows the summary statistics for the difference in the monetary policy surprises measured as one-day and two-day changes in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI during periods with different frequencies of scheduled announcements. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Monetary policy surprises which occur on Saturdays are excluded from the sample. The *Mean* column shows the mean of the absolute difference between the one-day and two-day MIBOR-OIS surprises.

Table G.2: Correlation between MIBOR-OIS surprises using one-day and two-day windows

One-day MIBOR-OIS surprise	Pooled	Scheduled	Unscheduled
Intercept	–0.025	–0.002	-0.138^{**}
	(0.018)	(0.010)	(0.058)
Two-day MIBOR-OIS surprise	0.394^{***}	0.646^{***}	0.279^{**}
	(0.103)	(0.077)	(0.101)
R^2	0.517	0.819	0.402
N	127	97	30

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$; Heteroskedasticity-robust S.E's reported;

Notes: This table shows the results of OLS regressions of the one-day change in the 1-month MIBOR-OIS fixed rate on the corresponding two-day change on all, scheduled and unscheduled announcement dates of the RBI. The data on 1-month MIBOR-OIS contracts are sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Monetary policy surprises which occur on Saturdays are excluded from the sample.

ference between the one-day and the two-day MIBOR-OIS surprises are much smaller on scheduled announcement dates than on unscheduled announcement dates. The standard deviation of the difference between the one-day and two-day MIBOR-OIS surprises are also much smaller on scheduled announcement dates than on unscheduled announcement dates. The R^2 of the regression of the one-day MIBOR-OIS surprise on the corresponding two-day MIBOR-OIS surprise, presented in Table G.2, also point to potentially substantial differences between the measured monetary policy surprises using one-day and two-day windows.

This suggests that particularly in contexts where there are a large number of unscheduled monetary policy announcements made outside market trading hours, the two-day window may be more appropriate for measuring monetary policy surprises, as it can more readily capture the effects of the announced monetary policy actions. Further, the fact that most scheduled announcement monetary policy surprises appear close to the 45-degree line in Figure G.1 also suggests that the extra noise introduced by using a two-day window relative to a one-day window is not quantitatively important for scheduled announcement dates.

Exsisting measures of monetary policy surprises in India like the one proposed by Lakdawala and Sengupta (2024) may effectively exclude many unscheduled monetary policy surprises through their use of a one-day window as compared to a two-day window used in this paper. A key concern with using longer time windows is that it may introduce background noise into the measured monetary policy surprises as pointed out by Nakamura and Steinsson (2018). However, when time stamps of monetary policy announcements are unavailable, using narrower time windows may fail to measure the true monetary policy surprise, particularly on unscheduled announcement dates.

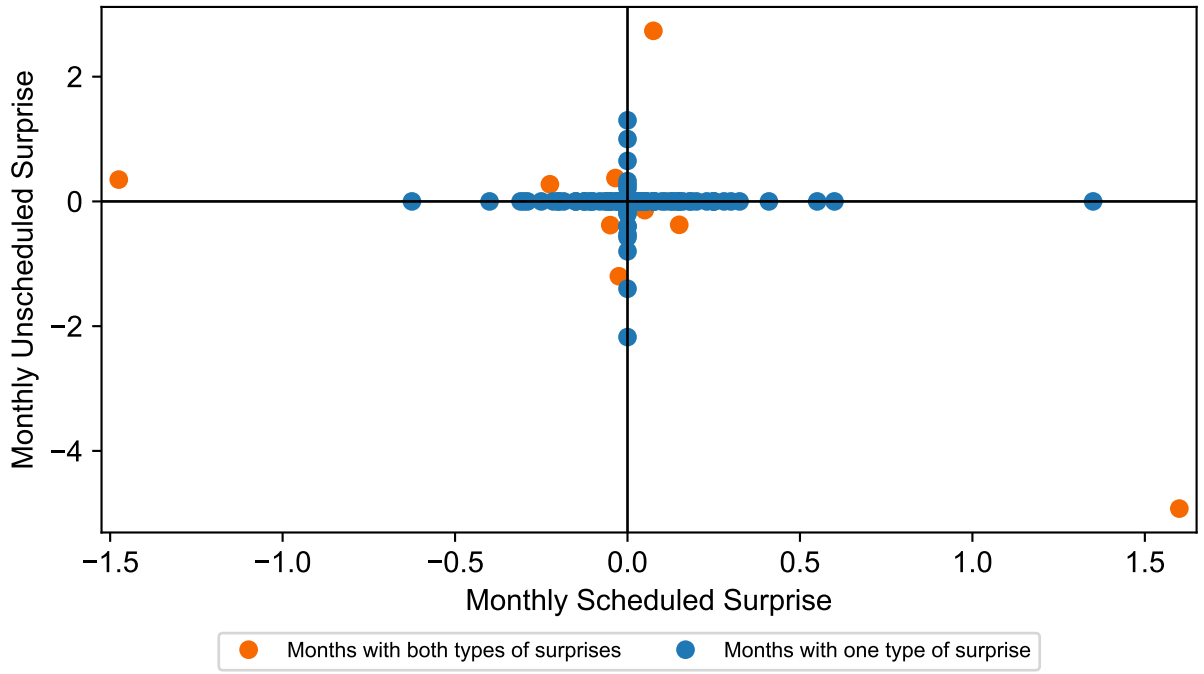
G.2 Correlation of scheduled and unscheduled monetary policy surprises

There is an emerging literature which suggests that temporal aggregation can bias the estimates of monetary policy transmission (Jacobson et al., 2024; Kilian, 2024). While estimating the effects of scheduled and unscheduled monetary surprises on lower frequency macroeconomic variables, it is important to ensure that the aggregation of the surprises to a lower frequency does not introduce bias.

When aggregating to a monthly frequency, a potential source of bias during months with both scheduled and unscheduled announcements is the correlation between the scheduled and unscheduled monetary policy surprises. If the two types of surprises are correlated, then estimating the effects of scheduled and unscheduled surprises separately without controlling for their correlation may lead to biased estimates.

Figure G.2 plots the monthly sum of scheduled and unscheduled monetary policy surprises for all months with a monetary policy announcement of the RBI between August 1999 and March 2020. While scheduled and unscheduled announcements did not typically occur during the same month, there were about 9 months during which they did. These months are shown in Table G.3. During these months, there appears to be an inverse relationship between the sign of the scheduled and unsched-

Figure G.2: Scheduled and unscheduled monetary policy surprises at a monthly frequency



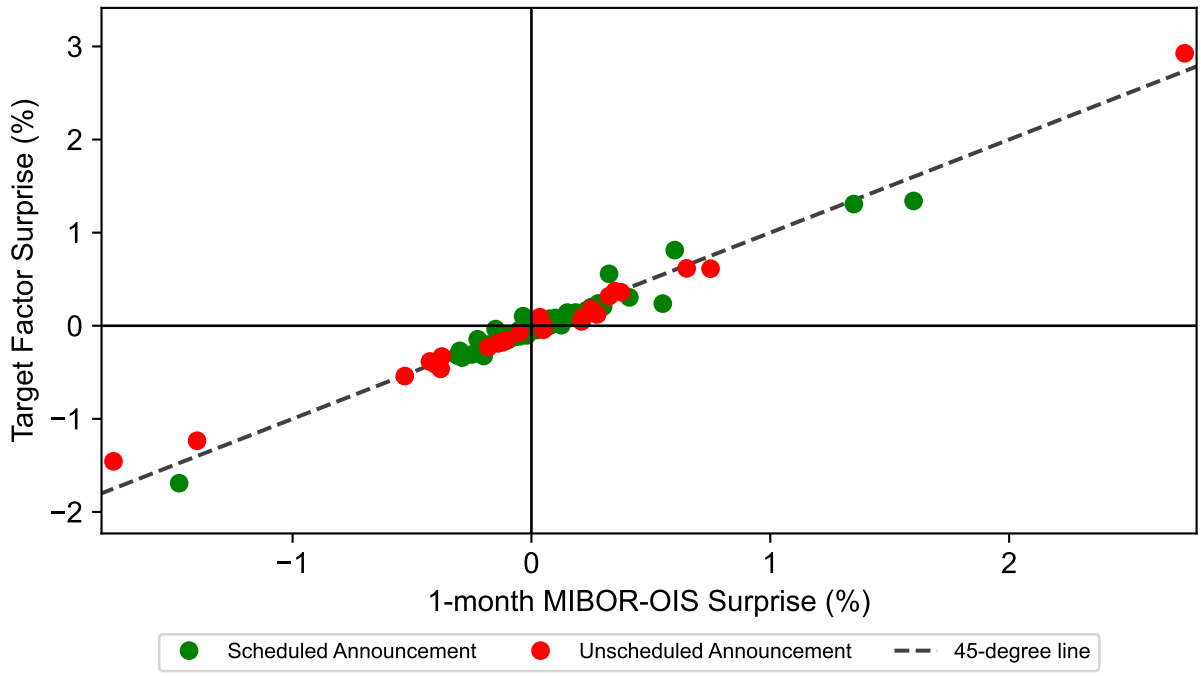
Notes: This figure plots the monthly sum of scheduled and unscheduled monetary policy surprises for all months with a monetary policy announcement of the RBI between August 1999 and March 2020. The monetary policy surprises are measured as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The data on 1-month MIBOR-OIS contracts are sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Table G.3: Months with both scheduled and unscheduled monetary policy surprises

