Three essays on monetary policy in India



Karthik Narayan Abhiramapuram Sridhar

Nuffield College

University of Oxford

A thesis submitted for the degree of

Doctor of Philosophy in Economics

Trinity Term 2026

Supervised by Stephen Bond and Christopher Adam

Abstract

This thesis consists of three separate papers on different aspects of monetary policy in India.

Chapter 1 examines heterogeneity in the effects of monetary policy surprises on output and inflation when measured on scheduled and unscheduled monetary policy announcement dates in India. A surprise monetary policy tightening on scheduled dates lowers forecasted and actual output and inflation, while a surprise tightening on unscheduled dates has the opposite effect. This paper accounts for this difference by providing evidence for the systematic endogeneity of measured monetary policy surprises on unscheduled announcement dates to contemporaneous and recent macroeconomic news.

Chapter 2 documents the effects of increasing formal financial inclusion on monetary policy transmission in India. Using variation across regions and over time in measures of formal financial access in India, this paper shows that greater formal financial inclusion is associated with weaker monetary policy transmission to household income and consumption.

Chapter 3 studies the interaction between mark-to-market accounting regulations and monetary policy. Using ex-ante variation in the exposure of Indian banks to mark-to-market losses before a sharp increase in interest rates in 2004, this paper shows that more exposed banks increased their lending to infrastructure-related sectors by proportionally larger amounts after 2004. This provides a novel supply-side explanation for the infrastructure lending boom in India.

Acknowledgements

I am deeply grateful to my thesis supervisors, Steve Bond and Chris Adam, for their rigorous feedback, constant guidance and support. This thesis would not have been possible without them. I am also extremely grateful to my college advisors, John Muellbauer and Bent Nielsen, for their thought-provoking conversations and useful feedback on all my thesis chapters. I am also grateful to Andrea Ferrero for his valuable advice and feedback at various stages of the DPhil. In addition, I am thankful to my co-authors, Vimal Balasubramaniam, Nirupama Kulkarni and Akshat Singh, from whom I have learnt a great deal through working together on research.

Early versions of all three thesis chapters were presented at research workshops of both the Oxford Macroeconomics Research Group and the Centre for the Study of African Economies. I am very grateful to members of these research groups for their useful feedback on all three thesis chapters. Some parts of this work were undertaken during a research visit to the Centre for Advanced Financial Research and Learning (CAFRAL) in Mumbai, a research organisation of the Reserve Bank of India, and I am grateful to Nirupama Kulkarni for hosting me at CAFRAL and enabling access to some of the data used in this thesis.

My thanks are also due to the Clarendon Fund of the University of Oxford, the David Walton Memorial Fund of the Department of Economics and Nuffield College for their generous financial support during the period when this thesis was written.

I am extremely thankful to Apoorv Gupta, Sylvan Herskowitz, Sanghamitra Mukherjee, Adam Szeidl, Simon Quinn, and especially Muhammad Meki, for many inspiring conversations on our shared interest in financial inclusion. Special thanks to Nanda H Krishna, who has been a constant source of advice on matters relating to computer programming. Finally, I would like to thank my parents, friends and extended family for their support through all the vicissitudes of doing research.

Declarations

1. **Supervision:**
   This thesis was supervised by Professor Stephen Bond and Professor Christopher Adam.

2. **Authorship:**
   Chapter 1, titled 'Macroeconomic Effects of Scheduled and Unscheduled Monetary Policy Surprises', is completely my own work. Chapter 2, titled 'Financial Inclusion and Monetary Policy Transmission: Evidence from Indian Households', is joint work with Vimal Balasubramaniam. I was responsible for conceptualizing the research question, collecting and cleaning the relevant data, and conducting the empirical analysis. I was also equally involved with my co-author in designing the empirical strategy and writing the paper. Chapter 3, titled 'Banking Catch-22? Trading off Mark-to-Market and Default Risk', is joint work with Nirupama Kulkarni and Akshat Singh. I was equally involved, with my co-authors, in conceptualizing the research question, collecting and cleaning the data, designing the empirical strategy, conducting the empirical analysis, and writing the paper.

3. **Funding:**
   During the period of writing this thesis, I received financial support from Nuffield College, the Clarendon Fund of the University of Oxford and the David Walton Memorial Fund of the Department of Economics. Their support is gratefully acknowledged.

4. **Total Words:**
   This thesis consists of approximately 62,832 words. This was calculated by multiplying the number of words in a representative page (561 words, Page 6) by the total number of pages (112) excluding the preamble, bibliography and appendices.

5. **Generative AI Use:**
   I acknowledge the use of OpenAI's Codex AI coding agent [based on OpenAI's GPT models] to review and test my code for logical and syntax errors and suggest appropriate changes where necessary.

Contents

Abstract i

Acknowledgements ii

Declarations iii

Introduction 1

1 Macroeconomic Effects of Scheduled and Unscheduled Monetary Policy Surprises 3

1.1 Introduction . . . 4

1.1.1 Related literature . . . 7

1.1.2 A reader's guide . . . 9

1.2 Identification of monetary policy surprises . . . 10

1.3 Monetary policy surprises from the MIBOR-OIS market . . . 14

1.3.1 Identifying monetary policy announcement dates . . . 14

1.3.2 Scheduled and unscheduled announcement dates . . . 15

1.3.3 MIBOR-OIS data . . . 15

1.4 Sources of monetary policy surprises . . . 20

1.5 Event study evidence from financial markets . . . 22

1.6 Evidence from consensus forecasts . . . 29

1.7 Monetary policy transmission to output and inflation . . . 32

1.8 Conclusion . . . 38

2 Financial Inclusion and Monetary Policy Transmission: Evidence from Indian Households 45

2.1 Introduction . . . 46

2.1.1 Contribution to the literature . . . 49

2.1.2 A reader's guide . . . 50

2.2 Data . . . 50
2.2.1 CPHS household survey data . . . 50
2.2.2 Banking data . . . 57
2.2.3 Monetary policy surprises in India . . . 62
2.3 Monetary policy transmission at the aggregate level . . . 64
2.3.1 Empirical specification . . . 64
2.3.2 Responses of household income and consumption . . . 65
2.4 Financial inclusion and monetary policy transmission . . . 68
2.4.1 Empirical specification . . . 68
2.4.2 OLS evidence on the role of financial inclusion . . . 69
2.5 Demonetization, financial inclusion and monetary transmission . . . 70
2.5.1 Indian demonetization of 2016 and financial inclusion . . . 73
2.5.2 Empirical specification . . . 75
2.5.3 Responses of household income and consumption . . . 76
2.5.4 Some additional IV evidence . . . 78
2.5.5 Discussion of findings . . . 80
2.6 Conclusion . . . 81

3 Banking Catch-22? Trading off Mark-to-Market and Default Risk 87
3.1 Introduction . . . 88
3.1.1 Related literature . . . 90
3.1.2 A reader's guide . . . 91
3.2 Institutional details . . . 91
3.2.1 Credit boom and lending to the infrastructure sector . . . 94
3.2.2 Long-term investments and mark-to-market accounting rules . . . 95
3.2.3 Consequences . . . 97
3.3 Data . . . 97
3.3.1 Data sources . . . 98
3.3.2 Data construction and cleaning . . . 98
3.3.3 Summary statistics . . . 99
3.4 Empirical strategy . . . 101
3.4.1 The rise in interest rates in 2004 . . . 101
3.4.2 Empirical specification . . . 106

3.5 Empirical results . . . 107
3.5.1 Mark-to-market exposure and bank lending . . . 107
3.5.2 Mark-to-market exposure and lending interest rates of banks . . . 109
3.6 Consequences for bank lending quality . . . 114
3.7 Alternative specifications and robustness checks . . . 117
3.8 Discussion of results . . . 120
3.9 Conclusion . . . 121

A Appendix to Chapter 1 **125**
A.1 MIBOR-OIS monetary policy surprises: additional results . . . 125
A.1.1 MIBOR-OIS market in India: a brief overview . . . 125
A.1.2 Auto-correlation of MIBOR-OIS surprises at monthly frequency . . . 126
A.1.3 Event study regressions: detailed regression tables . . . 127
A.1.4 Consensus forecast regressions: detailed regression tables . . . 127
A.2 Monetary policy surprises from longer-term OIS contracts . . . 133
A.2.1 3-Month MIBOR-OIS . . . 133
A.2.2 1-Year MIBOR-OIS . . . 142
A.2.3 Timing surprises and endogeneity . . . 151
A.3 Monetary policy surprises from exchange rate forwards . . . 156
A.3.1 Identification strategy . . . 156
A.3.2 Evidence from event studies in financial markets . . . 159
A.4 Consensus forecasts and monetary surprises: additional results . . . 163
A.4.1 Descriptive statistics . . . 163
A.4.2 Consensus forecasts and path surprises . . . 163
A.4.3 Interest rate forecasts and monetary policy surprises . . . 167
A.4.4 Robustness to an alternative specification . . . 172
A.5 Data sources . . . 175
A.5.1 Daily data . . . 175
A.5.2 Monthly data . . . 175
A.6 Event studies: additional descriptive evidence . . . 176
A.7 Some additional results on measured monetary policy surprises . . . 183
A.7.1 Monetary policy surprises using one-day window . . . 183
A.7.2 Correlation of scheduled and unscheduled monetary policy surprises . . . 185

A.7.3 Comparison with Lakdawala and Sengupta (2025) . . . 189
A.8 Monetary Policy Surprises with sign restrictions . . . 190
A.8.1 Jarocinski and Karadi (2020) sign restrictions . . . 190
A.8.2 Acosta (2023) sign restrictions . . . 192
A.9 Robustness to outlier observations . . . 198
A.9.1 Large surprises and surprises during the global financial crisis . . . 198
A.9.2 Surprises which coincide with FOMC announcements . . . 207
A.9.3 Surprises which occur in same month as surprises of different type . . . 216
A.10 Monetary policy surprises and macroeconomic data releases . . . 220
A.10.1 Sources of monetary policy surprises . . . 222
A.10.2 Event study regressions . . . 226
A.10.3 Consensus forecast regressions . . . 228
A.10.4 IRFs of macroeconomic variables . . . 230
A.11 Some additional results on monetary policy transmission . . . 231
A.11.1 Monetary policy transmission to other macroeconomic variables . . . 231
A.11.2 Robustness of the results to using longer maturity MIBOR-OIS surprises . . . 240

B Appendix to Chapter 2 **248**
B.1 Response rates and attrition in CPHS . . . 249
B.2 Time-series trends in financial inclusion in CPHS . . . 250
B.3 Monetary policy surprises on unscheduled announcement dates . . . 251
B.4 Persistence of monetary policy surprises . . . 252
B.5 Robustness for monetary policy transmission at the aggregate level . . . 253
B.6 Monetary policy transmission by Homogeneous Region . . . 256
B.7 Financial inclusion and monetary transmission: Additional results . . . 259
B.7.1 Robustness of OLS Evidence . . . 259
B.7.2 Constructing the demonetization exposure measure . . . 266
B.7.3 Summary statistics on the demonetization exposure measure . . . 266
B.7.4 IV First-Stage . . . 269
B.7.5 IV-2SLS Results . . . 270

C Appendix to Chapter 3 **272**
C.1 Sample of banks in the BSR data . . . 272
C.2 Sectoral lending patterns of Indian banks, 1999 - 2016 . . . 274

C.3 Banks with and without IFR in 2004 274
C.4 Distribution of key explanatory variables in 2004 276
C.5 Distribution of key dependent variables used in the analysis 281
C.6 IFR and infrastructure lending in 2008 285
C.7 Using infrastructure lending shares as the dependent variable 287
C.8 Clustering standard errors at the bank-level 287
C.9 Estimating the interest rate on outstanding infrastructure loans 287
C.10 DiD analysis of IFR in 2004 and NPAs between 2004 and 2016 295

List of Tables

1.1 Unscheduled monetary policy announcements of the RBI, October 1999 to March 2020 . 16
1.2 Summary statistics for monetary policy surprises on scheduled and unscheduled dates . 18
1.3 Auto-correlation of monetary policy surprises on RBI Announcement Dates 19
1.4 Predictability of Monetary Policy Surprises by Macroeconomic Data 23
1.5 Predictability of Monetary Policy Surprises by Macroeconomic Forecasts 24
1.6 Predictability of RBI Monetary Policy Surprises by FOMC Surprises 24
1.7 Summary statistics for daily financial market variables 25

2.1 Summary statistics on income and consumption in the CPHS, April 2014 and October 2019 51
2.2 Summary statistics on MIBOR-OIS monetary policy surprises, April 2013 to October 2019 64

3.1 Banks with above and below median IFR in 2004: Summary Statistics 100
3.2 Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans 108
3.3 Investment Fluctuation Reserve in 2004 and Interest Rate on Outstanding Infrastructure Loans 112
3.4 IFR in 2004 and NPAs in 2016 116
3.5 IFR in 2004 and Infrastructure Lending: Growth between 2004 and 2007 118
3.6 Long-term investments in 2004 and Infrastructure Lending: Growth between 2004 and 2007 119

A.1 Monthly auto-correlation of monetary policy surprises 126
A.2 Event Study Regressions for Financial Market Variables: All Announcement Dates 127
A.3 Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates 128
A.4 Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates 129
A.5 Consensus Forecast Revisions and Monetary Policy Surprises: All Announcements 130
A.6 Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements 131
A.7 Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements 132
A.8 3-Month MIBOR-OIS and 1-month MIBOR-OIS rate changes on RBI announcement dates 133

A.9 Event Study Regressions for Financial Market Variables: Scheduled Dates (timing surprises) 136
A.10 Event Study Regressions for Financial Market Variables: Unscheduled Dates (timing surprises) . . 137
A.11 Event Study Regressions for Financial Market Variables: Scheduled Dates (3m MIBOR-OIS) 138
A.12 Event Study Regressions for Financial Market Variables: Unscheduled Dates (3m MIBOR-OIS) . . 139
A.13 Consensus Forecast Regressions: Scheduled Dates (3m MIBOR-OIS) 140
A.14 Consensus Forecast Regressions: Unscheduled Dates (3m MIBOR-OIS) 141
A.15 1-Year MIBOR-OIS and 1-Month MIBOR-OIS rate changes on RBI announcement dates . 143
A.16 Event Study Regressions for Financial Market Variables: Scheduled Dates (path surprise) . 144
A.17 Event Study Regressions for Financial Market Variables: Unscheduled Dates (path surprise) 145
A.18 Event Study Regressions for Financial Market Variables: Scheduled Dates (1y MIBOR-OIS) 147
A.19 Event Study Regressions for Financial Market Variables: Unscheduled Dates (1y MIBOR-OIS) . . . 148
A.20 Consensus Forecast Regressions: Scheduled Dates (1y MIBOR-OIS) 149
A.21 Consensus Forecast Regressions: Unscheduled Dates (1y MIBOR-OIS) 150
A.22 Predictability of Monetary Policy Surprises by Macro Data (3m MIBOR-OIS) 152
A.23 Predictability of Monetary Policy Surprises by Macro Data (1y MIBOR-OIS) 153
A.24 Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (3m MIBOR-OIS) 154
A.25 Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (1y MIBOR-OIS) 155
A.26 FOMC announcements during two-day window around RBI announcements 157
A.27 1-month USD-INR forward premium and MIBOR-OIS changes on RBI announcement dates 159
A.28 Event Study Regressions for Financial Market Variables: Scheduled Dates (forward rate) . 160
A.29 Event Study Regressions for Financial Market Variables: Unscheduled Dates (forward rate) 161
A.30 Summary statistics for consensus forecast revisions following RBI announcements 167
A.31 Consensus Forecast Revisions and Path Surprises: All Announcements 168
A.32 Consensus Forecast Revisions and Path Surprises: Scheduled Announcements 169
A.33 Consensus Forecast Revisions and Path Surprises: Unscheduled Announcements 170
A.34 Interest Rate Forecast Revisions and Monetary Policy: Scheduled Announcements 171
A.35 Interest Rate Forecast Revisions and Monetary Policy: Unscheduled Announcements . . . 171
A.36 Consensus Forecast Revisions and Monetary Policy Surprises: Alternative Specification (Scheduled) 172
A.37 Consensus Forecast Revisions and Monetary Policy Surprises: Alternative Specification (Unscheduled) 173
A.38 Sources of Daily Data 175
A.39 Sources of Monthly Data 175

A.40 Summary statistics for the difference between one-day and two-day MIBOR-OIS surprises 184
A.41 Correlation between MIBOR-OIS surprises using one-day and two-day windows 184
A.42 Months with both scheduled and unscheduled monetary policy surprises 189
A.43 Predictability of Monetary Policy Surprises by Macroeconomic Data (Excluding Large and GFC Surprises) 200
A.44 Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (Excluding Large and GFC Surprises) 201
A.45 Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates (Excluding Large and GFC Surprises) 202
A.46 Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates (Excluding Large and GFC Surprises) 203
A.47 Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (Excluding Large and GFC Surprises) 204
A.48 Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements (Excluding Large and GFC Surprises) 205
A.49 Predictability of Monetary Policy Surprises by Macroeconomic Data (Excluding FOMC overlapping surprises) 209
A.50 Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (Excluding FOMC overlapping surprises) 210
A.51 Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates (Excluding FOMC overlapping surprises) 211
A.52 Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates (Excluding FOMC overlapping surprises) 212
A.53 Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (FOMC Control) 214
A.54 Consensus Forecast Regressions and Monetary Policy Surprises: Unscheduled Announcements (FOMC Control) 215
A.55 Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (Excluding months with both types of announcements) 217
A.56 Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements (Excluding months with both types of announcements) 218
A.57 RBI Monetary Policy Announcements overlapping with Macroeconomic Data Releases . . 223
A.58 Predictability of Monetary Policy Surprises by Macroeconomic Data (Excluding Overlaps with Macroeconomic Data Releases) 224
A.59 Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (Excluding Overlaps with Macroeconomic Data Releases) 225

A.60 Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates (Excluding Overlaps with Macroeconomic Data Releases) . . . 226

A.61 Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates (Excluding Overlaps with Macroeconomic Data Releases) . . . 227

A.62 Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (Excluding months with Announcements overlapping with Macroeconomic Data Releases) 228

A.63 Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements (Excluding months with Announcements overlapping with Macroeconomic Data Releases) . . . 229

B.1 Summary statistics of monetary policy surprises on unscheduled announcement dates . . 251

B.2 Summary statistics on demonetization exposure in India, 2016 . . . 266

B.3 Financial Inclusion and Monetary Policy Transmission: First-Stage IV Results . . . 269

C.1 Banks in and out of sample in 2004: Summary Statistics . . . 274

C.2 Summary statistics for key banking variables in India, 2004 . . . 276

C.3 IFR in 2004 and Outstanding Infrastructure Loans (Continuous variables) . . . 278

C.4 IFR in 2004 and NPAs in 2016 (Continuous Variables) . . . 280

C.5 Event-study coefficients for 2008, IFR and Outstanding Infrastructure Loans . . . 286

C.6 Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Lending Share . . 288

C.7 Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans [Triple Clustering] . . . 290

C.8 IFR in 2004 and Infrastructure Lending: Growth between 2004 and 2007 [Clustering by bank and district] . . . 292

C.9 Distribution of estimated infrastructure lending interest rates, 1999-2016 . . . 294

C.10 IFR in 2004 and change in NPAs from 2004 to 2016 . . . 296

List of Figures

1.1 Key macroeconomic indicators in India, August 1999 to March 2020 4
1.2 1-month MIBOR-OIS fixed rate and its two-day change, August 1999 to March 2020 17
1.3 1-month MIBOR-OIS fixed rate changes on monetary policy announcement dates of the RBI 17
1.4 Event Study Regressions for Financial Market Variables 27
1.5 Consensus Forecast Revisions and Monetary Policy Surprises 31
1.6 Impulse Response Functions of 1-month MIBOR-OIS fixed rate to Monetary Policy Surprises 34
1.7 Impulse Response Functions of Industrial Production to Monetary Policy Surprises 35
1.8 Impulse Response Functions of WPI Inflation to Monetary Policy Surprises 36

2.1 Account ownership at a formal financial institution, 2011 to 2021 46
2.2 Aggregate consumption in the national accounts and CPHS, Q2 2014 - Q3 2019 53
2.3 Formal and Informal borrowing in the CPHS, January 2014 to April 2020 54
2.4 Occupational distribution of households in the CPHS, April 2014 and October 2019 56
2.5 Measures of formal financial inclusion in India, December 2013 and March 2020 58
2.6 Time series of measures of formal financial inclusion in India, December 2013 to March 2020 60
2.7 Comparison of measures of financial inclusion from the RBI and CPHS, 2014 to 2020 . . . 61
2.8 Monetary policy surprises from MIBOR-OIS contracts, April 2013 to October 2019 63
2.9 Impulse response functions of household income and consumption to monetary surprises 66
2.10 Impulse response functions of Aggregate Economic Outcomes to Monetary Surprises . . . 67
2.11 Financial inclusion and monetary policy transmission: deposits per capita median split (Q1 2014) 71
2.12 Financial inclusion and monetary policy transmission: OLS evidence 72
2.13 Payment System Indicators in India, April 2013 to October 2019 74
2.14 Average change in deposits per capita following demonetization in India 75
2.15 Financial inclusion and monetary transmission: the role of demonetization 77
2.16 Implied response of consumption and income to monetary policy surprises 79

3.1 Time series of key banking sector variables, 2000 to 2016 92

3.2 Infrastructure Lending and Long-term Investment, 2003 to 2010 93
3.3 5 and 10 year Government Security Yields in India, 2001-2007 102
3.4 1 and 5 year MIBOR-OIS fixed rates in India, 2001-2007 103
3.5 Monthly Bank Credit Time Series 104
3.6 Infrastructure lending and investment fluctuation reserves 105
3.7 Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans 110
3.8 Investment Fluctuation Reserve in 2004 and Interest Rate on Outstanding Infrastructure Loans 113
3.9 Investment fluctuation reserves and non-performing loan ratio in 2016 115

A.1 3-month MIBOR-OIS rate changes on RBI monetary policy announcement dates 134
A.2 1-year MIBOR-OIS rate changes on monetary policy announcement dates of the RBI . . . 142
A.3 Forward premium surprises and MIBOR-OIS surprises on RBI announcement dates . . . 158
A.4 Consensus forecasts for real GDP growth in India, August 1999 to April 2020 164
A.5 Consensus forecasts for real investment growth in India, August 1999 to April 2020 165
A.6 Consensus forecasts for WPI inflation in India, August 1999 to April 2020 166
A.7 1-year government security (GSec) yield, August 1999 to March 2020 176
A.8 5-year government security (GSec) yield, August 1999 to March 2020 177
A.9 10-year government security (GSec) yield, August 1999 to March 2020 178
A.10 USD-INR exchange rate, August 1999 to March 2020 179
A.11 NSE NIFTY 50 Index, August 1999 to March 2020 180
A.12 BSE SENSEX Index, August 1999 to March 2020 181
A.13 BSE 200 Index, August 1999 to March 2020 182
A.14 MIBOR-OIS monetary policy surprises measured using one and two-day windows 183
A.15 Impulse Response Functions of IIP to Monetary Policy Surprises (1-day window) 186
A.16 Impulse Response Functions of WPI Inflation to Monetary Policy Surprises (1-day window) 187
A.17 Scheduled and unscheduled monetary policy surprises at a monthly frequency 188
A.18 Target Factor vs. 1-month MIBOR-OIS monetary policy surprises 190
A.19 NIFTY changes on monetary policy announcement dates of the RBI 191
A.20 IRFs of Industrial Production to Monetary Policy Surprises (JK Sign Restrictions) 192
A.21 IRFs of Wholesale Price Index Inflation to Monetary Policy Surprises (JK Sign Restrictions) 193
A.22 Revisions of growth and inflation forecasts following monetary policy announcements . . 195
A.23 IRFs of Industrial Production to Monetary Policy Surprises (Acosta Sign Restrictions) . . . 196

A.24 IRFs of WPI Inflation to Monetary Policy Surprises (Acosta Sign Restrictions) 196
A.25 IRFs of Industrial Production to Monetary Policy Surprises (Outlier Robustness) 206
A.26 IRFs of WPI Inflation to Monetary Policy Surprises (Outlier Robustness) 207
A.27 IRFs of IIP and WPI Inflation to Monetary Policy Surprises (Tightening Outlier Robustness) 208
A.28 IRFs of Industrial Production to Monetary Policy Surprises (FOMC Control) 213
A.29 IRFs of WPI Inflation to Monetary Policy Surprises (FOMC Control) 214
A.30 IRFs of Industrial Production to Monetary Policy Surprises (one type of surprise) 218
A.31 IRFs of WPI Inflation to Monetary Policy Surprises (one type of surprise) 219
A.32 IRFs of Industrial Production to Monetary Policy Surprises (Excluding Overlaps with Macroeconomic Data Releases) 230
A.33 IRFs of WPI Inflation to Monetary Policy Surprises (Excluding Overlaps with Macroeconomic Data Releases) 231
A.34 Impulse Response Functions of Goods Exports to Monetary Policy Surprises 232
A.35 Impulse Response Functions of Goods Exports to Monetary Policy Surprises (Excluding GFC Period) 232
A.36 Impulse Response Functions of Goods Imports to Monetary Policy Surprises 233
A.37 Impulse Response Functions of Goods Imports to Monetary Policy Surprises (Excluding GFC Period) 234
A.38 Impulse Response Functions of NIFTY to Monetary Policy Surprises 234
A.39 Impulse Response Functions of NIFTY to Monetary Policy Surprises (Excluding GFC Period) 235
A.40 Impulse Response Functions of overnight MIBOR to Monetary Policy Surprises 236
A.41 Impulse Response Functions of 10-year GSec Yield to Monetary Policy Surprises 236
A.42 Impulse Response Functions of USD-INR Exchange Rate to Monetary Policy Surprises . . 237
A.43 Impulse Response Functions of USD-INR to Monetary Policy Surprises (post-2011) 238
A.44 Impulse Response Functions of CPI Inflation to Monetary Policy Surprises 239
A.45 IRFs of Industrial Production to Monetary Policy Surprises (3m MIBOR-OIS) 241
A.46 IRFs of WPI Inflation to Monetary Policy Surprises (3m MIBOR-OIS) 242
A.47 IRFs of Industrial Production to Monetary Policy Surprises (1y MIBOR-OIS) 243
A.48 IRFs of WPI Inflation to Monetary Policy Surprises (1y MIBOR-OIS) 244

B.1 Response Rates in the CPHS, January 2014 to April 2023 249
B.2 Attrition of Wave 1 households in the CPHS, January 2014 to April 2023 249
B.3 Components of Formal and Informal borrowing in the CPHS, January 2014 to April 2020 . 250
B.4 Monetary policy surprises on unscheduled announcement dates 251

B.5 Impulse Response Function of Overnight MIBOR to Monetary Surprises 252
B.6 Impulse Response Function of Overnight MIBOR to Monetary Surprises (1-month) 252
B.7 Impulse Response Function of Overnight MIBOR to Monetary Surprises (1-year) 253
B.8 Impulse Response Functions of Consumption to Monetary Surprises (Total Expenditure) 253
B.9 Impulse Response Functions of Income and Consumption to Monetary Surprises (1-month) . . . 254
B.10 Impulse Response Functions of Income and Consumption to Monetary Surprises (1-year) 254
B.11 Impulse Response Functions of Aggregate Consumption to Monetary Surprises (Total Expenditure) 255
B.12 Impulse Response Functions of Aggregate Economic Outcomes to Monetary Surprises (1-month) 255
B.13 Impulse Response Functions of Aggregate Economic Outcomes to Monetary Surprises (1-year) . . 256
B.14 Impulse Response Functions of Household Consumption to Monetary Surprises by HR . . 257
B.15 Impulse Response Functions of Household Income to Monetary Surprises by HR 258
B.16 Financial inclusion and monetary policy transmission: OLS evidence (Q1 2014 DPC) 259
B.17 Financial inclusion and monetary policy transmission: OLS evidence (Total Expenditure) 260
B.18 Financial inclusion and monetary policy transmission: OLS evidence (1-month) 261
B.19 Financial inclusion and monetary policy transmission: OLS evidence (1-year) 262
B.20 Financial inclusion and monetary policy transmission: OLS evidence (credit per capita) 263
B.21 Financial inclusion and monetary policy transmission: OLS evidence (branches per 100,000 people) 264
B.22 Financial inclusion and monetary policy transmission: OLS evidence (formal borrowers in CPHS) 265
B.23 Currency chests and exposure to demonetization in India, 2016 267
B.24 Demonetization exposure and banking activity 268
B.25 Financial inclusion and monetary policy transmission: IV evidence 270

C.1 Market share of government owned banks in India, 1999-2016 272
C.2 Comparison of Prowess and BSR Lending Data, 2000-2016 273
C.3 Sectoral lending patterns of Indian banks, 1999-2016 275
C.4 Distribution of key banking variables in India, 2004 277
C.5 IFR in 2004 and Outstanding Infrastructure Loans (Continuous variables) 279
C.6 Distribution of outstanding infrastructure loans in India, 1999-2016 281
C.7 Proportion of districts with infrastructure lending by Indian banks, 1999-2016 282
C.8 Distribution of interest rates on outstanding infrastructure loans in India, 1999-2016 . . . 283
C.9 Distribution of NPAs as a share of total loans in India, 2016 284
C.10 Outstanding infrastructure lending by IFR group, 2003 - 2009 285
C.11 Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Lending Share . . 289

C.12 Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans [Triple Clustering] 291
C.13 Additional details on estimation of infrastructure lending interest rates, 1999-2016 293

Introduction

India is presently the world's most populous country and one of its largest economies. However, the limited availability of high-frequency and nationally representative data has historically restricted the ability of researchers to systematically study the economic consequences of macroeconomic policy, especially monetary policy, in the country. This thesis re-examines different aspects of monetary policy transmission in India, utilising recent advances in the availability of high-frequency and nationally representative economic data for India.

Existing empirical estimates of monetary policy transmission to aggregate demand in India suggest that it is either non-existent or inconsistent with standard macroeconomic theory. In the first chapter, using measures of monetary policy surprises derived from the Overnight Indexed Swap market in India, I document heterogeneity in the effects of monetary policy surprises measured on scheduled and unscheduled monetary policy announcement dates of the Reserve Bank of India. Higher interest rates on scheduled announcement dates lower stock prices and reduce forecasted and actual output as well as inflation. In contrast, measured monetary policy surprises on unscheduled announcement dates are predictable by past macroeconomic conditions, and higher interest rates on these dates are found to raise stock prices, output and inflation on impact. Moreover, unscheduled announcements are found to frequently coincide with important macroeconomic data releases. 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 to aggregate demand conditions in India, identified using monetary policy surprises on scheduled announcement dates, is found to be more theoretically consistent and significantly stronger than previously documented in the literature.

India, along with many other developing countries, has recently witnessed a significant increase in formal financial inclusion. How does financial inclusion shape the transmission of monetary policy? In the second chapter, co-authored with Vimal Balasubramaniam, we examine this question using a novel, nationally representative monthly panel of Indian households that tracks income and consumption expenditures, combined with administrative data on measures of formal financial access, and high-frequency, well-identified estimates of monetary policy surprises. We document strong, statistically significant, and persistent effects of monetary policy shocks on household outcomes at the sub-national level. Utilizing variation across both Indian regions and over time in measures of formal financial inclusion we document that regions with greater formal financial inclusion exhibit weaker transmission of monetary policy to household income and consumption in the months immediately following a policy surprise. We also find some evidence that improvements over time in formal financial access have weakened monetary policy transmission. These results point to an important role for general equilibrium effects in determining the impact of formal financial inclusion on monetary policy transmission in developing countries.

The final chapter, co-authored with Nirupama Kulkarni and Akshat Singh, considers how the Reserve Bank of India's monetary policy interacts with its regulatory and supervisory policies. We utilise branch-level administrative data on bank lending and the boom period of the 2000s in India as a laboratory. After long-term interest rates rose sharply in 2004, we document that banks with greater ex-ante investments in fixed-interest securities which they were required to report at market value on their balance sheets significantly increased their lending to the infrastructure sector. We find no evidence that these banks faced a differential increase in demand for infrastructure credit, pointing instead to an expansion in loan supply by banks that were more exposed to mark-to-market losses. Despite this increased exposure to the infrastructure sector, we find no systematic evidence that such banks subsequently ended up with more loan delinquencies. These results nonetheless highlight a potentially important tradeoff between exposure to mark-to-market and default risk for banks faced with a sudden increase in interest rates in the presence of mark-to-market accounting rules.

Each chapter contains a longer introduction and a literature review, as well as a concluding discussion.

Chapter 1

Macroeconomic Effects of Scheduled and Unscheduled Monetary Policy Surprises

Abstract

Using measures of monetary policy surprises 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 and reduce forecasted and actual output as well as inflation. In contrast, monetary policy surprises on unscheduled announcement dates are predictable by past macroeconomic conditions, and higher interest rates on these dates are found to raise stock prices, output and inflation on impact. Moreover, unscheduled announcements are found to frequently coincide with important macroeconomic data releases. 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 to aggregate demand conditions in India, identified using monetary policy surprises on scheduled announcement dates, is found to be more theoretically consistent and significantly stronger than previously documented in the literature.

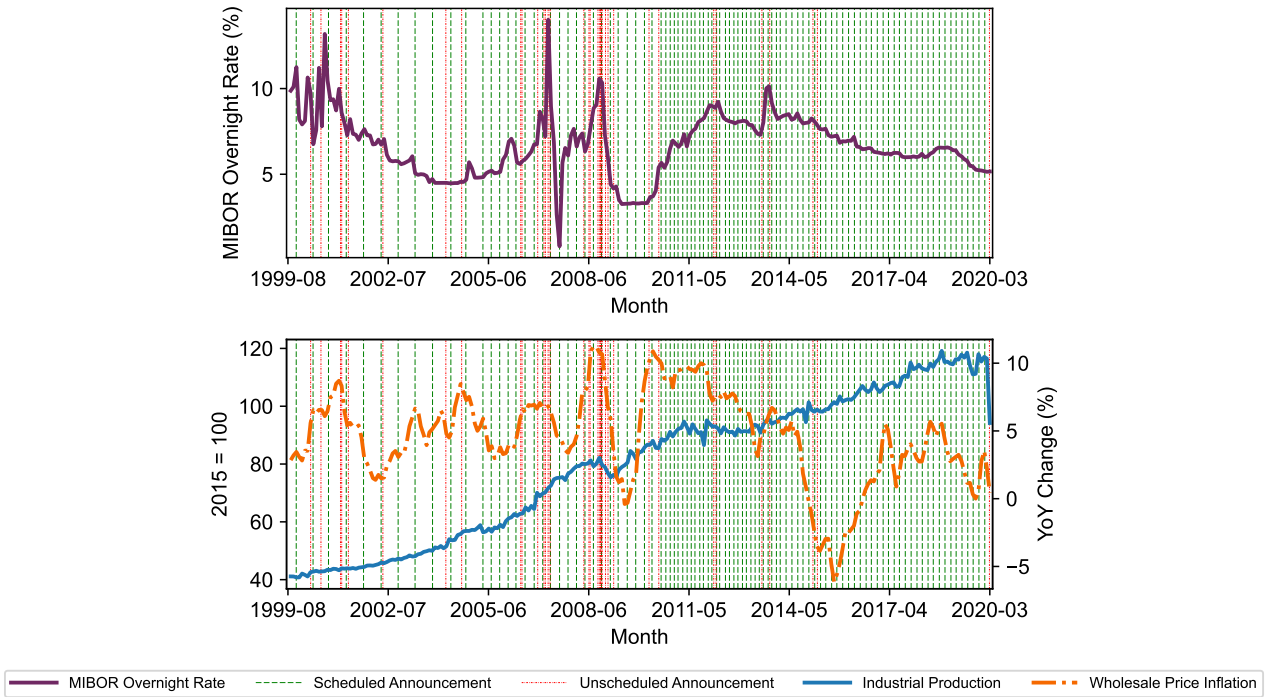
Acknowledgements:I am indebted to Chris Adam, Steve Bond, John Muellbauer and Bent Nielsen for their constant guidance and support. I also thank Sergio de Ferra, Andrea Ferrero, Gabriel Pombal Fritsch, Joe Hazell, Chris Hyland, Rustam Jamilov, Aeimit Lakdawala, Simon Lloyd, Michael McMahon, Silvia Miranda-Agrippino, Emi Nakamura, Golaka C Nath, Adrian Pagan, Rajeswari Sengupta, Gautham Udupa and William Witheridge as well as seminar participants at IGIDR, 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 referenced URLs were accessed on the dates indicated. Some may no longer be active due to subsequent website reorganization. All errors are my own.

1.1 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 occasionally make announcements about monetary policy outside these scheduled intervals in response to changing economic conditions. The timing of these unscheduled announcements is typically unanticipated by financial market participants and hence they 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 measured 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 a unique 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 1.1 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, especially during the 2008 Global Financial Crisis.

Figure 1.1: 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.

Using measures of monetary policy surprises derived 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 lower inflation. Following an unexpected 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 these monetary policy surprises.

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 the expectations 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 output and inflation on impact. Further, the responses of stock prices and consensus forecasts revisions of key macroeconomic variables are also in the opposite direction to the effects on scheduled announcement dates, although these point estimates are not statistically significant.

A useful framework for interpreting these differences is provided by the literature on the information effects of monetary policy announcements (Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020; Miranda-Agrippino and Ricco, 2021; Bauer and Swanson, 2023b). Monetary policy announcements reveal not only the central bank's policy stance but also its assessment of current and future economic conditions. Measured monetary policy surprises can therefore reflect not just surprise policy changes but also surprise information about economic conditions (or the central bank's assessment of these conditions).

Although this identification problem applies to both scheduled and unscheduled announcements, it is likely to be more severe on unscheduled dates. Scheduled announcements follow a regular, pre-announced calendar, allowing financial market participants to incorporate previously released economic information into their expectations. By contrast, the timing of an unscheduled announcement may itself be endogenous to unforeseen economic or financial market developments. Changes in MIBOR-OIS rates on unscheduled dates may therefore contain more information about prevailing economic conditions, making it harder to isolate exogenous changes in monetary policy.

[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).

This paper provides direct evidence consistent with this mechanism. More than half of the unscheduled monetary policy announcements coincided with the release of macroeconomic data, such as industrial production and inflation. In addition, both the direction and the magnitude of measured monetary policy surprises on unscheduled announcement dates are shown to be predictable by past macroeconomic conditions. We do not find evidence for such systematic endogeneity of monetary policy surprises measured on scheduled announcement dates. This makes it difficult to disentangle the effects of monetary policy surprises from the effects of news about the other macroeconomic conditions on unscheduled announcement dates, under relatively standard data availability conditions in emerging markets.

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 almost 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 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 rely 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 in India suggest that it is either non-existent or in a theoretically inconsistent direction (Mishra et al., 2016; Lakdawala and Sengupta, 2025). This paper documents 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 measured monetary policy surprises on unscheduled announcement to other contemporaneous developments. Monetary policy transmission to aggregate demand conditions in India, identified using monetary policy surprises on scheduled announcement dates only, is found to be broadly consistent with standard macroeconomic theory and significantly stronger than previously documented. In contrast, measured 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.

While this paper presents evidence of significant heterogeneity in the effects of monetary policy surprises measured on scheduled and unscheduled announcement dates, it does not establish that scheduled monetary policy surprises are completely free from endogeneity concerns. The delayed decline in inflation following a surprise tightening on scheduled announcement dates especially points to potential endogeneity concerns on scheduled announcement dates also.[2] Instead, this paper suggests that endogeneity concerns are likely to be significantly more severe on unscheduled announcement dates than on scheduled announcement dates, thereby requiring unscheduled monetary policy surprises to be handled with greater caution in the empirical analysis of monetary policy transmission.

[2] Using narrower time-windows around monetary policy announcements to measure monetary policy surprises and purging the measured monetary policy surprises of contemporaneous public and private information used by the central bank in its decision making could help to mitigate these concerns, but is outside the scope of this paper's central argument.

1.1.1 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 found statistically significant and economically meaningful effects of monetary policy on inflation and output, or in other words, aggregate demand in India. This has been commonly attributed to a wide range of factors ranging from fiscal dominance of monetary policy (Acharya, 2020) to government 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 (2025), 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 MIBOR-OIS rates up to 1 year ahead on monetary policy announcement dates into target and path factors, capturing respectively the contemporaneous 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. They 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 recent work of Lakdawala and Sengupta (2025) along four key dimensions. First, 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. Second, it distinguishes between monetary policy surprises measured on scheduled and unscheduled announcement dates of the RBI. Utilizing changes in the 1-month MIBOR-OIS fixed rate to measure changes in contemporaneous monetary policy, this paper finds statistically significant differences in the macroeconomic effects of monetary policy surprises measured on scheduled and unscheduled announcement dates. Monetary policy transmission in India, measured using only scheduled monetary policy surprises, is found to be much stronger than previously documented.

Third, this paper also adopts the Local Projections (LP) approach of Jordà (2005) to estimate the effects of monetary policy surprises on macroeconomic variables. As recent work by Plagborg-Møller and Wolf (2021) has shown, with finite lag lengths, LP specifications can provide more reliable estimates of the dynamic effects of monetary policy surprises than VAR models, particularly for time horizons exceeding the lag lengths. 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 mon-

etary policy on the expectations of economic agents, which can be an important channel through which monetary policy affects macroeconomic outcomes.

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 apparent 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, and focusing on scheduled monetary policy announcements.

These results are also in line with recent evidence on monetary transmission in emerging economies from Checo et al. (2024), who suggest theoretically consistent and economically meaningful effects of monetary policy on financial and macroeconomic variables in a sample of 18 emerging market economies, using a measure of monetary policy surprises constructed from Bloomberg forecasts of monetary policy announcements. Since forecasters are required to submit their forecasts in advance of the monetary announcement, the Bloomberg forecasts from professional forecasters are typically available only for scheduled monetary policy announcements. This paper provides evidence that a potentially important reason for the strong effects of monetary policy surprises on macroeconomic variables in emerging economies documented by Checo et al. (2024) is the consequent exclusion of unscheduled monetary policy announcements in these forecast-based measures 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 domestic 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.[3] 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. Miranda-Agrippino and Ricco (2021) also point to the revelation of private information about the Fed's assessment of economic conditions as an important component of measured monetary policy surprises. This paper suggests that the endogeneity of monetary policy surprises to contemporaneous macroeconomic news can be especially severe on unscheduled announcement dates, as unscheduled announcements are more likely to take place during periods when important macroeconomic information is revealed.

On the other hand, 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 from publicly available information about contemporaneous economic conditions, driven particularly by market misperceptions about the Fed's reaction function. This paper provides evidence from a novel context that the omitted variables bias could be particularly problematic on unscheduled announcement dates, where the endogeneity of measured monetary policy surprises to contemporaneous macroeconomic developments is found to be much higher than on scheduled dates.

1.1.2 A reader's guide

The rest of the paper is structured as follows. Section 1.2 outlines the theory underlying the identification of monetary policy surprises from the OIS market. Section 1.3 describes the MIBOR-OIS data and the monetary policy surprises on scheduled and unscheduled RBI announcement dates. Section 1.4 provides evidence on the sources of monetary policy surprises in India. Section 1.5 presents event-study evidence on transmission of monetary policy to financial market variables. Section 1.6 discusses the effects of monetary policy surprises on consensus forecasts of key macroeconomic variables. Section 1.7 documents the effects of monetary policy surprises on macroeconomic variables, particularly output and inflation. Section 1.8 concludes.

[3] Faust et al. (2004) is an early paper that provides some suggestive evidence that monetary policy surprises on unscheduled announcement dates may be endogenous to other contemporaneous information. However, unlike in the present paper, they do not provide systematic evidence of heterogeneity in the effects of monetary policy surprises measured on scheduled and unscheduled announcement dates and its implications for monetary policy transmission.

1.2 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 interdependencies* 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 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 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 RBI. This is similar in spirit to work on high-frequency identification in the US by Nakamura and Steinsson (2018). An advantage of this method 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.[4]

Monetary policy surprises are derived from the Overnight Indexed Swap (OIS) market for India. This is following the work of Lakdawala and Sengupta (2025), 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. OIS are a special type of interest rate swap contract and are widely used worldwide by banks and other financial institutions to swap their risky, floating interest rate income streams for fixed rate payments.

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

[4] Evidence on the effects of monetary policy surprises measured using the 3-month and 1-year MIBOR-OIS contracts can be found in Appendix A.2.1 and Appendix A.2.2 respectively.

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 (2021) 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.

In contrast, 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, unlike futures contracts such as Fed Funds futures which are tied to the average overnight rate over a fixed calendar month, OIS contracts reference the overnight rate over the specified contract duration and can be initiated on a continuous basis. 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 (change from one day before to one day after the monetary policy announcement) is used to compute monetary policy surprises in this study, for reasons explained in greater detail below.[5] In this context, identification of monetary policy surprises requires the following three identification assumptions, following Lloyd (2021):

Assumption 1: *No-arbitrage pricing* of the fixed leg of the MIBOR-OIS contract;
Assumption 2: *Rational expectations* about the *expected future path* of the floating interest rate of the MIBOR-OIS contract;
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 an n-day MIBOR-OIS contract starting at date t. The monetary policy surprise on an-

[5] 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 announcement.

nouncement 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*:

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

Proof: Let $i^{fixed}_{t,t+n}$ and $i^{float}_{t,t+n}$ be the fixed and floating rates on an 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.[6] 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 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 every day:[7]

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

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:[8]

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

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

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

[8] 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). Furthermore, it is assumed here for simplicity here that monetary policy actions of the central bank have no effect on term or risk premia. Recent evidence from Bauer et al. (2023) suggests that the effects of monetary policy on risk premia are an important channel of monetary policy transmission. Allowing for this would imply that the monetary policy surprise would also include the change in the risk premia caused by the monetary policy action, but identification of the monetary policy surprise would still require no changes to the risk premia caused by any other contemporaneous source of information during the event window.

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

$$\epsilon^m_{n,t} \equiv i^{fixed}_{t+1,t+1+n} - i^{fixed}_{t-1,t-1+n} = \left(\mathbb{E}_{t+1}\left[i^{float}_{t+1,t+1+n}\right] + \lambda_{t+1,t+1+n}\right) - \left(\mathbb{E}_{t-1}\left[i^{float}_{t-1,t-1+n}\right] + \lambda_{t-1,t-1+n}\right)$$

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

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

□

As of March 2020, the MIBOR-OIS market was the largest over-the-counter derivatives market in India.[9] 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. Additional details about the MIBOR-OIS market in India can be found in Appendix A.1.1.

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 returns 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 would be possible to isolate the monetary policy surprise by comparing MIBOR-OIS fixed rates just before and after a monetary policy announcement is made. However, such high-frequency time-stamped data is not available in a consistent fashion for the full time period under study.[10]

Moreover, 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.[11]

Using a two-day window comes with its own identification challenges. The typical time window that is

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

[10] Intraday tick-by-tick data on RBI announcement dates is available for the Bloomberg Generic Composite quote beginning in July 2011.

[11] In Appendix A.7.1, monetary policy surprises constructed using one-day and two-day windows are compared against each other, highlighting the possibility for mis-measurement of monetary policy surprises when using a one-day window. The possibility for mis-measurement is particularly acute on unscheduled announcement dates, as such announcements were more likely to be made after market hours. As an example, on 15 July 2013, the RBI announced a significant and unanticipated increase in the MSF/Bank Rate by 200 basis points after market hours, while also announcing other measures to tighten liquidity to the financial system [http://bit.ly/4nqv35Z, accessed 25 October, 2025]. Using a one-day window in this case leads to a severe underestimation of the monetary policy surprise, which stands at 0.04% using a one-day window, while it is 2.735% using a two-day window. In contrast, on scheduled announcement dates, the monetary policy surprises constructed using one-day and two-day windows are found to be very similar to each other.

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 measured monetary policy surprises to the choice of a narrower time window is an important avenue for future research.

Hence, *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. However, 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.

1.3 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.

1.3.1 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.[12]

[12] December 10, 2015, is excluded from the sample as it involved only the issuance of an RBI notification specifying operational details of a series of SLR cuts already announced on September 29, 2015. Dates of changes in the operational and implementation frameworks governing monetary policy instruments are also excluded from the sample, unless they are also accompanied by a change in the monetary policy instruments themselves. An exception to this is the inclusion of a set of unscheduled announcement dates in June 2006, March 2007 and April 2007 when the RBI made changes to the rate of interest paid on CRR balances held by banks in excess of the statutory minimum, which may affect liquidity conditions by themselves, but also explicitly stated that it would maintain the status quo with regard to the CRR rate. There were two announcements made regarding the interest rate on CRR balances in April 2007, one on the 4th of April, reducing the interest rate on eligible CRR balances from 1% p.a. to 0.5% p.a. from the fortnight beginning April 14, 2007 and the second on the 20th of April completely removing interest payments on CRR balances from the fortnight beginning March 31, 2007. Only the latter is included in the sample since it supersedes the first and contains no explicit information of the RBI's stance regarding the CRR except to re-state the implementation of a CRR change announced on March 30, 2007. Furthermore, the effects of the first announcement do not affect market expectations of interbank interest rates for a 1-month contract for more than 4 days, as interest on CRR balances were usually paid at the end of the calendar month. The IRFs of output and inflation on unscheduled announcement dates presented in Section 1.7 are robust to completely excluding months with administrative announcements marked in Table 1.1.

Dates of open market operations and speeches by the Governor of the RBI were not considered in constructing this sample but represent a potential area for future research (Swanson, 2023; Swanson and Jayawickrema, 2023).[13] A total of 133 monetary policy announcements were identified between August 1999 and March 2020. The series commences in August 1999 since the data on MIBOR-OIS is only available from this month. This is the longest sample of monetary policy announcements in India to date.

1.3.2 Scheduled and unscheduled announcement dates

Monetary policy announcement dates are classified into scheduled and unscheduled announcement dates. Scheduled announcement dates are those announcement dates which formed part of the RBI's regular schedule of reviews of monetary policy. 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 when 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. As previously discussed, this is on account of a lack of official publicly available time-stamps for monetary policy announcements in the sample.

Out of 133 announcement dates, 97 were scheduled announcement dates and 36 were unscheduled announcement dates. Table 1.1 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. A few unscheduled announcements were also undertaken in response to fiscal policy and recent macroeconomic data. Furthermore, there were 19 instances of unscheduled announcement dates coinciding with the release of important macroeconomic data.

1.3.3 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*

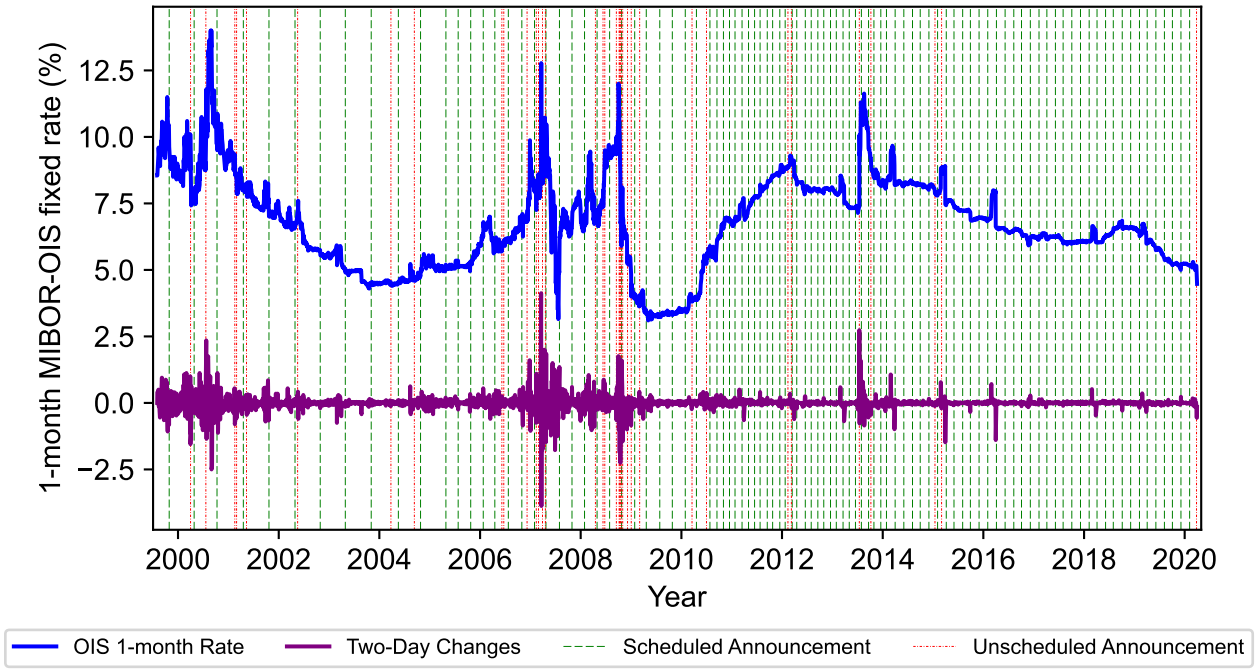
[13] Dates of changes in variable rate repo and reverse repo are also not included in the sample. This includes the period between June 2000 and the permanent introduction of fixed rate repo and reverse repo facilities by the RBI in March 2004, when the repos were conducted principally through variable rate auctions. Since the changes in repo and reverse repo rates during this period were determined on a daily basis and were partly market-determined, they are not included in the sample as they are not discrete monetary policy events. Moreover, the monetary policy stance was communicated more through the CRR and Bank Rate during this period. The results presented in this paper are not driven by this choice, with the key IRFs presented later in the paper robust to restricting the sample to start only in April 2004 with the introduction of the fixed rate repo and reverse repo facilities.

Table 1.1: 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

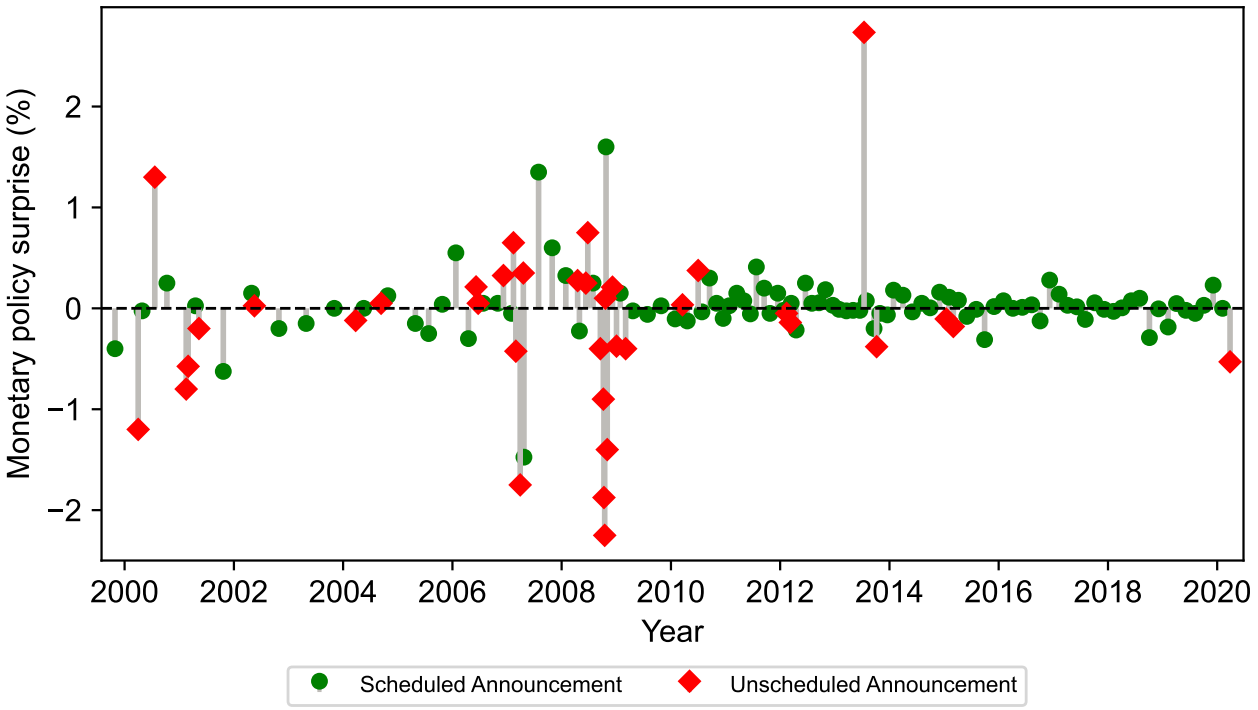
Notes: Unscheduled monetary policy announcements of the RBI were identified from the archive of RBI press releases available at https://rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx and the monetary policy surprises were computed using the two-day change in the 1-month MIBOR-OIS fixed rate on these dates. The 1-month MIBOR-OIS fixed rate was obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. † indicates that there was a macroeconomic data release during the two-day window around the monetary policy announcement. See Appendix A.10 for more details regarding overlaps.

Figure 1.2: 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.

Figure 1.3: 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 1.2: 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.

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). The results from measuring monetary policy surprises using instead the 3-month and 1-year MIBOR-OIS contracts are considered in further detail in Appendix A.2.1 and Appendix A.2.2 respectively.

Since the MIBOR-OIS contracts are traded over-the-counter, there is no centralised repository of time-stamped data on OIS trades for a number of years in the time period under study.[14] It is therefore important to note, while interpreting the results, that the monetary policy surprises are measured using the daily end-of-day market quotes rather than actual market trades.[15]

Figure 1.2 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.[16] 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 1.3 plots the monetary policy surprises calculated using a two-day window around monetary policy announcement dates of the RBI. Table 1.2 shows the summary statistics for OIS rate changes on scheduled and unscheduled announcement dates during periods with different frequencies of scheduled announce-

[14]There is a trade repository of all interest rate swap contracts maintained by the Clearing Corporation of India (CCIL) which commenced only in 2007.

[15]While in principle, the use of end-of-day quotes should allow for the identification of monetary policy surprises using a narrower one-day time window even for announcements made after trading hours, in practice, the end-of-day quotes are usually not updated beyond 5 pm IST (as verified for the time period for which such tick-by-tick data is available). Hence, using a two-day window is necessary for accurate measurement of monetary policy surprises, particularly for unscheduled announcements made late in the evening.

[16]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 1.3: Auto-correlation of monetary policy surprises on RBI Announcement Dates

	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 slope coefficients being zero is reported. For the estimations with scheduled and unscheduled dates, lags of the respective type of announcement dates are used.

ments. 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 (2025) have already noted, the movements in the one-month OIS rates were particularly large during the 2007-2009 period coinciding with the financial crisis.[17]

Monetary policy shocks are traditionally conceived in macroeconomic models to be random disturbances to the system which are typically not auto-correlated.[18] 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 measured monetary policy surprises. 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. To check the auto-correlation 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 an event study context.

Table 1.3 displays the results of a regression of the monetary policy surprise on its own first and second

[17] A comparison of the measured monetary policy surprises to those constructed by Lakdawala and Sengupta (2025) is presented in Appendix A.7.3. There is a strong positive correlation between the monetary policy surprises constructed in this paper and the Target Factor measure using two-day windows constructed by Lakdawala and Sengupta (2025), with a correlation coefficient of 0.98.

[18] 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.

lags on scheduled and unscheduled announcement dates.[19] There is no statistically significant auto-correlation between successive monetary policy surprises on either type of 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 in Appendix A.1.2 further confirms that even when the monetary surprises are aggregated to a monthly frequency, there is no statistically significant auto-correlation of monetary policy surprises on scheduled and unscheduled announcement dates.

1.4 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 measured 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 measured 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 measured 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:** 2-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 2-month change in IIP until 3 months before the monetary policy announcement is used.[20]

2. **Wholesale Price Index:** 2-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

[19] For inference and construction of confidence intervals for individual regression coefficients, heteroskedasticity-robust (HC1) standard errors and the associated t-statistics are used throughout the paper unless otherwise noted.

[20] Data on IIP release dates are sourced from Bloomberg Terminal's Economic Release Calendar for India, the online archive of the Press Information Bureau of the Government of India, available at archive.pib.gov.in/archive2/ and the online archive of the Ministry of Statistics and Programme Implementation (MoSPI) of the Government of India. The IIP release date is assumed to be the 12th of the month or the working day immediately preceding the 12th for months whose IIP data release dates are not available.

announcements made before the WPI release date for the month, the 2-month change in WPI until two months before the monetary policy announcement is used.[21]

3. **Rainfall:** 2-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:** 42-trading day change in the spread between the 10-year and 1-year Government Security (GSec) yields until the day before the monetary policy announcement.[22]

5. **Stock Market Returns:** 42-trading day log-change in the BSE SENSEX stock market index until the day before the monetary policy announcement.

6. **Exchange Rate:** 42-trading 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 stabilising '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 1.4. The reported F-statistics for the pooled and scheduled samples suggest that the monetary policy surprises are not predictable by key macroeconomic indicators that would typically enter a Taylor rule in the Indian context, like proxies for output growth and inflation. However, the results for the unscheduled monetary policy announcements suggest that past macroeconomic conditions are predictive of monetary policy surprises at the 1% level. In particular, periods of excess rainfall and faster growth in industrial output in the past few months are predictive of larger contractionary monetary policy surprises on unscheduled announcement dates.

Tables A.22 and A.23 in Appendix A.2.3 confirm that this heterogeneity in the predictability of monetary policy surprises by macroeconomic variables is robust to measuring monetary policy surprises using the 3-month and 1-year MIBOR-OIS contracts respectively. Moreover, these results are also robust to the exclusion of large monetary policy surprises and surprises during the Global Financial Crisis period, as well as monetary policy surprises which overlap with FOMC announcements, as shown in Tables A.43 and A.49. Furthermore, these results are also robust to the exclusion of monetary policy surprises coinciding with macroeconomic data releases as shown in Appendix A.10.

This adds to the evidence presented in Table 1.1 which documents the reasons cited by the RBI for unscheduled monetary policy announcements. The most common reasons cited, as previously discussed,

[21] Data on WPI release dates are sourced from Bloomberg Terminal's Economic Release Calendar for India, the online archive of the Press Information Bureau of the Government of India, available at archive.pib.gov.in/archive2/ and the online archive of the Office of Economic Advisor to the Department for the Promotion of Industry and Internal Trade (DPIIT) of the Government of India. Monthly releases of WPI data only commenced in November 2009. For the period before November 2009, there were weekly WPI releases with an approximately two-week time lag and hence the monthly WPI release date is approximated as the 14th of the month or the working day immediately following the 14th.

[22] 42-trading day changes are chosen to approximate the 2-month change in the variables with daily data, since there are usually around 251 trading days in a calendar year.

related to liquidity conditions in various financial markets. Moreover, as shown in Table 1.1 and documented in more detail in Appendix A.10, more than 50% of the unscheduled monetary policy announcements in the sample coincide with releases of macroeconomic data, particularly data on IIP and WPI. Hence, monetary policy surprises on unscheduled announcement dates are likely to be highly correlated with recent or contemporaneous information about 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. The endogeneity to past macroeconomic variables and contemporaneous macroeconomic news 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 the most recent forecasts for key macroeconomic indicators available at the time of the monetary policy announcement is tested in Table 1.5. 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 very small 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 Indian monetary policy surprises by previous US monetary policy surprises is considered in Table 1.6. There were 19 instances, documented in Appendix Table A.26, where there was an FOMC announcement within a two-day window around RBI announcements.[23] 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 most recent 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.

1.5 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) and MacKinlay (1997), 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-

[23] Appendix A.3, also considers an alternative identification scheme for monetary policy surprises in India, using the forward premium, proposed by Witheridge (2024).

Table 1.4: Predictability of Monetary Policy Surprises by Macroeconomic Data

	Pooled	Scheduled	Unscheduled
Intercept	–0.070	0.093*	–0.701***
	(0.063)	(0.050)	(0.204)
Δln (IIP) (2m)	1.684	0.256	8.869*
	(1.762)	(1.568)	(4.855)
Δln (WPI) (2m)	1.827	–1.574	5.084
	(2.558)	(1.963)	(4.145)
Drought (2m)	0.007	0.027*	–0.152
	(0.017)	(0.014)	(0.099)
Excess Rain (2m)	0.046	–0.019	0.739***
	(0.043)	(0.014)	(0.110)
Δ (10Y-1Y GSec Spread) (2m)	0.094	0.094	0.068
	(0.144)	(0.139)	(0.288)
Δln (*SENSEX*) (2m)	1.321**	0.223	0.569
	(0.632)	(0.658)	(1.117)
Δln (*USD* – *INR*) (2m)	1.569	2.785	–0.414
	(2.749)	(2.057)	(4.808)
F-statistic	1.038	0.828	15.645
p-value	0.408	0.567	0.000
R^2	0.086	0.108	0.600
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 2-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, online archives of PIB and MoSPI of the Government of India 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 2-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, online archives of PIB and Office of Economic Advisor to DPIIT of the Government of India and for months when 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 two months (in 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 two-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 two-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 42-trading 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 42-trading 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 42-trading 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 slope coefficients being zero is reported.

Table 1.5: 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 slope 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.

Table 1.6: Predictability of RBI Monetary Policy Surprises by FOMC 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. Data up to the end of 2019 is used in the analysis because the FOMC surprises from Bauer and Swanson (2023b) are only available until then.

Table 1.7: 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 A.5.1.

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 1.7 shows the mean of the absolute percentage changes and the standard deviation of the percentage changes in the 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.[24] 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. The sources of the daily datasets are documented in further detail in Appendix A.5.1.

Compared to non-announcement dates, the variance of the percentage changes in these financial market variables, except the exchange rate (discussed in more detail below), is 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 around 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.

[24] In the event study regressions, references to percentage changes in bond yields should be interpreted as changes in percentage points. For all other outcome variables, references to percentage changes denote changes in percentage terms.

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. Additional descriptive statistics on the daily financial market variables used in the event study regressions are provided in Appendix A.6.

Figure 1.4 documents the results of the event study regressions for selected financial market variables on all, scheduled and unscheduled monetary policy announcement dates of the RBI.[25] While it is common practice to pool scheduled and unscheduled announcement dates in event study regressions, the results in this paper will suggest that this may not be appropriate, at least 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, particularly including unscheduled announcements, which they indicate may be less well identified.

Monetary policy surprises are strongly positively correlated with changes in government bond yields at maturities of 1 year, 5 years and 10 years, on all, 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, 2025; 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.

However, 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.[26] In particular, the response on scheduled announcement dates is statistically significant and negative while the point estimates on unscheduled announcement dates are positive but not statistically significant at the 10% level.[27] As a result, given that measured monetary policy surprises on unscheduled announce-

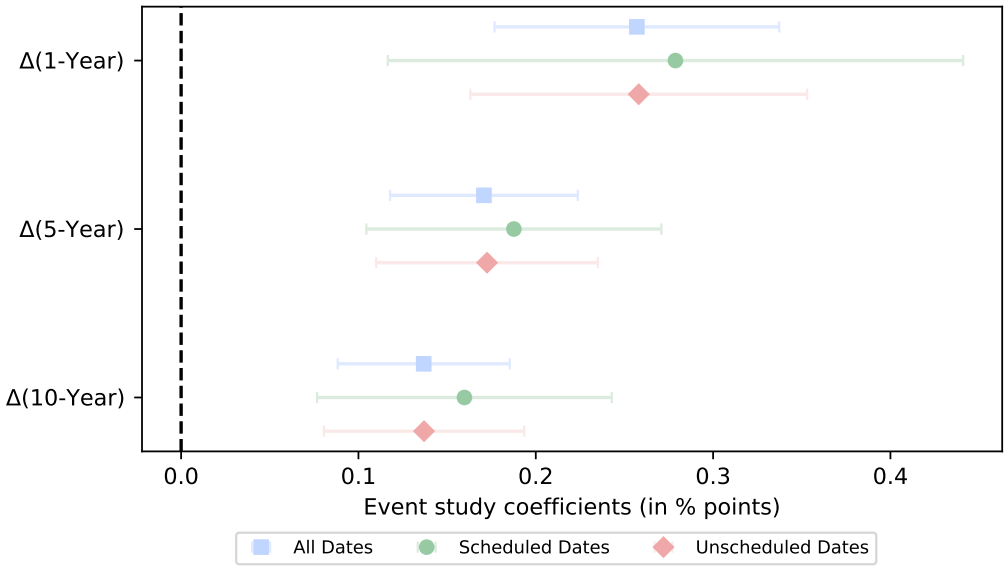
[25] Detailed regression tables on which the event study plot in Figure 1.4 is based can be found in Appendix A.1.3. Furthermore, the heterogeneity in the response of stock prices are found not just on impact, but they are also found to persist at least for a few months, as documented for the case of NIFTY in Figure A.38 in Appendix A.11.1.

[26] Furthermore, the differences in the responses of the stock market indices to monetary policy surprises on scheduled and unscheduled announcement dates are also found to be statistically significant at the 10% level, using a t-test on the interaction term in an augmented event study specification estimated on the sample of all monetary policy announcement dates, which regresses the change in the bond yield or asset price on the monetary policy surprise, an indicator for whether the monetary policy announcement was scheduled and the interaction between the monetary policy surprise and this indicator for scheduled announcements. Prabu A. et al. (2016) also examine stock-market reactions to monetary policy surprises on unscheduled announcement dates using a shorter sample period (2004–2014) and one-day event windows, while making an effort to account for the precise timing of RBI monetary policy announcements, and report negatively-signed statistically significant effects for some indices under certain specifications, although their baseline event study results are not statistically significant. Since the RBI does not publish official release timestamps for monetary policy announcements, a uniform two-day window, as previously noted, is used as a consistent, transparent and conservative measure that ensures the full market reaction is captured regardless of the precise timing of the announcement.

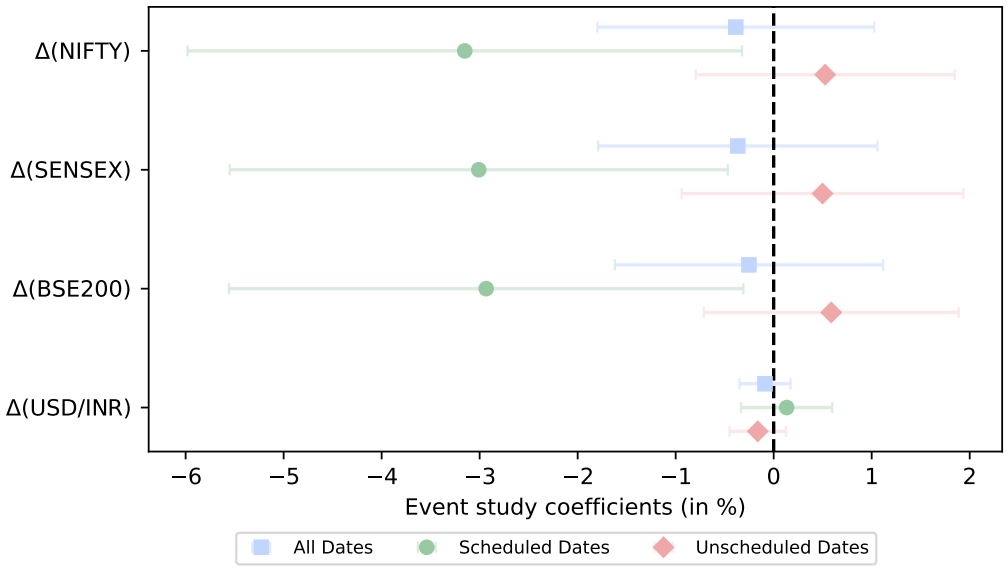
[27] The results of the event study specifications with monetary policy surprises measured using the 3-month and the 1-year MIBOR-OIS rates are discussed in greater detail in Appendix A.2.1 and Appendix A.2.2 respectively. The results, particularly using the 3-month MIBOR-OIS rate, are very similar to the results from the main specification. Furthermore, in Appendix A.9, it is documented that the observed heterogeneity in the estimated effects of monetary policy surprises on financial market variables on scheduled and unscheduled announcement dates is robust to the exclusion of large monetary policy surprises and surprises during the Global Financial Crisis. However, it is important to note here that the effects of monetary policy surprises are par-

Figure 1.4: Event Study Regressions for Financial Market Variables

(a) Government Security (GSec) Yields



(b) Asset Prices and Exchange Rate



Notes: This figure shows the results of OLS regressions of the two-day percentage change in selected financial market variables on the monetary policy surprises on all, scheduled and unscheduled monetary policy announcement dates of the RBI. The coefficient on the monetary policy surprise variable is reported along with 90% confidence intervals based on heteroskedasticity-robust standard errors. 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. Detailed regression results relating to these figures are documented in Appendix A.1.3.

ment dates are significantly larger in magnitude than those on scheduled announcement dates, the pooled event study regression results in weaker, statistically insignificant effects on stock prices.

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 also have the effect of reducing asset prices and increasing yields in response to higher interest rates.[28] 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 measured from the MIBOR-OIS market on unscheduled announcement dates are potentially endogenous to other contemporaneous economic conditions.

Finally, the response of the US dollar exchange rate is weak and not statistically significant in the event study regressions for all three samples. 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 low R^2 values in the event study regressions for stock prices relative to the bond yields (see Appendix A.1.3), 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 effects 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 windows around monetary policy announcements (Bernanke and Kuttner, 2005).

These event-study results, especially on asset prices, are also consistent with measured monetary policy surprises on unscheduled announcement dates being highly correlated with other macroeconomic information, and especially relative to the monetary policy surprises measured on scheduled announcement dates.[29] Changes in MIBOR-OIS fixed rates on unscheduled announcement dates are likely to contain significantly more information about economic conditions compared to the policy stance than those on

ticularly strong on stock prices during the Global Financial Crisis period, with the estimated effects of tighter monetary policy surprises on scheduled announcement dates causing much smaller stock price declines (around 0.5%) outside this period of uncertainty and with these estimates no longer being statistically significant. Moreover, the event study regression results on scheduled and unscheduled announcement dates are also robust to the exclusion of RBI monetary policy announcement dates overlapping with FOMC announcement dates.

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

[29] In Appendix A.10, it is shown that an important explanation for the positive point estimates in the event study specifications for asset prices on unscheduled announcement dates is the overlap of unscheduled monetary policy announcements with macroeconomic data releases.

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 may be important to use separate weights for scheduled and unscheduled announcement dates.

1.6 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 A.4.1. 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 a measure of the monetary policy surprise between the survey dates of months t and $t+1$. This specification is estimated using data for the 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 in which the dependent variable is the revision to forecasts of outcomes in the following financial year, 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 is 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 in which both types of announcements take place.[30]

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 forecast 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).

Figure 1.5 documents 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, scheduled and unscheduled announcement dates of the RBI.[31]

There is a statistically significant negative response of current and next year GDP growth forecasts to monetary policy surprises 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 the first systematic evidence for India that higher policy interest rates are associated with a decline in private sector expectations of economic prospects.[32] However, on unscheduled announcement dates, the point estimates are economically negligible (revisions of less than 5 basis points) and not statistically significant.[33] Pooling the two types of announcements together leads to statistically insignificant effects on growth forecast revisions.

The estimated effects of monetary policy surprises on investment growth forecasts are negative on scheduled announcement dates, and for the next financial year, they are larger than the response of GDP growth. The corresponding point estimates on unscheduled announcement dates are very small for the current

[30] The possibility for such correlation is examined in further detail in Appendix A.7.2. 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 A.4.4.

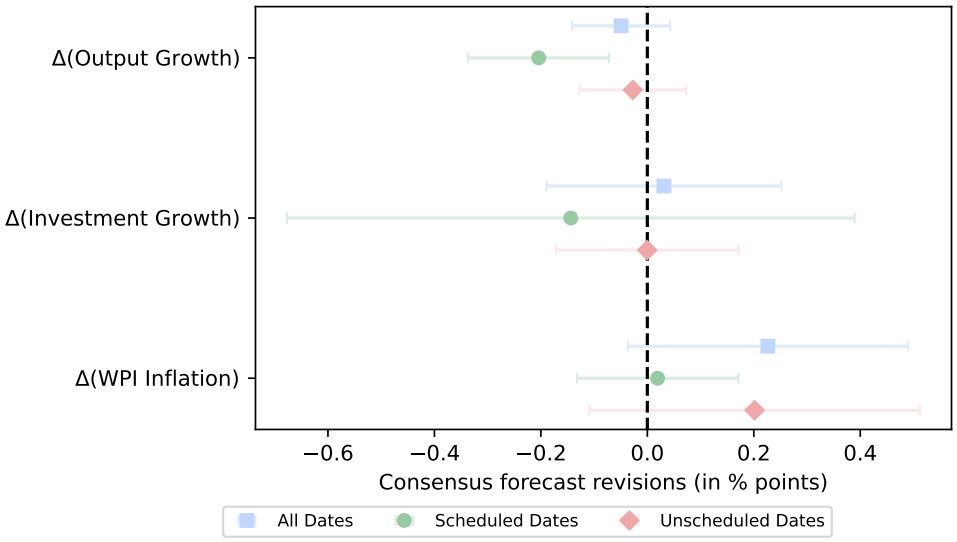
[31] Detailed regression tables on which Figure 1.5 is based are documented in Appendix A.1.4.

[32] 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. In Appendix A.10, it is shown that these results are also robust to the exclusion of observations where the monetary policy announcement date overlaps with the release of macroeconomic data. Furthermore, unlike the event-study evidence on asset prices, the effects on output growth forecast revisions continue to remain statistically significant even after excluding large monetary policy surprises and surprises during the Global Financial Crisis, as documented in Appendix A.9.

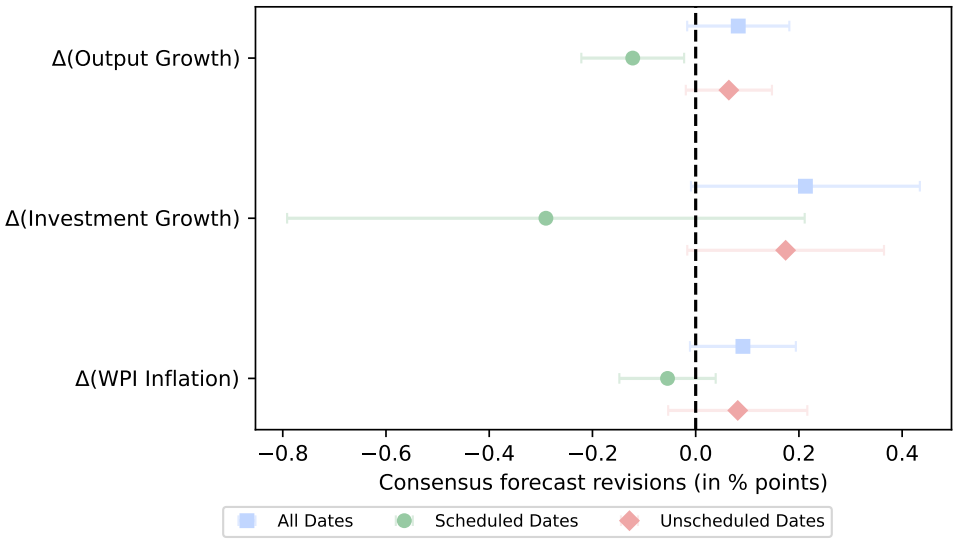
[33] Moreover, the differences in the responses of consensus output growth forecast revisions to monetary policy surprises on scheduled and unscheduled announcement dates are also found to be statistically significant at the 10% level, using a Wald test in a regression specification which pools together the sample of all months during which there were scheduled or unscheduled monetary policy surprises, and regressing consensus forecast revisions on both scheduled and unscheduled monetary policy surprises in each of these months (with appropriate time weights).

Figure 1.5: Consensus Forecast Revisions and Monetary Policy Surprises

(a) Current FY Consensus Forecasts



(b) Next FY Consensus Forecasts



Notes: This figure 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, scheduled and unscheduled announcement dates of the RBI. The coefficients on the monetary policy surprise are reported along with 90% confidence intervals based on heteroskedasticty-robust standard errors. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. For the regressions on scheduled announcement dates, all scheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy surprises which occur during the same period. Similarly, for the regressions on unscheduled announcement dates, all unscheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of scheduled monetary policy 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. Detailed regression results relating to these figures are documented in Appendix A.1.4.

financial year but larger and positive for the next financial year. However, the estimated effects on investment growth forecasts are not statistically significant at the 10% level. The pooled sample results again lead to statistically insignificant point estimates for the investment growth forecast revisions, similar in magnitude to the responses on unscheduled announcement dates.

The estimated effects of monetary policy surprises on the WPI inflation forecasts are 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.

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. These results suggest heterogeneity in the response of financial markets and professional forecasters to measured surprises following scheduled and unscheduled RBI monetary policy announcements. Importantly, even on scheduled announcement dates, the ability of higher interest rates to lower inflation expectations in India is quite weak, suggesting that the effects of monetary policy surprises on inflation expectations are not very strong.[34]

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 growth and investment growth (although not statistically significant) 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 measured using scheduled announcement dates on output and investment growth expectations are negative, suggesting that endogeneity of monetary policy surprises to other contemporaneous information may be less of a concern on scheduled announcement dates in India.

The responses of the forecast variables to unscheduled monetary policy announcements appear to be either insignificant or in the opposite direction, suggesting that the monetary policy surprises on unscheduled announcement dates may not be well identified in the Indian context. Concerns about endogeneity and confounding other correlated shocks with monetary policy surprises appear to be much stronger on unscheduled announcement dates compared to scheduled announcement dates. Some additional results on the responses of consensus forecasts to monetary policy surprises are presented in Appendix A.4.2 and A.4.3.

1.7 Monetary policy transmission to output and inflation

What are the effects of the measured 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 Re-

[34]The results for the consensus forecast regressions with monetary policy surprises measured using 3-month and 1-year MIBOR-OIS rates are shown in Appendix A.2.1 and Appendix A.2.2 respectively. They confirm the heterogeneity in the effects of monetary policy surprises on scheduled and unscheduled announcement dates. The observed heterogeneity in the estimated effects are also generally robust to (i) the exclusion of large monetary policy surprises and surprises during the Global Financial Crisis, (ii) controlling for FOMC monetary policy surprises during the month and (iii) focusing only on months with monetary policy announcements of a given type as documented in Appendix A.9.

sponse 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 measured monetary policy surprises, they lack the statistical power to identify the long-run effects of monetary policy (see Table 1.2). 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 for outcome 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.[35] 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 A.5.2. The IRFs are estimated using a Local Projection (LP) specification of the following form (Jordà, 2005):

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

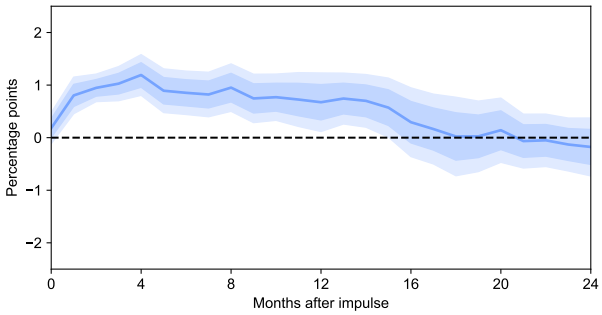
for $h = \{0, 1, 2, ..., 24\}$. $\left\{\epsilon_{1M,t-k}^m\right\}_{k=0}^{12}$ represent the monthly sum of the changes in the 1-month MIBOR-OIS rates on monetary policy announcement dates of a given type in month $t-k$. $\mathbf{X_t}$ consists of a set of additional control variables: (i) A measure 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.[36]

[35] 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.

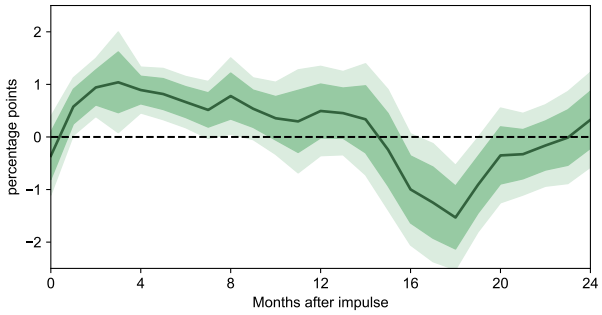
[36] The control for the contemporaneous surprise of the other type is not included in the specification with all announcement dates. Also note that while the equation above is used as the basis for the LP estimation on scheduled and unscheduled announcement dates, the main results are very similar when lags of the monetary policy surprises are not included as controls or when lags of the other type of monetary policy surprise are included as additional controls, unless otherwise specified.

Figure 1.6: Impulse Response Functions of 1-month MIBOR-OIS fixed rate to Monetary Policy Surprises

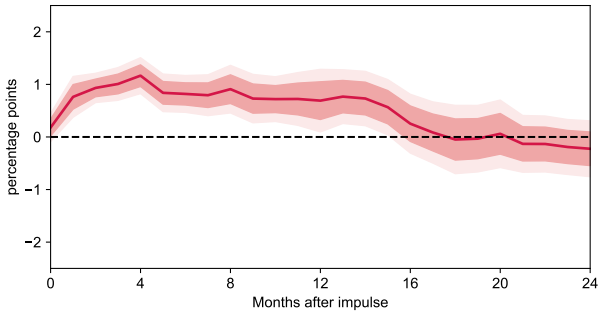
(a) All Dates



(b) Scheduled Dates



(c) Unscheduled Dates



Notes: This figure shows the impulse responses of the 1-month MIBOR-OIS to a 100-basis point contractionary monetary policy surprise on all, scheduled and unscheduled announcement dates of the RBI. The dependent variable is the monthly average of the 1-month MIBOR-OIS fixed rate. 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 1.7. 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.

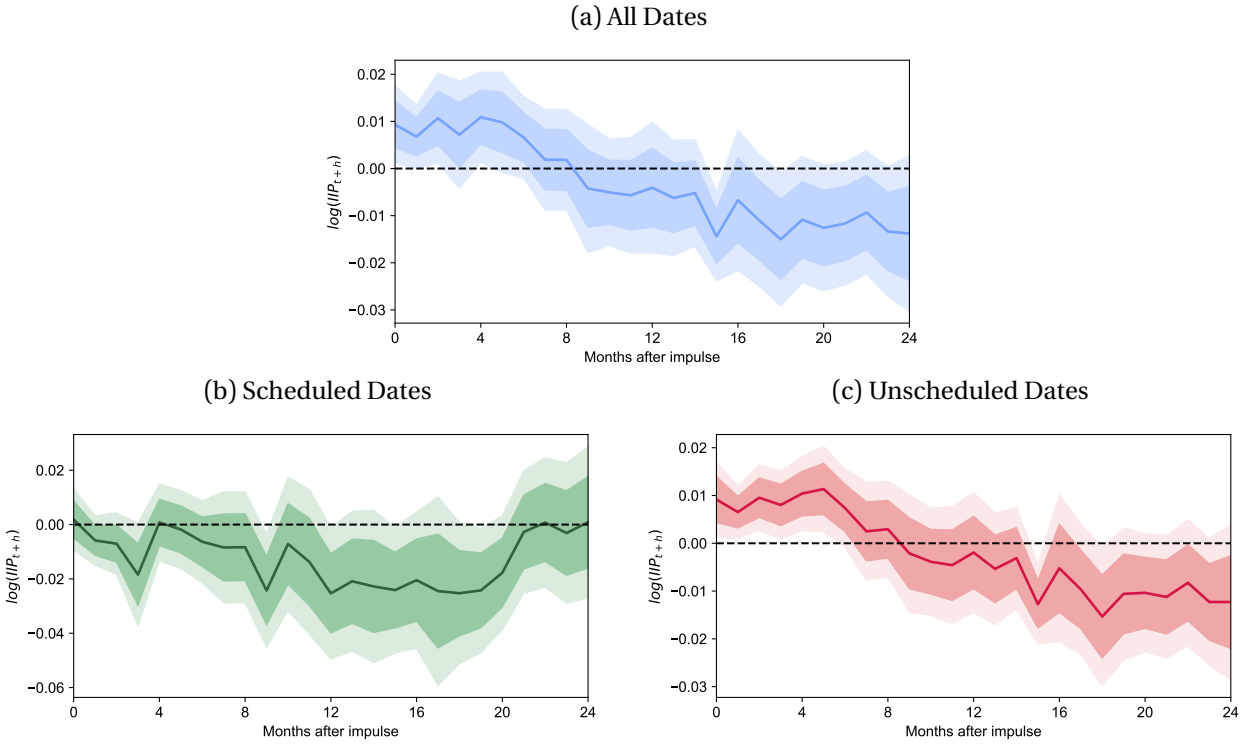
The controls for the lagged values of the relevant monetary policy surprise series, as well as measures of liquidity and volatility in the MIBOR-OIS market, are included to improve the precision of inference on the IRFs. The lagged dependent variable is included as a control, following Montiel Olea and Plagborg-Møller (2021), so that valid confidence intervals for the IRFs can be constructed using heteroskedasticity-robust standard errors. The inclusion of control variables in the LP specification is kept to a minimum to understand the average effects of measured monetary policy surprises on all, scheduled and unscheduled announcement dates on macroeconomic outcomes.