Month	Scheduled	Unscheduled
April 2000	-0.025	-1.200
April 2007	-1.475	0.350
April 2008	-0.225	0.275
October 2008	1.600	-4.925
January 2009	0.150	-0.375
July 2010	-0.035	0.375
March 2012	0.050	-0.140
July 2013	0.075	2.735
October 2013	-0.050	-0.380

Notes: This table shows the months between August 1999 and March 2020 during which both scheduled and unscheduled monetary policy announcements were made by the RBI and the corresponding monetary policy surprises. The monetary policy surprises are measured as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The data on 1-month MIBOR-OIS contracts are sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure G.3: Target Factor vs. 1-month MIBOR-OIS monetary policy surprises



Notes: This figure plots the monetary policy surprises measured as the two-day change in the 1-month MIBOR-OIS fixed rate against the Target Factor measure derived using two day changes by Lakdawala and Sengupta (2024). The data on 1-month MIBOR-OIS contracts are sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. The Target Factor measure is sourced from the replication package of Lakdawala and Sengupta (2024). Data between November 2003 and March 2020 is used, to ensure consistency with the sample period of Lakdawala and Sengupta (2024).

uled surprises, driven in particular by two months during which there were very large surprises in opposing directions on scheduled and unscheduled announcement dates.

This suggests that during these months, an announcement date of one type was usually reversing the course of monetary policy being set on dates of the other type, potentially in response to incoming news about macroeconomic conditions. The fact that such months mainly occurred during the 2007-2008 Global Financial Crisis and its aftermath suggest that these were months of particularly heightened macroeconomic uncertainity. This is likely to be a source of estimation bias in lower frequency regressions and hence it is good practice to control for unscheduled surprises when estimating the effects of scheduled surprises and vice versa.

G.3 Comparison with Lakdawala and Sengupta (2024)

Figure G.3 compares the 1-month MIBOR-OIS monetary policy surprises to the Target Factor derived by Lakdawala and Sengupta (2024) using fixed rate changes in MIBOR-OIS contracts of 1-month, 3-month, 6-month, 9-month and 12-month maturities following Gürkaynak et al. (2005). While Lakdawala and Sengupta (2024)'s preferred measure of the monetary policy surprises uses a one-day window, the figure uses the two-day window to match the measure of the 1-month MIBOR-OIS mone-

tary policy surprises. The figure shows that the two measures are highly correlated on both scheduled and unscheduled announcement dates, suggesting that the 1-month MIBOR-OIS monetary policy surprises are a good proxy for the Target Factor measure. The issues associated with using a one-day window for measuring monetary policy surprises in India, particularly on unscheduled announcement dates, were outlined in greater detail in Appendix G.1.

H Monetary Policy Surprises with Sign Restrictions

H.1 Jarocinski and Karadi (2020) sign restrictions

While the evidence presented in Section 4 suggests that an important reason behind the differences in the effects of measured monetary policy surprises on scheduled and unscheduled announcement dates is the differences in their predictability by contemporary and past macroeconomic data, another potential reason could be that there are differences in the magnitude and content of information about the state of the economy revealed by the RBI in the two sets of announcement dates.

Jarociński and Karadi (2020) suggest that one way of controlling for these 'information effects' of monetary policy surprises is to impose sign restrictions on the measured monetary policy surprises. In particular, since higher interest rates increase the discount rate and reduce asset prices while information about the state of the economy, to the extent that they are demand shocks, increase both interest rates and asset prices, monetary policy surprises can be purged of information effects by excluding surprises that are positively correlated with asset prices.

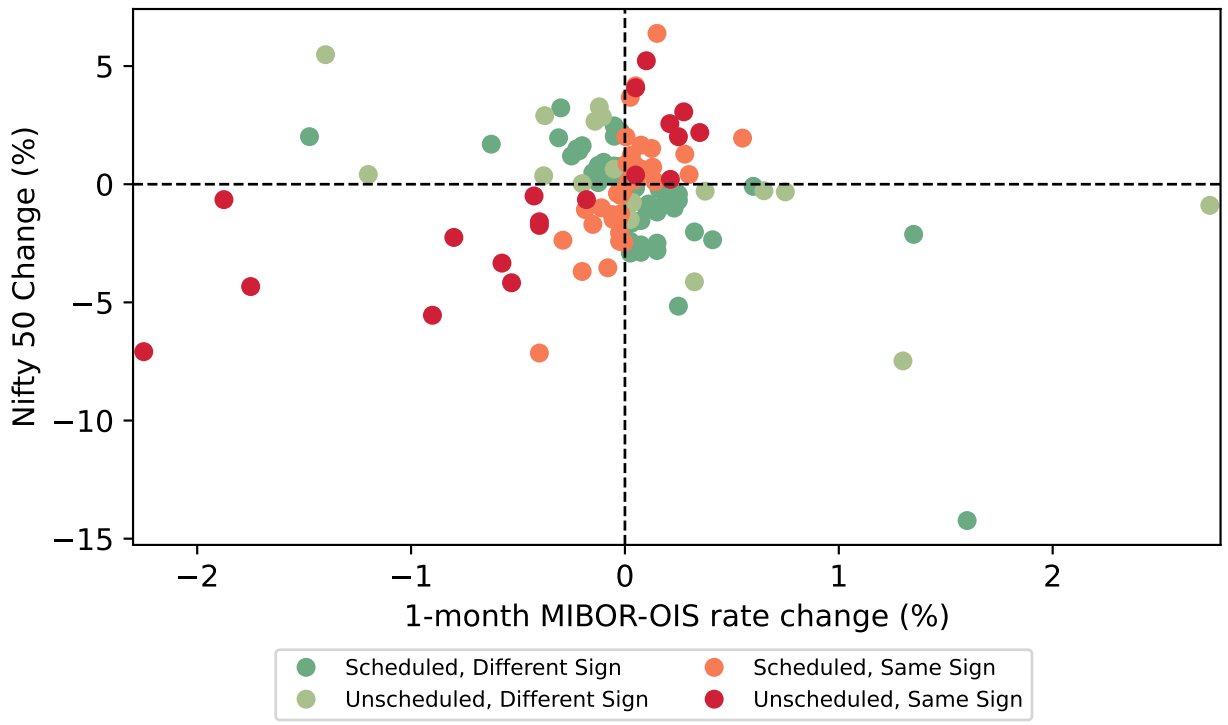
Figure H.1 considers the responses of the NIFTY stock market index and the 1-month MIBOR-OIS fixed rate on monetary policy announcement dates of the RBI. Out of the 133 RBI monetary policy announcement dates in the sample, both the NIFTY index and the 1-month MIBOR-OIS fixed rate responded in a two-day window around monetary policy announcements on 129 occassions.

Out of the 93 scheduled announcement dates with a response in both variables, the NIFTY index and the 1-month MIBOR-OIS fixed rate responded in opposing directions and satisfy the sign restriction on 55 occassions. Out of the 36 unscheduled announcement dates with a response in both variables, the NIFTY index and the 1-month MIBOR-OIS fixed rate satisfied the sign restriction on 17 occassions.

Figure H.2 considers the IRFs of the Index of Industrial Production (IIP) to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after imposing sign restrictions. Similarly, Figure H.3 considers the IRFs of Wholesale Price Index (WPI) Inflation to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after imposing sign restrictions.

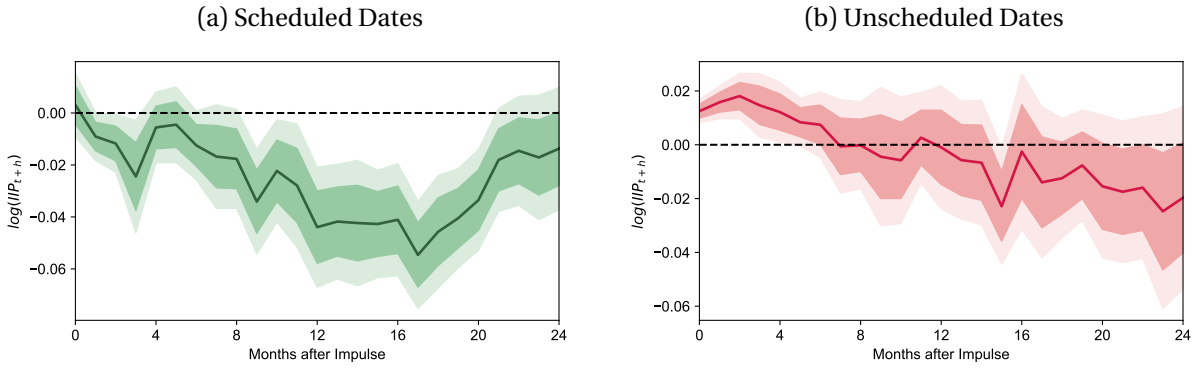
The IRFs for both IIP and WPI inflation are very similar to those in Section 6, suggesting that the differences in the effects of scheduled and unscheduled monetary policy surprises are not driven by differences in the content of information revealed by the RBI on these dates. The sign restriction instead serve to increase the precision of the estimated effects of monetary policy surprises on the macroeconomic variables in the same direction as in the main specification. This further strengthens the evidence in favour of endogeneity as the leading cause of the differences in the effects of scheduled and unscheduled monetary policy surprises on the Indian economy.