The IRF of interest is given by the series of regression coefficients: $\left\{\beta_0^h\right\}_{h=0}^{24}$. IRFs are separately estimated using monetary policy surprises on all, scheduled and unscheduled announcement dates of the RBI using the LP specification outlined above.

Before considering the effects on output and inflation, Figure 1.6 first plots the IRFs of the 1-month MIBOR-OIS fixed rate to the monetary policy surprises. The dependent variable in these regressions is the monthly average of the 1-month MIBOR-OIS. On both scheduled and unscheduled announcement dates, a surprise monetary policy tightening leads to an increase in the 1-month MIBOR-OIS fixed rate and this persists in both cases for just over 12 months.[37] This suggests that interest rates respond reasonably persistently, on

[37] While the responses are mostly similar in terms of their persistence, shape and magnitudes across scheduled and unscheduled announcement dates, the scheduled announcement IRF exhibits a decline in the interest rate about 18 months following the initial surprise tightening before gradually returning to baseline. However, in both cases, the peak effect on the 1-month MIBOR-

Figure 1.7: 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 all, 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 1.7. 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.

average, to measured monetary policy surprises and tend not to be immediately reversed by subsequent central bank actions. The response of the 1-month MIBOR-OIS fixed rate to monetary policy surprises on all announcement dates is therefore similar in shape to the responses on scheduled and unscheduled announcement dates.

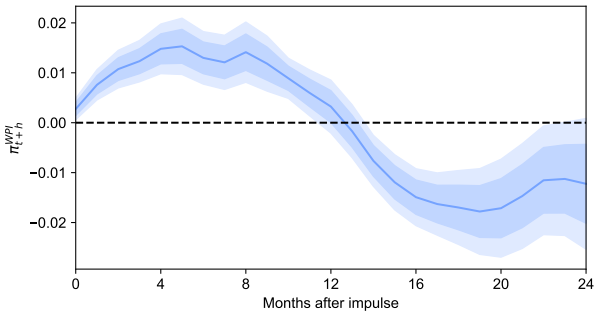
Figure 1.7 plots the IRFs of the Index of Industrial Production (IIP) to the monetary policy surprises. The dependent variable in these regressions is the Index of Industrial Production (in log-levels). On scheduled announcement dates, a 100-basis point contractionary monetary policy surprise leads to a decline in the IIP which persists for close to 24 months, with a maximum, statistically significant effect of around 2.5%, occurring between 12 and 18 months after the initial impulse.

In contrast, for unscheduled announcement dates, there is a statistically significant increase in IIP in the initial few months following the same 100 basis points monetary policy surprise. The response of IIP to measured surprises on unscheduled announcement dates is consistent with the potential endogeneity of unscheduled monetary policy surprises to lagged and contemporaneous developments in the economy, as documented in Section 1.4. Due to the larger magnitude of the measured monetary policy surprises

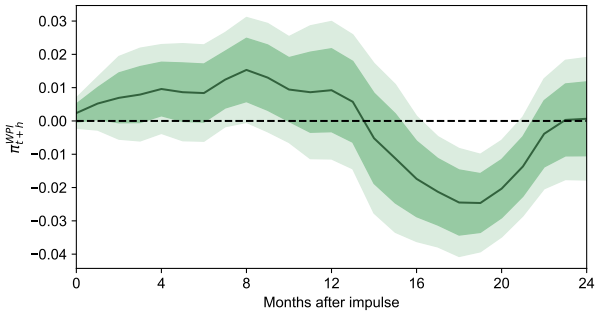
OIS fixed rate to a 100 basis points monetary policy surprise is close to 100 basis points. In terms of differences in magnitudes of the dynamic responses of the 1-month MIBOR-OIS fixed rates to a monetary policy surprise on scheduled and unscheduled announcement dates, these tend to remain within a 15-35 basis points range following a 100 basis points monetary policy surprise throughout the period during which the effects of the monetary policy surprises persist.

Figure 1.8: Impulse Response Functions of WPI Inflation to Monetary Policy Surprises

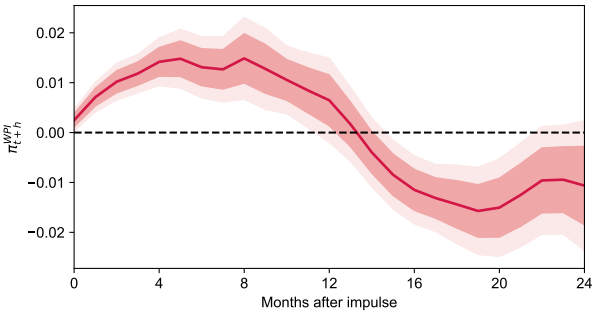
(a) All Dates



(b) Scheduled Dates



(c) Unscheduled Dates



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 all, 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 1.7. 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.

on unscheduled announcement dates, these surprises dominate the response of IIP in the full sample of announcement dates, leading to a potentially misleading representation of the dynamic responses of IIP to monetary policy surprises.[38]

Figure 1.8 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, there is a statistically significant decline in inflation 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.[39] This suggests

[38] Moreover, the difference in the responses of IIP to monetary policy surprises on scheduled and unscheduled announcement dates are also found to be statistically significant at the 10% level, using a Wald test on the baseline Local Projection specification, estimated without the lags of the monetary policy surprises. This parsimonious specification treats scheduled and unscheduled surprises symmetrically and avoids imposing potentially different dynamic structures across the two types of announcements while testing for differences in their effects.

[39] While the effect of monetary policy surprises on scheduled announcement dates is found to be mostly statistically indistinguishable from zero for the first 12 months after the monetary policy surprise under the baseline specification, this result is quite fragile to the inclusion of additional control variables, notably 12 lags of monetary policy surprises on unscheduled announcement dates. This compresses the confidence intervals and leads to a statistically significant positive effect on inflation for this period, even though the magnitude and shape of the impulse response function is largely unaffected.

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. There is a statistically significant increase in inflation in the first few months following an unscheduled monetary policy surprise. The magnitude and precision of the estimated response of inflation in the months immediately following an unscheduled monetary policy announcement further suggest the potential endogeneity of unscheduled monetary policy surprises to lagged and contemporaneous developments in the economy. As with IIP, the full sample IRFs for WPI inflation are dominated by the responses on unscheduled announcement dates, leading to a potentially misleading representation of the dynamic responses of WPI inflation to monetary policy surprises.[40]

The similarity of the estimated IRFs for WPI inflation on scheduled and unscheduled announcement dates suggests the possibility of unobserved endogeneity to macroeconomic conditions also affecting monetary policy surprises measured on scheduled announcement dates. However, as the responses of other output-adjacent variables to monetary policy surprises on scheduled and unscheduled announcement dates discussed so far suggest, the non-monetary information content of monetary policy surprises measured on unscheduled announcement dates is likely to be considerably greater than for surprises measured on scheduled announcement dates.[41]

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

In Appendix A.8.1 and Appendix A.8.2, the IRFs for output and inflation are estimated using sign restrictions on the responses of high-frequency financial market variables to monetary policy surprises, following Jarociński and Karadi (2020) and Acosta (2023) respectively. These sign restrictions attempt to control for the potential endogeneity of monetary policy surprises to new information about the state of the economy. The heterogeneity in the effects of monetary policy surprises on scheduled and unscheduled announcement dates is robust to the use of the sign restricted specifications as well, suggesting that endogeneity to past macroeconomic conditions may be a major source of bias in the estimation of the effects of monetary policy surprises in India.

In addition, in Appendix A.9, the heterogeneity in the effects of monetary policy surprises on scheduled

[40] As an additional caveat, it is important to note here that while the response of WPI inflation is statistically significant in a theoretically inconsistent direction in the first year in response to unscheduled monetary policy surprises, the difference in this response relative to what is found for scheduled announcement dates is not statistically significant at the 10% level using a Wald test on the baseline Local Projection specification estimated without the lags of the monetary policy surprises. This parsimonious specification treats scheduled and unscheduled surprises symmetrically and avoids imposing potentially different dynamic structures across the two types of announcements while testing for differences in their effects. Overall, this suggests that the differences in the WPI inflation responses on scheduled and unscheduled announcement dates are less pronounced than for the output-adjacent variables considered thus far in the paper.

[41] It is important to note here that part of the inflation response to monetary policy surprises on scheduled announcement dates may also reflect the true response of inflation to monetary policy surprises, especially given the possibility of monetary policy surprises to act as cost-push shocks in the Indian context, due to the nature of capital controls on equity and debt markets in India, a possibility which is further discussed in Appendix A.11.

and unscheduled announcement dates is also shown to be robust to: (i) the exclusion of large surprises and surprises during the global financial crisis, (ii) surprises overlapping with FOMC announcements and (iii) months with both scheduled and unscheduled monetary policy announcements.[42]

Furthermore, in Appendix A.10, the IRFs for output and inflation are also shown to be robust to the exclusion of observations where the monetary policy announcement date overlaps with the release of important macroeconomic data. These results also suggest that there are potentially additional unobserved sources of endogeneity to contemporaneous economic news and endogeneity to past macroeconomic conditions (as already documented in Section 1.4) driving the responses of macroeconomic variables to monetary policy surprises on unscheduled announcement dates.

Additionally, in Appendix A.11.1, the responses of a range of other macroeconomic variables to the monetary policy surprises on scheduled and unscheduled announcement dates are considered. These results also broadly confirm the heterogeneity in the effects of monetary policy surprises on scheduled and unscheduled announcement dates. Finally, in Appendix A.11.2, the robustness of the IRFs to the use of 3-month and 1-year MIBOR-OIS rates as measures of monetary policy surprises is considered, and these results too confirm the heterogeneity in the effects of monetary policy surprises on scheduled and unscheduled announcement dates.

This section provides evidence using MIBOR-OIS surprises on scheduled announcement dates that monetary policy has persistent, statistically significant and economically meaningful effects on aggregate demand in India. The results suggest that the absence of existing evidence for strong monetary policy transmission in India is not necessarily evidence of its absence.

1.8 Conclusion

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

The effects of scheduled monetary policy surprises are relatively more 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 (with a lag) decline. The magnitude of the estimated effects suggests that monetary policy transmission in India is stronger than previously estimated. In contrast, the effects of monetary policy surprises on unscheduled announcement dates are not well identified and estimated to be mostly inconsistent with the effects of scheduled monetary policy surprises. Asset prices, forecasted and actual output and inflation appear to increase on impact following an unscheduled surprise increase in interest rates. The unscheduled monetary policy surprises are however found to be strongly

[42] However, it is important to note here that when large surprises and surprises during the Global Financial Crisis are excluded in Appendix A.9.1, there is insufficient statistical power left on scheduled announcement dates to detect statistically significant effects of monetary policy surprises on IIP and WPI inflation, even though the shape of the IRFs are still in the theoretically expected direction.

predictable by past macroeconomic conditions, coincide frequently with macroeconomic data releases, and are also potentially strongly correlated with other contemporaneous real shocks, making them unsuitable for direct use as measures of monetary policy surprises.

These results have important implications for the identification of the causal effects of monetary policy from high-frequency data, particularly in developing country settings with a large number of unscheduled announcements.[43] While the central bank may choose to keep monetary policy unchanged on scheduled announcement dates, unscheduled monetary policy announcements are almost always associated with a change in monetary policy. This bias towards action on unscheduled announcement dates creates a *tradeoff between power and identification* for the econometrician. Measured monetary policy surprises on unscheduled announcement dates are 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 rely 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.

At this stage, it is also important to note that this paper is limited in its scope. It is an attempt at more refined measurement of the effects 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 provide any evidence on the mechanics of how monetary policy transmits in India but merely contributes towards improving measurement of the facts of monetary policy transmission.

Moreover, while this paper points to important differences in the endogeneity of measured monetary policy surprises on scheduled and unscheduled announcement dates to other macroeconomic information, it does not claim to fully resolve this endogeneity problem. Identifying plausibly exogenous variation in interest rates to identify the causal effects of monetary policy in developing countries remains an important direction for future research. The monetary policy surprises constructed in this paper could serve as a useful input for this endeavour.

[43] Another country with a similarly large number of unscheduled monetary policy announcements is China, as discussed by Kamber and Mohanty (2018). Recent evidence on monetary transmission from high-frequency identification in China from He et al. (2024) has been found to be mixed, with conventionally signed effects on inflation but non-existent effects on output. This suggests that systematic endogeneity in monetary policy surprises from unscheduled announcement dates, though still important, may be less influential in that context.

Bibliography

A., Edwin Prabu, Indranil Bhattacharyya, and Partha Ray, "Is the stock market impervious to monetary policy announcements: Evidence from emerging India," *International Review of Economics & Finance*, 2016, *46*, 166–179.

Acharya, Viral V., "Fiscal Dominance: A Theory of Everything in India," *Indian Public Policy Review*, 2020, *1* (2), 1–15.

Acosta, Miguel, "The Perceived Causes of Monetary Policy Surprises," *Working Paper*, 2023.

Adam, Christopher, Andrew Berg, Bin Grace Li, Peter Montiel, and Stephen O'Connell, "VAR meets DSGE: Uncovering the Monetary Transmission Mechanism in Low-Income Countries," *IMF Working Paper*, 2016, *WP/16/90*.

Barnichon, Régis and Geert Mesters, "A Sufficient Statistics Approach for Macro Policy," *The American Economic Review*, 2023, *113* (11), 2809–2845.

Bauer, Michael D. and Eric T. Swanson, "An Alternative Explanation for the "Fed Information Effect"," *The American Economic Review*, 2023, *113* (3), 664–700.

_ and _, "A Reassessment of Monetary Policy Surprises and High-Frequency Identification," *NBER Macroeconomics Annual 2022*, May 2023, *37*, 87–155.

_ , Ben S. Bernanke, and Eric Milstein, "Risk Appetite and the Risk-Taking Channel of Monetary Policy," *Journal of Economic Perspectives*, 2023, *37* (1), 77–100.

Bernanke, Ben S. and Kenneth N. Kuttner, "What Explains the Stock Market's Reaction to Federal Reserve Policy?," *Journal of Finance*, 2005, *60* (3), 1221–1257.

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

Bloomberg, "Bloomberg Currency Data Disclaimers," https://www.bloomberg.com/notices/currency-data/ 2023. Accessed: 2023-12-28.

Borio, Claudio, "Getting up from the floor," *BIS Working Paper*, 2023, *1100*.

Castillo-Martinez, Laura and Ricardo Reis, "How Do Central Banks Control Inflation? A Guide For the Perplexed," *Working Paper*, 2024.

Chari, Anusha, Karlye Dilts Stedman, and Christian Lundblad, "Taper Tantrums: Quantitative Easing, Its Aftermanth, and Emerging Market Capital Flows," *The Review of Financial Studies*, 2021, *34* (3), 1445–1508.

Checo, Ariadne, Francesco Grigoli, and Damiano Sandri, "Monetary Policy Transmission in Emerging Markets: Proverbial Concerns and New Evidence," *Working Paper*, 2024.

Choy, Wai Kin, "Introducing overnight indexed swaps," *Reserve Bank of New Zealand Bulletin*, 2003, *66* (1), 34–39.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans, "Monetary policy shocks: What have we learned and to what end?," in John B. Taylor and Michael Woodford, eds., *Handbook of Macroeconomics*, Vol. 1A, Amsterdam: Elsevier, 1999, pp. 65–148.

Cochrane, John H., *Asset Pricing*, revised ed., Princeton: Princeton University Press, 2005.

Coibion, Olivier and Yuriy Gorodnichenko, "Information Rigidity and the Expectations Formation Process: A Simple Framework and New Facts," *The American Economic Review*, 2015, *105* (8), 2644–2678.

Das, Satadru, Jay Surti, and Shekhar Tomar, "Does Inflation Targeting Help Information Transmission?," *SSRN Electronic Journal*, 2020.

Dua, Pami, "Monetary Policy Framework in India," *Indian Economic Review*, 2020, *55* (1), 117–154.

Faust, Jon, Eric T. Swanson, and Jonathan H. Wright, "Do Federal Reserve Policy Surprises Reveal Superior Information about the Economy?," *Contributions to Macroeconomics*, 2004, *4* (1).

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

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

Garga, Vaishali, Aeimit Lakdawala, and Rajeswari Sengupta, "Assessing Central Bank Commitment to Inflation Targeting: Evidence from Financial Market Expectations in India," *Federal Reserve Bank of Boston Working Paper*, 2022.

Goyal, Ashima and Prashant Parab, "Central Bank Communications and Professional Forecasts: Evidence from India," *Journal of Emerging Market Finance*, 2021, *20* (3), 308–336.

Gürkaynak, Refet S., Brian T. Sack, and Eric T. Swanson, "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements," *International Journal of Central Banking*, 2005, *1* (1), 55–93.

_ , _ , and _ , "Market-Based Measures of Monetary Policy Expectations," *Journal of Business & Economic Statistics*, 2007, *25* (2), 201–212.

Hack, Lukas, Klodiana Istrefi, and Matthias Meir, "Identification of Systematic Monetary Policy," *Working Paper*, 2023.

He, Jianyao, Dun Jia, Kai Li, and Wenbin Wu, "A High-Frequency Measure of Chinese Monetary Policy Shocks," *Working Paper*, 2024.

Hicks, John R., *Value and Capital*, Oxford: Clarendon Press, 1939.

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

Jarociński, Marek and Peter Karadi, "Deconstructing Monetary Policy Surprises - The Role of Information Shocks," *American Economic Journal: Macroeconomics*, 2020, *12* (2), 1–43.

Kamber, Gunes and M S Mohanty, "Do interest rates play a major role in monetary policy transmission in China?," *BIS Working Paper No. 714*, 2018.

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

Kumar, Arun Vishnu and Rituraj, "Assessing the future path of monetary policy from Overnight Indexed Swap (OIS) rates," *Reserve Bank of India Bulletin*, 2021, *75* (2), 73–84.

Kuttner, Kenneth N., "Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market," *Journal of Monetary Economics*, 2001, *47* (3), 523–544.

Lakdawala, Aeimit and Rajeswari Sengupta, "Measuring Monetary Policy Shocks in Emerging Economies: Evidence from India," *Journal of Money, Credit and Banking*, 2025, *57* (2-3), 407–437.

Lloyd, Simon P., "Overnight indexed swap-implied interest rate expectations," *Finance Research Letters*, 2021, *38*, 101430.

Lucas, Robert E., "Econometric Policy Evaluation: A Critique," *Carnegie-Rochester Conference Series on Public Policy*, 1976, *1*, 19–46.

_ , "Asset Prices in an Exchange Economy," *Econometrica*, 1978, *46* (6), 1429–1445.

MacKinlay, A. Craig, "Event Studies in Economics and Finance," *Journal of Economic Literature*, 1997, *35* (1), 13–39.

Mathur, Aakriti and Rajeswari Sengupta, "Analysing monetary policy statements of the Reserve Bank of India," *IGIDR Working Paper*, 2019, *2019* (012).

McKay, Alisdair and Christian Wolf, "What Can Time-Series Regressions Tell Us About Policy Counterfactuals?," *Econometrica*, 2023, *91* (5), 1695–1725.

Melosi, Leonardo, "Signaling Effects of Monetary Policy," *The Review of Economic Studies*, 2017, *84* (2), 853–884.

Miranda-Agrippino, Silvia and Giovanni Ricco, "The Transmission of Monetary Policy Shocks," *American Economic Journal: Macroeconomics*, July 2021, *13* (3), 74–107.

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

_ , _ , and Antonio Spilimbergo, "Monetary Transmission in Low Income Countries," *IMF Working Paper*, 2012, *WP/10/223*.

_ , _ , and Rajeswari Sengupta, "Monetary Policy Transmission in Developing Countries: Evidence from India," *IMF Working Paper*, 2016, *16* (167).

Muth, John F., "Rational Expectations and the Theory of Price Movements," *Econometrica*, 1961, *29* (3), 315–335.

Nakamura, Emi and Jon Steinsson, "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect," *The Quarterly Journal of Economics*, January 2018, *133* (3), 1283–1330.

Nath, Golaka C., "Mumbai Inter-Bank Overnight Rate: Benchmark Calculation and Methodology," *CCIL Monthly Newsletter*, 2018, *February 2018*.

Olea, José Luis Montiel and Mikkel Plagborg-Møller, "Local Projection Inference is Simpler and More Robust than You Think," *Econometrica*, 2021, *89* (4), 1789–1823.

Òscar Jordà, "Estimation and Inference of Impulse Responses by Local Projections," *The American Economic Review*, 2005, *95* (1), 161–182.

Óscar Jordà, Sanjay R. Singh, and Alan M. Taylor, "The Long-Run Effects of Monetary Policy," *NBER Working Paper*, 2020, *26666*.

Ottonello, Pablo and Thomas Winberry, "Financial Heterogeneity and the Investment Channel of Monetary Policy," *Econometrica*, 2020, *88* (6), 2473–2502.

Pagan, Adrian, "Econometric Issues in the Analysis of Regressions with Generated Regressors," *International Economic Review*, 1984, *25* (1), 221–247.

Patra, Michael Debabrata and Partha Ray, "Inflation Expectations and Monetary Policy in India: An Empirical Exploration," *IMF Working Paper*, 2010, *10* (84).

Pirozhkova, Ekaterina, Giovanni Ricco, and Nicola Viegi, "Trouble Every Day: Monetary Policy in an Open Emerging Economy," *Working Paper*, 2024.

Plagborg-Møller, Mikkel and Christian K. Wolf, "Local Projections and VARs Estimate the Same Impulse Responses," *Econometrica*, 2021, *89* (2), 955–980.

Rajan, Raghuram G., "Fighting Inflation," *Reserve Bank of India Bulletin*, 2014, *68* (3), 11–20.

Ramey, V.A., "Macroeconomic Shocks and Their Propagation," in John B. Taylor and Harald Uhlig, eds., *Handbook of Macroeconomics*, Vol. 2, Amsterdam: Elsevier, 2016, pp. 71–162.

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

Rey, Hélène, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence," *NBER Working Paper*, 2015, *21162*.

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

Sargent, Thomas J., *Rational expectations and inflation*, third ed., Princeton: Princeton University Press, 2013.

Sinha, Prabhakar, "Rates to harden further," *The Times of India*, 2007. 21st March 2007.

Solís, Pavel, "Does the Exchange Rate Respond to Monetary Policy in Mexico? Solving an Exchange Rate Puzzle in Emerging Markets," *Journal of Money, Credit and Banking*, December 2023, *55* (8), 2093–2113.

Swanson, Eric T., "The Macroeconomic Effects of the Federal Reserve's Conventional and Unconventional Monetary Policies," *NBER Working Paper*, 2023, *31603*.

_ **and Vishuddhi Jayawickrema**, "Speeches by the Fed Chair Are More Important Than FOMC Announcements: An Improved High-Frequency Measure of U.S. Monetary Policy Shocks," *Working Paper*, 2023.

Taylor, John B., "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, 1993, *39*, 195–214.

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

Witheridge, William, "Monetary Policy and Fiscal-led Inflation in Emerging Markets," *Working Paper*, 2024.

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

Chapter 2

Financial Inclusion and Monetary Policy Transmission: Evidence from Indian Households

(Co-authored with Vimal Balasubramaniam)

Abstract

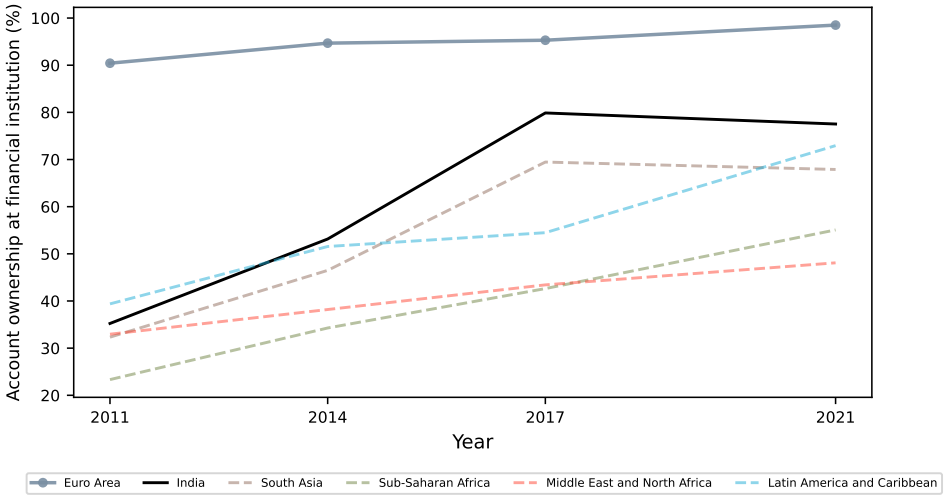
How does financial inclusion shape the transmission of monetary policy? We examine this question using a novel, nationally representative monthly panel of Indian households that tracks income and consumption expenditures, combined with administrative data on measures of formal financial access, and high-frequency, well-identified estimates of monetary policy surprises. We document strong, statistically significant, and persistent effects of monetary policy shocks on household outcomes at the sub-national level. Utilizing observed cross-regional and time series variation in formal financial access we document that regions with greater formal financial inclusion exhibit weaker transmission of monetary policy to household income and consumption in the months immediately following a policy surprise. These results point to an important role for general equilibrium effects in determining the effect of formal financial inclusion on monetary policy transmission in developing countries.

Acknowledgements: We thank Chris Adam, Steve Bond, Michael McMahon, John Muellbauer, Bent Nielsen and participants at the Oxford Macroeconomics Workshop for their valuable comments. We thank Apoorv Gupta for kindly sharing the data on currency chests and bank branches at the time of demonetization in India. We also thank Manas Vaidya, and CAFRAL for hosting Narayan and enabling access to the CPHS data. Narayan gratefully acknowledges financial support from the Clarendon Fund and Nuffield College. All errors are our own.

2.1 Introduction

The past decade has witnessed a rapid and widespread expansion in formal financial inclusion throughout the developing world. These changes have been driven both by government policy aimed at improving financial access for previously excluded populations as well as through the emergence of digital technologies that have reduced the costs of financial access. Figure 2.1 documents the time-series of the evolution of formal financial access, measured specifically here as the proportion of individuals with access to an account at a formal financial institution, in major developing regions of the world between 2011 and 2021. For reference, financial inclusion in the Euro Area is also shown. There has been a significant increase in formal financial inclusion, measured in this way, in every single major developing region in the world over this period, significantly closing the gap with advanced economies.

Figure 2.1: Account ownership at a formal financial institution, 2011 to 2021



Notes: This figure plots the evolution of the proportion of surveyed individuals in different regions of the world who are aged 15 and over and own an account (by themselves or together with someone else) at a bank or another type of financial institution or report personally using a mobile money service in the past year. The data comes from multiple rounds of the World Bank Global Findex survey between 2011 and 2021 and is available for download here: https://www.worldbank.org/en/publication/globalfindex/Data. The country codes to access the series used above are: Euro Area [**EMU**], India [**IND**], South Asia [**SAS**], Sub-Saharan Africa [**SSA**], Middle East and North Africa [**MNA**] and Latin America and the Caribbean [**LAC**]. The data series plotted above can be accessed through the variable name [**Account (% age 15+)**].

An extensive literature in development economics studies the implications of such improvements in financial access for economic growth and economic development (Burgess and Pande, 2005; Ji et al., 2023; Agarwal et al., 2023b; Chander et al., 2024; Fonseca and Matray, 2024; Cramer, 2025). However, the implications of formal financial inclusion for macroeconomic policy, and in particular, monetary policy have been less well understood. How does financial inclusion shape the transmission of monetary policy? We explore this question in the context of the most rapid expansion of financial inclusion in the world: India.

India is uniquely positioned to shed light on the relationship between financial inclusion and monetary policy transmission. First, it has experienced the most rapid expansion in formal financial access of any major developing country over the past decade, as shown in Figure 2.1. Between 2011 and 2021, the share of adults with access to a formal financial account rose from 35% to 78%. This expansion was driven largely by a government-led financial inclusion program launched in 2014, which brought nearly 280 million in-

dividuals into the formal financial system for the first time (Agarwal et al., 2023b). The rollout of India's digital payments infrastructure has further reduced access costs, particularly in underserved regions.

Moreover, India also offers an unusually rich data environment. The Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS) provides nationally representative panel data on monthly household income and consumption. When combined with administrative data on regional measures of financial access, this enables a disaggregated analysis of monetary policy transmission across Indian regions with different levels of formal financial access.

Therefore, to study the effects of formal financial inclusion on monetary policy transmission, we utilize observed cross-regional variation in formal financial access, particularly as measured through outstanding deposits per capita. We combine this with plausibly exogenous variation in the Reserve Bank of India's (RBI) monetary policy, identified through high-frequency changes in interest rate swap contracts around scheduled policy announcements, to answer our question of interest.

Integrating all these data sources, we first document persistent, statistically significant and economically meaningful effects of monetary policy on household income and consumption at the level of CPHS Homogeneous Regions (HRs) in India.[1] These effects begin almost immediately after a monetary policy surprise. The effects on both household income and consumption persist between 4-6 months following a 10-basis-point surprise increase in interest rates, with a maximum reduction of 1.4% on income and 1% on consumption.

Then, utilizing observed cross-regional and time series variation in the level of outstanding deposits per capita, we show that monetary policy transmission is weaker in regions with relatively higher levels of formal financial inclusion. Following a 10-basis-point surprise increase in interest rates, monetary policy transmission to household income was weaker by between 0.8-3.2% and to household consumption by between 0.6%-1.4% in regions with above median levels of outstanding bank deposits per capita measured at the start of our sample (Q1 2014). In addition, using a continuous interaction term, we estimate that an increase by ₹ 10,000 ($ 150) in an HR's deposits per capita is associated with weaker transmission of monetary policy to household income by 0.04–0.09% and household consumption by 0.02–0.04%, in response to a 10 basis points surprise interest rate increase.

On November 8, 2016, without any advance notice, the two largest denomination currency notes in India, ₹ 500 ($7.50) and ₹ 1000 ($15) ceased to be legal tender by midnight on the same day. These currency notes, which accounted for 86% of the existing currency in circulation, could no longer be used for most transactions, but could be deposited into bank accounts. As part of this demonetization policy, the demonetized currency notes were meant to be replaced by new ₹ 500 ($7.5) and ₹ 2000 ($30) currency notes. However, to maintain secrecy prior to the announcement of this policy, new currency notes were not printed and distributed before the announcement was made. As a result, Chodorow-Reich et al. (2020) document that total currency in circulation declined overnight by 75% and reached levels close to the pre-demonetization level only towards the end of 2017.

While the economic consequences of this policy were short-lived, with economic activity returning to pre-demonetization levels by March 2017 (Chodorow-Reich et al., 2020), this policy had significant and persis-

[1] The sub-national units studied in this paper are referred to as Homogeneous Regions. These are groups of contiguous Indian districts that are pooled together by CMIE for purposes of representative sampling based on agro-climatic conditions, urbanization levels, and female literacy rates. We have 95 Homogeneous Regions in our sample.

tent effects on the use of the formal financial system to conduct everyday transactions. The cash crunch engendered by the demonetization policy encouraged the rapid adoption of digital payments technologies for everyday transactions (Agarwal et al., 2023a; Crouzet et al., 2023). Due to the architecture of digital payments systems in India, digital payments essentially facilitated speedier transfer of money between bank accounts rather than between digital wallets outside the banking system. By October 2019, mobile payments accounted for almost 50% of all transaction volume in India's financial system, increasing from less than 2% in April 2013 (Figure 2.13). The demonetization policy had the unintended consequence of persistently increasing the participation of households and firms in the formal financial system.

Exploiting variation in the change in formal financial inclusion across Indian regions following this demonetization policy of 2016, we further find that these increases over time in formal financial inclusion are associated with weaker monetary policy transmission. We document that a ₹ 10,000 ($ 150) larger post-minus-pre demonetization average change in deposits per capita is associated with weaker transmission of monetary policy to both household income and consumption by 0.3% in response to a 10 basis points surprise interest rate increase.

We also present and discuss some empirical estimates from an instrumental variable strategy based on Crouzet et al. (2023)'s measure of differential regional exposure to demonetization but emphasise that these estimates are subject to severe under-identification and weak instrument problems. The results from this analysis especially for income, which do not provide any evidence that the OLS estimates overstate the attenuating effects of financial inclusion on monetary policy transmission, are suggestive evidence and not definitive causal proof of the role of financial inclusion in monetary policy transmission.

Our empirical results have potentially important implications for the conduct of monetary policy in developing countries witnessing rapid improvements in financial inclusion. They suggest that formal financial inclusion may weaken the ability of monetary policy to control aggregate demand. In other words, to the extent that these empirical relationships reflect a causal mechanism, the central bank of a developing country would have to act more aggressively to achieve the same aggregate demand outcomes in an environment with a higher level of formal financial inclusion.

How do we interpret these results? A useful conceptual framework to think about the role of financial inclusion in monetary policy transmission is the Two Agent New Keynesian (TANK) model of Bilbiie (2020). In this model, an interest rate increase affects aggregate demand through two distinct channels: (i) an inter-temporal substitution effect which causes financially included, interest-rate sensitive households to cut back on current consumption in response to an interest rate increase; and (ii) general equilibrium effects which lead to declines in consumption for both financially included and excluded households due to the initial declines in income brought about by the inter-temporal substitution effect.

As the proportion of financially included households in the economy rises, interest rate increases will have stronger inter-temporal substitution effects but weaker general equilibrium effects. This is due to the fact that while more financially included households become more interest-rate sensitive, their consumption also becomes less sensitive to their current income because they become better positioned to smooth their consumption in response to declines in their income brought about by the general equilibrium propagation of the monetary policy tightening through the economy. Our empirical results suggest that following a surprise rise in interest rates the effects of an increase in financial inclusion on the general equilibrium channel are much more important as a determinant of the effects of financial inclusion on monetary pol-

icy transmission than its effect on the inter-temporal substitution channel. This is also consistent with the findings in the quantitative Heterogeneous Agent New Keynesian (HANK) literature, as in Kaplan et al. (2018), which points to the importance of general equilibrium effects relative to inter-temporal substitution effects in accounting for the empirical effects of monetary policy observed in the data.

2.1.1 Contribution to the literature

In this paper, we contribute to three strands of the literature on monetary economics and finance in developing economies. Firstly, we contribute to the extensive literature studying the effects of financial access on economic outcomes at the firm and household level, as well as its contributions to aggregate economic outcomes. Notable papers in this literature include the pioneering work of Burgess and Pande (2005) and more recent contributions from Barboni et al. (2021) and Cramer (2025) examining household-level effects, Chander et al. (2024) and Fonseca and Matray (2024) examining firm-level effects and Ji et al. (2023) considering economy-wide general equilibrium effects of expanding financial access.

We contribute to this literature on the effects of financial development in developing countries, by pointing out that financial access matters not just for economic growth and development, but also for the business cycle. Adding to the evidence from Agarwal et al. (2023b) that financial access helps smooth household responses to rainfall shocks, we present evidence in this paper which is consistent with households also being better positioned to smooth the effects of monetary policy shocks with improved financial access. This has important implications for the effectiveness of monetary policy with increasing financial access in developing countries.

There is an extensive literature in macroeconomics quantitatively studying the role of household heterogeneity for monetary policy transmission, including the Two Agent New Keynesian (TANK) models of Bilbiie (2020) and Bilbiie et al. (2025) as well as more general Heterogeneous Agent New Keynesian (HANK) models like Kaplan et al. (2018). These papers all suggest that the presence of 'hand-to-mouth' or 'wealthy hand-to-mouth' households, a term coined by Kaplan et al. (2014), can be an important source of amplification of monetary policy in macroeconomic models and are essential to quantitatively match the estimated impulse responses of monetary policy in the data. Some recent papers providing empirical evidence on this question using household data include Cloyne et al. (2020), Foulis et al. (2026) and for the case of India Pizzolon and Singh (2025).

In this paper, using measures of household income and consumption from survey data, we document effects of monetary policy that are quite strong and statistically significant in India, particularly when studying monetary policy transmission at the sub-national level. Furthermore, we contribute empirical evidence to this literature, using novel monthly panel data, to document that regions which are more financially included, and hence likely to have fewer 'hand-to-mouth' households, respond more weakly to monetary policy than less financially included regions. This is extremely similar in spirit to the recent findings by Herreño and Pedemonte (2025) for the U.S.

Finally, we take a fresh methodological approach in this paper to understand how financial development matters for monetary policy transmission by considering within-country variation in formal financial inclusion. Existing empirical studies which have attempted to understand the role of financial development for monetary policy transmission have often relied on cross-country datasets, making it harder to disen-

tangle the role of formal financial inclusion from other institutional features determining differences in monetary policy transmission. Major studies looking at this issue include Mishra and Montiel (2013), Mishra et al. (2014), Mehrotra and Yetman (2014) and Ma and Lin (2016). In this paper, we utilize within-country variation in formal financial inclusion that can provide a more reliable estimate of the effects of formal financial inclusion on monetary policy transmission.

2.1.2 A reader's guide

The rest of the paper is structured as follows. In Section 2.2, we introduce the datasets that we will use in the empirical analysis and provide some summary statistics on these datasets. In Section 2.3, we document our empirical estimates of monetary policy transmission at the regional level in India and provide a comparison of these estimates against more conventional time-series estimates of monetary policy transmission in India. Then, in Section 2.4, we provide some empirical evidence on the possible role of financial inclusion for monetary policy transmission in India using time-invariant and time-varying measures of formal financial inclusion. In Section 2.5, we exploit the variation in the level of formal financial inclusion across different Indian regions following the demonetization policy of 2016, investigate the heterogeneity in the transmission of monetary policy surprises between regions with different levels of financial inclusion and interpret our empirical findings. Finally, we provide a brief conclusion in Section 2.6.

2.2 Data

In order to understand the effects of financial inclusion on monetary policy transmission, we combine the following three datasets: (i) survey data on monthly household income and consumption of a representative sample of Indian households, (ii) administrative data on banking activity from the RBI and (iii) monetary policy surprises of the RBI identified from high-frequency financial market data. The following sections describe each of these datasets in detail, outlining their scope and usefulness to understand our main research question of interest.

2.2.1 CPHS household survey data

In order to understand the transmission of monetary policy to household incomes and consumption at a monthly frequency, we use the Consumer Pyramids Household Survey (CPHS) conducted by the Centre for Monitoring the Indian Economy (CMIE). The CPHS collects panel data on household consumption, income, assets and liabilities from a nationally representative sample of households. Households are surveyed every 4 months and are asked about their income and expenses over each of the preceding 4 months as well as their assets and liabilities at the time of the survey.[2] Hence, the survey provides us with information on household income and expenditure at a monthly frequency and information on household balance sheets every 4 months. There were 174,405 households in the January - April 2020 wave of the survey.

[2]The CPHS survey is conducted in three annual rounds, with all households in the panel being surveyed once during each of these rounds. The first round is from January to April, the second round is from May to August, and the third round is from September to December. Each round consists of four monthly slots, and roughly one-quarter of the total households are surveyed during each of the four months in every round (Vyas, 2020c).

It is important to note that while the survey collects granular quantitative information on the components of household expenditure and sources of household income, it collects minimal information about the household balance sheet, limited to data on sources and uses of borrowing, ownership of specific assets as well intentions about acquiring them in the next 4 months. There is no information available about the value of household assets and liabilities in this survey.

The survey commenced data collection in January 2014. We utilize data up to the period before the start of the COVID-19 pandemic and associated lockdowns in March 2020 in our analysis. For the purposes of consistency, we do not use more recent data following the start of the COVID-19 pandemic, as response rates for the majority of this period were significantly below pre-pandemic levels (Figure B.1) caused by frequent lockdowns in different parts of India and a shift from in-person to phone call enumeration of survey responses (Vyas, 2020e). This provides us with 19 waves of CPHS data, with information on monthly household income and expenditure available for all households for the period between April 2014 and October 2019.[3]

Table 2.1: Summary statistics on income and consumption in the CPHS, April 2014 and October 2019

(a) Consumption

	N	Mean	Std.Dev	min	25%	50%	75%	max
April 2014	140692	8270.80	5018.37	526.00	5148.00	7171.00	9865.00	397988.00
October 2019	147739	13291.34	6998.01	180.00	9114.00	11846.00	15636.00	513672.00

(b) Income

	N	Mean	Std.Dev	min	25%	50%	75%	max
April 2014	139412	15436.64	26162.20	200.00	6000.00	9300.00	16000.00	1956000.00
October 2019	146621	22607.43	27433.79	50.00	10500.00	15858.00	25300.00	865220.00

Notes: This table documents summary statistics (in ₹, current prices) on monthly consumption expenditure and income for households surveyed in the Consumer Pyramids Households Survey (CPHS) conducted by the Centre for Monitoring the Indian Economy (CMIE). Monthly consumption expenditure for each household is defined as adjusted total expenditure [**ADJ_TOT_EXP**] net of all EMIs [**M_EXP_ALL_EMIS**], remittances [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Income refers to total income of the household from all sources [**TOT_INC**]. Data on income and consumption pertaining to April 2014 and October 2019 are shown in the above tables. Only accepted survey responses [**RESPONSE_STATUS**] with total [**TOT_EXP**] and adjusted total expenditure [**ADJ_TOT_EXP**] greater than 0 (in the case of consumption) and total income [**TOT_INC**] greater than 0 (in the case of income) are used in the analysis. The individual observations are weighted by their corresponding survey weights [**HH_WGT_MS**] after adjusting for non-response [**HH_NR_MS**] in producing the descriptive statistics.

Table 2.1 provides some basic summary statistics on consumption expenditure and income (in current prices) in April 2014 and October 2019 which correspond to the start and end periods of the data being used in the analysis.[4] In each of these periods, we have around 140,000 respondents in this survey. Average monthly household consumption expenditure amongst CPHS respondents was ₹8,271 in April 2014, as against an average income of ₹15,437, while these increased to ₹13,291 and ₹22,607 respectively in Oc-

[3]While information on income and consumption is also available for all households between January and March 2014, we lose this information for many households in some of the regression analysis that follows, when this data is combined with information on borrowing status in previous waves, which does not exist for these months as information for these months was collected in the first survey wave for most households. Therefore, we exclude these months from our sample for consistency.

[4]We focus on current price estimates of statistics from the CPHS data, as we will use nominal household consumption expenditure and income as the outcome variables of interest in the empirical analysis that follows. Nominal household income and consumption expenditure reflect both price and quantity changes over time, and are therefore useful for summarizing the total effects of monetary policy on both prices and quantities.

tober 2019.[5] The consumption shares of monthly income were 53.58% in April 2014 and 58.79% in October 2019, very similar to the Private Final Consumption Expenditure (PFCE) shares of Gross Domestic Product (GDP) of 59.7% in 2013-14 and 60.5% 2019-20 respectively (Ministry of Statistics and Programme Implementation, 2015b, 2021a).[6] However, these shares are significantly lower than the shares of household final consumption expenditure in gross household disposable income reported in the national accounts, which were 75.98% in 2013-14 and 76.84% in 2019-20 (Ministry of Statistics and Programme Implementation, 2015a, 2021b).[7]

The coefficient of variation of household consumption expenditure was 0.61 in April 2014 and 0.53 in October 2019. In contrast, the coefficient of variation of household income was 1.69 in April 2014 and 1.21 in October 2019. This is consistent with both a more precise measurement of consumption expenditure relative to income in the CPHS as well as a smoother cross-sectional profile of consumption than of income among Indian households. Aggregate household consumption expenditure in the CPHS is computed as the sum of survey responses of consumption expenditure within granular consumption buckets, while aggregate household income is computed as the sum of survey responses of household income from a few broadly defined sources. The granular consumption buckets are intended to capture all non-durable expenditure and durable expenditure on household, kitchen and other electronic appliances. However, they do not explicitly capture durable expenditure on outright purchase of vehicles or houses.[8] The detailed survey questionnaire outlining all the granular consumption buckets and sources of income can be found in Vyas (2020d).

The CPHS is designed to ensure a nationally representative sample of households through a multi-stage stratified sampling frame. At the broadest level of stratification, India's 640 districts in the 2011 census are grouped into 102 Homogeneous Regions (HRs). HRs consist of a set of contiguous districts within a state that share similar agro-climatic conditions, urbanization levels, female literacy and size of households. Each HR is further divided into rural and urban sub-strata. The urban region of a HR was further stratified into four strata based on their population of households, because of the high variation in characteristics of towns based on their size. A total of 379 strata were surveyed during the period under study, accounting for 98.5% of the total population of India.[9]

[5] 'Income' will be used as a shorthand throughout this paper to refer to total household income [**TOT_INC**] reported in the Income Pyramids module of the CPHS. However, the survey documentation and questionnaire are unclear about whether this income is net of taxes. As a result, a more conservative interpretation of this measure would be as self-reported household receipts in both cash and kind.

[6] It is also possible to calculate per capita consumption expenditure from the CPHS by multiplying the household survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**] by their respective populations [**SIZE_GROUP**]. Assigning a size of 9 members to the '8-10 Members' size group, 13 to the '11-15 Members' size group and 16 to the '> 15 Members' size group yields an annual estimate of per capita household expenditure of ₹22,683 in April 2014 and ₹40,488 in October 2019. These estimates are much lower than the estimated per capita PFCE estimates of ₹54,133 for 2013-14 and ₹91,790 for 2019-20 despite the evidence discussed later in this section which suggests a bias towards wealthier households in the CPHS. A potential explanation for this is the presence of imputed expenditures towards owner-occupied housing and in kind transfers received from the government and non-profit sectors in the PFCE measures while they are not captured in the CPHS measures of consumption expenditure. An additional explanation is that the CPHS, unlike the national accounts data, fails to capture the right tail of the income distribution which lowers the per capita estimates of consumption from the CPHS (Dhingra and Ghatak, 2021).

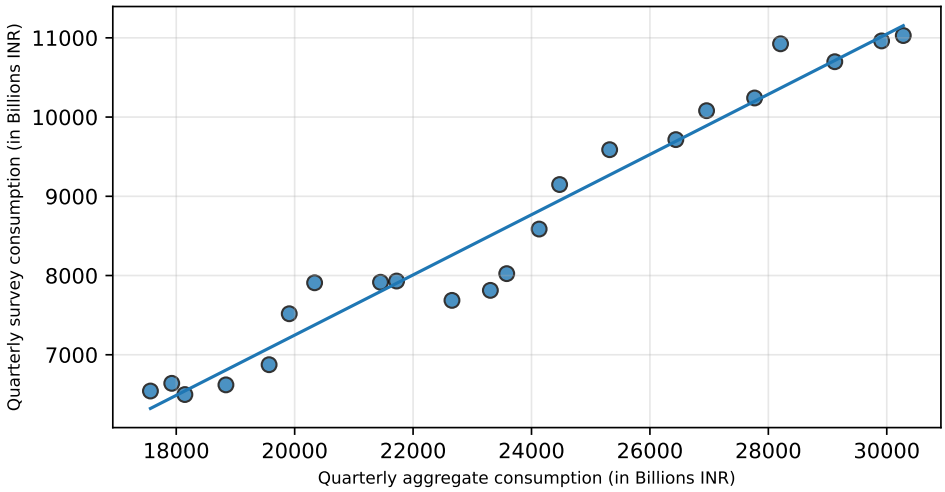
[7] These figures refer to the share, in current prices, of final consumption expenditure to gross disposable income of households and non-profit institutions serving households. Estimates are sourced from Statement 1.14 of the National Accounts Statistics reports for the years 2015 and 2021.

[8] Expenditures under these heads are instead intended to be captured through expenditure buckets on monthly loan repayments towards vehicle loans or housing loans, provided that they are purchased with credit.

[9] The survey was not conducted in some of the smaller Indian states and union territories considered remote and inaccessible by CMIE.

Within each rural stratum of a HR, 25-30 villages were chosen by simple random sampling for the purpose of conducting the survey. In the case of the urban strata, one town was generally selected at random from each size-based urban stratum within the HR and 21 Census Enumeration Blocks (CEBs) were selected through simple random sampling from within this town for the purpose of conducting the survey. In each village or CEB, 16 households were selected for the survey. Household selection proceeded by first selecting a random number n between 5 and 15 and selecting every n^{th} household from a village/CEB street for the survey. Household selection always began from the main street of each village/CEB and only proceeded to the inner streets if 16 households could not be chosen in the main street (Vyas, 2020b).

Figure 2.2: Aggregate consumption in the national accounts and CPHS, Q2 2014 - Q3 2019



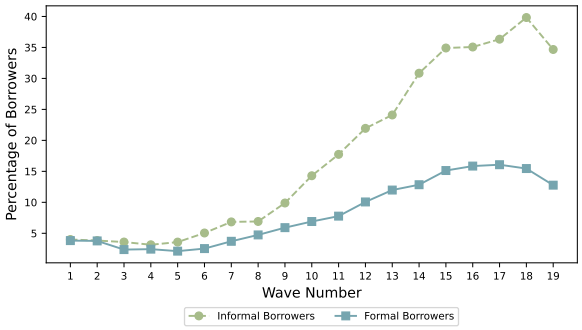
Notes: This figure plots private final consumption expenditure from India's national accounts data against national aggregate consumption expenditure from the CPHS data at a quarterly frequency between Q2 2014 and Q3 2019. Quarterly survey consumption expenditure is defined as adjusted total expenditure [**ADJ_TOT_EXP**] net of all EMIs [**M_EXP_ALL_EMIS**], remittances [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Only accepted survey responses [**RESPONSE_STATUS**] with total [**TOT_EXP**] and adjusted total expenditure [**ADJ_TOT_EXP**] greater than 0 are used in the analysis. The individual observations are weighted by their corresponding survey weights [**HH_WGT_MS**] after adjusting for non-response [**HH_NR_MS**] in computing aggregate quarterly survey consumption expenditure. Data on quarterly private final consumption expenditure from the national accounts refers to seasonally adjusted quarterly private final consumption expenditure at current prices from FRED (accessed on 14th August, 2023): **INDPFCEQDSMEI**.

Figure 2.2 shows a scatter-plot of national consumption expenditure derived from the national accounts data and from the CPHS data. The available evidence suggests that trends in the aggregate national accounts time series for consumption are captured well by household consumption dynamics in the CPHS.

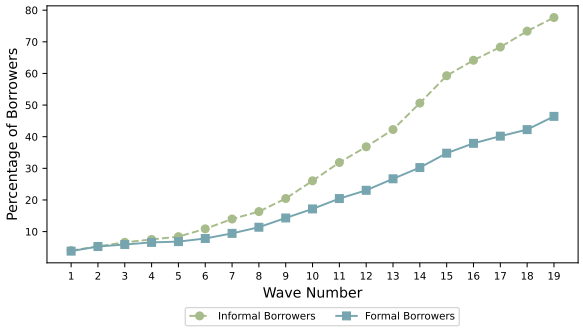
We can also observe household borrowing patterns in the CPHS. The Aspirational India module of the CPHS records the source and purpose of outstanding household debt at the time of each survey wave. In particular, we can construct measures of the proportion of households in each HR borrowing from formal credit sources. Formal credit sources, in this context, are defined to include: (i) banks, (ii) non-bank financial companies, (iii) self-help groups and microfinance institutions as well as (iv) credit cards. We focus especially on three measures of household borrowing at the HR-Wave level: (i) proportion of households borrowing from formal sources in the current survey wave, (ii) proportion of households who have borrowed from formal sources in the current or any previous survey wave and (iii) proportion of households who have borrowed from formal and informal sources at any point during the time period

Figure 2.3: Formal and Informal borrowing in the CPHS, January 2014 to April 2020

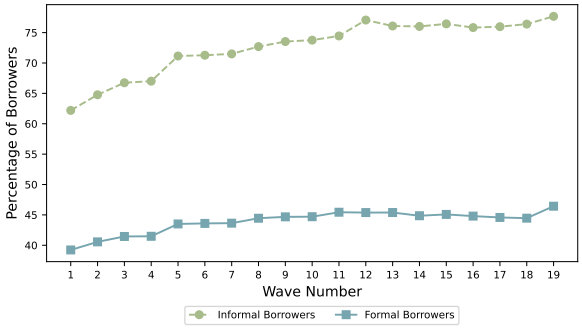
(a) Borrowing in wave



(b) Borrowing in the past



(c) Borrowing at any point



Notes: This figure shows the time series of the proportion of surveyed households in India who borrow from formal and informal sources. The first panel shows the proportion of households who had borrowed from a formal or informal credit source in that wave. The second panel shows the proportion of households who had borrowed from a formal or informal credit source in any wave up to the present wave. The third panel shows the proportion of households who had borrowed from a formal or informal credit source in any of the 19 waves of the survey considered in the analysis. Data from the first 19 waves of the Consumer Pyramids Household Survey (CPHS) of the Centre for Monitoring the Indian Economy (CMIE) are used in the analysis, corresponding to the period between January 2014 and April 2020. In particular, data from the Aspirational India module for households with accepted survey responses [**RESPONSE_STATUS**] are used to compute measures of formal and informal borrowing. Formal borrowers refers to households in each wave who borrow from either banks [**BORR_FRM_BANK**], non-bank financial companies [**BORR_FRM_NBFC**], self-help groups or micro-finance institutions [**BORR_FRM_SHG_MFI**] and credit cards [**BORR_FRM_CC**]. Informal borrowers refers to households in each wave who borrow from either moneylenders [**BORR_FRM_LENDER**], employers [**BORR_FRM_EMPLOYER**], relatives or friends [**BORR_FRM_REL_FRNDS**], shops [**BORR_FRM_SHOPS**] or chit funds [**BORR_FRM_CHTFUND**]. In order to construct the proportion of households borrowing from formal and informal sources at the wave level, all households borrowing from either formal or informal sources are weighted by their wave-level survey weights [**HH_WGT_W**] adjusted for non-response [**HH_NR_W**].

under study. It is also possible to derive similar measures of informal borrowing from the CPHS survey data. These informal sources include (i) moneylenders, (ii) employers, (iii) relatives and friends, (iv) shops and (v) chit funds.[10]

Figure 2.3 plots these measures of household borrowing at the national level over successive CPHS survey waves for the time period under study.[11] The first and second panels of this figure both point to the fact that both formal and informal borrowing have increased in prevalence over time amongst the survey respondents. All three panels confirm that informal borrowing was more prevalent than formal borrowing during the time period under study despite the large strides in formal financial inclusion visible in the

[10] We focus on measures aggregated to the HR level because that is the finest level of granularity at which we can consistently match the RBI administrative data on financial access with the CPHS survey data.

[11] It is possible for a household to borrow from both formal and informal sources at the same point in time, and in such cases, that household would count towards both measures of financial inclusion.

CPHS dataset. Appendix B.2 provides a further breakdown of the wave-level borrowing estimates from formal and informal sources into their component parts.[12]

How representative is the CPHS dataset? There is an extensive literature examining the representativeness of the CPHS as compared to official sample surveys and census data. It has been suggested that the CPHS tends to under-represent more populous regions and over-represent wealthier main streets due to its sampling design, which selects villages and towns at random without giving more populous areas a higher probability of selection into the sample and tends to begin sample selection within the village or town from the main street. Furthermore, the CPHS has been found to over-represent well educated households, under-represent women and completely exclude households at the tails of the income distribution who are either extremely poor or extremely affluent (Somanchi, 2021; Dhingra and Ghatak, 2021).[13]

However, the occupational structure of households in the CPHS appears to be broadly representative compared to estimates from official sample surveys conducted by the Government of India (Pais and Rawal, 2021). Figure 2.4 presents the occupational distribution of households in the CPHS in April 2014 and October 2019. Wage labourers, small and marginal farmers and entrepreneurs constitute the largest occupational groups of households in this survey.[14]

An important trend in the occupational structure of the surveyed sample that is noticeable during this time period is the increase in the relative proportions of wealthier occupational groups at the expense of poorer occupational groups. There is a noticeable increase in the proportion of surveyed entrepreneurs, organised farmers and white-collar employees at the expense of wage labourers, agricultural labourers and industrial workers. Selective attrition of poorer households from the CPHS sample has been pointed out as a reason for these trends, by comparing estimates from the CPHS sample with lower frequency survey data collected in official surveys (Somanchi, 2021).[15] One potential reason for selective attrition in the survey is due to CMIE's policy of only choosing to replace entire villages or CEBs due to low rates of response rather than to replace non-responding households within the same village or CEB (Vyas, 2020a). Additional information about rates of attrition and response rates in the CPHS can be found in Appendix B.1.

However, despite the biases towards richer households in the CPHS noted above, it has the advantage of being nationally representative and has the unique feature of providing information on household consumption expenditure and income at a monthly frequency. This ensures that there is sufficiently representative variation in income and consumption between HRs with different levels of financial development to enable the study of the effects of financial inclusion on monetary policy transmission. The monthly frequency of the CPHS dataset has meant that it has been utilized extensively in studies of short-term changes in output, employment and inflation in India. Notable examples of the use of CPHS data include the study of the Indian demonetization episode by Chodorow-Reich et al. (2020), and in particular, the

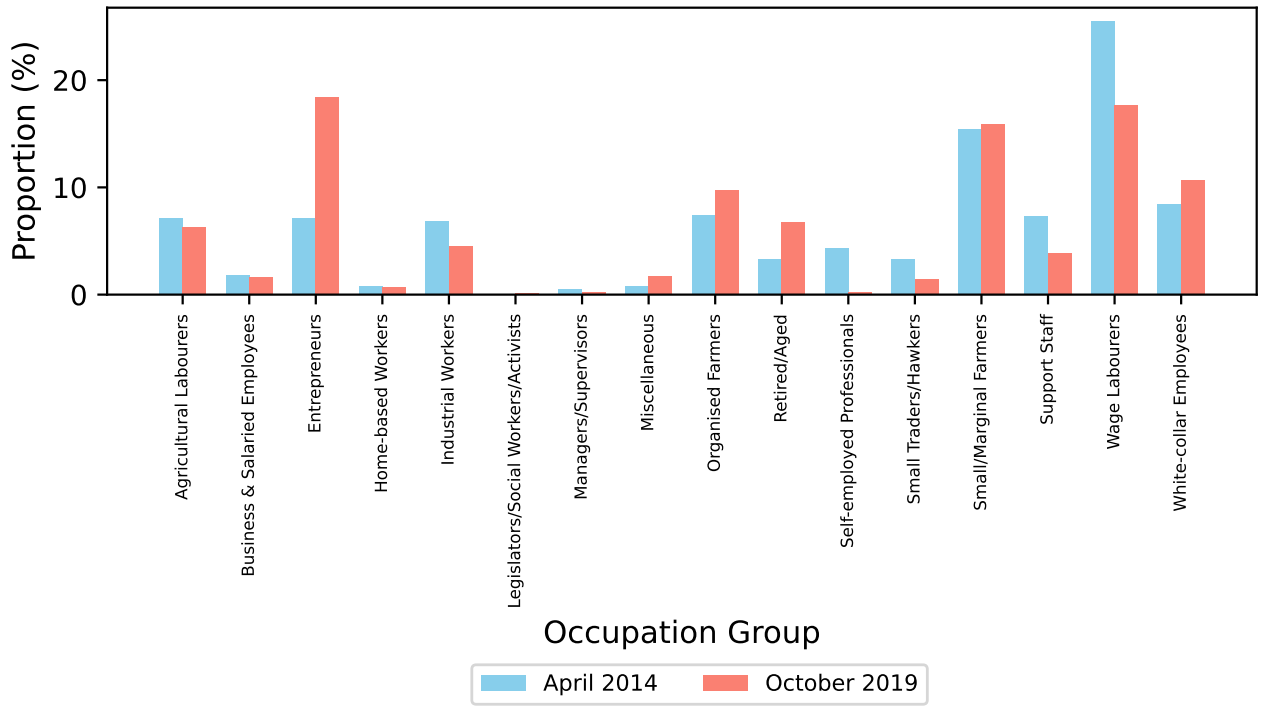
[12]The third panel also tells us that the CPHS sample is unbalanced as the proportion of households who had borrowed from formal and informal sources at any point during the survey is changing over time. Additional details about attrition and response rates in the CPHS can be found in Appendix B.1.

[13]While the focus of our analysis is on the CPHS data on income and expenditure collected at the household level, the CPHS also collects information, through the People of India module, on the characteristics of household members, on the basis of which the above claims about under and over representation of household attributes have been made in the literature.

[14]It is important to note here that we use the occupation labels assigned by CMIE to households based on the numerically dominant occupation amongst individual household members in the analysis of occupational structure.

[15]An additional potential reason for the shifts towards entrepreneurship over time could be due to potential relabelling of self-employed professionals earlier in the sample as entrepreneurs later in the sample.

Figure 2.4: Occupational distribution of households in the CPHS, April 2014 and October 2019



Notes: This figure plots the proportion of households belonging to each occupational group in April 2014 and October 2019 Consumer Pyramids Household Survey (CPHS) conducted by the Centre for Monitoring the Indian Economy (CMIE). Data from the consumption pyramids module of the CPHS is used in this analysis. Occupation Group refers to an occupational classification of the household based on occupations of individual household members by CMIE [**OCCUPATION_GROUP**]. Only accepted survey responses [**RESPONSE_STATUS**] with total [**TOT_EXP**] and adjusted total expenditure [**ADJ_TOT_EXP**] greater than 0 are considered in this analysis. The definition of adjusted total expenditure is the same as in Table 2.1. For presentational convenience, 'White-collar Clerical employees', 'White-collar Professional employees' and 'Non-industrial Technical Employees' have been categorized as 'White-collar employees', 'Qualified Self-employed Professionals' have been categorized as 'Self-employed Professionals' and 'Self-employed Entrepreneurs' have been categorized as 'Entrepreneurs'. The individual observations are weighted by their corresponding survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**] in producing the proportions in each period.

recent work of Bhattarai et al. (2025) as well as Pizzolon and Singh (2025) who both utilize this monthly data on household income and consumption from the CPHS.

2.2.2 Banking data

We combine the monthly household survey data from the CPHS outlined above with administrative data on banking activity at the district level, available at a quarterly frequency from the Reserve Bank of India (RBI). The RBI's publication, *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*, provides quarterly data on commercial bank branches, deposits and credit at the district-level, covering the universe of banking activity in India.[16]

We merge this quarterly banking dataset at the district level to 2011 Census district boundaries to ensure consistency and comparability with the groupings of districts into HRs used by the CPHS. Next, to ensure compatibility with the CPHS dataset, we aggregate the district-level banking dataset to the HR-level, using the HR-District mappings available in Vyas (2020b). There were a few instances where new districts were formed post-2011 from parent districts belonging to different HRs. In these instances, we aggregated these HRs to form a single, larger HR for use in the empirical analysis.[17] We also merged district-level population data, aggregated to the HR-level, from the 2011 Census with the banking dataset in order to construct per capita measures of formal banking activity at the HR level.[18]
We construct the following measures of financial inclusion at the HR-Quarter level using this dataset:

$$\overline{\text{APPBO}}_{i,t} = \frac{\text{Population in 2011 Census}}{\text{Number of Bank Branches}_{i,t}}; \quad \overline{\text{Deposits}}_{i,t} = \frac{\text{Total Deposits Outstanding}_{i,t}}{\text{Population in 2011 Census}}; \quad \overline{\text{Credit}}_{i,t} = \frac{\text{Total Credit Outstanding}_{i,t}}{\text{Population in 2011 Census}}$$

where $\overline{\text{APPBO}}_{i,t}$, $\overline{\text{Deposits}}_{i,t}$ and $\overline{\text{Credit}}_{i,t}$ refer to Average Population Per Branch Office (APPBO), Deposits Per Capita and Credit Per Capita in HR i during quarter t respectively. It is important to note that $\overline{\text{APPBO}}_{i,t}$ as defined is inversely related to the level of financial inclusion, with a lower value of $\overline{\text{APPBO}}_{i,t}$ indicating a higher level of financial inclusion in HR i during quarter t. $\overline{\text{Deposits}}_{i,t}$ and $\overline{\text{Credit}}_{i,t}$ are both expressed in constant March 2014 prices, using the general CPI-Combined price index for India.

Figure 2.5 plots these measures of formal financial inclusion in different CPHS HRs in December 2013 and March 2020, corresponding roughly to the first and last CPHS survey waves being used in the analysis. There are two striking patterns in the geographic distribution of financial access and its evolution over time in India.

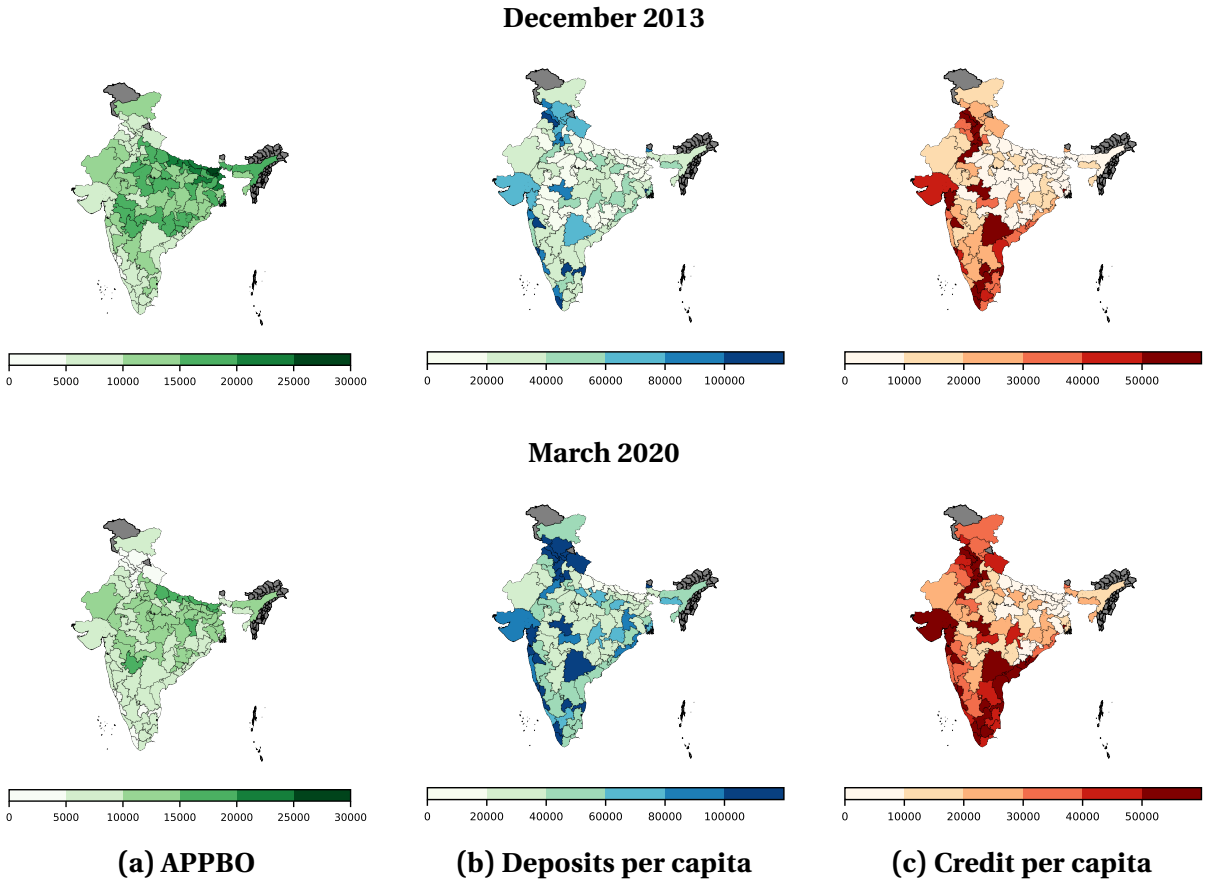
Firstly, there has been a visible improvement in measures of financial inclusion throughout the country in the period between December 2013 and March 2020. This has been aided by both government policy

[16] Statement No. 4 and Statement No. 4A from the *Quarterly Statistics* contain the district-level data on banking activity. This data was downloaded from the RBI's Database on the Indian Economy (DBIE) which can be accessed online at https://data.rbi.org.in/ and was accessed in October 2022. The *Quarterly Statistics* publication was replaced in 2023 with the publication titled *Spatial Distribution of Deposits and Credit (Quarterly)*. With a subsequent update to the structure of the website, the *Quarterly Statistics* data tables can now be accessed from Statement No. 4A under the time series publication titled *Quarterly Spatial Distribution of Deposits and Credit*.

[17] More specifically, HR 67, HR 68 and HR 69 in Telangana (erstwhile Andhra Pradesh) were combined into a single HR 201, HR 34, HR 35, HR 36 and HR 37 in Gujarat were combined into a single HR 202, HR 18 and HR 32 in Uttar Pradesh were combined into a single HR 203 and HR 23 and HR 26 in Uttar Pradesh were combined into a single HR 204. This leaves a total of 95 unique HRs in the CPHS dataset.

[18] Data on district-level population for Indian districts was obtained from the 2011 Census, available for download here: https://censusindia.gov.in/census.website/data/population-finder.

Figure 2.5: Measures of formal financial inclusion in India, December 2013 and March 2020



Notes: This figure plots measures of formal financial inclusion in different Consumer Pyramids Household Survey (CPHS) Homogeneous Regions (HRs) in India in December 2013 and March 2020. The first panel plots Average Population per Branch Office, the second panel plots Deposits per capita and the third panel plots Credit per capita in different HRs. APPBO is calculated as the ratio of the Census 2011 population in each HR to the number of bank branches operating in that HR in December 2013 and March 2020. Deposits per capita is calculated as the ratio of total deposits outstanding in each HR in December 2013 and March 2020 to the Census 2011 population in that HR. Credit per capita is calculated as the ratio of total credit outstanding in each HR in December 2013 and March 2020 to the Census 2011 population in that HR. Data on bank branches, deposits and credit outstanding are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. The mapping from districts to CPHS HRs is from Vyas (2020b). HR 67, HR 68 and HR 69 in Telangana, HR 34, HR 35, HR 36 and HR 37 in Gujarat and HR 18 and HR 32 as well as HR 23 and HR 26 in Uttar Pradesh have each been aggregated into a single HR within their respective states to deal with changes in district boundaries post-2011 that affect all these individual HRs. Deposits per capita and Credit per capita are expressed in constant March 2014 prices using the General CPI-Combined price index. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/. The HR and district shape files used for plotting the above figures was obtained from xKDR's Maps of India, available at https://github.com/xKDR/india-maps.

aimed at improving financial access as well as the emergence of digital technologies which have lowered the costs of financial access. A large-scale, financial inclusion program launched by the Government of India in 2014, resulted in almost 280 million individuals, who previously did not have a bank account, obtaining access to a savings bank account through a debit card and mobile banking services. A detailed description of this program and its rollout can be found in Agarwal et al. (2023b). The development of a Digital Payments Infrastructure (DPI) in India, beginning in 2016, built on top of this increase in bank account access, helped to further lower the costs of regularly accessing financial services, particularly in regions where physical bank branches were difficult to access. The demonetization of large denomination currency notes in 2016, as shown in Chodorow-Reich et al. (2020), also helped to speed up the process of adoption of digital financial services. As Agarwal et al. (2023b) note, these improvements in financial access allowed a larger number of households than ever before to use financial services to smooth their consumption in response to seasonal and aggregate shocks to their income.

However, despite these tremendous improvements in financial access in India, important geographic differences in financial access continue to persist. In particular, southern and western peninsular India continue to enjoy significantly greater financial access than the landlocked northern and eastern regions of the country. This geographic distribution of financial access has also been quite persistent, with similar patterns of financial access observable also at the start of an earlier push towards financial inclusion undertaken by the RBI in 2005, as documented in Cramer (2025).

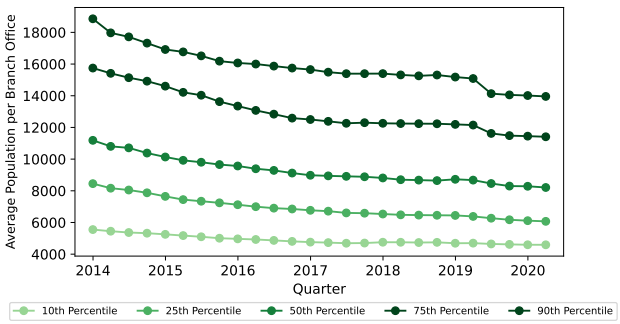
This is evident in Figure 2.6, which plots the time series of different percentiles of the distributions of our formal financial inclusion measures in CPHS Homogeneous Regions. Average population per branch office for the median HR has steadily declined during the time period under study, accompanied by a steady increase in deposits and credit per capita in the median HR. These improvements in financial access are also visible throughout the formal financial inclusion distributions. However, there has been no sign of convergence in terms of financial access metrics across different CPHS Homogeneous Regions, with large gaps in financial access still persisting at the end of our sample period.

These patterns of financial access in the RBI data are also visible in the CPHS survey data. Figure 2.7 compares APPBO with the proportion of households borrowing from formal and informal credit sources at the HR-Quarter level. The proportion of households in the CPHS borrowing from formal credit sources is significantly higher in HRs with more formal banking access, as proxied by a lower APPBO, than in HRs with less formal banking access. This serves as a useful validation of both the CPHS and RBI administrative datasets since they provide a fairly consistent picture of formal financial access in India.

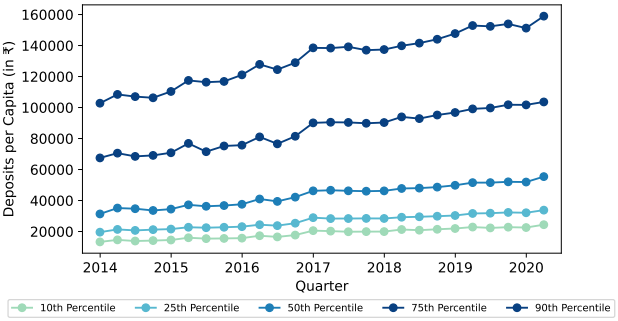
Figure 2.7 shows that the proportion of households borrowing from informal credit sources is also greater in HRs with more formal financial access. This suggests that informal sources of credit appear to be *complements* rather than *substitutes* for formal access to credit. These results are consistent with microeconometric evidence from Surendra (2025), which also documents the complementarities between formal and informal credit sources, with informal credit supply increasing in regions with increasing bank credit supply. Furthermore, these results also shed light on the effects of formal financial development on informal credit markets, an issue discussed at length in the context of Thailand by Sripakdeevong and Townsend (2022). In line with the findings in Thailand, in India too, access to formal credit sources complement access to informal sources of credit. However, we do not have the granularity in the data to address an important point made by Sripakdeevong and Townsend (2022) and Ru and Townsend (2022),

Figure 2.6: Time series of measures of formal financial inclusion in India, December 2013 to March 2020

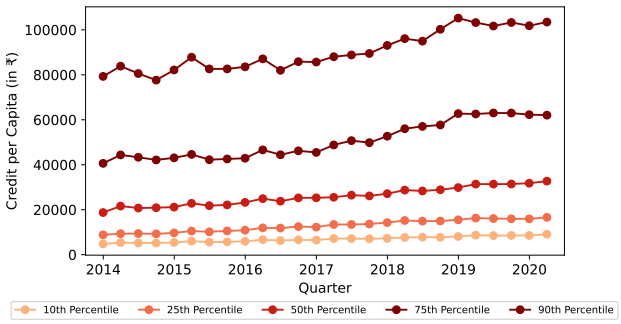
(a) APPBO



(b) Deposits per capita

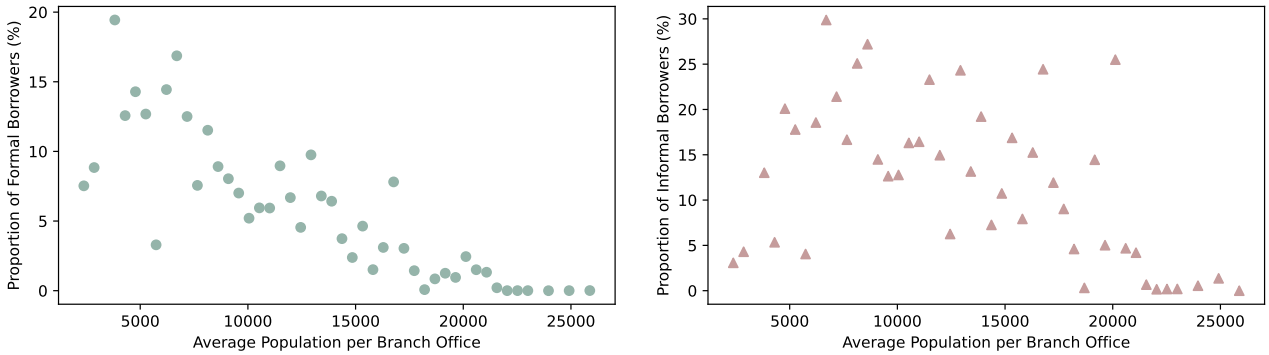


(c) Credit per capita



Notes: This figure plots the time series of different percentiles of the distributions of our formal financial inclusion measures in different Consumer Pyramids Household Survey (CPHS) Homogeneous Regions (HRs) in India between December 2013 and March 2020. The first panel plots Average Population per Branch Office, the second panel plots Deposits per capita and the third panel plots Credit per capita in different HRs. APPBO is calculated as the ratio of the Census 2011 population in each HR to the number of bank branches operating in that HR in December 2013 and March 2020. Deposits per capita is calculated as the ratio of total deposits outstanding in each HR in December 2013 and March 2020 to the Census 2011 population in that HR. Credit per capita is calculated as the ratio of total credit outstanding in each HR in December 2013 and March 2020 to the Census 2011 population in that HR. Deposits per capita and Credit per capita are expressed in constant March 2014 prices using the General CPI-Combined price index (2012 base series). Data on bank branches, deposits and credit outstanding are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/. The mapping from districts to CPHS HRs is from Vyas (2020b). HR 67, HR 68 and HR 69 in Telangana, HR 34, HR 35, HR 36 and HR 37 in Gujarat and HR 18 and HR 32 as well as HR 23 and HR 26 in Uttar Pradesh have each been aggregated into a single HR within their respective states to deal with changes in district boundaries post-2011 that affect all these individual HRs.

Figure 2.7: Comparison of measures of financial inclusion from the RBI and CPHS, 2014 to 2020



(a) Borrowing from formal sources

(b) Borrowing from informal sources

Notes: This figure shows binned scatterplots (with 50 bins) of Average Population per Branch Office (APPBO) in each Homogeneous Region (HR)-Quarter against proportions of responding households in that HR-Quarter who had outstanding borrowing from formal and informal sources. Data from the first 19 waves of the Consumer Pyramids Household Survey (CPHS) of the Centre for Monitoring the Indian Economy (CMIE) are used in the analysis, corresponding to the period between January 2014 and April 2020. In particular, data from the Aspirational India module for households with accepted survey responses [**RESPONSE_STATUS**] are used to compute measures of formal and informal borrowing. The quarter for each HR-Wave [**WAVE_NO**] is assigned as the earliest quarter to which the month [**MONTH_SLOT**] in which households from that HR-Wave are surveyed belongs. Formal borrowers refers to households each HR-Quarter who borrow from either banks [**BORR_FRM_BANK**], non-bank financial companies [**BORR_FRM_NBFC**], self-help groups or micro-finance institutions [**BORR_FRM_SHG_MFI**] and credit cards [**BORR_FRM_CC**]. Informal borrowers refers to households in each HR-Quarter who borrow from either moneylenders [**BORR_FRM_LENDER**], employers [**BORR_FRM_EMPLOYER**], relatives or friends [**BORR_FRM_REL_FRNDS**], shops [**BORR_FRM_SHOPS**] or chit funds [**BORR_FRM_CHTFUND**]. In order to construct the proportion of households borrowing from formal and informal sources at the HR-Quarter level, all households borrowing from either formal or informal sources are weighted by their wave-level survey weights [**HH_WGT_W**] adjusted for non-response [**HH_NR_W**]. APPBO is calculated as the ratio of the Census 2011 population in each HR to the number of bank branches operating in that HR. Data on bank branches are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. The mapping from districts to CPHS HRs is from Vyas (2020b). HR 67, HR 68 and HR 69 in Telangana, HR 34, HR 35, HR 36 and HR 37 in Gujarat and HR 18 and HR 32 as well as HR 23 and HR 26 in Uttar Pradesh have each been aggregated into a single HR within their respective states to deal with changes in district boundaries post-2011 that affect all these individual HRs. APPBO at the beginning of each HR-Quarter are used in the scatterplots.

that while formal financial access may complement informal credit sources for well networked individuals, they may exacerbate financial exclusion for poorly networked households.

These results stand in contrast to the findings in Agarwal et al. (2023b), which document that regions which witnessed greater formal financial inclusion following the Indian government's 2014 financial inclusion policy, actually see a larger decline in informal borrowing by households in the CPHS. We think that the principal reason for this discrepancy is due to our differing definitions of what counts as an informal source of credit. As shown in Appendix B.2, credit offered by shops is an important and growing source of informal credit for Indian households. However, this is not explicitly counted as an informal source of lending by Agarwal et al. (2023b).

2.2.3 Monetary policy surprises in India

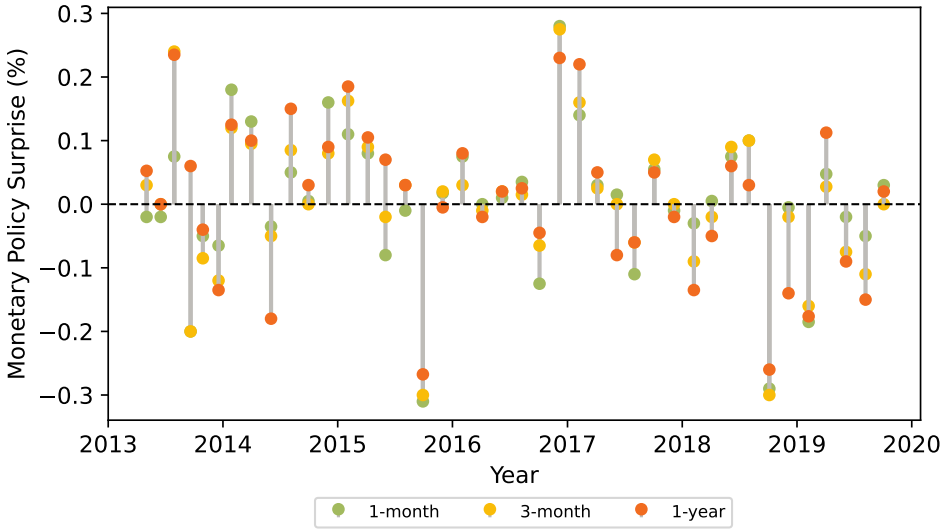
A key challenge in identifying the causal effects of monetary policy on economic activity lies in the endogeneity of changes in monetary policy to macroeconomic conditions. An extensive literature, summarized in Ramey (2016), examines the various approaches utilized by macroeconomists to identify plausibly exogenous variation in monetary policy which can be used to assess the causal effects of monetary policy actions undertaken by the central bank.

A leading approach to identifying plausibly exogenous variation in monetary policy, pioneered by Kuttner (2001) with further development by Gürkaynak et al. (2005) and Nakamura and Steinsson (2018), uses high-frequency changes in forward-looking derivatives contracts linked to the central bank policy interest rate in narrow time windows around key monetary policy announcements of the central bank to identify changes in monetary policy that were unanticipated by financial market participants, and hence not priced in to these derivatives contracts. These monetary policy surprises are then used to identify the causal effects of monetary policy, under a set of identification assumptions.

In the Indian context, the use of the high-frequency identification approach to identify monetary policy surprises was pioneered by Lakdawala and Sengupta (2025) and was further refined by Narayan (2026). The derivative contract that is typically used to identify monetary policy surprises in India is the Overnight Indexed Swap (OIS) contract linked to the Mumbai Interbank Outright Rate (MIBOR) of various different maturities. MIBOR-OIS contracts have a market determined fixed leg and a floating leg tied to MIBOR, which is the Reserve Bank of India (RBI)'s operating target for its monetary policy. These swap contracts are typically utilised by banks and other financial institutions to hedge against their interest rate risks by swapping their fluctuating interest rate income streams for a fixed interest rate income stream. Additional details about the MIBOR-OIS contracts and the identification assumptions required to obtain monetary policy surprises from changes in the fixed rate of MIBOR-OIS contracts can be found in Narayan (2026).

We use MIBOR-OIS based monetary policy surprises based on contracts of 1-month, 3-month and 1-year maturity in the analysis, with a focus on the monetary policy surprises based on the 3-month rate since that captures the average time period between two monetary policy announcements during the time period under consideration. Monetary policy surprises are computed as the two-day change (change from the closing price on the day before the monetary policy announcement to the closing price on the day after the announcement) in the fixed rate of the MIBOR-OIS contracts on scheduled monetary policy announcement dates of the RBI. The necessity to use two-day windows and to restrict focus to scheduled

Figure 2.8: Monetary policy surprises from MIBOR-OIS contracts, April 2013 to October 2019



Notes: This figure plots the monetary policy surprises for India computed from MIBOR-OIS contracts of different maturities. The monetary policy surprises are calculated as the two-day change in the fixed leg of 1-month, 3-month and 1-year MIBOR-OIS contracts around scheduled announcement dates of the RBI. Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. Monetary policy announcement dates of the RBI are sourced from Narayan (2026).

announcement dates for the proper identification of monetary policy surprises in India is discussed in further detail in Narayan (2026).

Between April 2013 and October 2019, the period from which monetary policy surprises will be drawn for use in the subsequent empirical analysis, there were 41 scheduled announcements of the RBI. There were also 4 unscheduled announcements of the RBI during the same period. The RBI had scheduled reviews of monetary policy twice every quarter, once at the middle and once at the end of each quarter between 2011 and 2013. Beginning in 2014 the RBI had bi-monthly (once every two months) scheduled meetings of the Monetary Policy Committee which reviewed and determined the monetary policy stance on the basis of a majority vote. The changes in the fixed leg of the MIBOR-OIS contracts of different maturities around monetary policy announcement dates, shown in Figure 2.8, should capture the unanticipated component of changes in the entire time path of monetary policy up to one-year ahead under the standard identification assumptions underlying the high-frequency identification approach.

Table 2.2 presents summary statistics on these monetary policy surprises. The mean absolute change of the monetary policy surprises across different maturities, was around 10 basis points, with a standard deviation of around 12 basis points. The largest individual surprise changes in monetary policy in the sample range from a 31 basis points surprise cut in interest rates to a 28 basis points surprise increase in interest rates. In the analysis which follows, we use these monetary policy surprises as the main source of variation to identify the effects of monetary policy on household-level income and consumption. We will focus particularly on the effects of a 10 basis points change in monetary policy (approximately a 1 standard deviation change) on outcomes of interest in the survey data. Appendix B.3 provides similar summary statistics on monetary policy surprises on unscheduled announcement dates of the RBI.

Table 2.2: Summary statistics on MIBOR-OIS monetary policy surprises, April 2013 to October 2019

	N	Mean	Std.Dev	min	25%	50%	75%	max
1-month	41	0.081	0.115	-0.310	-0.035	0.005	0.075	0.280
3-month	41	0.084	0.119	-0.300	-0.060	0.000	0.080	0.275
1-year	41	0.097	0.123	-0.267	-0.060	0.025	0.080	0.235

Notes: This table documents the summary statistics for monetary policy surprises for India computed from MIBOR-OIS contracts of different maturities. The monetary policy surprises are calculated as the two-day change in the fixed leg of 1-month, 3-month and 1-year MIBOR-OIS contracts around scheduled announcement dates of the RBI. Mean refers to mean of the absolute changes in the fixed leg of the relevant MIBOR-OIS contract on monetary policy announcement dates. Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. Monetary policy announcement dates of the RBI are sourced from Narayan (2026).

2.3 Monetary policy transmission at the aggregate level

2.3.1 Empirical specification

Before proceeding to examine the role of financial inclusion in monetary policy transmission, we begin with an examination of monetary policy transmission to household income and consumption in the CPHS data. We think that this is helpful as an initial validation check for our CPHS and monetary policy surprises data. In order to study monetary policy transmission using CPHS, we first aggregate the household-level CPHS data to the HR level and work with an HR-Month panel dataset. We then merge the monetary policy surprises data from Narayan (2026) with this HR-Month panel dataset in order to study the effects of monetary policy on household income and consumption at the HR level. This yields an unbalanced panel dataset for 95 distinct HRs between April 2014 and October 2019.[19]

In order to understand the dynamic responses of household income and consumption to monetary policy surprises, we estimate a Local Projections (LP) specification, following Jordà (2005), as follows:

$$\Delta y_{i,t+h,t-1} = \alpha_{i,h} + \beta_h \text{MonSurprise}_t + \Gamma_h' \mathbf{X}_{i,t} + \varepsilon_{i,t+h} \tag{2.1}$$

for $h = 0, 1, 2, \ldots, 9$, where $\Delta y_{i,t+h,t-1} \left(\equiv y_{i,t+h} - y_{i,t-1}\right)$ is the change in the outcome variable of interest in HR i between months $t-1$ and $t+h$, MonSurprise_t is the monetary policy surprise on scheduled announcement dates in month t and $\mathbf{X}_{i,t}$ is a set of control variables added to the specification to improve the precision of the estimated impulse response functions.[20] $\alpha_{i,h}$ are HR-level fixed effects. $\{\beta_h\}_{h=0}^{9}$ are the coefficients of interest and trace out an impulse response function of the dynamic causal effects of a surprise change in monetary policy on the outcomes of interest.

[19] The unbalanced nature of the panel at the HR-Month level is primarily due to lack of complete data coverage in the CPHS for the smaller states of Sikkim, Meghalaya and Tripura. We also restrict focus to the period beginning in April 2014, corresponding to the second wave of the survey, instead of starting our sample in January 2014. This ensures a consistent dataset throughout the analysis, since we will utilize first wave measures of financial inclusion as lagged indicators for financial access in Section 2.4.

[20] Following the standard practice in the literature, monetary policy surprises in month t are calculated as the sum of all monetary policy surprises during that month, if there are multiple monetary policy announcements during any given month, and are set to 0 in months where there was no monetary policy announcement. During the time period under study, there was no instance of multiple scheduled monetary policy announcements occurring during the same month.

We control for the following variables in the analysis to improve the precision with which we estimate our impulse response functions of interest: (i) change in the outcome variable for the past two months, relative to month $t-1$ $\left(\Delta y_{i,t-1,t-2}, \Delta y_{i,t-1,t-3}\right)$, (ii) month of the year indicator variables, (iii) 12 lags of the monetary policy surprises on scheduled announcement dates, (iv) monetary policy surprises on unscheduled announcement dates, (v) 12 lags of the monetary policy surprises on unscheduled announcement dates and (vi) a dummy for the demonetization period (November 2016 and March 2017).[21] We express household income and consumption in logarithms. Hence our dependent variables represent an approximate percentage change in household income and consumption. Furthermore, monetary policy surprises based on the 3-month MIBOR-OIS contract forms the main focus of our analysis in this section. We cluster the standard errors by month to construct confidence intervals for the impulse response functions.

We will focus throughout on the impulse responses to a 10-basis-point surprise increase in the fixed rate of the 3-month MIBOR-OIS contract, as this corresponds approximately to a 1 standard deviation monetary policy surprise during this period, as shown in Table 2.2. Finally, in order to compare the estimates of the effects of monetary policy surprises at the HR-Month level with more conventional estimates of the effects of monetary policy using time series data on country-level macroeconomic variables, we also estimate an aggregate time series version of Equation 2.1 for the same time period, using monthly household income and consumption from the CPHS aggregated across all HRs to give measures for the whole of India.

2.3.2 Responses of household income and consumption

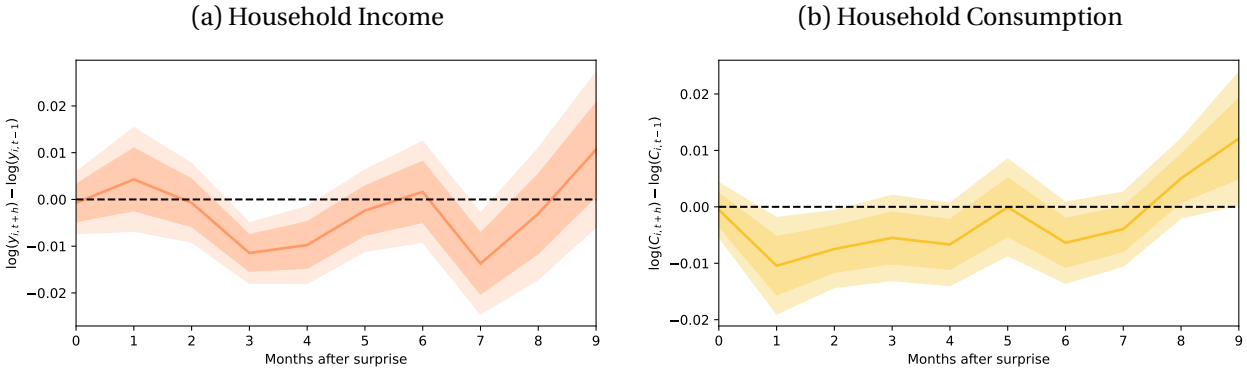
Figure 2.9 documents the impulse responses of household income and consumption, at the HR-Month level, to a 10-basis-point surprise increase in the 3-month MIBOR-OIS fixed rate. The dynamic responses of household income and consumption to monetary policy surprises suggest that monetary policy surprises have strong, persistent and almost immediate effects on aggregate demand. The effects on household income and consumption are mostly present for around 6 months following a monetary policy surprise.

Following a 10-basis-point surprise increase in the 3-month MIBOR-OIS fixed rate, the impact on household income only takes effect about 3 months following a monetary policy surprise. However, household income falls by around 1.0-1.1% in months 3 and 4 following a monetary policy surprise, with a maximum effect in month 7 of 1.4%. In contrast, household consumption falls in the first month after the surprise by about 1.0%. Effects of between 0.6-0.7% continue to persist until month 6 immediately following the monetary policy surprise, before dissipating. The weaker estimated effects of a surprise monetary policy tightening on consumption compared to income is consistent with consumption smoothing undertaken by households. These dynamic effects are in response to monetary policy surprises whose effects on the overnight MIBOR also tend to persist on average for about 9 months, as shown in Appendix B.4.

The evidence presented here adds to the recent work on monetary policy transmission, particularly by Buda et al. (2026) and Miranda-Agrippino and Ricco (2021), which suggests that the effects of monetary policy are evident almost immediately after a change in interest rates by the central banks, standing in

[21] We control for changes in the outcome variable up to 3 months before month t to control for any serial correlation in survey responses collected during a single wave of the survey. The choice of specifying November 2016 and March 2017 as being the demonetization period is motivated by the results in Chodorow-Reich et al. (2020), which shows that the economic effects of demonetization were short-lived and restricted to this time period.

Figure 2.9: Impulse response functions of household income and consumption to monetary surprises



Notes: The above figures plot the impulse response functions of household income and household consumption (in logarithms) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. The impulse response functions are estimated using Equation 2.1 outlined in the main text. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household income refers to income of all household members from all sources [**TOT_INC**]. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**] net of EMIs [**M_EXP_ALL_EMIS**], remittances sent [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Data on household income and consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of income and consumption expenditure are aggregated to the level of the CPHS Homogeneous Region using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

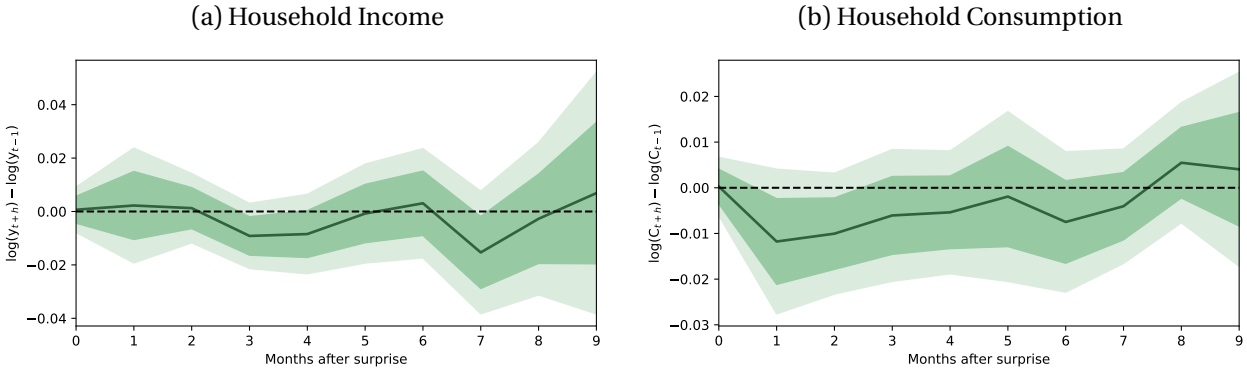
contrast to the standard view that the effects of monetary policy occur with 'long and variable lags' as suggested by Friedman (1961). Monetary policy, even in developing countries, appears to have strong and almost immediate effects, especially on household consumption.

These results are broadly robust to an alternative definition of household consumption expenditure, as shown in Figure B.8, as well as to the use of 1-month or 1-year MIBOR-OIS monetary policy surprises, as documented in Figures B.9 and B.10, with effects on household income and consumption being stronger with 1-year MIBOR-OIS monetary policy surprises. Finally, as we document in Figures B.14 and B.15, our panel OLS estimates of the aggregate effects of monetary policy surprises are also extremely similar to estimates from a mean-group estimator. In terms of quantitative magnitudes, our results are very similar to recent estimates of monetary policy transmission from similar high-frequency, disaggregated data, such as those in Buda et al. (2026). Their estimates suggest that a 10 basis-point surprise increase in interest rates leads to a roughly 1.3% decline in output in Spain.[22]

Figure 2.10 considers the responses of aggregate household income and consumption at the national level to a 10-basis-point surprise increase in the 3-month MIBOR-OIS fixed rate. The results for income and consumption suggest similar estimated effects of monetary policy at the aggregate level to the estimated effects of monetary policy found using the panel data for CPHS Homogeneous Regions. While household income and consumption continue to see a decline in response to a surprise monetary policy tightening even at the aggregate level, with a maximum decline in both cases of around 1%, the estimated confidence intervals are much wider. Hence, at least for this sample period, it is mostly not possible to detect statis-

[22] In order to arrive at this assessment, we proportionally adjust the Buda et al. (2026) estimates of the impulse response function for real corporate sales, their broadest measure of economic activity, to a 10 basis-point surprise increase in interest rates.

Figure 2.10: Impulse response functions of Aggregate Economic Outcomes to Monetary Surprises



Notes: The above figures plot the impulse response functions of aggregate monthly household income and household consumption (in logarithms) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on heteroscedasticity-robust standard errors are displayed. The impulse response functions are estimated using Equation 2.1 outlined in the main text, but without an index for HR, as there is only a single observation per month. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household income refers to income of all household members from all sources [**TOT_INC**]. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**] net of EMIs [**M_EXP_ALL_EMIS**], remittances sent [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Data on household income and consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of income and consumption expenditure are aggregated to the level of India using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

tically significant effects of monetary policy surprises on aggregate household income and consumption even with 1 standard deviation confidence intervals. These results too are broadly robust to an alternative definition of household consumption expenditure (Figure B.11), the use of 1-month MIBOR-OIS monetary policy surprises (Figure B.12) and the use of 1-year MIBOR-OIS monetary policy surprises (Figure B.13).

A key challenge in empirically estimating the effects of monetary policy lies in getting sufficiently large, plausibly exogenous variation in monetary policy over a sufficiently long time period. This has been referred to in the literature as the 'power problem' in identifying the causal effects of monetary policy , as discussed by Nakamura and Steinsson (2018). Monetary policy surprises tend to be relatively small, as central banks strive to conduct and communicate monetary policy in a very systematic and predictable fashion. For instance, in our sample of monetary policy surprises, the largest individual monetary policy surprise is no greater than 31 basis points, as documented in Table 2.2. Furthermore, the lack of statistical power is exacerbated by the short length of monetary policy surprise series due to limited availability of high-frequency financial market and macroeconomic data. These issues are particularly relevant in developing countries and are a potentially important cause of the weak estimated effects of monetary policy in many developing countries, as shown by Adam et al. (2016) and Mishra and Montiel (2013).

Just as how Buda et al. (2026) show that temporal disaggregation can improve our understanding of monetary policy transmission, we document that working with spatially disaggregated data can allow us to estimate the aggregate effects of a monetary policy surprise more precisely and allow us to improve our understanding of the causal effects of monetary policy.

Moreover, even while we search for more statistical power to detect the effects of monetary policy at the aggregate level, monetary policy surprises in developing countries can still be very useful to answer novel questions about differences in monetary policy transmission across different sub-national regions, when combined with the appropriate datasets. In the rest of the paper, we ask one such question: How do differences in formal financial inclusion affect monetary policy transmission across different CPHS Homogeneous Regions in India?

2.4 Financial inclusion and monetary policy transmission

2.4.1 Empirical specification

In order to understand the effects of formal financial inclusion on monetary policy transmission, we augment the HR-Month panel dataset used in Section 2.3 with HR-level information from the RBI on total bank deposits outstanding. As before, this yields an unbalanced panel dataset for 95 distinct HRs between April 2014 and October 2019. This dataset will form the main basis for our analysis of the role of financial inclusion for monetary policy transmission. In this section, we document empirical evidence on this question, utilizing observed (i) time-invariant cross-sectional variation in formal financial inclusion and (ii) variation over time and across space in formal financial inclusion. We will estimate panel Local Projection specifications to trace the observed effects of financial inclusion on monetary transmission.

First, we split CPHS HRs into two groups based on their median level of deposits per capita at the start of the sample (Q1 2014), and estimate Equation 2.1 separately for these two groups. We then formally test for differences in the strength of monetary policy transmission in HRs with above and below median levels of deposits per capita in Q1 2014, using the following augmented version of Equation 2.1:

$$\begin{aligned}\Delta y_{i,t+h,t-1} = \alpha_{i,h} + \beta_h \text{MonSurprise}_t + \Gamma_h' \mathbf{X}_{i,t} \\ + \gamma_h \left[\text{MonSurprise}_t \cdot D_{i,2014Q1}\right] + \Lambda_h' \left[\mathbf{X}_{i,t} \cdot D_{i,2014Q1}\right] + \varepsilon_{i,t+h}.\end{aligned} \tag{2.2}$$

for $h = 0, 1, 2, \ldots, 9$, where $D_{i,2014Q1}$ is an indicator variable equal to 1 if deposits per capita in HR i was above the median level amongst all HRs in the quarter ending on 31st March 2014 and 0 otherwise.

Next, we utilise both time-series and cross-sectional variation in formal financial inclusion to estimate the following panel Local Projections specification:

$$\begin{aligned}\Delta y_{i,t+h,t-1} = \alpha_{i,h} + \beta_h \,\text{MonSurprise}_t + \Gamma_h' \mathbf{X}_{i,t} + \delta_h \,\overline{\text{Deposits}}_{i,t-1} \\ + \gamma_h \left[\text{MonSurprise}_t \cdot \overline{\text{Deposits}}_{i,t-1}\right] + \Lambda_h' \left[\mathbf{X}_{i,t} \cdot \overline{\text{Deposits}}_{i,t-1}\right] + \varepsilon_{i,t+h}\end{aligned} \tag{2.3}$$

for $h = 0, 1, 2, \ldots, 9$, where $\overline{\text{Deposits}}_{i,t-1}$ is a measure of total bank deposits per capita outstanding in period $t-1$. Since we do not have data from the RBI at a monthly frequency, $t-1$ refers to the quarter immediately preceding the quarter to which month t belongs for the RBI dataset.

We focus on deposits per capita as our main measure of formal financial inclusion in this empirical analysis. Furthermore, we scale $\overline{\text{Deposits}}_{i,t-1}$ such that a unit change in this variable represents a ₹ 10,000 ($150) increase in deposits per capita at the HR level. Additionally, we adjust deposits per capita for inflation us-

ing the national General CPI-Combined (2012 base series) price index. Finally, we de-mean $\overline{\text{Deposits}}_{i,t-1}$ by its pooled full-sample average, so that the β_h coefficients estimate the impulse response function at the average level of deposits per capita in our sample. In addition to the set of control variables outlined in Section 2.3, we control for $\overline{\text{Deposits}}_{i,t-1}$ and its interaction with all the control variables outlined in Equation 2.1.

As in Section 2.3, we focus on the responses of household consumption and income throughout and express both these variables in logarithms. As before, our dependent variables represent an approximate percentage change in household income and consumption. Furthermore, monetary policy surprises based on the 3-month MIBOR-OIS contract form the main focus of our analysis in this section. We cluster the standard errors by month to construct confidence intervals for the impulse response functions.

We will focus throughout on the impulse responses to a 10-basis-point surprise increase in the fixed rate of the 3-month MIBOR-OIS contract, as this corresponds approximately to a 1 standard deviation monetary policy surprise during this period, as shown in Table 2.2. In both Equations 2.2 and 2.3, our focus will be on the estimated γ_h coefficients, which captures the estimated effects of different levels of formal financial inclusion, as measured using outstanding bank deposits per capita, on monetary policy transmission. We will estimate all these specifications by Ordinary Least Squares (OLS). The objective of these specifications is to establish descriptive, correlational evidence on the role of financial inclusion for monetary policy transmission.

2.4.2 OLS evidence on the role of financial inclusion

In Figure 2.11, we document the results from estimating Equation 2.1 separately for HRs that were above and below the median level of deposits per capita in March 2014 (Q1 2014), as well as the estimated γ_h coefficients from Equation 2.2. The median level of deposits per capita in March 2014 was approximately ₹ 33,400 ($\approx$ \$ 500). There is a visually perceptible difference in the transmission of monetary policy to income in regions with above and below median levels of deposits per capita in March 2014. We find that regions with above median levels of deposits per capita in March 2014 had much weaker monetary policy transmission relative to their counterparts with below median financial inclusion. The point estimates for consumption too suggest relatively weaker monetary policy transmission in more financially included regions. However the confidence intervals for these two sets of estimates overlap more closely.

Therefore, in order to test for significant differences in monetary policy transmission to income and consumption between regions with above and below median deposits per capita in March 2014, we also examine the estimated γ_h coefficients from Equation 2.2. This interaction term captures the difference between the estimated effects of monetary policy surprises on household income and consumption at horizon h between regions with above and below median levels of bank deposits per capita in March 2014. Note that the estimated β_h coefficients from Equation 2.2 are identical to the β_h coefficients from estimating Equation 2.1 using data only on HRs with below median levels of deposits per capita in March 2014.

These estimates suggest statistically significant differences in the estimated effects of monetary policy on both income and consumption between above and below median financial inclusion regions. In particular, following a 10-basis-point monetary policy surprise tightening, the response of income was generally weaker in above median financial inclusion regions by between 0.8–3.2%, while the consumption re-

sponses were generally weaker by between 0.6–1.4%. Taken together, these results suggest that greater formal financial inclusion across regions is associated with weaker monetary policy transmission to household income and consumption.[23]

Do we still find evidence that financial inclusion dampens monetary policy transmission when also additionally utilizing the time series variation in deposits per capita? Figure 2.12 documents these results from estimating Equation 2.3 using household income and consumption at the HR-Month level. The interaction term γ_h now captures the difference in the estimated effect of monetary policy surprises on household income and consumption at horizon h associated with an additional ₹ 10,000 of bank deposits per capita. Higher levels of deposits per capita are associated with weaker monetary policy transmission to income and consumption. Following a 10-basis-point monetary policy surprise, ₹ 10,000 higher deposits per capita leads to weaker contractionary effects of monetary policy to income of between 0.04–0.09%. The effects on consumption were weaker by between 0.02–0.04%. These effects are present almost throughout the time horizons considered, especially between horizons two and seven.[24]

These effects are very similar quantitatively to the estimates of γ_h from a version of Equation 2.2, where the indicator variable for deposits per capita is replaced with a continuous time-invariant measure of deposits per capita in March 2014 (Figure B.16). Moreover, the estimated baseline responses of household income and consumption from Equation 2.3 are similar in shape and in magnitude to the results from the panel specification considered in Section 2.3.

These results are broadly robust to an alternative definition of household consumption expenditure (Figure B.17) as well as the use of 1-month (Figure B.18) and 1-year (Figure B.19) MIBOR-OIS monetary policy surprises. Moreover, we also find extremely similar differential effects when we measure financial inclusion using credit per capita (Figure B.20) or branches per 100,000 people (a measure closely related to APPBO, Figure B.21). We also test for heterogeneity based on a measure of financial inclusion from the CPHS data, the proportion of households in each HR who have borrowed in any previous survey wave from formal sources, and find statistically significant effects using this measure in the specification for income (Figure B.22).

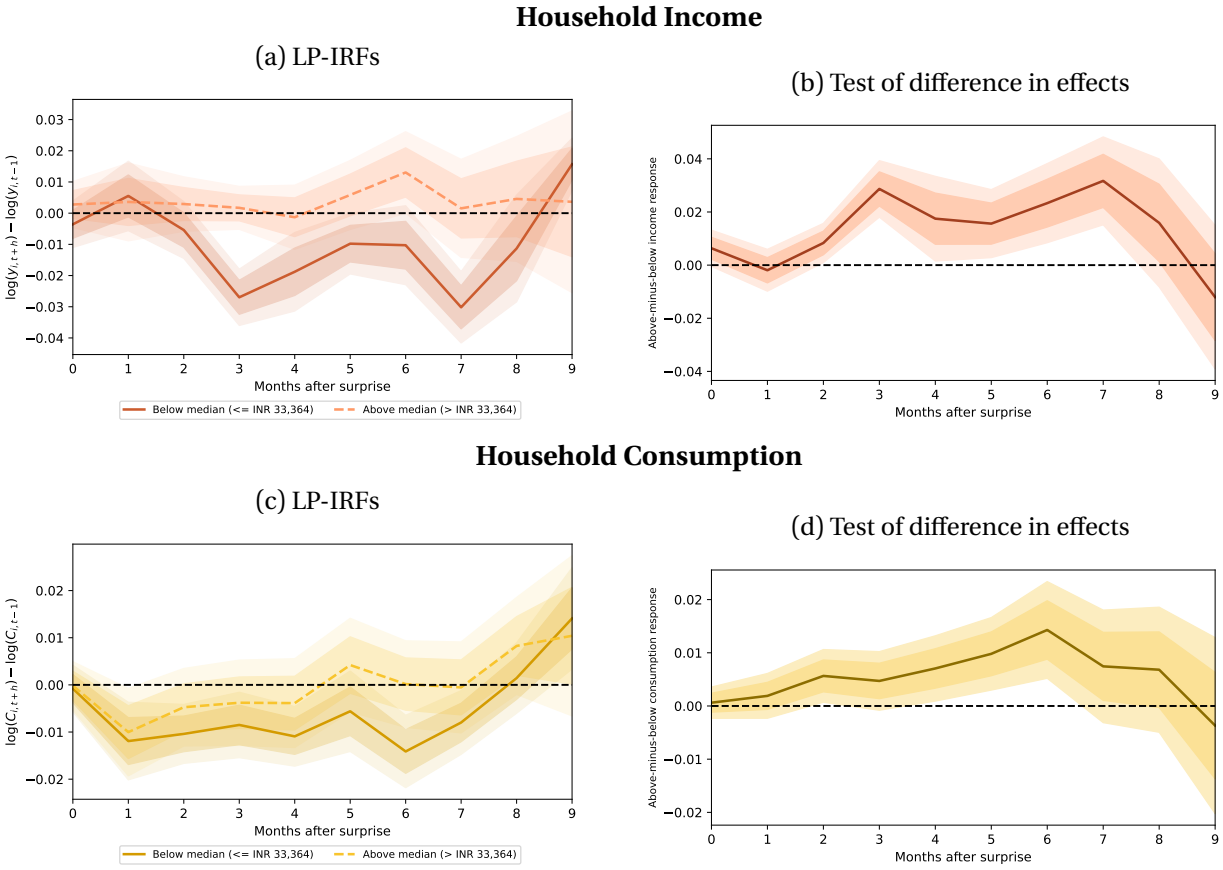
These results suggest a broadly consistent picture. The OLS evidence presented in this section points to greater financial inclusion, as measured by deposits per capita, being associated with weaker effects of monetary policy surprises on income and consumption. In the following section, we will exploit variation in deposits per capita following the demonetization episode of November 2016, to provide further evidence about the role of financial inclusion for monetary policy transmission.

2.5 Demonetization, financial inclusion and monetary transmission

[23] Note that, quantitatively, the estimated effects of monetary policy surprises on household income in below median financial inclusion regions in Figure 2.11 are much larger than the estimated effects from the panel specification in Figure 2.9. This explains why the estimated γ_h coefficients are much larger in absolute terms than the estimated effects of monetary policy on household income in Figure 2.9.

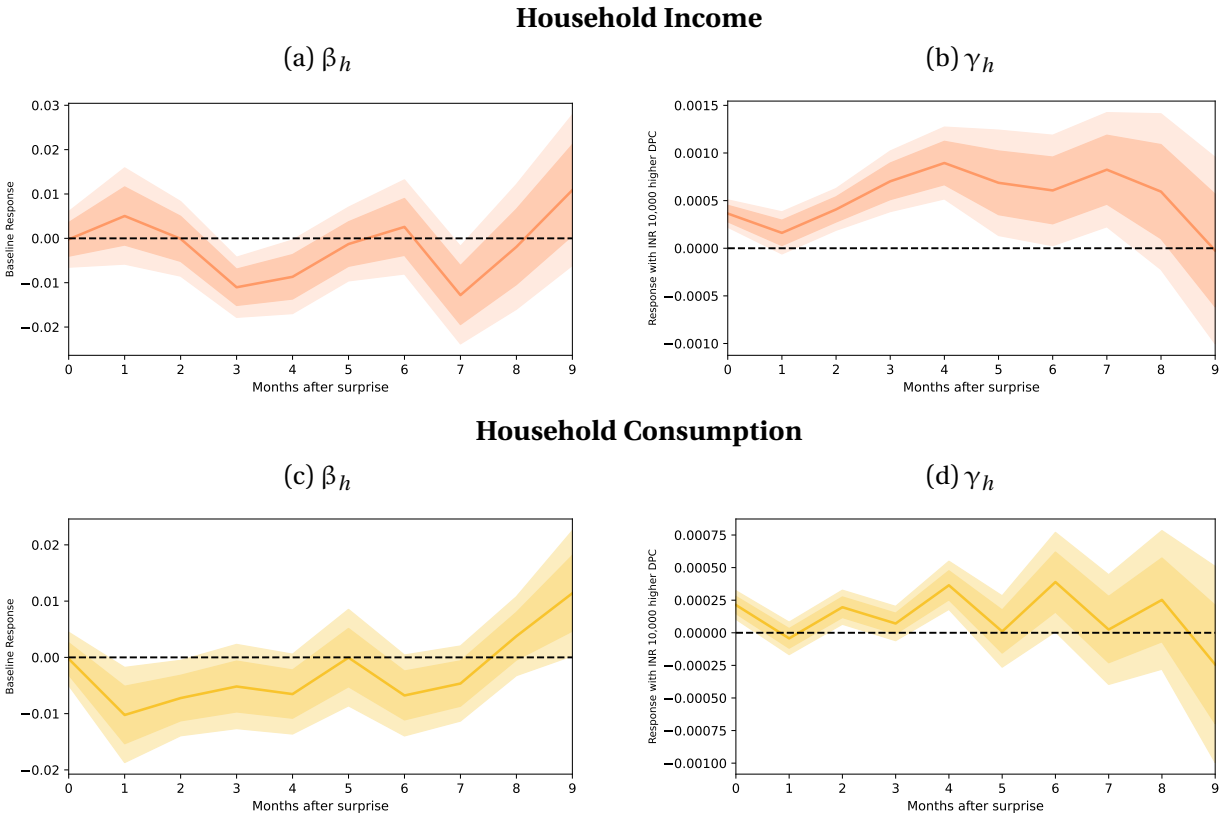
[24] Moreover, the estimated effects of monetary policy surprises at the pooled sample mean level of deposits per capita, which are captured by the β_h coefficients displayed in Figure 2.12, are similar in shape and magnitude to the results from the panel specification in Figure 2.9.

Figure 2.11: Financial inclusion and monetary policy transmission: deposits per capita median split (Q1 2014)



Notes: The left-hand panels plot OLS estimates of the LP-IRFs of household income and household consumption (in logarithms) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. The LP-IRFs are estimated using Equation 2.1 separately for HRs with deposits per capita at or below the median and HRs with deposits per capita above the median. HRs are classified using deposits per capita in March 2014 and this classification is held fixed throughout the sample period. The right-hand panels plot the estimated difference between the responses of the above-median and below-median groups (above minus below), obtained from estimating Equation 2.2. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*.

Figure 2.12: Financial inclusion and monetary policy transmission: OLS evidence



Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.3. γ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 higher deposits per capita to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

2.5.1 Indian demonetization of 2016 and financial inclusion

On November 8, 2016, without any advance notice, at 8.15 pm, the Prime Minister of India announced, in a nationally televised address, that the two largest denomination currency notes, ₹ 500 ($7.50) and ₹ 1000 ($15) would cease to be legal tender by midnight on the same day. These currency notes, which accounted for 86% of the existing currency in circulation, could no longer be used for most transactions, but could be deposited into bank accounts. The stated intention of this sudden announcement was to curb the proliferation of fake currency notes and to bring untaxed sources of wealth held in cash into the purview of the financial system and the tax authorities. 97% of this demonetized currency in circulation was deposited into the banking system by December 2016, which was the main deadline for these notes to reach the banking system. Additional information about this demonetization episode and its economic effects can be found in Chodorow-Reich et al. (2020) and Lahiri (2020).

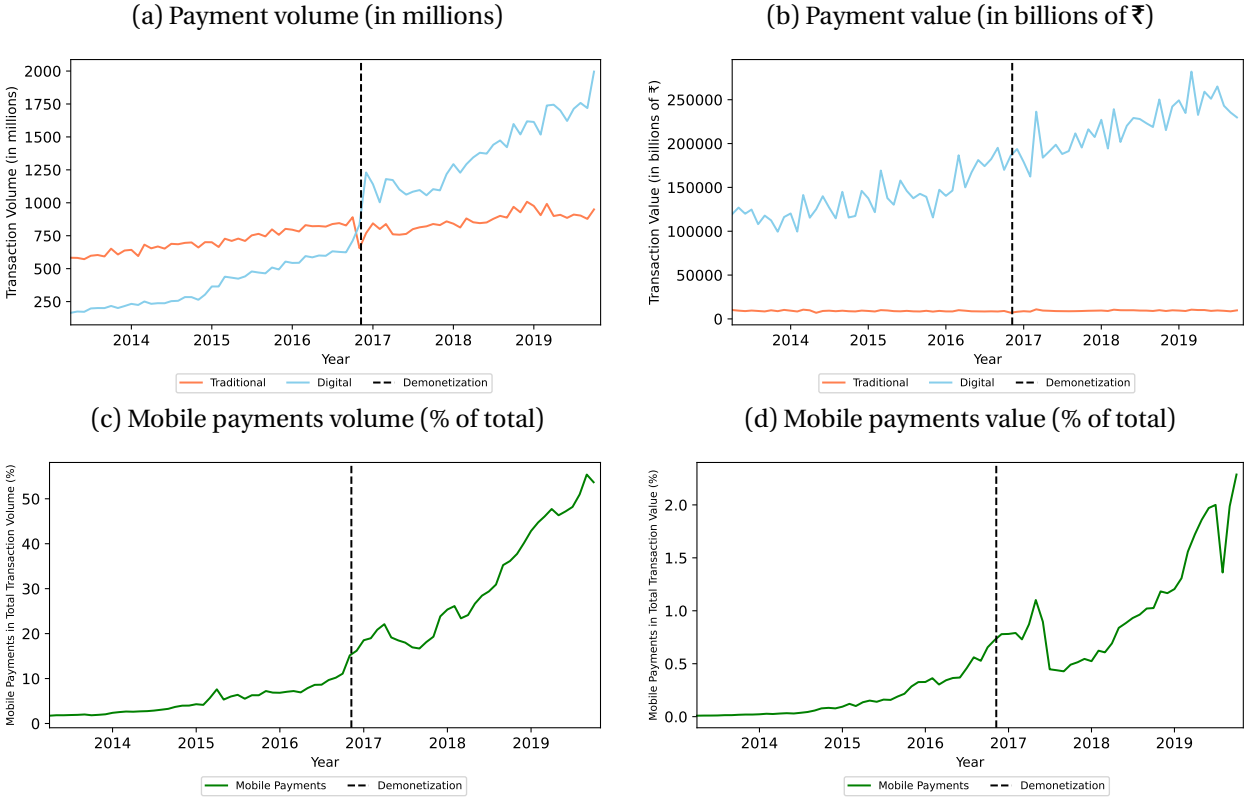
As part of this policy, the demonetized currency notes were meant to be replaced by new ₹ 500 ($7.5) and ₹ 2000 ($30) currency notes. However, to maintain secrecy prior to the announcement of this policy, new currency notes were not printed and distributed before the announcement was made. As a result, Chodorow-Reich et al. (2020) document that total currency in circulation declined overnight by 75% and reached levels close to the pre-demonetization level only towards the end of 2017. However, perceived constraints on the availability of cash began to ease much earlier, with online searches for cash related keywords returning to October 2016 levels by February 2017 (Crouzet et al., 2023). The economic consequences of this policy were also short-lived, with economic activity returning to pre-demonetization levels by March 2017 (Chodorow-Reich et al., 2020).

Despite the temporary economic effects of this policy, it has been documented to have had very significant and persistent effects on the use of the formal financial system to conduct everyday transactions. Both Crouzet et al. (2023) and Agarwal et al. (2023a) point to persistent increases in the usage of digital payment technologies by households and firms in India following the demonetization episode. Given the architecture of digital payments systems in India, digital payments essentially facilitated speedier transfer of money between existing bank accounts. As a result, the demonetization policy had the unintended consequence of persistently increasing the participation of households and firms in the formal banking system.[25] More details about India's digital payments system can be found in Copestake et al. (2025).

Figure 2.13 documents some time series evidence on the effects of demonetization on the usage of the formal financial system. While digital transactions volume was already on an upward trajectory before demonetization, and accounted for the bulk of total transactions value, there was a sharp jump in digital transactions volume immediately following demonetization, which caused digital transactions volume to overtake traditional (cheque payments and cash withdrawals) transactions volume for the first time. The fact that this was not accompanied by any visible structural break in digital transactions value suggests that this uptick in digital transactions volume was driven primarily by a shift of smaller value, day to day payments to the digital domain. This point is further demonstrated by the fact that by October 2019, mobile transactions accounted for almost 50% of all monthly transactions in India's financial system, up from less than 2% in 2013, while the value of these transactions still amounted to no more than 2% of total

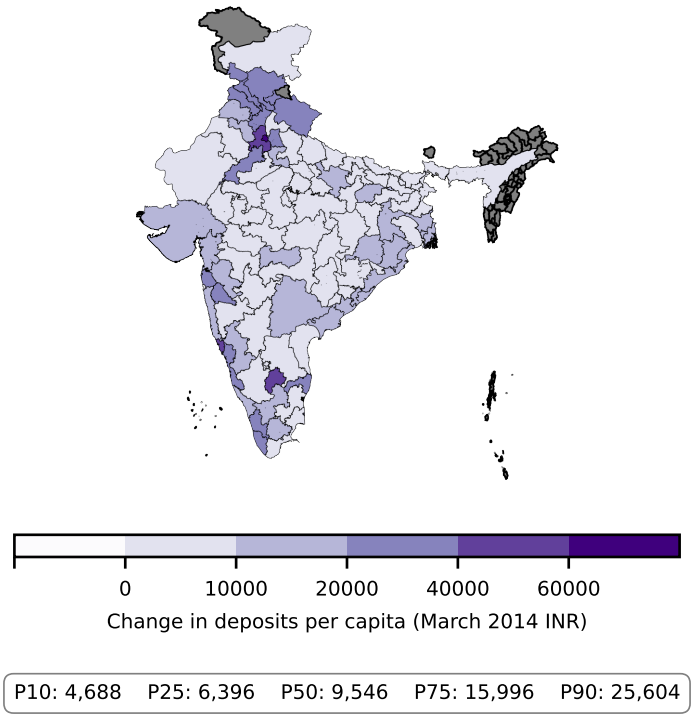
[25] In the initial phase post-demonetization, mobile wallets too were a popular digital payment option. But since these mobile wallets had to be 'topped-up' mainly using bank transfers, these wallets too had the effect of encouraging more active participation in the formal financial system.

Figure 2.13: Payment System Indicators in India, April 2013 to October 2019



Notes: This figure documents the time-series of different payment system indicators from India's formal financial system between April 2013 and October 2019. These include (i) the total volume of traditional and digital transactions (in millions), (ii) the total value of traditional and digital transactions (in billions of ₹), (iii) the share of mobile payments in total transaction volume and (iv) the share of mobile payments in total transaction value. The demonetization episode of 8 November, 2016 is marked on all plots. Following Lahiri (2020), traditional transactions refer to paper clearing and the use of credit and debit cards to make cash withdrawals from ATMs. All other transactions in the payment system are classified as digital transactions. Mobile payments refer to mobile banking transactions and m-wallet transactions. The data on monthly payment system indicators is from the Reserve Bank of India's Database on Indian Economy (DBIE): https://data.rbi.org.in/DBIE/ (Accessed March 31, 2026).

Figure 2.14: Average change in deposits per capita following demonetization in India



Notes: This figure plots the average change in deposits per capita after the demonetization episode compared to the period before it in different Consumer Pyramids Household Survey (CPHS) Homogeneous Regions (HRs) in India. Deposits per capita is calculated as the ratio of total deposits outstanding in each HR to the Census 2011 population in that HR. The change in deposits per capita in each HR is calculated as the difference between the average deposits per capita in that HR in the post-demonetization period (Q4 2016–Q3 2019) relative to the pre-demonetization period (Q1 2014–Q3 2016). Data on deposits outstanding is from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. The mapping from districts to CPHS HRs is from Vyas (2020b). HR 67, HR 68 and HR 69 in Telangana, HR 34, HR 35, HR 36 and HR 37 in Gujarat and HR 18 and HR 32 as well as HR 23 and HR 26 in Uttar Pradesh have each been aggregated into a single HR within their respective states to deal with changes in district boundaries post-2011 that affect all these individual HRs. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/. The HR and district shape files used for plotting the above figures was obtained from xKDR's Maps of India, available at https://github.com/xKDR/india-maps. The 10th, 25th, 50th, 75th and 90th percentiles of the deposits per capita change distribution are also reported.

transactions value by 2019.

Figure 2.14 documents the average change in the level of deposits per capita (in constant March 2014 prices) before and after the demonetization episode. There was an increase in deposits per capita following the demonetization episode in almost all regions of the country, with a median change of close to ₹ 10,000 ($ 150). Hence, as an additional empirical specification, we consider the effects of the changes in formal financial inclusion following the demonetization episode on monetary policy transmission in this section.

2.5.2 Empirical specification

We will continue working with the unbalanced HR-Month panel described in Section 2.4. In order to specifically assess the effects of changes in deposits per capita following the demonetization episode on monetary policy transmission, we estimate the following variant of the panel Local Projection specifica-

tions in Section 2.4:

$$\begin{aligned}\Delta y_{i,t+h,t-1} = \alpha_{i,h} + \beta_h \, \text{MonSurprise}_t + \Gamma_h' \mathbf{X}_{i,t} + \lambda_h \left[\text{MonSurprise}_t \cdot \overline{\text{D}}_{i,pre}\right] \\ + \gamma_h \left[\text{MonSurprise}_t \cdot \overline{\text{D}}_{i,chg}\right] + \Pi_h' \left[\mathbf{X}_{i,t} \cdot \overline{\text{D}}_{i,pre}\right] + \Lambda_h' \left[\mathbf{X}_{i,t} \cdot \overline{\text{D}}_{i,chg}\right] + \varepsilon_{i,t+h}\end{aligned} \tag{2.4}$$

where $\overline{\text{D}}_{i,pre}$ refers to the average level of deposits per capita in the period before the demonetization episode (Q1 2014–Q3 2016) and $\overline{\text{D}}_{i,chg}$ refers to the difference between the average level of deposits per capita in the post-demonetization period (Q4 2016–Q3 2019) relative to the pre-demonetization level for each HR. Both $\overline{\text{D}}_{i,pre}$ and $\overline{\text{D}}_{i,chg}$ are calculated after inflation-adjusting deposits per capita using the national General CPI-Combined (2012 base series) price index. They are also de-meaned by their respective pooled full-sample averages and scaled such that a unit change in either variable represents a ₹ 10,000 ($ 150) increase in deposits per capita at the HR level. The monetary policy surprise and all control variables are interacted with both a measure of financial inclusion which captures pre-existing differences between HRs in their level of formal financial access ($\overline{\text{D}}_{i,pre}$) and a measure of the change in financial inclusion in each HR following the demonetization episode ($\overline{\text{D}}_{i,chg}$). This specification is otherwise identical to the panel Local Projection specifications in Section 2.4.

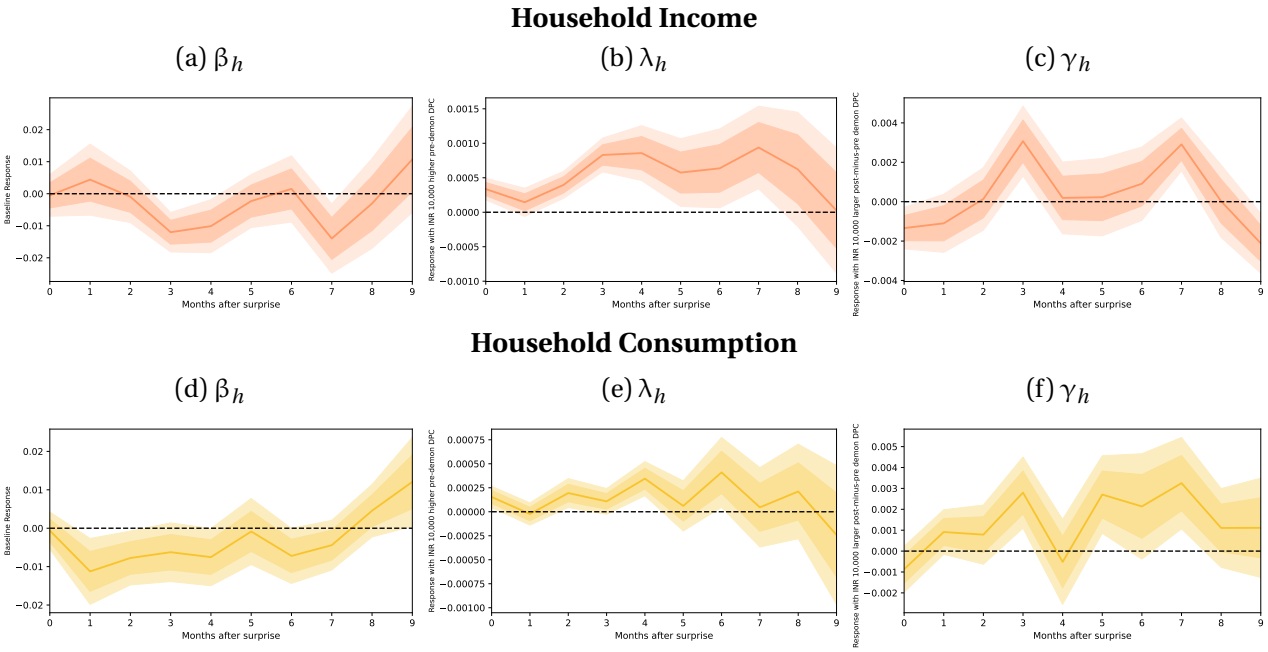
This specification is closely connected to the rise in formal financial inclusion documented in Figure 2.1. It examines whether regions experiencing larger increases in deposits per capita following demonetization experience weaker monetary policy transmission, conditional on their pre-demonetization levels of deposits per capita. As in Sections 2.3 and 2.4, we focus on the responses of household consumption and income throughout and express both these variables in logarithms. As before, our dependent variables represent an approximate percentage change in household income and consumption. Furthermore, monetary policy surprises based on the 3-month MIBOR-OIS contract form the main focus of our analysis in this section. We cluster the standard errors by month to construct confidence intervals for the impulse response functions.

We will focus throughout on the impulse responses to a 10-basis-point surprise increase in the fixed rate of the 3-month MIBOR-OIS contract, as this corresponds approximately to a 1 standard deviation monetary policy surprise during this period, as shown in Table 2.2. Our focus will especially be on the estimated γ_h coefficient, which captures the differential effect of formal financial inclusion, as measured using outstanding bank deposits per capita, following the demonetization episode on monetary policy transmission. We will also report the corresponding β_h and λ_h coefficients for comparison. λ_h captures the differences in the impulse response functions to monetary policy surprises in regions with ₹ 10,000 higher average bank deposits per capita in the pre-demonetization period. These specifications will be estimated by Ordinary Least Squares (OLS).

2.5.3 Responses of household income and consumption

Figure 2.15 documents the β_h, λ_h and γ_h coefficients from estimating Equation 2.4 using OLS. The λ_h coefficients indicate that regions with a higher pre-demonetization level of deposits per capita experienced weaker monetary policy transmission to household income and consumption. Following a 10-basis-point surprise monetary policy tightening, the λ_h coefficients suggest that regions with ₹ 10,000 higher average pre-demonetization deposits per capita witnessed weaker transmission of monetary policy to income by

Figure 2.15: Financial inclusion and monetary transmission: the role of demonetization



Notes: The above figures plot OLS estimates of the β_h, λ_h and γ_h coefficients from the LP-IRF specification in Equation 2.4. λ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 higher deposits per capita before the demonetization episode to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. γ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 larger post-minus-pre demonetization change in average deposits per capita to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

between 0.03–0.09% and to consumption by between 0.02–0.04%. These results are extremely similar in magnitudes to the OLS evidence presented in Section 2.4.[26]

The γ_h coefficients indicate that regions which experienced a larger increase in deposits per capita from the pre-demonetization to the post-demonetization sub-period also experienced weaker monetary policy transmission to household income and consumption. An identical 10-basis-point surprise monetary policy tightening results in weaker effects in regions with ₹ 10,000 higher average change in deposits per capita from the pre-demonetization period to the post-demonetization period by roughly 0.3% on both income and consumption. These results provide evidence consistent with the possibility that rising formal financial inclusion during this period weakened monetary policy transmission.

What do these results suggest about the implied differences in monetary policy transmission associated

[26]The estimated effects of monetary policy surprises at the pooled sample mean level of pre-demonetization deposits per capita and with the pooled sample mean level of pre-post demonetization change in deposits per capita, which are captured by the β_h coefficients in Figure 2.15, are also similar in shape and magnitude to the results from the panel specification in Figure 2.9.

with differences in deposits per capita in India during the time period under study? Figure 2.16 considers this question in two ways, by plotting the implied impulse response functions for household income and consumption at different percentiles using (i) the pre-demonetization distribution in average deposits per capita $\left(\beta_h + \lambda_h \times \overline{D}_{\text{pre}}\right)$ and (ii) the pre-post demonetization average change in deposits per capita $\left(\beta_h + \gamma_h \times \overline{D}_{\text{chg}}\right)$ distributions, using our estimated OLS coefficients.

First, we consider the difference between the impulse responses of household income and household consumption to monetary policy surprises at different percentiles of the deposits per capita distribution in the pre-demonetization period (Q1 2014–Q3 2016). These results also visually document that regions with higher levels of deposits per capita in the pre-demonetization period generally witness weaker monetary policy transmission to income and consumption. More specifically, comparing the 10th and 90th percentile responses, our implied impulse response functions suggest that income responds by up to 1% less and consumption by up to 0.4% less to a 10-basis-point surprise monetary policy tightening.

We also consider the implied income and consumption responses at different quantiles of the pre-post demonetization average change in deposits per capita distribution. These results also visually document the weaker transmission of monetary policy to income and consumption in regions which witnessed larger increases in financial inclusion following demonetization. Quantitatively, the estimates are very similar to the results above, with a roughly 0.7% weaker income and consumption response at the 90th percentile compared to the 10th percentile of the distribution.

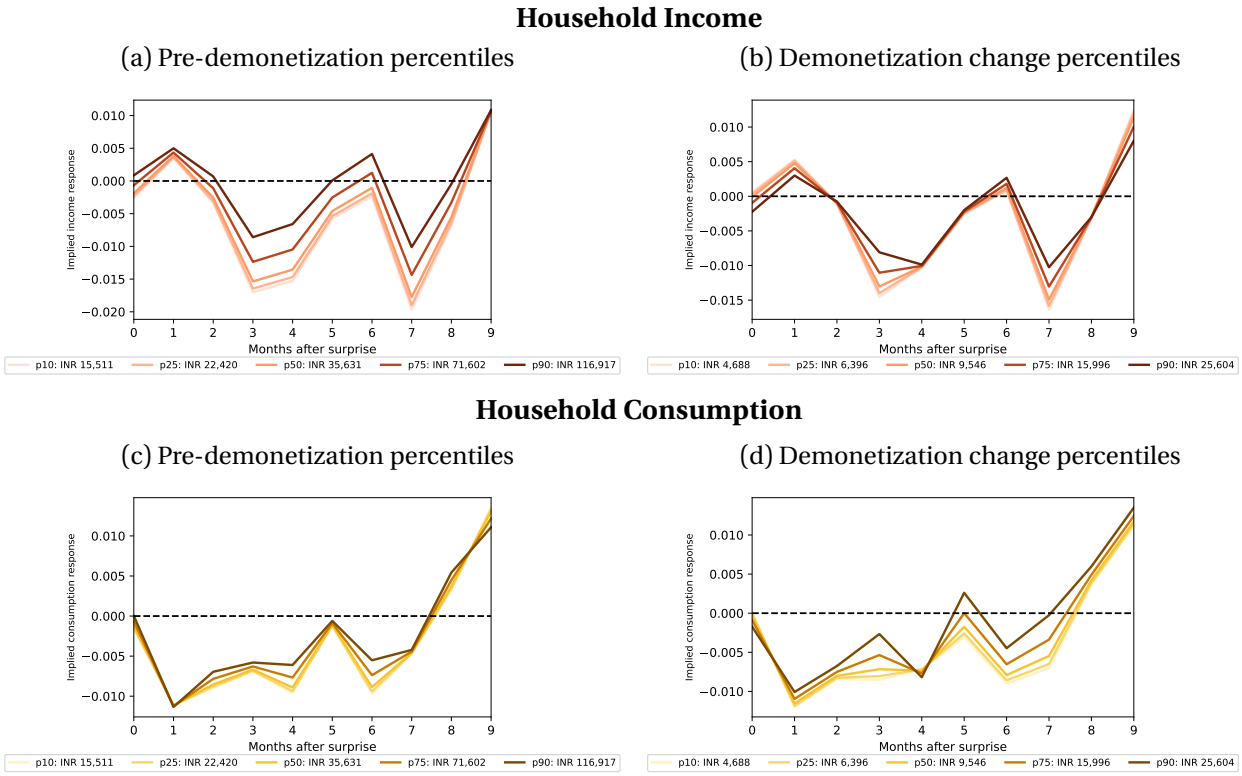
2.5.4 Some additional IV evidence

In this section, we briefly consider results from also estimating Equation 2.4 using an instrumental variables strategy. Crouzet et al. (2023) show that the adoption of digital payments technologies was particularly high in places that were more severely exposed to the cash shortage following demonetization, suggesting an important role for network effects in facilitating the adoption of digital payments technology. They point out that the share of deposits in banks with currency chest branches (which are designated bank branches responsible for currency distribution activity in their local areas) in that region is an excellent proxy for the severity of the region's exposure to the cash shortage brought about by the demonetization policy. Moreover, since the deposit market shares of currency chest branches was completely predetermined with respect to demonetization, they argue that this provides quasi-exogenous variation in regional exposure to demonetization.

We will continue working with the unbalanced HR-Month panel described in Section 2.4 to implement the IV strategy. We construct a HR-level measure of demonetization exposure following Crouzet et al. (2023) (additional details about constructing this exposure measure can be found in Appendix B.7.2) and merge it with the HR-Month panel. This demonetization exposure measure, which we term Exposure_i, exhibits wide geographic variation throughout India and does not display any systematic geographic pattern. Summary statistics about this exposure measure can be found in Table B.2 and Figure B.23. Moreover, as shown in Figure B.24, high exposure regions witness systematically faster deposits per capita growth (in constant prices) both in the short-run and the medium-run, while the relationship with credit per capita growth is much weaker.

We will estimate Equation 2.4 using an instrumental variables strategy. More specifically, we will instru-

Figure 2.16: Implied response of consumption and income to monetary policy surprises



Notes: The above figures plot the implied responses ($\beta_h + \lambda_h * \overline{D}_{pre}$ and $\beta_h + \gamma_h * \overline{D}_{chg}$) of household income and consumption from the LP-IRF specification in Equation 2.4 estimated by OLS. $\overline{D}_{chg}$ is held at its pooled full-sample mean when calculating the implied responses using $\overline{D}_{pre}$ and vice-versa. These represent the estimated response of household income and household consumption (in logarithms) associated with the 10th, 25th, 50th, 75th and 90th percentile of the (i) pre-demonetization period (Q1 2014–Q3 2016) distribution of average deposits per capita and (ii) the distribution of the average changes in deposits per capita between the pre-demonetization and post-demonetization (Q4 2016–Q3 2019) periods to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average before estimation. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

ment for $\overline{\mathrm{D}}_{i,\mathrm{chg}}$, wherever it appears in Equation 2.4, using the Crouzet et al. (2023) demonetization exposure measure $\mathrm{Exposure}_i$. More concretely, since we have two main sets of terms with $\overline{\mathrm{D}}_{i,\mathrm{chg}}$ in Equation 2.4, namely: (i) the interaction with $\mathrm{MonSurprise}_t$ and (ii) the interaction with the full set of control variables ($\mathbf{X}_{i,t}$) we utilize the following set of instrumental variables:

$$\underbrace{\begin{bmatrix} \overline{\mathrm{D}}_{i,\mathrm{chg}} \times \mathrm{MonSurprise}_t \\ \overline{\mathrm{D}}_{i,\mathrm{chg}} \times \mathbf{X}_{i,t} \end{bmatrix}}_{\text{endogenous variables}} \longleftarrow \underbrace{\begin{bmatrix} \mathrm{Exposure}_i \times \mathrm{MonSurprise}_t \\ \mathrm{Exposure}_i \times \mathbf{X}_{i,t} \end{bmatrix}}_{\text{instruments}}. \tag{2.5}$$

Our main coefficient of interest here will be the interaction term $\{\gamma_h\}_{h=0}^{9}$ in Equation 2.4. We estimate Equation 2.4 using the instrumental variables in Equation 2.5 through Two-Stage Least Squares (2SLS). The first-stage regressions for the Horizon 0 income and consumption LP-IRF specifications are reported in Table B.3.[27] These results suggest severe under-identification concerns for the consumption LP-IRF specification, with the Kleibergen-Paap rk LM test of the null hypothesis of under-identification in our specifications for Horizon 0 not being rejected (with a p-value of 0.8). Under-identification is less of a concern with the income specification, but the Kleibergen-Paap rk Wald F statistic of 0.11 still suggests significant weak instrument concerns with the income specification.

Figure B.25 plots the β_h, λ_h and γ_h coefficients in Equation 2.4 estimated using 2SLS. γ_h captures the differences in the impulse responses to monetary policy surprises in regions with ₹ 10,000 larger post-minus-pre demonetization average change in deposits per capita. While the consumption results are not interpretable due to under-identification concerns, the 2SLS results for income have a similar shape for the interaction term to the OLS results above, although with significantly wider confidence intervals. There is no evidence from the income 2SLS point estimates that the OLS estimates overstate the attenuating effects of formal financial inclusion on monetary policy transmission.

The 2SLS results presented in this section must be interpreted with the caveats of potentially important under-identification and weak instrument problems associated with our instrumental variable estimation approach. However, the available evidence suggests a reassuringly consistent pattern across a wide range of specifications, both OLS and 2SLS, of higher deposits per capita regions witnessing weaker monetary policy transmission. Taken together, there is consistent evidence that formal financial inclusion weakens monetary policy transmission, even as the precise quantitative significance of these results and a robust causal estimate of these effects require further investigation.

2.5.5 Discussion of findings

How do we contextualize these findings on the role of financial inclusion in monetary policy transmission? A useful starting point to think about this question more formally is the class of Two Agent New Keynesian (TANK) models, as discussed in Bilbiie (2020). In these models, there are two kinds of economic agents, whom we can label as Ricardian and Keynesian. These agents have identical preferences but differ in terms of their access to financial markets. Ricardian agents have complete access to financial markets, which

[27] In discussing the first-stage diagnostics, we focus throughout on horizon 0, since the longer horizon first-stage regressions are identical to those for horizon 0, except that they use fewer observations due to data loss from taking longer leads of the outcome variable.

they can use to smooth their consumption over time. Keynesian agents, on the other hand, are completely shut out from financial markets, preventing them from being able to save or borrow. An implication of this is that Keynesian agents have higher Marginal Propensities to Consume (MPC) out of current income than Ricardian agents, as Keynesian agents are forced to shift their consumption one-for-one in response to shifts in their current income.

In TANK models, a monetary policy tightening has two distinct kinds of effects. When the central bank raises interest rates, the rate of return to saving rises for the Ricardian agents, who cut their consumption today in order to save more to consume in the future. This is the direct or inter-temporal substitution effect. This initial fall in consumption is going to lead to a fall in income for both Ricardian and Keynesian agents. This in turn leads to further declines in income and consumption, this time for both Ricardian and Keynesian agents. These are the indirect or general equilibrium effects of the monetary policy tightening in this class of models.

At a conceptual level, it is possible to think of the process of financial inclusion in an economy as corresponding to an increase in the relative proportion of Ricardian agents in the TANK economy. As Bilbiie (2020) points out, the increase in the proportion of Ricardian agents in the TANK economy strengthens the direct effects while weakening the indirect effects associated with a change in monetary policy.

When there are more Ricardian agents in the economy, a larger share of economic agents inter-temporally substitute consumption in response to interest rate increases, leading to stronger direct effects. However, the general equilibrium effects of the interest rate increase will become relatively weaker as the proportion of Ricardian agents increase. Ricardian agents are better placed to smooth the effects of the initial declines in current income brought about by inter-temporal substitution than Keynesian agents. Hence, the second-round declines in income and consumption will be proportionally smaller in more financially included economies.

The empirical results presented in Sections 2.4 and 2.5, which suggest weaker monetary policy transmission to aggregate demand with relatively more financial inclusion, are broadly in line with stronger general equilibrium effects than inter-temporal substitution effects with rising financial inclusion in the economy. Bilbiie (2020) suggests that the weakening indirect effects dominate, with a rising share of Ricardian households in the TANK economy, when the elasticity of income of Keynesian households to aggregate income is greater than 1. The presence of countercyclical inequality, which is implied by this parameter restriction, seems quite plausible in the Indian context, given the lack of sufficient fiscal redistribution towards poorer households, constrained by a low tax base, and pervasive labour market informality. These results are also consistent with the predictions of more quantitative Heterogeneous Agent New Keynesian (HANK) models which suggest that general equilibrium effects amplify the effects of monetary policy in the presence of 'hand-to-mouth' and 'wealthy hand-to-mouth' households.

2.6 Conclusion

Combining monthly panel data on household income and consumption with administrative data on measures of financial access from the RBI and high-frequency identified monetary policy surprises, we have documented strong and statistically significant effects of monetary policy on household income and consumption at the sub-national level in India. Monetary policy has economically meaningful and persistent

effects on household income and consumption at the level of CPHS Homogeneous Regions (groups of contiguous Indian districts).

Utilizing observed cross-sectional and time-series variation in measures of formal financial inclusion, we then document that regions with greater financial access witnessed weaker transmission of monetary policy to household income and consumption. These effects are robust to different ways of measuring formal financial inclusion. We emphasize that the results which we present are suggestive evidence and not definitive causal proof of the role of financial inclusion for monetary policy transmission.

One possible and potentially important explanation for the differences in the estimated impulse response functions is the ability of households with financial access to better smooth their consumption in response to a change in interest rates. These results have important implications for the design of optimal monetary policy in response to rapidly improving financial access throughout the developing world. Attempting to utilize quasi-exogenous variation in financial access to assess the causal effects of financial inclusion for monetary policy transmission remains an important direction for future research.

Bibliography

Adam, Christopher, Andrew Berg, Bin Grace Li, Peter Montiel, and Stephen O'Connell, "VAR meets DSGE: Uncovering the Monetary Transmission Mechanism in Low-Income Countries," *IMF Working Paper*, 2016, *WP/16/90*.

Agarwal, Bhavya, Nirupama Kulkarni, and S K Ritadhi, "Cash Is King: The Role of Financial Infrastructure in Digital Adoption," *The Review of Corporate Finance Studies*, 2023, *12* (4), 867–905.

Agarwal, Sumit, Shashwat Alok, Pulak Ghosh, Sourav Ghosh, Tomasz Piskorski, and Amit Seru, "Banking the Unbanked: What Do 255 Million New Bank Accounts Reveal About Financial Access?," *Working Paper*, 2023.

Barboni, Giorgia, Erica Field, and Rohini Pande, "Rural Banks Can Reduce Poverty: Evidence from 870 Indian Villages," *Working Paper*, 2021.

Bhattarai, Saroj, Arpita Chatterjee, and Gautham Udupa, "Food, Fuel, and Facts: Distributional Effects of Global Price Shocks," *Working Paper*, 2025.

Bilbiie, Florin O., "The New Keynesian cross," *Journal of Monetary Economics*, 2020, *114*, 90–108.

_ , Sigurd Mølster Galaasen, Refet S. Gürkaynak, Mathis Mæhlum, and Krisztina Molnar, "HANKSSON," *CEPR Discussion Paper No. 20090*, 2025.

Buda, Gergeley, Vasco M. Carvalho, Giancarlo Corsetti, João B. Duarte, Stephen Hansen, Afonso S. Moura, Álvaro Ortiz, Tomasa Rodrigo, José V. Rodríguez Mora, and Guilherme Alves da Silva, "The Short Lags of Monetary Policy," *Working Paper*, 2026.

Burgess, Robin and Rohini Pande, "Do Rural Banks Matter? Evidence from the Indian Social Banking Experiment," *The American Economic Review*, 2005, *95* (3), 780–795.

Chander, Bharat, Dian Jiao, and Marshall Mo, "Bank Expansion, Firm Dynamics, and Structural Transformation: Evidence from India's Policy Experiment," *Working Paper*, 2024.

Chodorow-Reich, Gabriel, Gita Gopinath, Prachi Mishra, and Abhinav Narayanan, "Cash and the Economy: Evidence from India's Demonetization," *The Quarterly Journal of Economics*, 2020, *135* (1), 57–103.

Cloyne, James, Clodomiro Ferreira, and Paolo Surico, "Monetary Policy when Households have Debt: New Evidence on the Transmission Mechanism," *Review of Economic Studies*, 2020, *87*, 102–129.

Copestake, Alexander, Divya Kirti, Maria Soledad Martinez Peria, and Yao Zeng, "Integrating Fragmented Networks: Interoperability in Money and Payments," *IMF Working Paper*, 2025, *WP/25/126*.

Cramer, Kim Fe, "Bank Presence and Health," *Review of Finance*, 2025, *29* (5), 1497–1535.

Crouzet, Nicolas, Apoorv Gupta, and Filippo Mezzanotti, "Shocks and Technology Adoption: Evidence from Electronic Payment Systems," *Journal of Political Economy*, 2023, *131* (11), 3003–3065.

Dhingra, Swati and Maitreesh Ghatak, "How has Covid-19 affected India's economy?," *Economics Observatory*, 2021.

Fonseca, Julia and Adrien Matray, "Financial inclusion, economic development, and inequality: Evidence from Brazil," *Journal of Financial Economics*, 2024, *156*, 103854.

Foulis, Angus, Jonathon Hazell, Atif Mian, and Belinda Tracey, "How Do Interest Rates Affect Consumption? Household Debt and the Role of Asset Prices," *Working Paper*, 2026.

Friedman, Milton, "The lag in effect of monetary policy," *The Journal of Political Economy*, 1961, *69* (5), 447–466.

Gürkaynak, Refet S., Brian T. Sack, and Eric T. Swanson, "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements," *International Journal of Central Banking*, 2005, *1* (1), 55–93.

Herreño, Juan and Mathieu Pedemonte, "The Geographic Effects of Monetary Policy Shocks," *Working Paper*, 2025.

Ji, Yan, Songyuan Teng, and Robert M. Townsend, "Dynamic Bank Expansion: Spatial Growth, Financial Access, and Inequality," *Journal of Political Economy*, 2023, *121* (8), 2209–2275.

Jordà, Òscar, "Estimation and Inference of Impulse Responses by Local Projections," *The American Economic Review*, 2005, *95* (1), 161–182.

Kaplan, Greg, Benjamin Moll, and Giovanni L. Violante, "Monetary Policy According to HANK," *The American Economic Review*, 2018, *108* (3), 697–743.

_ , Giovanni L. Violante, and Justin Weidner, "The Wealthy Hand-to-Mouth," *Brookings Papers on Economic Activity*, 2014, *2014* (1), 77–138.

Kuttner, Kenneth N., "Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market," *Journal of Monetary Economics*, 2001, *47* (3), 523–544.

Lahiri, Amartya, "The Great Indian Demonetization," *Journal of Economic Perspectives*, 2020, *34* (1), 55–74.

Lakdawala, Aeimit and Rajeswari Sengupta, "Measuring Monetary Policy Shocks in Emerging Economies: Evidence from India," *Journal of Money, Credit and Banking*, 2025, *57* (2-3), 407–437.

Ma, Yong and Xingkai Lin, "Financial development and the effectiveness of monetary policy," *Journal of Banking & Finance*, 2016, *68*, 1–11.

Mehrotra, Aaron and James Yetman, "Financial inclusion and optimal monetary policy," *BIS Working Papers*, 2014, *476*.

Ministry of Statistics and Programme Implementation, "National Accounts Statistics - 2015," 2015. Accessed on 25th August, 2025.

_ , "New Series Estimates of National Income, Consumption Expenditure, Saving and Capital Formation (Base Year 2011-12)," 2015. Released on January 30, 2015.

_ , "First Revised Estimates of National Income, Consumption Expenditure, Saving and Capital Formation, 2019–20," 2021. Released on January 29, 2021.

_ , "National Accounts Statistics - 2021," 2021. Accessed on 25th August, 2025.

Miranda-Agrippino, Silvia and Giovanni Ricco, "The Transmission of Monetary Policy Shocks," *American Economic Journal: Macroeconomics*, July 2021, *13* (3), 74–107.

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

_ , _ , Peter Pedroni, and Antonio Spilimbergo, "Monetary policy and bank lending rates in low-income countries: Heterogeneous panel estimates," *Journal of Development Economics*, 2014, *111*, 117–131.

Nakamura, Emi and Jon Steinsson, "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect," *The Quarterly Journal of Economics*, January 2018, *133* (3), 1283–1330.

Narayan, Karthik, "Macroeconomic Effects of Scheduled and Unscheduled Monetary Policy Surprises," *Working Paper*, 2026.

Pais, Jesim and Vikas Rawal, "CMIE's Consumer Pyramids Household Survey: An Assessment," *Working Paper*, 2021.

Pizzolon, Fiorella and Aditi Singh, "Unequal Transmission: Monetary Policy and Household Consumption in India," *Working Paper*, 2025.

Ramey, V.A., "Macroeconomic Shocks and Their Propagation," in John B. Taylor and Harald Uhlig, eds., *Handbook of Macroeconomics*, Vol. 2, Amsterdam: Elsevier, 2016, pp. 71–162.

Ru, Hong and Robert M. Townsend, "Kinship Networks Enhanced by a Formal Financial Intervention," *Working Paper*, 2022.

Somanchi, Anmol, "Missing the Poor, Big Time: A Critical Assessment of the Consumer Pyramids Household Survey," *Working Paper*, 2021.

Sripakdeevong, Parit and Robert M. Townsend, "The Village Money Market Revealed: Financial Access and Credit Chain Links Between Formal and Informal Sectors," *Annual Review of Financial Economics*, 2022, *14*, 1–20.

Surendra, Vaishnavi, "The Moneylender as Middleman: Formal Credit Supply and Informal Loans in Rural India," *Working Paper*, 2025.

Vyas, Mahesh, "Consumer Pyramids Household Survey: Sample Survival and Response Rate," *Centre for Monitoring the Indian Economy*, 2020.

_ , "Consumer Pyramids Household Survey: Survey Design and Sample," *Centre for Monitoring the Indian Economy*, 2020.

_ , "Consumer Pyramids Household Survey: Survey Execution," *Centre for Monitoring the Indian Economy*, 2020.

_ , "Consumer Pyramids Household Survey: The Questionnaire," *Centre for Monitoring the Indian Economy*, 2020.

_ , "CPHS execution during the lockdown of 2020," *Centre for Monitoring the Indian Economy*, 2020.

Chapter 3

Banking Catch-22? Trading off Mark-to-Market and Default Risk

(Co-authored with Nirupama Kulkarni and Akshat Singh)

Abstract

Using the boom period of the 2000s in India as a laboratory, when long-term interest rates rose sharply, we document that banks with greater ex-ante investments in marked-to-market securities significantly increased their lending to the infrastructure sector. We find no evidence that these banks faced a differential increase in demand for infrastructure credit, pointing instead to an expansion in loan supply by banks more exposed to marked-to-market losses. Despite this increased exposure to the infrastructure sector, we find no systematic evidence that such banks subsequently ended up with more loan delinquencies. These results nonetheless highlight a potentially important tradeoff between exposure to mark-to-market and default risk for banks faced with a sudden increase in interest rates in the presence of mark-to-market accounting rules.

Acknowledgements: The views expressed in this paper are those of the authors and do not necessarily reflect the views of CAFRAL or the IMF. We are grateful to Viral Acharya, Chris Adam, Diana Bonfim, Steve Bond, Andrea Ferrero, Rustam Jamilov, Kose John, John Muellbauer, Toni Oki, Tirthankar Patnaik, the discussant Alexi Savov, for helpful comments and suggestions. Akshat Singh thanks the NSE-NYU Stern Initiative on the Study of Indian Capital Markets for financial support. Karthik Narayan thanks the Clarendon Fund and Nuffield College for financial support. We also thank seminar participants at the Webinar series in Finance and Development (WEFIDEV), the NSE-NYU Conference on Indian Financial Markets, 2021, the Indian Statistical Institute and IMAEF 2026 for useful comments. All errors are our own.

3.1 Introduction

How do banks trade off interest rate risk and default risk on their balance sheets? This question has received renewed attention in recent times with the failure of the Silicon Valley Bank (SVB) in the United States in March 2023, driven principally by the sharp fall in the value of its investments in fixed-income securities following interest rate increases. Holding government securities provides the benefits of liquidity and low default risk. However, due to the fixed rate of return on these holdings, it is accompanied by substantial interest rate risk. These interest rate risks are further exacerbated by mark-to-market accounting rules, which require banks to mark their investment portfolio in financial securities to market value at periodic intervals. On the other hand, financing private sector investment through bank loans comes at the expense of illiquidity and higher default risk. But interest rates on loans are typically flexible and loans need not be marked to their market value on bank balance sheets.

In this paper, we examine how banks make these tradeoffs, particularly in the presence of mark-to-market accounting rules on bank balance sheets. The Indian context provides a unique setting to explore the interaction between mark-to-market risk and default risk for three reasons. Firstly, Indian banks had atypically high holdings of long-term government securities prior to 2004, making them uniquely vulnerable to mark-to-market losses arising from interest rate increases. Moreover, unlike the US or the Eurozone, there were strict caps on the ability of banks to avoid mark-to-market losses on their investments by accounting for them at acquisition cost. Finally, there was a sharp increase in lending by banks to the infrastructure sector beginning in the mid-2000s.

Using an unanticipated increase in long-term interest rates in 2004 as a laboratory, we document that banks which had greater ex-ante exposure to mark-to-market losses subsequently increased their lending to the infrastructure sector by proportionately larger amounts. However, conditional on other bank characteristics, these banks did not end up with a higher share of non-performing loans on their balance sheets. Government ownership, as already documented in the literature, was a much more important driver of loan delinquencies than mark-to-market loss exposure.

In one of the most notable developments of the Indian economy in recent history, the share of bank credit to the infrastructure sector doubled within a span of four years from 2004 to 2008.[1] While most advanced economies witnessed a mortgage lending boom during this period, India was distinctive in having a lending boom to the infrastructure sector. In the aftermath of this infrastructure lending boom, a significant fraction of infrastructure loans on bank balance sheets turned bad, resulting in a stark increase in the ratio of non-performing loans to total assets.[2] Contrary to common perception, there was substantial cross-sectional heterogeneity in the extent of infrastructure lending undertaken by Indian banks during this period. In this paper, we attempt to utilise this heterogeneity to offer a distinct explanation for the bank lending behaviour in India during this period based on differential exposure to marked-to-market securities.

For this purpose, we utilise granular branch-level administrative data on Indian banks, aggregated to the bank-district level, collected by the Reserve Bank of India as part of its annual Basic Statistical Returns

[1] Shah (2015) finds a 300% increase in infrastructure lending during the period, with the exact estimate depending on the definition of infrastructure used. However, the trends are largely the same.

[2] Following the start of an asset quality review by the Reserve Bank of India in 2015, conservative estimates placed the ratio of non-performing loans to total assets at more than 6%, among the highest in the world.

(BSR). The data is collected as of 31st March every year and contains highly granular information on bank lending and deposits, including the amount of deposits by type, amount of credit by sector, average lending interest rates, branch and personnel characteristics, as well as non-performing loans.

Using this bank-district level panel data for India between 1999 and 2016, we present three main sets of findings. First, we document that following a sudden and unanticipated rise in long-term government bond yields starting in mid-2004, when interest rates on 5-year and 10-year government bonds increased by 160 and 180 basis points respectively in a 6-month period, there was a shift in banking sector assets away from government securities towards loans, especially loans to the infrastructure sector. We argue that banks undertook this shift in their balance sheet composition in order to reduce exposure to the concomitant mark-to-market losses associated with government security holdings. Between 2004 and 2010, the average ratio of long term securities to bank assets declined drastically from about 0.25 to 0.15, while the ratio of infrastructure loans to assets almost doubled from about 0.05 to 0.09.[3]

Exploiting differences in ex-ante exposure to government securities in a Difference-in-Differences design, we find that this shift towards infrastructure sector loans was more pronounced for banks with higher ex-ante exposure to mark-to-market losses. Banks' mark-to-market risk exposure is typically very difficult to estimate. We utilise a regulatory requirement specific to Indian banks to develop a novel proxy to measure ex-ante exposure to mark-to-market losses at the bank-level, using banks' holdings of Investment Fluctuation Reserves (IFR), which they were directed to build up in proportion to their holdings of marked-to-market securities.

Under our preferred specification for the Difference-in-Differences design, which allows us to control for demand side factors as well as other important bank characteristics which may explain the differences that we document, we find that banks with above median exposure to mark-to-market securities in March 2004 increased their lending to the infrastructure sector by 36.62% more than banks with below median exposure following the interest rate shock (2005-2016) relative to the period before the shock (1999-2004). Further, we find that these effects were driven principally by increases in lending to the infrastructure sector by high exposure banks in the years immediately following 2004. In 2005, 2006 and 2007, infrastructure lending by high exposure banks was higher than for low exposure banks by 41.2%, 63.07% and 76.12% respectively.

Correspondingly, we also document that these results are not driven by differential changes in the demand for infrastructure lending between high and low mark-to-market exposure banks. In order to test whether demand for infrastructure loans varied across banks, we estimate bank-state-year level interest rates on infrastructure loans from BSR data.[4] We hypothesise that if demand were the main cause of this heterogeneous lending behaviour, then we should find a rise in infrastructure lending rates among the subset of banks which were central to the credit boom. However, consistent with the supply side explanation,

[3] This increase in lending to the infrastructure sector represented the largest rise in lending share among all sectors during this period. Additional details can be found in Appendix C.2. Indian banks' investment portfolios consisted mainly of government securities at this time. Sy (2005) documents that the ratio of government securities to total investments in the banking system was about 80% in March 2004. A potential concern here is that the fall in the ratio of long-term securities may simply reflect mark-to-market losses rather than an actual shift in banks' portfolio allocation. However, at least since 2002, all securities subject to mark-to-market accounting rules continued to be listed on the banks' balance sheets at book value. Any losses arising out of revaluation of these investments were charged to the banks' Profit and Loss Account to create a separate provision on the balance sheet holding revaluation losses. For more details, refer to RBI (2002a) and RBI (2021).

[4] Our data provides weighted average lending rates at the branch-year level, but lacks the granularity to estimate the sector-specific lending rates at the bank-district-year level.

we find that the infrastructure lending rates of banks with greater ex-ante exposure to mark-to-market losses did not increase relative to the rates offered by banks with lesser exposure, despite the significant difference in the volume of lending to the sector during the period.

Finally, we test whether the portfolio reallocation by banks away from long-term securities investments towards lending to finance infrastructure investment led to larger shares of non-performing assets in the balance sheet of banks with high mark-to-market exposure. We find that while the share of non-performing assets at the end of our sample was larger on average for banks highly exposed to mark-to-market losses in 2004, under our preferred specification which controls for other bank characteristics, we do not find any evidence for higher non-performing asset exposure for highly exposed banks, with the non-performing asset exposure in fact being slightly lower for the highly exposed banks.

We also show that, as documented previously in the literature, government ownership of banks was a significantly more important determinant of non-performing asset exposure and absorbs all of the reduced-form positive correlation between non-performing asset exposure and ex-ante exposure to mark-to-market losses. However, our results still highlight a potentially important tradeoff between exposure to mark-to-market and default risk for banks faced with a sudden increase in interest rates in the presence of mark-to-market accounting rules, even though they did not actually materialise in our specific setting.

3.1.1 Related literature

We contribute to the literature on the destabilising effects of mark-to-market or fair value accounting rules. Heaton et al. (2010) point to the adverse consequences of the interaction of mark-to-market accounting rules and regulatory capital requirements. A related literature also examines the implications of accounting rules that delay loss recognition on bank lending behaviour (Begenau et al., 2024a). Recent work by Begenau et al. (2024b) attempts to rationalise the recent run on Silicon Valley Bank (SVB) by analysing the financial stability consequences of banks' interest rate risk exposure. Blattner et al. (2023) document the effects of bank capital regulations on the asset side of bank balance sheets, demonstrating using a natural experiment that tighter regulations led to a deterioration in bank lending quality. Greenwald et al. (2024) document that US banks which experienced larger mark-to-market losses on their securities portfolio following the 2022-23 interest rate tightening extended less credit to firms in the quarters immediately following the tightening. Our paper provides new evidence about the unintended consequences of a sudden increase in interest rates for banks' financial stability by showing that banks with greater mark-to-market loss exposure significantly increase their lending activity in the medium-run and in the process expose themselves to greater default risk.

Our paper is also related to a strand of literature on the crowding-out effects associated with bank lending decisions to the government and private sector in emerging market countries with shallow financial markets. Cross-country panel data from emerging market economies, documented in Bouis (2019), suggests that there is a negative relationship between the banking sector's government debt holdings and credit growth to the private sector. Portfolio re-balancing away from private sector credit towards less risky and more liquid sovereign debt during times of stress is suggested as an important explanation for these observations, as shown by Altavilla et al. (2017) and Dell'Ariccia et al. (2018). Additional evidence from more granular credit registry data is available for China (Huang et al., 2020), Mexico (Morais et al., 2021), Colom-

bia (Williams, 2018) and Nigeria (Oki, 2023). This paper adds to this literature, using granular branch-level lending data, to show that portfolio re-balancing may happen away from sovereign lending towards the private sector in response to higher mark-to-market losses associated with holding government securities.

Finally, the Indian banking system witnessed an unprecedented lending boom in the mid-2000s, particularly towards infrastructure projects, following which there was a marked increase in non-performing loans in the banking system. An emerging literature examines the causes of this episode. Lahiri and Neelakatan (2024) suggest that "developmental" and "socio-political" considerations of state-owned banks were principally responsible for the infrastructure lending boom. Furthermore, the unwillingness of markets to recapitalize these banks following the recognition of bad debts, as documented in Chopra et al. (2021), also points to non-market considerations at play in explaining the infrastructure lending boom. We contribute to this literature by pointing to a market-based channel which has also contributed to the infrastructure lending boom. Banks which were more severely affected by mark-to-market losses following the sudden increase in interest rates in 2004 increased their lending to the infrastructure sector by proportionately larger amounts. This complements the traditional political economy explanations for the bank lending boom.

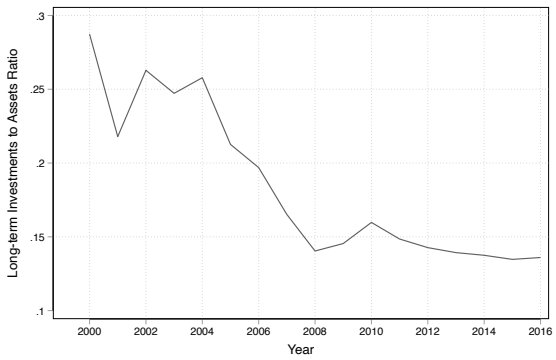
3.1.2 A reader's guide

Our paper is organised as follows: Section 3.2 provides an overview of the institutional context for the study. Section 3.3 provides a detailed description of the data. Our identification strategy to estimate the effects on infrastructure lending is outlined in Section 3.4. Section 3.5 presents the empirical results from our identification strategy for infrastructure lending. The effects on non-performing loans are discussed in Section 3.6. Section 3.7 provides some robustness results. Section 3.8 interprets the empirical findings of our paper and Section 3.9 concludes.

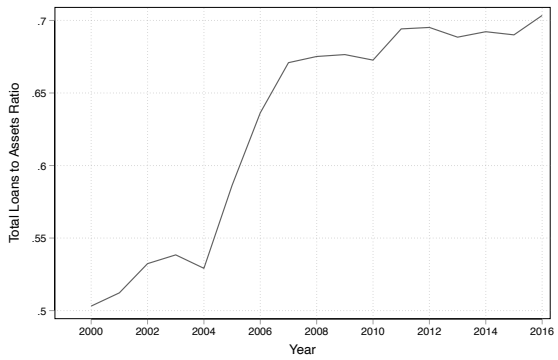
3.2 Institutional details

The Indian banking sector is characterised by the co-existence of government-owned banks, commonly referred to as Public Sector Banks (PSBs), and banks under private ownership and control, commonly referred to as private sector banks. Historically, the banking sector was dominated by public sector banks, with the government having a major say in the banks' lending decisions. Economic liberalisation in the 1990s ushered in a new phase of the Indian banking sector by removing barriers to the entry of private sector banks and subsequently improving their ease of functioning through further reforms. Consequently, the dominance of the public sector banks started to recede over the next two decades and the Indian banking sector transformed from being primarily centrally governed to a system driven by market forces.[5] In this section we highlight some of the institutional details relevant to our study.

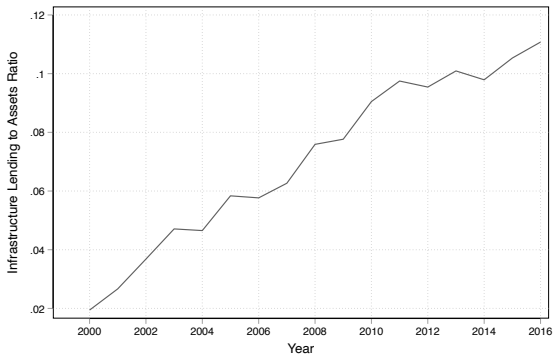
Figure 3.1: Time series of key banking sector variables, 2000 to 2016



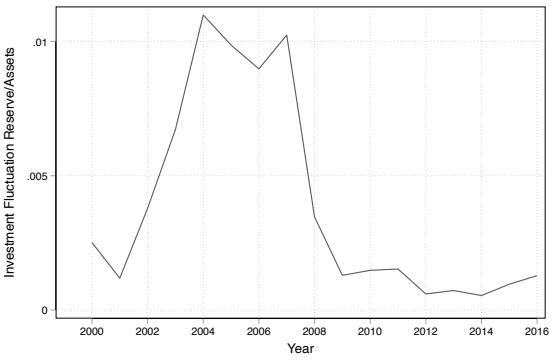
(a) **Long-term investments (as a share of total assets)**



(b) **Loans (as a share of total assets)**



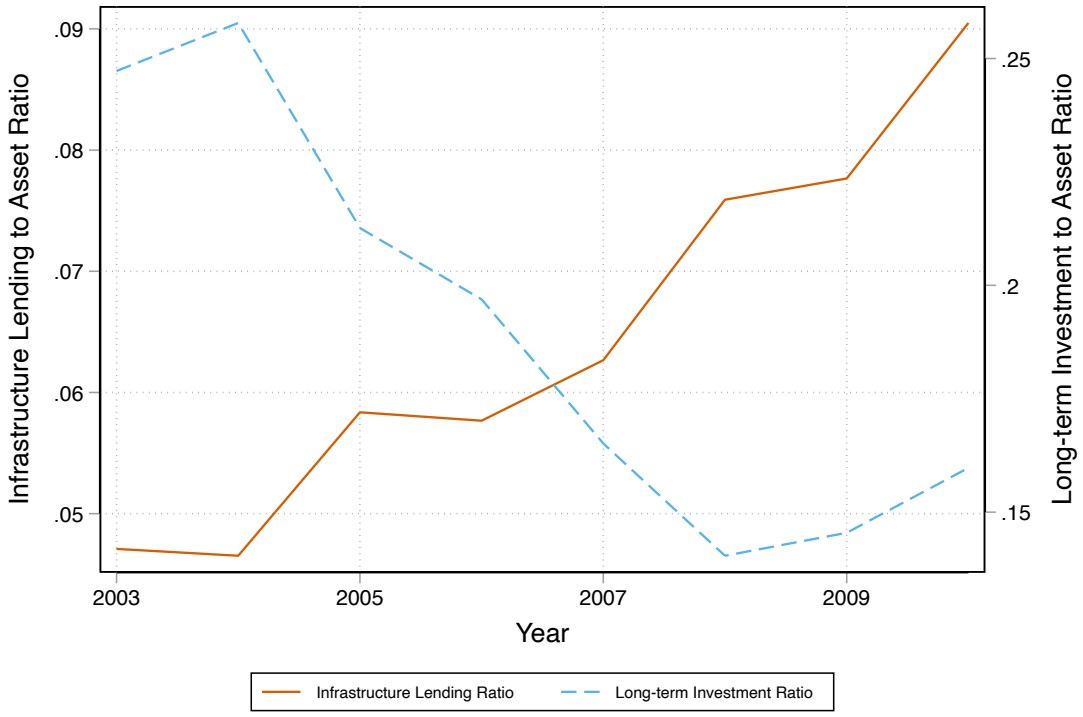
(c) **Infrastructure loans (as a share of total assets)**



(d) **IFR (as a share of total assets)**

Notes: These figures show the time series of the share of long-term investments, total loans, infrastructure loans and investment fluctuation reserves in total assets for scheduled commercial banks in our sample. Panel (a) plots the time series of the average share of long-term investments in total assets from 2000 to 2016. Long-term investments refer to banks' investments with maturity >= 5 years. Panel (b) plots the time series of the average share of total loans in total assets from 2000 to 2016. Panel (c) plots the time series of the average share of infrastructure loans in total assets from 2000 to 2016. Infrastructure lending refers to bank loans towards construction, mining, and electricity, gas & water sectors. Panel (d) plots the time series of the average share of investment fluctuation reserve in total assets from 2000 to 2016. Total assets refer to the sum of all loans and investments made by banks. The data on total assets, long-term investments, long-term loans and investment fluctuation reserve are sourced from CMIE Prowess. The data on infrastructure lending are sourced from Basic Statistical Returns (RBI). Data on public sector banks and domestically-owned private sector banks are considered for this analysis. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Figure 3.2: Infrastructure Lending and Long-term Investment, 2003 to 2010



Notes: These figures show the time series of the average share of long-term securities and infrastructure loans in total assets of scheduled commercial banks in our sample during the period of credit boom between 2003 and 2010. Long-term securities refer to securities with maturity >= 5 years. Infrastructure lending refers to bank loans towards construction, mining, and electricity, gas & water sectors. Total assets refers to the sum of all loans and investments made by banks. The data on total assets and long-term investments are sourced from CMIE Prowess. The data on infrastructure lending are sourced from Basic Statistical Returns (RBI). Data on public sector banks and domestically-owned private sector banks are considered for this analysis. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

3.2.1 Credit boom and lending to the infrastructure sector

India experienced a massive boom in bank credit between 2002 and 2012. Domestic credit to the private sector, as a share of GDP, rose from 32% in 2002 to almost 52% in 2012 (World Bank, 2024). A substantial share of the increase in bank credit during this time was accounted for by lending to the infrastructure sector. Outstanding bank credit to the sector increased from ₹ 95 billion in March 2001 to ₹ 9,853 billion in March 2016 (Vishwanathan, 2016).[6]

Given the potential for the development of natural monopolies in this sector, investment activity in this area was undertaken by (national or state) government agencies themselves or more often by the private sector in partnership with relevant government agencies (in so-called 'Public Private Partnerships').[7] Between 2003 and 2010, loans to the infrastructure sector, defined here to include the construction, mining, electricity, gas and water sectors, almost doubled from just under 5% to 9% of total assets.[8] During the same period, as discussed in the next section, there was almost a 10-percentage-point fall in the share of long-term investments in total bank assets, as shown in Figures 3.1 and 3.2.