Figure H.1: NIFTY changes on monetary policy announcement dates of the RBI



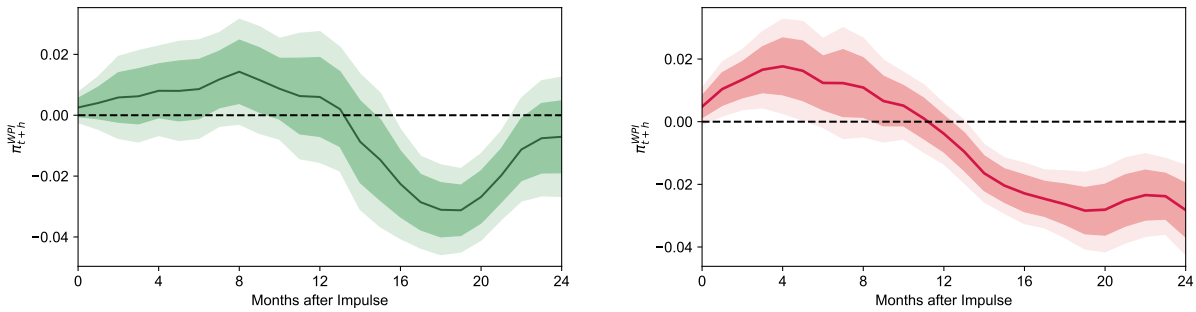
Notes: This figure plots the monetary policy surprises derived as the two-day change in the 1-month MIBOR-OIS fixed rate against the corresponding two-day percentage changes in the NIFTY stock market index on monetary policy announcement dates of the RBI. Announcement dates during which the monetary policy surprise and the NIFTY change have opposite signs are shown in green and those where they have the same sign are shown in red. The 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on the NIFTY 50 Index is from www.niftyindices.com/reports/historical-data. Annnouncement dates during which the change in either the MIBOR-OIS rate or NIFTY index is 0 are excluded from the sample.

Figure H.2: IRFs of Industrial Production to Monetary Policy Surprises (Sign Restrictions)



Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. They are then sign-restricted by only keeping monetary policy surprises that are inversely correlated with the two-day change in the NIFTY stock market index around monetary policy announcements, following Jarociński and Karadi (2020). The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the IIP is sourced from FRED with ticker: INDPROINDMISMEI. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on the NIFTY 50 Index is from www.niftyindices.com/reports/historical-data.

Figure H.3: IRFs of Wholesale Price Index Inflation to Monetary Policy Surprises (Sign Restrictions)



Notes: This figure shows the impulse responses of the Wholesale Price Index (WPI) Inflation to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year percentage change in the WPI calculated as the logarithmic difference. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. They are then sign-restricted by only keeping monetary policy surprises that are inversely correlated with the two-day change in the NIFTY stock market index around monetary policy announcements, following Jarociński and Karadi (2020). The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the WPI is sourced from FRED with ticker: WPIATT01INM661N. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on the NIFTY 50 Index is from www.niftyindices.com/reports/historical-data.

H.2 Acosta (2023) sign restrictions

Recent work by Acosta (2023) points out that information about supply shocks may also be revealed on monetary policy announcement dates. When information about monetary policy, demand and supply are revelead on monetary policy announcement dates, the Jarociński and Karadi (2020) sign restrictions imposed using just two variables cannot uniquely identify monetary policy shocks. In addition, Acosta (2023) also points out that the response of stock prices is not very informative about the information contained in monetary policy communications. This is particularly important in the context of emerging economies, since as Frankel (2010) points out, supply shocks are more frequent and have much larger effects on economic activity in these economies.

Figure H.4 considers the revisions of real GDP growth and WPI inflation forecasts during months with a monetary policy announcement of the RBI, except those announcements which occur on the same day as a forecast survey and those announcements during which there was no monetary policy surprise. The plots consider the cases with an overall tightening and easing of monetary policy, as proxied by the sum of the monetary policy surprises during the month, in separate panels.

The revisions are measured as the change in the next financial year's forecast for real GDP growth and WPI inflation respectively between two consecutive forecast surveys during which there was a monetary policy announcement of the RBI. The data on real GDP growth and WPI inflation forecasts are sourced from Consensus Economics. Since Consensus Economics reports forecasts on a financial year basis, the current financial year's forecast revisions are not available for the monetary policy announcements made in March. Hence, to ensure complete coverage, the analysis is performed using next financial year's forecast revisions.[17]

While Acosta (2023) suggests using high-frequency revisions in forecasts around monetary policy announcements by deriving the implied forecast revisions based on newspaper reports, and then identifying the structural shocks using identification through heteroskedasticity, the analysis here is conducted at a monthly frequency using sign restrictions which seeks to mirror the spirit of the approach, while noting that this may lead to a contamination of the revisions by other news. Constructing high-frequency measures of forecast revisions around monetary policy announcements in India is an important avenue for future research. The identification scheme used here is more likely to result in false negatives (misclassifying months which actually satisfy the sign restriction) rather than false positives (misclassifying months which do not satisfy the sign restriction). Hence, the results presented here are likely to be conservative measures of monetary policy shocks which satisfy the sign restrictions.

Acosta (2023) suggests that a distinguishing feature of monetary policy shocks relative to supply shocks is their effect on the expectations of economic growth and inflation. While supply shocks tend to move both growth and inflation forecasts in opposite directions, monetary policy shocks tend to move both growth and inflation forecasts in the same direction. Furthermore, to the extent that there is also rev-

[17] When the analysis in this section is performed using the current financial year's forecast revisions, excluding the March announcements, the results (not reported here) are very similar.

elation of information about positive demand shocks (during announcements with monetary policy tightening) and negative demand shocks (during announcements with monetary policy easing), the sign restrictions can also control for these effects since they will move output and inflation forecasts in the opposite direction to a monetary policy shock.

Figure H.4 suggests that out of 52 months with scheduled monetary policy surprise tightening, output growth and inflation forecasts were revised in the theoretically expected direction during 19 months. Out of 41 months with scheduled monetary policy surprise easing, output growth and inflation forecasts were revised in the theoretically expected direction during 8 months.

Similarly, out of 14 months with unscheduled monetary policy surprise tightening, output growth and inflation forecasts were revised in the theoretically expected direction in 6 months. Out of 14 months with unscheduled monetary policy surprise easing, output growth and inflation forecasts were never revised in the theoretically expected direction.

On both scheduled and unscheduled announcement dates, the revisions of output growth and inflation forecasts are more likely to be in the theoretically expected direction during periods of monetary policy tightening than during periods of monetary policy easing. The sign-restricted monetary policy surprises are then used to estimate the effects of monetary policy surprises on output and inflation using the local projections specification in Section 6.

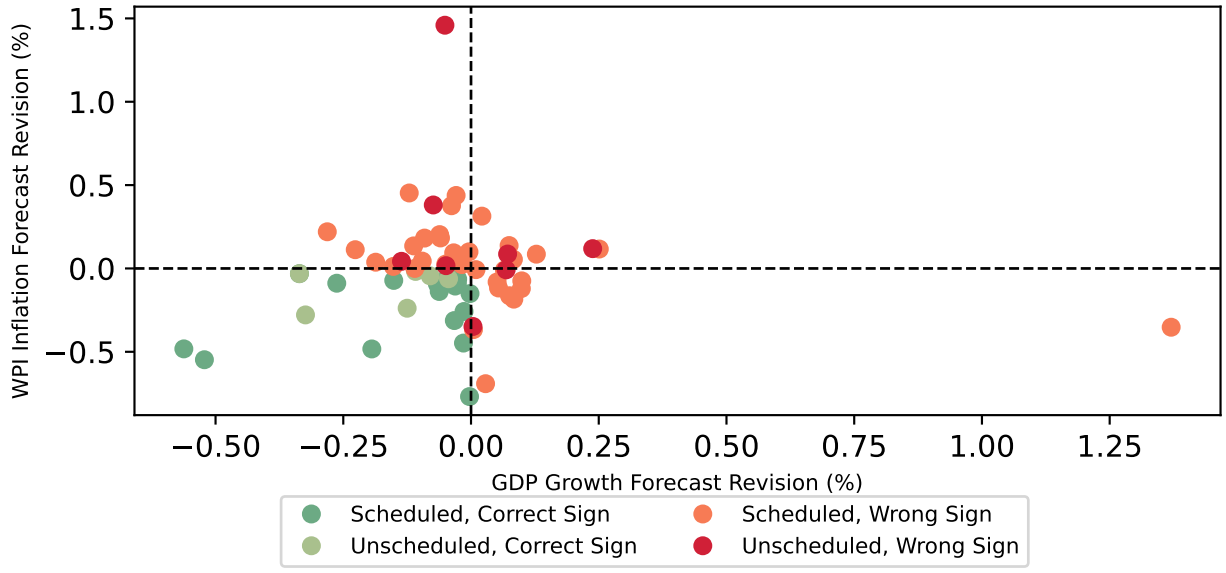
Figure H.5 considers the IRFs of the Index of Industrial Production (IIP) to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after imposing sign restrictions using a procedure based on Acosta (2023). Even after imposing sign restrictions, there is significant heterogeneity in the effects of monetary policy surprises on IIP across scheduled and unscheduled announcement dates, mirroring the evidence presented in Section 6. On scheduled announcement dates, IIP begins to decline almost immediately after a contractionary monetary policy surprise, reaching a trough after about 15 months. On unscheduled announcement dates, IIP increases on impact and the response is positive and statistically significant for most of the first two years after the initial impulse.