Buoyed by the prospect of rising economic growth in the early 2000s, many firms in India both by themselves and in partnership with government agencies launched new projects with sizeable investment outlays in infrastructure-related areas setting off one of the biggest investment booms in the country's history (Economic Survey, 2017). In October 2015, there were close to 1200 'Public Private Partnership' projects at various stages of development and implementation, amounting to a total estimated investment of ₹ 7.2 trillion (Department of Economic Affairs, 2015).[9] Raising funds for these projects from corporate bond markets was very difficult given the lack of a well developed private bond market in India at the time.

Lending to the infrastructure sector is inherently different from lending to other sectors. Usually, infrastructure projects require long-term financing ranging from 10 to 25 years. With developed financial markets, a majority of such investment is financed through long-term bonds purchased and held by institutions with corresponding long-term liabilities. However, in an economy with underdeveloped bond markets like India, a majority of the lending to the infrastructure sector is carried out by commercial banks.

[5] In our sample the market share of government owned banks fell from approximately 89% in 1999 to 73% in 2016 (see Appendix Figure C.1).

[6] While Vishwanathan (2016) does not state the precise definition of the infrastructure sector used for this measurement exercise, it is stated to include lending to projects like the construction of roads, railways, ports and airports as well as power generation and water supply.

[7] In a typical Public Private Partnership in India during this period, the risks and obligations for constructing a new infrastructure project with public benefit were jointly shared by the public and private sectors. For example, in a Build-Operate-Transfer (BOT) highway construction project, the public sector would be responsible for providing the required land and necessary assistance to secure all relevant permits and approvals, while the private sector would be responsible for the financing, design, engineering, procurement, construction and maintenance (for a specified period) of the highway. The private sector would be allowed to charge a toll during the operating period to recover costs. For an example of a recent model agreement, see Ministry of Road Transport and Highways (2020).

[8] We define the infrastructure sector based on Lahiri and Neelakatan (2024). The vast majority of sectoral output from 'Mining and Quarrying' (74.8%), 'Construction' (100%) and 'Electricity, Gas and Water' (100%) served as inputs into infrastructure activity. While Lahiri and Neelakatan (2024) also include 'Basic Metals and Metal Products' as an infrastructure linked sector, we do not focus on this sector as only 44.6% of its output was used as inputs for infrastructure.

[9] While 'Public Private Partnership' projects range from unit price or item rate contracts to more elaborate build, finance, operate and transfer models, the allocation of risks and obligations to the private sector often tended to follow set templates laid down by the concerned government ministry, with very limited project specific modifications. However, managing financial risk, which is most relevant for our analysis in this paper, was mainly seen as a responsibility of the private sector in these contracts. More information about the obligations of the public and private sectors as well as risk sharing arrangements between the two parties in these arrangements can be found in Department of Economic Affairs (2015).

Since bank deposits are of a significantly shorter maturity, infrastructure lending exposes banks to substantial maturity mismatch, thus posing a threat to the financial sector as a whole. Moreover, infrastructure projects in India are subject to diverse risks including abrupt changes in government policies, issues related to project clearances, natural calamities etc. These factors have an important bearing on the economic viability of the project and ultimately that of the infrastructure loan. Finally, as highlighted by Vishwanathan (2016), infrastructure projects are often extremely complex and involve a large number of parties. All of these features contribute to the credit and liquidity risk associated with infrastructure loans in India.

A range of factors played a role in the sharp rise in bank lending to the infrastructure sector and the decline in their holdings of long-term investments during this period. Prior to 1997, Development Finance Institutions (DFIs) were the main providers of finance to the infrastructure sector. The perceived need for these specialised institutions arose primarily because of the inability of commercial banks to shoulder the liquidity and credit risks associated with lending to the infrastructure sector. By providing DFIs with long term subsidized finance, the government had essentially assumed the role of primary financier to infrastructure projects. With the liberalization of the financial sector in the 1990s, the concessional financing available to DFIs ended while commercial banks were simultaneously allowed to engage in project financing. Due to the risky nature of the lending activity undertaken by DFIs, their borrowing costs rose substantially, making them less competitive against commercial banks, which could obtain cheap and stable financing from deposits. As a result, by the early 2000s, the main DFIs had either closed down or decided to convert into commercial banks so that they could raise resources at cheaper rates (Chakrabarty, 2013).

This move was accompanied by other steps to free up the resources of commercial banks, such as the reduction in the Statutory Liquidity Ratio, which was reduced from 32% to 25% in 1997. All of these developments made it more attractive for banks to lend more to the real economy and in particular to the infrastructure sector beginning in the early 2000s. As shown in Figure 3.1, bank lending as a share of total banking assets rose from around 50% in 2000 to around 70% by 2016.

3.2.2 Long-term investments and mark-to-market accounting rules

Figure 3.1 shows the time series of long-term investments of Indian banks, as a share of total assets, between 2000 and 2016. Long-term investments are defined here as the total book value of investments held by banks with a duration of 5 years and above.[10] In 2000, long-term investments as a proportion of total assets were close to 30%. Fixed-rate securities with a duration between 5-30 years accounted for 58.2% of banks' total investment portfolios in March 2004, with an average duration of around 6 years, as documented by Sy (2005). As discussed in the previous section and documented in Figure 3.2, the proportion of long-term investments declined at the expense of infrastructure lending, in particular lending to projects in the construction, mining, electricity, gas and water sectors.

In October 2000, in order to improve transparency in banks' accounting practices, the RBI directed banks

[10]This measure corresponds to the CMIE Prowess code *sa_mp_invest_at_bv_5y_abv* and is based on the mandatory regulatory disclosure of the duration of specified assets and liabilities in the 'Notes to Accounts' section of a bank's annual financial statements. Investments are defined here to include: (i) domestic and foreign investments in government securities of national and state governments, (ii) domestic and foreign investments in debentures and bonds of corporations, (iii) domestic and foreign investments in shares of corporations, (iv) domestic and foreign investments in subsidiaries or joint ventures as well as (v) any other investment in securities approved by the RBI. Additional details are available at RBI (2025).

to classify their entire investment portfolio into three categories, in line with international standards: (i) 'Held to Maturity', (ii) 'Available for Sale' and (iii) 'Held for Trading'. Banks had to decide the category of investment at the time of acquisition (with classification of existing investments being done retrospectively).[11]

Securities which banks expected to hold to maturity were expected to be classified under the 'Held to Maturity' category, which could not exceed 25% of their total investments. Investments under this category were not expected to be marked-to-market and carried on the balance sheet at acquisition cost, and if that was greater than the face value of the security, the premium was expected to be amortized over the period remaining to maturity. Securities which were held with the expectation of being sold within a period of 90 days were to be categorised as 'Held for Trading' while all remaining securities were classified as 'Available for Sale'. Securities in the 'Held for Trading' category were expected to be revalued and marked-to-market at monthly or more frequent intervals, while securities in the 'Available for Sale' category were expected to be marked-to-market at year-end or more frequent intervals.[12] Marked-to-market losses, at least since 2002, were charged to the Profit and Loss Account of the bank to create a separate provision on the balance sheet to hold these revaluation losses, while retaining the investments themselves at book value (RBI, 2021, 2002a). The frequency of mark-to-market valuations of 'Available for Sale' securities was subsequently changed to a quarterly frequency in 2002 (RBI, 2002c). Additional information about these regulations can be found in RBI (2000). Analysis by Sy (2005) suggests that mark-to-market risk exposure was quite substantial by March 2004, as the proportion of 'Available for Sale' and 'Held for Trading' government securities in total government securities stood at 79.6%.

Investment Fluctuation Reserves: Having introduced these regulations, the RBI sought to ensure that banks with significant duration risk on their balance sheets had enough reserves to weather potential losses from swings in yields on bank holdings of fixed-rate securities. In keeping with this objective, in 2002, the RBI directed banks to build investment fluctuation reserves of a minimum of 5% of investments classified in the 'Held for Trading' and 'Available for Sale' categories within a period of 5 years, by transferring gains from the sale of investments in securities. Additional information about these regulations can be found in RBI (2002b) and RBI (2002c). According to Sy (2007), these reserves were initially introduced as an alternative to Basel 1 requirements. However, in October 2005, a capital charge for market risk was introduced in accordance with the Basel norms, with these reserves gradually merged into Tier 1 capital, as documented in RBI (2005). Since IFR provides a more direct measure of our subject of interest, i.e. bank exposure to high duration securities, as opposed to Tier 1 capital which has a broader role in guarding banks against a variety of risks, we are fortunate that IFR was replaced by a capital charge only post-2004. As shown in Figure 3.1, IFR grew significantly till 2004, remained at elevated levels until 2007,

[11] These measures were the culmination of a process, which commenced in April 1992, when the RBI began the process of gradually subjecting banks' investment portfolios to macro-prudential regulation. Initially, 30% of the investment portfolio was required to be marked-to-market, which increased to 50% by the financial year 1996-97 and 75% by the financial year 1999-2000. Additional information can be found in Roy (2022), page 377 and in the RBI Governor's Monetary Policy Statement on April 29, 1998, available here: https://rbi.org.in/scripts/BS_ViewMonetaryCreditPolicy.aspx?Id=2264 (Accessed 2nd March, 2026).

[12] Following the accounting convention of prudence, 'mark-to-market' accounting in practice only applied to the recognition and provisioning for unrealised losses from revaluing the investment portfolio at market value and never permitted the booking of accounting profits from the unrealised gains on marking the investment portfolio to market value. However, since banks were only required to provide for net depreciation on broad investment categories, they were allowed to take account of mark-to-market gains within each investment category while reckoning the net depreciation for such category. If such calculation resulted in a net appreciation, such appreciation was not permitted to be reflected in the banks' financial statements. For more details, see RBI (2000).

but fell drastically as the Basel norms came into place.

3.2.3 Consequences

Non-performing Assets (NPAs) in the Indian banking system rose from just 2.4% in March 2011 to 11.2% in March 2018 (Lahiri and Neelakatan, 2024). This substantial increase in disclosed NPAs was brought about mainly because of the RBI's Asset Quality Review (AQR) initiated in 2015 to introduce more stringent regulatory requirements for disclosing non-performing loan accounts.[13] While there were a myriad of internal and external reasons for the sharp rise in non-performing loans in the banking sector, infrastructure loans contributed significantly to the problem. Lahiri and Neelakatan (2024) find that four sectors, Basic Metals and Metal Products, Construction, Electricity, Gas, and Water, and Mining and Quarrying, all of which are closely related to infrastructure, were responsible for nearly half of the total NPAs as of 2018.

Between 1999 and 2018, the 'Mining', 'Construction' and 'Electricity, Gas and Water' sectors (as classified in the RBI's administrative data) had the highest loan growth rates (Lahiri and Neelakatan, 2024). Worrying signs regarding the quality of infrastructure loans had begun appearing as early as 2008 (Chari et al., 2021). In view of the deterioration in the cash flow of overly leveraged firms due to the Great Recession, the RBI announced a 'Special Regulatory Treatment' for restructuring debt. While this asset quality forbearance was initially introduced as a temporary relief measure, restructuring of assets became the norm. Chari et al. (2021) find that by 2013, restructured assets constituted close to 70% (50%) of stressed assets for public (private) banks. In May 2013, the RBI announced the start of the process of winding down widespread asset restructuring, by stating its intention to withdraw the 'Special Regulatory Treatment' of restructured assets by April 1, 2015. This eventually led to the AQR, under which banks were forced to recognise many of these restructured assets as non-performing loans in their balance sheets, and the proportion of restructured assets finally began to decline at the expense of higher NPAs.

This deterioration in bank balance sheets was mirrored on the borrower side by significant stress on corporate balance sheets. By 2013, nearly one-third of corporate debt was owed by companies with an interest coverage ratio less than 1, with many of them in the power generation and metals sectors. In policy discussions in India, this came to be referred to as the 'Twin Balance Sheet' problem (Economic Survey, 2017). The delays faced in acquiring environmental clearances for projects as well as land acquisition, along with an inability by private sector firms to infuse fresh equity into stalled 'Public Private Partnership' projects, were seen as being primarily responsible for the stalling and subsequent lack of financial viability of infrastructure projects (Economic Survey, 2015).

3.3 Data

[13] RBI inspectors usually examine the books of accounts of Indian banks as part of their Annual Financial Inspection (AFI). A routine AFI involves selecting a small sample of loans sanctioned by the bank and checking if the asset classifications for these loans were appropriate given the loan repayments being made and if adequate provisions were being made where necessary. The Asset Quality Review (AQR) was a special AFI, where a significantly larger sample of loans (including most large borrower accounts) were selected for this kind of inspection. Loans identified as being incorrectly classified in the books of accounts were then mandated by the RBI to be appropriately classified by March 2016 (Sinha, 2016). One important concern here is that the increases in observed NPAs during this period reflect actual new increases in NPAs rather than disclosure of existing NPAs. However, as Chari et al. (2021) document, the sharp increase in reported NPAs was primarily the result of the RBI forcing banks to recognise many 'hidden' NPAs on their balance sheets as non-performing loans.

3.3.1 Data sources

We use annual data at the bank branch level from the Reserve Bank of India's Basic Statistical Returns (BSR).[14] This data is collected as of March 31st of every year and covers a wide range of variables, such as amounts of deposits by type (demand, savings and term), amounts of credit by sector, weighted average lending rate, branch characteristics, personnel characteristics (skilled/unskilled) and non-performing loans. While bank level data is publicly available, branch-level data is only collected for regulatory purposes and is proprietary. The regulatory branch-level data, also called Basic Statistical Returns (BSR), has previously been used by Das et al. (2015) and Cole (2009). Data on Non-performing Loans, also called Non-performing Assets (NPAs) is also from the RBI, though it does not have the same comprehensive coverage as other parts of the BSR data, with only about 76% of the branches with reported data on NPA.[15]

We also use annual bank balance sheet data from CMIE Prowess. This contains information about investment fluctuation reserves, investments and lending by duration as well as total assets. This is a private database covering the universe of listed companies as well as a large set of unlisted companies by compiling data from audited annual reports of companies. This dataset has been used extensively in the study of firm performance in India, most recently by Kotia (2025).

3.3.2 Data construction and cleaning

We use an unbalanced panel at the bank-district-year level of deposit and credit data from 1999 to 2016 for our regression analysis. We aggregate the branch level data to the bank-district level to deal with any within-district specialisation in infrastructure lending activity.

We harmonise district boundaries in the dataset to ensure that we use a consistent set of district boundaries throughout the time period under study. This harmonisation procedure involved merging districts split after 1999 back into their parent districts, and in cases where the newly created district was formed from multiple parent districts, all such parent and child districts were assigned a single composite district code. Furthermore, in order to ensure that we have a common starting point for all districts in the panel, we also merged some districts formed before 1999 (for which data is only available at some point after 1999) back to their parent districts.

The harmonisation process for districts split before 2011 was completed using the state-wise administrative atlases prepared as part of the 2011 and 2001 Censuses of India.[16] Districts formed after 2011 were

[14] More specifically, we focus on the BSR1A dataset for our analysis. This captures data on all loan accounts with credit limits exceeding ₹25,000 (approx. £250) (until March 2001) and credit limits exceeding ₹200,000 (approx. £2,000) (from March 2002 until March 2012). During this period BSR1B reported the data on loan accounts with credit limits below these thresholds. From 2013 onwards, BSR1A and BSR1B were combined, and for this period our dataset covers the universe of all loan accounts. Our choice is principally dictated by data constraints, as BSR1B lacks data on weighted average lending rates, which is an important outcome variable in our analysis. Crucially, there is no change in coverage during the main time period of interest in our study, between March 2002 and March 2012.

[15] This refers to the total number of bank branches reporting data on loan accounts with *asst* code greater than 1 (referring to sub-standard, doubtful and loss assets) when compared with the total number of bank branches in the BSR dataset with asset classification of loan accounts.

[16] The state-wise administrative atlases prepared for the 2011 Census can be accessed here: https://censusindia.gov.in/census.website/data/atlas (Accessed December 22, 2025). An equivalence table of administrative units prepared as part of the administrative atlas for the 2001 Census can be found in Appendix III of a publication entitled *India Administrative Atlas, 1872-2001: A Historical Perspective* published in 2004 by the Government of India. This has been preserved by Aditya Dasgupta of UC Merced and can be accessed here: https://sites.google.com/view/adasgupta/data (Accessed December 22, 2025).

harmonised based on the relevant government notifications announcing the new districts or descriptions contained in the websites of the respective districts and if these were not available, they were based on the district boundary changes documented in the *India State Stories Project*.[17] After this harmonisation procedure, our main dataset covers 530 districts. Districts are economically integrated areas, comparable to counties within the US. The average Indian district had a population of roughly 1.9 million in the 2011 Census.[18]

We omit the Central Bank of India, State Bank of Patiala and Jammu & Kashmir Bank from our analysis due to issues with the accuracy of the reported data for these banks in the BSR. Additionally, we omit IDBI bank from our sample due to the transition it underwent during the time period under study from being a development finance institution to a commercial bank. This yields a sample of 62 banks, with 26 public sector banks and 36 private sector banks. Out of these, only 53 banks were in operation in 2004 and out of these only 35 banks had a reported value for the investment fluctuation reserve ratio (as a share of total assets) in 2004.[19] These 35 banks, consisting of 20 public sector and 15 private sector banks, form the main sample of banks used in the analysis.

In Appendix C.3, we provide additional information about the sample of banks in operation in 2004 which did not report investment fluctuation reserves. These banks were much smaller, on average, than the banks in our sample, while being broadly similar along the other dimensions considered. Among banks operational in March 2004, the banks in our sample accounted for about 90.31% of total banking assets.

3.3.3 Summary statistics

Table 3.1 presents summary statistics on the sample of 35 banks with positive investment fluctuation reserves (as a share of total assets) in March 2004. The mean and standard deviation for a range of financial indicators are presented for the periods 1999-2004 and 2005-2010 for the banks with above and below median investment fluctuation reserves as a proportion of total assets in 2004. The median proportion of investment fluctuation reserves as a percentage of total assets in 2004 was 1.13%. In the discussion that follows, we will refer to banks with above and below median investment fluctuation reserves as a percentage of total assets in 2004 as High IFR and Low IFR banks respectively.

Across both High and Low IFR banks, there was a substantial increase in the size of the bank balance sheet between 1999 and 2010. Total assets for Low IFR banks rose on average by 208% between the periods 1999-2004 and 2005-2010 and increased by 135% for High IFR banks during the same period. While High IFR banks were on average larger than Low IFR banks in both periods, this size difference declined in the period following 2004.

This growth in banking assets was accompanied by a significant portfolio re-balancing by both sets of banks away from investments in financial assets towards lending activity. Investments (short-term + long-term) as a percentage of total assets declined from approximately 44% to 35% for Low IFR banks and from 49% to 34% for High IFR banks between 1999-2004 and 2005-2010. During the same periods, lending as

[17] District boundary changes as recorded by the India State Stories Project can be accessed here: https://docs.google.com/spreadsheets/d/1grK3qO2fTYxLo1Eo4byTIz00gyd5fBhd/ (Accessed December 22, 2025).

[18] This is based on estimates by the *Economic Times*: https://economictimes.indiatimes.com/news/politics-and-nation/do-indias-newly-added-districts-yield-desired-governance-results/articleshow/70516246.cms (Accessed December 22, 2025).

[19] For the purposes of the construction of the investment fluctuation reserve ratio, we define total assets as the sum of total loans and total investments made by the bank.

Table 3.1: Banks with above and below median IFR in 2004: Summary Statistics

	(1) Below median IFR ratio (1999-2004)	(2) Below median IFR ratio (2005-2010)	(3) Above median IFR ratio (1999-2004)	(4) Above median IFR ratio (2005-2010)
Total Assets (in billion Rs.)	234.5179	720.4751	383.0741	900.3246
	(258.9)	(799.9)	(625.2)	(1507.1)
Deposits/Assets (in %)	98.1017	94.6374	101.6989	97.7621
	(16.03)	(12.05)	(7.648)	(5.452)
Investments/Assets (in %)	44.3479	35.4913	49.4061	34.3778
	(7.494)	(5.943)	(4.297)	(5.976)
Loans/Assets (in %)	55.6521	64.5087	50.5939	65.6222
	(7.494)	(5.943)	(4.297)	(5.976)
Long-term investments/Assets (in %)	20.2886	13.9569	29.8396	18.5583
	(11.87)	(8.558)	(4.765)	(7.214)
Long-term loans/Assets (in %)	6.8018	10.6136	5.9864	9.7494
	(4.632)	(7.005)	(2.946)	(3.707)
IFR/Assets (in %)	0.5070	0.7032	0.7471	1.2167
	(0.344)	(0.387)	(0.503)	(0.291)
Infrastructure loans/Assets (in %)	4.4698	6.5968	3.8161	7.5236
	(3.013)	(3.403)	(1.775)	(4.022)
Metropolitan deposits/Deposits (in %)	75.7577	82.0140	65.2901	73.2672
	(15.82)	(12.37)	(13.34)	(10.87)
Observations	103	98	102	100
No. of Public Sector Banks	6	6	14	14
No. of Banks	18	18	17	17

Notes: This table provides summary statistics on key banking indicators of commercial banks with investment fluctuation reserves to total assets ratio above and below the median value in 2004 during the periods 1999-2004 and 2005-2010. Total assets refers to the sum of total loans and total investments made by the banks. Data on total assets, investments, loans and investment fluctuation reserve are from CMIE Prowess. Data on deposits, metropolitan deposits and infrastructure loans are from the Basic Statistical Returns (BSR) of the Reserve Bank of India. Infrastructure loans refer to loans outstanding to the mining, construction and electricity, gas and water sectors. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample. The mean of each variable is displayed along with standard deviations in parentheses.

a percentage of total assets increased from 56% to 65% for Low IFR banks and from 51% to 66% for High IFR banks.

The differences between High and Low IFR banks in the 1999-2004 period are particularly striking in their holdings of long-term investments on their balance sheets with High IFR banks' holdings exceeding Low IFR banks' holdings on average by about 10 percentage points. The change in long-term investments between the periods 1999-2004 and 2005-2010 confirms further that the portfolio re-balancing was driven particularly by the movement of banks away from long-term investments.

The increases and relative magnitudes of long-term lending as a percentage of total assets were broadly similar between both High and Low IFR banks suggesting the impact of broad-based economic growth on credit demand across both types of banks. However, lending to the infrastructure sector in particular increased to a much larger extent between 1999-2004 and 2005-2010 in High IFR banks compared to Low IFR banks.

Finally, it is worth noting that the metropolitan deposits share of total deposits was much lower in High IFR banks than in Low IFR banks. The greater rural presence of High IFR banks is particularly a consequence of the larger number of government owned banks (14) in the sample of High IFR banks than in the sample of Low IFR banks (6), as government owned banks were historically mandated to increase their banking presence in under-banked rural areas (Burgess and Pande, 2005).

3.4 Empirical strategy

What was responsible for this portfolio reallocation of Indian banks away from holding financial assets towards lending more actively? In this paper, we try to test one particular explanation for this reallocation: the exposure to interest rate risk due to mark-to-market accounting regulations.

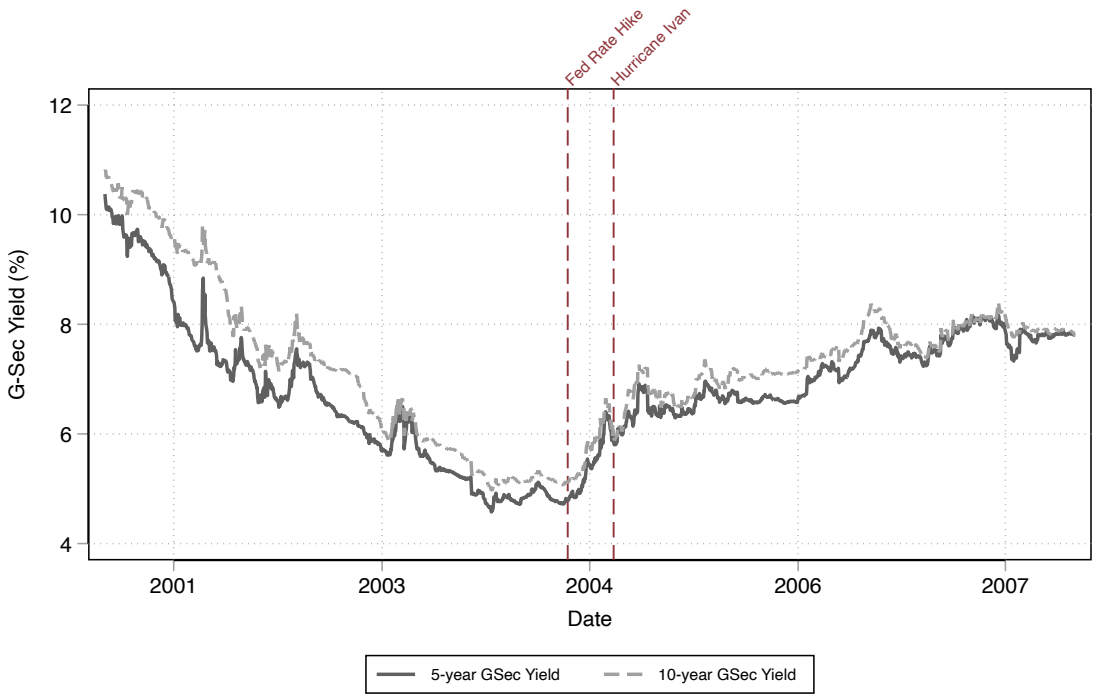
Identification of this particular channel requires some plausibly exogenous variation in the interest rate risk exposure of Indian banks. For this purpose, we utilise the unexpected and large increases in the yields on government securities beginning in the second half of 2004.

3.4.1 The rise in interest rates in 2004

Figure 3.3 plots the time series of 5-year and 10-year government security (GSec) yields between 2001 and 2007. Between 2001 and 2004, both 5-year and 10-year GSec yields were on a sharply decreasing trajectory, declining by around 560 basis points during this period, coinciding with a domestic and global interest rate easing cycle. Most government securities held by Indian banks were in the nature of long-term fixed-rate government bonds. Hence, holding these long-term, fixed-rate government securities proved to be particularly attractive to Indian commercial banks during this period.

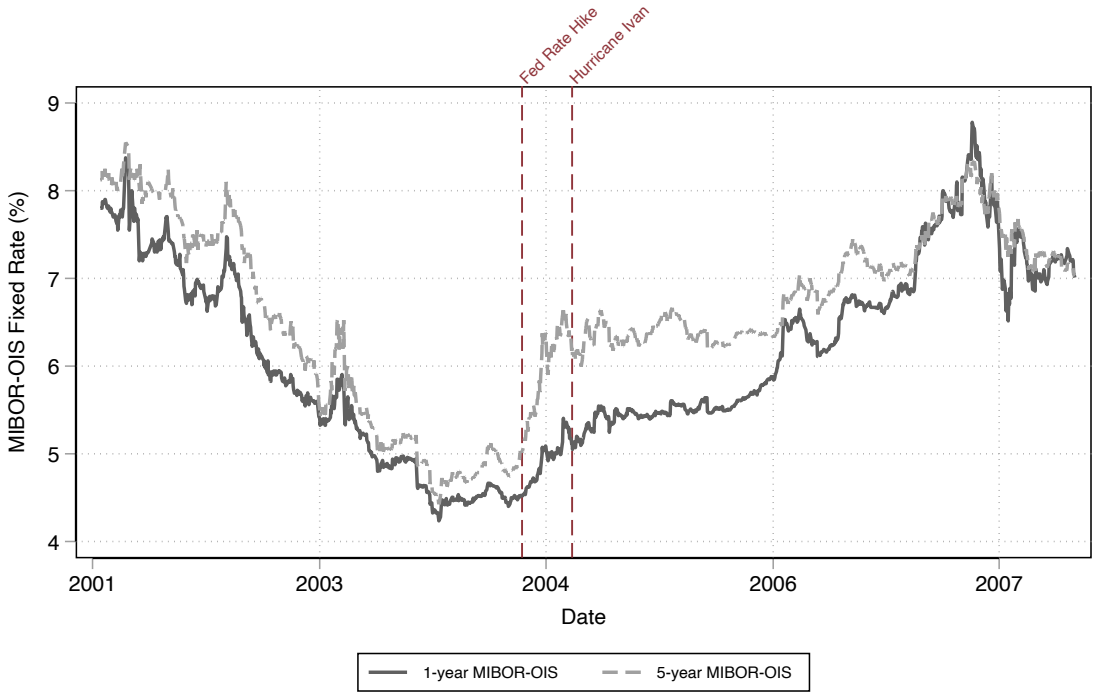
However, beginning in May 2004, this trend in interest rates began to reverse. The U.S. Federal Reserve, in its May 2004 meeting, announced a "measured pace" of withdrawal of policy accommodation. This was interpreted by the market as forward guidance that the Federal Reserve would begin to raise interest rates for the first time since May 2000, following a 4 year period of interest rate cuts (Thornton, 2006). Furthermore, the generalised increase in global oil prices, along with supply uncertainties exacerbated

Figure 3.3: 5 and 10 year Government Security Yields in India, 2001-2007



Notes: This figure shows the aggregate time series of the yields of the 5-year and 10-year government securities in India between 1st January 2001 and 31st December 2007. The FOMC announcement of 4th May, 2004 and the onset of Hurricane Ivan on 2nd September, 2004 are highlighted in the figure. The data on 5-year and 10-year government securities yield is from investing.com.

Figure 3.4: 1 and 5 year MIBOR-OIS fixed rates in India, 2001-2007



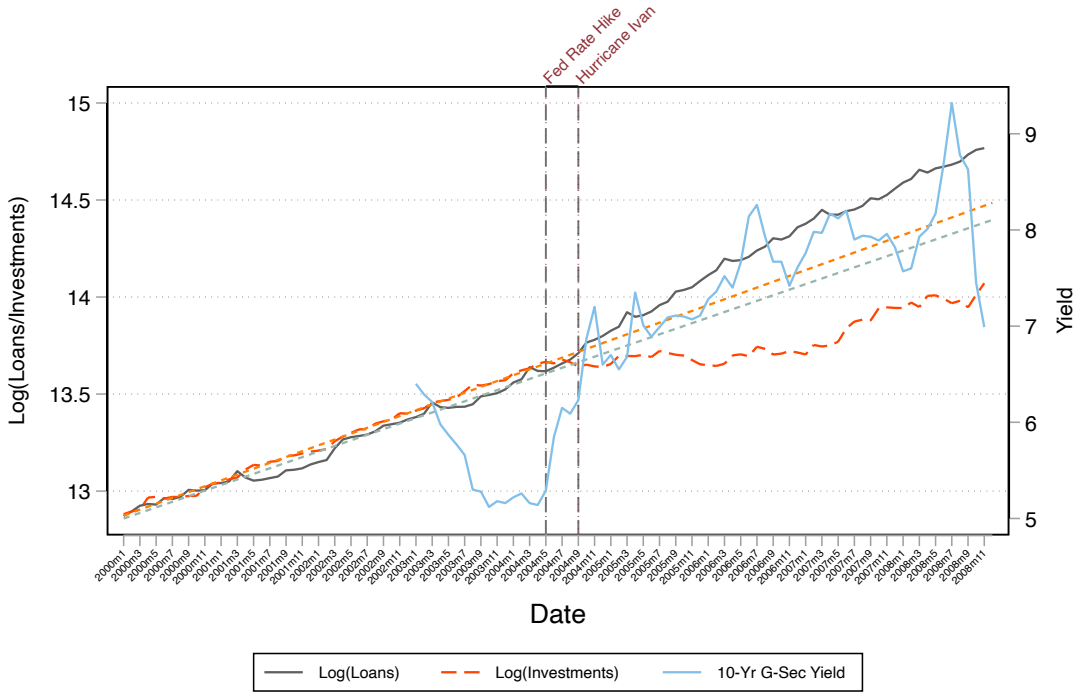
Notes: This figure shows the aggregate time series of the fixed rate of the 1-year and 5-year MIBOR-linked overnight indexed swaps (MIBOR-OIS) in India between 20th July 2001 and 31st December 2007. The FOMC announcement of 4th May, 2004 and the onset of Hurricane Ivan on 2nd September, 2004 are highlighted in the figure. The data on 1-year MIBOR-OIS fixed rates is from Bloomberg with ticker: IRSWO1 BGN Curncy. The data on 5-year MIBOR-OIS fixed rates is from Bloomberg with ticker: IRSWO5 BGN Curncy.

by events like Hurricane Ivan in the Gulf of Mexico and conflict in the Middle East, added to domestic inflationary pressures in India, thereby increasing government security yields even further in the second half of 2004.

Between May and November 2004, the yield on the 5-year government securities rose by close to 160 basis points while the yield on the 10-year government securities rose by 180 basis points. An analysis done by Sy (2005), using bank portfolio exposures in early 2004, suggested that a 100 basis points increase in interest rates could result in losses in the value of government securities holdings amounting to ₹ 300 billion, or 6% of the total portfolio, in the absence of any interest rate risk management strategies adopted by the banking system. Contemporary estimates of the losses to the banking system were pegged at close to ₹ 500 billion, amounting to approximately 10% of the total investment portfolio (Roy, 2022, 377–378).

Figure 3.4 plots the time series of the 1-year and 5-year MIBOR-OIS fixed rates between 2001 and 2007. MIBOR-OIS contracts are interest rate swap contracts where the floating leg of the interest rate is the overnight benchmark interbank interest rate. Therefore, the fixed rates on these contracts represent interest rate expectations for the duration of these contracts. As such, these securities are less subject to changes in liquidity and term premia and provide a more accurate measure of interest rate expectations than government security yields.

Figure 3.5: Monthly Bank Credit Time Series



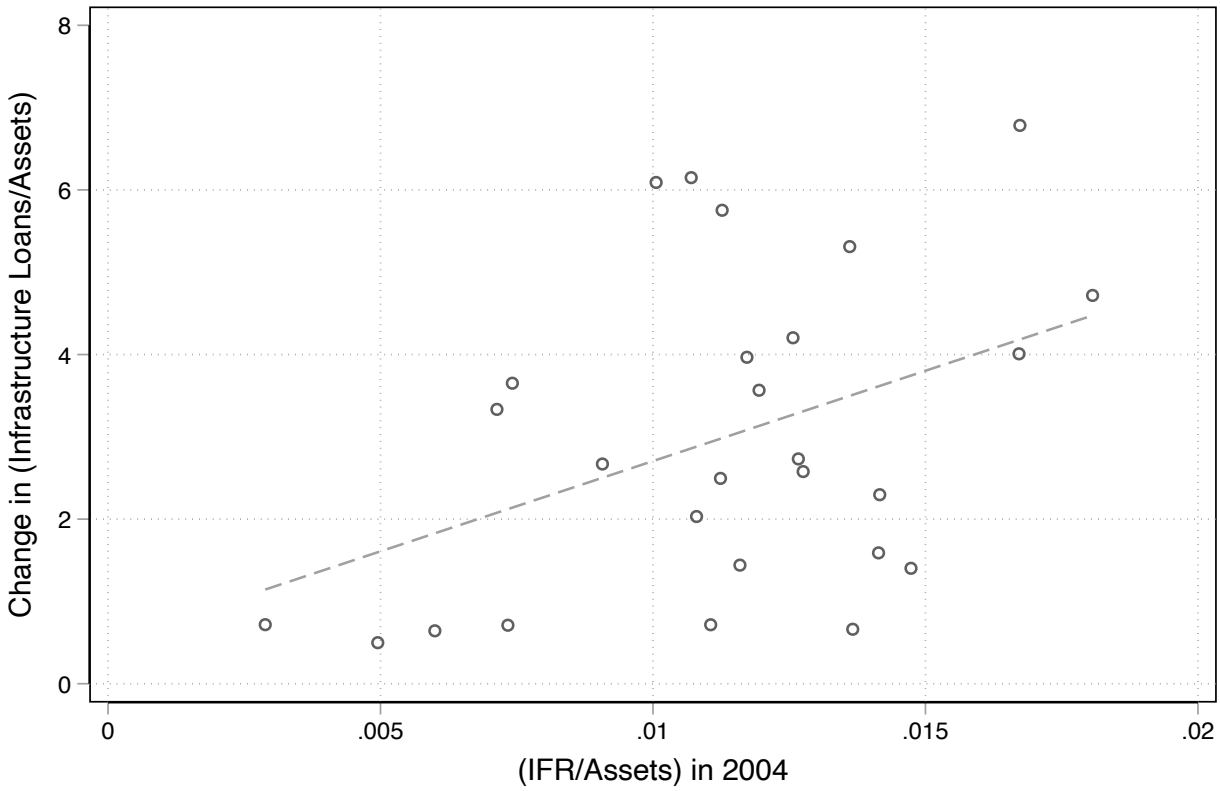
Notes: This figure shows the aggregate time series of non-food bank credit and total investment by all banks in India along with the 10-year government bond yields between 2000 and 2008. Total investments are defined to include: (i) credit to the government (through government bonds), (ii) investment in other approved securities and (iii) investment in non-SLR securities. It shows that the changes in their trends coincide with an exogenous shock to Indian government bond yields due to the announcement of the first possible US federal funds rate hike since 2000 in May 2004 and higher oil prices caused by Hurricane Ivan in September 2004. The data are monthly from RBI DBIE, 2000 to 2008. The short-dashed lines represent the line of best fit for the time series on total credit and total investments for the period between January 2000 and July 2004.

Forward-looking interest rate expectations too followed a similar trajectory to GSec yields. Between May and November 2004, the 5-year MIBOR-OIS fixed rate rose by about 140 basis points, suggesting that a substantial fraction of the increase in government securities yields arose from an increase in expectations of shorter term interest rates in the immediate future. The fact that interest rate expectations were also low prior to May 2004 and followed a similar trajectory to the GSec yields after May 2004 suggests that the increase in interest rates was completely unanticipated by market participants, and that banks were unlikely to have made any portfolio reallocation decisions in anticipation of this interest rate surge.

Figure 3.5 documents the consequences of these increases in long-term interest rates for the aggregate portfolio composition of the banking system. The pace of growth of total lending significantly increases while the pace of growth of total investments declines at precisely the time when these long-term interest rates begin to increase.

In the formal econometric analysis which follows in subsequent sections, we utilise this plausibly exogenous variation in domestic long-term interest rates in mid-2004 to analyse the consequences that this had for lending decisions of Indian banks, particularly towards the infrastructure sector, which witnessed a massive lending boom during this period. Furthermore, the availability of rich, granular banking data

Figure 3.6: Infrastructure lending and investment fluctuation reserves



Notes: This figure shows a scatter plot of the change in the share of infrastructure lending in total assets between 2002 and 2010 against the share of the investment fluctuation reserve in total assets in 2004 for public and private sector banks in India. Infrastructure lending is defined as the total loans outstanding to construction, mining and electricity, gas and water sectors. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

will allow us to explicitly control for local demand effects and disentangle demand-side explanations for the lending boom from supply-side factors. Figure 3.6 anticipates this analysis by providing suggestive evidence that banks with greater exposure to mark-to-market losses stemming from higher interest rates witnessed a faster growth rate of lending, particularly towards the infrastructure sector.

3.4.2 Empirical specification

We now outline the empirical specification we utilise to conduct a more formal analysis of the consequences of the exposure to mark-to-market losses for bank lending decisions, in particular lending to the infrastructure sector. Our granular dataset on bank lending activities allows us to conduct a within district comparison of the evolution of sectoral lending across banks to identify whether ex-ante variation in mark-to-market loss exposure had a significant role to play in the lending patterns observed after 2004. By controlling for district-time fixed effects and bank-district fixed effects, we hope to be able to disentangle the supply side variations arising in bank lending behaviour due to ex-ante government securities holdings of banks from demand side factors.

We conduct the following difference-in-differences regression analysis to identify the impact of banks' ex-ante exposure to mark-to-market losses on their infrastructure lending post 2004:

$$y_{idt} = \alpha_{d,t} + \delta_{i,d} + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \Gamma' \left[\mathbf{X}_{2004,i} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \epsilon_{idt} \tag{3.1}$$

where y_{idt} is the outcome variable of interest, measuring the logarithm of total outstanding loans to the infrastructure sector for bank i in district d at time t, $\alpha_{d,t}$ refers to district-time fixed effects and $\delta_{i,d}$ refers to bank-district fixed effects, with the former being the crucial inclusion so as to control for time-varying, district-specific demand side effects common across banks.[20] With the inclusion of bank-district and district-time fixed effects, our identification strategy essentially amounts to a within-district difference-in-differences specification, exploiting the differential within-district changes in infrastructure lending before and after 2004 by banks with different levels of ex-ante exposure to mark-to-market losses.[21,]

IFR ratio is measured as the investment fluctuation reserves relative to the total assets for a bank. The variable $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 if the IFR ratio of a bank in March 2004 is above the median IFR ratio of Indian Banks. The median of this ratio was 0.0113. $\mathbb{1}\{Post_{2004,t}\}$ is an indicator variable which takes the value 1 for years after the financial year ending in March 2004. As indicated earlier, we use this measure to proxy for the mark-to-market risk exposure of Indian banks. This is principally on account of the fact that information on the actual holdings of mark-to-market securities during this period is not available in the public domain. Therefore, the investment fluctuation reserve is the closest available proxy for the mark-to-market risk exposure of Indian banks. Moreover, analysis by Sy (2005) shows that investment fluctuation reserves as a percentage of eligible securities at most Indian banks stood at around 3% in March 2004, very close to the regulatory target set by the RBI, further

[20] We provide some additional information about the distribution of the dependent variable in Appendix C.5. Our results are broadly robust to defining the dependent variable (outstanding infrastructure lending) as a share of total loans in the bank-district (also expressed in logarithms), as described in greater detail in Appendix C.7.

[21] Note that, in particular, our specification is primarily focused on the intensive margin, comparing within each district, banks which were already operational in that district before 2004 and which had lent to the infrastructure sector before 2004 and continued to do so after 2004. We abstract from extensive margin considerations, which would arise from new bank entry into a district or an existing bank deciding to start lending afresh to the infrastructure sector in that district, by expressing the dependent variable in logarithms.

suggesting that this is an accurate proxy for mark-to-market risk exposure of Indian banks.

Controls $\mathbf{X}_{2004,i}$ include: (i) size of the banks (as measured by balance sheet size from CMIE Prowess) in March 2004, (ii) fraction of total deposits raised in urban areas and metropolitan cities in March 2004 from the RBI's Basic Statistical Returns, and (iii) ownership category of the bank (whether government owned or privately owned) as indicated in the RBI's Basic Statistical Returns. All three controls are expressed as indicator variables, with the indicators for size and urban deposit shares indicating whether these values were above or below the median in 2004 for each bank in the sample; Importantly, all three indicator variables are interacted with $\mathbb{1}\{Post_{2004,t}\}$.

These additional interaction terms (which we refer to as 'controls' in the tables) are included in the specification to control for the effect of any differential change in lending behaviour of Indian banks during this period on account of differences in their size, ownership and location of operation. Appendix C.4 provides more information on the distribution of these variables and results from a Difference-in-Differences specification with continuous variables.

We estimate these specifications using annual data at the level of each bank in each district between 1999 and 2016. All annual data is measured at the end of each fiscal year ending March 31st. In addition to the main specification above, we also consider specifications without fixed effects and additional interaction terms in order to investigate the robustness of the results to these choices. We (two-way) cluster standard errors by district and year.[22]

To examine the temporal dynamics and the existence of any pre-trends, we will also estimate the following event study specification with 2004 as the reference year:

$$y_{idt} = \alpha_{d,t} + \delta_{i,d} + \sum_{\substack{\tau=1999 \\ \tau \neq 2004}}^{2016} \left[\beta_\tau \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}_\tau\right] + \Gamma'_\tau \left[\mathbf{X}_{2004,i} \times \mathbb{1}_\tau\right]\right] + \epsilon_{idt} \tag{3.2}$$

Finally, we will also estimate some difference-in-differences regressions at the state-level using data on bank lending interest rates towards the infrastructure sector, which will be discussed in greater detail in Section 3.5. For these regressions too, we will use a specification identical to Equation 3.1, except that references to districts will now refer to states.

3.5 Empirical results

3.5.1 Mark-to-market exposure and bank lending

The empirical results from the specifications outlined above are now considered. In Table 3.2, we first consider the results of estimating Equation 3.1, using the log of outstanding infrastructure loans at the bank-district-year level as the dependent variable. Column (1) of Table 3.2 first presents the results of this specification before the inclusion of fixed effects and additional interaction terms. Post-2004, banks with above median ex-ante mark-to-market exposure saw their total outstanding lending to the infrastructure sector increase by 10.74% more than below median banks, although this effect is not statistically signif-

[22] Since we treat bank-districts as separate operational units, we do not allow for any correlation between residuals that are neither in the same district nor same year, ruling out residual correlation caused by any persistent and common bank-wide shocks. For robustness to (three-way) clustering by bank, district and year, see Section 3.7.

Table 3.2: Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans

$$\log(\text{Infra}_{idt}) = \alpha_{d,t} + \delta_{i,d} + \beta\left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \Gamma'\left[\mathbf{X}_{2004,i} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \epsilon_{idt}$$

Dependent variable:	log(Infra)		
	(1)	(2)	(3)
$\text{Post}_{2004,t} = 1$	1.013^{***}		
	(0.092)		
High IFR $\text{Ratio}_{2004,i} = 1$	0.092		
	(0.078)		
$\text{Post}_{2004,t} \times$ High IFR $\text{Ratio}_{2004,i} = 1$	0.102	0.223^{**}	0.312^{***}
	(0.083)	(0.078)	(0.083)
Observations	74765	74765	74765
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	502	502	502
No. of banks	35	35	35
R^2	0.029	0.779	0.780

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a difference-in-differences regression to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.1. The dependent variable is outstanding bank-district level infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{Post}_{2004,t}\}$ is an indicator variable which takes the value 1 for years post 2004, and 0 otherwise. Exposure measure takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and these are also interacted with the post period dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data are winsorized at the 0.1% level. Standard errors are (two-way) clustered at the district and year level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

icant. Column (2) reports the results of this specification after including district-year and bank-district fixed effects. With the inclusion of these fixed effects, the effect increases to 24.98%, and is statistically significant at the 5% level. Finally, in Column (3), the results of the full specification with fixed effects and additional interaction terms are presented. In the full specification, banks with above median ex-ante mark-to-market exposure saw their lending to the infrastructure sector after 2004 increase by 36.62% more than banks with below median exposure, with this effect being statistically significant at the 1% level.

In Figure 3.7, we show the event study plot of the estimated β_τ coefficients from Equation 3.2, using the same dependent variable. These plots help us to check for any pre-trends in infrastructure lending between banks with above and below median investment fluctuation reserve ratios in 2004, as well as to understand the time pattern of the effects on infrastructure lending following the increase in long-term interest rates in 2004.

This event study plot confirms that there was no systematic differential positive trend in infrastructure lending by banks with above median ex-ante mark-to-market exposure in the period before the increase in long-term interest rates in 2004. Furthermore, there were large and statistically significant positive effects immediately following the interest rate increases in 2004. In the financial years ending 2005, 2006 and 2007, total outstanding loans to the infrastructure sector in above median IFR ratio banks increased by 41.2%, 63.07% and 76.12% respectively relative to below median IFR ratio banks. Following this period, outstanding infrastructure lending continued to remain at higher levels among above median IFR banks relative to below median IFR banks, with a statistically significant effect of 28.4% at the end of our sample in 2016.[23]

3.5.2 Mark-to-market exposure and lending interest rates of banks

An alternative explanation for the observed pattern of infrastructure lending may be increased demand for infrastructure loans after 2004 from a particular subset of the banks. If this were the case, we would expect a relative increase in interest rates on infrastructure loans of banks with above median IFR ratio in 2004. We now proceed to test this hypothesis.

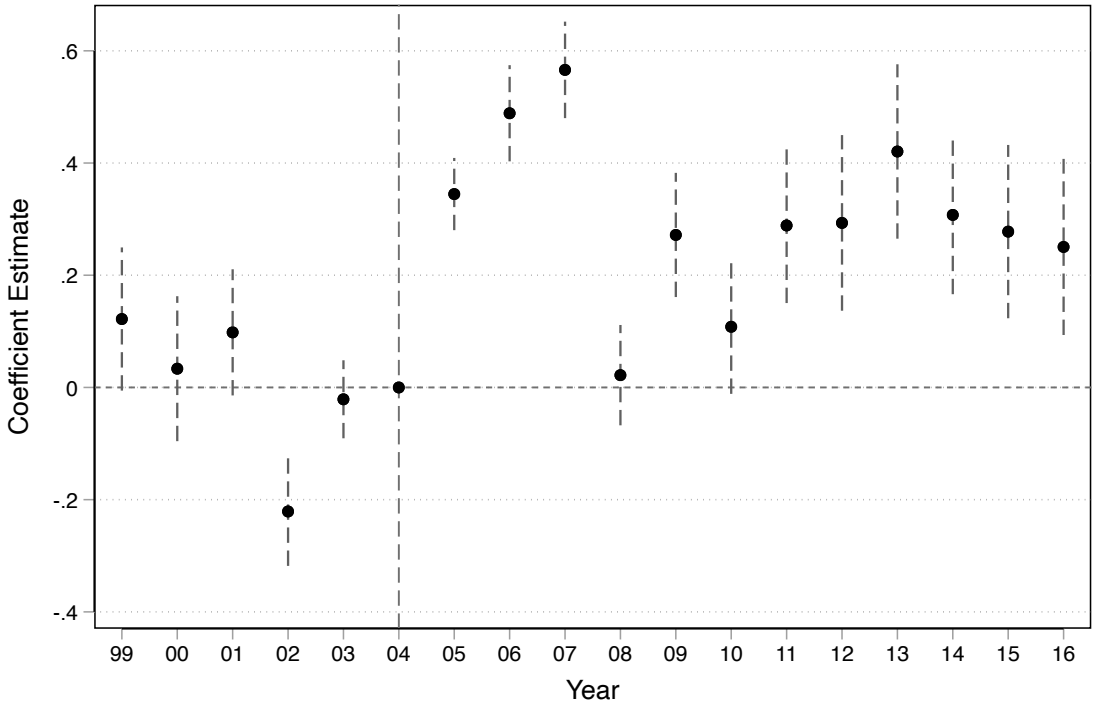
The BSR data provides annual estimates of the weighted average lending rate at the branch level. This allows us to estimate the average lending rate to the infrastructure sector for each bank in each state in each year, under the assumption that all borrowers belonging to a particular sector in a given bank, state and year have the same interest rate on their loans. We can estimate an average lending interest rate to the infrastructure sector for each bank-state-year combination, under this assumption, by regressing the branch-level weighted average lending rate on the shares of lending to each sector in a given year for each branch of a given bank operating in a particular state. More specifically, we estimate the following regression specification to estimate lending rates for the infrastructure sector in each bank in each state in each year:

$$\text{walr}_b = \sum_{j \in \mathbf{J}} \left(\beta^j_{ist} \times \text{loanshare}^j_b \right) + \varepsilon_b, \quad \text{for} \quad b \in \mathbf{B}_{ist}. \tag{3.3}$$

[23] The reasons for the dip in the event study coefficient in 2008 are examined in more detail in Appendix C.6. The decline in the coefficient is mainly driven by other bank characteristics explaining most of the variation in outstanding loans in that year, and is not driven by any significant overall decline in infrastructure lending.

Figure 3.7: Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans

$$\log(\text{Infra}_{idt}) = \alpha_{d,t} + \delta_{i,d} + \sum_{\substack{\tau=1999 \\ \tau \neq 2004}}^{2016} \left[\beta_\tau \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}_\tau\right] + \Gamma'_\tau \left[\mathbf{X}_{2004,i} \times \mathbb{1}_\tau\right]\right] + \epsilon_{idt}$$



Notes: This figure shows the event study estimates obtained from fixed-effects panel regressions to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.2. The dependent variable is the outstanding bank-district level infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}_\tau$ is an indicator variable which takes the value 1 for year τ, and 0 otherwise (with 2004 being the reference year). Exposure measure $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and they are interacted with the year dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data is winsorized at the 0.1% level. Standard errors are (two-way) clustered at the district and year level. 95% confidence intervals are displayed. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

where walr_b is the weighted average lending rate in branch b and loanshare_b^j is the share of total outstanding loans to sector j in total outstanding loans for branch b. We estimate this regression specification separately for each bank-state-year utilising variation across branches belonging to a particular bank in a particular state during a given year ($b \in \mathbf{B}_{ist}$) to obtain β_{ist}^j, which are the sector-specific average lending rates for each bank-state-year combination.[24] We then omit all estimated infrastructure lending interest rates that are negative, log-transform the average infrastructure lending interest rates and winsorize the variable at the 1% level for use in subsequent empirical analysis.[25] Additional details about the results of these regressions can be found in Appendix C.9.

With these predicted values for the log of infrastructure lending interest rates at the bank-state-year level as the dependent variable, we then estimate the following DiD specification:

$$y_{ist} = \alpha_{s,t} + \delta_{i,s} + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \Gamma' \left[\mathbf{X}_{2004,i} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \epsilon_{ist} \tag{3.4}$$

and a corresponding event study specification to study the temporal dynamics of the effect:

$$y_{ist} = \alpha_{s,t} + \delta_{i,s} + \sum_{\substack{\tau=1999 \\ \tau \neq 2004}}^{2016} \left[\beta_\tau \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}_\tau\right] + \Gamma'_\tau \left[\mathbf{X}_{2004,i} \times \mathbb{1}_\tau\right]\right] + \epsilon_{ist} \tag{3.5}$$

These specifications are identical in structure to Equations 3.1 and 3.2 above, except that the spatial unit of analysis is now a state rather than a district. All explanatory variables are identical to those used in Equations 3.1 and 3.2, and state-year and bank-state fixed effects are included. The dependent variable is the estimated average infrastructure lending rate (in logarithms) for bank i in state s at time t, estimated using Equation 3.3 above. The results from estimating Equation 3.4 are presented in Table 3.3.

Contrary to the demand-driven explanation, we do not find any evidence in Table 3.3 that the interest rate on outstanding infrastructure loans after 2004 increased differentially for banks with higher investment fluctuation reserves. Column (1) presents the results from the specification without controls and fixed effects, Column (2) includes fixed effects and Column (3) also includes additional interaction terms as before. In all three cases, the coefficients are both statistically and quantitatively insignificant, with estimated differences of less than 10% in all cases.

Figure 3.8 plots the results from the associated event study specification, and this too confirms that there are no systematic statistically significant differences in the interest rates charged on infrastructure loans by banks with above and below median IFR ratio before and after 2004. The individual annual coefficients for almost all years during the relevant period of the infrastructure boom are further not statistically significant at the 5% level. This is especially the case during the period immediately following the unanticipated interest rate increases, between 2005-2007, which witnessed the largest differences in infrastructure lending between the above and below median IFR banks.

[24] We estimate this specification using branch-level data, rather than district-level data as done elsewhere in the analysis, as we cannot directly sum the values of the weighted average lending rate across branches belonging to a particular district to obtain a district level weighted average lending rate, as it is possible to do with outstanding loans, total deposits or non-performing loans. In addition, since we are estimating this regression separately for each bank-state-year combination, estimating this regression at the branch-level, rather than the district level, gives us a lot more variation to estimate the average lending interest rate to the infrastructure sector for each bank-state-year combination.

[25] We provide some additional information about the distribution of the dependent variable in Appendix C.5.

Table 3.3: Investment Fluctuation Reserve in 2004 and Interest Rate on Outstanding Infrastructure Loans

$$\log(\text{Infra Int Rate}_{ist}) = \alpha_{s,t} + \delta_{i,s} + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \Gamma' \left[\mathbf{X}_{2004,i} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \epsilon_{ist}$$

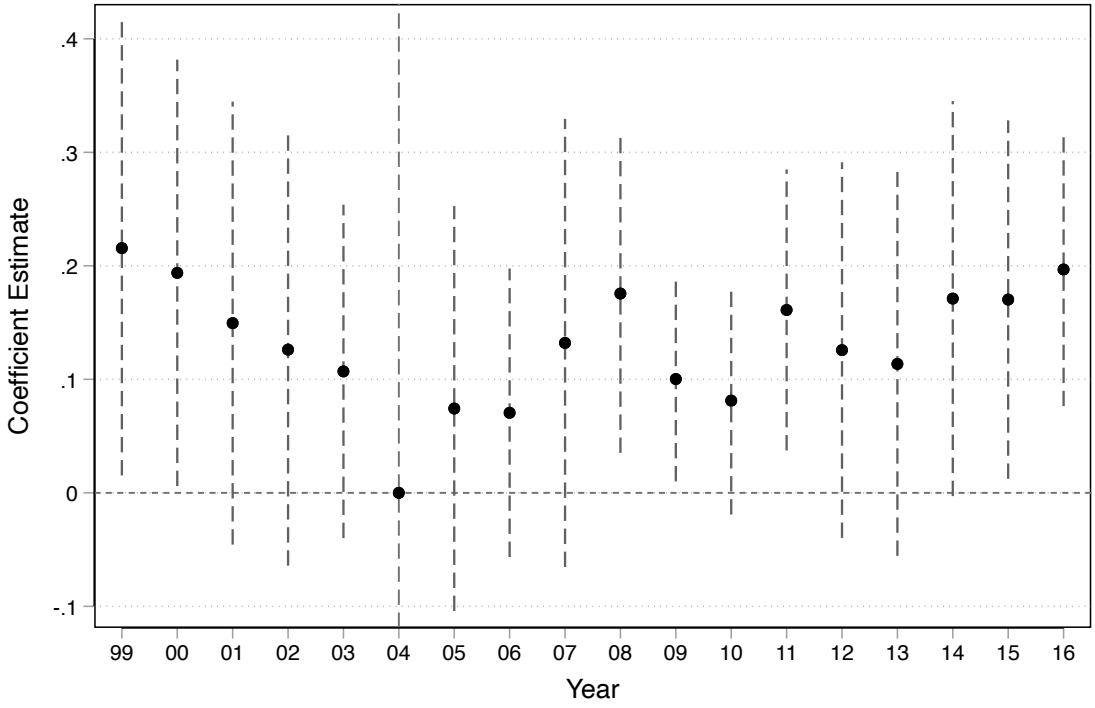
Dependent variable:	log(Infra Int Rate)		
	(1)	(2)	(3)
$\text{Post}_{2004,t} = 1$	–0.190***		
	(0.036)		
High IFR $\text{Ratio}_{2004,i} = 1$	–0.035		
	(0.042)		
$\text{Post}_{2004,t} \times$ High IFR $\text{Ratio}_{2004,i} = 1$	–0.011	0.037	0.002
	(0.046)	(0.044)	(0.032)
Observations	7372	7372	7372
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of states	29	29	29
No. of banks	35	35	35
R^2	0.025	0.305	0.308

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a difference-in-differences regression to assess the relevance of ex-ante investment fluctuation reserves in 2004 for interest rate on infrastructure lending as described in equation 3.4. The dependent variable is the interest rate charged on infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{Post}_{2004,t}\}$ is an indicator variable which takes the value 1 for years post 2004, and 0 otherwise. $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls which are also interacted with the post period dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-state and state-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data are winsorized at the 1% level. Standard errors are (two-way) clustered at the state and year level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. The data on infrastructure interest rate is obtained by regressing branch-level weighted average lending rates on the lending shares at the bank-state-year level, as described in Equation 3.3. The data on branch-level weighted average lending rate and sectoral lending are from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Figure 3.8: Investment Fluctuation Reserve in 2004 and Interest Rate on Outstanding Infrastructure Loans

$$\log(\text{Infra Int Rate}_{ist}) = \alpha_{s,t} + \delta_{i,s} + \sum_{\substack{\tau=1999 \\ \tau \neq 2004}}^{2016} \left[\beta_\tau \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}_\tau\right] + \Gamma'_\tau \left[\mathbf{X}_{2004,i} \times \mathbb{1}_\tau\right]\right] + \epsilon_{ist}$$



Notes: This figure shows the event study estimates obtained from fixed-effects panel regressions to assess the relevance of ex-ante investment fluctuation reserves in 2004 for interest rate on outstanding infrastructure loans as described in equation 3.5. The dependent variable $\log(\text{Infra Int Rate}_{ist})$ is the interest rate on outstanding infrastructure loans in bank i in state s at time t in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}_\tau$ is an indicator variable which takes the value 1 for year τ, and 0 otherwise (with 2004 being the reference year). Exposure measure $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and they are also interacted with the year dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-state and state-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data is winsorized at the 1% level. Standard errors are (two-way) clustered at the state and year level. 95% confidence intervals are displayed. The data on infrastructure interest rate is obtained by regressing branch-level weighted average lending rates on the lending shares at the bank-state-year level, as described in Equation 3.3. The data on branch-level weighted average lending rate and sectoral lending are from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

This evidence, along with the higher outstanding infrastructure loans by banks with above median IFR ratio in 2004, is consistent with a supply side explanation for the infrastructure lending boom in India. Banks with higher duration risk in 2004, as measured by their IFR ratios, undertook substitution of assets from long term fixed rate securities to lending to the infrastructure sector in order to hedge against interest rate risk.

The results we provide may be especially important in the Indian context, because they imply that banks' exposure to infrastructure sectors over the boom period may have been incentivised partly by pure market forces instead of being driven solely by government pressure, as is usually portrayed in media. This may have important policy implications for the future.

3.6 Consequences for bank lending quality

This finding may have important implications for the financial system and the economy as a whole on account of the higher default risk associated with infrastructure loans. It is possible that in order to hedge against interest rate risk, banks with greater ex-ante exposure to mark-to-market losses may be influenced to undertake greater exposure to default risk.[26] We explicitly test for this by comparing the ex-ante mark-to-market risk exposure of banks to their ex-post non-performing assets (NPA). However, on account of regulatory forbearance on restructured advances during the boom period (Chari et al., 2021), which carried on until the Asset Quality Review in 2014-15, obtaining an accurate measure of non-performing loans for Indian banks is a challenge.

As a starting point, we use banks' NPAs (as a ratio of total loans) in 2016, at the end of our sample, as a proxy for their realised default risk in the boom period. We choose the financial year ending March 2016 as this is the latest available data following the RBI's withdrawal of 'Special Regulatory Treatment' for restructured assets and its commencement of the 'Asset Quality Review'. Figure 3.9 presents the relationship between investment fluctuation reserves in 2004 and the NPA ratio of banks in 2016. This provides suggestive evidence that banks with higher ex-ante mark-to-market risk exposure were associated with a greater NPA ratio by the end of our sample, indicating a potential link between the ex-ante mark-to-market exposure of banks and their subsequent exposure to loan defaults. To investigate this relationship further using our granular branch-level data on non-performing loans, we estimate the following regression specification:[27]

$$\text{Log}(\text{NPA}_{2016,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}\right] + \Gamma' \mathbf{X}_{2004,i} + \epsilon_{id} \tag{3.6}$$

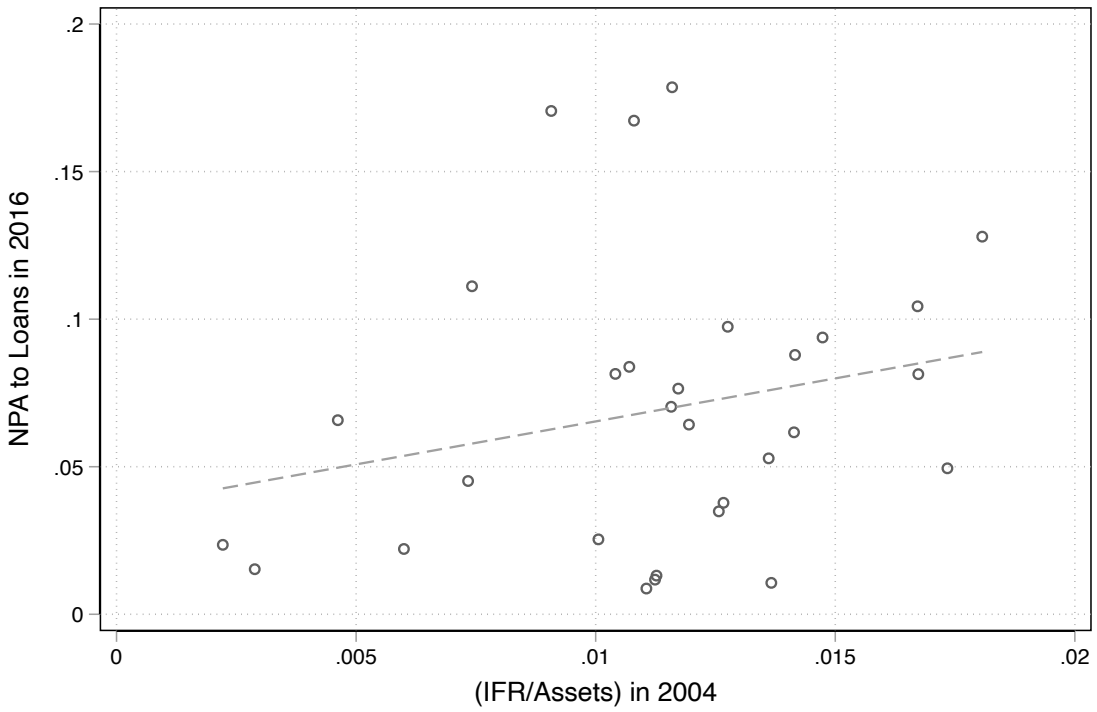
where $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is again an indicator variable which takes the value 1 if the bank has an above median value of investment fluctuation reserves as a share of total assets in March 2004. $\text{Log}(\text{NPA}_{2016,id})$ refers to non-performing loans as a share of total loans in bank i and district d in 2016, expressed in logarithms.[28] α_d refers to district fixed effects and is included to control for demand side effects. Controls,

[26] This risk was evident ex-ante, at least to some extent, and consequently priced in to lending rates to the infrastructure sector, as the median estimated lending rate stood at around 12.6% p.a for private sector banks and 12.1% p.a for public sector banks in March 2005, while the yield on 10-year government securities was 6.7% p.a.

[27] As with the analysis of bank lending behaviour, we aggregate the branch-level data to the district-level to account for any within-district specialisation in infrastructure lending, which may have led to a concentration of non-performing loans within a few branches within each district.

[28] We provide some additional information about the distribution of the dependent variable in Appendix C.5.

Figure 3.9: Investment fluctuation reserves and non-performing loan ratio in 2016



Notes: This figure shows a scatter plot of the NPA ratio of public and private sector banks in March 2016 as a proportion of total loans in India against their investment fluctuation reserves in 2004. We focus on the NPA ratio in 2016 as this is the latest available data following the RBI's withdrawal of 'Special Regulatory Treatment' for restructured assets and the commencement of the 'Asset Quality Review'. Non-performing loans are defined as outstanding loans with the classifications of sub-standard, doubtful or loss. Data on banks' non-performing loans is from Basic Statistical Returns (RBI). Data on total loans at the bank level is obtained from CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

represented by $\mathbf{X}_{2004,i}$, include size of the banks, fraction of total deposits raised in urban and metropolitan areas, and ownership category of the banks, as previously discussed in Section 3.4. Appendix C.4 provides more information on the distribution of these variables and results from a specification with continuous variables.

Table 3.4: IFR in 2004 and NPAs in 2016

$$\text{Log}(\text{NPA}_{2016,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}\right] + \Gamma' \mathbf{X}_{2004,i} + \epsilon_{id}$$

Dependent variable:	$\log(\text{NPA}_{2016})$		
	(1)	(2)	(3)
High IFR $\text{Ratio}_{2004,i} = 1$	0.355^{***}	0.362^{***}	-0.191^{***}
	(0.033)	(0.032)	(0.043)
High $\text{Assets}_{2004,i} = 1$			-0.107^{*}
			(0.062)
High Metro $\text{Deposits}_{2004,i} = 1$			-0.112^{**}
			(0.045)
Public Sector $\text{Bank}_i = 1$			1.470^{***}
			(0.062)
Observations	8439	8439	8439
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	514	514	514
No. of banks	30	30	30
R^2	0.012	0.123	0.251

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a regression specification to assess the relevance of ex-ante investment fluctuation reserves in 2004 for bank NPAs as described in equation 3.6. The dependent variable is non-performing loans in 2016 in bank i in district d as a share of total loans (expressed in logarithms). $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 for banks with above median investment fluctuation reserves as a percentage of total assets and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. District fixed effects are included as indicated. The data are winsorized at the 0.1% level. Standard errors are clustered at the district level. The data on non-performing loans is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

For the purposes of the formal econometric analysis, given our interest in understanding the consequences of the infrastructure lending boom on bank asset quality, we choose the end of our sample, March 2016, to investigate the effects of the infrastructure lending boom on the share of non-performing assets, as it marks the period when the non-performing loans came to be recognised following the Asset Quality Review of the RBI. Table 3.4 presents the results of this regression specification.[29]

Column (1) of Table 3.4 considers the results of the specification above without including any fixed effects or controls. This suggests that banks with above median ex-ante mark-to-market exposure saw their ex-post NPA ratios rise by 42.62% more than those banks below the median. The inclusion of district fixed effects in Column (2), leads to a positive and statistically significant effect of a larger magnitude of 43.62%.

[29] In Appendix C.10, we also present results on the effect of ex-ante IFR ratios on the change in NPA ratios from 2004 to 2016, and the results for our preferred specification are very similar to the results presented in Table 3.4.

Column (3) considers the results from the full specification, inclusive of controls and fixed effects. The coefficient of interest now changes sign, suggesting that in our main specification, banks with above median ex-ante exposure to mark-to-market losses saw 17.4% lower ex-post default rates relative to below median exposure banks, after controlling for the size and ownership characteristics of these banks.

As column (3) highlights, a far more important factor driving differences in ex-post default rates amongst Indian banks was their ownership status, with the NPA ratio in 2016 almost 334.92% higher for government-controlled public sector banks than it was for their private sector counterparts.[30] These results suggest that while NPAs were higher amongst the above median IFR banks on average, this is principally driven by other bank characteristics. In particular, public ownership of the bank, as previously documented in the literature, was a much more important driver of the deterioration of bank lending quality during this period than the portfolio reallocation away from marked-to-market investments which forms the primary focus of our study.

3.7 Alternative specifications and robustness checks

In this section, we consider the sensitivity of the magnitude and direction of the impact of mark-to-market exposure on the infrastructure lending behaviour of Indian banks, to using an alternative regression specification as well as an alternative way of measuring mark-to-market exposure. Firstly, we consider an alternative regression specification, similar to the one employed by Drechsler et al. (2022):

$$\Delta\text{Log}(\text{Infra}_{2007\text{–}2004,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}\right] + \Gamma'\mathbf{X}_{2004,i} + \epsilon_{id} \tag{3.7}$$

where $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 if the bank has an above median value of investment fluctuation reserves as a share of total assets in March 2004. $\Delta\text{Log}(\text{Infra}_{2007\text{–}2004,id})$ refers to the increase in outstanding infrastructure loans by bank i in district d from 2004 to 2007, as measured in logs, $\text{Log}(\text{Infra}_{2007,id})$- $\text{Log}(\text{Infra}_{2004,id})$. α_d refers to district fixed effects and is included to control for demand side effects. Controls, symbolised by $\mathbf{X}_{2004,i}$, include size of the banks, fraction of total deposits raised in metropolitan cities, and ownership category of the banks. Compared to the main difference-in-differences specification in Equation 3.1, there are two main differences in Equation 3.7. Firstly, we restrict our attention to lending growth during the period after 2004 only, without any consideration of the pre-2004 period. More importantly, we focus only on infrastructure lending growth between 2004 and 2007, the period during which the interest rate tightening cycle lasted, rather than until the end of our data in 2016.

The results are shown in Table 3.5. Column (1) of Table 3.5 shows the results of the above specification before including fixed effects and controls. Banks with above median ex-ante mark-to-market exposure saw their lending to the infrastructure sector increase by 13.09% relative to banks with below median exposure between 2004 and 2007 under this specification. In Column (2), we augment this specification with district fixed effects, which increases the magnitude of the effect to 22.75%. With the further addition of controls in Column (3), we find that banks with above median mark-to-market exposure in 2004 are characterised

[30] We also note here that the results on public sector bank ownership are extremely similar even when other variables in the regression specification are expressed in continuous terms, as shown in Table C.4.

Table 3.5: IFR in 2004 and Infrastructure Lending: Growth between 2004 and 2007

$$\Delta \text{Log}(\text{Infra}_{2007\text{–}2004,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}\right] + \Gamma' \mathbf{X}_{2004,i} + \epsilon_{id}$$

Dependent variable:	Δ log(Infra$_{2007\text{–}2004}$)		
	(1)	(2)	(3)
High IFR Ratio$_{2004,i}$ = 1	0.123*	0.205***	0.446***
	(0.065)	(0.070)	(0.075)
Observations	2769	2769	2769
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	386	386	386
No. of banks	33	33	33
R^2	0.001	0.141	0.160

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a regression specification to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.7. The dependent variable is the change in the log of outstanding infrastructure credit in 2007 relative to the log of outstanding infrastructure credit in 2004. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 for banks with above median investment fluctuation reserves as a percentage of total assets and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. District fixed effects are included as indicated. The data are winsorized at the 0.1% level. Standard errors are clustered at the district level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

by about 56.21% higher growth in infrastructure loans from 2004 to 2007. These effects are statistically significant at least at the 10% level. This suggests that results from the Difference-in-Differences and Event Study specifications in Section 3.5 are robust to this alternative specification.

As an additional robustness check, we also estimate the following specification:

$$\Delta\text{Log}(\text{Infra}_{2007\text{–}2004,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High Long-term investment ratio}_{2004,i}\}\right] + \Gamma'\mathbf{X}_{2004,i} + \epsilon_{id} \quad (3.8)$$

where $\mathbb{1}\{\text{High Long-term investment ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 if the bank has an above median value of investments with duration in excess of 5 years as a share of total assets in March 2004. $\Delta\text{Log}(\text{Infra}_{2007\text{–}2004,id})$ refers to the increase in outstanding infrastructure loans by bank i in district d from 2004 to 2007, $\text{Log}(\text{Infra}_{2007,id})$- $\text{Log}(\text{Infra}_{2004,id})$, as measured in logs. α_d refers to district fixed effects and is included to control for demand side effects. Controls, symbolised by $\mathbf{X}_{2004,i}$, include size of the banks, fraction of total deposits raised in metropolitan cities, and ownership category of the banks.

Table 3.6: Long-term investments in 2004 and Infrastructure Lending: Growth between 2004 and 2007

$$\Delta\text{Log}(\text{Infra}_{2007\text{–}2004,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High Long-term investment ratio}_{2004,i}\}\right] + \Gamma'\mathbf{X}_{2004,i} + \epsilon_{id}$$

Dependent variable:	Δ log(Infra$_{2007\text{–}2004}$)		
	(1)	(2)	(3)
High Long-term Investment Ratio$_{2004,i}$ = 1	0.213***	0.258***	0.294***
	(0.067)	(0.071)	(0.071)
Observations	2858	2858	2858
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	387	387	387
No. of banks	36	36	36
R^2	0.004	0.138	0.151

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a regression specification to assess the relevance of ex-ante long-term investments ratio in 2004 for infrastructure lending as described in equation 3.8. The dependent variable is the change in the log of outstanding infrastructure credit in 2007 relative to the log of outstanding infrastructure credit in 2004. Infrastructure loans refer to bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{High Long-term investment ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 for banks with above median investments with duration in excess of 5 years as a percentage of total assets and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. District fixed effects are included as indicated. The data are winsorized at the 0.1% level. Standard errors are clustered at the district level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

This specification checks if the results presented above are robust to using the long-term investment ratio as an alternative, albeit more indirect, measure of mark-to-market exposure.[31] The results are presented in Table 3.6. Column (1) presents the results from the above specification before including fixed effects and controls. This suggests that banks with ex-ante above median long-term investments saw their in-

[31] This measure is more indirect due to the fact that some proportion of these long-term securities may be classified as 'Held to Maturity' by banks.

frastructure lending increase by 23.74% more than below median long-term investments between 2004 and 2007. With the inclusion of fixed effects, the effect becomes even larger at 29.43%. With the additional inclusion of control variables, we get an effect of 34.18% which is statistically significant at the 1% level. Hence, the effects on infrastructure lending appear robust to alternative ways of measuring the ex-ante mark-to-market exposure among banks as well.

Finally, in order to test the robustness of the results to our choice of (two-way) clustering standard errors by district and year, in Appendix C.8, we (three-way) cluster standard errors by bank, district and year. Allowing for additional residual dependence at the bank level substantially increases the estimated standard errors, leading to statistically insignificant effects in our main difference-in-differences specification. However, we continue to find statistically significant effects in the associated event-study specifications for the period immediately following the interest rate shock (2005, 2006 and 2007). Moreover, we still find statistically significant effects at the 10% level, when we consider a more focused version of the difference-in-differences specification considering only on the period between 2004 and 2007, which is the specification in Equation 3.7.

3.8 Discussion of results

What do the above results imply? Firstly, they point to a novel explanation of the infrastructure lending boom in India, complementing existing explanations which emphasise political economy factors on the supply side and strong economic growth on the demand side. High mark-to-market loss exposure for commercial banks in India induced many of them to significantly increase their lending activity to the private sector, particularly towards infrastructure projects, thereby contributing to the infrastructure lending boom.

An important potential reason why the infrastructure sector was a particularly important beneficiary of bank portfolio reallocation to the real economy is the similarity of mark-to-market risk in long-term investments to default risk in this sector. Mark-to-market interest rate risks are very high at the beginning of a new bond issue but decline as the bond approaches maturity. Similarly, the default risks in project finance are also front-loaded, with high uncertainty before the project is executed which declines as the project reaches completion and starts generating cash flows.

Secondly, these results also point to the importance of crowding-in and crowding-out effects in affecting the supply of private sector lending in an emerging market context where financial markets are incomplete and potentially shallow. In contrast to more advanced economies with well developed markets for long-term capital, the bulk of long-term financing has to be performed by commercial banks in India. Given the risk management imperatives facing commercial banks which are documented in this paper, long-term financing of critical infrastructure projects is much more sensitive to short-term interest rate cycles in developing countries with shallower financial markets than is potentially socially optimal.

Finally, while we do not find any systematic evidence that the reallocation of bank lending to the infrastructure sector, in response to the interest rate increases in 2004, resulted in significantly higher ex-post NPAs, these results still suggest that there are potentially unintended consequences associated with the interaction between mark-to-market risk and monetary policy actions of the central bank. Higher interest rates, while helping to lower aggregate demand and reduce inflation, may also contribute towards

increasing the banking sector's exposure to loan default risks, pointing to the importance for central banks to consider the financial stability implications of their monetary policy actions.

3.9 Conclusion

Using the boom period of the 2000s in India as a laboratory, we document that banks with higher ex-ante exposure to marked-to-market government securities increased their lending by proportionately larger amounts towards Mining, Construction and Electricity, Gas and Water sectors, all of which are closely associated with the infrastructure sector in India, following a sudden, unanticipated increase in long-term interest rates towards the end of 2004. Using regulatory branch-level data on bank lending, we establish that the faster rate of loan growth towards infrastructure sectors by banks highly exposed to marked-to-market losses exists even after controlling for demand-side factors.

Traditional accounts of the infrastructure lending boom in India emphasise demand-side factors, including rapid economic growth and a governmental focus on infrastructure creation as well as political economy considerations on the supply-side. This paper complements these explanations by documenting that market-based supply-side factors also contributed to the infrastructure lending boom in India during the mid-2000s. The similarity of the default risk profile in project financing to the accounting risk profile of government bonds, with risks being greatest at the start of the loan and declining over time, was potentially responsible for the results that we document in the data.

These results also highlight the potentially unintended consequences of the interaction between sound macro-prudential and sound monetary policy. Higher interest rates, while helping to lower aggregate demand and reduce inflation, can also contribute to financial sector instability by increasing marked-to-market losses on bank balance sheets and a reallocation of bank portfolios from financial assets towards lending, substantially increasing the default risk exposure of the banking system as a whole.

While banks with greater ex-ante marked-to-market exposure, on average, ended up with a higher share of non-performing loans by 2016, this result is not robust to controlling for other bank characteristics. However, the empirical results documented in this paper still suggest that banks face a potentially important tradeoff between mark-to-market risk and default risk in the absence of safe long-term lending avenues when faced with higher long-term interest rates.

Bibliography

Altavilla, Carlo, Marco Pagano, and Saverio Simonelli, "Bank Exposures and Sovereign Stress Transmission," *Review of Finance*, 2017, *21* (6), 2103–2139.

Begenau, Juliane, Saki Bigio, Jeremy Majerovitz, and Matias Vieyra, "A Q-Theory of Banks," *Working Paper*, 2024.

__ **, Vadim Elenev, and Tim Landvoigt**, "Interest Rate Risk and Cross-Sectional Effects of Micro-Prudential Regulation," *Working Paper*, 2024.

Blattner, Laura, Luisa Farinha, and Francisca Rebelo, "When Losses Turn into Loans: The Cost of Weak Banks," *The American Economic Review*, 2023, *113*, 1600–1641.

Bouis, Romain, "Banks' Holdings of Government Securities and Credit to the Private Sector in Emerging Market and Developing Economies," *IMF Working Paper*, 2019, *WP/19/224*.

Burgess, Robin and Rohini Pande, "Do Rural Banks Matter? Evidence from the Indian Social Banking Experiment," *The American Economic Review*, 2005, *95* (3), 780–795.

Chakrabarty, K.C., "Transformation of DFIs into commercial banks – the case of the IDBI and the role of employee unions," https://www.bis.org/review/r131002f.pdf 2013.

Chari, Anusha, Lakshita Jain, and Nirupama Kulkarni, "The Unholy Trinity: Regulatory Forbearance, Stressed Banks and Zombie Firms," Technical Report 2021.

Chopra, Yakshup, Krishnamurthy Subramaniam, and Prasanna L. Tantri, "Bank Cleanups, Capitalization, and Lending: Evidence from India," *The Review of Financial Studies*, 2021, *34* (9), 4132–4176.

Cole, S, "Fixing Market Failures or Fixing Elections? Elections, Banks, and Agricultural Credit in India," *American Economic Journal: Applied Economics*, 2009, *1* (1), 219–250.

Das, Abhiman, Prachi Mishra, and Nagpurnanand Prabhala, "The Transmission of Monetary Policy within Banks: Evidence from India," Technical Report 2015.

Dell'Ariccia, Giovanni, Ciao Ferreira, Nigel Jenkinson, Luc Laeven, Alberto Martin, Camelia Minoiu, and Alexander Popov, "Managing the sovereign-bank nexus," *ECB Working Paper*, 2018, *2177*.

Department of Economic Affairs, "Report of the Committee on Revisiting and Revitalizing Public Private Partnership Model OF Infrastructure," Ministry of Finance, Government of India. https://www.pppinindia.gov.in/report/Report%20of%20the%20Committee%20on%20Revisiting%

20&%20Revitalizing%20the%20Public%20Private%20Partnership%20Model%20of%20Infrastructure%20(Kelkar%20Committee%20Report).pdf_1685171086.pdf 2015.

Drechsler, Itamar, Alexi Savov, and Philipp Schnabl, "How monetary policy shaped the housing boom," *Journal of Financial Economics*, 2022, *144* (3), 992–1021.

Economic Survey, "The Investment Climate: Stalled Projects, Debt Overhang and the Equity Puzzle," https://www.indiabudget.gov.in/budget2015-2016/es2014-15/echapvol1-04.pdf 2015.

_ , "The Festering Twin Balance Sheet Problem," https://www.indiabudget.gov.in/budget2017-2018/es2016-17/echap04.pdf 2017.

Greenwald, Daniel, John Krainer, and Pascal Paul, "Monetary Transmission Through Bank Securities Portfolios," *Working Paper*, 2024.

Heaton, John C., Deborah Lucas, and Robert L. McDonald, "Is mark-to-market accounting destabilizing? Analysis and implications for policy," *Journal of Monetary Economics*, 2010, *57* (1), 64–75.

Huang, Yi, Marco Pagano, and Ugo Panizza, "Local Crowding-Out in China," *The Journal of Finance*, 2020, *75* (6), 2855–2898.

Kotia, Ananya, "When Competition Compels Change: Trade, Management and Productivity," *Working Paper*, 2025.

Lahiri, Amartya and Urvi Neelakatan, "The role of public sector banks in India," *Indian Economic Review*, 2024, *59*, 1–26.

Ministry of Road Transport and Highways, "Public Private Partnership in National Highways: Model Concession Agreement," Government of India. https://www.pppinindia.gov.in/report/updatedbotupdted.pdf_1685191272.pdf 2020.

Morais, Bernardo, Javier Perez-Estrada, José-Luis Peydró, and Claudia Ruiz-Ortega, "Expansionary Austerity: Reallocating Credit Amid Fiscal Consolidation," *Working Paper*, 2021.

Oki, Oluwatoni, "Crowding Out in Shallow Markets," *Unpublished manuscript*, 2023.

RBI, "Guidelines for Classification and Valuation of Investments by Banks," October 16, 2000. https://www.rbi.org.in/upload/Notification/pdfs/16445.pdf 2000.

_ , "Master Circular - Prudential norms for classification, valuation and operation of investment portfolio by banks," July 11, 2002. https://rbidocs.rbi.org.in/rdocs/notification/PDFs/23134.PDF 2002.

_ , "Monetary and Credit Policy 2002-03: Investment Fluctuation Reserve," May 3, 2002. https://rbidocs.rbi.org.in/rdocs/notification/PDFs/28497.pdf 2002.

_ , "Valuation of investments by banks," January 10, 2002. https://rbidocs.rbi.org.in/rdocs/notification/PDFs/25450.PDF 2002.

_ , "Capital Adequacy - Investment Fluctuation Reserve," October10,2005.https://rbidocs.rbi.org.in/rdocs/notification/PDFs/66563.PDF 2005.

_ , "Master Direction - Classification, Valuation and Operation of Investment Portfolio of Commercial Banks (Directions), 2021," August 25, 2021. https://rbidocs.rbi.org.in/rdocs/notification/PDFs/81MDBANKS25082021BC0CC10147494B67ADAA6285904566BB.PDF 2021.

_ , "Reserve Bank of India (Commercial Banks – Financial Statements: Presentation and Disclosures) Directions, 2025," November 28, 2025. https://rbidocs.rbi.org.in/rdocs/notification/PDFs/167MD.PDF 2025.

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

Shah, Ajay, "The anatomy of the Indian credit boom of 2004-2008," Technical Report 2015.

Sinha, Manojit, "Asset Quality Review and its impact on banks," July 17, 2016. Article in *The Hindu*. https://www.thehindu.com/business/Industry/Asset-Quality-Review-and-its-impact-on-banks/article60462450.ece 2016.