Similarly, Figure H.6 considers the IRFs of Wholesale Price Index (WPI) inflation to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after imposing sign restrictions using a procedure based on Acosta (2023). On scheduled announcemement dates, WPI inflation declines but does so only after a lag of about 1 year, while on unscheduled announcement dates there is a positive and statistically significant effect on WPI inflation for the first few months after the initial impulse.

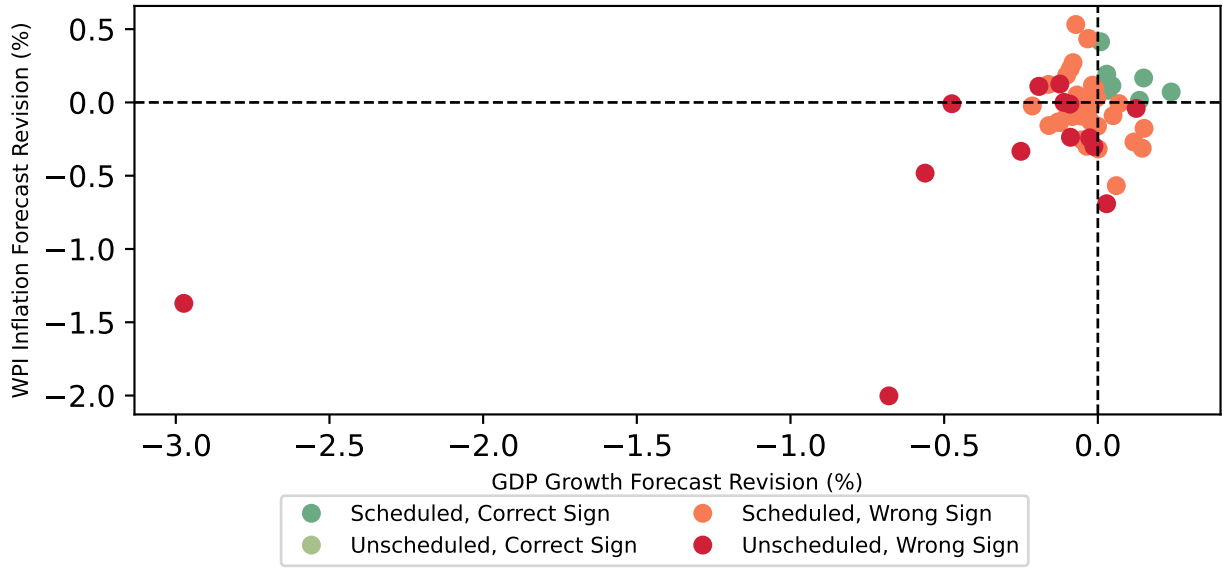
This evidence suggests that information about the economic outlook, including information about demand and supply shocks, do not seem to explain the differences in the impulse responses of key macroeconomic variables on scheduled and unscheduled announcement dates. Instead, endogeneity appears to be the most promising explanation of the differences in the effects of scheduled and unscheduled monetary policy surprises on the Indian economy. The sign restrictions based on Acosta (2023) do not appear to substantially alter the IRFs of IIP and WPI inflation in Section 6.

Figure H.4: Revisions of growth and inflation forecasts following monetary policy announcements

(a) Monetary policy tightening

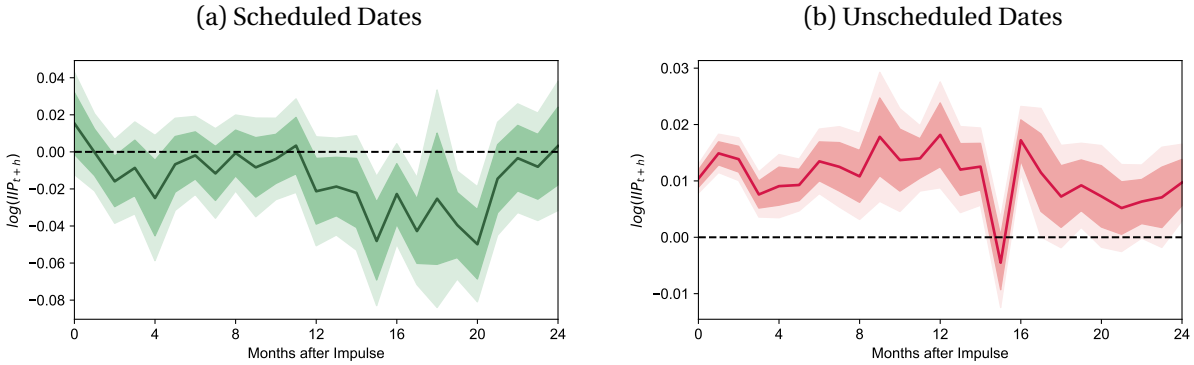


(b) Monetary policy easing



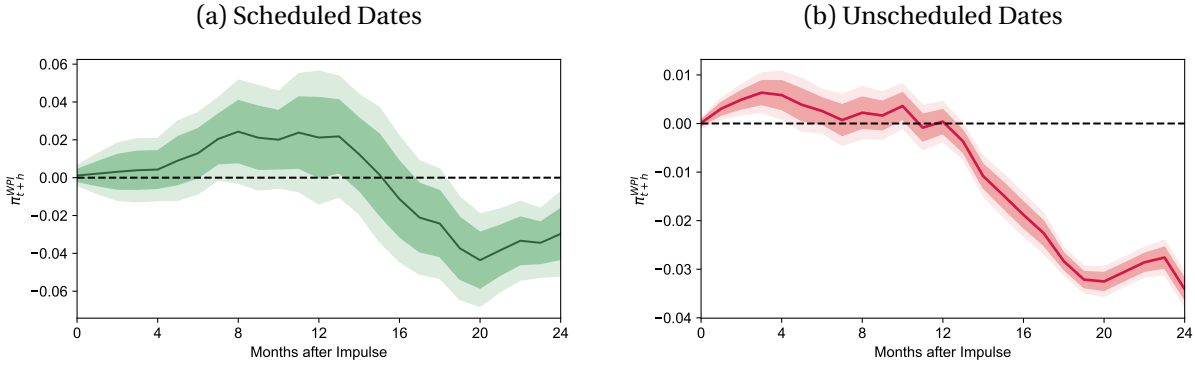
Notes: The upper and lower panels plots the revisions of real GDP growth and WPI inflation forecasts following monetary policy announcements of the RBI, separately for periods when the overall stance of monetary policy, as proxied by monetary policy surprises indicate a tightening and easing respectively. The revisions are measured as the change in the next financial year's forecast for real GDP growth and WPI inflation respectively between two consecutive forecast surveys during which there was a monetary policy announcement of the RBI. The data on real GDP growth and WPI inflation forecasts are sourced from Consensus Economics. During periods between two forecast surveys when there are multiple monetary policy announcements of a particular type, the monetary policy surprises are summed to determine whether there has been an overall tightening or easing of monetary policy. The two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcements is used as the measure of monetary policy surprises. The data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Monetary policy announcements which occur on the same day as a forecast survey and monetary policy announcement dates during which there was no monetary policy surprise are excluded from the sample.

Figure H.5: IRFs of Industrial Production to Monetary Policy Surprises (Acosta Sign Restrictions)



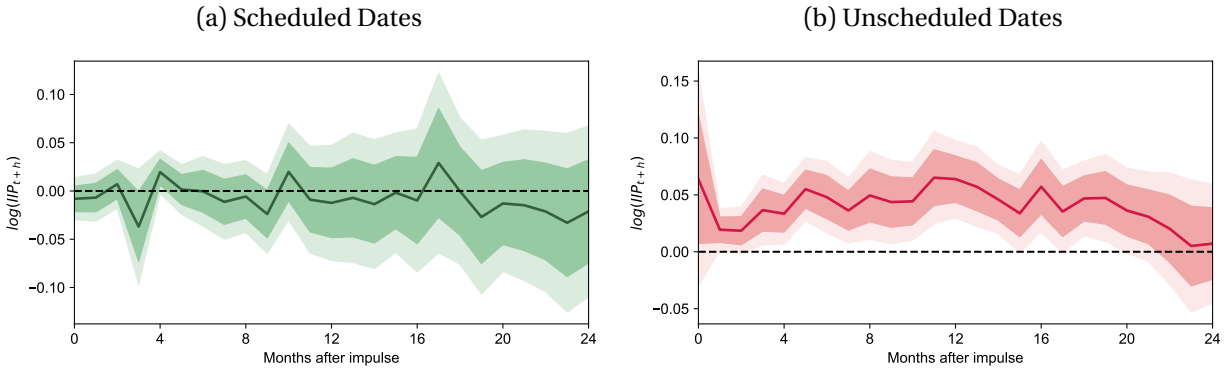
Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI and then sign restricted using a procedure based on Acosta (2023). In particular, all monetary policy surprises of each type between two consensus forecast surveys are summed and only monthly monetary policy surprise tightenings which lower both next financial year's real GDP growth forecasts and WPI inflation forecasts and monetary policy surprise easings which raise next financial year's real GDP growth forecasts and WPI inflation forecasts are kept in the sample. Monetary policy surprises in other months are set to 0. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the IIP is sourced from FRED with ticker: INDPROINDMISMEI. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure H.6: IRFs of WPI Inflation to Monetary Policy Surprises (Acosta Sign Restrictions)



Notes: This figure shows the impulse responses of the Wholesale Price Index (WPI) Inflation to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year percentage change in the WPI calculated as the logarithmic difference. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI and then sign restricted using a procedure based on Acosta (2023). In particular, all monetary policy surprises of each type between two consensus forecast surveys are summed and only monthly monetary policy surprise tightenings which lower both next financial year's real GDP growth forecasts and WPI inflation forecasts and monetary policy surprise easings which raise next financial year's real GDP growth forecasts and WPI inflation forecasts are kept in the sample. Monetary policy surprises in other months are set to 0. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the WPI is sourced from FRED with ticker: WPIATT01INM661N. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure I.1: IRFs of Industrial Production to Monetary Policy Surprises (Outlier Robustness)



Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the IIP is sourced from FRED with ticker: INDPROINDMISMEI. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Dummy variables are included in the specification to control for the effects of monthly monetary policy surprises greater than 1, less than -1 and surprises which occur between April 2007 and March 2009.

I Robustness to outlier observations

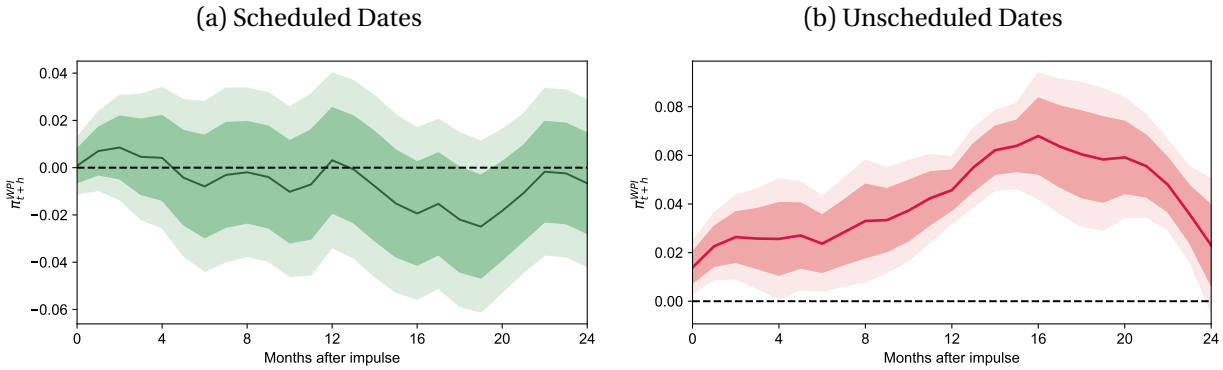
I.1 Large surprises and surprises during the global financial crisis

This section considers the robustness of the IRFs in Section 6 to the exclusion of months with large surprises (defined as monthly aggregate surprises less than -1 or greater than 1) and months during the Global Financial Crisis (April 2007 to March 2009). This is implemented in practice by including dummy variables for each monthly observation satisfying the above conditions in the regression specification outlined in Section 6.

Figure I.1 considers the IRFs of the Index of Industrial Production (IIP) to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after excluding months with large surprises and months during the Global Financial Crisis. Similarly, Figure I.2 considers the IRFs of Wholesale Price Index (WPI) Inflation to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after excluding months with large surprises and months during the Global Financial Crisis.

While there is a decline in the precision of the estimated effects of monetary policy on IIP and WPI inflation on scheduled announcement dates when the large surprises are excluded, the responses on unscheduled announcement dates remain large and precisely estimated. However, the differences in the responses of macroeconomic variables on scheduled and unscheduled announcement dates documented in Section 6 are present even when the large monetary policy surprises are excluded from the analysis. These results confirm that the differences in the effects of measured monetary policy surprises on scheduled and unscheduled announcement dates are not driven by the presence of large surprises

Figure I.2: IRFs of WPI Inflation to Monetary Policy Surprises (Outlier Robustness)



Notes: This figure shows the impulse responses of the Wholesale Price Index (WPI) Inflation to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year percentage change in the WPI calculated as the logarithmic difference. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the WPI is sourced from FRED with ticker: WPIATT01INM661N. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Dummy variables are included in the specification to control for the effects of monthly monetary policy surprises greater than 1, less than -1 and surprises which occur between April 2007 and March 2009.

or the Global Financial Crisis.

I.2 Surprises which coincide with FOMC announcements

This section considers the robustness of the IRFs in Section 6 to the inclusion of the present month and previous 12 months' FOMC monetary policy surprises, constructed by Bauer and Swanson (2023a), as control variables in the local projections specification. The FOMC monetary policy surprises are included to control for the effects of global monetary policy surprises on the Indian economy.

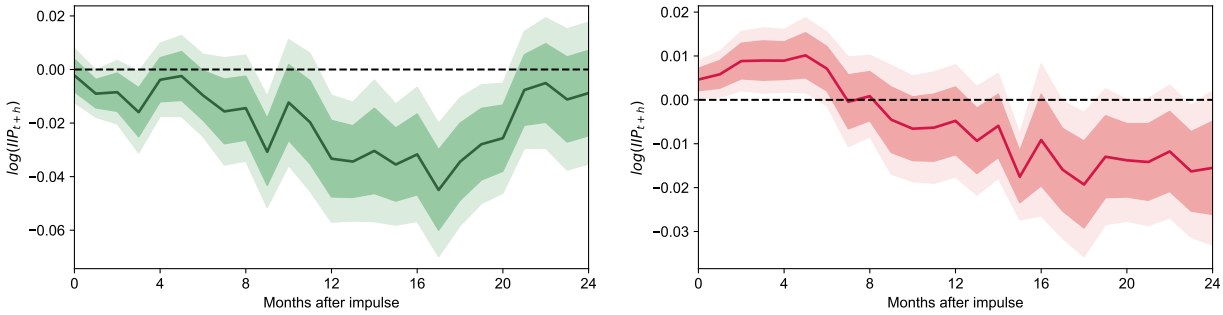
Figure I.3 considers the IRFs of the Index of Industrial Production (IIP) to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after including the present month and previous 12 months' FOMC monetary policy surprises as control variables. Similarly, Figure I.4 considers the IRFs of Wholesale Price Index (WPI) Inflation to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after including the present month and previous 12 months' FOMC monetary policy surprises as control variables.

The controls for FOMC monetary policy surprises do not change the results in Section 6. The differences in the effects of scheduled and unscheduled monetary policy surprises on the Indian economy are robust to the inclusion of the present month and previous 12 months' FOMC monetary policy surprises as control variables in the local projections specification. In fact, the responses, particularly for IIP, are more precisely estimated when the FOMC monetary policy surprises are included as control variables.

Figure I.3: IRFs of Industrial Production to Monetary Policy Surprises (FOMC Control)

(a) Scheduled Dates

(b) Unscheduled Dates

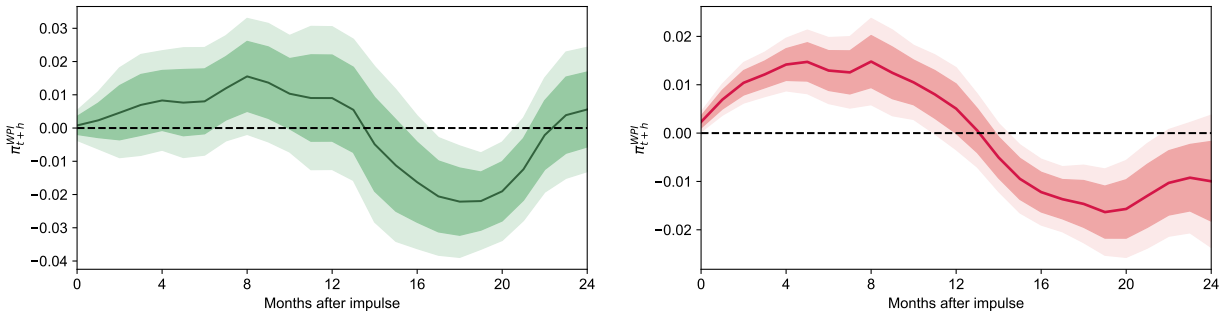


Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the IIP is sourced from FRED with ticker: INDPROINDMISMEI. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. In addtion to the control variables specified in Section 6, the present month and previous 12 months' FOMC monetary policy surprises, constructed by Bauer and Swanson (2023a), are included as control variables in the local projections specification.