Sy, Amadou, "Managing the Interest Rate Risk of Indian Banks' Government Securities Holdings," *IMF Working Paper*, 2005, *WP/05/78*.

_ , "Indian Banks' Diminishing Appetite for Government Securities: A Change of Diet?," *Economic and Political Weekly*, 2007, pp. 1211–1218.

Thornton, Daniel L., ""Measured Pace" in the Conduct of Monetary Policy," *Economic Synopses*, 2006, *6*.

Vishwanathan, Shri N. S., "Issues in Infrastructure Financing in India," Technical Report 2016.

Williams, Tomas, "Capital Inflows, Sovereign Debt and Bank Lending: Micro-Evidence from an Emerging Market," *The Review of Financial Studies*, 2018, *31*, 4958–4994.

World Bank, "World Development Indicators," https://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS?locations=IN 2024.

Appendix A

Appendix to Chapter 1

A.1 MIBOR-OIS monetary policy surprises: additional results

A.1.1 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 multilateral (net) settlement of these contracts in 2008 and centralised counterparty clearing of IRS contracts in 2014.[1] 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%)

[1] Settlement of interest rate swaps through CCIL occurred only on a non-guaranteed basis through CCIL until 2014, which did not require any collateral or margin to be posted. With the introduction of centralised counterparty clearing in 2014, settlement could occur with or without a settlement guarantee from CCIL. While non-guaranteed trades did not require any collateral or margin to be posted by either counterparty, such a requirement was in place to avail of the guaranteed settlement service offered by CCIL.

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.

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 on account of their implicit state-guarantees, which Foreign Banks and Private Sector Banks lack.[2]

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 the present analysis as it uses data on quoted rates rather than traded rates.

A.1.2 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

[2] 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.

Table A.2: Event Study Regressions for Financial Market Variables: All Announcement Dates

In %	Intercept	Monetary Surprise	N	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.

first lag of the monetary surprise does seem to have some predictive capacity, this further confirms the results in Table 1.3 that the monetary policy surprises are not systematically auto-correlated across RBI announcement dates.

A.1.3 Event study regressions: detailed regression tables

This section presents the detailed regression tables for the event study regressions presented in Figure 1.4 in Section 1.5. Tables A.2, A.3 and A.4 present the detailed regression results of the event study regressions for all, scheduled and unscheduled announcement dates respectively.

A.1.4 Consensus forecast regressions: detailed regression tables

This section presents the detailed regression tables for the consensus forecast regressions presented in Figure 1.5 in Section 1.6. Tables A.5, A.6 and A.7 present the detailed regression results of the consensus forecast regressions for all, scheduled and unscheduled announcement dates respectively.

The statistically significant negative intercepts for the revisions of the growth and investment forecasts

Table A.3: 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	0.320
	(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 A.4: 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.

Table A.5: 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	0.020
	(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.

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.

Table A.6: 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 monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy 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 A.7: 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 monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of scheduled monetary policy 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 A.8: 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.

A.2 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, it may be useful 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.

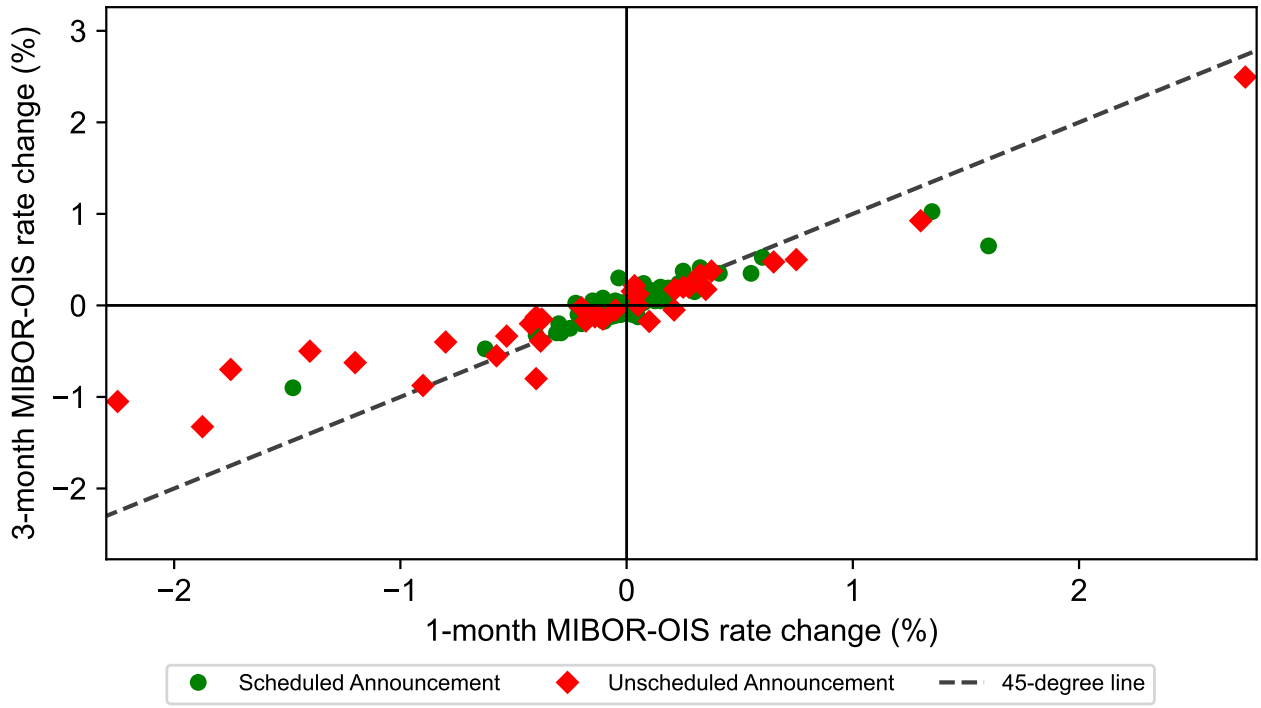
Moreover, on monetary policy announcement dates, information is revealed not just about the current policy rates but also about central bank assessments about future macroeconomic conditions and the path of future policy rates. In this context, it is useful to consider monetary policy surprises derived 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.

A.2.1 3-Month MIBOR-OIS

Figure A.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 A.8, 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 instru-

Figure A.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.

ments, 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 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 amount 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 A.9 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 A.10 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

Table A.9: 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 A.10: Event Study Regressions for Financial 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.

Table A.11: Event Study Regressions for Financial Market Variables: Scheduled Dates (3m MIBOR-OIS)

In %	**Intercept**	**3-month MIBOR-OIS Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	–0.019	0.486***	97	0.482
	(0.013)	(0.110)		
Δ (5-Year GSec Yield)	–0.004	0.339***	97	0.327
	(0.011)	(0.069)		
Δ (10-Year GSec Yield)	0.000	0.300***	97	0.251
	(0.012)	(0.069)		
Δ (NIFTY)	–0.095	–3.214*	97	0.065
	(0.263)	(1.881)		
Δ (SENSEX)	–0.042	–3.228*	97	0.071
	(0.255)	(1.734)		
Δ (BSE200)	–0.053	–3.001*	97	0.054
	(0.276)	(1.806)		
Δ (USD/INR)	–0.053	0.158	97	0.003
	(0.066)	(0.385)		

* 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 3-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 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Values less than 0.001 in absolute value are reported as 0.000.

magnitude. Since, the point estimates in Table A.9 are now much smaller in magnitude and statistically insignificant compared to Table A.3, 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.

The robustness of the event study regressions and the consensus forecast regressions to monetary policy surprises measured using 3-month MIBOR-OIS contracts instead of 1-month MIBOR-OIS contracts is now considered. Tables A.11 and A.12 present the results of the event study regressions for scheduled and unscheduled announcement dates respectively. The results are quantitatively similar to those obtained using the 1-month MIBOR-OIS rate on both scheduled and unscheduled announcement dates, as documented in Tables A.3 and A.4. In fact, the effects of monetary policy surprises on both bond yields and asset prices tend to be slightly larger in response 3-month MIBOR-OIS monetary policy surprises. The heterogeneity in effects of monetary policy surprises on stock prices on scheduled and unscheduled announcement dates is therefore robust to the use of 3-month MIBOR-OIS rate surprises. Interestingly, with the 3-month MIBOR-OIS based monetary policy surprises, the exchange rate appreciates in response to monetary policy surprises on unscheduled announcement dates.

Table A.12: Event Study Regressions for Financial Market Variables: Unscheduled Dates (3m MIBOR-OIS)

In %	**Intercept**	**3-month MIBOR-OIS Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	0.014	0.402***	36	0.625
	(0.035)	(0.064)		
Δ (5-Year GSec Yield)	0.027	0.270***	36	0.711
	(0.018)	(0.024)		
Δ (10-Year GSec Yield)	0.036*	0.210***	36	0.582
	(0.019)	(0.029)		
Δ (NIFTY)	–0.226	0.403	36	0.007
	(0.530)	(0.898)		
Δ (SENSEX)	–0.204	0.408	36	0.005
	(0.602)	(0.985)		
Δ (BSE200)	–0.415	0.614	36	0.013
	(0.583)	(0.944)		
Δ (USD/INR)	–0.048	–0.343*	36	0.104
	(0.101)	(0.180)		

* 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 3-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 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

Table A.13: Consensus Forecast Regressions: Scheduled Dates (3m MIBOR-OIS)

	Intercept	**3-month MIBOR-OIS Surprise**	**N**	**R^2**
Δ(Current FY Output Growth)	–0.034**	–0.272***	88	0.100
	(0.014)	(0.101)		
Δ(Current FY Investment Growth)	–0.190***	–0.249	88	0.006
	(0.056)	(0.481)		
Δ(Current FY WPI Inflation)	–0.011	0.179	88	0.008
	(0.035)	(0.187)		
Δ(Next FY Output Growth)	–0.023	–0.154*	97	0.031
	(0.018)	(0.080)		
Δ(Next FY Investment Growth)	–0.113**	–0.451	97	0.037
	(0.048)	(0.413)		
Δ(Next FY WPI Inflation)	–0.033	–0.061	97	0.003
	(0.026)	(0.094)		

* 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 3-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All scheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy 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 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC 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.

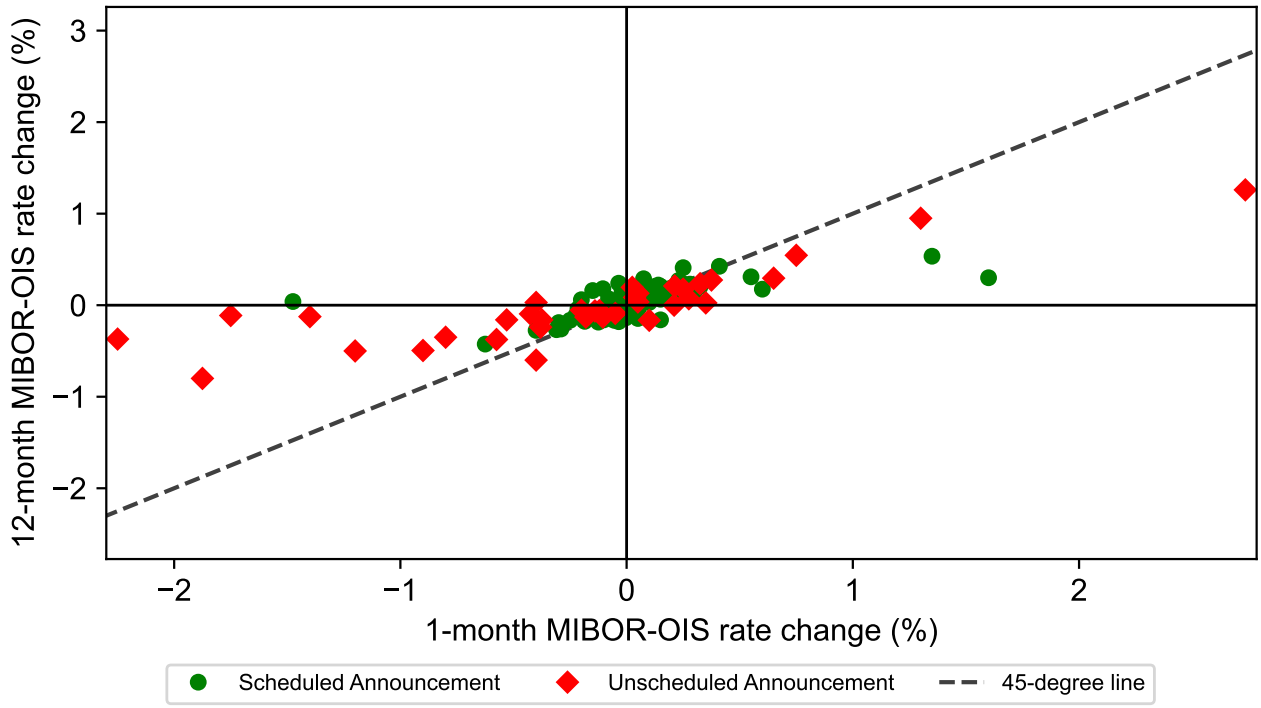
Table A.14: Consensus Forecast Regressions: Unscheduled Dates (3m MIBOR-OIS)

	Intercept	**3-month MIBOR-OIS Surprise**	**N**	**R^2**
Δ(Current FY Output Growth)	–0.071**	–0.018	23	0.005
	(0.034)	(0.079)		
Δ(Current FY Investment Growth)	–0.408***	0.059	23	0.007
	(0.094)	(0.115)		
Δ(Current FY WPI Inflation)	0.050	0.245	23	0.072
	(0.111)	(0.204)		
Δ(Next FY Output Growth)	–0.219*	0.094	28	0.022
	(0.107)	(0.060)		
Δ(Next FY Investment Growth)	–0.530**	0.272*	28	0.042
	(0.218)	(0.138)		
Δ(Next FY WPI Inflation)	–0.149	0.096	28	0.023
	(0.110)	(0.090)		

* 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 3-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All unscheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of scheduled monetary policy 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 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC 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.

Figure A.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.

The consensus forecast regressions in Tables A.13 and A.14 show that the results are also quantitatively similar to those obtained using the 1-month MIBOR-OIS rate in Tables A.6 and A.7. Here too, the effects are slightly larger using 3-month MIBOR-OIS monetary policy surprises than 1-month MIBOR-OIS monetary policy surprises. There are strong and statistically significant effects of monetary policy surprises on the consensus forecasts of the current and next year's output growth forecasts on scheduled announcement dates while the effects of unscheduled monetary policy surprises are much weaker and statistically insignificant. These results are also robust to the use of 3-month MIBOR-OIS rate surprises.

This evidence suggests that the results presented in Sections 1.5 and 1.6 are robust to the use of monetary policy surprises derived from 3-month MIBOR-OIS contracts. While the 3-month MIBOR-OIS contracts are more likely to respond to timing surprises and news about future economic conditions, their influence on the overall behaviour of the monetary policy surprises is limited.

A.2.2 1-Year MIBOR-OIS

Figure A.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 usually changes in the same direction as the 1-month rate on monetary policy announcement dates.

Further, Table A.15 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 coeffi-

Table A.15: 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.

cient 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 guidance about the future path of monetary policy (RBI, 2018).[3] 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

[3]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.

Table A.16: Event Study Regressions for Financial Market Variables: Scheduled Dates (path surprise)

In %	**Intercept**	**Monetary Surprise**	**Path Surprise**	**N**	$\mathbf{R^2}$
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 A.17: Event Study Regressions for Financial Market Variables: Unscheduled Dates (path surprise)

In %	**Intercept**	**Monetary Surprise**	**Path Surprise**	**N**	$\mathbf{R^2}$
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.

variables (Pagan, 1984; Coibion and Gorodnichenko, 2015).[4]

Table A.16 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 monetary policy surprise, shorter horizon yields react more strongly than longer horizon yields. The exchange rate response is weak and not statistically 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 A.17 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 indices, but these effects are not statistically significant.

However, as Table A.15 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.

The robustness of the results in Sections 1.5 and 1.6 to measuring monetary policy surprises using 1-year MIBOR-OIS contracts is now considered. Tables A.18 and A.19 report the results of event study regressions for financial market variables on scheduled and unscheduled monetary policy announcement dates using the 1-year MIBOR-OIS rate as the measure of monetary policy surprises.

On scheduled announcement dates, there are large and statistically significant effects of monetary policy surprises on government bond yields, with the effects being stronger for shorter horizon yields. The stock market response is large but is not statistically significant. The response of bond yields is very similar on unscheduled announcement dates. However, the effects on stock prices, while no longer positive, are still attenuated towards zero and not statistically significant. However, there does seem to be a statistically significant effect on the exchange rate on unscheduled announcement dates, which is not present on scheduled announcement dates. The heterogeneity in the response of the stock market variables on scheduled and unscheduled announcement dates is still broadly true when using the 1-year MIBOR-OIS rate as the measure of monetary policy surprises, even though the responses are biased by the presence of information about future economic condiitons.

Tables A.20 and A.21 present the results of consensus forecast regressions for the current and next financial year on scheduled and unscheduled announcement dates using the 1-year MIBOR-OIS rate as the measure of monetary policy surprises. The results are broadly similar to those obtained using the 1-month MIBOR-OIS rate as the measure of monetary policy surprises. On scheduled announcement dates, there

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

Table A.18: Event Study Regressions for Financial Market Variables: Scheduled Dates (1y MIBOR-OIS)

In %	**Intercept**	**1-year MIBOR-OIS Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	–0.028***	0.714***	97	0.572
	(0.010)	(0.083)		
Δ (5-Year GSec Yield)	–0.016**	0.644***	97	0.648
	(0.008)	(0.055)		
Δ (10-Year GSec Yield)	–0.010	0.594***	97	0.540
	(0.009)	(0.062)		
Δ (NIFTY)	–0.101	–2.839	97	0.028
	(0.276)	(1.938)		
Δ (SENSEX)	–0.048	–2.826	97	0.030
	(0.268)	(1.843)		
Δ (BSE200)	–0.064	–2.482	97	0.020
	(0.290)	(1.964)		
Δ (USD/INR)	–0.042	–0.169	97	0.002
	(0.063)	(0.318)		

* 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-year 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-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

Table A.19: Event Study Regressions for Financial Market Variables: Unscheduled Dates (1y MIBOR-OIS)

In %	**Intercept**	**1-year MIBOR-OIS Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	–0.004	0.716***	36	0.737
	(0.028)	(0.083)		
Δ (5-Year GSec Yield)	0.015	0.466***	36	0.784
	(0.016)	(0.050)		
Δ (10-Year GSec Yield)	0.027	0.374***	36	0.684
	(0.016)	(0.046)		
Δ (NIFTY)	–0.261	–0.412	36	0.003
	(0.533)	(1.550)		
Δ (SENSEX)	–0.243	–0.637	36	0.005
	(0.606)	(1.763)		
Δ (BSE200)	–0.459	–0.074	36	0.000
	(0.587)	(1.760)		
Δ (USD/INR)	–0.033	–0.626***	36	0.128
	(0.106)	(0.217)		

* 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-year 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-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. Values less than 0.001 in absolute value are reported as 0.000.

Table A.20: Consensus Forecast Regressions: Scheduled Dates (1y MIBOR-OIS)

	Intercept	**1-year MIBOR-OIS Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.031**	–0.380***	88	0.091
	(0.014)	(0.122)		
Δ (Current FY Investment Growth)	–0.179***	–0.796	88	0.027
	(0.055)	(0.635)		
Δ (Current FY WPI Inflation)	–0.016	0.444	88	0.023
	(0.036)	(0.351)		
Δ (Next FY Output Growth)	–0.023	–0.151	97	0.017
	(0.017)	(0.106)		
Δ (Next FY Investment Growth)	–0.101**	–0.764*	97	0.059
	(0.049)	(0.430)		
Δ (Next FY WPI Inflation)	–0.034	–0.043	97	0.001
	(0.027)	(0.148)		

* 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-year MIBOR-OIS fixed rate around RBI monetary policy announcements. All scheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy 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-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 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 A.21: Consensus Forecast Regressions: Unscheduled Dates (1y MIBOR-OIS)

	Intercept	**1-year MIBOR-OIS Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.073**	0.021	23	0.003
	(0.033)	(0.108)		
Δ (Current FY Investment Growth)	–0.413***	0.142	23	0.015
	(0.095)	(0.208)		
Δ (Current FY WPI Inflation)	0.030	0.564	23	0.141
	(0.098)	(0.429)		
Δ (Next FY Output Growth)	–0.224**	0.162**	28	0.024
	(0.108)	(0.078)		
Δ (Next FY Investment Growth)	–0.544**	0.460**	28	0.045
	(0.222)	(0.207)		
Δ (Next FY WPI Inflation)	–0.152	0.218	28	0.045
	(0.108)	(0.203)		

* 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-year MIBOR-OIS fixed rate around RBI monetary policy announcements. All unscheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of scheduled monetary policy 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-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 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.

is a statistically significant decline in the consensus forecasts for current year output growth and next year's investment growth. On unscheduled announcement dates, there is a statistically significant increase in the consensus forecasts for next year's output growth and investment growth.

A.2.3 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 1.4, 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 A.22 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 1.4, 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 A.23 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 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.

For completeness, Tables A.24 and A.25 present the results of OLS regressions of the 3-month and 1-year MIBOR-OIS rate changes on the latest available survey forecasts of key macroeconomic indicators for the current and next financial years on all, scheduled and unscheduled monetary policy announcement dates of the RBI, following Table 1.5. In contrast to the results with 1-month MIBOR-OIS rates, the unscheduled monetary policy surprsies are also endogenous to macroeconomic forecasts when measured using 3-month and 1-year MIBOR-OIS rates, further highlighting issues of endogeneity associated with these surprises. While there is some evidence of endogeneity of monetary policy surprises to macroeconomic forecasts on scheduled announcement dates using the 3-month MIBOR-OIS rate, the IRFs for macroeconomic variables, presented in Figures A.45 and A.46, suggest that the endogeneity of monetary policy surprises to macroeconomic forecasts on scheduled announcement dates still leads to estimates of the effects of monetary policy surprises on macroeconomic variables that are consistent with the results using 1-month MIBOR-OIS rates.

Table A.22: Predictability of Monetary Policy Surprises by Macro Data (3m MIBOR-OIS)

3-month MIBOR-OIS	Pooled	Scheduled	Unscheduled
Intercept	–0.014	0.077**	–0.433***
	(0.040)	(0.032)	(0.113)
Δln (IIP) (2m)	0.635	–0.585	5.133
	(1.307)	(1.229)	(3.033)
Δln (WPI) (2m)	0.725	–0.513	1.606
	(1.927)	(1.333)	(2.610)
Drought (2m)	0.009	0.020*	–0.103*
	(0.012)	(0.010)	(0.057)
Excess Rain (2m)	0.037	–0.012	0.592***
	(0.037)	(0.010)	(0.110)
Δ (10Y-1Y GSec Spread) (2m)	0.035	0.041	0.027
	(0.101)	(0.103)	(0.208)
Δln (*SENSEX*) (2m)	0.865**	0.309	0.153
	(0.428)	(0.410)	(0.812)
Δln (*USD* – *INR*) (2m)	0.827	1.251	–0.809
	(2.006)	(1.229)	(3.403)
F-statistic	1.348	1.074	9.994
p-value	0.234	0.387	0.000
R^2	0.087	0.079	0.664
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 2-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, online archives of PIB and MosPI of the Government of India 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 2-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, online archives of PIB and Office of the Economic Advisor to DPIIT of the Government of India and for months when 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 two months (in 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 two-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 two-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 42-trading 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 42-trading 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 42-trading 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 slope coefficients being zero is reported.

Table A.23: Predictability of Monetary Policy Surprises by Macro Data (1y MIBOR-OIS)

1-year MIBOR-OIS	Pooled	Scheduled	Unscheduled
Intercept	0.025	0.076***	–0.227***
	(0.028)	(0.024)	(0.081)
Δln (IIP) (2m)	–0.347	–1.129	2.794
	(0.853)	(0.898)	(1.949)
Δln (WPI) (2m)	1.125	0.217	1.996
	(1.284)	(1.211)	(1.819)
Drought (2m)	0.011	0.017**	–0.055
	(0.009)	(0.009)	(0.041)
Excess Rain (2m)	0.024	–0.002	0.323***
	(0.020)	(0.007)	(0.065)
Δ (10Y-1Y GSec Spread) (2m)	–0.013	–0.025	0.030
	(0.064)	(0.065)	(0.158)
Δln (*SENSEX*) (2m)	0.329	0.013	0.049
	(0.281)	(0.228)	(0.655)
Δln (*USD – INR*) (2m)	–0.062	–0.272	–0.168
	(1.109)	(0.641)	(2.298)
F-statistic	1.651	1.143	8.104
p-value	0.127	0.344	0.000
R^2	0.079	0.106	0.522
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 2-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, online archives of PIB and MoSPI of the Government of India 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 2-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, online archives of PIB and Office of the Economic Advisor to DPIIT of the Government of India and for months when 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 two months (in 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 two-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 two-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 42-trading 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 42-trading 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 42-trading 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 slope coefficients being zero is reported.

Table A.24: Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (3m MIBOR-OIS)

	Pooled	Scheduled	Unscheduled
Intercept	–0.284	–0.159	–0.019
	(0.223)	(0.167)	(0.779)
Current FY Growth Forecast	–0.006	0.018	0.004
	(0.062)	(0.062)	(0.165)
Next FY Growth Forecast	0.046	0.016	0.055
	(0.073)	(0.068)	(0.174)
Current FY WPI Inflation Forecast	–0.028	0.029**	–0.113*
	(0.025)	(0.014)	(0.058)
Next FY WPI Inflation Forecast	0.028	–0.039	0.052
	(0.042)	(0.027)	(0.137)
F-statistic	1.478	2.077	2.485
p-value	0.213	0.090	0.065
R^2	0.026	0.066	0.155
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 3-month MIBOR-OIS fixed rate. The 3-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOC 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 slope coefficients being zero is reported. Monetary policy announcements which occurred on the same day as the forecast survey are excluded from the analysis.

Table A.25: Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (1y MIBOR-OIS)

	Pooled	Scheduled	Unscheduled
Intercept	–0.177	–0.098	–0.122
	(0.175)	(0.186)	(0.470)
Current FY Growth Forecast	0.010	0.005	0.049
	(0.040)	(0.039)	(0.099)
Next FY Growth Forecast	0.016	0.015	0.016
	(0.057)	(0.054)	(0.133)
Current FY WPI Inflation Forecast	–0.013	0.021*	–0.063
	(0.017)	(0.012)	(0.041)
Next FY WPI Inflation Forecast	0.016	–0.022	0.013
	(0.033)	(0.025)	(0.099)
F-statistic	0.946	1.621	2.870
p-value	0.440	0.176	0.040
R^2	0.016	0.056	0.145
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-year MIBOR-OIS fixed rate. The 1-year MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWO1 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 slope coefficients being zero is reported. Monetary policy announcements which occurred on the same day as the forecast survey are excluded from the analysis.

A.3 Monetary policy surprises from exchange rate forwards

Monetary policy surprises measured 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.

A.3.1 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 purpose of obtaining the monetary policy surprises to retain comparability with the MIBOR-OIS surprise series.

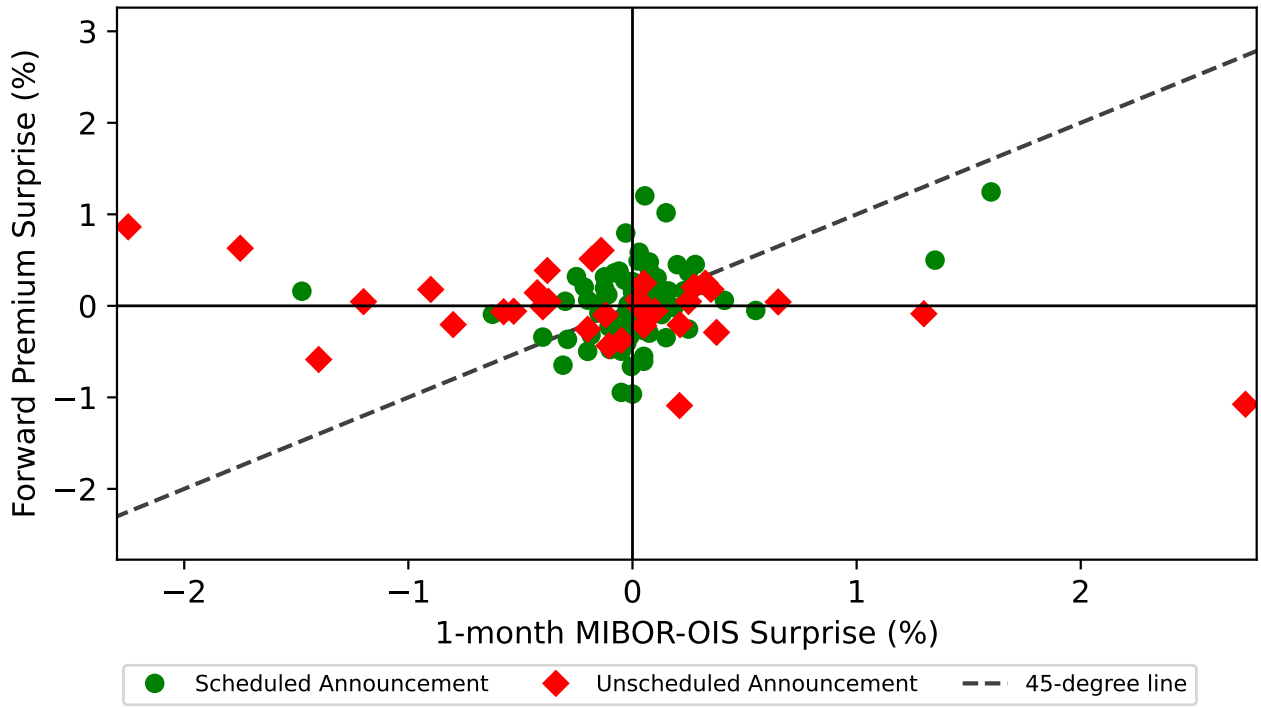
A key identification assumption in this strategy is that $r^{\$}_{t,t+n}$ is constant during the time window used for deriving the surprises. With the use of two day windows, this is unlikely to be satisfied during windows around RBI monetary policy announcements coinciding with FOMC announcements. In this sample, there are 19 instances, documented in Table A.26, where FOMC announcements coincide with RBI announcement windows. These instances are dropped from the sample to maintain consistency with the identification assumptions.

Table A.26: 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. The overlaps were identified by searching for FOMC announcements on the day of the RBI announcement, the previous working day and the next working day of the MIBOR market. Data on overnight MIBOR is sourced from the Bloomberg Terminal with ticker: IN00O/N Index.

Figure A.3: 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.

Table A.27: 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.

Figure A.3 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 A.27 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 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 measured on unscheduled announcement dates for monetary policy analysis due to their sensitivity to the choice of instrument used for measurement.

A.3.2 Evidence from event studies in financial markets

Table A.28 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

Table A.28: 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 A.29: Event Study Regressions for Financial Market Variables: Unscheduled Dates (forward rate)

In %	**Intercept**	**Forward Premium Surprise**	**N**	**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.

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 indices to the forward premium surprises are estimated to be much smaller in magnitude.

Table A.29 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.

A.4 Consensus forecasts and monetary surprises: additional results

A.4.1 Descriptive statistics

Figures A.4, A.5 and A.6 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 A.30 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.

A.4.2 Consensus forecasts and path surprises

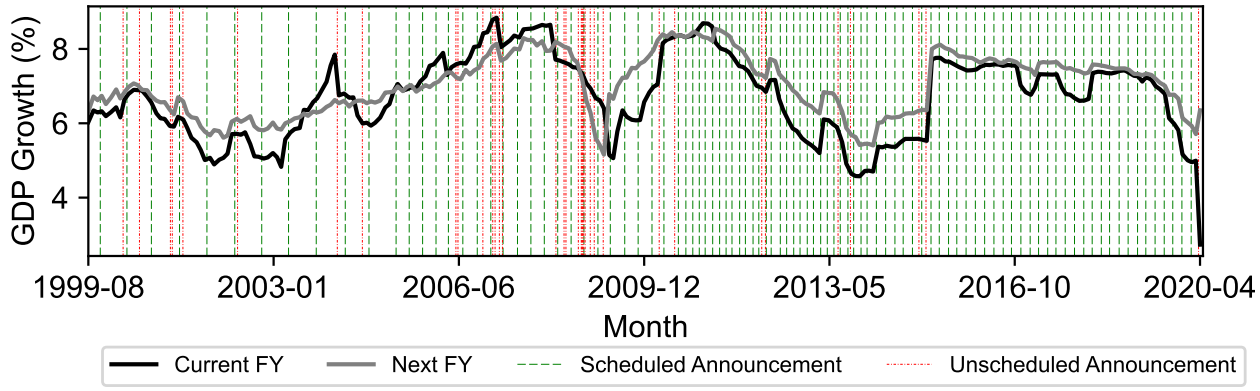
The responses of the consensus forecasts of GDP growth, investment growth and WPI inflation to the *Path Surprise* are now considered. Tables A.31, A.32 and A.33 document the results of these regressions on all, scheduled and unscheduled announcement dates of the RBI respectively.

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

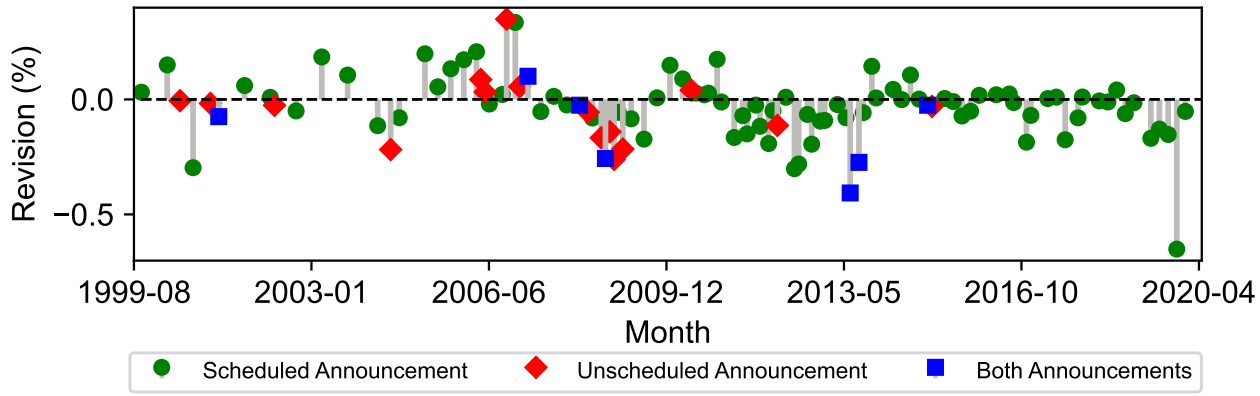
This suggests that *Path Surprises* are associated with a revelation of information by the central bank of higher than expected inflation in the future. The point estimates of GDP growth and investment growth

Figure A.4: Consensus forecasts for real GDP growth in India, August 1999 to April 2020

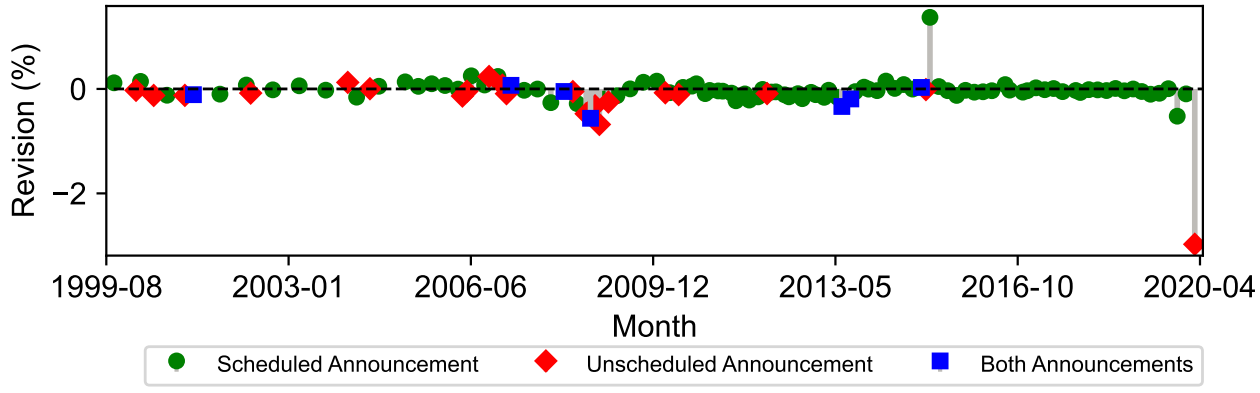
(a) Time series



(b) Current FY forecast revisions during announcement months



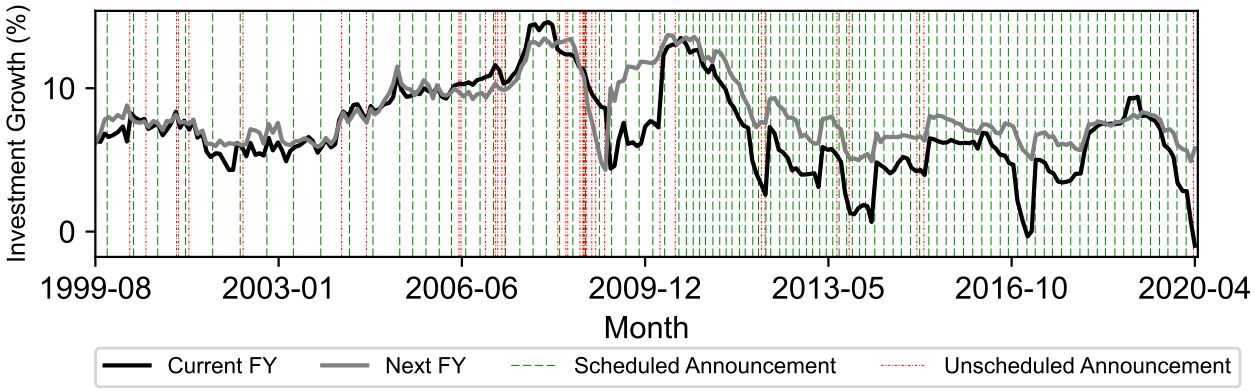
(c) Next FY forecast revisions during announcement months



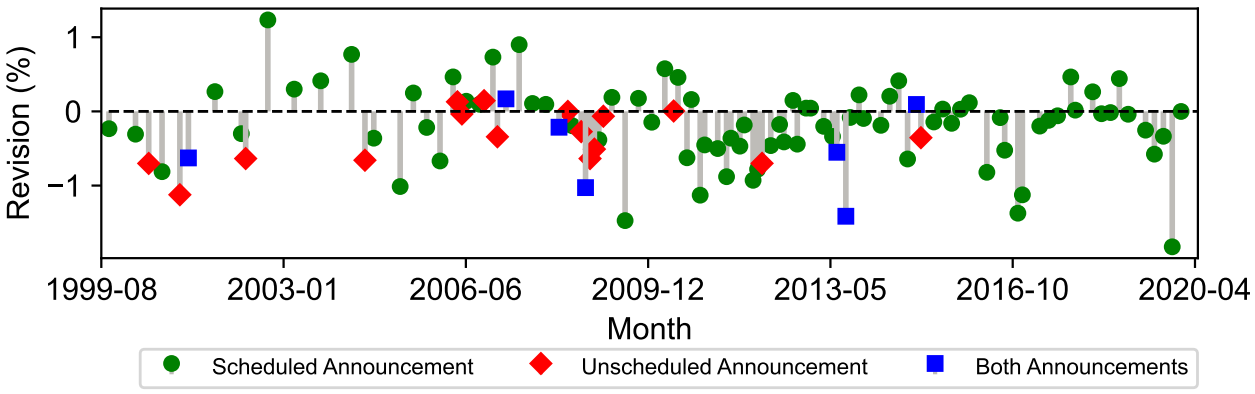
Notes: The first panel plots the time series of monthly consensus forecasts for real GDP growth in India for the current and next financial year. The second and third panels plot the revisions in the consensus forecasts for real GDP growth for the current and next financial year in India between months 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 A.5: Consensus forecasts for real investment growth in India, August 1999 to April 2020

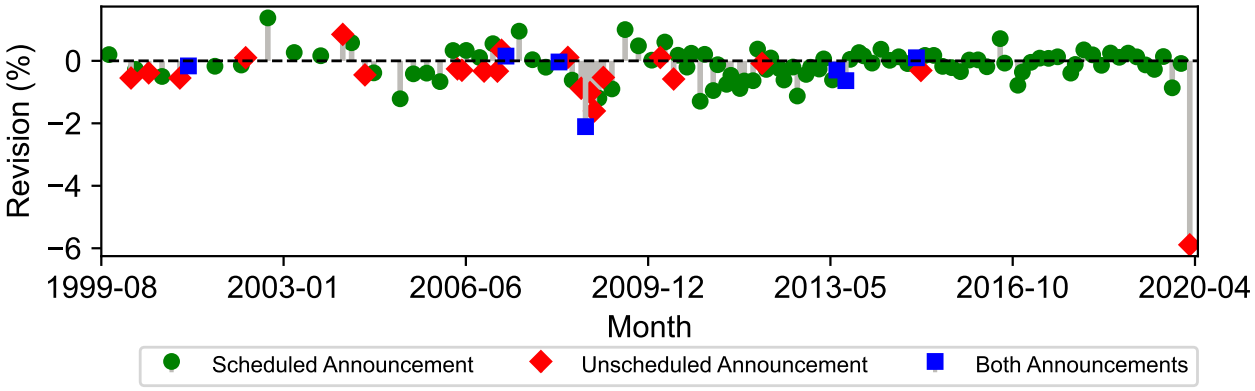
(a) Time series



(b) Current FY forecast revisions during announcement months



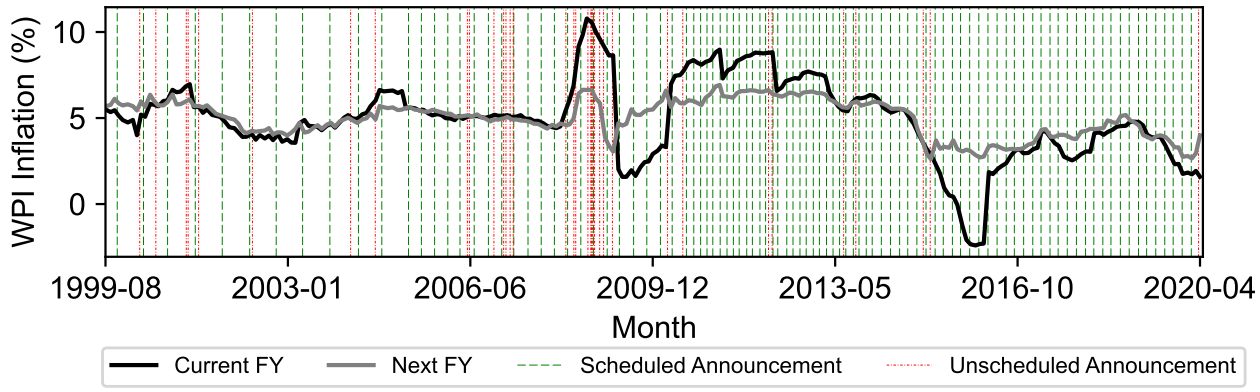
(c) Next FY forecast revisions during announcement months



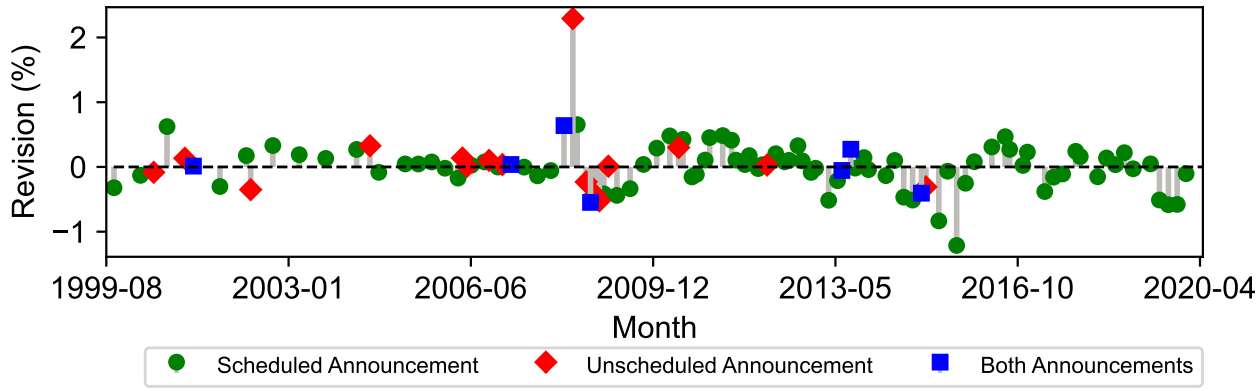
Notes: The first panel plots the time series of monthly consensus forecasts for real investment growth in India for the current and next financial year. The second and third panels plot the revisions in the consensus forecasts for real investment growth for the current and next financial year in India 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 A.6: Consensus forecasts for WPI inflation in India, August 1999 to April 2020

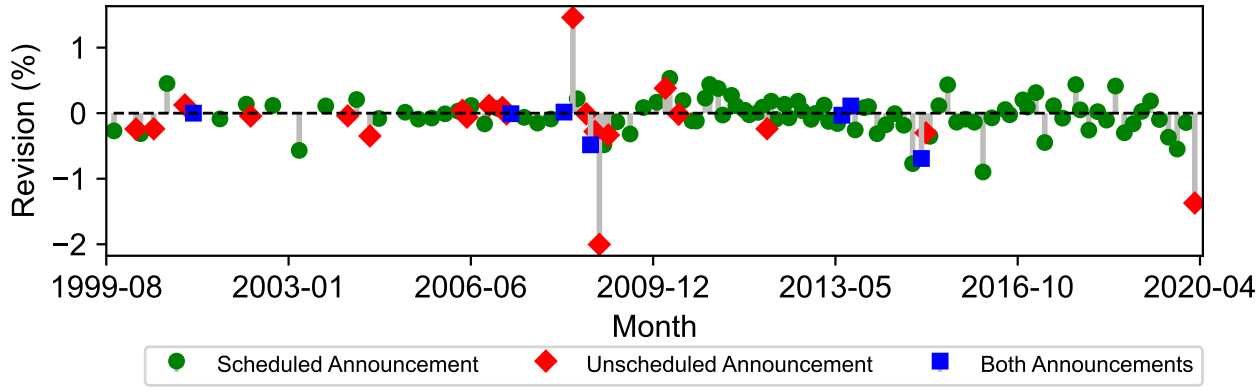
(a) Time series



(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 A.30: 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*	0.106	0.105	0.266
	Std. Dev	0.139	0.191	0.574
Δ (Next FY Investment Growth)	*Mean*	0.370	0.380	0.680
	Std. Dev	0.500	0.513	1.192
Δ (Next FY WPI Inflation)	*Mean*	0.180	0.189	0.325
	Std. Dev	0.266	0.258	0.571
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 between 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.

rates to the *Path Surprises* are mostly negative and not statistically significant, on both scheduled and unscheduled announcement dates.

A.4.3 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 A.34 and A.35. The specification is identical to the one used in Section 1.6.

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 announcement dates, the forecast revisions are positive and statistically significant. On scheduled announcement dates, the surprise tightening of contemporaneous 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 A.15 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

Table A.31: 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 A.32: 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 A.33: 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 A.34: 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.

Table A.35: 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.

Table A.36: 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.

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 A.2.2) 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 contemporaneous 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.

A.4.4 Robustness to an alternative specification

Tables A.36 and A.37 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 1.6. The regressions directly control for the scheduled and unscheduled monetary pol-

Table A.37: 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.

icy 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.

A.5 Data sources

A.5.1 Daily data

Table A.38: 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	05-12-2022
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	22-01-2024
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	03-06-2024
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
Overnight MIBOR	Bloomberg Terminal, Ticker: IN00O/N Index	PX_LAST quote is used	06-03-2023

Notes: Data on BSE SENSEX and BSE 200 were re-downloaded from the Yahoo Finance website on 20-08-2025 while refining the plots in Appendix A.6. A visual inspection suggested no differences relative to the data used in the original analysis. Bloomberg Terminal data was accessed while setting time settings to Indian Standard Time (IST). While the overnight MIBOR data was obtained before switching to IST from UK time, since MIBOR is released by FBIL at 12:45 pm IST daily, the data is unlikely to be affected by this change. While the 1-month MIBOR-OIS was also downloaded before switching to IST, the data was verified to be identical to a data pull made after switching to IST.

A.5.2 Monthly data

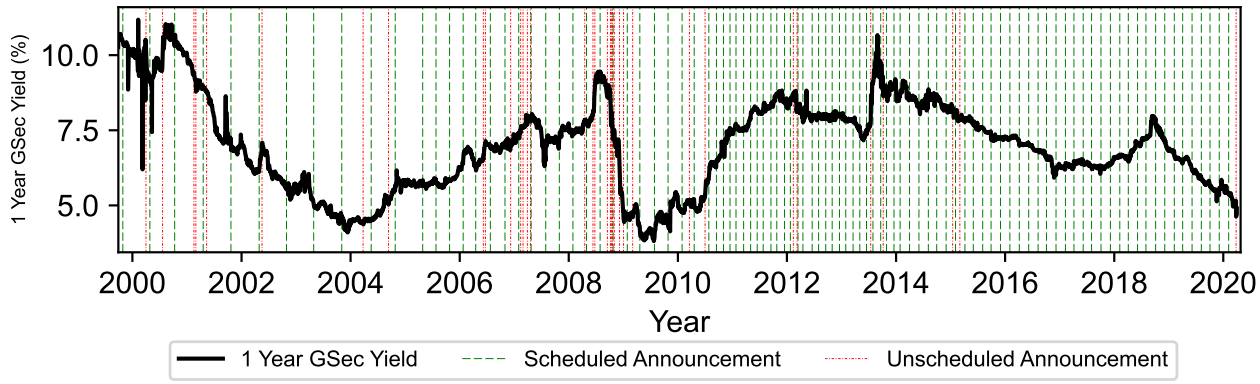
Table A.39: Sources of Monthly Data

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
Consumer Price Index (CPI)	FRED, Ticker: INDCPIALLMINMEI	Consumer Price Index: All Items for India (Index 2015 = 100, Not Seasonally Adjusted)	14-08-2023
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

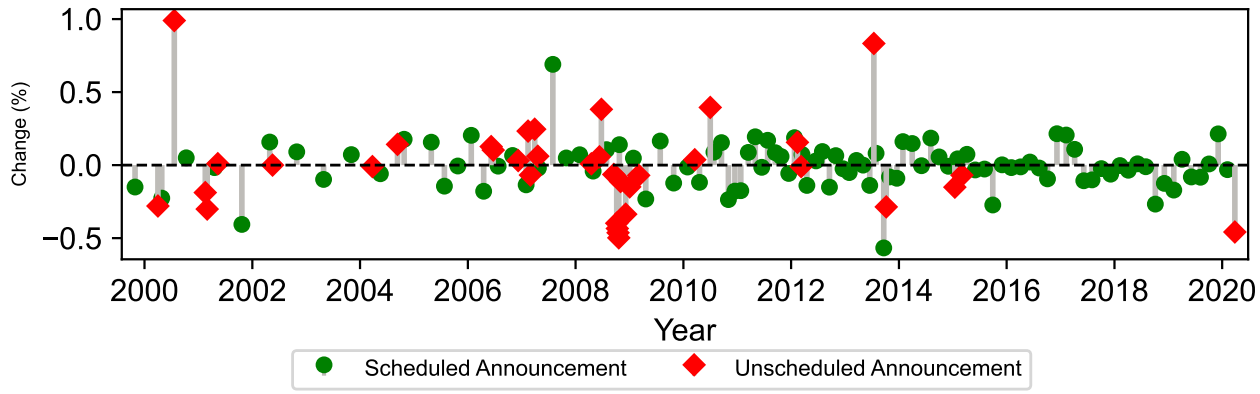
A.6 Event studies: additional descriptive evidence

Figure A.7: 1-year government security (GSec) yield, August 1999 to March 2020

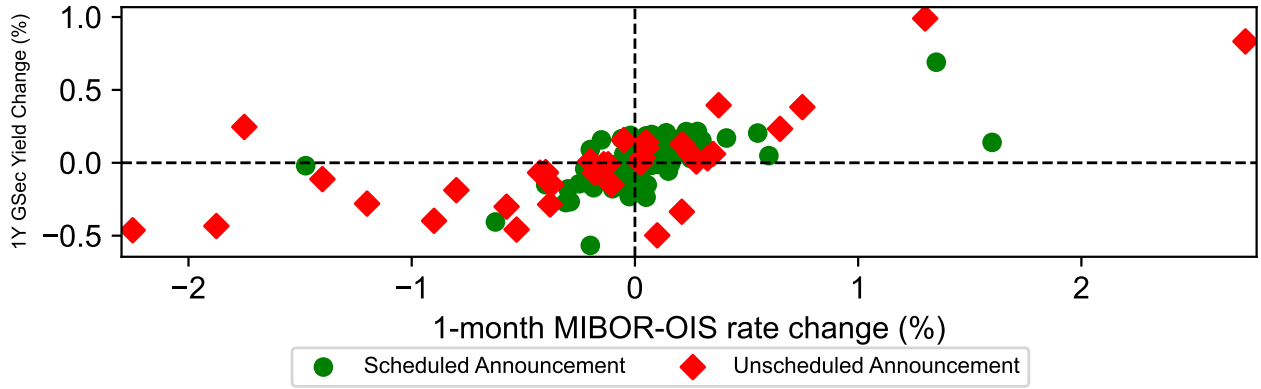
(a) Time series



(b) Changes on monetary policy announcement dates



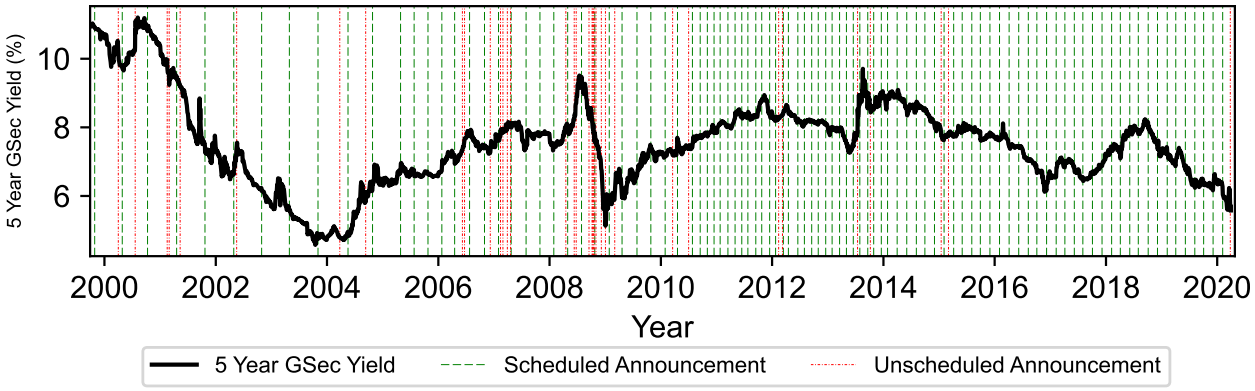
(c) Correlation with MIBOR-OIS surprises



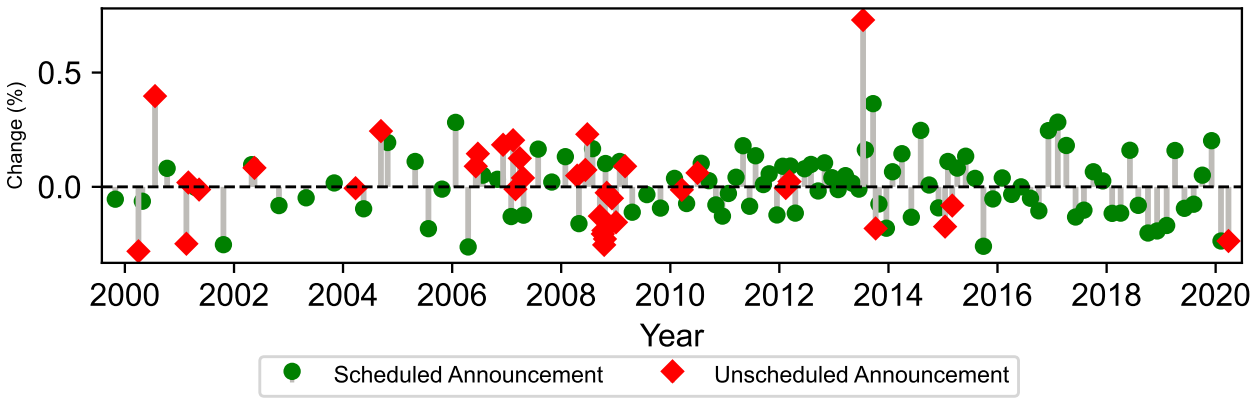
Notes: The first panel plots the time series of the 1-year government security (GSec) yield from August 1999 to March 2020. The second panel plots the two-day percentage change in the 1-year GSec yield on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change 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 A.8: 5-year government security (GSec) yield, August 1999 to March 2020

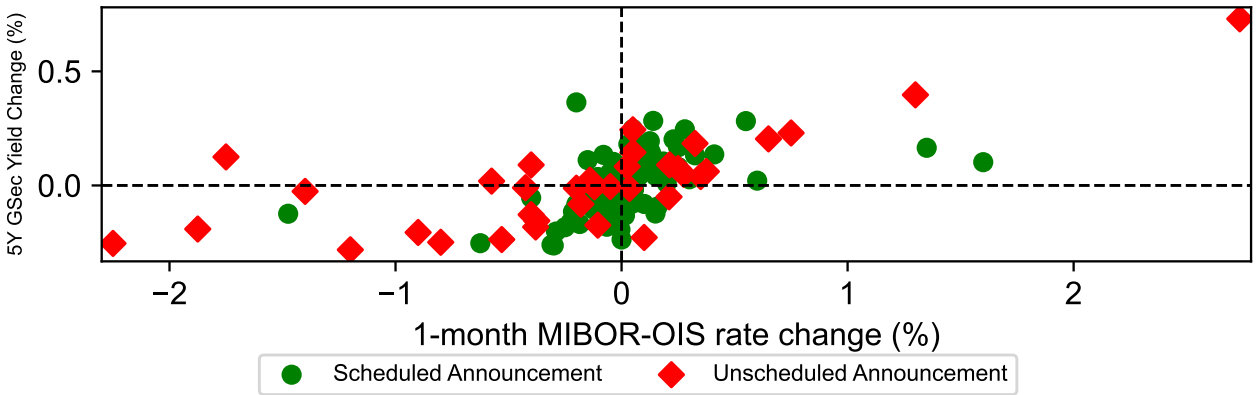
(a) Time series



(b) Changes on monetary policy announcement dates



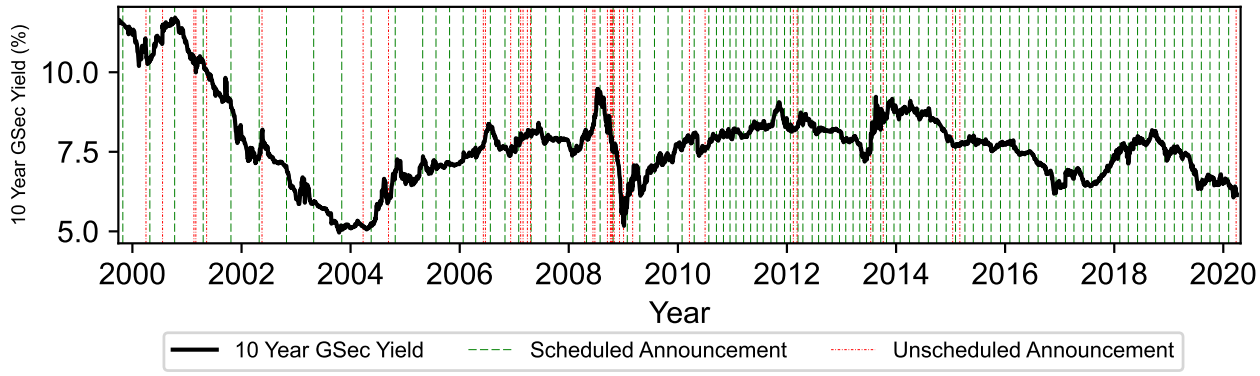
(c) Correlation with MIBOR-OIS surprises



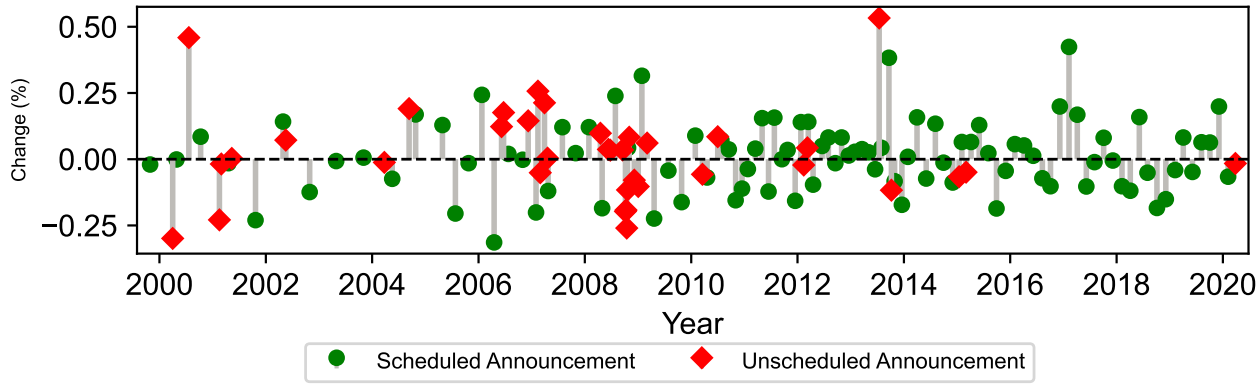
Notes: The first panel plots the time series of the 5-year government security (GSec) yield from August 1999 to March 2020. The second panel plots the two-day percentage change in the 5-year GSec yield on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change 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 A.9: 10-year government security (GSec) yield, August 1999 to March 2020

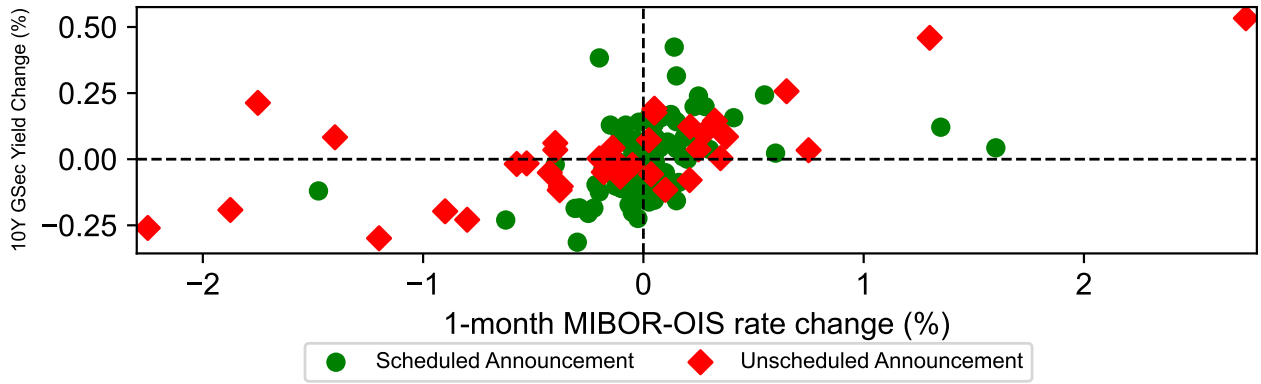
(a) Time series



(b) Changes on monetary policy announcement dates



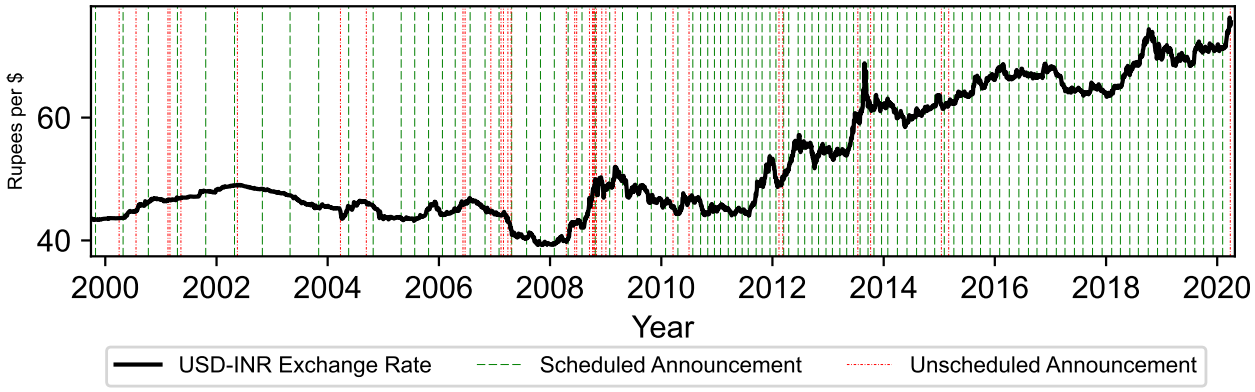
(c) Correlation with MIBOR-OIS surprises



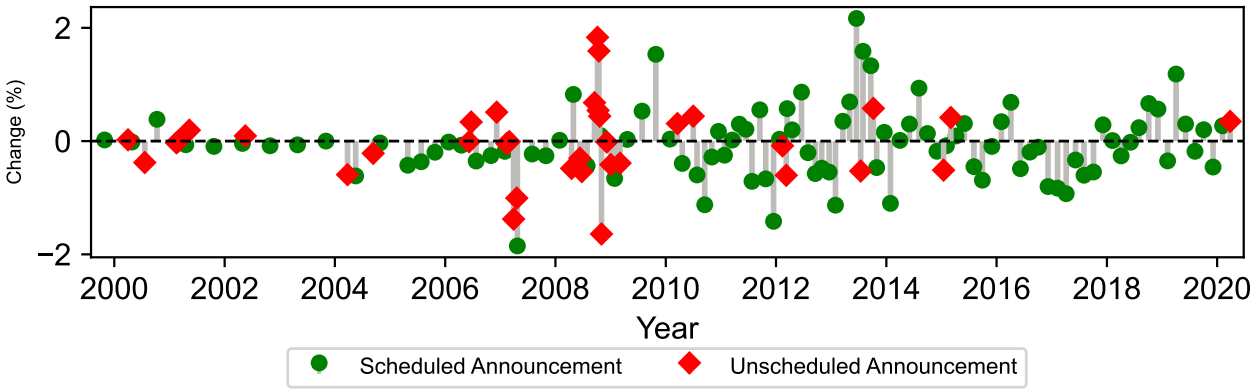
Notes: The first panel plots the time series of the 10-year government security (GSec) yield from August 1999 to March 2020. The second panel plots the two-day percentage change in the 10-year GSec yield on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change 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 A.10: USD-INR exchange rate, August 1999 to March 2020

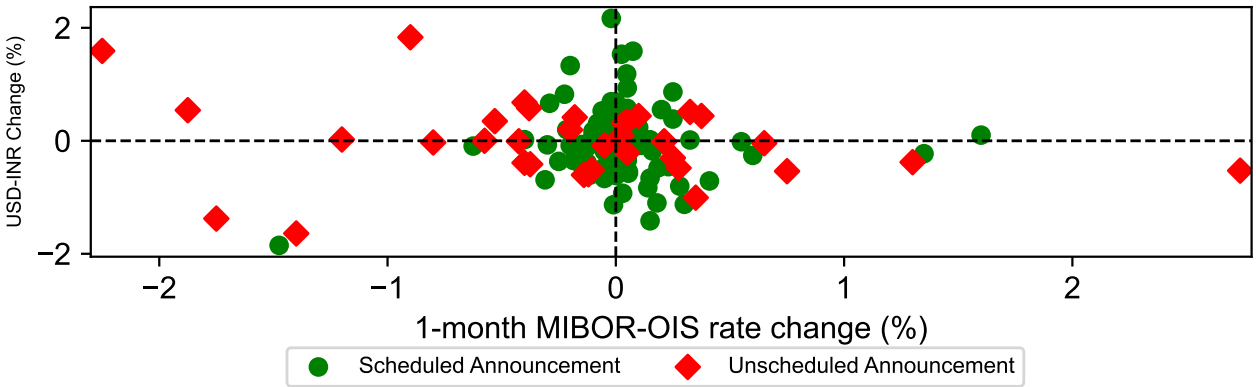
(a) Time series



(b) Changes on monetary policy announcement dates



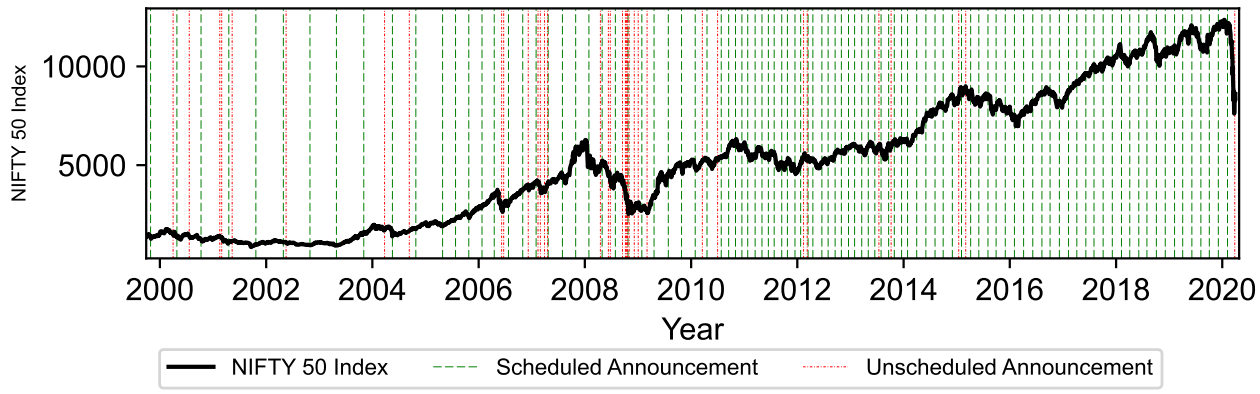
(c) Correlation with MIBOR-OIS surprises



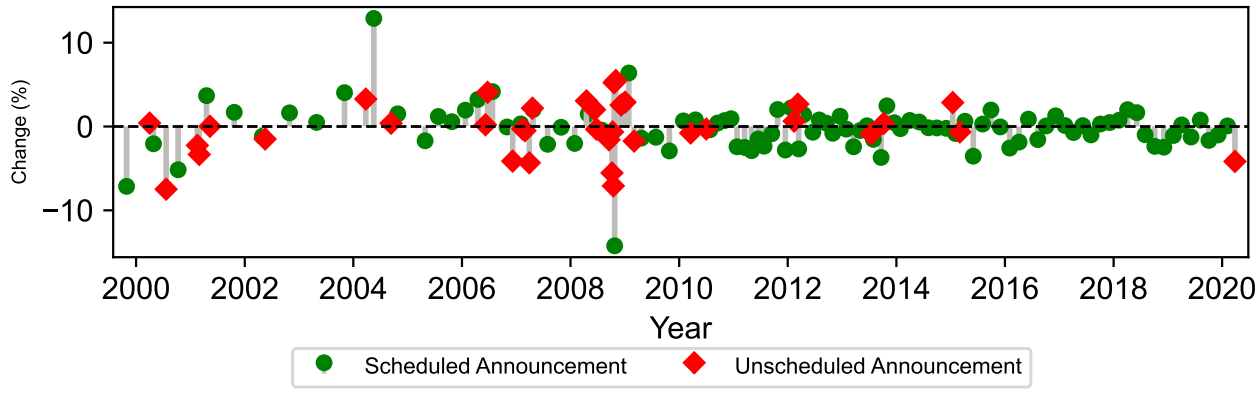
Notes: The first panel plots the time series of the USD-INR exchange rate from August 1999 to March 2020. The second panel plots the two-day percentage change in the USD-INR exchange rate on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the USD-INR 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 A.11: NSE NIFTY 50 Index, August 1999 to March 2020

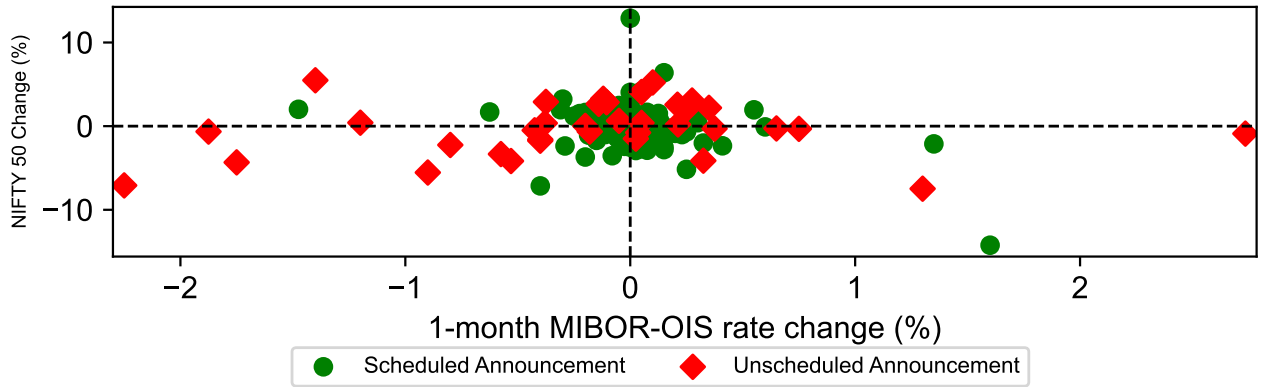
(a) Time series



(b) Changes on monetary policy announcement dates



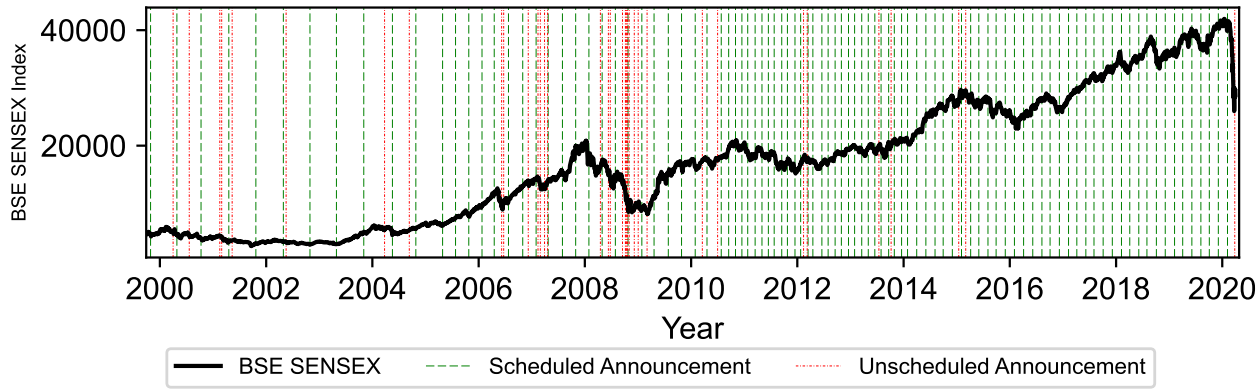
(c) Correlation with MIBOR-OIS surprises



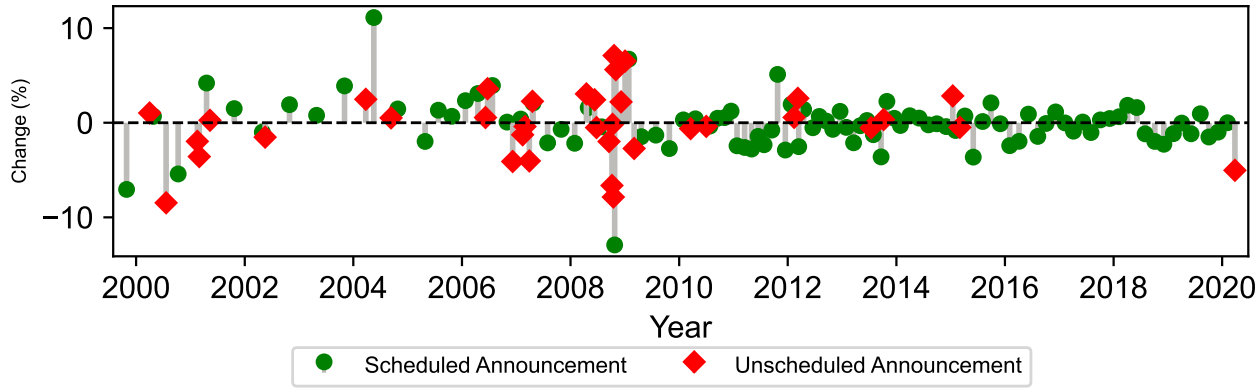
Notes: The first panel plots the time series of the NSE NIFTY 50 Index from August 1999 to March 2020. The second panel plots the two-day percentage change in the NSE NIFTY 50 Index on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the NSE NIFTY 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 A.12: BSE SENSEX Index, August 1999 to March 2020

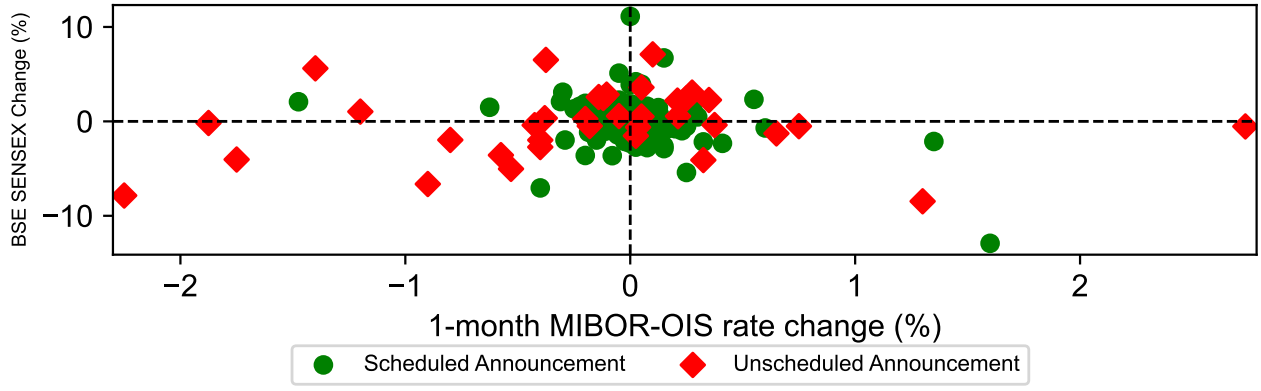
(a) Time series



(b) Changes on monetary policy announcement dates



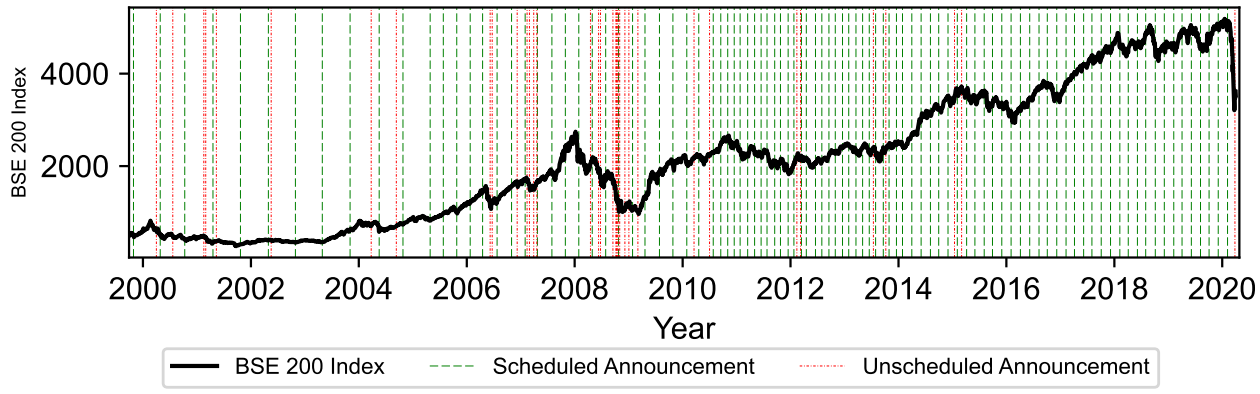
(c) Correlation with MIBOR-OIS surprises



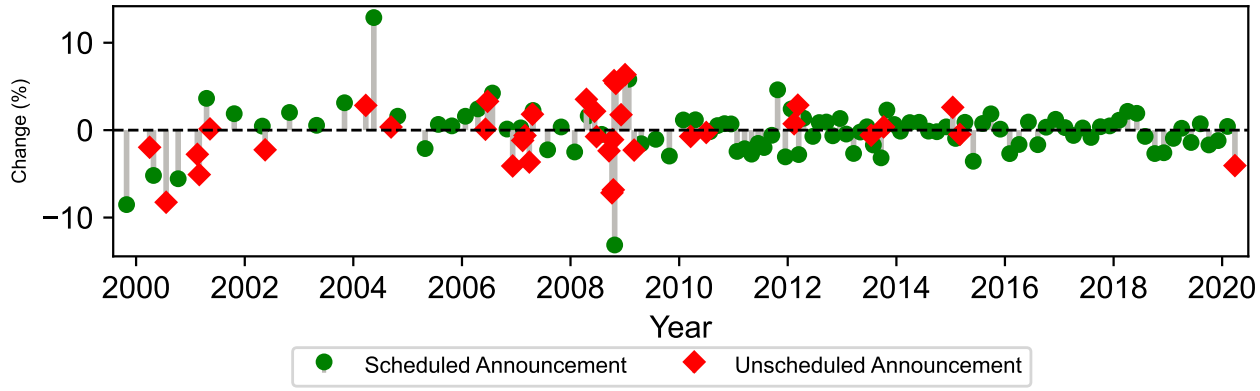
Notes: The first panel plots the time series of the BSE SENSEX Index from August 1999 to March 2020. The second panel plots the two-day percentage change in the BSE SENSEX Index on monetary policy announcement dates of the RBI. The third panel plots the two-day percentage change in the BSE SENSEX Index 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 A.13: BSE 200 Index, August 1999 to March 2020

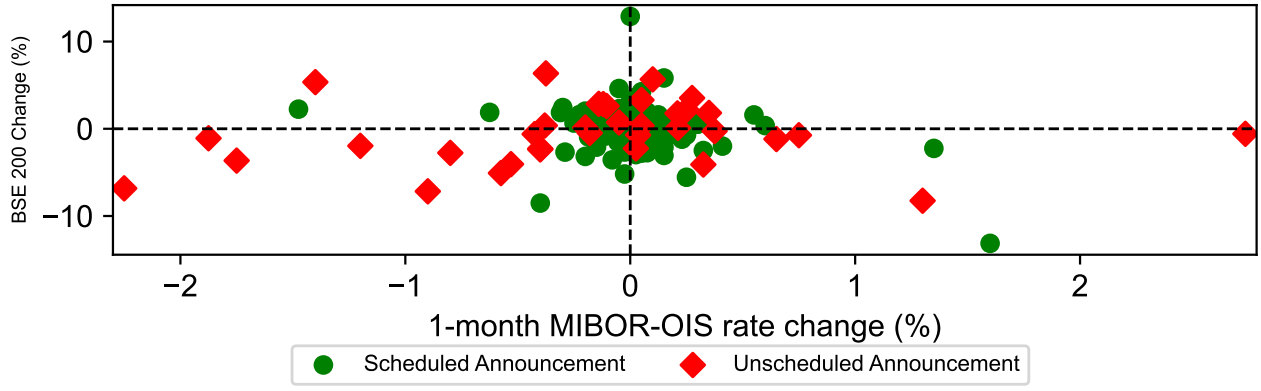
(a) Time series



(b) Changes on monetary policy announcement dates

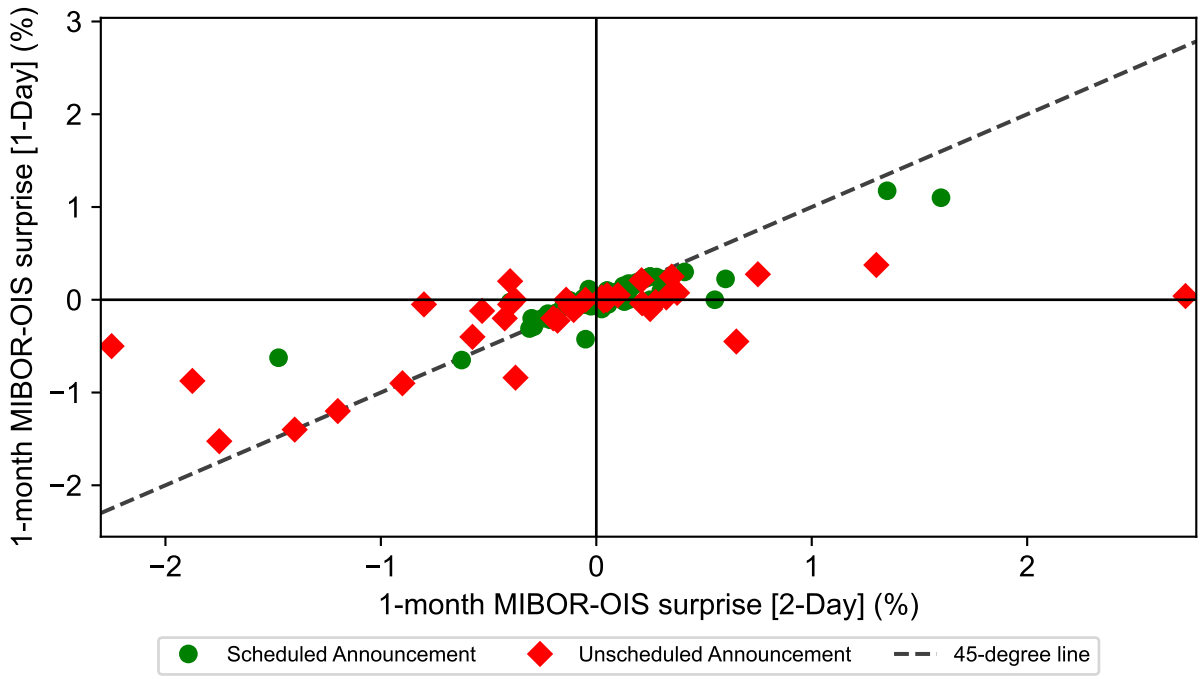


(c) Correlation with MIBOR-OIS surprises



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 A.14: 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.

A.7 Some additional results on measured monetary policy surprises

A.7.1 Monetary policy surprises using one-day window

Figure A.14 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. For monetary policy announcements which occurred on Saturday, the two-day window continues to be used to measure monetary policy surprises as it is not possible to compute one-day surprises for these announcements. There were six such instances of Saturday announcements 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 A.40. The mean of the absolute difference 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

Table A.40: 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	8	0.238	0.455	-0.925	-0.000	0.000	0.081	0.750
	2005 - 2009	19	0.399	0.608	-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. The *Mean* column shows the mean of the absolute difference between the one-day and two-day MIBOR-OIS surprises.

Table A.41: Correlation between MIBOR-OIS surprises using one-day and two-day windows

One-day MIBOR-OIS surprise	Pooled	Scheduled	Unscheduled
Intercept	–0.034*	–0.002	–0.152**
	(0.019)	(0.010)	(0.059)
Two-day MIBOR-OIS surprise	0.446***	0.646***	0.351***
	(0.107)	(0.077)	(0.112)
R^2	0.554	0.819	0.452
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 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.

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 A.41, 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 A.14 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 (2025) 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. As an example, on 15 July 2013, the RBI announced a significant and unanticipated increase in the MSF/Bank Rate by 200 basis points after market hours, while also announcing other measures to tighten liquidity to the financial system [http://bit.ly/4nqv35Z, accessed 25 October, 2025]. Using a one-day window in this case leads to a severe underestimation of the monetary policy surprise, which stands at 0.04% using a one-day window, while it is 2.735% using a two-day window.