Figure I.4: IRFs of WPI Inflation to Monetary Policy Surprises (FOMC Control)

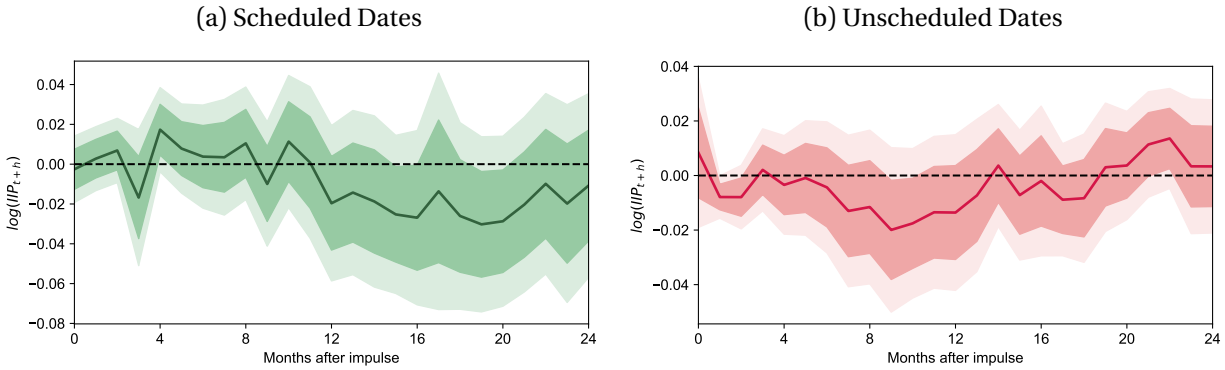
(a) Scheduled Dates

(b) Unscheduled Dates



Notes: This figure shows the impulse responses of the Wholesale Price Index (WPI) Inflation to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year percentage change in the WPI calculated as the logarithmic difference. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the WPI is sourced from FRED with ticker: WPIATT01INM661N. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. In addtion to the control variables specified in Section 6, the present month and previous 12 months' FOMC monetary policy surprises, constructed by Bauer and Swanson (2023a), are included as control variables in the local projections specification.

Figure I.5: IRFs of Industrial Production to Monetary Policy Surprises (one type of surprise)



Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the IIP is sourced from FRED with ticker: INDPROINDMISMEI. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Dummy variables are included in the specification to control for the effects of monthly monetary policy surprises occurring during months with both scheduled and unscheduled monetary policy announcements.

I.3 Surprises which occur in same month as surprises of different type

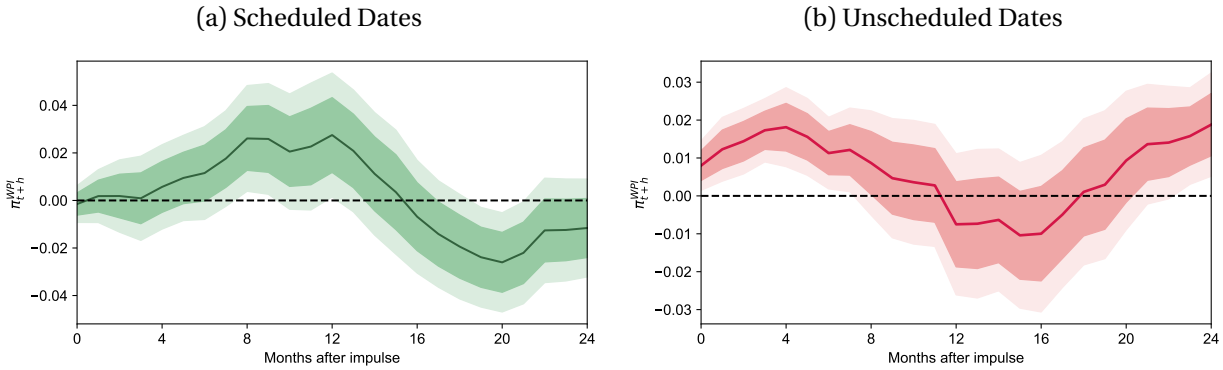
This section considers the robustness of the IRFs in Section 6 to the exclusion of months in which both scheduled and unscheduled monetary policy announcements were made by the RBI. As discussed in greater detail in Section G, there were nine occasions on which both scheduled and unscheduled announcements were made by the RBI in the same month. These months are shown in Table G.3. The local projection specification in Section 6 is modified to include dummy variables for each monthly observation satisfying the above condition.

Figure I.5 considers the IRFs of the Index of Industrial Production (IIP) to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after excluding months with both scheduled and unscheduled announcements.

Similarly, Figure I.6 considers the IRFs of Wholesale Price Index (WPI) Inflation to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after excluding months with both scheduled and unscheduled announcements.

The results for WPI inflation are fairly robust to the removal of monetary policy surprises in months with both scheduled and unscheduled moentary policy announcements, with a strong statistically significant increase in inflation on impact following a monetary policy tightening on unscheduled announcement dates while there is a lagged statistically significant decline in WPI inflation on scheduled announcement dates. However, the strong positive coefficient on impact for IIP on unscheduled announcement dates is no longer present when the monetary policy surprises in months with both scheduled and unscheduled announcements are excluded from the analysis. This suggests that the

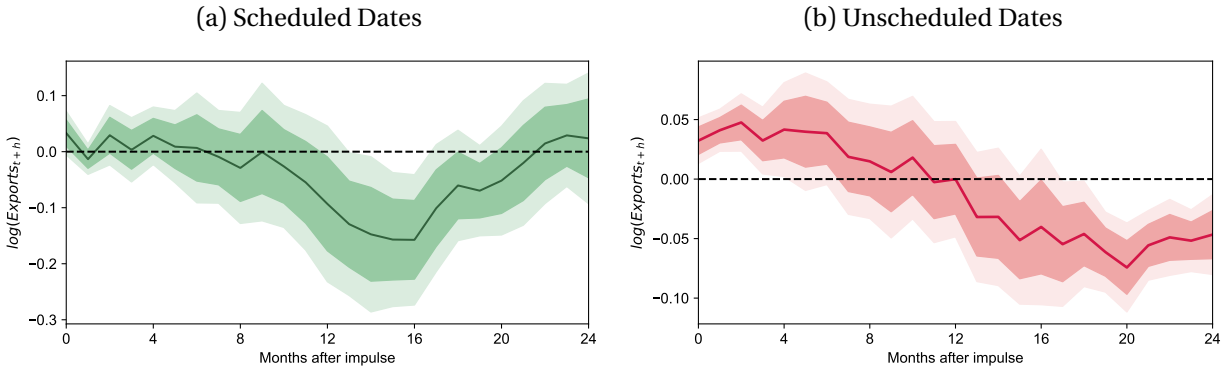
Figure I.6: IRFs of WPI Inflation to Monetary Policy Surprises (one type of surprise)



Notes: This figure shows the impulse responses of the Wholesale Price Index (WPI) Inflation to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year percentage change in the WPI calculated as the logarithmic difference. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the WPI is sourced from FRED with ticker: WPIATT01INM661N. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Dummy variables are included in the specification to control for the effects of monthly monetary policy surprises occurring during months with both scheduled and unscheduled monetary policy announcements.

strong positive response of IIP to monetary policy surprises on unscheduled announcement dates is driven particularly by unscheduled monetary policy surprises in months with both scheduled and unscheduled announcements.