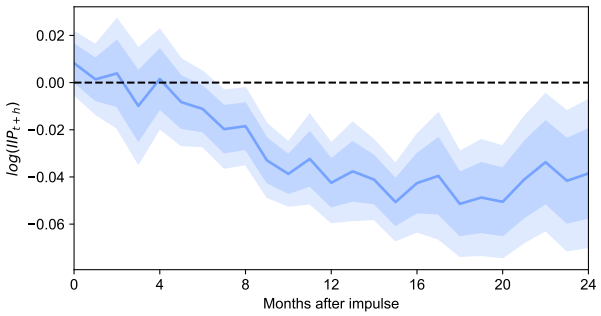
Figures A.15 and A.16 present the impulse response functions of the Index of Industrial Production (IIP) and Wholesale Price Index (WPI) inflation to monetary policy surprises measured using a one-day window. These IRFs are extremely similar on both scheduled and unscheduled announcement dates to Figures 1.7 and 1.8 in the paper, although on unscheduled announcement dates the initial increases in IIP are much smaller and statistically insignificant when using the one-day window. Moreover, the estimated magnitudes of the responses on both dates are larger compared to those using the two-day window. While the mismeasurement of monetary policy surprises using one-day windows on unscheduled announcement dates attenuates the initially positive response of IIP, the overall shape of the responses remain robust to using a one-day or two-day window. As with the two-day window, the responses in the pooled sample continue to be driven primarily by unscheduled announcement dates, suggesting that the power-identification tradeoff discussed in the paper is also robust to the choice of a one-day window.

A.7.2 Correlation of scheduled and unscheduled monetary policy surprises

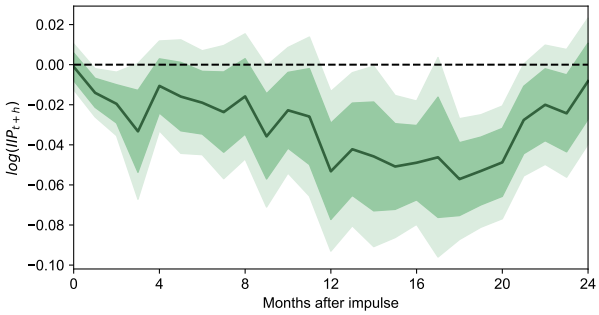
There is an emerging literature which suggests that temporal aggregation can bias the estimates of monetary policy transmission (Jacobson et al., 2024; Kilian, 2024). While estimating the effects of scheduled and unscheduled monetary surprises on lower frequency macroeconomic variables, it is important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

Figure A.15: Impulse Response Functions of IIP to Monetary Policy Surprises (1-day window)

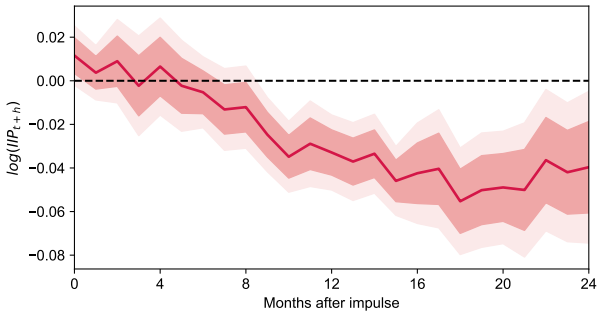
(a) All Dates



(b) Scheduled Dates



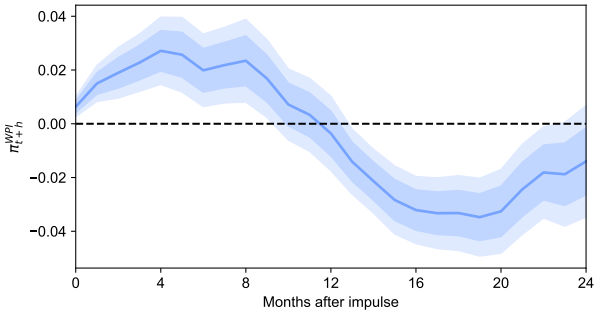
(c) Unscheduled Dates



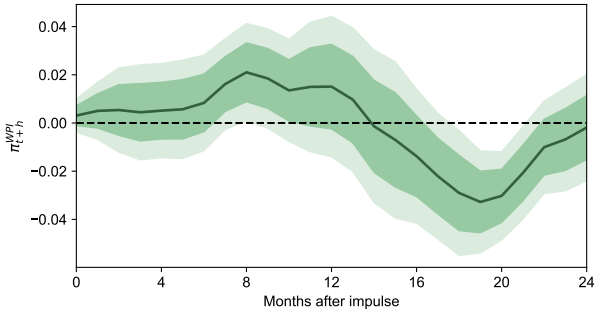
Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on all, scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the one-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 1.7. 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 A.16: Impulse Response Functions of WPI Inflation to Monetary Policy Surprises (1-day window)

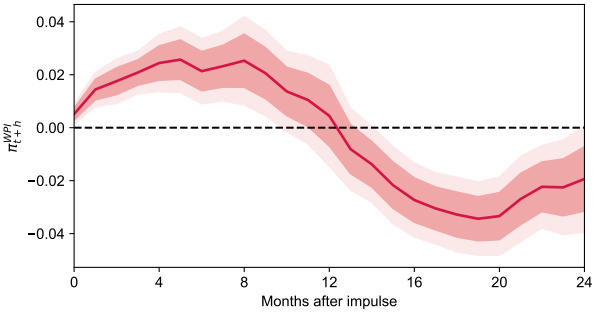
(a) All Dates



(b) Scheduled Dates

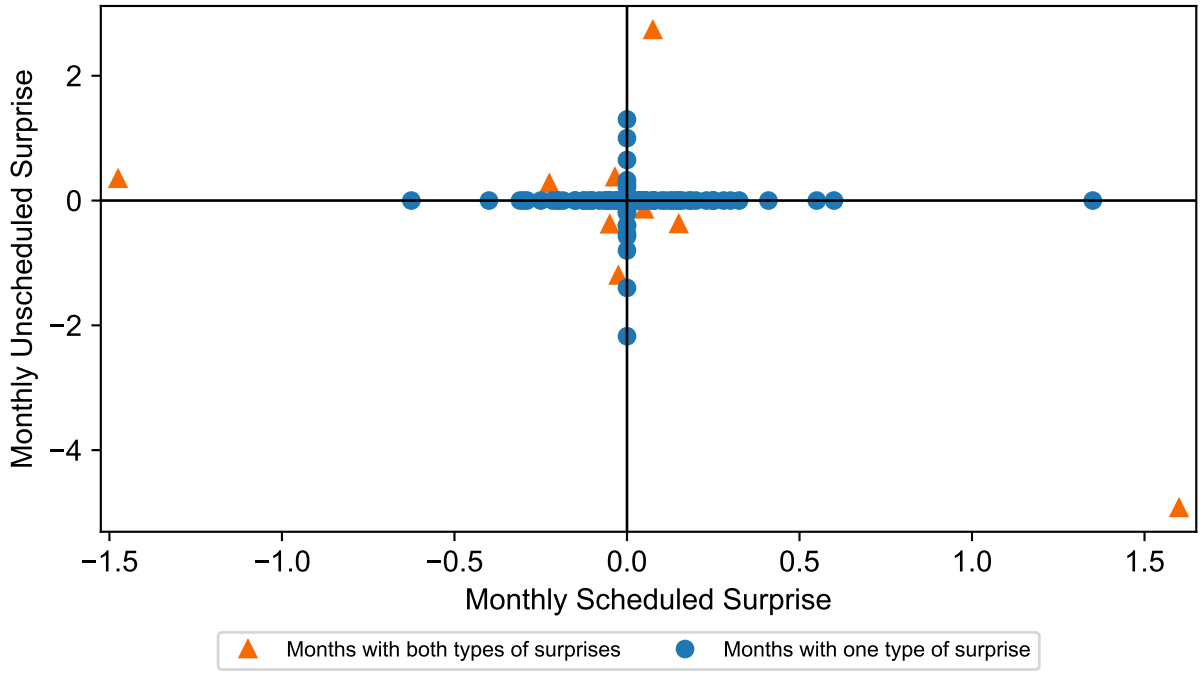


(c) Unscheduled Dates



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 all, 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 one-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 1.7. 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 A.17: 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.

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 monetary policy surprises separately without controlling for their correlation may lead to biased estimates.

Figure A.17 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 A.42. During these months, there appears to be an inverse relationship between the sign of the scheduled and unscheduled monetary policy 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 monetary policy surprises when estimating the effects of scheduled monetary policy surprises and vice versa.

Table A.42: 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

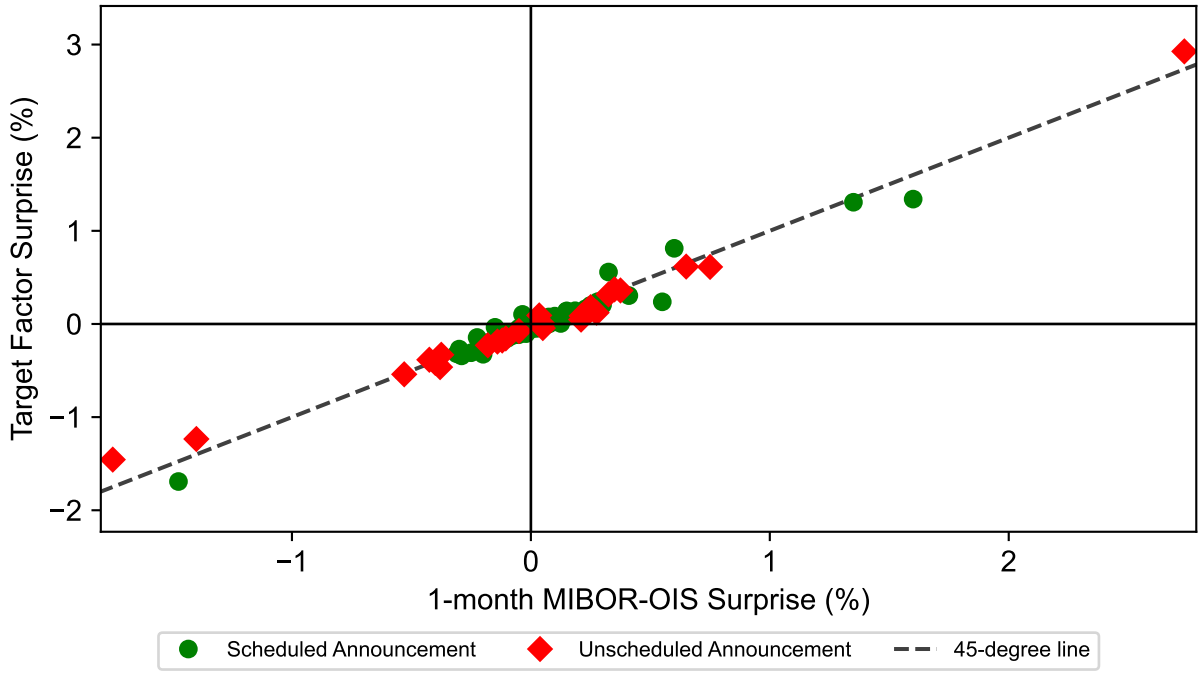
Notes: This table shows the months between August 1999 and March 2020 during which both scheduled and unscheduled monetary policy announcements were made by the RBI and the corresponding monetary policy surprises. The monetary policy surprises are measured as the two-day change in the 1-month MIBOR-OIS 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.

A.7.3 Comparison with Lakdawala and Sengupta (2025)

Figure A.18 compares the 1-month MIBOR-OIS monetary policy surprises to the Target Factor derived by Lakdawala and Sengupta (2025) 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).[5] While Lakdawala and Sengupta (2025)'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 monetary 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 correlation coefficient between the two measures is around 0.98, indicating a very high degree of similarity between the two series. 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 A.7.1.

[5] It is important to note that relative to the set of announcement dates of the RBI used in the present analysis, Lakdawala and Sengupta (2025) do not use information on monetary policy announcements during the Global Financial Crisis period in September and October 2008 and also do not consider an announcement date on 18th May 2004. The monetary policy surprises from these dates are not considered for the comparative analysis in this section.

Figure A.18: 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 (2025). 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 (2025). Data on announcement dates present in both samples between November 2003 and March 2020 is used to ensure consistency with the sample period of Lakdawala and Sengupta (2025).

A.8 Monetary Policy Surprises with sign restrictions

A.8.1 Jarocinski and Karadi (2020) sign restrictions

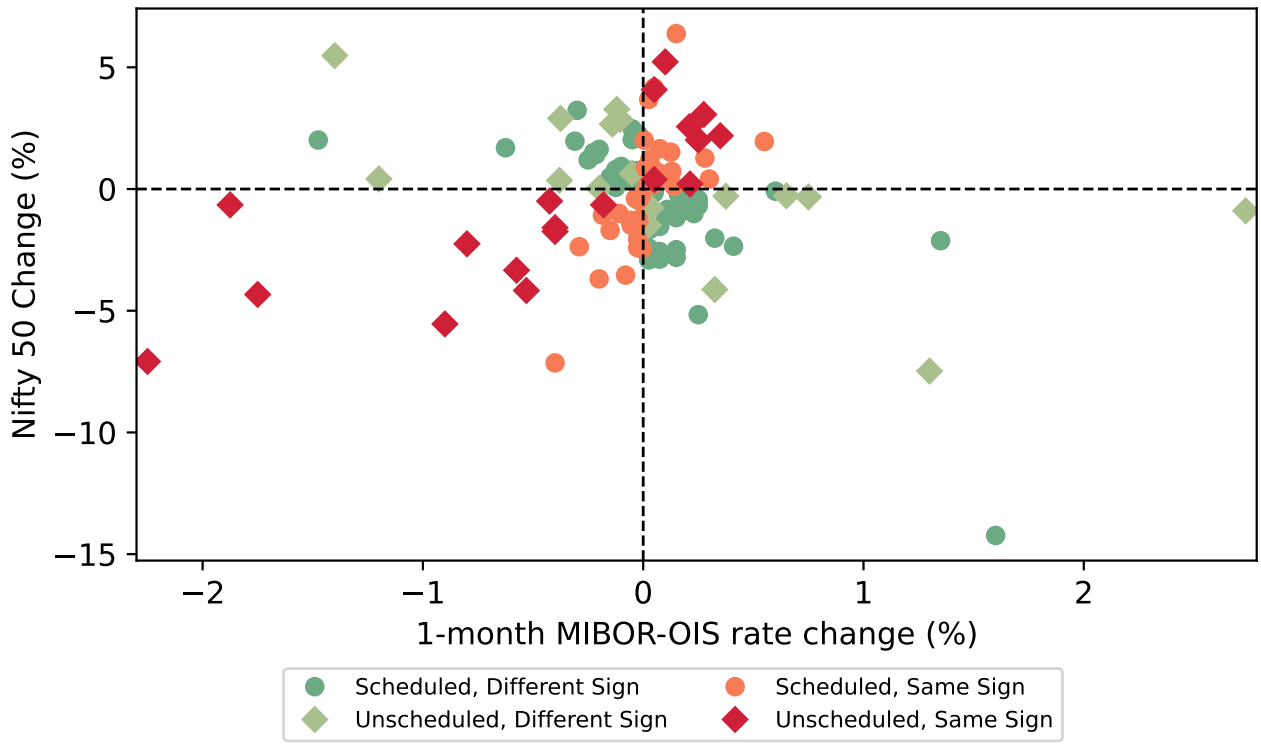
While the evidence presented in Section 1.4 suggests that an important reason behind the differences in the effects of measured monetary policy surprises on scheduled and unscheduled announcement dates is the differences in their predictability by contemporary and past macroeconomic data, another potential 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 A.19 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 occasions.

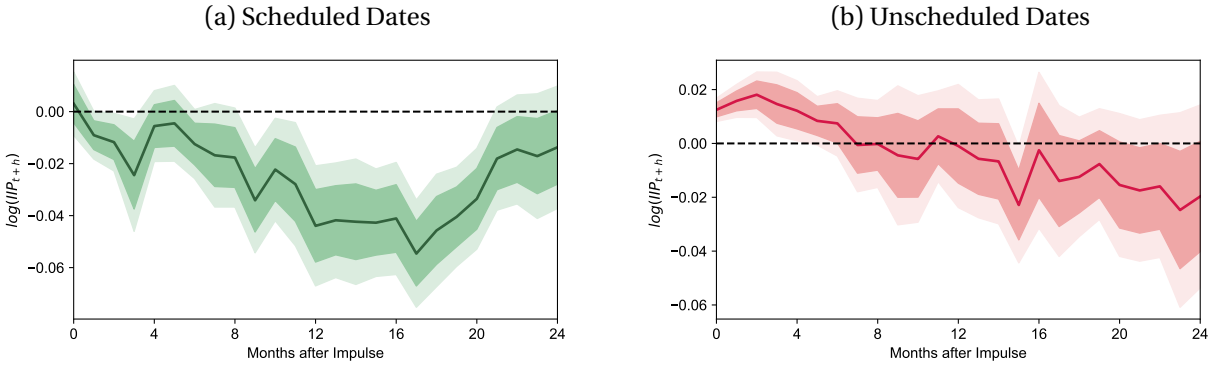
Out of the 93 scheduled announcement dates with a response in both variables, the NIFTY index and the

Figure A.19: 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. In the local projections specification, the measured monetary policy surprise of the other type is controlled for without imposing sign restrictions to control for the effects of all possible information contained in surprises of the other type.

Figure A.20: IRFs of Industrial Production to Monetary Policy Surprises (JK 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 1.7. 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.

1-month MIBOR-OIS fixed rate responded in opposing directions and satisfy the sign restriction on 55 occasions. 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 occasions.

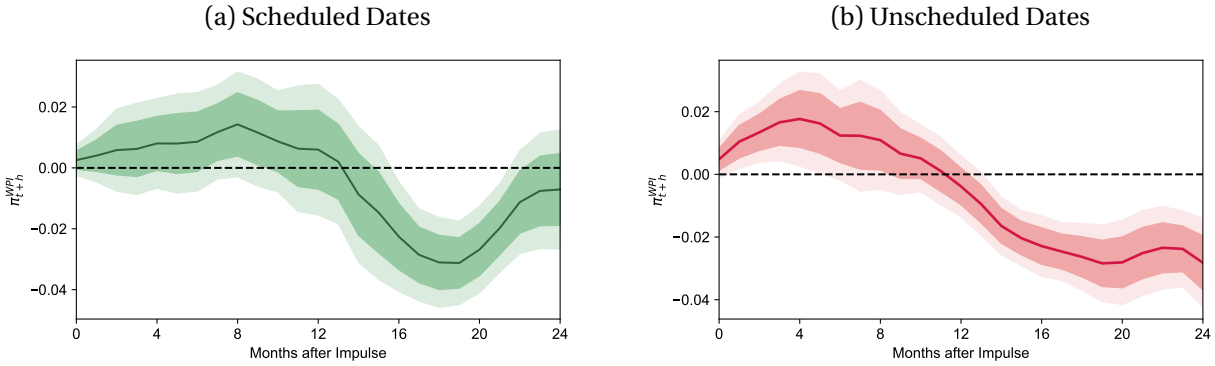
Figure A.20 considers the IRFs of the Index of Industrial Production (IIP) to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after imposing sign restrictions. Similarly, Figure A.21 considers the IRFs of Wholesale Price Index (WPI) Inflation to monetary policy surprises 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 1.7, 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.

A.8.2 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 revealed 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

Figure A.21: IRFs of Wholesale Price Index Inflation to Monetary Policy Surprises (JK 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 1.7. 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. In the local projections specification, the measured monetary policy surprise of the other type is controlled for without imposing sign restrictions to control for the effects of all possible information contained in surprises of the other type.

effects on economic activity in these economies.

Figure A.22 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.[6]

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

[6]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.

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 revelation 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 A.22 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 1.7.

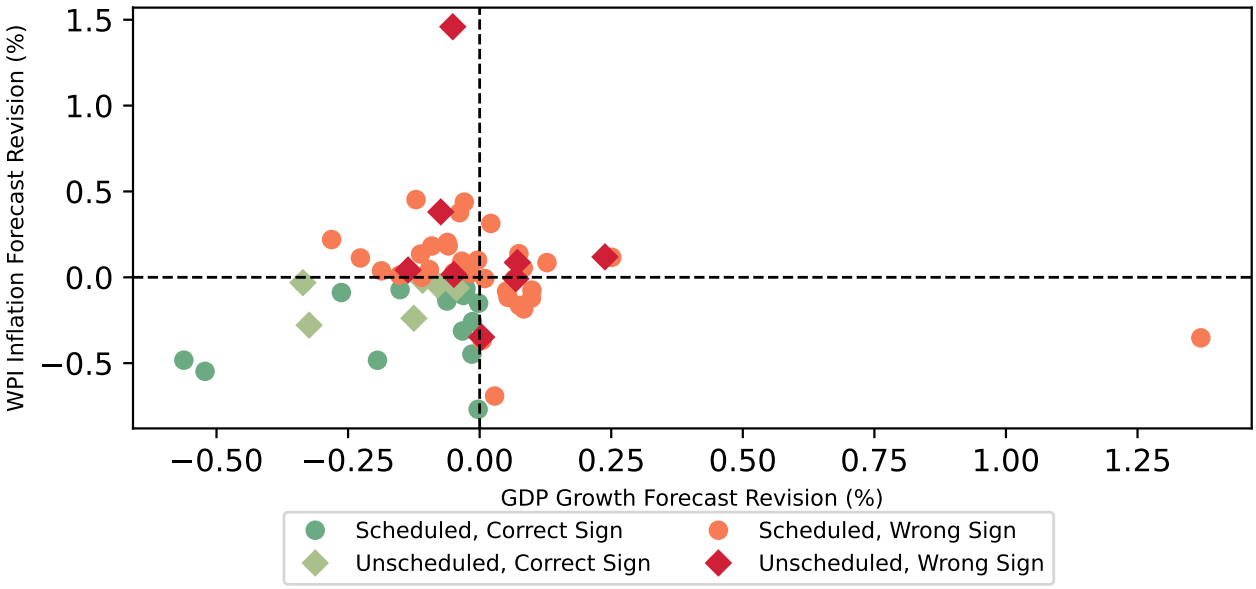
Figure A.23 considers the IRFs of the Index of Industrial Production (IIP) to monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after imposing sign restrictions using a procedure based on Acosta (2023). Even after imposing sign restrictions, there is significant heterogeneity in the effects of monetary policy surprises on IIP across scheduled and unscheduled announcement dates, mirroring the evidence presented in Section 1.7. 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 A.24 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 announcement 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.

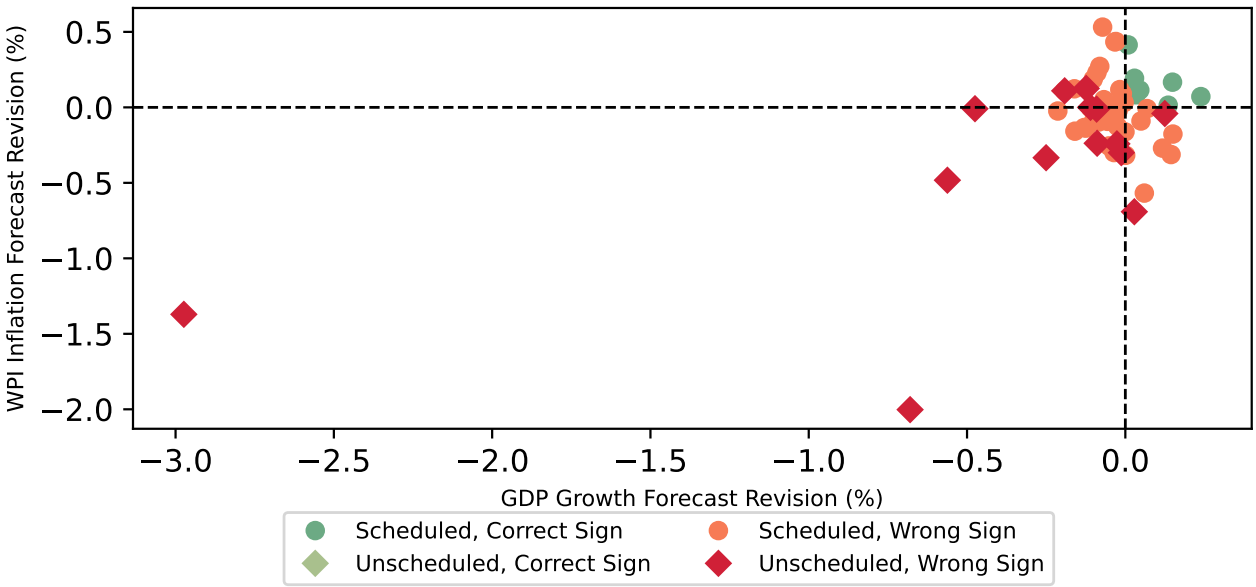
The results suggest that information about the economic outlook, including information about demand and supply shocks, do not seem to explain the differences in the impulse responses of key macroeconomic variables on scheduled and unscheduled announcement dates. Instead, endogeneity appears to be the most promising explanation of the differences in the effects of scheduled and unscheduled mone-

Figure A.22: Revisions of growth and inflation forecasts following monetary policy announcements

(a) Monetary policy tightening

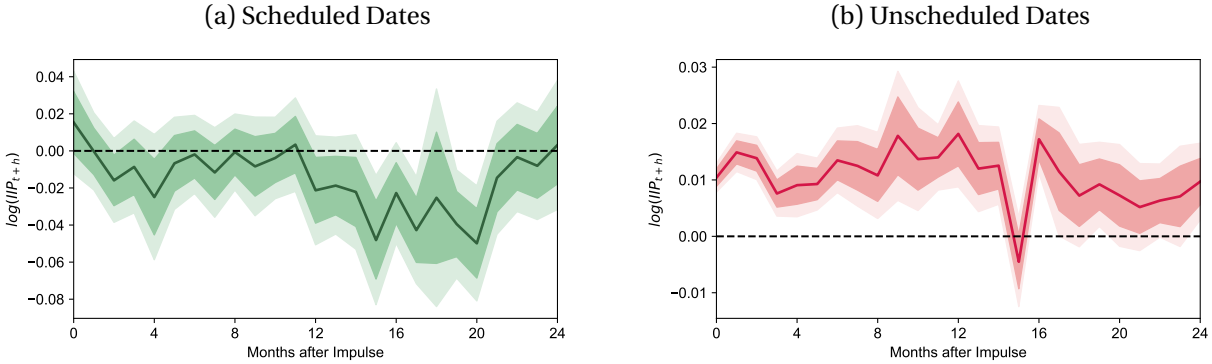


(b) Monetary policy easing



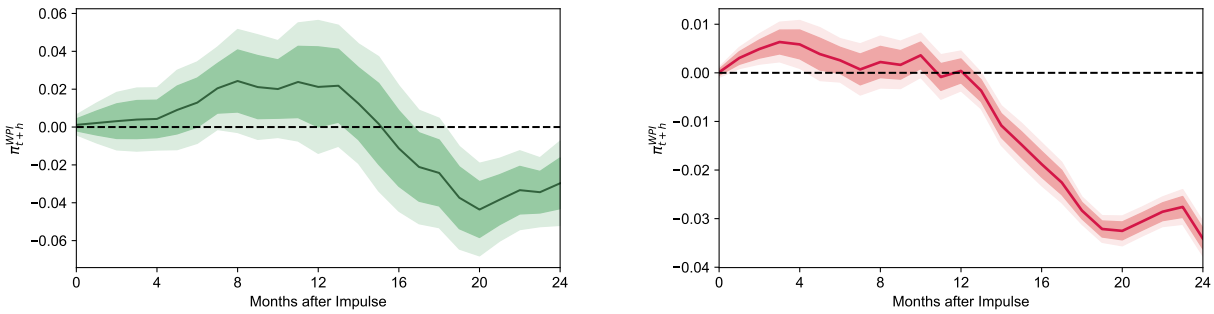
Notes: The upper and lower panels plots the revisions of real GDP growth and WPI inflation forecasts following monetary policy announcements of the RBI, separately for periods when the overall stance of monetary policy, as proxied by monetary policy surprises indicate a tightening and easing respectively. 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 A.23: 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 1.7. 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 the local projections specification, the measured monetary policy surprise of the other type is controlled for without imposing sign restrictions to control for the effects of all possible information contained in surprises of the other type.

Figure A.24: 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 1.7. 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 the local projections specification, the measured monetary policy surprise of the other type is controlled for without imposing sign restrictions to control for the effects of all possible information contained in surprises of the other type.

tary 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 1.7.

A.9 Robustness to outlier observations

A.9.1 Large surprises and surprises during the global financial crisis

This section considers the robustness of the key regression results in Sections 1.4, 1.5 and 1.6 as well as the IRFs in Section 1.7 to the exclusion of large surprises and monetary policy surprises during the Global Financial Crisis (April 2007 to March 2009). Large surprises are defined here as being measured or aggregated surprises less than 1 in absolute value.

Large surprises on unscheduled announcement dates and their reasons were already outlined in Table 1.1. There were 7 instances of large surprises on unscheduled announcement dates during the sample period and they typically occurred during periods of heightened macroeconomic uncertainty or in response to unforeseen macroeconomic developments. Furthermore, 3 of the 7 large surprises on unscheduled announcement dates occurred during the period of the Global Financial Crisis (April 2007 to March 2009). In addition, there were 10 further instances of unscheduled monetary policy announcements during the financial crisis period.

On scheduled announcement dates, there were 3 instances of measured monetary policy surprises greater than 1 in absolute value. The first of these instances was on 24th April 2007, when the RBI decided to keep key interest rates unchanged despite a widespread expectation that it would raise interest rates due to high inflation (The Times of India, 2007b). In addition, there was also an expectation that the RBI would increase risk weights on bank lending to key sectors of the economy, but there was actually a surprise cut in risk weights for lending to many key sectors. These measures resulted in a measured monetary policy surprise of -1.475.

The second instance was on 31st July 2007, when contrary to market expectations of no change in policy rates, the RBI increased the CRR by 50 basis points (The Times of India, 2007a). In addition, there were operational changes to the Liquidity Adjustment Facility that removed the second LAF auction that was typically conducted later in the day. These measures resulted in a measured monetary policy surprise of 1.35.

Finally, on 24th October 2008, the RBI again kept key interest rates unchanged despite widespread expectations of a rate cut due to the global financial crisis (The Times of India, 2008). This resulted in a measured monetary policy surprise of 1.6. These instances seem particularly helpful in understanding the causal effects on monetary policy and are mainly excluded from the sample here to test if the heterogeneity in the effects of monetary policy surprises on the Indian economy is robust to the exclusion of these large surprises. In addition, they highlight that announcements about administrative changes to monetary policy implementation and prudential regulations can also be important sources of exogenous variation to overnight interest rates which can be used to identify the causal effects of monetary policy. There were 5 further instances of scheduled monetary policy announcements during the Global Financial Crisis period which are also excluded from the sample.

Sources of monetary policy surprises

A key source of the heterogeneity in the effects of monetary policy on scheduled and unscheduled announcement dates is due to differences in their endogeneity to past macroeconomic data. To test if this result is robust, the regressions to produce Table 1.4 are first repeated while excluding measured surprises greater than or equal to 1 in absolute value as well as monetary policy surprises during the Global Financial Crisis period (April 2007 to March 2009).

Table A.43 suggests that the results in Table 1.4 are robust to the exclusion of large measured surprises and monetary policy surprises during the Global Financial Crisis period. Monetary policy surprises on unscheduled announcement dates continue to remain endogenous to past macroeconomic conditions while there is no evidence for endogeneity of monetary policy surprises on scheduled announcement dates. The results in Table A.44 also provide evidence in favour of the endogeneity of monetary policy surprise on unscheduled announcement dates to prevailing forecasts of key macroeconomic variables.

Event study regressions

For the event study specifications, monetary policy announcement dates where the measured monetary policy surprise is less than or equal to -1 or greater than or equal to 1 as well as the monetary announcements which occur during the financial crisis period are excluded from the sample while estimating the event study specification in Section 1.5.

Tables A.45 and A.46 present the results of the event study regressions for financial market variables on scheduled and unscheduled announcement dates of the RBI after excluding large surprises and monetary policy surprises during the Global Financial Crisis period. The results are consistent with the evidence in Section 1.5 and suggest that the heterogeneity in the effects of monetary policy surprises on the Indian economy is robust to the exclusion of large surprises and monetary policy surprises during the Global Financial Crisis period. However, the estimated effects of monetary policy surprises on scheduled announcement dates on stock market variables are much weaker and not statistically significant after excluding large surprises and monetary policy surprises during the Global Financial Crisis period.

Consensus forecast regressions

Next, the robustness of the consensus forecast regressions in Section 1.6 to the exclusion of large surprises and monetary policy surprises during the Global Financial Crisis period is tested. Large surprises are now defined as being monthly aggregated surprises less than or equal to -1 or greater than or equal to 1.

Tables A.47 and A.48 confirm that the heterogeneity in the effects of monetary policy on consensus forecast revisions on scheduled and unscheduled announcement dates, shown in Tables A.6 and A.7, are robust to the exclusion of large surprises and monetary policy surprises during the Global Financial Crisis period. On scheduled announcement dates, tighter interest rates lead to downward revisions in the forecasts for output and investment growth in the current financial year as well as investment growth in the next financial year. On unscheduled announcement dates, tighter interest rates lead to upward revisions in the forecasts for output growth and investment growth in the current financial year and WPI inflation in the next financial year.

Table A.43: Predictability of Monetary Policy Surprises by Macroeconomic Data (Excluding Large and GFC Surprises)

	Pooled	Scheduled	Unscheduled
Intercept	0.004	0.042	–0.330
	(0.029)	(0.025)	(0.220)
Δln (IIP) (2m)	–1.373	–1.656*	3.771
	(1.054)	(0.833)	(6.332)
Δln (WPI) (2m)	1.616	0.121	3.439
	(1.374)	(1.306)	(2.967)
Drought (2m)	0.008	0.011	–0.025
	(0.010)	(0.011)	(0.067)
Excess Rain (2m)	0.004	–0.002	0.504
	(0.008)	(0.007)	(0.323)
Δ (10Y-1Y GSec Spread) (2m)	–0.143***	–0.099*	–0.491**
	(0.053)	(0.053)	(0.188)
Δln (*SENSEX*) (2m)	0.381	0.243	0.334
	(0.292)	(0.252)	(0.962)
Δln (*USD – INR*) (2m)	–0.658	–0.717	–0.010
	(0.708)	(0.698)	(4.374)
F-statistic	1.895	1.486	3.465
p-value	0.078	0.184	0.033
R^2	0.109	0.144	0.373
N	108	89	19

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 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. Monetary policy announcement dates during which the measured monetary policy surprise is less than or equal to -1 or greater than or equal to 1 and monetary policy announcement dates during the global financial crisis period (April 2007 to March 2009) are excluded from the analysis. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Δln (IIP) is calculated as the 2-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, online archives of PIB and MoSPI of the Government of India 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 2-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, online archives of PIB and Office of Economic Advisor to DPIIT of the Government of India and for months when 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 two months (in 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 two-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 two-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 42-trading 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 42-trading 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 42-trading 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 slope coefficients being zero is reported.

Table A.44: Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (Excluding Large and GFC Surprises)

	Pooled	Scheduled	Unscheduled
Intercept	–0.454**	–0.094	–1.703***
	(0.216)	(0.219)	(0.513)
Current FY Growth Forecast	0.005	–0.014	0.046
	(0.052)	(0.055)	(0.083)
Next FY Growth Forecast	0.062	0.036	0.258***
	(0.068)	(0.075)	(0.074)
Current FY WPI Inflation Forecast	0.015	0.023*	0.004
	(0.012)	(0.013)	(0.025)
Next FY WPI Inflation Forecast	–0.021	–0.035	–0.102*
	(0.027)	(0.028)	(0.052)
F-statistic	1.924	1.334	3.638
p-value	0.112	0.264	0.034
R^2	0.075	0.041	0.460
N	107	89	18

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 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. Monetary policy announcement dates during which the measured monetary policy surprise is less than or equal to -1 or greater than or equal to 1 and monetary policy announcement dates during the global financial crisis period (April 2007 to March 2009) are excluded from the analysis. 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 slope 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.

Table A.45: Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates (Excluding Large and GFC Surprises)

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	–0.019*	0.573***	89	0.440
	(0.011)	(0.065)		
Δ (5-Year GSec Yield)	–0.001	0.455***	89	0.321
	(0.012)	(0.068)		
Δ (10-Year GSec Yield)	0.002	0.393***	89	0.250
	(0.012)	(0.071)		
Δ (NIFTY)	–0.110	–0.587	89	0.002
	(0.253)	(1.792)		
Δ (SENSEX)	–0.064	–0.639	89	0.002
	(0.246)	(1.806)		
Δ (BSE200)	–0.067	–0.172	89	0.000
	(0.270)	(1.941)		
Δ (USD/INR)	–0.022	–0.398	89	0.012
	(0.064)	(0.343)		

* 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. Monetary policy announcement dates during which the measured monetary policy surprise is less than or equal to -1 or greater than or equal to 1 and monetary policy announcement dates during the global financial crisis period (April 2007 to March 2009) are excluded from the analysis. 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 A.46: Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates (Excluding Large and GFC Surprises)

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	0.027	0.465***	19	0.667
	(0.027)	(0.099)		
Δ (5-Year GSec Yield)	0.033	0.304***	19	0.571
	(0.021)	(0.056)		
Δ (10-Year GSec Yield)	0.050***	0.272***	19	0.661
	(0.016)	(0.041)		
Δ (NIFTY)	–0.042	1.455	19	0.049
	(0.565)	(1.421)		
Δ (SENSEX)	–0.181	1.252	19	0.036
	(0.560)	(1.570)		
Δ (BSE200)	–0.284	1.585	19	0.054
	(0.575)	(1.613)		
Δ (USD/INR)	0.065	0.067	19	0.004
	(0.086)	(0.165)		

* 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. Monetary policy announcement dates during which the measured monetary policy surprise is less than or equal to -1 or greater than or equal to 1 and monetary policy announcement dates during the global financial crisis period (April 2007 to March 2009) are excluded from the analysis. 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.

Table A.47: Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (Excluding Large and GFC Surprises)

	Intercept	Monetary Surprise	N	R^2
Δ (Current FY Output Growth)	–0.039**	–0.512***	80	0.126
	(0.015)	(0.144)		
Δ (Current FY Investment Growth)	–0.214***	–1.261**	80	0.055
	(0.058)	(0.499)		
Δ (Current FY WPI Inflation)	–0.009	0.466	80	0.022
	(0.034)	(0.354)		
Δ (Next FY Output Growth)	–0.016	–0.048	89	0.002
	(0.020)	(0.095)		
Δ (Next FY Investment Growth)	–0.100**	–0.808***	89	0.082
	(0.048)	(0.289)		
Δ (Next FY WPI Inflation)	–0.026	–0.002	89	0.000
	(0.027)	(0.145)		

* 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 monthly sums of scheduled monetary policy surprises between two forecast surveys greater than or equal to 1 in absolute value as well as monetary policy surprises which occur between forecast surveys in March 2007 and March 2009 are excluded from the analysis. All remaining scheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy 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.

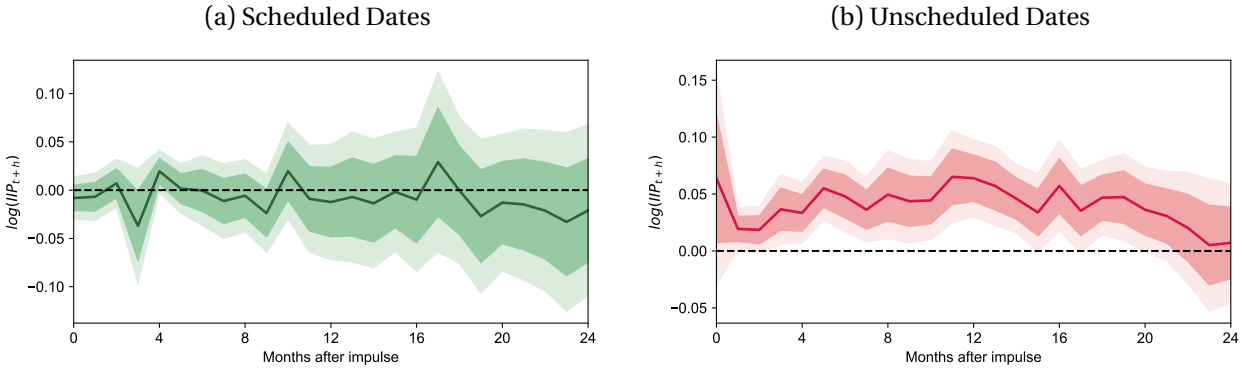
Table A.48: Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements (Excluding Large and GFC Surprises)

	Intercept	**Monetary Surprise**	**N**	**R^2**
Δ (Current FY Output Growth)	–0.034	0.584*	12	0.265
	(0.040)	(0.285)		
Δ (Current FY Investment Growth)	–0.423***	1.947**	12	0.337
	(0.129)	(0.742)		
Δ (Current FY WPI Inflation)	–0.005	0.648	12	0.131
	(0.077)	(0.383)		
Δ (Next FY Output Growth)	–0.187	1.926	15	0.367
	(0.147)	(1.269)		
Δ (Next FY Investment Growth)	–0.486	3.124	15	0.247
	(0.320)	(2.691)		
Δ (Next FY WPI Inflation)	–0.136	1.181**	15	0.469
	(0.077)	(0.475)		

* 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 monthly sums of unscheduled monetary policy surprises between two consecutive forecast surveys greater than or equal to 1 in absolute value as well as monetary policy surprises between forecast surveys in March 2007 and March 2009 are excluded from the analysis. All remaining unscheduled monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of scheduled monetary policy 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. Consensus forecast revisions for the current financial year from March to April are unavailable and hence are not included in the analysis.

Figure A.25: 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 1.7. 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 or equal to 1, less than or equal to -1 and surprises which occur between April 2007 and March 2009.

IRFs of macroeconomic variables

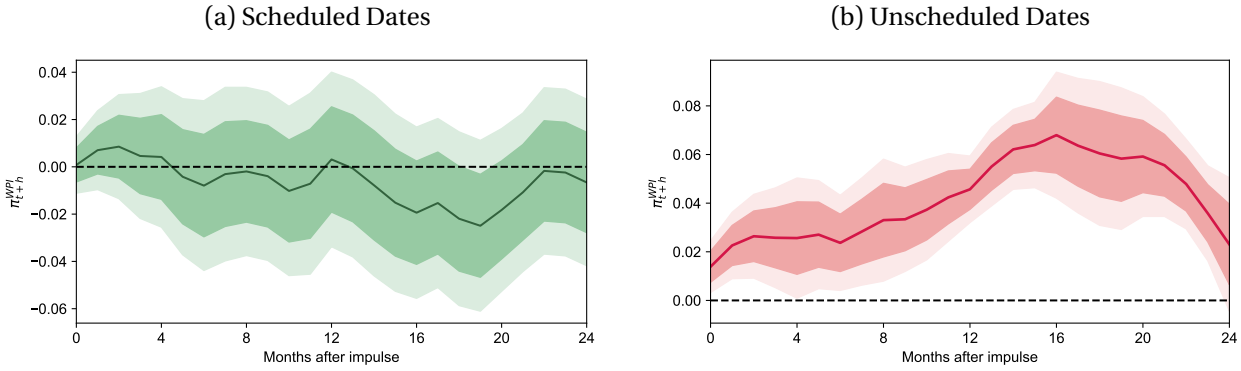
For the IRF estimations, monthly aggregate surprises less than or equal to -1 or greater than or equal to 1 are excluded from the sample along with months during the financial crisis period. This is implemented in practice by including dummy variables for each monthly observation satisfying the above conditions in the regression specification outlined in Section 1.7.

Figure A.25 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 A.26 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 1.7 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 or the Global Financial Crisis.

An important concern with the estimated effects of monetary policy surprises on output and inflation on scheduled announcement dates is that the statistical power to identify the effects of monetary policy appear to come mainly from monetary policy surprises in the 2007-2009 period. Since external demand shocks during the Global Financial Crisis period may have also been responsible for the changes in output and inflation during this period, the effects of contractionary monetary policy surprises in particular may be biased in the direction of suggesting much stronger effects of monetary policy on output and in-

Figure A.26: 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 1.7. 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 or equal to 1, less than or equal to -1 and surprises which occur between April 2007 and March 2009.

flation than are actually present. In order to test the robustness of the results to this concern, the IRFs are estimated on scheduled announcements dates while excluding only the contractionary monetary policy surprises during the Global Financial Crisis period or greater than 1. While the effects of monetary policy surprise easings during this period are going to be attenuated as a result of the negative demand shocks during the financial crisis, they will still provide a useful lower bound on the effects of monetary policy on output and inflation.

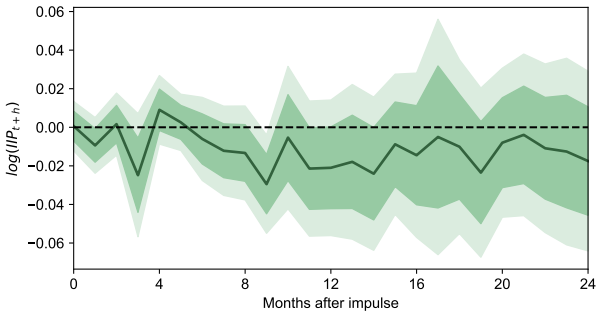
Figure A.27 considers the IRFs of the Index of Industrial Production (IIP) and Wholesale Price Index (WPI) Inflation to monetary policy surprises on scheduled announcement dates of the RBI after excluding contractionary monetary policy surprises during the Global Financial Crisis period or greater than 1. The results suggest that the effects of contractionary monetary policy surprises on output and inflation on scheduled announcement dates are not driven by the presence of large surprises or the Global Financial Crisis. The response of IIP in particular is estimated with much less precision when the contractionary monetary policy surprises during the Global Financial Crisis period are excluded from the analysis. However, the magnitude of the response of IIP to contractionary monetary policy surprises on scheduled announcement dates is still very similar to the results in Section 1.7. For WPI inflation, not only are the magnitudes of the responses similar to the results in Section 1.7, but the responses also continue to remain statistically significant at conventional levels of significance.

A.9.2 Surprises which coincide with FOMC announcements

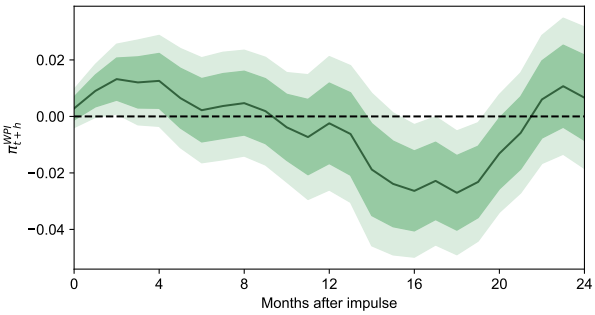
This section considers the robustness of the results in the paper to controlling for the effects of monetary policy surprises of the Federal Open Market Committee (FOMC) of the United States. The effects of US monetary policy may potentially have large effects on capital flows and demand for Indian goods and services and it is important to ensure that the effects of RBI monetary policy are not being attributed

Figure A.27: IRFs of IIP and WPI Inflation to Monetary Policy Surprises (Tightening Outlier Robustness)

(a) Industrial Production



(b) WPI Inflation



Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) and Wholesale Price Index (WPI) Inflation to a 100-basis point contractionary monetary policy surprise on scheduled announcement dates of the RBI. The dependent variables are respectively the logarithm of the IIP and 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 1.7. 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 or equal to 1 and surprises greater than 0 which occur between April 2007 and March 2009.

to changing US monetary policy. The monetary policy surprises of the FOMC along with the associated announcement dates are obtained from Bauer and Swanson (2023b).

Sources of monetary policy surprises

The robustness of the results presented in Section 1.4 to the exclusion of FOMC monetary policy surprises is first considered. All monetary policy announcements of the RBI during whose two-day windows there is a FOMC announcement are excluded from the analysis. There were 19 such instances between August 1999 and March 2020, documented in Table A.26. Out of these, 16 were scheduled and 3 were unscheduled announcements.

Table A.49 presents the results of the regressions of monetary policy surprises on macroeconomic variables on all, scheduled and unscheduled monetary policy announcement dates of the RBI after excluding the RBI monetary policy announcements coinciding with FOMC announcements. The results are very similar to the main results in Section 1.4 and suggest that while unscheduled monetary policy surprises are endogenous to past macroeconomic condiitons in India, this is not the case for scheduled monetary policy surprises.

Similarly, Table A.50 presents the results of the regressions of monetary policy surprises on consensus forecasts of output growth and inflation after excluding RBI monetary policy announcements which coincide with FOMC announcements. Like Table 1.5, the results do not suggest any endogeneity of scheduled or unscheduled monetary policy surprises to past forecasts of output growth and inflation.

Table A.49: Predictability of Monetary Policy Surprises by Macroeconomic Data (Excluding FOMC overlapping surprises)

	Pooled	Scheduled	Unscheduled
Intercept	–0.079	0.081	–0.629***
	(0.068)	(0.061)	(0.198)
Δln (IIP) (2m)	2.251	0.514	9.414*
	(1.901)	(1.861)	(4.982)
Δln (WPI) (2m)	3.543	–0.536	4.773
	(2.602)	(2.532)	(3.823)
Drought (2m)	0.018	0.031*	–0.092
	(0.017)	(0.016)	(0.098)
Excess Rain (2m)	0.041	–0.026	0.692***
	(0.047)	(0.017)	(0.110)
Δ (10Y-1Y GSec Spread) (2m)	0.108	0.155	0.157
	(0.166)	(0.171)	(0.282)
Δln (*SENSEX*) (2m)	1.504**	–0.043	1.109
	(0.713)	(0.747)	(1.096)
Δln (*USD – INR*) (2m)	3.135	3.127	1.839
	(2.986)	(2.137)	(5.182)
F-statistic	1.326	0.773	21.499
p-value	0.245	0.611	0.000
R^2	0.098	0.155	0.628
N	114	81	33

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 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. RBI monetary policy announcement dates around whose two-day windows there is also an FOMC announcement are excluded from the analysis. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Δln (IIP) is calculated as the 2-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, online archives of PIB and MoSPI of the Government of India 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 2-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, online archives of PIB and Office of Economic Advisor to DPIIT of the Government of India and for months when 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 two months (in 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 two-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 two-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 42-trading 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 42-trading 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 42-trading 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 FOMC announcement dates are sourced from Bauer and Swanson (2023b) and https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm. The F-statistic and p-value corresponding to a joint test of the significance of all slope coefficients being zero is reported.

Table A.50: Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (Excluding FOMC overlapping surprises)

	Pooled	Scheduled	Unscheduled
Intercept	–0.589**	–0.084	–0.245
	(0.271)	(0.295)	(0.996)
Current FY Growth Forecast	–0.100	0.002	–0.081
	(0.103)	(0.117)	(0.224)
Next FY Growth Forecast	0.173*	0.027	0.155
	(0.100)	(0.129)	(0.205)
Current FY WPI Inflation Forecast	–0.011	0.055*	–0.101
	(0.037)	(0.030)	(0.091)
Next FY WPI Inflation Forecast	0.013	–0.073*	0.039
	(0.058)	(0.042)	(0.171)
F-statistic	2.440	1.218	1.029
p-value	0.051	0.310	0.410
R^2	0.019	0.066	0.082
N	113	81	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 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. RBI monetary policy announcement dates around whose two-day windows there is also an FOMC announcement are excluded from the analysis. 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 FOMC announcement dates are sourced from Bauer and Swanson (2023b) and https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm. The F-statistic and p-value corresponding to a joint test of the significance of all slope 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.

Table A.51: Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates (Excluding FOMC overlapping surprises)

In %	**Intercept**	**Monetary Surprise**	**N**	**R^2**
Δ (1-Year GSec Yield)	–0.012	0.284***	81	0.340
	(0.015)	(0.105)		
Δ (5-Year GSec Yield)	0.003	0.184***	81	0.203
	(0.014)	(0.051)		
Δ (10-Year GSec Yield)	0.009	0.152***	81	0.148
	(0.014)	(0.051)		
Δ (NIFTY)	–0.287	–3.296*	81	0.147
	(0.287)	(1.756)		
Δ (SENSEX)	–0.225	–3.096*	81	0.143
	(0.276)	(1.583)		
Δ (BSE200)	–0.230	–3.066*	81	0.121
	(0.303)	(1.624)		
Δ (USD/INR)	–0.048	0.189	81	0.011
	(0.070)	(0.285)		

* 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. RBI monetary policy announcement dates around whose two-day windows there is also an FOMC announcement are excluded from the analysis. 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. FOMC announcement dates are sourced from Bauer and Swanson (2023b) and https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm.

Event study regressions

The robustness of the event study regressions in Section 1.5 to excluding RBI announcement dates coinciding with FOMC announcement dates is now considered. Tables A.51 and A.52 present the results of the event study regressions of financial market variables on monetary policy surprises on scheduled and unscheduled announcement dates of the RBI after excluding the RBI monetary policy announcements coinciding with FOMC announcements. The results are very similar to the main results in Tables A.3 and A.4, suggesting that the effects of monetary policy surprises on financial market variables on scheduled and unscheduled announcement dates are not driven by their coincidence with FOMC monetary policy surprises.

Consensus forecast regressions

Next, the robustness of the results in Section 1.6 to controlling for the effects of FOMC monetary policy surprises is considered. Since the consensus forecasts are available at a monthly frequency, the regression

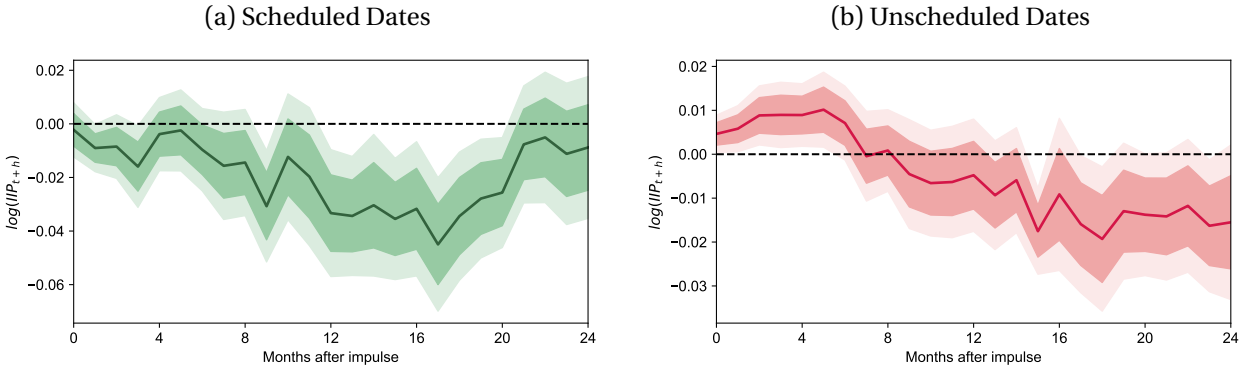
Table A.52: Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates (Excluding FOMC overlapping surprises)

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	0.025	0.254***	33	0.461
	(0.043)	(0.066)		
Δ (5-Year GSec Yield)	0.037	0.176***	33	0.547
	(0.024)	(0.042)		
Δ (10-Year GSec Yield)	0.048**	0.143***	33	0.475
	(0.021)	(0.038)		
Δ (NIFTY)	–0.117	0.570	33	0.022
	(0.581)	(0.917)		
Δ (SENSEX)	–0.089	0.575	33	0.018
	(0.660)	(0.996)		
Δ (BSE200)	–0.281	0.626	33	0.022
	(0.640)	(0.905)		
Δ (USD/INR)	–0.064	–0.121	33	0.023
	(0.100)	(0.202)		

* 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. RBI monetary policy announcement dates around whose two-day windows there is also an FOMC announcement are excluded from the analysis. 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. FOMC announcement dates are sourced from Bauer and Swanson (2023b) and and https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm.

Figure A.28: IRFs of Industrial Production to Monetary Policy Surprises (FOMC Control)



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 1.7. 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 1.7, 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.

specification in Section 1.6 is modified to include the sum of FOMC monetary policy surprises, from Bauer and Swanson (2023b), between two consecutive forecast surveys as a control variable (and time-weighting them for the current financial year's forecast revision regressions). Only data up to December 2019 is used in the analysis since the FOMC monetary policy surprises are available only until this date.

Tables A.53 and A.54 present the results of the consensus forecast regressions of output growth, investment growth and WPI inflation on monetary policy surprises on scheduled and unscheduled announcement dates of the RBI controlling for FOMC monetary policy surprises. The results are very similar to the main results in Tables A.6 and A.7, suggesting that the effects of monetary policy surprises on consensus forecasts of output growth, investment growth and WPI inflation on scheduled and unscheduled announcement dates are not driven by their coincidence with FOMC monetary policy surprises.

On scheduled announcement dates, higher interest rates lead to lower forecasts for output growth in both the present and next financial years by a similar magnitude to the main specification with statistical significance. On unscheduled announcement dates, higher interest rates appear to increase real investment growth in the present financial year in a statistically significant manner, further highlighting the heterogeneity in the effects of monetary policy surprises on scheduled and unscheduled announcement dates. The coefficients on output growth and inflation, while not statistically significant, are also similar to the results in the main specification on both scheduled and unscheduled announcement dates.

IRFs of macroeconomic variables

This section considers the robustness of the IRFs in Section 1.7 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.

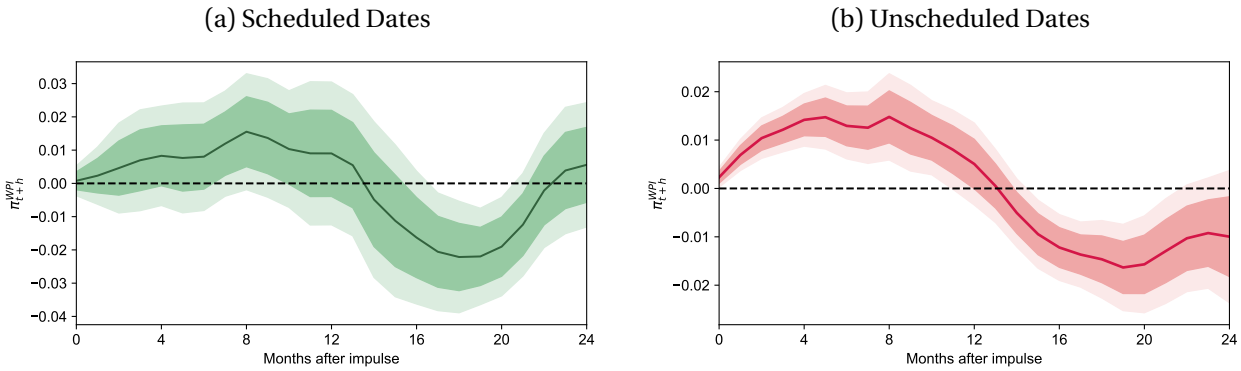
Table A.53: Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (FOMC Control)

	Intercept	Monetary Surprise	FOMC Surprise	N	R^2
Δ (Current FY Output Growth)	–0.037**	–0.204**	–0.162	87	0.109
	(0.015)	(0.079)	(0.289)		
Δ (Current FY Investment Growth)	–0.195***	–0.143	–0.334	87	0.004
	(0.058)	(0.324)	(1.443)		
Δ (Current FY WPI Inflation)	–0.009	0.020	–0.509	87	0.004
	(0.035)	(0.095)	(0.638)		
Δ (Next FY Output Growth)	–0.023	–0.123*	0.069	96	0.033
	(0.017)	(0.063)	(0.445)		
Δ (Next FY Investment Growth)	–0.125**	–0.273	–1.055	96	0.036
	(0.049)	(0.306)	(0.917)		
Δ (Next FY WPI Inflation)	–0.029	–0.064	0.562	96	0.015
	(0.026)	(0.058)	(0.478)		

* 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, controlling for FOMC monetary policy surprises. 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 monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy surprises which occur during the same period. The FOMC surprises between two consecutive forecast surveys are also 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. FOMC monetary policy surprises are obtained from Bauer and Swanson (2023b). RBI and FOMC 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.

Figure A.29: IRFs of WPI Inflation to Monetary Policy Surprises (FOMC Control)



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 1.7. 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 1.7, 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.

Table A.54: Consensus Forecast Regressions and Monetary Policy Surprises: Unscheduled Announcements (FOMC Control)

	Intercept	Monetary Surprise	FOMC Surprise	N	R^2
Δ (Current FY Output Growth)	–0.070*	–0.026	0.165	23	0.022
	(0.037)	(0.062)	(0.281)		
Δ (Current FY Investment Growth)	–0.391***	0.011	1.065*	23	0.031
	(0.097)	(0.098)	(0.579)		
Δ (Current FY WPI Inflation)	0.061	0.199	–0.220	23	0.074
	(0.117)	(0.183)	(0.733)		
Δ (Next FY Output Growth)	–0.103**	0.041	0.597	27	0.103
	(0.039)	(0.052)	(0.673)		
Δ (Next FY Investment Growth)	–0.312***	0.127	0.768	27	0.066
	(0.090)	(0.105)	(1.671)		
Δ (Next FY WPI Inflation)	–0.047	0.083	2.073	27	0.132
	(0.089)	(0.076)	(2.172)		

* 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, controlling for FOMC monetary policy surprises. 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 monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of scheduled monetary policy surprises which occur during the same period. The FOMC surprises between two consecutive forecast surveys are also 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. FOMC monetary policy surprises are obtained from Bauer and Swanson (2023b). RBI and FOMC 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.

Figure A.28 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 A.29 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 1.7. 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.

A.9.3 Surprises which occur in same month as surprises of different type

The robustness of the results in the paper to the exclusion of monetary policy surprises which occur in the same month as surprises of a different type is now considered. As discussed in Section A.7, there were nine occasions on which both scheduled and unscheduled announcements were made by the RBI in the same calendar month. These months are shown in Table A.42. The robustness of the results only in Section 1.6 and Section 1.7 to the exclusion of these months is considered. The sources regressions and the event study regressions are not affected by the exclusion of these months.

Consensus forecast regressions

The robustness of the consensus forecast regressions to the exclusion of months in which both scheduled and unscheduled announcements were made by the RBI is now considered. Any two consecutive consensus forecasts surveys during which both scheduled and unscheduled announcements were made by the RBI are excluded from the analysis. The regression specification in Section 1.6 is then modified to regress the consensus forecast revisions on monetary policy surprises of each type separately (without first projecting them onto surprises of the other type) with time weights as appropriate.

Tables A.55 and A.56 present the results of the consensus forecast regressions of output growth, investment growth and WPI inflation on monetary policy surprises on scheduled and unscheduled announcement dates of the RBI excluding months in which both types of announcements were made. The results are very similar to the main results in Tables A.6 and A.7. On scheduled announcement dates, there is a statistically significant decline in current year output growth forecasts in response to higher interest rates as in the main specification. However, the effects on next year output growth as well as investment growth are much weaker than in the main specification. This is likely due to the exclusion of months which have large scheduled announcement surprises which also happened to have unscheduled announcements in the same month.

On unscheduled announcement dates, in contrast to the main specification, there are now statistically significant positive effects of higher interest rates for both the current and next financial years. The effects on investment growth and inflation are also positive but not statistically significant. The magnitude of the

Table A.55: Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (Excluding months with both types of announcements)

	Intercept	Monetary Surprise	N	R^2
Δ (Current FY Output Growth)	–0.025*	–0.236*	81	0.074
	(0.014)	(0.127)		
Δ (Current FY Investment Growth)	–0.166***	0.031	81	0
	(0.059)	(0.594)		
Δ (Current FY WPI Inflation)	–0.012	0.252	81	0.015
	(0.036)	(0.215)		
Δ (Next FY Output Growth)	–0.015	–0.072	90	0.008
	(0.019)	(0.054)		
Δ (Next FY Investment Growth)	–0.098*	–0.181	90	0.007
	(0.051)	(0.411)		
Δ (Next FY WPI Inflation)	–0.025	–0.013	90	0
	(0.027)	(0.076)		

* 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 monetary policy 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. Scheduled monetary policy surprises which occur between two consecutive forecast surveys during which there are also unscheduled monetary policy announcements are excluded from the analysis. 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. FOMC monetary policy surprises are obtained from Bauer and Swanson (2023b). RBI 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.

effects are generally much larger than in the main specification.

However, these results too confirm the heterogeneity in the effects of monetary policy surprises on consensus forecasts of output growth, investment growth and WPI inflation on scheduled and unscheduled announcement dates.

IRFs for macroeconomic variables

This section considers the robustness of the IRFs in Section 1.7 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 A.7, 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 A.42. The local projection specification in Section 1.7 is modified to include dummy variables for each monthly observation satisfying the above condition.

Figure A.30 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 sched-

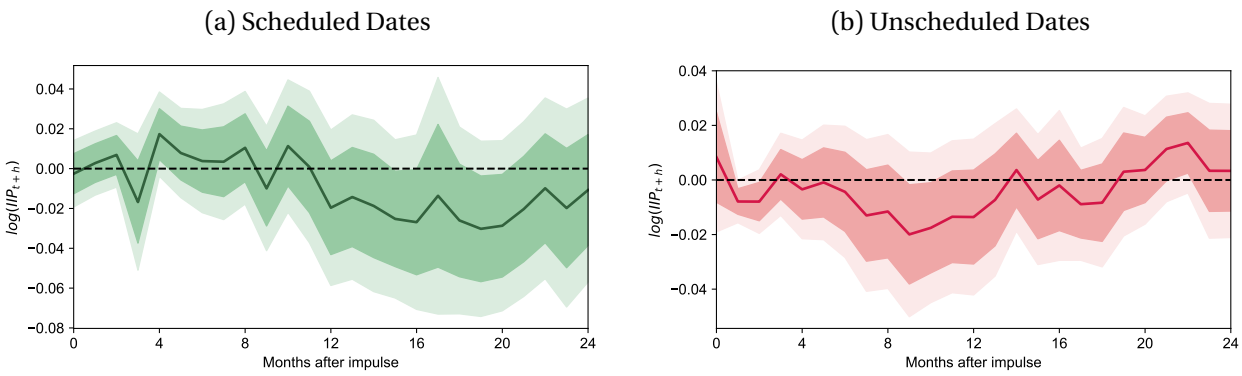
Table A.56: Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements (Excluding months with both types of announcements)

	Intercept	Monetary Surprise	N	R^2
Δ (Current FY Output Growth)	–0.045	0.073***	16	0.085
	(0.037)	(0.019)		
Δ (Current FY Investment Growth)	–0.361***	0.045	16	0.005
	(0.095)	(0.122)		
Δ (Current FY WPI Inflation)	0.081	0.446	16	0.173
	(0.145)	(0.377)		
Δ (Next FY Output Growth)	–0.219	0.116*	21	0.03
	(0.134)	(0.061)		
Δ (Next FY Investment Growth)	–0.553*	0.169	21	0.016
	(0.271)	(0.140)		
Δ (Next FY WPI Inflation)	–0.129	0.114	21	0.03
	(0.152)	(0.140)		

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

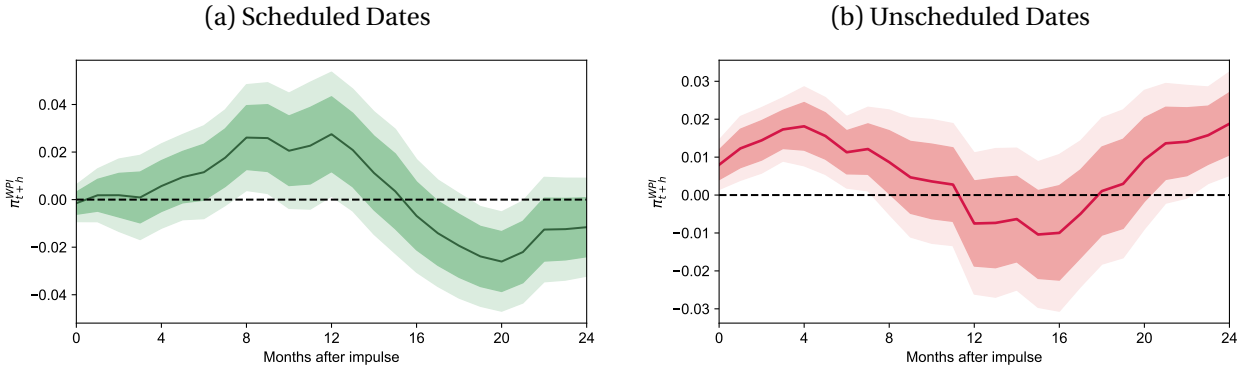
Notes: This table shows the results of OLS regressions of the monthly consensus forecast revisions of key macroeconomic indicators for the current and next financial years on monetary policy surprises on unscheduled announcement dates of the RBI. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. All unscheduled monetary policy 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. Unscheduled monetary policy surprises which occur between two consecutive forecast surveys during which there are also scheduled monetary policy announcements are excluded from the analysis. 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. FOMC monetary policy surprises are obtained from Bauer and Swanson (2023b). RBI 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.

Figure A.30: 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 1.7. 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.

Figure A.31: 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 1.7. 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.

uled and unscheduled announcements. Similarly, Figure A.31 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 robust to the removal of monetary policy surprises in months with both scheduled and unscheduled monetary policy announcements, with a 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 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. In addition, the effects of monetary policy surprises on IIP on scheduled announcement dates are now much weaker than in the main specification with the exclusion of some large monetary policy surprises occurring during months with both scheduled and unscheduled announcements.

A.10 Monetary policy surprises and macroeconomic data releases

This section investigates the role of macroeconomic data releases in explaining the heterogeneity in the estimated macroeconomic effects of scheduled and unscheduled monetary policy surprises presented in the paper. In particular, the importance of overlaps of monetary policy announcement dates with the release dates of data on IIP, WPI and GDP in explaining the heterogeneous macroeconomic effects of scheduled and unscheduled monetary policy surprises is analysed.

Data on IIP, as previously discussed in Section 1.4, is released at a monthly frequency by the Ministry of Statistics and Programme Implementation (MoSPI), generally on the 12th of each month, and if the 12th is a holiday, on the working day immediately preceding the 12th (Ministry of Statistics and Programme Implementation, 2008).[7] The list of monthly IIP data release dates were obtained from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of the PIB as well as MoSPI and Bloomberg Terminal's Economic Data Release Calendar for India.[8] The IIP release dates also generally coincide with release dates for the nationally representative Consumer Price Index-Combined (CPI-C) launched in 2011 and hence for the period when the CPI became a relevant measure of inflation for the central bank, the analysis in this section also generally excludes monetary policy surprises measured using two-day windows during which there was a release of information about the CPI (Ministry of Statistics and Programme Implementation, 2015).[9]

Data on WPI is released by the Office of the Economic Advisor to the Department for Promotion of Industry and Internal Trade of the Ministry of Commerce and Industry. The WPI data was released at a weekly frequency until 19th October 2009 (Ministry of Commerce & Industry, 2009). The data was usually released on Thursday or Friday of each week.[10] Between 19th October 2009 and 2nd February 2012, the main WPI index was released at a monthly frequency on the 14th of each month, and if the 14th was a holiday, on the working day immediately following the 14th (Office of the Economic Adviser, 2024), while sub-indices relating to primary articles and fuel continued to be released on a weekly basis, usually on Thursdays. In case there was a holiday on Thursday, the weekly WPI indices were usually released on Fridays.[11] The release of weekly WPI data was completely discontinued from 2nd February 2012, with only the main WPI index being released as per the previously established schedule (Ministry of Commerce & Industry, 2012).[12] WPI data release dates were obtained from the online archive of the Press Information Bureau

[7] The practice of releasing IIP data on the 12th of each month or the working day immediately preceding it if the 12th was a holiday was not followed in November 2002, when the IIP was released on the 13th. Furthermore, in June 2013, corrigenda to the original IIP release on the 12th were released on the 13th, and these corrigenda are included as part of the set of IIP release dates in the analysis.

[8] The Bloomberg Economic Data Release Calendar can be accessed using the **ECO** function on Bloomberg Terminal.

[9] CPI has generally been released on the 12th of the month, or the working day immediately following the 12th, if the 12th was a government holiday, at least since 2013. Since the monthly WPI was released on the 14th, even in cases where the 12th was a holiday, the dates of overlap between monetary policy announcement windows and monthly CPI releases would be usually excluded from the analysis beginning in 2013. Explicitly including overlaps with CPI release dates only results in one additional overlap, that too with a scheduled announcement date pre-2013, on 18th June 2012.

[10] The WPI compilation manual issued in 2006 and the available weekly WPI press releases from 2006 suggest a Friday release date (Office of the Economic Adviser, 2006). However, the regular day of weekly WPI releases between July 2008 and February 2012 appears to be Thursday. The only exception to this appears in August 2009, when the weekly WPI release was on Wednesday 26th rather than 27th.

[11] However, there were a few instances when weekly WPI releases occurred on a day other than Thursday despite there being no holiday on the Thursday of that week. In May 2009, weekly WPI release was on Friday 8th despite there being no holiday on 7th. In October 2010, the weekly WPI release was on Friday 15th despite there being no holiday on 14th.

[12] While the release schedule outlined above for the monthly WPI releases was generally followed, there were a few deviations

(PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of the PIB as well as Office of the Economic Advisor. While this leads to comprehensive coverage of all monthly WPI release dates, weekly WPI release dates are only available regularly starting in 2006 and available with consistency only after July 2008 and these are the weekly WPI dates that are considered in the analysis.

Data on GDP is released by the Ministry of Statistics and Programme Implementation (MoSPI) at both a quarterly and annual frequency. Annual GDP data is calculated and released on a financial year basis (1st April - 31st March). The annual GDP data are subject to multiple revisions as more data becomes available over time. An advance estimate of GDP for the financial year ending in March was released on the 7th of February of that calendar year, and if the 7th was a holiday, on the working day immediately following the 7th until 2016.[13] Commencing in 2017, in order to accommodate the presentation of the Union Budget on the 1st of February, a first advance estimate of GDP for the financial year ending in March was released on the 7th of January of that calendar year, and if the 7th was a holiday, on the working day immediately preceding the 7th. A second advance estimate was then released on the last working day in February of that calendar year (Ministry of Statistics and Programme Implementation, 2016). Thereafter, a provisional estimate of annual GDP for the financial year ending in March was released on the last working day in June of that calendar year until 2005 and on the last working day in May beginning in 2006. Subsequent revisions to estimates of annual GDP for the financial year ending in March were released on the last working day in January of succeeding calendar years, with a final revised estimate of annual GDP being released three calendar years following the end of the concerned financial year.[14] Hence, between 1999 and 2016, there were three main occasions on which annual GDP data was released by MoSPI, corresponding to the release of (i) Revised Estimates of GDP for preceding financial years in January, (ii) Advance Estimates of GDP for the ongoing financial year in Februrary and (iii) Provisional Estimates of GDP for the recently completed financial year in May/June. A fourth annual GDP data release date was added in 2017, with the replacement of the Advance Estimates of GDP for the ongoing financial year in Februrary with two Advance Estimates in January and February. The annual GDP data release dates were collected from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, as well as archived webpages of PIB.[15]

Quarterly GDP data was released four times in each calendar year during the time period under study. GDP estimates for the January-March quarter were released on the last working day in June until 2005 and on the last working day in May thereafter. Similarly, for the April-June quarter, GDP estimates were released on the last working day in September until 2006 and on the last working day in August thereafter. For the

from the regular schedule. In November 2009, the WPI monthly release was on the 14th, which was a Saturday, instead of the 16th which would have been the first working day after the 14th. In September 2010, the monthly WPI press release was on the 13th, not following the practice of releasing the WPI on the 14th or following working day. In October 2010, monthly WPI press release was on 15th even though there was no holiday on the 14th. In May 2017, the monthly WPI press release was on the 12th, not following the regular schedule, due to the release of data coinciding with a press conference on base revision of WPI on that date.

[13]The practice of releasing the Advance Estimates of annual GDP on the 7th of February, or the following working day if the 7th was a holiday, was not followed in the calendar years 1999, 2000, 2001 and 2002, when these estimates were released on 9th February (instead of 8th February), 4th February (instead of 7th February), 5th February (instead of 7th February) and 5th February (instead of 7th February) respectively.

[14]The practice of releasing the Revised Estimates of annual GDP on the last working day in January was not followed in the calendar years 1999, 2000 and 2001 when these estimates were instead released on 3rd February (instead of 29th January), 28th January (instead of 31st January) and 30th January (instead of 31st January) respectively.

[15]Beginning in 2023, the revised estimates of GDP for previous financial years are released along with the second advance estimates for the ongoing financial year on the last working day in February.

July-September quarter, GDP estimates were released on the last working day in December until 2004 and on the last working day in November thereafter. Finally, GDP estimates for the October-December quarter were released on the last working day of the following March until 2005 and on the last working day in February thereafter.[16] The quarterly GDP data release dates were collected from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, as well as archived webpages of MoSPI and PIB.

This yielded a total 729 macroeconomic data release dates between February 1999 and March 2020. There were 37 instances of macroeconomic data releases occurring in the two-day window around monetary policy announcements of the RBI. This is a conservative estimate of the total number of overlaps between monetary policy announcement windows and macroeconomic data releases as any occurrence of a macroeconomic data release on the day before the announcement, the day of the announcement or the day after the announcement are considered to overlap with the window used to calculate the monetary policy surprises. These are shown in Table A.57.

This corresponds to 33 distinct RBI monetary policy announcement dates which had a macroeconomic data release occurring during the two day window used to calculate monetary policy surprises for these dates. Of these, 19 were unscheduled announcement dates and 14 were scheduled announcement dates. Only 7 out of the 19 cases of overlap between unscheduled announcement date windows and macroeconomic data release dates is due to the use of a two-day window instead of a one-day window.

In the sections which follow, the role of macroeconomic data releases in explaining the heterogeneity in the macroeconomic effects of scheduled and unscheduled monetary policy surprises will be considered in more detail. In the analysis of the sources of monetary policy surprises, the event study regressions of financial market variables as well as the consensus forecast regressions, the overlapping monetary policy surprises (or the months containing overlapping monetary policy surprises, as the case may be) will be excluded completely from the analysis. In the analysis of the IRFs of macroeconomic variables, the overlapping monetary policy surprises will be separately controlled for in the regression specifications using dummy variables for months with overlapping announcement dates.

A.10.1 Sources of monetary policy surprises

This section considers whether the results in Table 1.4 and Table 1.5 continue to hold when the monetary policy surprises are calculated excluding the monetary policy announcements which overlap with macroeconomic data releases. The results of the regressions of monetary policy surprises on macroeconomic data and forecasts excluding these overlaps are shown in Table A.58 and Table A.59 respectively.

The p-values for the joint test of significance of the regression coefficients on unscheduled announcement dates in Table A.58 continue to suggest the existence of endogeneity of the remaining monetary policy surprises to past macroeconomic conditions as in Table 1.4. However, the p-values are much larger in Table A.59 than in Table 1.5 for the test of endogeneity of monetary policy surprises on unscheduled announcement dates. The results for scheduled announcement dates remain largely unchanged even with the exclusion of overlaps with macroeconomic data releases, further pointing to the better identification

[16] In 2015 and 2016, the quarterly GDP estimates for the October-December quarter were released along with the advance estimates for annual GDP on the 9th and 8th respectively, instead of the last working day in February.

Table A.57: RBI Monetary Policy Announcements overlapping with Macroeconomic Data Releases

Date of Data Release	Date of Announcement	Type of Announcement	Type of Data Release	Monetary Surprise
31 March 2000	01 April 2000	Unscheduled	Quarterly GDP	-1.20
11 May 2001	12 May 2001	Unscheduled	IIP	-0.20
10 September 2004	11 September 2004	Unscheduled	IIP	0.05
09 June 2006	08 June 2006	Unscheduled	WPI	0.21
23 June 2006	22 June 2006	Unscheduled	WPI	0.05
31 January 2007	31 January 2007	Scheduled	Annual GDP	-0.05
12 February 2007	13 February 2007	Unscheduled	IIP	0.65
28 February 2007	01 March 2007	Unscheduled	Quarterly GDP	-0.42
12 June 2008	11 June 2008	Unscheduled	IIP	0.25
03 October 2008	06 October 2008	Unscheduled	WPI	-0.90
10 October 2008	10 October 2008	Unscheduled	WPI	-1.88
10 October 2008	10 October 2008	Unscheduled	IIP	-1.88
16 October 2008	15 October 2008	Unscheduled	WPI	-2.25
23 October 2008	24 October 2008	Scheduled	WPI	1.60
01 January 2009	02 January 2009	Unscheduled	WPI	-0.38
05 March 2009	04 March 2009	Unscheduled	WPI	-0.40
28 January 2010	29 January 2010	Scheduled	WPI	-0.10
29 January 2010	29 January 2010	Scheduled	Annual GDP	-0.10
18 March 2010	19 March 2010	Unscheduled	WPI	0.04
01 July 2010	02 July 2010	Unscheduled	WPI	0.38
16 September 2010	16 September 2010	Scheduled	WPI	0.30
16 December 2010	16 December 2010	Scheduled	WPI	-0.10
17 March 2011	17 March 2011	Scheduled	WPI	0.15
16 June 2011	16 June 2011	Scheduled	WPI	-0.06
15 September 2011	16 September 2011	Scheduled	WPI	0.20
15 December 2011	16 December 2011	Scheduled	WPI	0.15
10 February 2012	13 February 2012	Unscheduled	IIP	-0.05
14 February 2012	13 February 2012	Unscheduled	WPI	-0.05
12 March 2012	09 March 2012	Unscheduled	IIP	-0.14
14 March 2012	15 March 2012	Scheduled	WPI	0.05
16 April 2012	17 April 2012	Scheduled	WPI	-0.21
14 September 2012	17 September 2012	Scheduled	WPI	0.05
14 June 2013	17 June 2013	Scheduled	WPI	-0.02
12 July 2013	15 July 2013	Unscheduled	IIP	2.73
15 July 2013	15 July 2013	Unscheduled	WPI	2.73
14 January 2015	15 January 2015	Unscheduled	WPI	-0.11
30 November 2015	01 December 2015	Scheduled	Quarterly GDP	0.02

Notes: This table shows the dates of RBI monetary policy announcements around whose two-day windows (which were used to calculate monetary policy surprises) there were macroeconomic data releases. Data releases of the Index of Industrial Production (IIP), the Wholesale Price Index (WPI), annual and quarterly Gross Domestic Product (GDP) are considered in this analysis. In each case, the type of macroeconomic data release, the date of the data release, the type of monetary policy announcement and the monetary policy surprise are also shown. Announcement dates which overlapped with multiple macroeconomic data releases are displayed multiple times with each entry corresponding to a particular overlap. The monetary policy surprises are computed as the two-day change in the 1-month MIBOR-OIS fixed rate around RBI monetary policy announcements. Data on the 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on macroeconomic data releases are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India.

Table A.58: Predictability of Monetary Policy Surprises by Macroeconomic Data (Excluding Overlaps with Macroeconomic Data Releases)

	Pooled	Scheduled	Unscheduled
Intercept	–0.004	0.049	–0.788**
	(0.058)	(0.042)	(0.297)
Δln (IIP) (2m)	1.085	–0.458	44.994***
	(1.966)	(1.952)	(10.519)
Δln (WPI) (2m)	1.835	–0.020	23.387**
	(2.122)	(1.716)	(9.884)
Drought (2m)	0.020	0.018	0.163
	(0.013)	(0.013)	(0.106)
Excess Rain (2m)	0.001	–0.014	0.400**
	(0.016)	(0.015)	(0.135)
Δ (10Y-1Y GSec Spread) (2m)	0.107	0.102	–0.828**
	(0.169)	(0.164)	(0.260)
Δln (*SENSEX*) (2m)	1.113*	0.824	1.595*
	(0.611)	(0.533)	(0.832)
Δln (*USD – INR*) (2m)	1.365	1.118	14.353**
	(2.254)	(2.142)	(4.995)
F-statistic	0.942	0.876	13.132
p-value	0.479	0.529	0.000
R^2	0.091	0.083	0.752
N	100	83	17

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 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. RBI monetary policy announcement dates around whose two-day windows there are macroeconomic data release announcements of Annual or Quarterly GDP, IIP or WPI are excluded from the analysis. The 1-month MIBOR-OIS fixed rate is obtained from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Δln (IIP) is calculated as the 2-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, online archives of PIB and MoSPI of the Government of India 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 2-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, online archives of PIB and Office of Economic Advisor to DPIIT of the Government of India and for months when 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 two months (in 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 two-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 two-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 42-trading 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. Δln (*SENSEX*) is defined as the 42-trading 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. Δln (*USD-INR*) is defined as the 42-trading 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. Macroeconomic data release dates are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India. The F-statistic and p-value corresponding to a joint test of the significance of all slope coefficients being zero is reported.

Table A.59: Predictability of Monetary Policy Surprises by Macroeconomic Forecasts (Excluding Overlaps with Macroeconomic Data Releases)

	Pooled	Scheduled	Unscheduled
Intercept	–0.417	–0.211	–1.432
	(0.313)	(0.226)	(2.334)
Current FY Growth Forecast	–0.053	0.002	–0.152
	(0.109)	(0.100)	(0.299)
Next FY Growth Forecast	0.116	0.037	0.339
	(0.111)	(0.103)	(0.373)
Current FY WPI Inflation Forecast	0.003	0.024	–0.062
	(0.032)	(0.016)	(0.215)
Next FY WPI Inflation Forecast	–0.016	–0.033	0.066
	(0.059)	(0.035)	(0.426)
F-statistic	0.747	1.186	0.241
p-value	0.563	0.324	0.909
R^2	0.015	0.024	0.045
N	100	83	17

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$; 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. RBI monetary policy announcement dates around whose two-day windows there are macroeconomic data release announcements of Annual or Quarterly GDP, IIP or WPI are excluded from the analysis. 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. Macroeconomic data release dates are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India. The F-statistic and p-value corresponding to a joint test of the significance of all slope 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.

Table A.60: Event Study Regressions for Financial Market Variables: Scheduled Announcement Dates (Excluding Overlaps with Macroeconomic Data Releases)

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	–0.005	0.339***	83	0.365
	(0.015)	(0.124)		
Δ (5-Year GSec Yield)	0.008	0.234***	83	0.237
	(0.013)	(0.066)		
Δ (10-Year GSec Yield)	0.014	0.211***	83	0.195
	(0.014)	(0.063)		
Δ (NIFTY)	0.028	–0.919	83	0.011
	(0.277)	(0.696)		
Δ (SENSEX)	0.076	–1.016	83	0.014
	(0.270)	(0.693)		
Δ (BSE200)	0.053	–0.871	83	0.009
	(0.293)	(0.779)		
Δ (USD/INR)	–0.067	0.234	83	0.013
	(0.065)	(0.359)		

* 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. RBI monetary policy announcement dates around whose two-day windows there are macroeconomic data release announcements of Annual or Quarterly GDP, IIP or WPI are excluded from the analysis. 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. Macroeconomic data release dates are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India.

of monetary policy surprises on scheduled announcement dates.

A.10.2 Event study regressions

This section considers whether the results in Section 1.5 continue to hold when the monetary policy surprises are calculated excluding the monetary policy announcements which overlap with macroeconomic data releases. The results of the regressions of financial market variables on monetary policy surprises excluding these overlaps are shown in Table A.60 and Table A.61 for scheduled and unscheduled announcement dates respectively.

Here too, the positive point estimates for the response of asset prices to monetary policy surprises on unscheduled announcement dates are reversed when the monetary policy surprises which overlap with macroeconomic data releases are excluded, suggesting an improvement in the identification of monetary policy surprises on unscheduled announcement dates when these overlaps are excluded. The results

Table A.61: Event Study Regressions for Financial Market Variables: Unscheduled Announcement Dates (Excluding Overlaps with Macroeconomic Data Releases)

In %	**Intercept**	**Monetary Surprise**	**N**	$\mathbf{R^2}$
Δ (1-Year GSec Yield)	–0.001	0.208	17	0.193
	(0.088)	(0.180)		
Δ (5-Year GSec Yield)	0.015	0.114	17	0.228
	(0.038)	(0.079)		
Δ (10-Year GSec Yield)	0.039	0.058	17	0.079
	(0.040)	(0.086)		
Δ (NIFTY)	–0.520	–0.441	17	0.008
	(0.970)	(1.723)		
Δ (SENSEX)	–0.610	–0.618	17	0.013
	(1.071)	(1.807)		
Δ (BSE200)	–0.832	–0.619	17	0.014
	(1.025)	(1.698)		
Δ (USD/INR)	–0.132	0.272	17	0.085
	(0.161)	(0.273)		

* 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. RBI monetary policy announcement dates around whose two-day windows there are macroeconomic data release announcements of Annual or Quarterly GDP, IIP or WPI are excluded from the analysis. 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. Macroeconomic data release dates are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India.

Table A.62: Consensus Forecast Revisions and Monetary Policy Surprises: Scheduled Announcements (Excluding months with Announcements overlapping with Macroeconomic Data Releases)

	Intercept	Monetary Surprise	N	R^2
Δ (Current FY Output Growth)	–0.043***	–0.161**	76	0.074
	(0.015)	(0.062)		
Δ (Current FY Investment Growth)	–0.156**	–0.071	76	0.001
	(0.062)	(0.319)		
Δ (Current FY WPI Inflation)	–0.012	0.076	76	0.003
	(0.038)	(0.106)		
Δ (Next FY Output Growth)	–0.020	–0.064	83	0.009
	(0.021)	(0.039)		
Δ (Next FY Investment Growth)	–0.055	–0.126	83	0.006
	(0.049)	(0.262)		
Δ (Next FY WPI Inflation)	–0.048	–0.028	83	0.001
	(0.029)	(0.052)		

* 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. Months with scheduled RBI announcement dates during whose two-day windows there are macroeconomic data releases of Annual or Quarterly GDP, IIP and WPI are excluded from the analysis. 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 monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy 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. Data on macroeconomic data releases are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India.

for scheduled announcement dates remain largely unchanged even with the exclusion of overlaps with macroeconomic data releases, further pointing to the better identification of monetary policy surprises on scheduled announcement dates. These results too point to the endogeneity of monetary policy surprises on unscheduled announcement dates to macroeconomic data releases.

A.10.3 Consensus forecast regressions

This section considers whether the results in Section 1.6 continue to hold when the months with monetary policy announcements overlapping with macroeconomic data releases are excluded. The results of the regressions of consensus forecast revisions on monetary policy surprises excluding these overlaps are shown in Table A.62 and Table A.63 for scheduled and unscheduled announcement dates respectively.

The results for scheduled and unscheduled announcements are largely unchanged in this specification, suggesting that there are other potential sources of endogeneity remaining in the monetary policy surprises on unscheduled announcement dates. While on scheduled announcement dates, forecasts of output growth and investment growth continue to get revised downwards following a monetary policy tight-

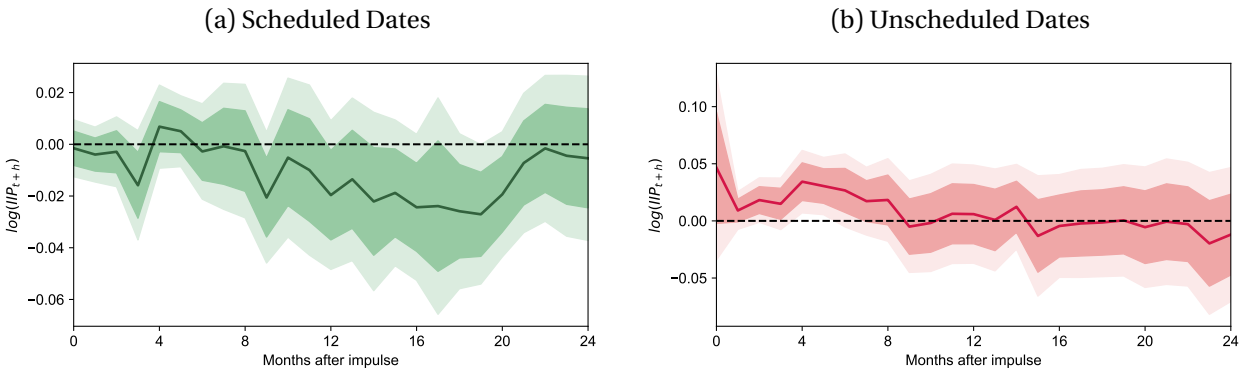
Table A.63: Consensus Forecast Revisions and Monetary Policy Surprises: Unscheduled Announcements (Excluding months with Announcements overlapping with Macroeconomic Data Releases)

	Intercept	**Monetary Surprise**	**N**	R^2
Δ (Current FY Output Growth)	–0.019	0.102	9	0.047
	(0.063)	(0.122)		
Δ (Current FY Investment Growth)	–0.565**	0.335	9	0.052
	(0.204)	(0.564)		
Δ (Current FY WPI Inflation)	0.007	–0.057	9	0.004
	(0.122)	(0.150)		
Δ (Next FY Output Growth)	–0.264	0.165	12	0.023
	(0.229)	(0.199)		
Δ (Next FY Investment Growth)	–0.609	0.177	12	0.007
	(0.465)	(0.426)		
Δ (Next FY WPI Inflation)	–0.163	–0.015	12	0.001
	(0.112)	(0.094)		

* 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. Months with unscheduled RBI announcement dates during whose two-day windows there are macroeconomic data releases of Annual or Quarterly GDP, IIP and WPI are excluded from the analysis. 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 monetary policy surprises which occur between two consecutive surveys are summed and then residualised by projecting on the sum of unscheduled monetary policy 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. Data on macroeconomic data releases are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India.

Figure A.32: IRFs of Industrial Production to Monetary Policy Surprises (Excluding Overlaps with Macroeconomic Data Releases)



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 1.7. 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 monetary policy announcements during whose two-day windows there is a macroeconomic data release of Quarterly and Annual GDP, IIP or WPI. Data on macroeconomic data releases are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India.

ening surprise, the opposite is true for unscheduled announcement dates. This suggests that there are potentially additional unobserved sources of endogeneity in the monetary policy surprises on unscheduled announcement dates, which are not captured by the macroeconomic data releases.[17]

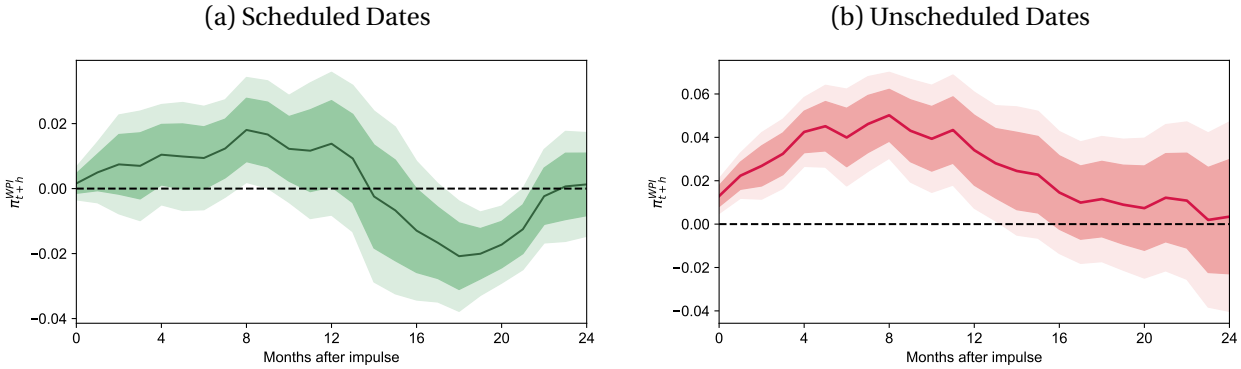
A.10.4 IRFs of macroeconomic variables

This section considers the robustness of the IRFs in Section 1.7 to the exclusion of monetary policy surprises which overlap with macroeconomic data releases. In practice, this is implemented through the inclusion of dummy variables in the Local Projection specification for each month with a monetary policy surprise which overlaps with a macroeconomic data release. The results of the IRFs of IIP and WPI inflation to monetary policy surprises on scheduled and unscheduled announcement dates excluding these overlaps are shown in Figure A.32 and Figure A.33 respectively.

These results are broadly in line with the results in Section 1.7. IIP and WPI inflation continue to decline in response to a contractionary monetary policy surprise on scheduled announcement dates, while they rise in response to a contractionary monetary policy surprise on unscheduled announcement dates. These results also suggest that some endogeneity remains in the monetary policy surprises on unscheduled announcement dates, which is not captured by the macroeconomic data releases. However, the IRFs on scheduled announcement dates are largely unchanged, further pointing to the better identification of monetary policy surprises on scheduled announcement dates.

[17] The results for unscheduled announcements continue to suggest some unobserved endogeneity of monetary policy surprises to macroeconomic conditions on unscheduled announcement dates, even after residualising the monetary policy surprises on unscheduled announcement dates by past macroeconomic conditions.

Figure A.33: IRFs of WPI Inflation to Monetary Policy Surprises (Excluding Overlaps with Macroeconomic Data Releases)



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 1.7. 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 monetary policy announcements during whose two-day windows there is a macroeconomic data release of Quarterly and Annual GDP, IIP or WPI. Data on macroeconomic data releases are sourced from the online archive of the Press Information Bureau (PIB) of the Government of India, available at archive.pib.gov.in/archive2/, archived webpages of PIB, MoSPI and Office of the Economic Advisor as well as Bloomberg Terminal's Economic Data Release Calendar for India.

A.11 Some additional results on monetary policy transmission

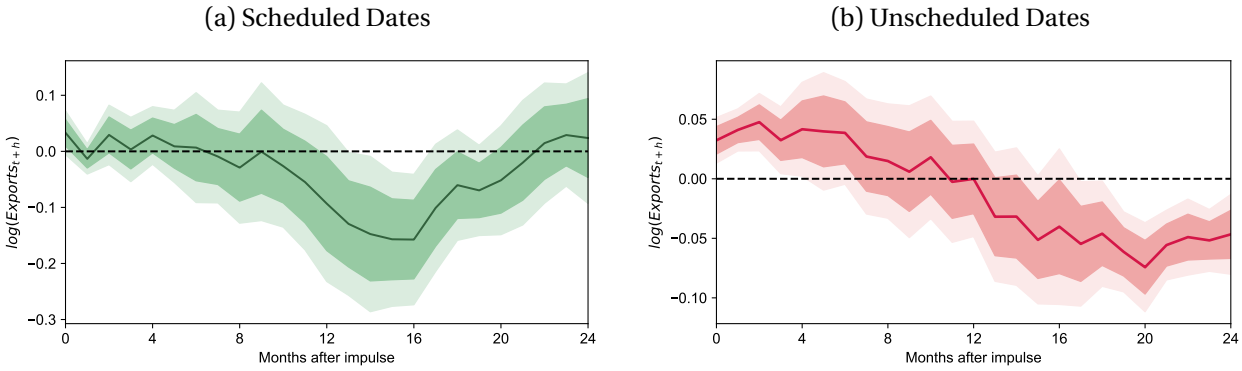
A.11.1 Monetary policy transmission to other macroeconomic variables

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 1.7.

Figure A.34 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.

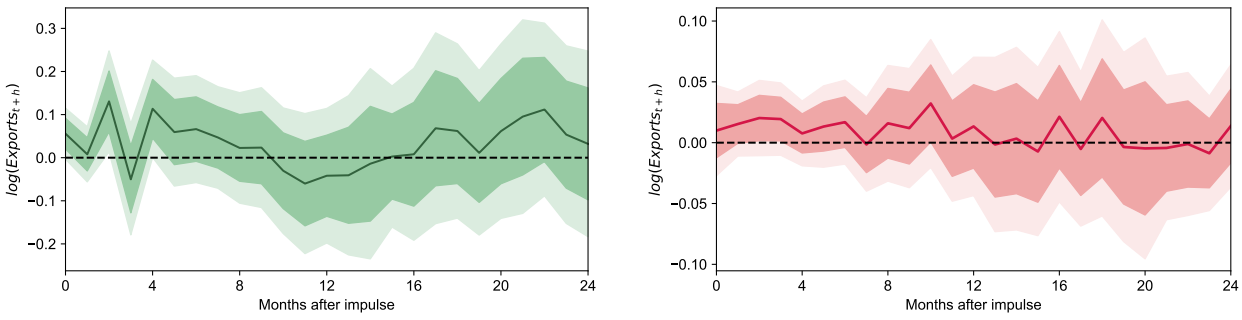
One potential concern with these results is that the large estimated magnitudes of the responses of exports on scheduled and unscheduled announcement dates, which may be driven by the large declines in export volumes during the Global Financial Crisis. Figure A.35 considers the IRFs of goods exports to monetary policy surprises on scheduled and unscheduled announcement dates excluding data between April 2007 and March 2009. These results suggest that outside of the GFC period, while the estimated magnitudes are more muted, there is not much heterogeneity in the response of exports to monetary policy surprises on scheduled and unscheduled announcement dates.

Figure A.34: Impulse Response Functions of Goods Exports to Monetary Policy Surprises



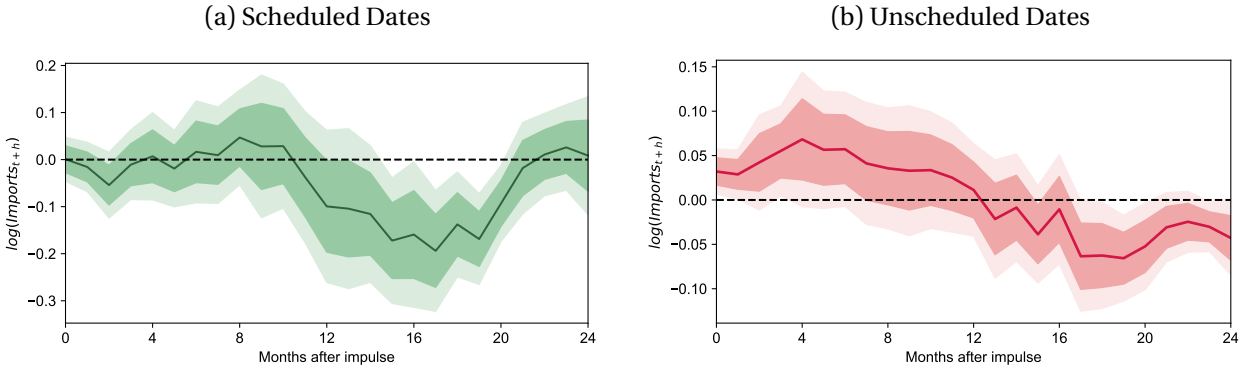
Notes: This figure shows the impulse responses of goods exports from India to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the total monthly value of goods exports expressed in US Dollars. 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 1.7. 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.

Figure A.35: Impulse Response Functions of Goods Exports to Monetary Policy Surprises (Excluding GFC Period)



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 1.7. 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. Dummy variables are included in the specification to control for the effects of surprises which occur between April 2007 and March 2009.

Figure A.36: 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 1.7. 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.

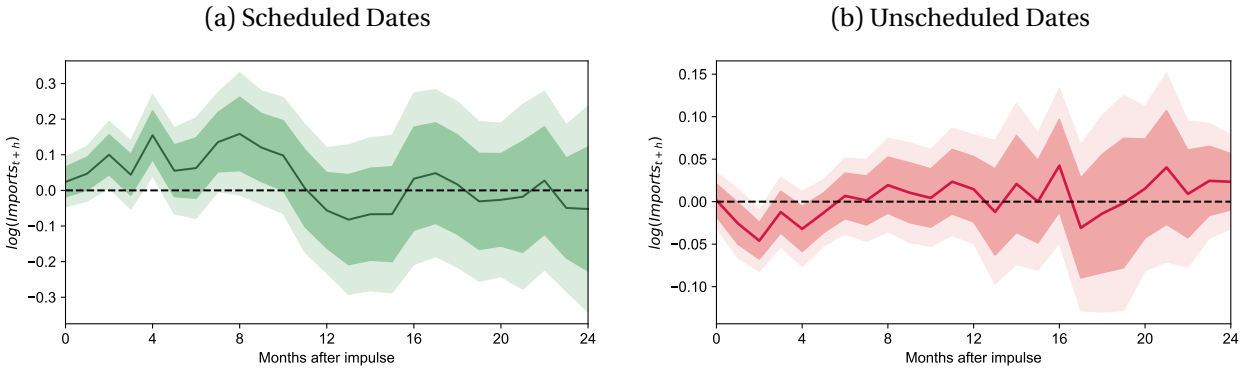
Figure A.36 considers the impulse response of goods imports to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is the logarithm of the total monthly value of goods imports expressed in US Dollars. On scheduled announcement dates, goods imports tend to 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.

As with goods exports, Figure A.37 considers the IRFs of goods imports to monetary policy surprises on scheduled and unscheduled announcement dates excluding data between April 2007 and March 2009. These results too suggest that outside of the GFC period, while the estimated effects are more muted there is not much heterogeneity in the response of imports to monetary policy surprises on scheduled and unscheduled announcement dates.

Figure A.38 considers the impulse response of the NIFTY stock market index to monetary policy surprises 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 1.5. 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.

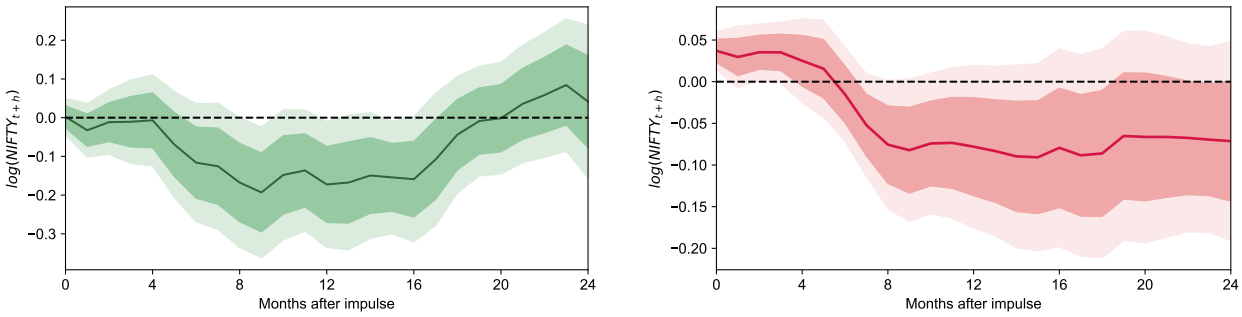
Again, to address concerns about the large estimated magnitudes of the responses of the NIFTY index on scheduled and unscheduled announcement dates being driven by the large declines in stock prices during the Global Financial Crisis, Figure A.39 considers the IRFs of the NIFTY index to monetary policy surprises

Figure A.37: Impulse Response Functions of Goods Imports to Monetary Policy Surprises (Excluding GFC Period)



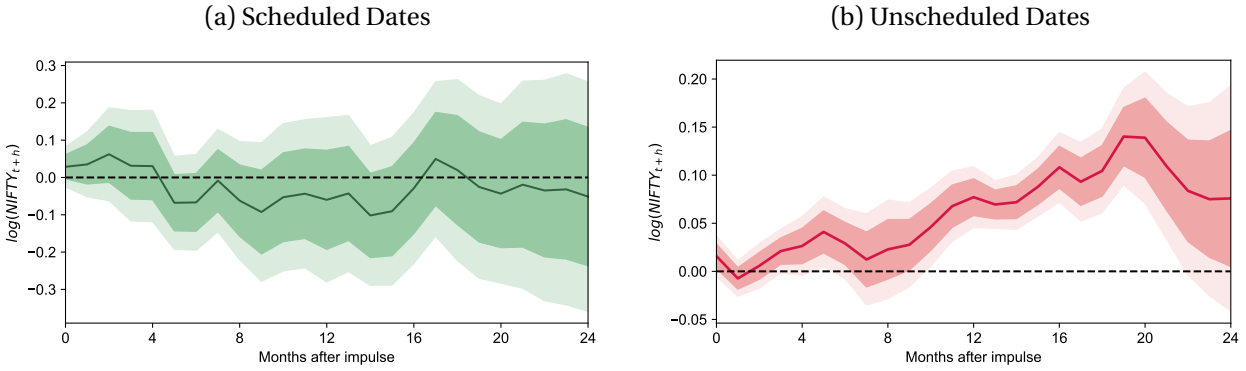
Notes: This figure shows the impulse responses of goods imports into India to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the total monthly value of goods imports expressed in US Dollars. 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 1.7. 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. Dummy variables are included in the specification to control for the effects of surprises which occur between April 2007 and March 2009.

Figure A.38: 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 1.7. 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 A.39: Impulse Response Functions of NIFTY to Monetary Policy Surprises (Excluding GFC Period)



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 1.7. 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. Dummy variables are included in the specification to control for the effects of surprises which occur between April 2007 and March 2009.

on scheduled and unscheduled announcement dates excluding data between April 2007 and March 2009. These results suggest that even outside of the GFC period, while the quantitative estimates are smaller there is still heterogeneity in the response of the NIFTY index to monetary policy surprises on scheduled and unscheduled announcement dates. On scheduled announcement dates, while the point estimates (while not statistically significant) are generally negative, on unscheduled announcement dates they are positive and statistically significant.

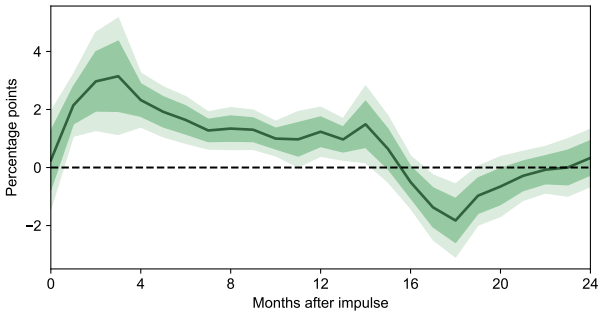
Figure A.40 considers the impulse response of the overnight MIBOR rate to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is the monthly average overnight MIBOR in percentage points. The responses of overnight MIBOR to a monetary policy tightening are very similar in shape on scheduled and unscheduled announcement dates, mirroring the similar responses of the 1-month MIBOR-OIS fixed rate documented in Figure 1.6. However, relative to the response of the 1-month MIBOR-OIS fixed rate, the overnight MIBOR responds with a much larger magnitude in the first few months following the monetary policy surprise on scheduled announcement dates relative to unscheduled announcement dates, before converging to similar magnitudes at longer horizons.

Figure A.41 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 tightening are very similar on scheduled and unscheduled announcement dates, mirroring the similar responses of the 1-month MIBOR-OIS fixed rate documented in Figure 1.6.

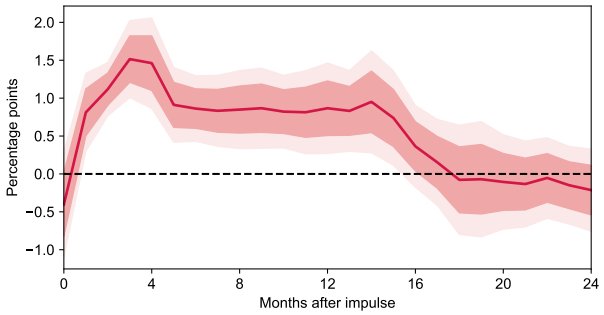
Figure A.42 considers the impulse response of the nominal exchange rate between the US Dollar and Indian Rupee to monetary policy surprises on scheduled and unscheduled announcement dates. The dependent variable is ₹ per $ expressed in logarithms. Rather surprisingly, on scheduled announcement dates, 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

Figure A.40: Impulse Response Functions of overnight MIBOR to Monetary Policy Surprises

(a) Scheduled Dates



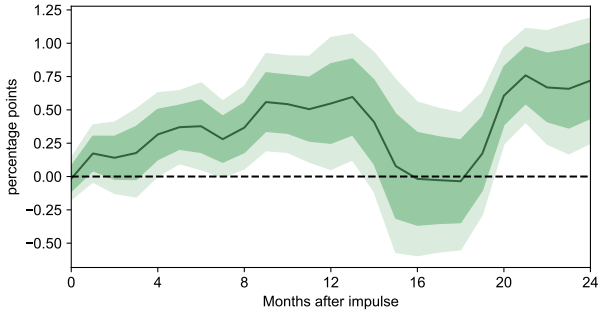
(b) Unscheduled Dates



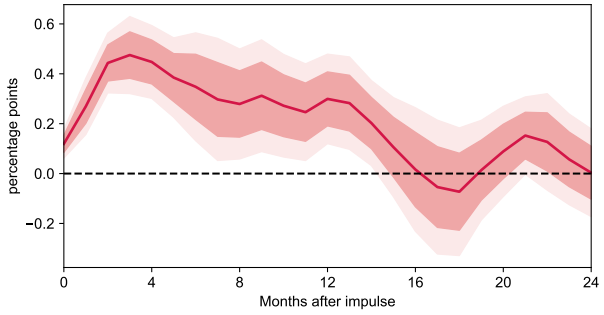
Notes: This figure shows the impulse responses of the overnight Mumbai Interbank Outright Rate (MIBOR) to a 100-basis point contractionary monetary policy surprise on scheduled and unscheduled announcement dates of the RBI. The dependent variable is the monthly average of overnight MIBOR in percentage 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 1.7. 90% and 68% heteroskedasticity-robust confidence intervals based on Montiel Olea and Plagborg-Møller (2021) are displayed. Data on the overnight MIBOR is obtained from Bloomberg Terminal with ticker: IN00O/N Index. Data on 1-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure A.41: Impulse Response Functions of 10-year GSec Yield to Monetary Policy Surprises

(a) Scheduled Dates

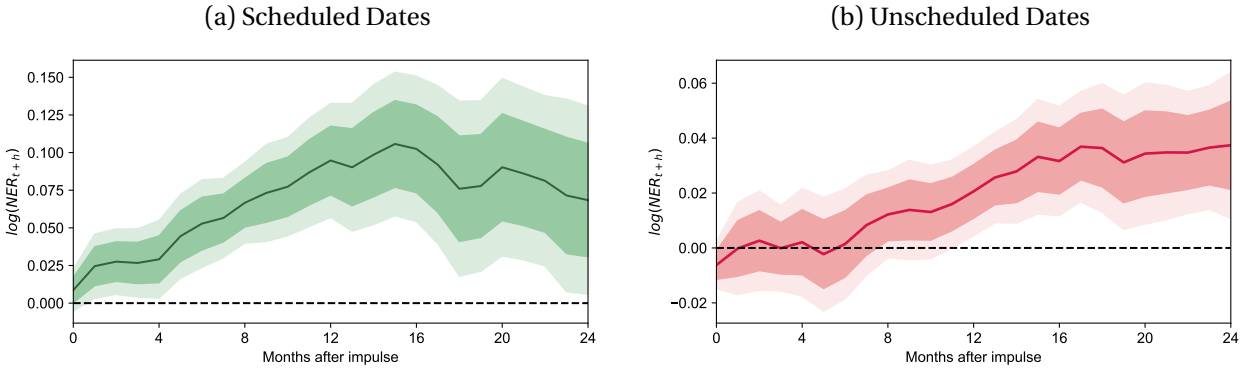


(b) Unscheduled Dates



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 1.7. 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.

Figure A.42: 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 1.7. 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.

following a monetary policy tightening, although it does so with a lag and by a smaller magnitude.

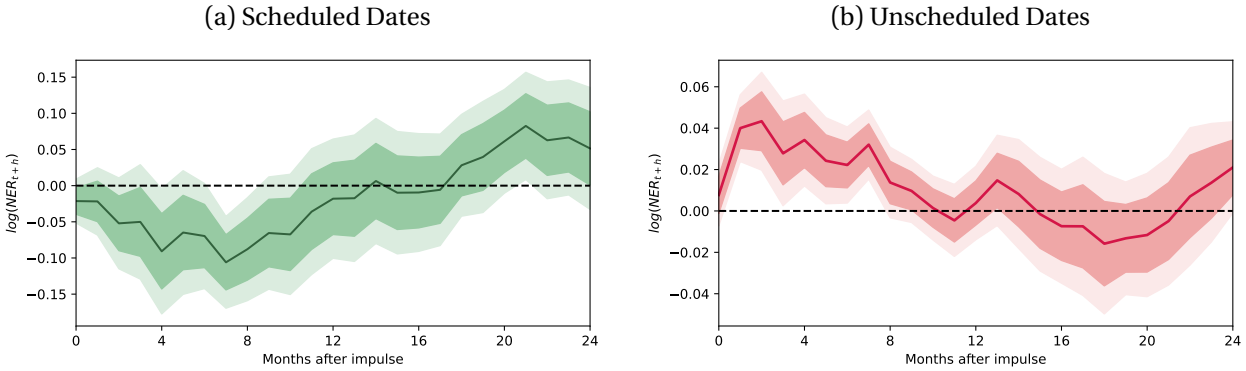
The IRFs for the exchange rate stand in contrast to theories of the Uncovered Interest Parity (UIP) which suggest that the domestic currency should appreciate following an interest rate increase in the domestic country, as foreign investors move their capital into the country to take advantage of the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

However, the results for the exchange rate are much more in line with the UIP condition and with the results on heterogeneity in the responses on scheduled and unscheduled announcement dates when the analysis is restricted to the period post-2011, when capital controls on foreign investment in Indian debt markets were significantly lower and the effects of the global financial crisis were no longer being felt in India. Notable reforms that relaxed capital controls in the Indian debt market during this period, include

Figure A.43: Impulse Response Functions of USD-INR to Monetary Policy Surprises (post-2011)



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 post-January 2011. 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 1.7. 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.

the removal of minimum lock-in periods for foreign ownership of infrastructure-related debt in January 2013 and measures in September 2015 that almost doubled the permitted level of foreign participation in the government debt market, while also moving to a regime where limits were specified as a percentage of the outstanding debt stock.[18] The results for this period are shown in Figure A.43.

Figure A.44 considers the impulse response of the year-on-year change in the Consumer Price Index (CPI) 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. The responses of CPI inflation are considered separately in the periods before and after the introduction of an inflation targeting regime by the RBI, explicitly focused on targeting CPI inflation.[19] In the period before inflation targeting, CPI inflation increases following a monetary policy surprise tightening. However, following the adoption of inflation targeting, there is an immediate and strong decline in CPI inflation in the months immediately following the monetary policy surprise.[20] On unscheduled announcement dates, where there are an insufficient number of unscheduled announcements in the inflation targeting period, there is a statistically insignificant response of CPI inflation to a monetary policy tightening in the entire time sample. The effectiveness of interest rate policy in controlling CPI inflation is significantly dependent on the monetary policy regime in place, with the RBI's inflation targeting framework leading to a much stronger response of CPI inflation to monetary policy surprises. This is in line with recent theoretical work by Cochrane (2024) which suggests that in standard New Keynesian models, the response of inflation to monetary pol-

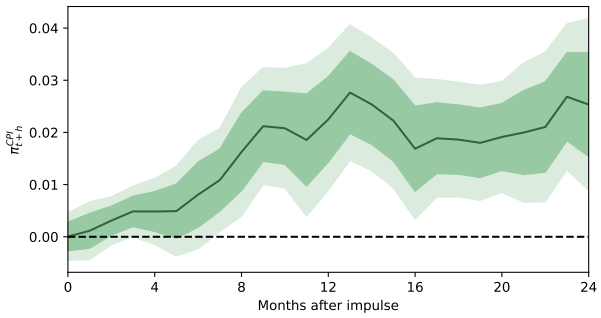
[18] See https://www.reuters.com/article/business/rbi-relaxes-foreign-investment-rules-in-debt-markets-idUSDEE90N06M/ (Accessed November 10, 2025) and https://www.thehindubusinessline.com/money-and-banking/rbi-hikes-fpi-investment-limit-in-gsecs-to-5-of-outstanding-stock/article7701865.ece (Accessed 10 November, 2025) for more details regarding these reforms.

[19] The framework agreement for inflation targeting between the RBI and India's Finance Ministry was signed in February 2015: https://economictimes.indiatimes.com/news/economy/indicators/govt-changes-rule-to-make-rbi-more-accountable-governor-will-have-to-explain-failure-if-inflation-targets-are-not-met/articleshow/46436554.cms.

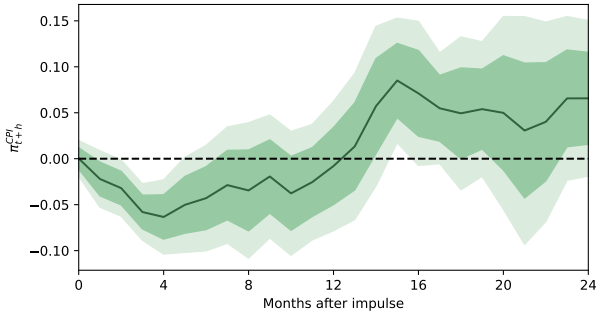
[20] An important concern here is that the IRFs for CPI inflation in the post-2015 period are likely to be confounded by the effects of demonetization. Including dummies for the demonetization period in the IRFs does not significantly alter the dynamics of the CPI response to monetary policy surprises in the Inflation Targeting period.

Figure A.44: Impulse Response Functions of CPI Inflation to Monetary Policy Surprises

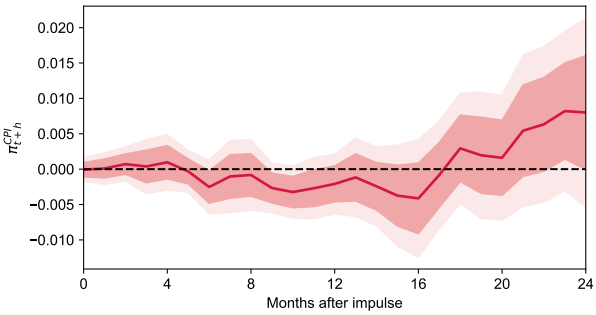
(a) Scheduled Dates (Pre-IT)



(b) Scheduled Dates (Post-IT)



(c) Unscheduled Dates



Notes: This figure shows the impulse responses of the year-on-year change in the Consumer Price Index (CPI) to a 100-basis point contractionary monetary policy surprise on scheduled (pre and post March 2015) 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 1.7. 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.

icy shocks is highly dependent on equilibrium selection i.e., the monetary-fiscal regime.

The rise in CPI inflation and the depreciation of the nominal exchange rate following a monetary policy tightening on scheduled announcement dates during the period with tighter capital controls also points to the potential role of monetary policy tightenings acting as cost-push shocks in the Indian context during this time period, as the depreciation induced by higher interest rates leads to higher import prices, particularly of energy, which is a key component of the household consumption basket in India.

A.11.2 Robustness of the results to using longer maturity MIBOR-OIS surprises

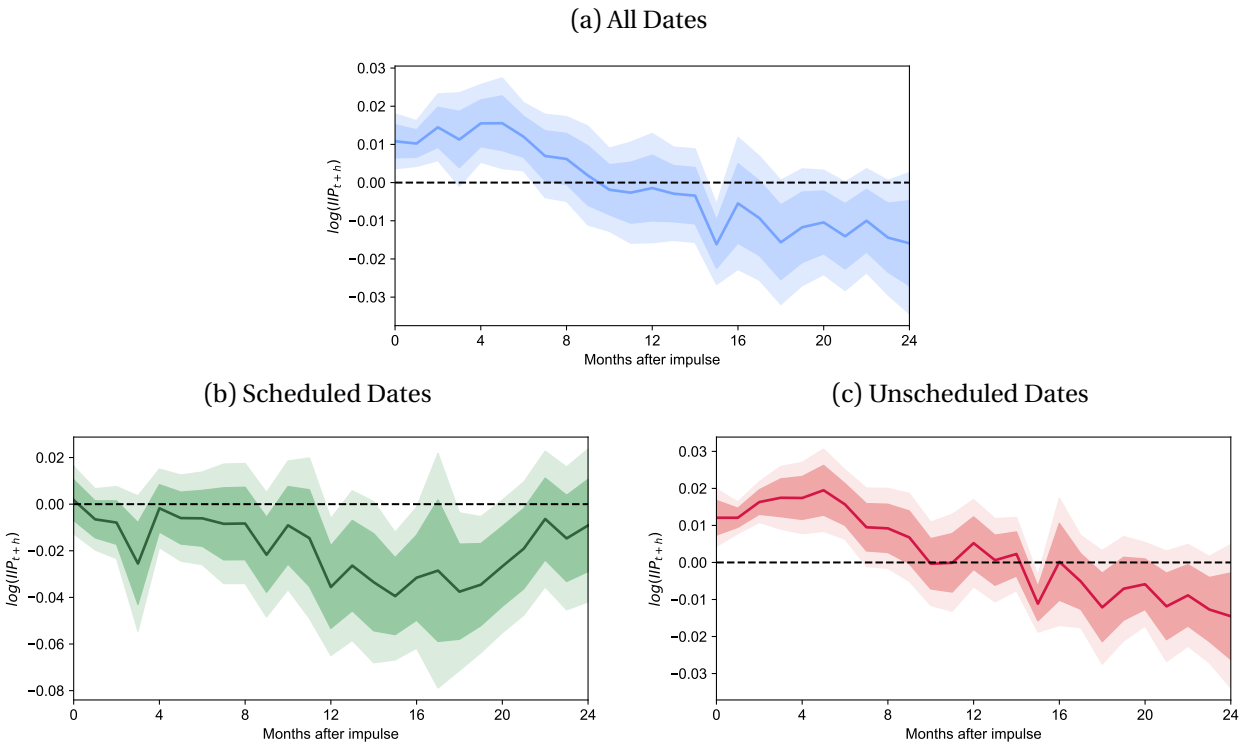
This section investigates the robustness of the heterogeneity in the impulse responses of macroeconomic variables to monetary policy surprises on scheduled and unscheduled announcement dates to the use of longer maturity MIBOR-OIS surprises. The results in this section are based on the Local Projection Specification in Section 1.7. In particular, the results in this section are based on monetary policy surprises constructed using 3-month and 1-year MIBOR-OIS contracts, while keeping all other variables unchanged in the main LP specification.

Figures A.45 and A.46 consider the impulse responses of the Index of Industrial Production (IIP) and Wholesale Price Index (WPI) Inflation to monetary policy surprises on all, scheduled and unscheduled announcement dates using 3-month MIBOR-OIS surprises. The results are very similar to those obtained using 1-month MIBOR-OIS surprises. The IIP declines following a monetary policy tightening on scheduled announcement dates, while it increases on unscheduled announcement dates. WPI inflation declines with a lag following a monetary policy tightening on scheduled announcement dates, while it increases on impact on unscheduled announcement dates. Moreover, the pooled responses of both IIP and WPI inflation to monetary policy surprises closely mirror the responses on unscheduled announcement dates, as was the case with 1-month MIBOR-OIS surprises.

Figures A.47 and A.48 consider the impulse responses of the Index of Industrial Production (IIP) and Wholesale Price Index (WPI) Inflation to monetary policy surprises on scheduled and unscheduled announcement dates using 1-year MIBOR-OIS surprises. Here too, the results are very similar to those obtained using 1-month MIBOR-OIS surprises. The IIP declines following a monetary policy tightening on scheduled announcement dates, while it increases on unscheduled announcement dates. WPI inflation declines following a monetary policy tightening on scheduled announcement dates but is not statistically significant, while it increases on impact on unscheduled announcement dates. The pooled sample responses of both IIP and WPI inflation to monetary policy surprises closely mirror the responses on unscheduled announcement dates, as was the case with 1-month MIBOR-OIS surprises.

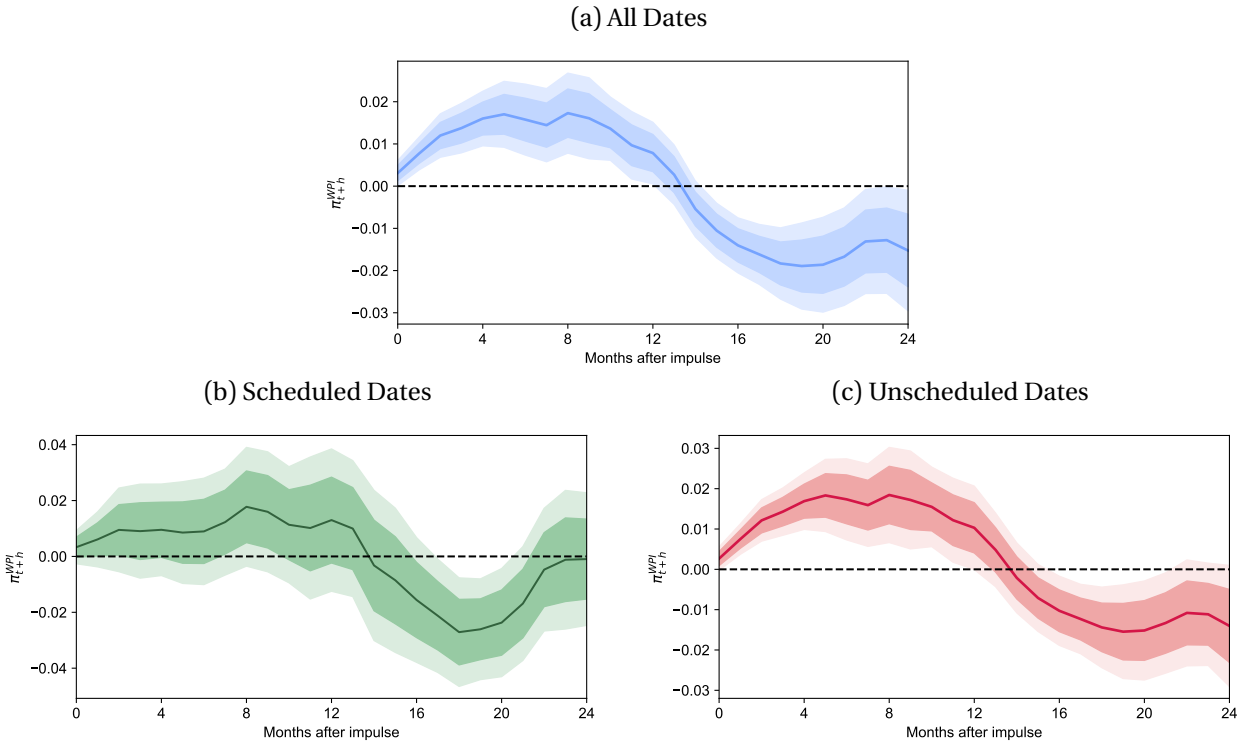
As a result, the results in Section 1.7 are not driven by the choice of the maturity of the MIBOR-OIS contracts used to construct monetary policy surprises. The results in this section, taken together with the evidence presented in Appendix A.2.3, suggest that the heterogeneity in the impulse responses of macroeconomic variables to monetary policy surprises on scheduled and unscheduled announcement dates is robust to the use of monetary policy surprises constructed using different maturity MIBOR-OIS contracts. Moreover, the results further suggest that the power-identification tradeoff discussed in the paper in the context of the 1-month MIBOR-OIS monetary policy surprsies are also relevant for the 3-month and 1-year MIBOR-OIS monetary policy surprises.

Figure A.45: IRFs of Industrial Production to Monetary Policy Surprises (3m MIBOR-OIS)



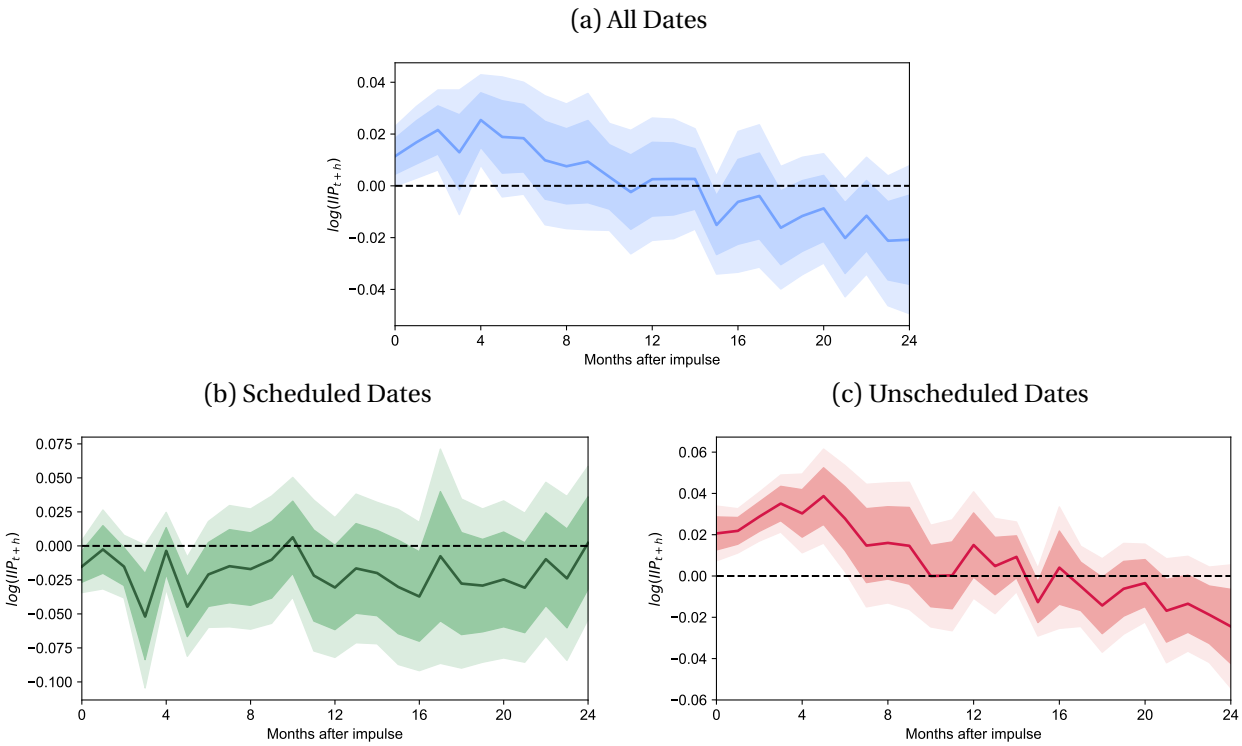
Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on all, scheduled and unscheduled announcement dates of the RBI. The dependent variable is the logarithm of the IIP. Data between August 1999 and March 2020 is used in the analysis. The monetary policy surprises are computed as the two-day change in the 3-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 1.7. 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 3-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

Figure A.46: IRFs of WPI Inflation to Monetary Policy Surprises (3m MIBOR-OIS)



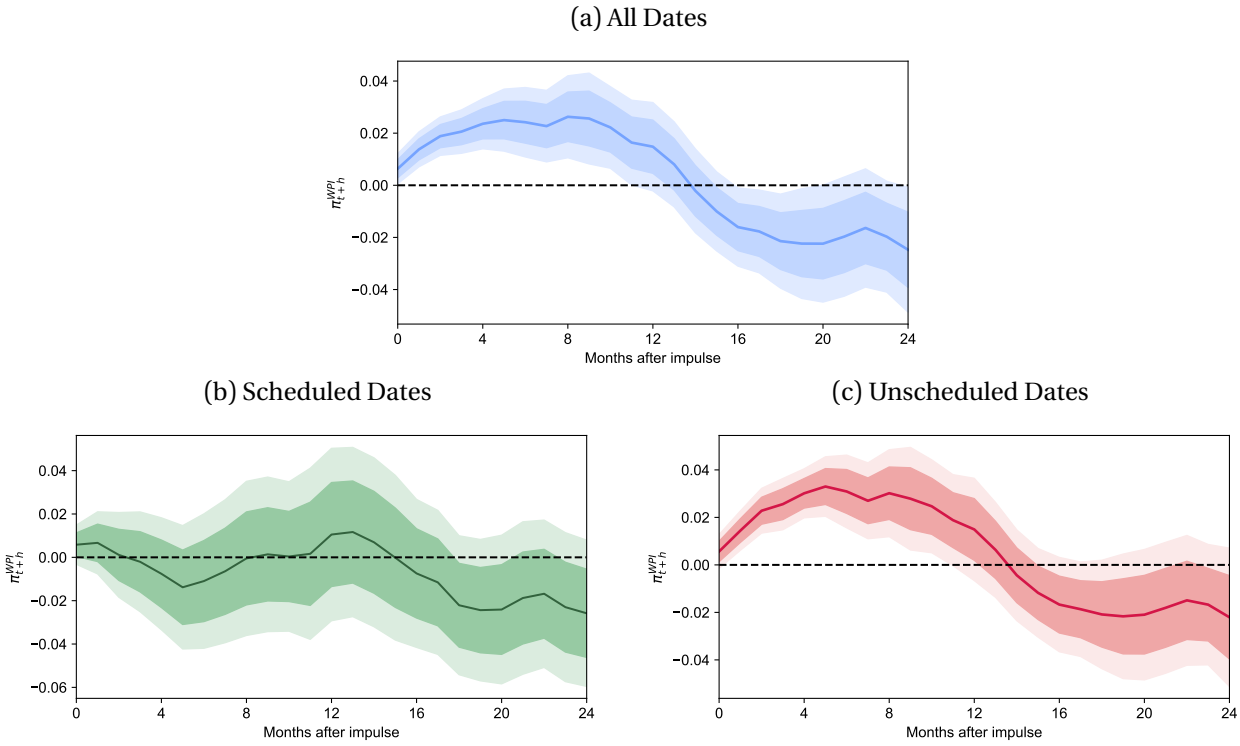
Notes: This figure shows the impulse responses of the year-on-year change in the Wholesale Price Index (WPI) to a 100-basis point contractionary monetary policy surprise on all, scheduled and unscheduled announcement dates of the RBI. The dependent variable is the year-on-year change in the WPI calculated 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 3-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 1.7. 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 3-month MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

Figure A.47: IRFs of Industrial Production to Monetary Policy Surprises (1y MIBOR-OIS)



Notes: This figure shows the impulse responses of the Index of Industrial Production (IIP) to a 100-basis point contractionary monetary policy surprise on all, 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-year MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 1.7. 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-year MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

Figure A.48: IRFs of WPI Inflation to Monetary Policy Surprises (1y MIBOR-OIS)



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 all, 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-year MIBOR-OIS fixed rate around monetary policy announcement dates of the RBI. The IRFs are estimated using a Local Projection specification outlined in Section 1.7. 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-year MIBOR-OIS is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

Bibliography

Acosta, Miguel, "The Perceived Causes of Monetary Policy Surprises," *Working Paper*, 2023.

Bauer, Michael D. and Eric T. Swanson, "An Alternative Explanation for the "Fed Information Effect"," *The American Economic Review*, 2023, *113* (3), 664–700.

_ **and** _ , "A Reassessment of Monetary Policy Surprises and High-Frequency Identification," *NBER Macroeconomics Annual 2022*, May 2023, *37*, 87–155.

Bernanke, Ben S. and Kenneth N. Kuttner, "What Explains the Stock Market's Reaction to Federal Reserve Policy?," *Journal of Finance*, 2005, *60* (3), 1221–1257.

CCIL, "CCIL IRS/FRA Trade Repository," https://www.ccilindia.com/IRSS_HOME.aspx 2024. Accessed: 2024-02-23.

_ , "CCIL Monthly Newsletter, December 2023," https://www.ccilindia.com/Documents/Rakshitra/2024/Jan/Statistics.pdf 2024. Accessed: 2024-02-23.

Cochrane, John H., "Expectations and the Neutrality of Interest Rates," *Review of Economic Dynamics*, 2024, *53*, 194–223.

Coibion, Olivier and Yuriy Gorodnichenko, "Information Rigidity and the Expectations Formation Process: A Simple Framework and New Facts," *The American Economic Review*, 2015, *105* (8), 2644–2678.

Frankel, Jeffrey, "Monetary Policy in Emerging Markets," in Benjamin M. Friedman and Michael Woodford, eds., *Handbook of Monetary Economics*, Vol. 3, Amsterdam: Elsevier, 2010, pp. 1439–1520.

Goyal, Ashima and Sanchit Arora, "The Indian exchange rate and Central Bank action: An EGARCH analysis," *Journal of Asian Economics*, 2012, *23* (1), 60–72.

Gürkaynak, Refet S., A. Hakan Kara, Burçin Kısacıkoğlu, and Sang Seok Lee, "Monetary Policy Surprises and Exchange Rate Behavior," *Journal of International Economics*, 2021, *130* (103443), 1–24.

_ **, Brian T. Sack, and Eric T. Swanson**, "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements," *International Journal of Central Banking*, 2005, *1* (1), 55–93.

_ **,** _ **, and** _ , "Market-Based Measures of Monetary Policy Expectations," *Journal of Business & Economic Statistics*, 2007, *25* (2), 201–212.

Jacobson, Margaret M., Christian Matthes, and Todd B. Walker, "Temporal Aggregation Bias and Monetary Policy Transmission," *Working Paper*, 2024.

Jarociński, Marek and Peter Karadi, "Deconstructing Monetary Policy Surprises - The Role of Information Shocks," *American Economic Journal: Macroeconomics*, 2020, *12* (2), 1–43.

Kilian, Lutz, "How to Construct Monthly VAR Proxies Based on Daily Surprises in Futures Markets," *Working Paper*, 2024.

Lakdawala, Aeimit and Rajeswari Sengupta, "Measuring Monetary Policy Shocks in Emerging Economies: Evidence from India," *Journal of Money, Credit and Banking*, 2025, *57* (2-3), 407–437.

Ministry of Commerce & Industry, "Release of Wholesale Price Index (WPI) on a monthly basis," https://archive.pib.gov.in/newsite/PrintRelease.aspx?relid=53259 2009. 19th October 2009. Accessed: 2024-12-27.

_ , "WPI Weekly Discontinued with Immediate Effect," https://pib.gov.in/newsite/PrintRelease.aspx?relid=80051 2012. 2nd February 2012. Accessed: 2024-12-27.

Ministry of Statistics and Programme Implementation, "Manual on Index of Industrial Production (IIP)," https://www.mospi.gov.in/sites/default/files/publication_reports/manual_iip_23oct08_0.pdf 2008. 23rd October 2008. Accessed: 2024-12-28.

_ , "Consumer Price Index: Changes in the revised series (Base Year 2012=100)," https://cpi.mospi.gov.in/PDFile/CPI-Changes_in_the_Revised_Series.pdf 2015. Accessed: 2024-12-28.

_ , "Statement on Release Calendar of Annual and Quarterly Estimates of GDP and policy of revision of Annual & Quarterly Estimates of GDP and related Macro-economic Aggregates," https://mospi.gov.in/sites/default/files/press_releases_statements/Modification_Rev%20Policy_16.11.2016.pdf 2016. 16th November 2016. Accessed: 2025-1-12.

Nakamura, Emi and Jon Steinsson, "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect," *The Quarterly Journal of Economics*, January 2018, *133* (3), 1283–1330.

Office of the Economic Adviser, "Manual on Compilation of Index Number of Wholesale Prices in India," https://web.archive.org/web/20060613032438/http://eaindustry.nic.in/manual_out.htm 2006. 13th June 2006. Accessed 2024-12-28.

_ , "Metadata - Wholesale Price Index," https://eaindustry.nic.in/pdf_files/Metadata_WPI.pdf 2024. Accessed: 2024-12-28.

Olea, José Luis Montiel and Mikkel Plagborg-Møller, "Local Projection Inference is Simpler and More Robust than You Think," *Econometrica*, 2021, *89* (4), 1789–1823.

Pagan, Adrian, "Econometric Issues in the Analysis of Regressions with Generated Regressors," *International Economic Review*, 1984, *25* (1), 221–247.

Patnaik, Ila and Ajay Shah, "Did the Indian Capital Controls Work as a Tool of Macroeconomic Policy?," *IMF Economic Review*, 2013, *60* (3), 439–464.

_ , **Sarat Malik, Radhika Pandey, and Prateek**, "Foreign investment in the Indian Government bond market," *Working Paper*, 2013.

Pawaskar, Vardhana and Payal Ghose, "The Changing Dynamics of the Indian Interest Rate Derivatives Market," *CCIL Monthly Newsletter*, 2019, *January 2019*, 7–22.

Pirozhkova, Ekaterina, Giovanni Ricco, and Nicola Viegi, "Trouble Every Day: Monetary Policy in an Open Emerging Economy," *Working Paper*, 2024.

RBI, "Communication Policy of the RBI," https://web.archive.org/web/20181029064140/https://rbi.org.in/Scripts/CommunicationPolicy.aspx 2018. Accessed: 2024-03-06.

The Times of India, "RBI may keep key rates unchanged," 2007. 31st July 2007.

_ , "RBI to focus on inflation, hike in key rates likely," 2007. 23rd April 2007.

_ , "Bad Friday," 2008. 24th October 2008.

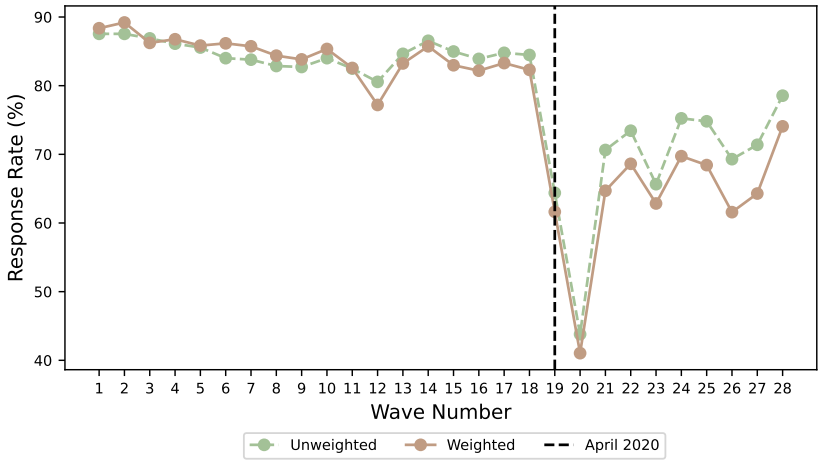
Witheridge, William, "Monetary Policy and Fiscal-led Inflation in Emerging Markets," *Working Paper*, 2024.

Appendix B

Appendix to Chapter 2

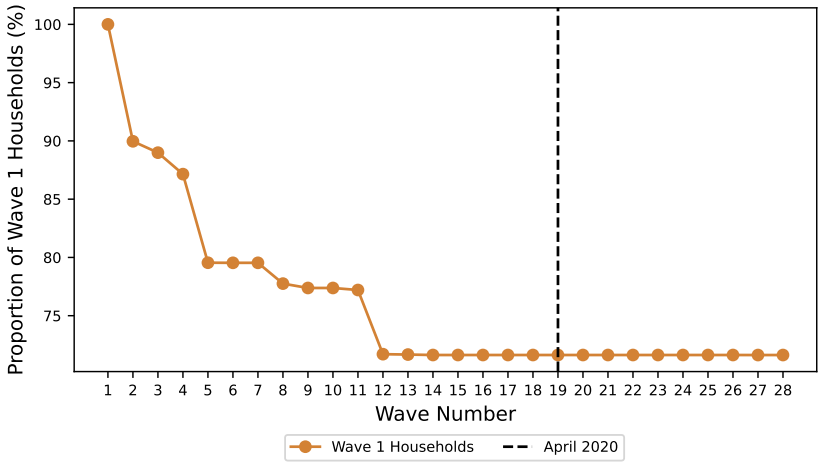
B.1 Response rates and attrition in CPHS

Figure B.1: Response Rates in the CPHS, January 2014 to April 2023



Notes: This figure plots the wave-level weighted and unweighted response rates amongst surveyed households in the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS) between January 2014 and April 2023, corresponding to the first 28 survey waves of the CPHS. Data from the Aspirational India module of the CPHS is used in this analysis. The unweighted response rate refers to the proportion of 'Accepted' survey responses [**RESPONSE_STATUS**] amongst all surveyed households in each wave [**WAVE_NO**] of the Aspirational India dataset. The weighted response rates are calculated by weighting both the accepted responses and total surveyed households by their respective wave-level survey weights [**HH_WGT_W**]. The last wave survey wave in our sample, ending in April 2020, is marked for reference.

Figure B.2: Attrition of Wave 1 households in the CPHS, January 2014 to April 2023

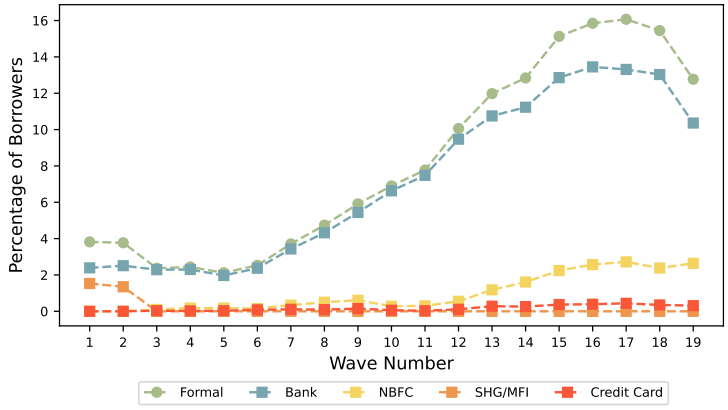


Notes: This figure plots the proportion of households [**HH_ID**] present in Wave 1 of the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS) who continue to be present in subsequent waves of the survey for the period between January 2014 and April 2023, corresponding to the first 28 survey waves. Data from the Aspirational India module of the CPHS is used. The last wave survey wave in our sample, ending in April 2020, is marked for reference.

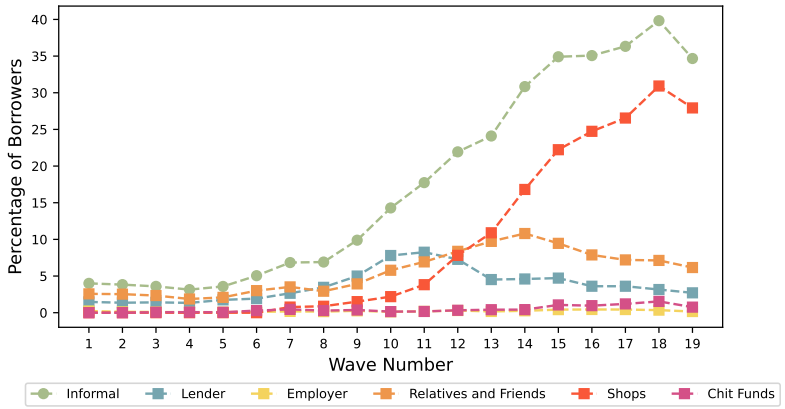
B.2 Time-series trends in financial inclusion in CPHS

Figure B.3: Components of Formal and Informal borrowing in the CPHS, January 2014 to April 2020

(a) Formal Borrowing



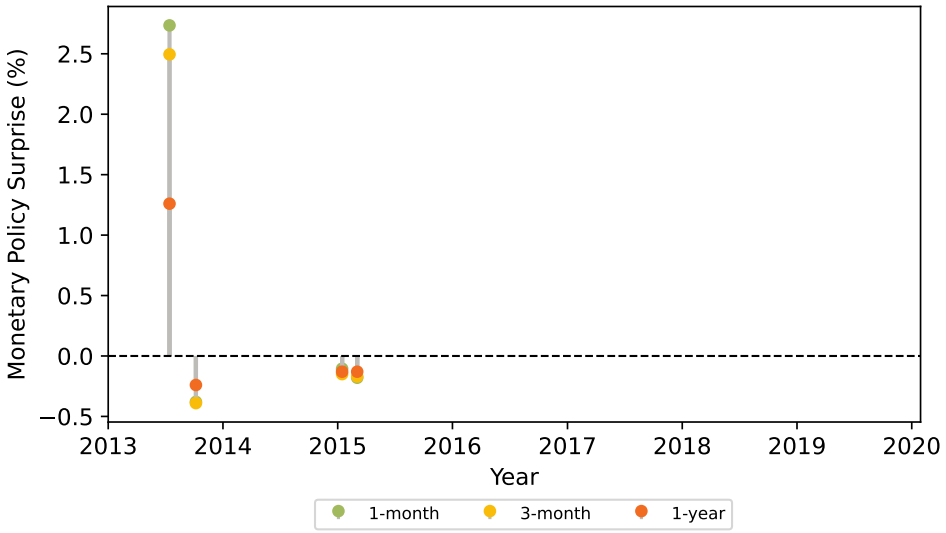
(b) Informal Borrowing



Notes: This figure shows the time series of the proportion of surveyed households in India who borrow from different formal and informal credit sources. The first panel shows the proportion of households who had borrowed from a formal credit source in that wave. The second panel shows the proportion of households who had borrowed from an informal credit source in that wave. Data from the first 19 waves of the Consumer Pyramids Household Survey (CPHS) of the Centre for Monitoring the Indian Economy (CMIE) are used in the analysis, corresponding to the period between January 2014 and April 2020. In particular, data from the Aspirational India module for households with accepted survey responses [**RESPONSE_STATUS**] are used to compute measures of formal and informal borrowing. Formal borrowers refers to households in each wave who borrow from either banks [**BORR_FRM_BANK**], non-bank financial companies [**BORR_FRM_NBFC**], self-help groups or microfinance institutions [**BORR_FRM_SHG_MFI**] and credit cards [**BORR_FRM_CC**]. Informal borrowers refers to households in each wave who borrow from either moneylenders [**BORR_FRM_LENDER**], employers [**BORR_FRM_EMPLOYER**], relatives or friends [**BORR_FRM_REL_FRNDS**], shops [**BORR_FRM_SHOPS**] or chit funds [**BORR_FRM_CHTFUND**]. In order to construct the proportion of households borrowing from formal and informal sources at the wave level, all households borrowing from any particular formal or informal sources are weighted by their wave-level survey weights [**HH_WGT_W**] adjusted for non-response [**HH_NR_W**].

B.3 Monetary policy surprises on unscheduled announcement dates

Figure B.4: Monetary policy surprises on unscheduled announcement dates



Notes: This figure plots the monetary policy surprises for India computed from MIBOR-OIS contracts of different maturities between April 2013 and October 2019. The monetary policy surprises are calculated as the two-day change in the fixed leg of 1-month, 3-month and 1-year MIBOR-OIS contracts around unscheduled announcement dates of the RBI. Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. Monetary policy announcement dates of the RBI are sourced from Narayan (2026).

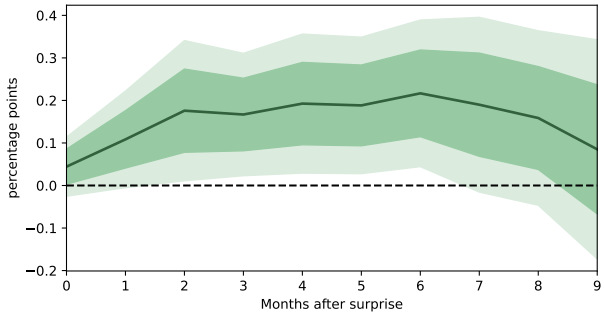
Table B.1: Summary statistics of monetary policy surprises on unscheduled announcement dates

	N	Mean	Std.Dev	min	25%	50%	75%	max
1-month	4	0.850	1.483	-0.380	-0.230	-0.143	0.605	2.735
3-month	4	0.801	1.370	-0.390	-0.225	-0.160	0.511	2.495
1-year	4	0.440	0.715	-0.240	-0.158	-0.130	0.218	1.260

Notes: This table documents the summary statistics for monetary policy surprises for India computed from MIBOR-OIS contracts of different maturities between April 2013 and October 2019. The monetary policy surprises are calculated as the two-day change in the fixed leg of 1-month, 3-month and 1-year MIBOR-OIS contracts around scheduled announcement dates of the RBI. Mean refers to mean of the absolute changes in the fixed leg of the relevant MIBOR-OIS contract on monetary policy announcement dates. Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. Monetary policy announcement dates of the RBI are sourced from Narayan (2026).

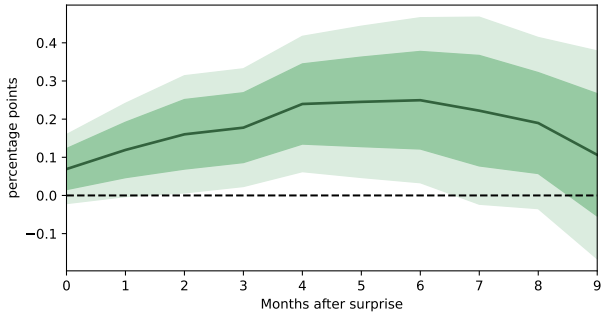
B.4 Persistence of monetary policy surprises

Figure B.5: Impulse Response Function of Overnight MIBOR to Monetary Surprises



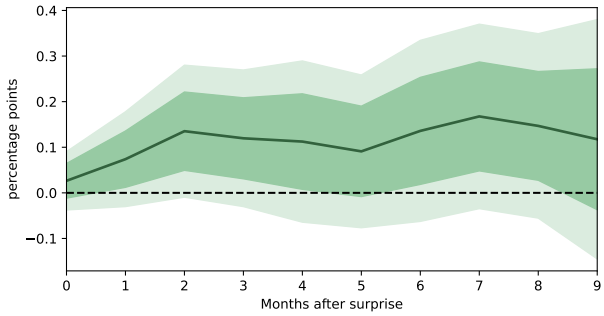
Notes: The above figure plots the impulse response function of the overnight Mumbai Interbank Outright Rate (MIBOR) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on heteroscedasticity-robust standard errors are displayed. The impulse response function is estimated using Equation 2.1 outlined in the main text, but with overnight MIBOR in levels, and a control for the first lag of overnight MIBOR relative to month t in place of the lagged outcome variables, and without an index for HR as there is only a single observation per month. Data on Overnight MIBOR is from Bloomberg Terminal with ticker: IN00O/N Index. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

Figure B.6: Impulse Response Function of Overnight MIBOR to Monetary Surprises (1-month)



Notes: The above figure plots the impulse response function of the overnight Mumbai Interbank Outright Rate (MIBOR) to a 10 basis points change in the 1-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on heteroscedasticity-robust standard errors are displayed. The impulse response function is estimated using Equation 2.1 outlined in the main text, but with overnight MIBOR in levels, and a control for the first lag of overnight MIBOR relative to month t in place of the lagged outcome variables, and without an index for HR as there is only a single observation per month. Data on Overnight MIBOR is from Bloomberg Terminal with ticker: IN00O/N Index. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

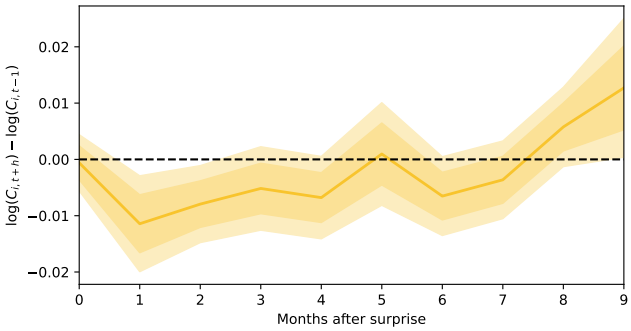
Figure B.7: Impulse Response Function of Overnight MIBOR to Monetary Surprises (1-year)



Notes: The above figure plots the impulse response function of the overnight Mumbai Interbank Outright Rate (MIBOR) to a 10 basis points change in the 1-year MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on heteroscedasticity-robust standard errors are displayed. The impulse response function is estimated using Equation 2.1 outlined in the main text, but with overnight MIBOR in levels, and a control for the first lag of overnight MIBOR relative to month t in place of the lagged outcome variables, and without an index for HR as there is only a single observation per month. Data on Overnight MIBOR is from Bloomberg Terminal with ticker: IN00O/N Index. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

B.5 Robustness for monetary policy transmission at the aggregate level

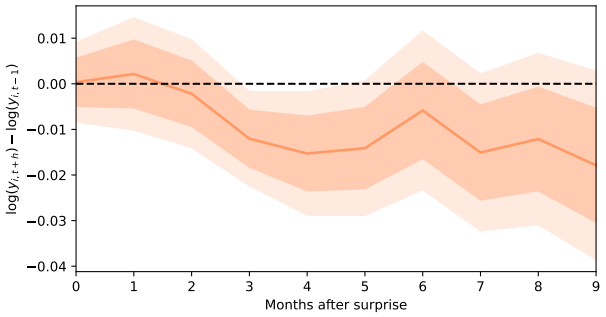
Figure B.8: Impulse Response Functions of Consumption to Monetary Surprises (Total Expenditure)



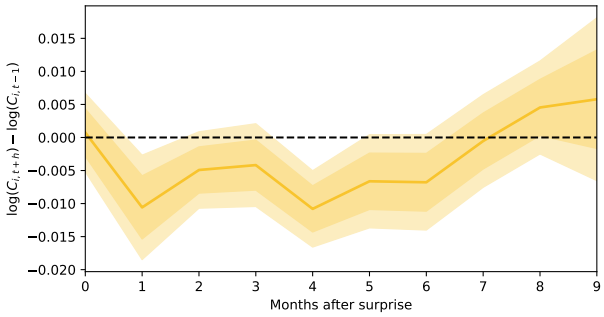
Notes: The above figures plot the impulse response functions of household consumption (in logarithms) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. The impulse response function is estimated using Equation 2.1 outlined in the main text. Household consumption is obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**]. Data on household consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of consumption expenditure are aggregated to the level of the CPHS Homogeneous Region using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

Figure B.9: Impulse Response Functions of Income and Consumption to Monetary Surprises (1-month)

(a) Household Income



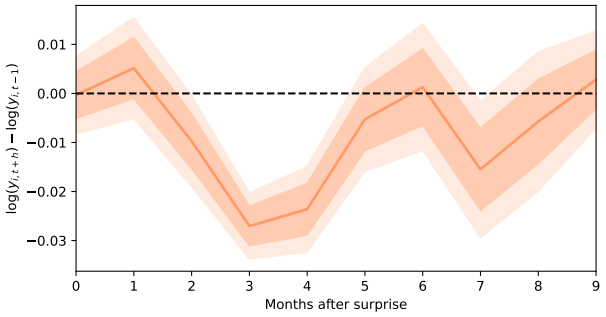
(b) Household Consumption



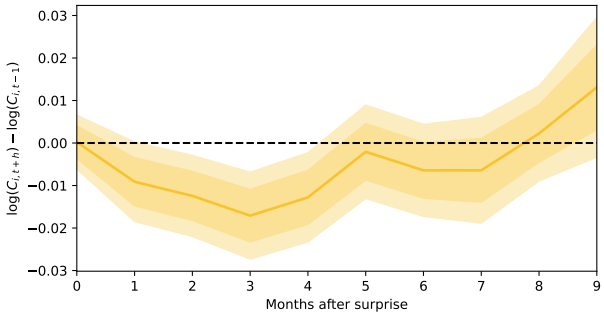
Notes: The above figures plot the impulse response functions of household income and household consumption (in logarithms) to a 10 basis points change in the 1-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. The impulse response functions are estimated using Equation 2.1 outlined in the main text. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household income refers to income of all household members from all sources [**TOT_INC**]. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**] net of EMIs [**M_EXP_ALL_EMIS**], remittances sent [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Data on household income and consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of income and consumption expenditure are aggregated to the level of the CPHS Homogeneous Region using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure B.10: Impulse Response Functions of Income and Consumption to Monetary Surprises (1-year)

(a) Household Income

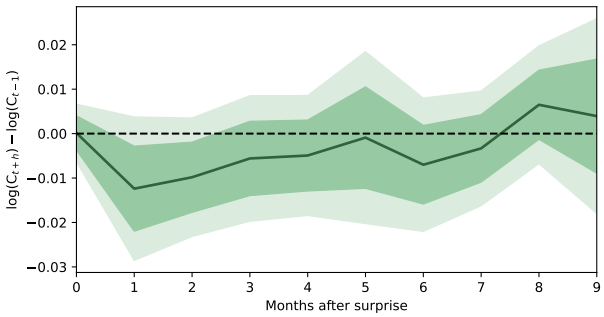


(b) Household Consumption



Notes: The above figures plot the impulse response functions of household income and household consumption (in logarithms) to a 10 basis points change in the 1-year MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. The impulse response functions are estimated using Equation 2.1 outlined in the main text. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household income refers to income of all household members from all sources [**TOT_INC**]. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**] net of EMIs [**M_EXP_ALL_EMIS**], remittances sent [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Data on household income and consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of income and consumption expenditure are aggregated to the level of the CPHS Homogeneous Region using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

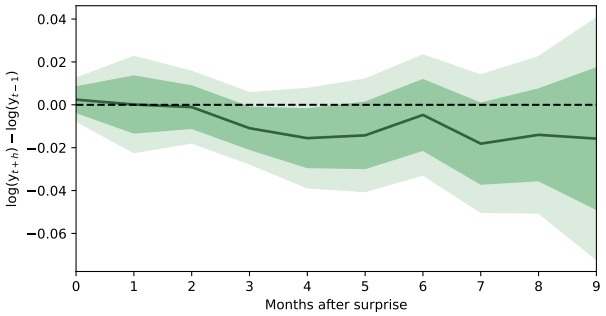
Figure B.11: Impulse Response Functions of Aggregate Consumption to Monetary Surprises (Total Expenditure)



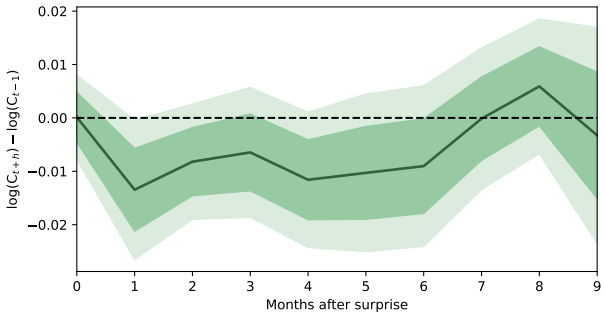
Notes: The above figures plot the impulse response functions of aggregate monthly household consumption (in logarithms) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on heteroscedasticity-robust standard errors are displayed. The impulse response function is estimated using Equation 2.1 outlined in the main text, but without an index for HR, as there is only a single observation per month. Household consumption data is obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**]. Data on household consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of consumption expenditure are aggregated to the level of India using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

Figure B.12: Impulse Response Functions of Aggregate Economic Outcomes to Monetary Surprises (1-month)

(a) Household Income



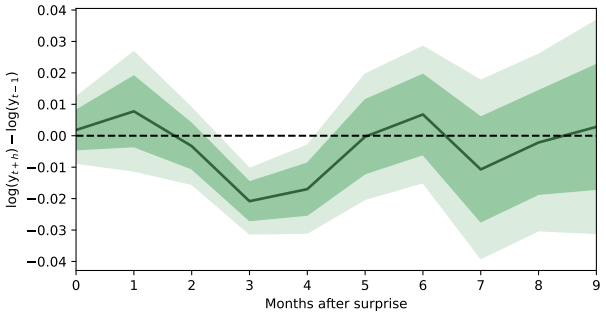
(b) Household Consumption



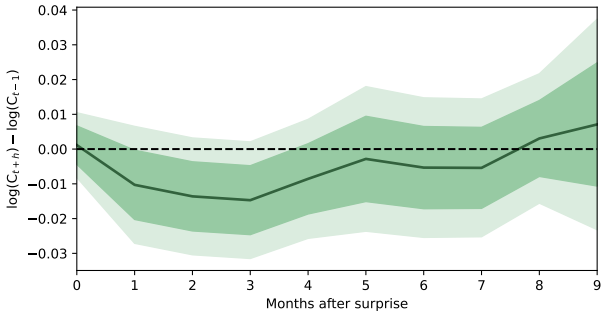
Notes: The above figures plot the impulse response functions of aggregate monthly household income and household consumption (in logarithms) to a 10 basis points change in the 1-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on heteroscedasticity-robust standard errors are displayed. The impulse response functions are estimated using Equation 2.1 outlined in the main text, but without an index for HR, as there is only a single observation per month. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household income refers to income of all household members from all sources [**TOT_INC**]. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**] net of EMIs [**M_EXP_ALL_EMIS**], remittances sent [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Data on household income and consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of income and consumption expenditure are aggregated to the level of India using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy.

Figure B.13: Impulse Response Functions of Aggregate Economic Outcomes to Monetary Surprises (1-year)

(a) Household Income



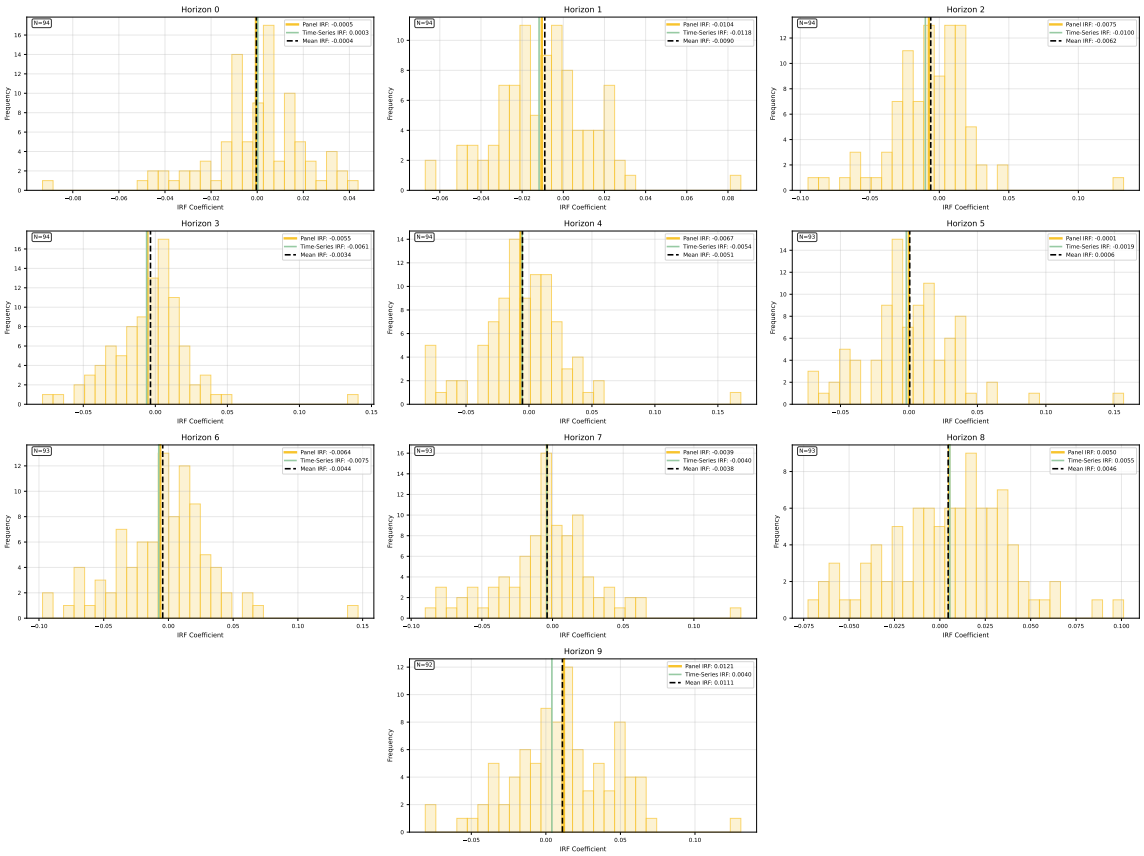
(b) Household Consumption



Notes: The above figures plot the impulse response functions of aggregate monthly household income and household consumption (in logarithms) to a 10 basis points change in the 1-year MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on heteroscedasticity-robust standard errors are displayed. The impulse response functions are estimated using Equation 2.1 outlined in the main text, but without an index for HR, as there is only a single observation per month. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household income refers to income of all household members from all sources [**TOT_INC**]. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**] net of EMIs [**M_EXP_ALL_EMIS**], remittances sent [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Data on household income and consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of income and consumption expenditure are aggregated to the level of India using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy.

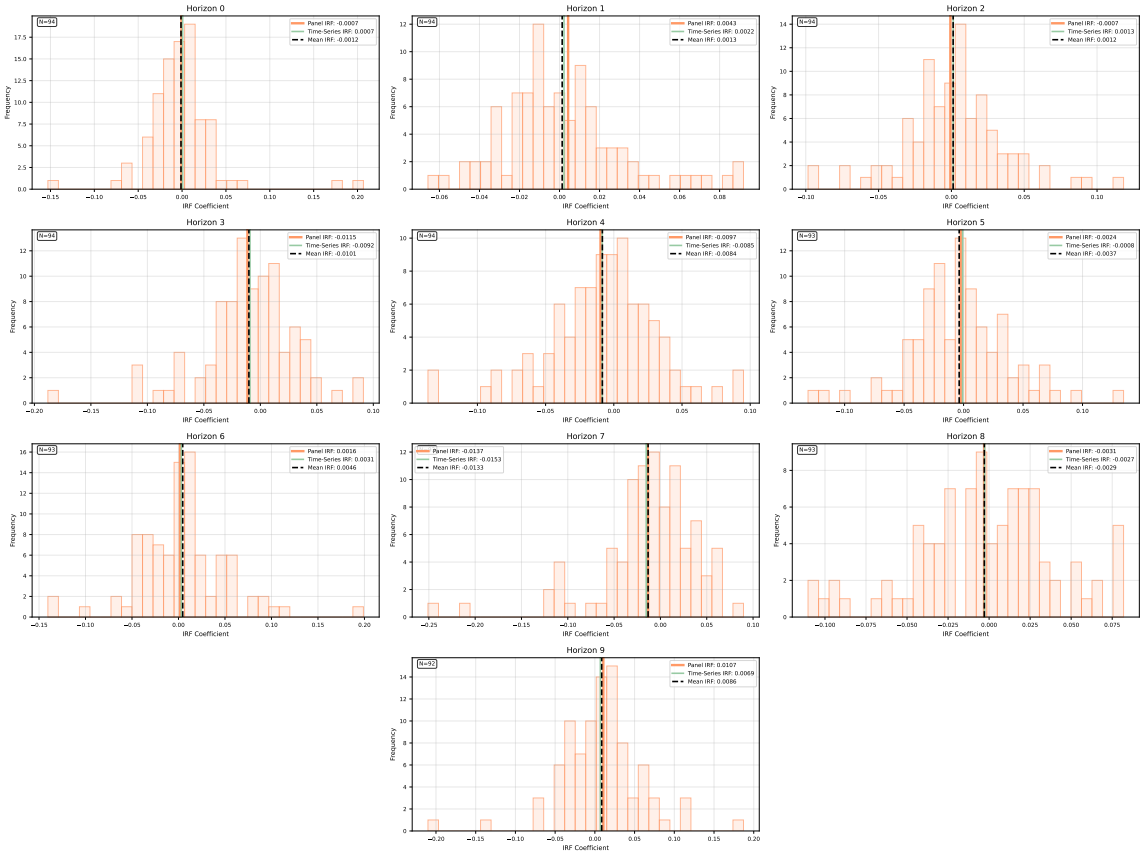
B.6 Monetary policy transmission by Homogeneous Region

Figure B.14: Impulse Response Functions of Household Consumption to Monetary Surprises by HR



Notes: The above figures plots the distribution across CPHS Homogeneous Regions (HRs) of the impulse response function of household consumption (in logarithms) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. The impulse response functions are estimated separately for each HR using a time-series version of Equation 2.1. Household consumption data is obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on consumption expenditure is from the Consumption Pyramids module of the CPHS. Household consumption refers to total household consumption expenditure [**ADJ_TOT_EXP**] net of EMIs [**M_EXP_ALL_EMIS**], remittances sent [**M_EXP_REMITTANCES_SENT**] and payments towards social [**M_EXP_SOCIAL_OBLIGATIONS**] and religious obligations [**M_EXP_RELIGIOUS_OBLIGATIONS**]. Data on household consumption expenditure for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of consumption expenditure are aggregated to the level of the CPHS Homogeneous Region using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. For each horizon, the panel regression coefficient from estimating Equation 2.1, the aggregate time series regression coefficient and the mean of the HR-level coefficients are also displayed.

Figure B.15: Impulse Response Functions of Household Income to Monetary Surprises by HR



Notes: The above figures plots the distribution across CPHS Homogeneous Regions (HRs) of the impulse response function of household income (in logarithms) to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. The impulse response functions are estimated separately for each HR using a time-series version of Equation 2.1. Household income data is obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module of the CPHS. Household income refers to total household income [**TOT_INC**]. Data on household income for households with accepted survey responses [**RESPONSE_STATUS**] and positive values of income are aggregated to the level of the CPHS Homogeneous Region using appropriate monthly survey weights [**HH_WGT_MS**] adjusted for non-response [**HH_NR_MS**]. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. For each horizon, the panel regression coefficient from estimating Equation 2.1, the aggregate time series regression coefficient and the mean of the HR-level coefficients are also displayed.