Figure J.1: Impulse Response Functions of Goods Exports to Monetary Policy Surprises



Notes: This figure shows the impulse responses of goods exports from India to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the total monthly value of goods exports expressed in US Dollars. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on goods exports from India is sourced from FRED with ticker: XTEXVA01INM667S. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

J Some additional results on monetary policy transmission

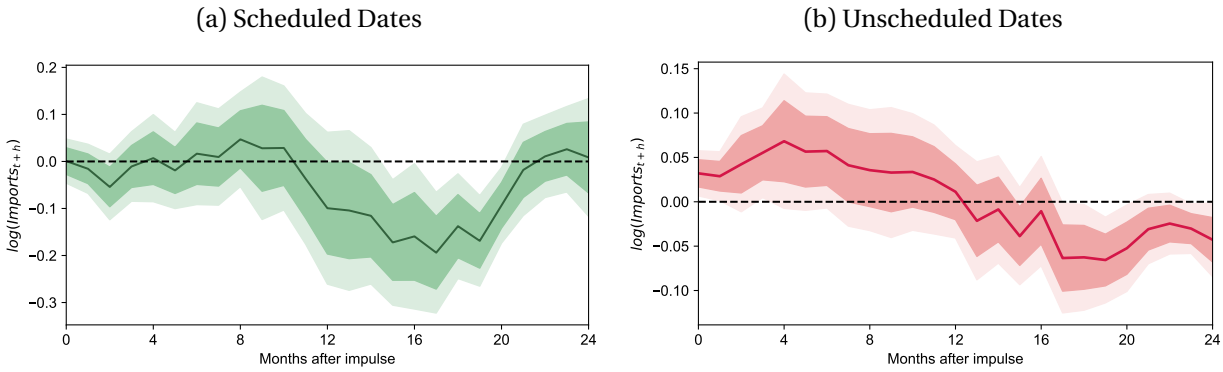
This section considers some additional results on impulse response functions of macroeconomic variables to monetary policy surprises on scheduled and unscheduled announcement dates. All the results in this section are based on the Local Projection Specification in Section 6.

Figure J.1 considers the impulse response of goods exports to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is the logarithm of the total monthly value of goods exports expressed in US Dollars. On scheduled announcement dates, the goods exports decline in response to a contractionary monetary policy surprise, with a maximum decline of about 15% occurring about 16 months after the initial impulse. In contrast, on unscheduled announcement dates, there is a statistically significant increase in exports in response to a contractionary monetary policy surprise for the first few months, before beginning to decline.

Figure J.2 considers the impulse response of goods imports to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is the logarithm of the total monthly value of goods imports expressed in US Dollars. On scheduled announcement dates, goods imports tend to decline following a monetary policy tightening, with a maximum decline of about 20% occurring 17 months after the initial impulse. In contrast, goods imports tend to increase following a monetary policy tightening on unscheduled announcement dates and only begin to decline after 12 months. The response of exports and imports to a monetary policy tightening on scheduled announcement dates is much more consistent with empirical evidence from other countries (Pirozhkova et al., 2024) than on unscheduled announcement dates.

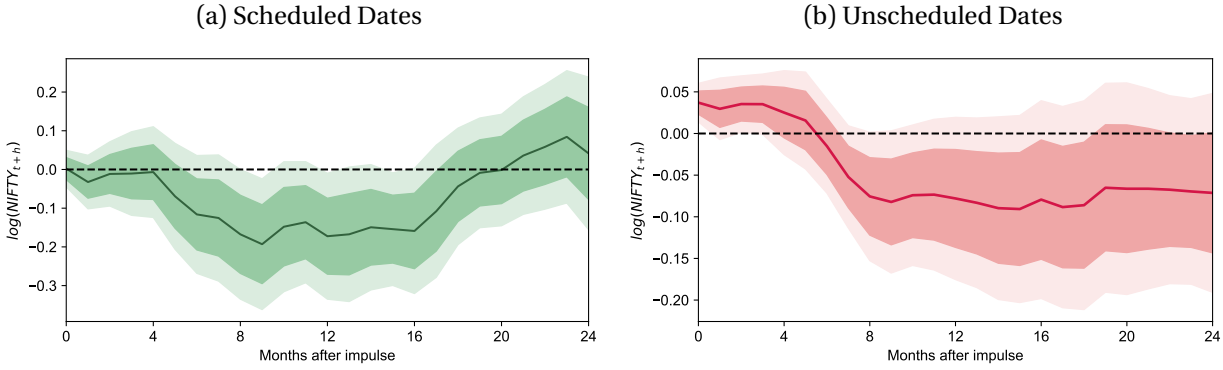
Figure J.3 considers the impulse response of the NIFTY stock market index to monetary policy surprises

Figure J.2: Impulse Response Functions of Goods Imports to Monetary Policy Surprises



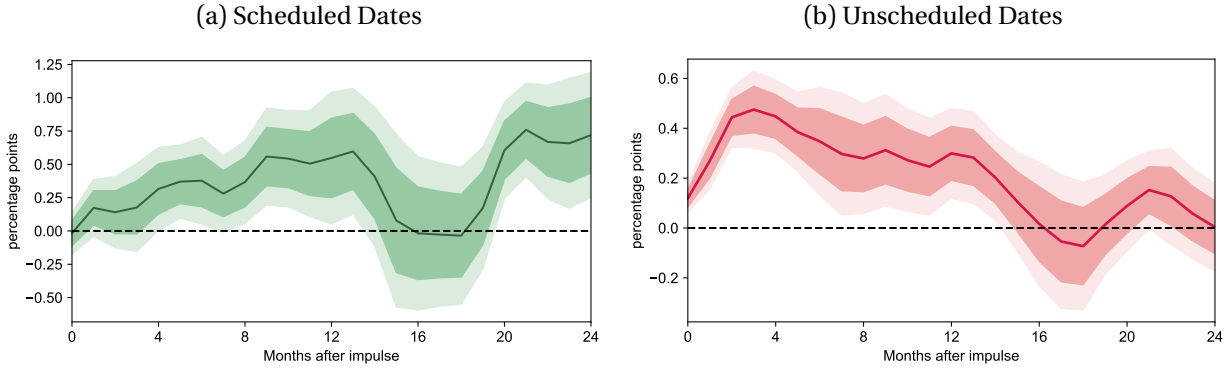
Notes: This figure shows the impulse responses of goods imports into India to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the total monthly value of goods imports expressed in US Dollars. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on goods exports from India is sourced from FRED with ticker: XTIMVA01INM667S. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure J.3: Impulse Response Functions of NIFTY to Monetary Policy Surprises



Notes: This figure shows the impulse responses of NIFTY to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the NIFTY stock market index. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the NIFTY stock market index is obtained from www.niftyindices.com/reports/historical-data. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure J.4: Impulse Response Functions of 10-year GSec Yield to Monetary Policy Surprises



Notes: This figure shows the impulse responses of the 10-year Governemnt Security (GSec) yield to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the monthly average 10-year GSec yield in percentage points. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the 10-year GSec yield is obtained from investing.com. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

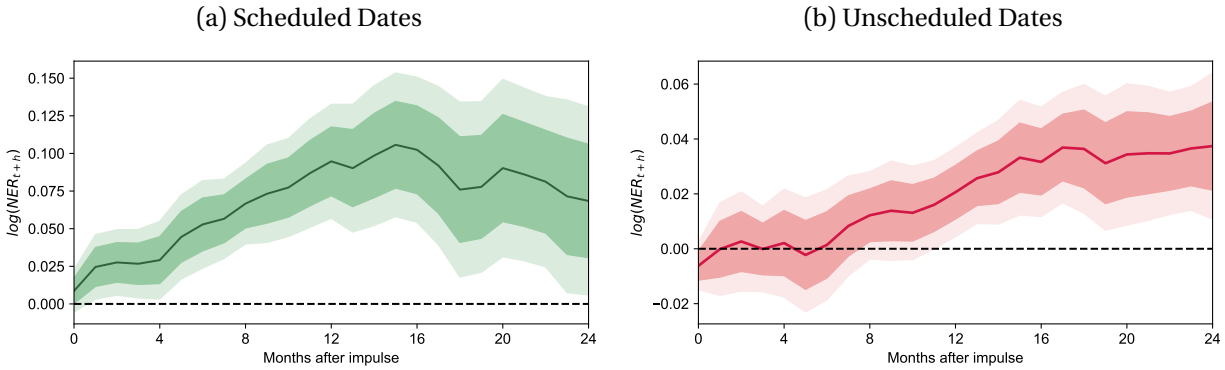
on scheduled and unscheduled announcement dates. The dependent variable is the logarithm of the NIFTY stock market index. The impulse responses of the NIFTY stock market index on scheduled and unscheduled announcement dates are similar to the event study results for the index documented in Section 5.1. On scheduled announcement dates, the NIFTY index declines following a monetary policy tightening, with a maximum decline of about 20% occurring 8 months after the initial impulse. On unscheduled announcement dates, there is a very strong statistically significant increase in the stock market index on impact which persists for the first few months after the initial impulse.

Figure J.4 considers the impulse response of the 10-year Government Security (GSec) yield to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is the monthly average 10-year GSec yield in percentage points. The response of the 10-year GSec yield to a monetary policy tigtening are very similar on scheduled and unscheduled announcement dates, mirroring the similar responses of the overnight MIBOR documented in Figure 4.

Figure J.5 considers the impulse response of the nominal exchange rate between the US Dollar and Indian Rupee to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is ₹ per $ expressed in logarithms. Rather surprisingly, on scheduled announcement dates, the exchange rate of the Indian Rupee against the US Dollar depreciates (by close to 10%) following a monetary policy tightening. On unscheduled announcement dates too, the exchange rate depreciates following a monetary policy tightening, although it does so with a lag and by a smaller magnitude.

The IRFs for the exchange rate stand in contrast to theories of the Uncovered Interest Parity (UIP) which suggest that the domestic currency should appreciate following an interest rate increase in the domestic country, as foreign investors move their capital into the country to take advantage of the higher interest

Figure J.5: Impulse Response Functions of USD-INR Exchange Rate to Monetary Policy Surprises



Notes: This figure shows the impulse responses of the nominal exchange rate between the US Dollar and Indian Rupee to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is ₹ per $ expressed in logarithms. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the USD-INR nominal exchange rate is obtained from Bloomberg Terminal with ticker: INR REGN Curncy. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

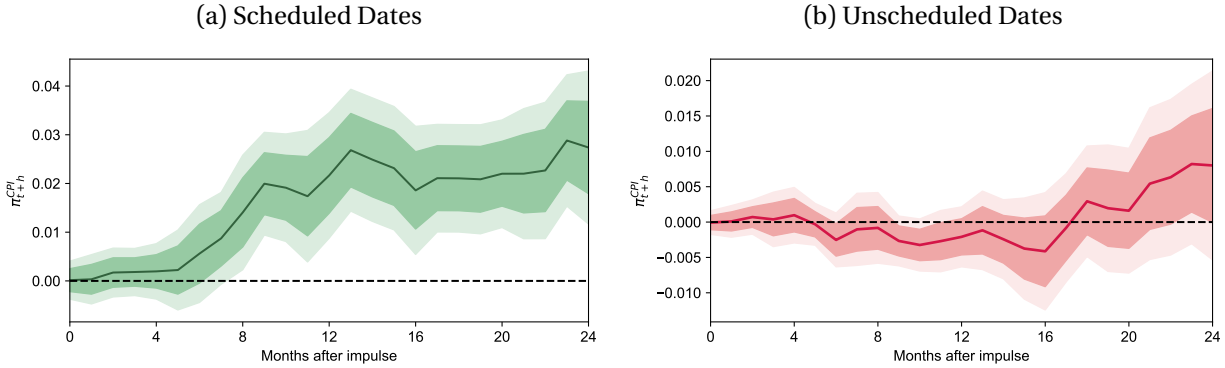
rates on offer (Gürkaynak et al., 2021).

However, this is not the first study to point out such departures from the UIP condition in the Indian context. Goyal and Arora (2012) point out that the Indian Rupee tends to depreciate against the US Dollar following an increase in the interest rate differential between India and the United States. While the growth reducing effects of higher domestic interest rates may be one reason for the depreciation of the Indian Rupee following a monetary policy tightening, capital controls are also likely to be an important explanation.

Patnaik and Shah (2013) and Patnaik et al. (2013) point out that Indian capital controls severely limited access to domestic debt markets for foreign investors, while foreign investment flows into Indian equity markets were subject to very limited restrictions. Foreign holdings of Indian government debt amounted to just 1.6% of total debt outstanding in 2013 (Patnaik et al., 2013). As a result, when domestic interest rates rose, foreign investors may have found exit from equity markets relatively easy while entry into debt markets was highly restricted. The asymmetric capital controls on equity and debt may potentially explain the depreciation of the Indian Rupee following a monetary policy tightening. Accounting for the theoretically inconsistent response of the exchange rate to measured monetary policy surprises is an important avenue for future research.

Figure J.6 considers the impulse response of the year-on-year change in the Consumer Price Index (WPI) to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is the year-on-year change in the CPI calculated as the logarithmic difference. On scheduled announcement dates, CPI inflation increases following a monetary policy surprise tightening while on unscheduled announcement dates there is a negative but statistically insignificant response of CPI inflation to a monetary policy tightening. This stands in contradiction to the results for

Figure J.6: Impulse Response Functions of CPI Inflation to Monetary Policy Surprises



Notes: This figure shows the impulse responses of the year-on-year change in the Consumer Price Index (WPI) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year change in the CPI calculated as the logarithmic difference. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 6. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the CPI is sourced from FRED with ticker: INDCPIALLMINMEI. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

WPI inflation in Figure 6. A potential reason for the CPI inflation increase could be the exchange rate depreciation following a monetary policy tightening on scheduled announcement dates, which may lead to an increase in the prices of imported goods and services. This is likely to be particularly relevant for India, as close to 86% of India's imports are invoiced in US Dollars (Gopinath, 2017).

However, it is important to note that there was no nationally representative CPI index available for much of the time period under study and the CPI index used here is constructed based on an extrapolation from the CPI indices for industrial and agricultural workers. The results for CPI inflation should therefore be interpreted with caution and require further investigation.

References

Acosta, M. (2023). The perceived causes of monetary policy surprises. *Working Paper*.

Bauer, M. D. and Swanson, E. T. (2023a). An alternative explanation for the "fed information effect". *The American Economic Review*, 113(3):664–700.

Bauer, M. D. and Swanson, E. T. (2023b). A reassessment of monetary policy surprises and high-frequency identification. *NBER Macroeconomics Annual 2022*, 37:87–155.

Bernanke, B. S. and Kuttner, K. N. (2005). What explains the stock market's reaction to federal reserve policy? *Journal of Finance*, 60(3):1221–1257.

CCIL (2024a). Ccil irs/fra trade repository. https://www.ccilindia.com/IRSS_HOME.aspx. Accessed: 2024-02-23.

CCIL (2024b). Ccil monthly newsletter, december 2023. https://www.ccilindia.com/Documents/Rakshitra/2024/Jan/Statistics.pdf. Accessed: 2024-02-23.

Coibion, O. and Gorodnichenko, Y. (2015). Information rigidity and the expectations formation process: A simple framework and new facts. *The American Economic Review*, 105(8):2644–2678.

Frankel, J. (2010). Monetary policy in emerging markets. In Friedman, B. M. and Woodford, M., editors, *Handbook of Monetary Economics*, volume 3, pages 1439–1520. Elsevier, Amsterdam.

Gopinath, G. (2017). Dollar dominance in trade: Facts and implications. http://bit.ly/3SXKlCG. EXIM Bank of India 33rd Commencement Day Lecture.

Goyal, A. and Arora, S. (2012). The indian exchange rate and central bank action: An egarch analysis. *Journal of Asian Economics*, 23(1):60–72.

Gürkaynak, R. S., Kara, A. H., Kısacıkoğlu, B., and Lee, S. S. (2021). Monetary policy surprises and exchange rate behavior. *Journal of International Economics*, 130(103443):1–24.

Gürkaynak, R. S., Sack, B. T., and Swanson, E. T. (2005). Do actions speak louder than words? the response of asset prices to monetary policy actions and statements. *International Journal of Central Banking*, 1(1):55–93.

Gürkaynak, R. S., Sack, B. T., and Swanson, E. T. (2007). Market-based measures of monetary policy expectations. *Journal of Business & Economic Statistics*, 25(2):201–212.

Jacobson, M. M., Matthes, C., and Walker, T. B. (2024). Temporal aggregation bias and monetary policy transmission. *Working Paper*.

Jarociński, M. and Karadi, P. (2020). Deconstructing monetary policy surprises - the role of information shocks. *American Economic Journal: Macroeconomics*, 12(2):1–43.

Kilian, L. (2024). How to construct monthly var proxies based on daily surprises in futures markets. *Working Paper*.

Lakdawala, A. and Sengupta, R. (2024). Measuring monetary policy shocks in emerging economies: Evidence from india. *Journal of Money, Credit and Banking*. forthcoming.

Miranda-Agrippino, S. and Ricco, G. (2021). The transmission of monetary policy shocks. *American Economic Journal: Macroeconomics*, 13(3):74–107.

Montiel Olea, J. L. and Plagborg-Møller, M. (2021). Local projection inference is simpler and more robust than you think. *Econometrica*, 89(4):1789–1823.

Nakamura, E. and Steinsson, J. (2018). High-frequency identification of monetary non-neutrality: The information effect. *The Quarterly Journal of Economics*, 133(3):1283–1330.

Pagan, A. (1984). Econometric issues in the analysis of regressions with generated regressors. *International Economic Review*, 25(1):221–247.

Patnaik, I., Malik, S., Pandey, R., and Prateek (2013). Foreign investment in the indian government bond market. *Working Paper*.

Patnaik, I. and Shah, A. (2013). Did the indian capital controls work as a tool of macroeconomic policy? *IMF Economic Review*, 60(3):439–464.

Pawaskar, V. and Ghose, P. (2019). The changing dynamics of the indian interest rate derivatives market. *CCIL Monthly Newsletter*, January 2019:7–22.

Pirozhkova, E., Ricco, G., and Viega, N. (2024). Trouble every day: Monetary policy in an open emerging economy. *Working Paper*.

RBI (2018). Communication policy of the rbi. https://web.archive.org/web/20181029064140/https://rbi.org.in/Scripts/CommunicationPolicy.aspx. Accessed: 2024-03-06.

Reis, R. (2006). Inattentive consumers. *Journal of Monetary Economics*, 53(8):1761–1800.

Witheridge, W. (2024). Monetary policy and fiscal-led inflation in emerging markets. *Working Paper*.