B.7 Financial inclusion and monetary transmission: Additional results

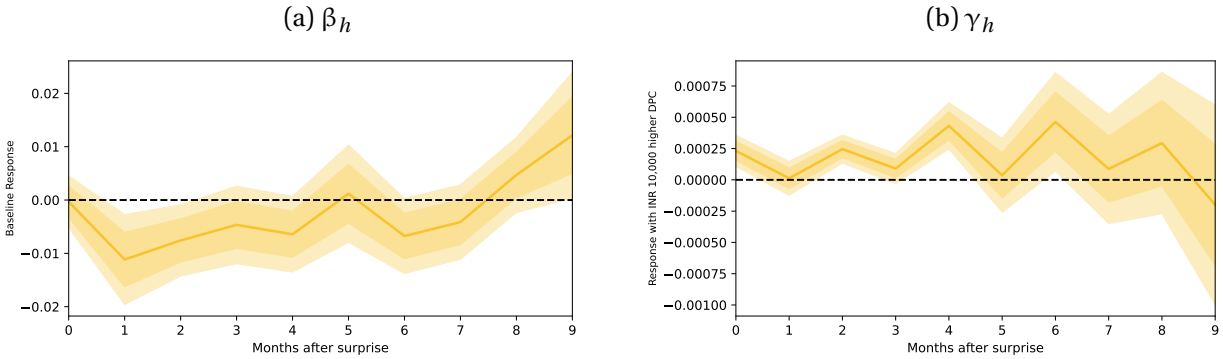
B.7.1 Robustness of OLS Evidence

Figure B.16: Financial inclusion and monetary policy transmission: OLS evidence (Q1 2014 DPC)



Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.2, with the deposits per capita indicator variable replaced with a continuous measure of deposits per capita in the quarter ending March 2014. γ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 higher deposits per capita to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Deposits per capita is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*.

Figure B.17: Financial inclusion and monetary policy transmission: OLS evidence (Total Expenditure)



Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.3. γ_h captures the differential response of total household consumption expenditure (in logarithms) associated with ₹ 10,000 higher deposits per capita to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household consumption is obtained from the Consumption Pyramids module of the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). Further details about the calculation of consumption at the HR-Month level can be found in the notes to Figure B.8. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks.* Data on population in each HR is from the *Census of India, 2011.* Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

Figure B.18: Financial inclusion and monetary policy transmission: OLS evidence (1-month)



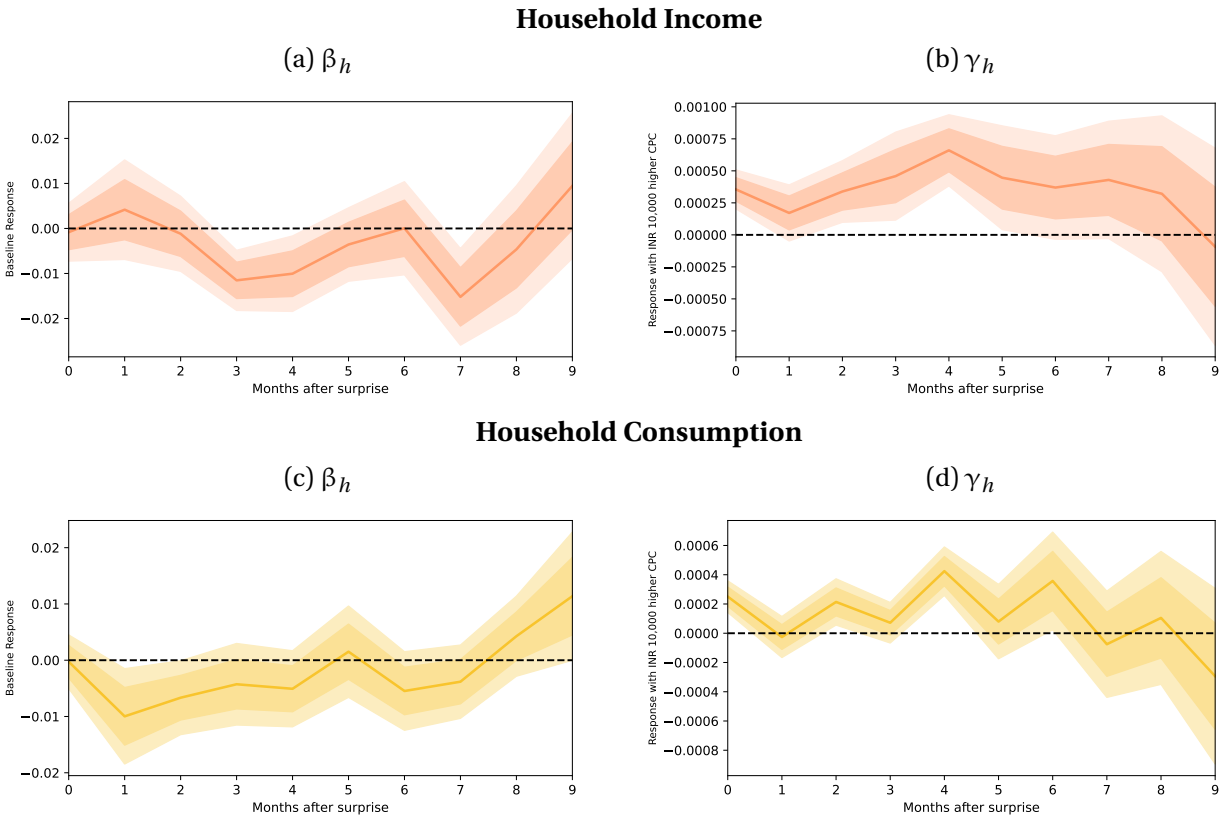
Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.3. γ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 higher deposits per capita to a 10 basis points change in the 1-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOA BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

Figure B.19: Financial inclusion and monetary policy transmission: OLS evidence (1-year)



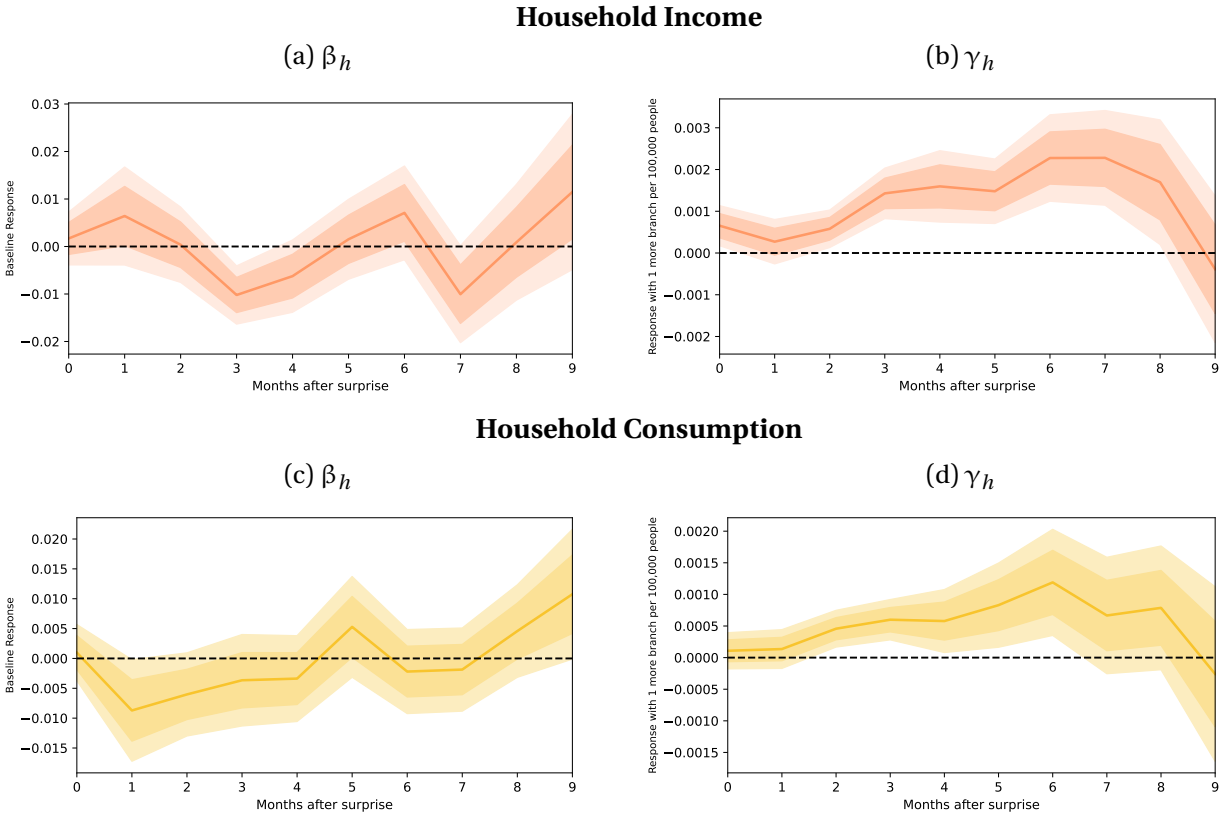
Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.3. γ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 higher deposits per capita to a 10 basis points change in the 1-year MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 1-year MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWO1 BGN Curncy. Data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

Figure B.20: Financial inclusion and monetary policy transmission: OLS evidence (credit per capita)



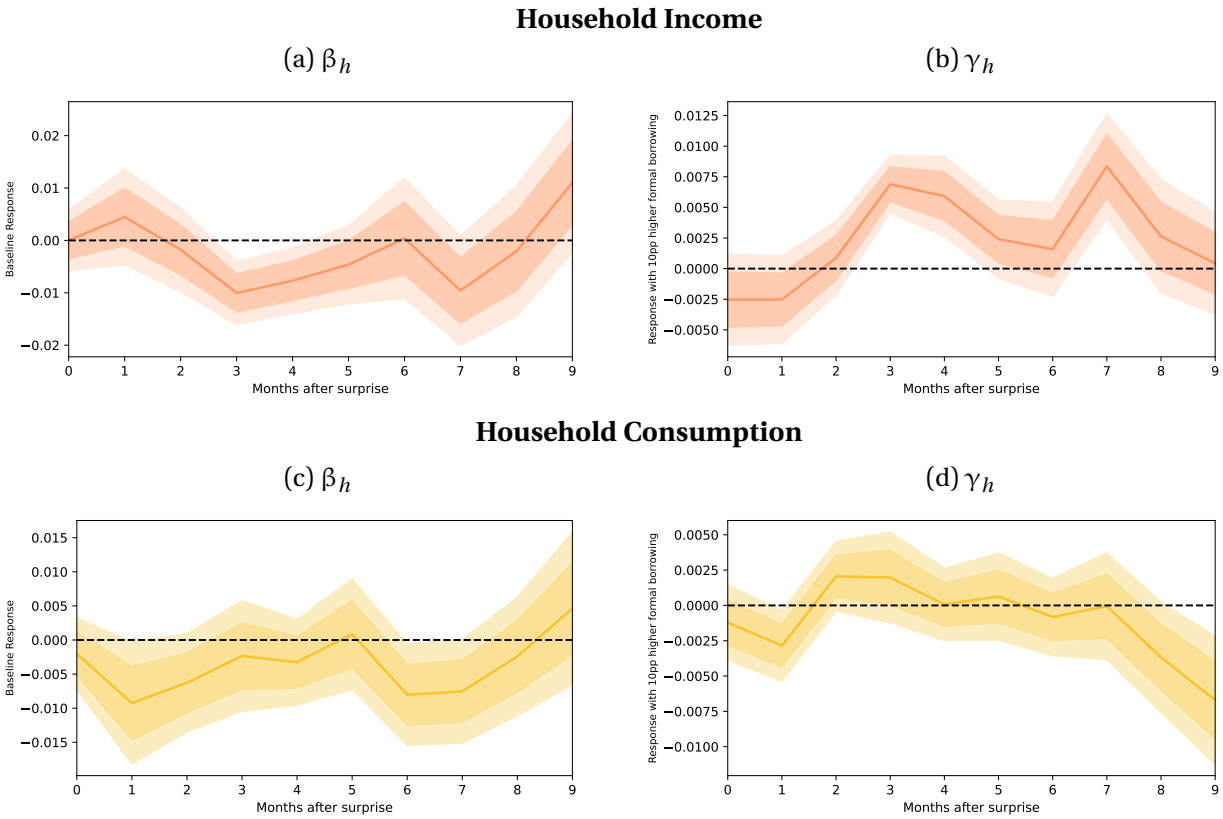
Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.3. For this robustness exercise, credit per capita replaces deposits per capita in Equation 2.3. γ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 higher credit per capita to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Credit per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on credit is from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

Figure B.21: Financial inclusion and monetary policy transmission: OLS evidence (branches per 100,000 people)



Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.3. For this robustness exercise, the number of branches per 100,000 people replaces deposits per capita in Equation 2.3. γ_h captures the differential response of household income and household consumption (in logarithms) associated with having an extra bank branch per 100,000 people to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Branches per 100,000 people is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on bank branches are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*.

Figure B.22: Financial inclusion and monetary policy transmission: OLS evidence (formal borrowers in CPHS)



Notes: The above figures plot OLS estimates of the β_h and γ_h coefficients from the LP-IRF specification in Equation 2.3. For this robustness exercise, the share of households that reported formal borrowing replaces deposits per capita in Equation 2.3. γ_h captures the differential response of household income and household consumption (in logarithms) associated with a 10 percentage-point increase in the share of households that reported borrowing from formal sources in the most recent preceding CPHS survey wave or in any earlier survey wave to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. Formal borrowing is defined as borrowing from banks, non-bank financial companies, self-help groups or microfinance institutions, and credit cards. The formal borrowing measure is constructed using data from the Aspirational India module of the CPHS. Further details about its construction can be found in the notes to Figure 2.3. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. The formal borrowing proportion measure is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy.

B.7.2 Constructing the demonetization exposure measure

Following Crouzet et al. (2023), we define the currency chests based demonetization exposure measure for HR i $\left(\text{Exposure}_i\right)$ as the share of deposits in HR i in banks with no currency chest branches in the HR:

$$\text{Exposure}_i = 1 - \left[\frac{1}{D_i}\left(\sum_{g \in G_i}\left(D_{gi} \times \frac{N^c_{gi}}{N_{gi}}\right)\right)\right] \approx 1 - \left[\frac{\sum_{b \in C_i}\sum_j D_{jbi}}{\sum_{b \in B_i}\sum_j D_{jbi}}\right] \tag{B.1}$$

where j indexes bank branches, b indexes banks, g indexes bank groups, D_i refers to total bank deposits in HR i, D_{gi} refers to total deposits in bank group g in HR i, N_{gi} refers to total bank branches in bank group g in HR i and N^c_{gi} refers to total bank branches with at least one currency chest branch in bank group g in HR i. G_i refers to the set of all bank groups present in HR i, C_i refers to the set of all banks with at least one currency chest branch in HR i and B_i refers to the set of all banks in HR i.

Since we only have access to bank deposits at the level of bank groups in each district, we approximate the deposit share of banks with currency chests in each HR in the following way. Within each HR, for each bank group, we scale total deposits for that bank group by the share of bank branches with at least one currency chest branch in that HR in the total number of bank branches of that bank group in that HR. We then sum this measure across different bank groups and divide by the total deposits in that HR to obtain the deposit shares of banks with at least one currency chest branch. For the purpose of calculating the exposure measure, following Crouzet et al. (2023), we use outstanding deposits in the quarter ending 31st December 2015 (the year before demonetization). Our approach to constructing the demonetization exposure measure is identical to Crouzet et al. (2023) except in one respect. While Crouzet et al. (2023) construct the demonetization exposure measure at the district level, we do so at the CPHS HR level, since that is the relevant level at which we have representative survey data available from the CPHS. We also focus on the list of total bank branches from the Crouzet et al. (2023) dataset which were operational as on 31st December 2015 and the list of all currency chest branches present in the Crouzet et al. (2023) dataset.

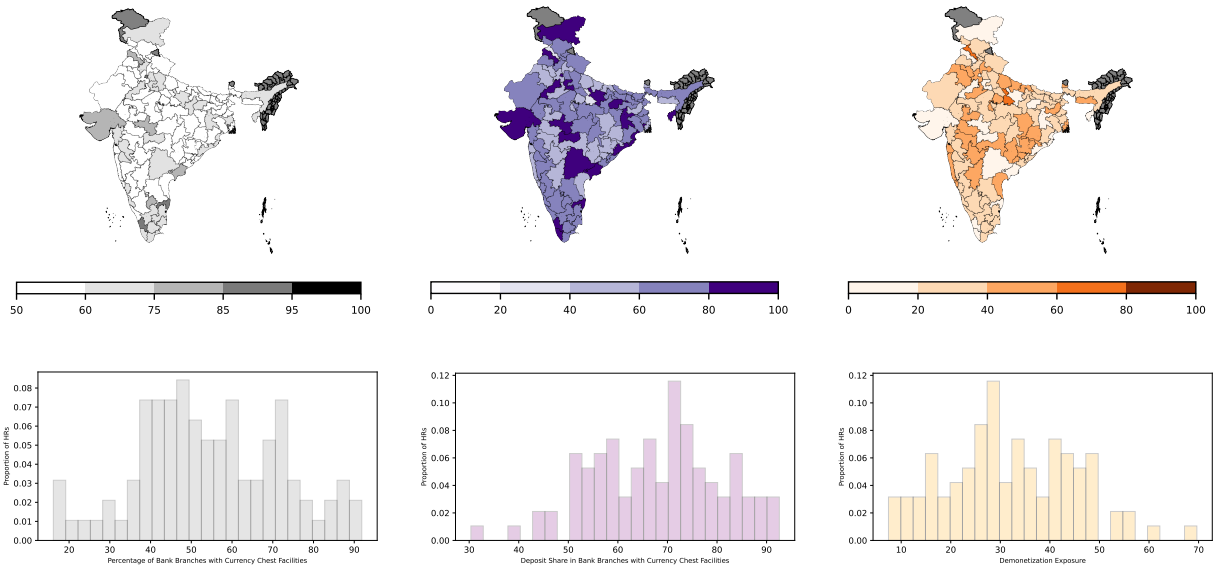
B.7.3 Summary statistics on the demonetization exposure measure

Table B.2: Summary statistics on demonetization exposure in India, 2016

	N	Mean	Std.Dev	min	25%	50%	75%	max
Bank Branches with CC (%)	95	54.494	17.329	16.143	43.250	54.091	68.336	91.840
Deposits in Branches with CC (%)	95	67.794	12.866	30.350	57.849	69.080	75.894	92.567
Demonetization Exposure (%)	95	32.206	12.866	7.433	24.106	30.920	42.151	69.650

Notes: This table documents the summary statistics of the demonetization exposure measure $\left(\textbf{Exposure}_\textbf{i}\right)$ across Consumer Pyramids Household Survey (CPHS) Homogeneous Regions (HRs) in India. The demonetization exposure measure is calculated using Equation B.1. The data on currency chest branches and total number of bank branches is from Crouzet et al. (2023). Data on outstanding deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Outstanding deposits and bank branches as on 31st December 2015 is used in constructing these measures. The mapping from districts to CPHS HRs is from Vyas (2020). HR 67, HR 68 and HR 69 in Telangana, HR 34, HR 35, HR 36 and HR 37 in Gujarat and HR 18 and HR 32 as well as HR 23 and HR 26 in Uttar Pradesh have each been aggregated into a single HR within their respective states to deal with changes in district boundaries post-2011 that affect all these individual HRs.

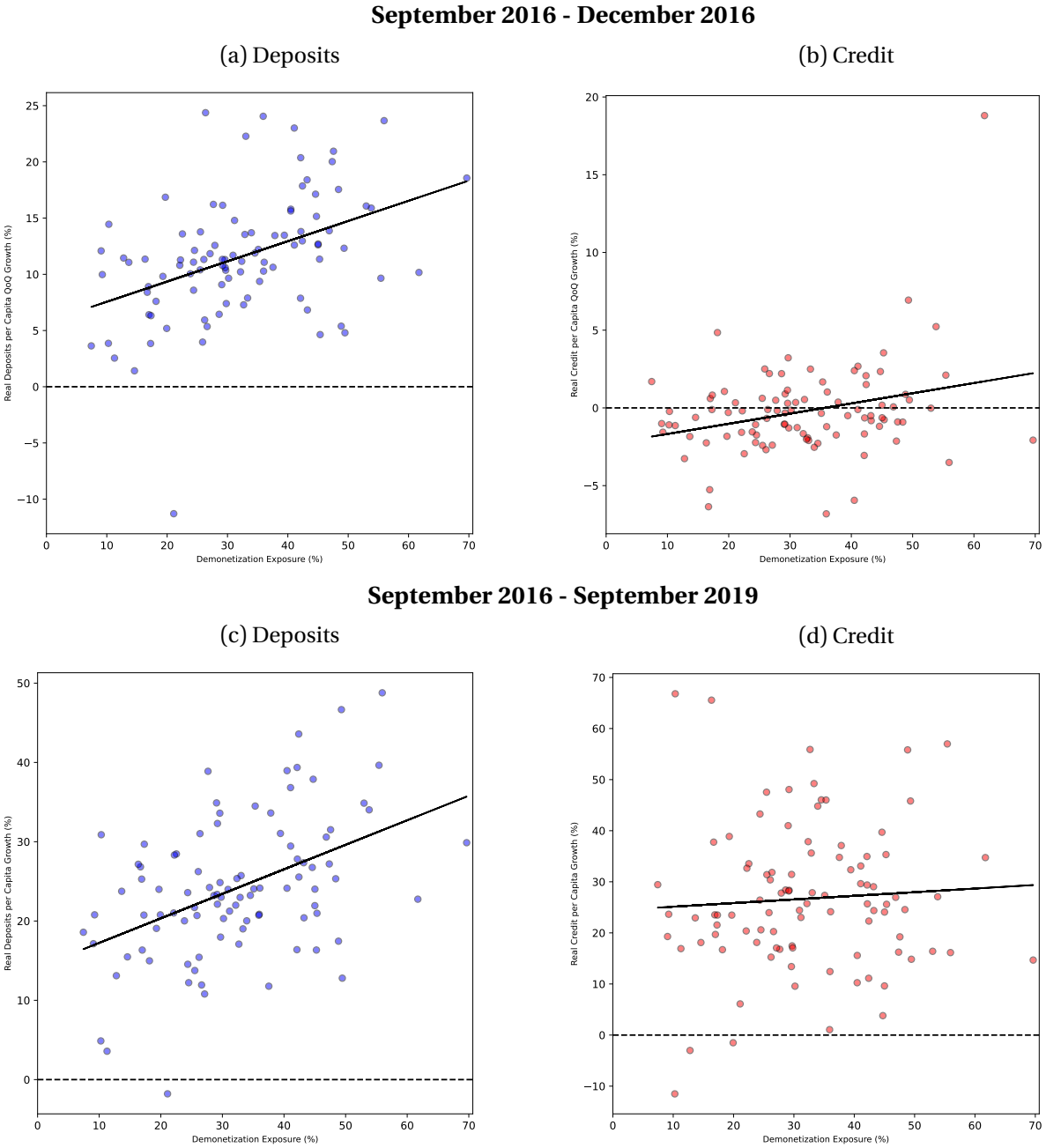
Figure B.23: Currency chests and exposure to demonetization in India, 2016



(a) Currency chests (% of total bank branches) **(b) Currency chest deposits (% of total bank deposits)** **(c) Demonetization Exposure ($\textbf{Exposure}_i$)**

Notes: This figure plots the distributions (i) branches of banks with at least one currency chest (as a % of total bank branches), (ii) total deposits in these branches (as a % of total bank deposits) and (iii) the demonetization exposure measure ($\textbf{Exposure}_i$) across different Consumer Pyramids Household Survey (CPHS) Homogeneous Regions (HRs) in India. The first row of plots visualize these measures spatially while in the second row, their distribution is shown as a histogram. The demonetization exposure measure is calculated using Equation B.1. The data on currency chest branches and total number of bank branches is from Crouzet et al. (2023). Data on outstanding deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Outstanding deposits and bank branches as on 31st December 2015 is used in constructing these measures. The mapping from districts to CPHS HRs is from Vyas (2020). HR 67, HR 68 and HR 69 in Telangana, HR 34, HR 35, HR 36 and HR 37 in Gujarat and HR 18 and HR 32 as well as HR 23 and HR 26 in Uttar Pradesh have each been aggregated into a single HR within their respective states to deal with changes in district boundaries post-2011 that affect all these individual HRs. The HR and district shape files used for plotting the above figures was obtained from xKDR's Maps of India, available at https://github.com/xKDR/india-maps.

Figure B.24: Demonetization exposure and banking activity



Notes: This figures documents scatterplots of the demonetization exposure measure $\left(\textbf{Exposure}_i\right)$ and growth rates in real per capita deposits outstanding and credit outstanding. The first row plots the Quarter-on-Quarter growth in real per capita deposits and credit outstanding between September 2016 and December 2016, the quarter during which the demonetization episode occurred on 8 November, 2016 for each Consumer Pyramids Household Survey (CPHS) Homogeneous Region (HR). The second row plots the growth in real per capita deposits and credit outstanding between September 2016, the end of the quarter before demonetization to September 2019, the latest quarter in our sample period. The demonetization exposure measure is calculated using Equation B.1. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index. The data on currency chest branches and total number of bank branches is from Crouzet et al. (2023). Data on outstanding deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/. Outstanding deposits and bank branches as on 31st December 2015 is used in constructing these measures. The mapping from districts to CPHS HRs is from Vyas (2020). HR 67, HR 68 and HR 69 in Telangana, HR 34, HR 35, HR 36 and HR 37 in Gujarat and HR 18 and HR 32 as well as HR 23 and HR 26 in Uttar Pradesh have each been aggregated into a single HR within their respective states to deal with changes in district boundaries post-2011 that affect all these individual HRs. The OLS regression line is also displayed in both plots.

B.7.4 IV First-Stage

Table B.3: Financial Inclusion and Monetary Policy Transmission: First-Stage IV Results

(a) Income

	(1) Scheduled surprise x DPC change	(2) Demonetization x DPC change
Partial F: excluded instruments	21167.147	8583.845
p-value: excluded instruments	0.000	0.000
Kleibergen-Paap rk LM	3.939	3.939
KP rk LM p-value	0.047	0.047
Kleibergen-Paap rk Wald F	0.107	0.107
Observations	5888	5888

The partial F tests all 40 excluded exposure interactions.
KP statistics refer to the complete 40-equation IV system.
Month-clustered standard errors; HR fixed effects included.

(b) Consumption

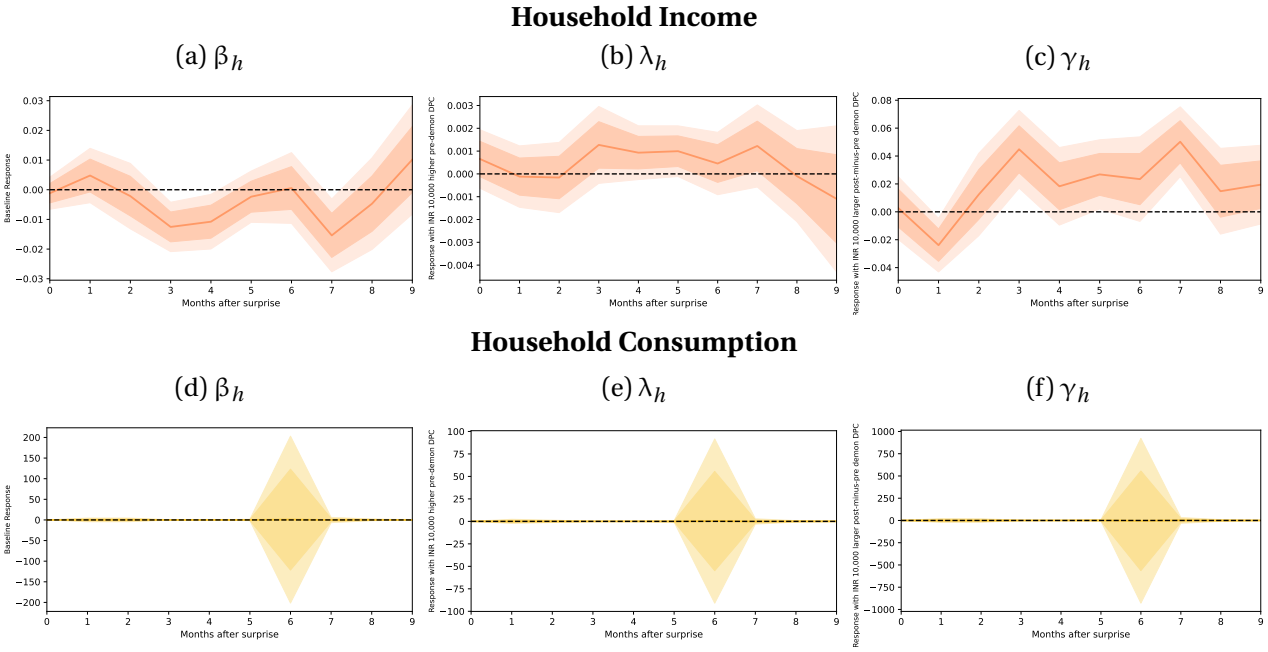
	(1) Scheduled surprise x DPC change	(2) Demonetization x DPC change
Partial F: excluded instruments	3367.439	5919.443
p-value: excluded instruments	0.000	0.000
Kleibergen-Paap rk LM	0.060	0.060
KP rk LM p-value	0.807	0.807
Kleibergen-Paap rk Wald F	0.001	0.001
Observations	5888	5888

The partial F tests all 40 excluded exposure interactions.
KP statistics refer to the complete 40-equation IV system.
Month-clustered standard errors; HR fixed effects included.

Notes: This table reports partial first-stage F-statistics and associated p-values for joint tests of all 40 excluded instruments in the first-stage regressions for two selected endogenous variables in Equation 2.4: (i) the post-minus-pre demonetization change in average deposits per capita interacted with the scheduled monetary policy surprise, and (ii) the same change interacted with the demonetization-period indicator (November 2016–March 2017). The excluded instruments are interactions of the demonetization exposure measure defined in Equation B.1 with the monetary policy surprise and all control variables. The original regressors and their interactions with pre-demonetization average deposits per capita are included as exogenous controls. The Kleibergen-Paap rk Wald F-statistic for weak identification, the Kleibergen-Paap rk LM statistic for underidentification and its p-value refer to the complete system of 40 endogenous interaction terms and are repeated across the two columns. These results correspond to the horizon-zero specification estimated by 2SLS, with HR fixed effects and standard errors clustered by month. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Monetary policy surprises are based on the 3-month MIBOR–OIS fixed rate sourced from Bloomberg Terminal (ticker: IRSWOC BGN Curncy). Data on currency-chest bank branches are from Crouzet et al. (2023), and data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR are from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

B.7.5 IV-2SLS Results

Figure B.25: Financial inclusion and monetary policy transmission: IV evidence



Notes: The above figures plot 2SLS estimates of the β_h, λ_h and γ_h coefficients from the LP-IRF specification in Equation 2.4. γ_h captures the differential response of household income and household consumption (in logarithms) associated with ₹ 10,000 larger post-minus-pre demonetization change in average deposits per capita to a 10 basis points change in the 3-month MIBOR-OIS fixed rate on scheduled monetary policy announcement dates of the Reserve Bank of India. For the 2SLS specification, interactions of the post-minus-pre demonetization change in average deposits per capita with the monetary policy surprise and all control variables are instrumented by the corresponding interactions with the demonetization exposure measure in Equation B.1. 90% and 68% confidence intervals based on standard errors clustered by month are displayed. Household income and household consumption are obtained from the Centre for Monitoring the Indian Economy (CMIE)'s Consumer Pyramids Household Survey (CPHS). The data on income is from the Income Pyramids module and on consumption expenditure is from the Consumption Pyramids module of the CPHS. Further details about the calculation of income and consumption at the HR-Month level can be found in the notes to Figures 2.9 and 2.10. Deposits per capita is expressed in constant March 2014 prices using the General CPI-Combined price index and is de-meaned by its pooled full-sample average. Data on monetary policy announcement dates of the Reserve Bank of India are from Narayan (2026). Data on the 3-month MIBOR-OIS fixed rate is sourced from Bloomberg Terminal with ticker: IRSWOC BGN Curncy. Data on currency chest bank branches are from Crouzet et al. (2023) and data on deposits are from the RBI's *Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks*. Data on population in each HR is from the *Census of India, 2011*. Data on the General CPI-Combined price index (2012 base series) for India is from the RBI's Database on the Indian Economy (DBIE), which can be accessed online at https://data.rbi.org.in/.

Bibliography

Crouzet, Nicolas, Apoorv Gupta, and Filippo Mezzanotti, "Shocks and Technology Adoption: Evidence from Electronic Payment Systems," *Journal of Political Economy*, 2023, *131* (11), 3003–3065.

Narayan, Karthik, "Macroeconomic Effects of Scheduled and Unscheduled Monetary Policy Surprises," *Working Paper*, 2026.

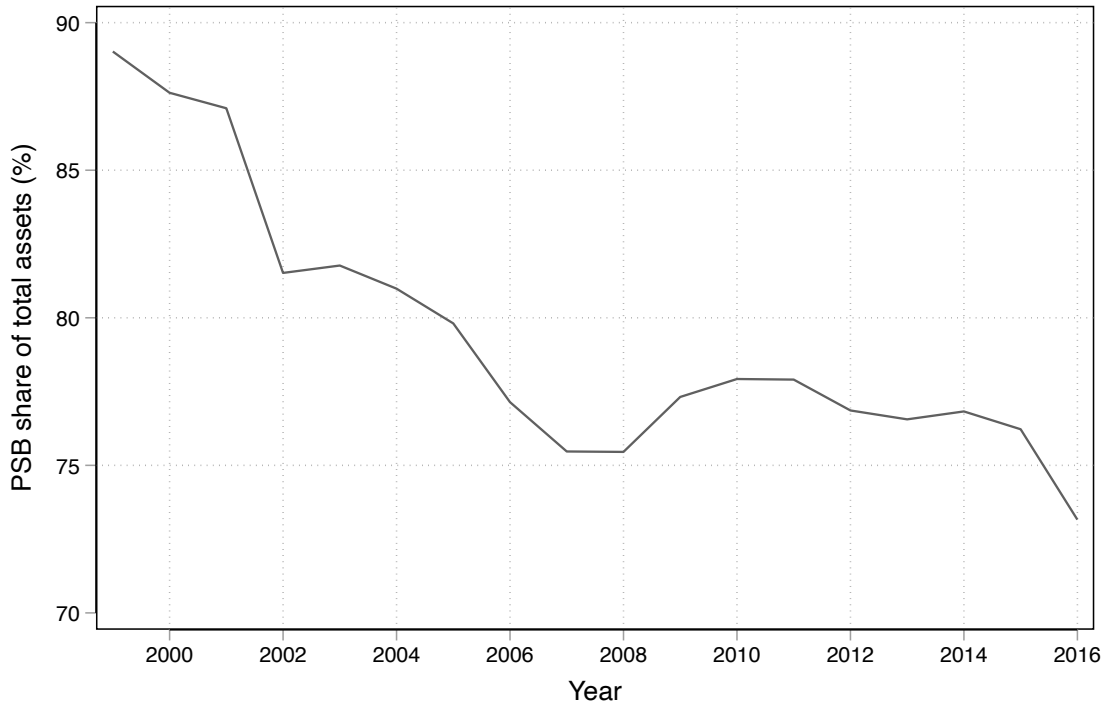
Vyas, Mahesh, "Consumer Pyramids Household Survey: Survey Design and Sample," *Centre for Monitoring the Indian Economy*, 2020.

Appendix C

Appendix to Chapter 3

C.1 Sample of banks in the BSR data

Figure C.1: Market share of government owned banks in India, 1999-2016

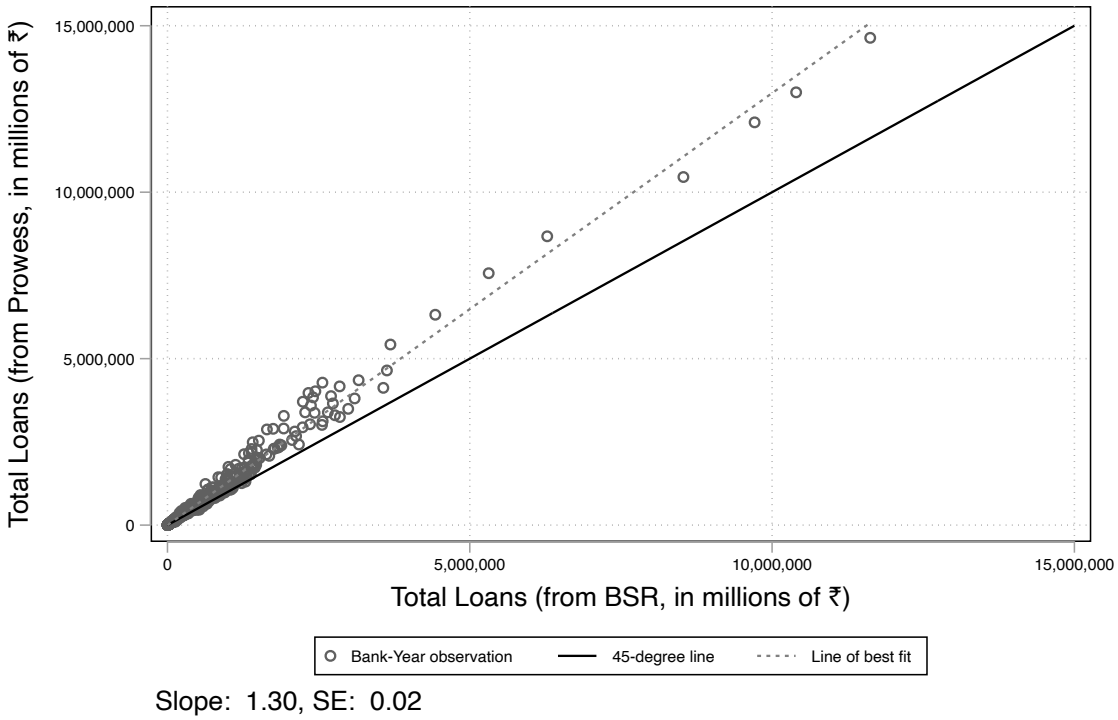


Notes: This figure documents the time series of the market share of government owned (public sector) banks in India between 1999 and 2016. Public sector banks are defined here to include all banks in the category of 'State Bank of India and its associates' and 'Nationalised Banks' as defined in the RBI's Basic Statistical Returns (BSR). The market share is defined as the percentage of total assets (defined here to include all assets on the banks' balance sheets) in a given year across all banks in the BSR that belong to the above defined public sector banks. For the purpose of calculating total assets, attention is restricted to banks which belong to the following categories: 'State Bank of India and its associates', 'Nationalised Banks' and 'Private Sector Banks'. These banks form the main sample used for analysis in the paper. Data on total assets of banks is from CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Figure C.1 documents the time series of the market share of public sector (government owned) banks in

our sample of banks in India between 1999 and 2016, which is the time period under study. The period under study coincided with a continuous decline in the market share of public sector (government-owned) banks from 89% in 1999 to around 73% in 2016.[1]

Figure C.2: Comparison of Prowess and BSR Lending Data, 2000-2016



Notes: This figure documents a bank-year scatter-plot of total lending obtained from RBI's Basic Statistical Returns (BSR) with total lending obtained from CMIE Prowess, between 2000 and 2016. For the purpose of this analysis, attention is restricted to banks which belong to the following categories: 'State Bank of India and its associates', 'Nationalised Banks' and 'Private Sector Banks'. These banks form the main sample used for analysis in the paper. Total loans from the BSR is calculated as the sum of total outstanding loans across the 9 main sectors of lending activity. 45-degree line and OLS regression line are also displayed. The slope coefficient and the associated heteroscedasticity-robust standard errors are also reported.

Since we utilise information on bank lending from both CMIE Prowess and the RBI's Basic Statistical Returns (BSR), we provide a direct comparison of the bank-level annual outstanding lending obtained from the two data sources in Figure C.2. Reassuringly, they are highly correlated with each other, with the R^2 from an OLS regression of close to 0.99. However, there does exist a level difference between the two series, with the BSR data reporting total lending which is approximately 21% lower than what is reported in CMIE Prowess.[2] We will use the Prowess balance sheet data to express lending shares at the aggregate level throughout this paper, unless otherwise specified.

[1] As a robustness check, the share in 1999 stood at around 81% (when including foreign banks, which we do not include in our analysis) in the official statistics, while the share in 2016 was approximately 70% in the official statistics, see in particular the *Report on Trend and Progress of Banking in India 1998-99*, page 50 and *Report on Trend and Progress of Banking in India 2015-16*, page 9. Available here: https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/9902.pdf, https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/0FRTP16A120A29D260148E58B484D4A60E381BB.PDF (Accessed 2nd March, 2026).

[2] This 21% is based on the average of the ratio of total loans at the bank-year level from CMIE Prowess and the RBI's BSR between 2000 and 2016.

C.2 Sectoral lending patterns of Indian banks, 1999 - 2016

Figure C.3 provides some additional details about the sectoral lending patterns of banks during the period under study. In the paper, we had documented that between 2004 and 2010, the average share of infrastructure loans in total assets rose from about 0.05 to 0.09, while the share of long-term investments declined from 0.25 to 0.15.

Changes in other key sectors of lending activity, accounting for the rest of the shift from investments towards lending by banks, were as follows: (i) share of the agricultural sector increased from 0.03 to 0.05, (ii) share of industries (excluding the infrastructure sector) increased from 0.15 to 0.16, (iii) share of the services sector increased from 0.10 to 0.12 and the (iv) share of personal loans increased from 0.05 to 0.07, with a small decline from 0.03 to 0.02 in the "others" sector accounting for the remaining difference. As is clear from a consideration of these sectoral patterns, the largest increase in lending shares during this period was in the infrastructure sector.

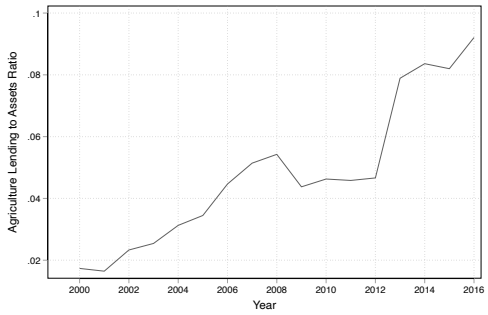
C.3 Banks with and without IFR in 2004

Table C.1: Banks in and out of sample in 2004: Summary Statistics

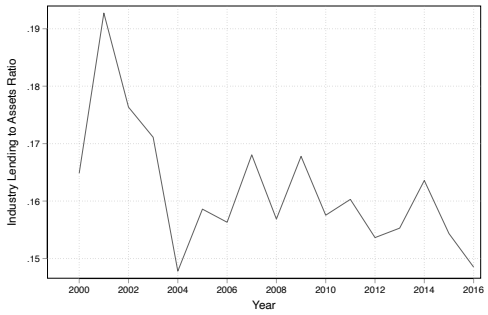
	(1) Banks in sample (1999-2004)	(2) Banks in sample (2005-2010)	(3) Banks out of sample (1999-2004)	(4) Banks out of sample (2005-2010)
Total Assets (in billion Rs.)	310.0340	809.9291	62.3692	228.2026
	(485.1)	(1204.9)	(67.27)	(221.6)
Deposits/Assets (in %)	99.9303	96.1916	107.1259	101.3664
	(12.57)	(9.475)	(8.757)	(7.638)
Investments/Assets (in %)	46.9191	34.9375	47.8771	34.6223
	(6.567)	(5.970)	(9.282)	(5.914)
Loans/Assets (in %)	53.0809	65.0625	52.1229	65.3777
	(6.567)	(5.970)	(9.282)	(5.914)
Long-term investments/Assets (in %)	25.1437	16.2455	24.0425	20.0939
	(10.16)	(8.227)	(15.59)	(7.245)
Long-term loans/Assets (in %)	6.3838	10.1837	5.6474	9.4216
	(3.866)	(5.614)	(3.655)	(4.320)
IFR/Assets (in %)	0.6312	0.9036	0.2313	0.7912
	(0.449)	(0.431)	(0.246)	(0.525)
Infrastructure loans/Assets (in %)	4.1375	7.0578	2.7058	6.3174
	(2.474)	(3.743)	(1.478)	(3.028)
Metropolitan deposits/Deposits (in %)	70.5494	77.5964	69.6807	73.1561
	(15.52)	(12.41)	(16.20)	(11.77)
Observations	205	198	98	78
No. of Public Sector Banks	20	20	5	5
No. of Banks	35	35	18	17

Notes: This table provides summary statistics on key banking indicators of commercial banks in our sample and outside our sample during the periods 1999-2004 and 2005-2010. Only commercial banks in operation in 2004 are considered in the analysis. Total assets refers to the sum of total loans and total investments made by the banks. Data on total assets, investments, loans and investment fluctuation reserve are from CMIE Prowess. Data on deposits, metropolitan deposits and infrastructure loans are from the Basic Statistical Returns (BSR) of the Reserve Bank of India. Infrastructure loans refer to loans outstanding to the mining, construction and electricity, gas and water sectors. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample. The mean of each variable is displayed along with standard deviations in parentheses.

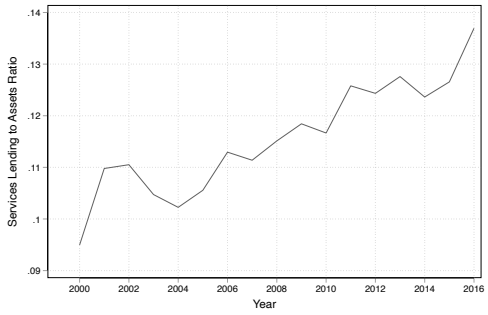
Figure C.3: Sectoral lending patterns of Indian banks, 1999-2016



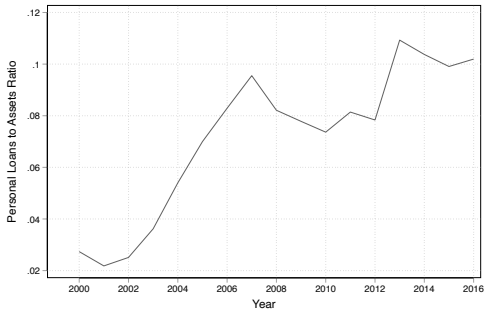
(a) Agriculture



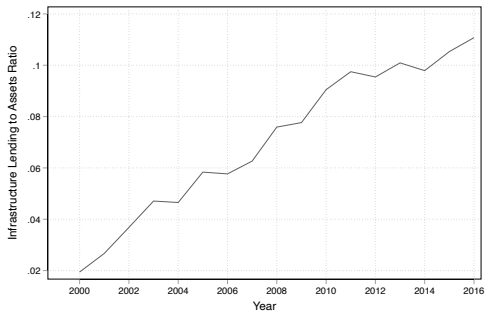
(b) Industry (excluding infrastructure sectors)



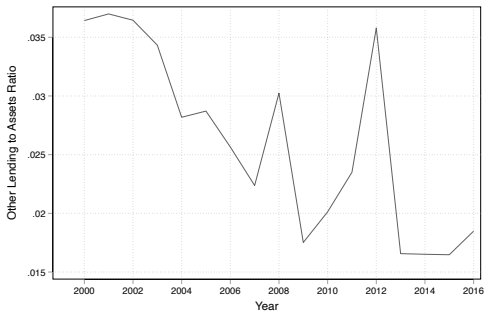
(c) Services



(d) Personal



(e) Infrastructure



(f) Others

Notes: This figure documents the time series of the average share of outstanding loans in total assets belonging to different sectors for Indian banks between 1999 and 2016. For the purpose of this analysis, attention is restricted to banks which belong to the following categories: 'State Bank of India and its associates', 'Nationalised Banks' and 'Private Sector Banks'. These banks form the main sample used for analysis in the paper. Data on total assets of banks is from CMIE Prowess. Total assets is defined here to be the sum of total loans and total investments outstanding on banks' balance sheets. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample. Infrastructure sector refers to construction, mining, and electricity, gas & water sectors. Services includes transport, trade, finance and other professional services.

Table C.1 presents summary statistics on the set of banks which were operating in 2004 and reporting investment fluctuation reserves (Banks in sample) and those which did not (Banks out of sample). We present the mean and standard deviation of several key financial indicators of banks in and out of sample during the periods 1999-2004 and 2005-2010. While there are 35 banks in the sample, including 20 public sector banks, there are 18 banks out of sample, including 5 public sector banks.

While both the in sample and out of sample banks witnessed an increase in total assets between 1999-2004 and 2005-2010, in both periods the in sample banks were on average much larger than the out of sample banks. However, the broad patterns of portfolio composition and their changes over time are very similar for the banks in and out of the sample and also similar to the patterns seen in Table 3.1.

C.4 Distribution of key explanatory variables in 2004

Table C.2: Summary statistics for key banking variables in India, 2004

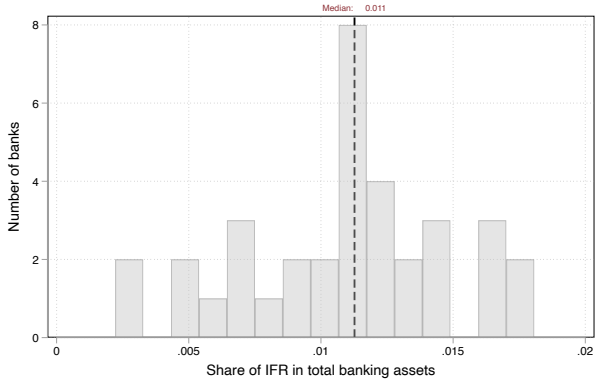
Statistic	IFR (share of total banking assets)	Metropolitan deposits (share of total deposits)	Total Assets (in billions of ₹)
Mean	0.0110	0.7279	438.6186
Std. Dev.	0.0040	0.1533	708.3380
P10	0.0049	0.5684	53.9262
P25	0.0080	0.6460	92.5406
Median	0.0113	0.7470	240.7294
P75	0.0137	0.8072	472.2318
P90	0.0167	0.9480	993.2249
Observations	35	35	35

Notes: This table documents summary statistics of some key variables of Indian banks in our sample as on 31st March 2004, which reported positive Investment Fluctuation Reserves (IFR) on that date. In particular, the distributions of: (i) the share of IFR to total banking assets, (ii) the share of deposits in metropolitan areas to total bank deposits and (iii) balance sheet size of banks are reported. Total banking assets here refer to the sum of all outstanding loans and investments made by the bank as on 31st March 2004. Data on all these variables is sourced from CMIE Prowess, except for the metropolitan deposit share, which is sourced from the RBI's Basic Statistical Returns (BSR). Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

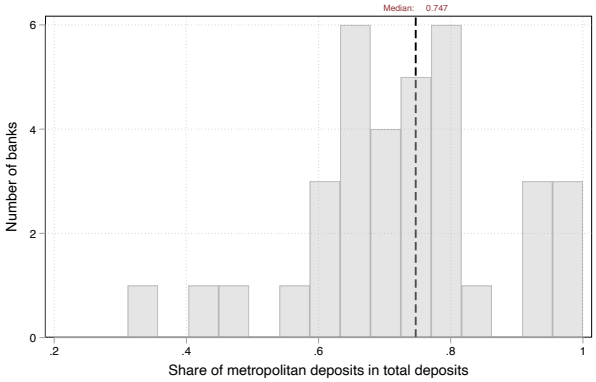
Since we utilise indicator variables based on a median-split of key banking variables to determine both our measures of ex-ante exposure to mark-to-market losses as well as control variables which are utilised in our main analysis in the paper, we present some descriptive statistics about the distributions of these variables in this section. Figure C.4 plots the distribution of the following variables across the banks in our sample in the financial year ending 31st March 2004: (i) IFR (as a share of total banking assets), (ii) Metropolitan deposits (as a share of total bank deposits) and (iii) Total balance sheet size of the banks. Detailed summary statistics for the distribution of these three variables are documented in Table C.2.

As a robustness check, the main Difference-in-Differences specification for the response of infrastructure lending to ex-ante mark-to-market loss exposure is repeated using a continuous measure of exposure (IFR ratio in 2004) along with continuous control variables in Table C.3 and Figure C.5. For a 1pp increase in the

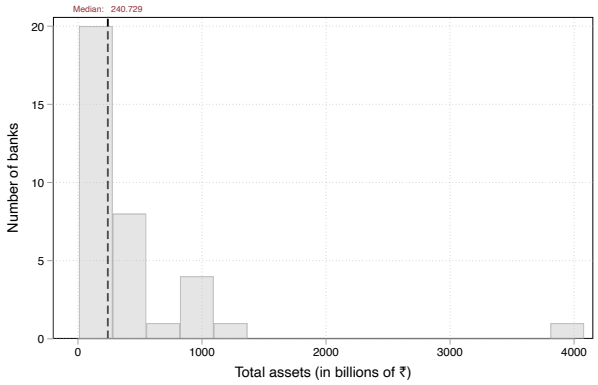
Figure C.4: Distribution of key banking variables in India, 2004



(a) IFR share of total banking assets



(b) Metropolitan deposits share of total deposits



(c) Total balance sheet size (in billions of ₹)

Notes: This figure documents the distribution of some key variables of Indian banks in our sample as on 31st March 2004, which reported positive Investment Fluctuation Reserves (IFR) on that date. In particular, the distributions of: (i) the share of IFR to total banking assets, (ii) the share of deposits in metropolitan areas to total bank deposits and (iii) balance sheet size of banks are reported. Total banking assets here refer to the sum of all outstanding loans and investments made by the bank as on 31st March 2004. Data on all these variables is sourced from CMIE Prowess, except for the metropolitan deposit share, which is sourced from the RBI's Basic Statistical Returns (BSR). The median of the distribution of each of these variables is also indicated as a dashed line in each plot. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Table C.3: IFR in 2004 and Outstanding Infrastructure Loans (Continuous variables)

$$\log(\text{Infra}_{idt}) = \alpha_{d,t} + \delta_{i,d} + \beta \left[\{\text{IFR ratio}_{2004,i}\} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \Gamma' \left[\mathbf{X}_{2004,i} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \epsilon_{idt}$$

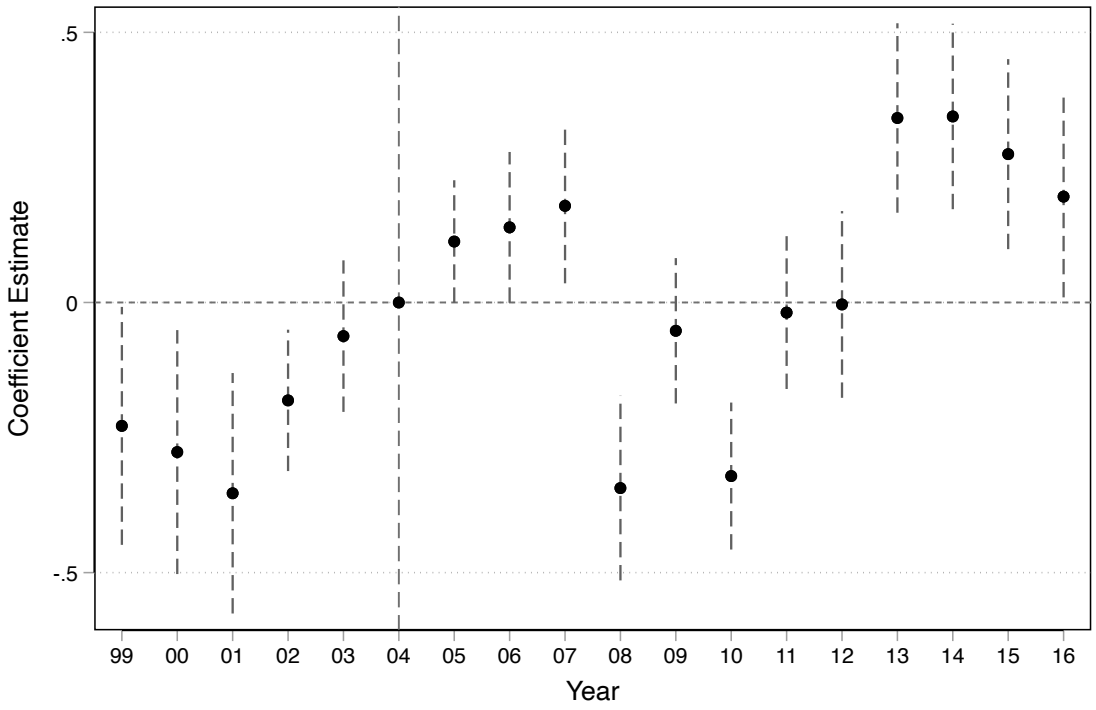
Dependent variable:	log(Infra)		
	(1)	(2)	(3)
$\text{Post}_{2004,t} = 1$	0.970***		
	(0.149)		
$\text{IFR Ratio}_{2004,i}$	–0.054		
	(0.123)		
$\text{Post}_{2004,t} \times \text{IFR Ratio}_{2004,i}$	0.077	0.521***	0.233*
	(0.126)	(0.122)	(0.115)
Observations	74765	74765	74765
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	502	502	502
No. of banks	35	35	35
R^2	0.028	0.779	0.781

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a difference-in-differences regression to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.1. The dependent variable is outstanding bank-district level infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{Post}_{2004,t}\}$ is an indicator variable which takes the value 1 for years post 2004, and 0 otherwise. Exposure measure takes the value of investment fluctuation reserves as a percentage of total assets in 2004. $\mathbf{X}_{2004,i}$ refers to bank level controls and these are also interacted with the post period dummy variable. Controls include total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data are winsorized at the 0.1% level. Standard errors are (two-way) clustered at the district and year level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Figure C.5: IFR in 2004 and Outstanding Infrastructure Loans (Continuous variables)

$$\log(\text{Infra}_{idt}) = \alpha_{d,t} + \delta_{i,d} + \sum_{\substack{\tau=1999 \\ \tau \neq 2004}}^{2016} \left[\beta_\tau \left[\{\text{IFR ratio}_{2004,i}\} \times \mathbb{1}_\tau\right] + \Gamma'_\tau \left[\mathbf{X}_{2004,i} \times \mathbb{1}_\tau\right]\right] + \epsilon_{idt}$$



Notes: This figure shows the event study estimates obtained from fixed-effects panel regressions to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.2. The dependent variable is the outstanding bank-district level infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}_\tau$ is an indicator variable which takes the value 1 for year τ, and 0 otherwise (with 2004 being the reference year). Exposure measure is the value of investment fluctuation reserves as a percentage of total assets in 2004. $\mathbf{X}_{2004,i}$ refers to bank level controls and they are interacted with the year dummy variable. Controls include total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data is winsorized at the 0.1% level. Standard errors are (two-way) clustered at the district and year level. 95% confidence intervals are displayed. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

IFR share of total assets (which roughly represents a move from the 10th percentile to the 90th percentile of the IFR distribution across banks in 2004), under the main specification with bank-district and district-year fixed effects as well as controls, even with continuous explanatory variables there is a statistically significant 26.24% increase in outstanding infrastructure loans.

The event study specification continues to suggest a statistically significant increase in outstanding infrastructure lending in the year immediately following 2004. However, in contrast to the main specification, the pre-trends are now negative and statistically significant and for the period between 2008-2012, there are now statistically significant negative responses, before a recovery starting in 2013. In general, while the patterns are robust, there is a downward shift in the magnitudes of all the estimated coefficients relative to the main event study specification.

Table C.4: IFR in 2004 and NPAs in 2016 (Continuous Variables)

$$\text{Log}(\text{NPA}_{2016,id}) = \alpha_d + \beta \left[\{\text{IFR ratio}_{2004,i}\}\right] + \Gamma' \mathbf{X}_{2004,i} + \epsilon_{id}$$

Dependent variable:	$\log(\text{NPA}_{2016})$		
	(1)	(2)	(3)
$\text{IFR Ratio}_{2004,i}$	0.221^{***}	0.224^{***}	-0.641^{***}
	(0.051)	(0.051)	(0.056)
$\text{Assets}_{2004,i}$			0.004^{***}
			(0.001)
$\text{Metro Deposits}_{2004,i}$			–0.003
			(0.002)
Public Sector Bank_i			1.525^{***}
			(0.060)
Observations	8439	8439	8439
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	514	514	514
No. of banks	30	30	30
R^2	0.002	0.114	0.261

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

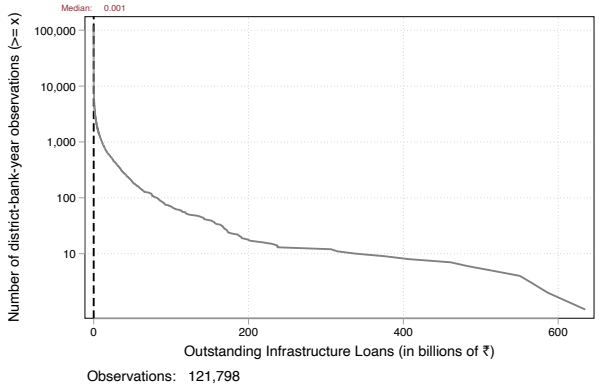
Notes: This table provides estimates of a regression specification to assess the relevance of ex-ante investment fluctuation reserves in 2004 for bank NPAs as described in equation 3.6. The dependent variable is non-performing loans in 2016 in bank i in district d as a share of total loans (expressed in logarithms). $\{\text{IFR ratio}_{2004,i}\}$ refers to investment fluctuation reserves as a percentage of total assets as on 31st March 2004. $\mathbf{X}_{2004,i}$ refers to bank level controls. Controls include total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. District fixed effects are included as indicated. The data are winsorized at the 0.1% level. Standard errors are clustered at the district level. The data on non-performing loans is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Similarly, we also repeat the NPA regression in Table 3.4 using continuous variables in Table C.4. The results are very similar in terms of the pattern of responses to what we find with the main specification, with a positive, statistically significant relationship between mark-to-market exposure and ex-post non-performing assets performance before controlling for other bank-level characteristics, which changes sign with the inclusion of these bank-level controls. As before, the indicator for government ownership is positive, large and statistically significant, driving a significant proportion of the variation in non-performing

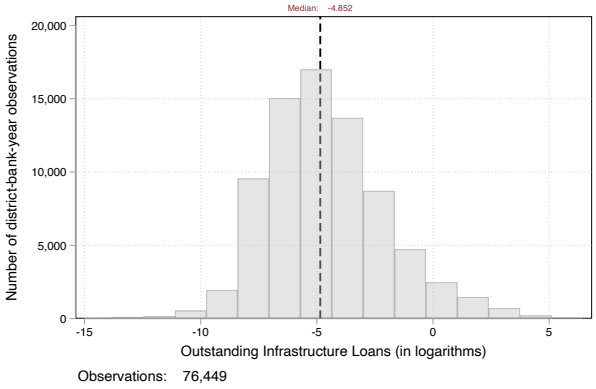
assets performance across the sample of Indian banks in 2016.

C.5 Distribution of key dependent variables used in the analysis

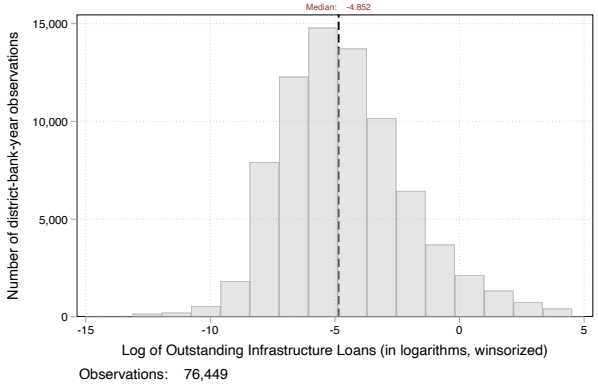
Figure C.6: Distribution of outstanding infrastructure loans in India, 1999-2016



(a) In billions of ₹



(b) In logarithms



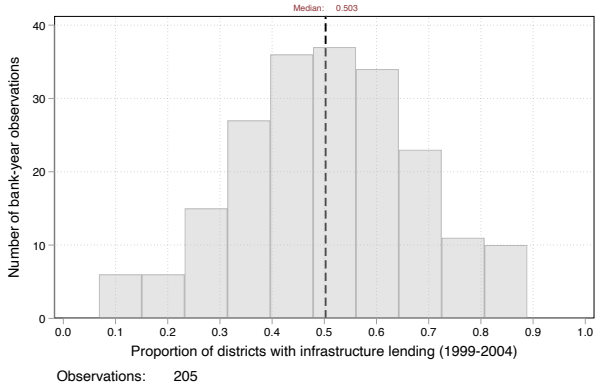
(c) In logarithms (with 0.1% winsorization)

Notes: This figure documents the distribution of outstanding loans to the infrastructure sector in India by banks which reported positive Investment Fluctuation Reserves (IFR) on 31st March 2004 between March 1999 and March 2016. In particular: (i) the complementary cumulative distribution function of total outstanding infrastructure loans (in billions of ₹), (ii) the distribution of this variable in logarithms and (iii) the distribution of this variable in logarithms after winsorization at the 0.1% level. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

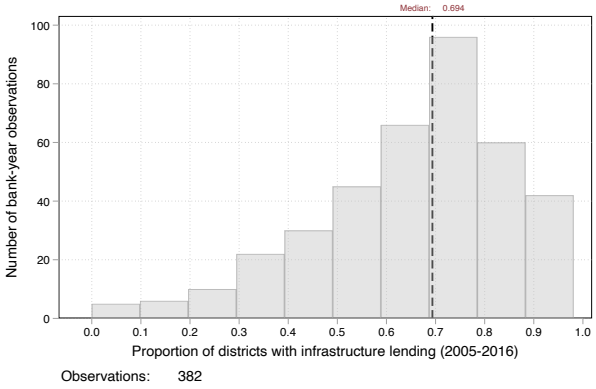
Figure C.6 documents the distribution of outstanding infrastructure loans between 1999 and 2016 for the set of Indian banks in our sample. Two aspects of the raw distribution of this variable are noteworthy. Firstly, this distribution is extremely skewed to the right, with a small minority of bank-districts handling significantly larger magnitudes of infrastructure loans than the vast majority of bank-districts in our sample. These were typically the bank branches in large metropolitan cities like Delhi and Mumbai. Moreover, as a comparison with the distribution in logarithms (which excludes the bank-districts with no infrastructure lending), a substantial number of bank-districts in our sample do not witness any infrastructure lend-

ing activity. Roughly 37% of the bank-district-year observations in our sample do not have any outstanding infrastructure loans. The remaining 63% of bank-district-year observations form the main sample which we utilise in our analysis. Logarithmic transformation and winsorization at the 0.1% level both help with reducing the influence of outliers on our regression coefficients.

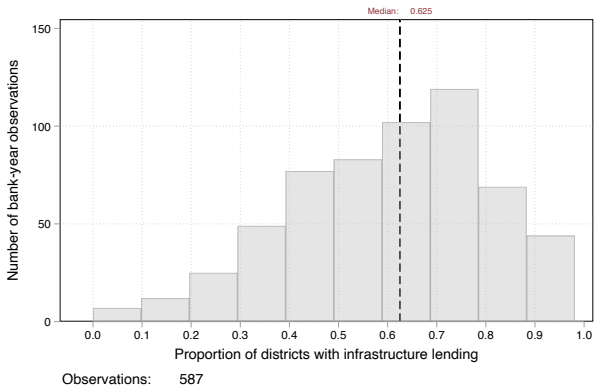
Figure C.7: Proportion of districts with infrastructure lending by Indian banks, 1999-2016



(a) 1999 - 2004



(b) 2005 - 2016



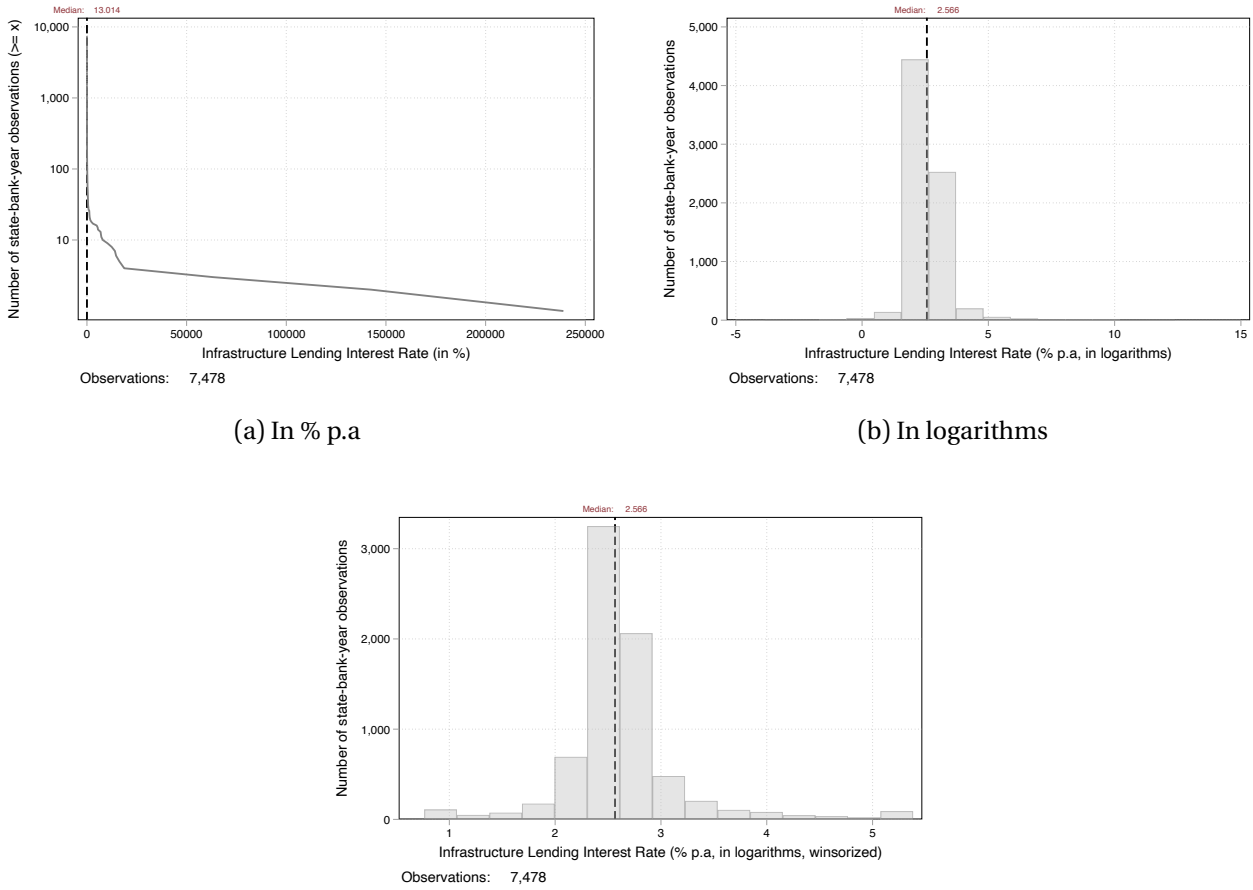
(c) Full sample

Notes: This figure documents the distribution at the bank-year level of the proportion of districts with positive outstanding loans to the infrastructure sector for the group of banks in our sample which reported positive Investment Fluctuation Reserves (IFR) on 31st March 2004 between March 1999 and March 2016. The distribution is shown for the full sample period, as well as for the periods between 1999-2004 and 2005-2016 separately. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

In addition, in Figure C.7, we also report the distribution of the proportion of districts with outstanding infrastructure loans for each bank-year pair in our sample. As is clear from the high median value of 0.625, a large number of bank-year pairs report positive amounts of lending to the infrastructure sector in a substantial proportion of their districts. While there has been a significant increase in the proportion of districts with infrastructure lending between the periods 1999-2004 and 2005-2016, even in the pre-2004 period, the median was relatively high at 0.503. This suggests that there is no extreme locational specialisation of infrastructure lending activity and provides support for our empirical strategy of utilising within-district variation over time to identify the effects of ex-ante mark-to-market loss exposure on

infrastructure lending.

Figure C.8: Distribution of interest rates on outstanding infrastructure loans in India, 1999-2016



(a) In % p.a

(b) In logarithms

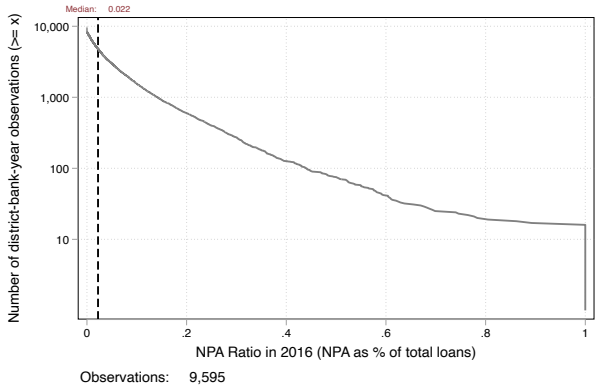
(c) In logarithms (with 1% winsorization)

Notes: This figure documents the distribution of interest rates on outstanding loans to the infrastructure sector in India by banks which reported positive Investment Fluctuation Reserves (IFR) on 31st March 2004 between March 1999 and March 2016. In particular: (i) the complementary cumulative distribution function of interest rates, (ii) the distribution of this variable in logarithms and (iii) the distribution of this variable in logarithms after winsorization at the 1% level. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. The data on infrastructure interest rate is obtained by regressing branch-level weighted average lending rates on the lending shares at the bank-state-year level, as described in Equation 3.3. Interest rates estimated to be less than 0 are excluded from the sample. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are also excluded from the sample.

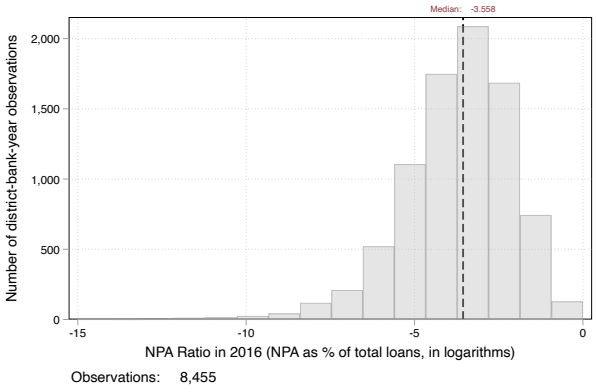
Figure C.8 documents a similar distribution for the estimated interest rate on outstanding infrastructure loans at the bank-state level for the same time period. Here too, we find a strongly right-skewed raw distribution, with a small minority of observations with implausibly high estimated infrastructure lending rates. Again to reduce the influence of outliers, we express the infrastructure lending rate in logarithms and winsorize at the 1% level to reduce the influence of these outliers on our regression coefficients of interest. We will provide some further information on the results of the interest rate estimation procedure, explained in Section 3.5.2, in a subsequent Appendix section.

Finally, Figure C.9 documents the distribution for NPAs (as a share of total loans) in March 2016 at the bank-district level. We also have evidence for a right-skewed distribution, with a small proportion of bank-districts reporting very large NPA ratios in March 2016. To reduce the influence of outliers, we also express

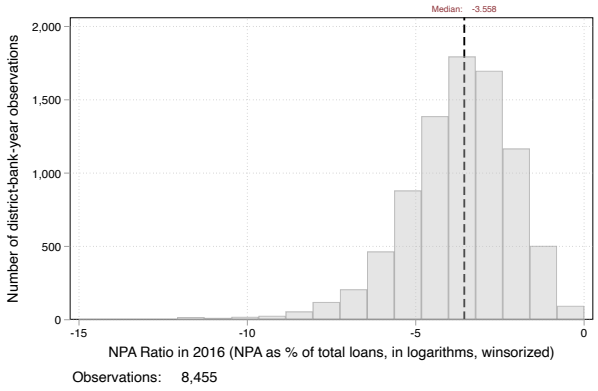
Figure C.9: Distribution of NPAs as a share of total loans in India, 2016



(a) As a share of total loans



(b) In logarithms



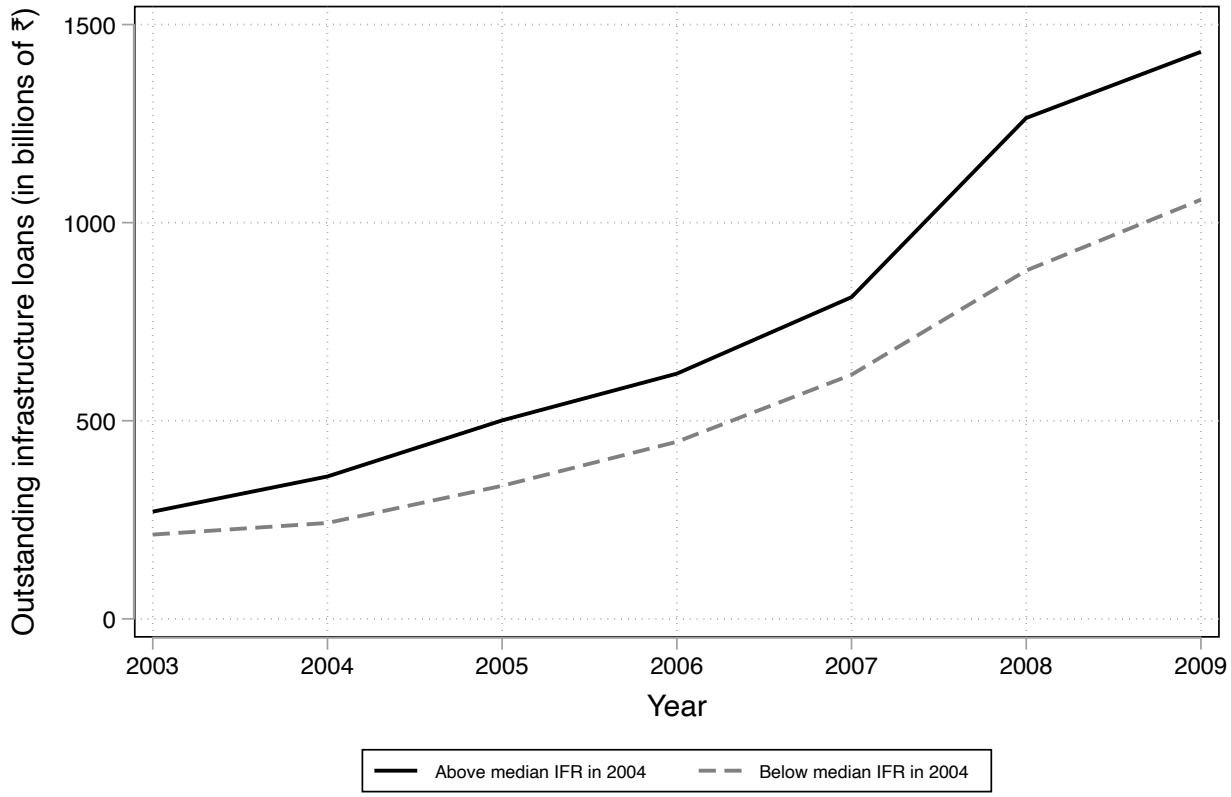
(c) In logarithms (with 0.1% winsorization)

Notes: This figure documents the distribution of the share of non-performing assets (NPAs) in total loans in India in March 2016 by banks which reported positive Investment Fluctuation Reserves (IFR) on 31st March 2004. In particular: (i) the complementary cumulative distribution function of this NPA ratio, (ii) the distribution of this variable in logarithms and (iii) the distribution of this variable in logarithms after winsorization at the 0.1% level. The data on NPAs is obtained from the RBI's BSR. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are also excluded from the sample.

the NPA ratio in logarithms and winsorize at the 0.1% level to reduce the influence of outliers on our regression coefficients of interest.

C.6 IFR and infrastructure lending in 2008

Figure C.10: Outstanding infrastructure lending by IFR group, 2003 - 2009



Notes: This figure documents the time series of total outstanding infrastructure lending between 2003 and 2009 amongst banks in our sample with Investment Fluctuation Reserves (IFR) as a share of total assets above and below the median level in 2004. We restrict focus to banks which reported positive IFR on 31st March 2004. Data on infrastructure loans is from the Reserve Bank of India's Basic Statistical Returns. Data on IFR and total assets (defined as total investments + total loans) is from CMIE Prowess. Data between March 2003 and March 2009 is used in the analysis. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are also excluded from the sample.

In this section, we report some additional results on the factors determining the decline in the event study coefficient reported in Figure 3.7 in 2008, following a steady differential increase in outstanding infrastructure lending for above median IFR banks in 2005, 2006 and 2007. As documented in Figure C.10, there was no decline in outstanding infrastructure lending by above or below median banks in 2008. In fact, both groups of banks witnessed an increase in outstanding infrastructure lending in 2008 relative to 2007. However, as documented in Table C.5, much of this change can be explained by other observable bank characteristics, and they are primarily responsible for the statistically insignificant coefficient on the IFR ratio in 2008.

Table C.5: Event-study coefficients for 2008, IFR and Outstanding Infrastructure Loans

Dependent variable:	log(Infra)
	(1)
2008 x IFR Ratio$_{2004,i}$	0.0219
	(0.0424)
2008 x Assets$_{2004,i}$	1.1147***
	(0.1052)
2008 x Metro Deposits$_{2004,i}$	-0.5599***
	(0.0457)
2008 x PSB$_i$	-0.9908***
	(0.1112)
Observations	74765

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table shows the event study estimates obtained from fixed-effects panel regressions to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.2. Only coefficients from the financial year ending March 2008 are reported. The dependent variable is the outstanding bank-district level infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}_\tau$ is an indicator variable which takes the value 1 for year τ, and 0 otherwise (with 2004 being the reference year). Exposure measure $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and they are interacted with the year dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data is winsorized at the 0.1% level. Standard errors are (two-way) clustered at the district and year level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

C.7 Using infrastructure lending shares as the dependent variable

In this section, we present some robustness results to the main infrastructure difference-in-differences and event study regressions presented in Table 3.2 and Figure 3.7, using the share of outstanding infrastructure lending in total lending by each bank-district in each year (expressed in logarithms) as the dependent variable. Table C.6 presents the main difference-in-differences results using infrastructure lending share as the dependent variable, and under the main specification, we find broadly similar results to Table 3.2.[3] Banks with above median ex-ante exposure to mark-to-market losses saw their lending share to the infrastructure sector increase by 34.99% relative to below median exposure banks, which is of a roughly similar quantitative magnitude to the results reported in the main paper. Similarly, the event-study evidence presented using this alternate dependent variable in Figure C.11, also continue to suggest a similar pattern of responses to Figure 3.7, with the effects concentrated especially in the years immediately following the interest rate shock of 2004.

C.8 Clustering standard errors at the bank-level

The empirical results presented in the main text double-cluster standard errors by district and year. Given that the ex-ante exposure to mark-to-market losses varies principally at the bank-level, we also present estimates of the main full-sample difference-in-differences and event-study results for infrastructure lending, triple-clustering by bank, district and year. Additionally, we also present results for the long-difference specification, double-clustering by bank and district. Understandably, this is going to involve some loss of precision, but is undertaken as an exercise to examine the robustness of our empirical results.

While the full-sample difference-in-differences specification, presented in Table C.7, no longer suggests any statistically significant effects, the associated event-study plots in Figure C.12 continue to suggest statistically significant effects at the 95% level in the years immediately following the interest rate increase in 2004, especially 2005, 2006 and 2007. Moreover, looking at the long-difference specification between 2004 and 2007 with standard errors (two-way) clustered by bank and district in Table C.8, the main specification with fixed effects and controls continues to suggest statistically significant effects at the 10% level. These results suggest that even with a more conservative clustering strategy, our results continue to retain statistical significance for the period immediately following the interest rate shock of 2004.

C.9 Estimating the interest rate on outstanding infrastructure loans

Since sector specific lending rates are not readily available in the RBI's BSR data, we estimate the lending rates on outstanding loans to the infrastructure sector from the branch-level weighted average lending rates (WALR) available from the BSR data. The procedure followed to estimate the infrastructure lending

[3] Note, that in column (1), the coefficient on the post-2004 dummy is actually negative despite the aggregate trends suggesting an increase in the infrastructure lending share, including for below median IFR banks. This is likely to reflect the effect of new bank-districts entering infrastructure lending in the post-2004 period, since this specification compares the pooled average level of infrastructure lending shares before and after 2004. In columns (2) and (3), with the inclusion of district level fixed effects, we identify the interaction coefficient primarily from variation before and after 2004 amongst bank-districts with observed positive lending to the infrastructure sector before and after 2004, and abstract from these extensive margin considerations.

Table C.6: Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Lending Share

$$\log\left(\frac{\text{Infra}_{idt}}{\text{Total Loans}_{idt}}\right) = \alpha_{d,t} + \delta_{i,d} + \beta\left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \Gamma'\left[\mathbf{X}_{2004,i} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \epsilon_{idt}$$

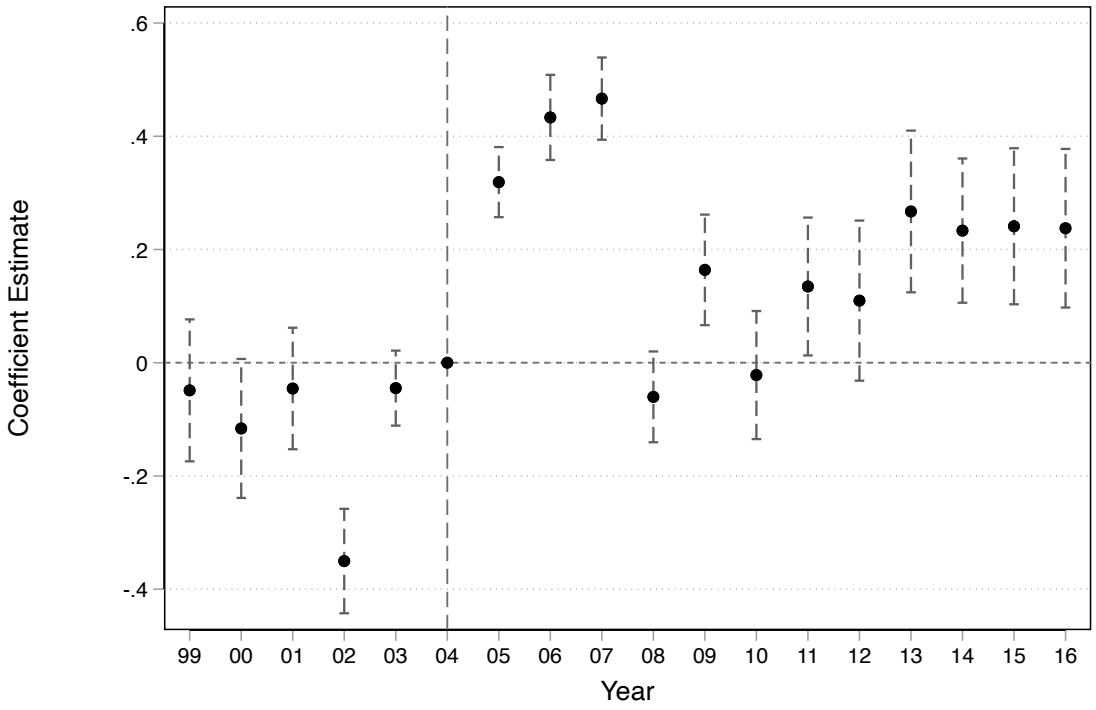
Dependent variable:	log(infrastructure (share of total))		
	(1)	(2)	(3)
$\text{Post}_{2004,t} = 1$	–0.313**		
	(0.117)		
High IFR $\text{Ratio}_{2004,i} = 1$	–0.020		
	(0.074)		
$\text{Post}_{2004,t} \times$ High IFR $\text{Ratio}_{2004,i} = 1$	0.083	0.169*	0.300***
	(0.097)	(0.084)	(0.083)
Observations	74765	74765	74765
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	502	502	502
No. of banks	35	35	35
R^2	0.004	0.573	0.575

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a difference-in-differences regression to assess the relevance of ex-ante investment fluctuation reserves in 2004 for the share of infrastructure lending as described in equation 3.1. The dependent variable is the share of outstanding bank-district level infrastructure loans in total outstanding loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{Post}_{2004,t}\}$ is an indicator variable which takes the value 1 for years post 2004, and 0 otherwise. Exposure measure takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and these are also interacted with the post period dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data are winsorized at the 0.1% level. Standard errors are (two-way) clustered at the district and year level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Figure C.11: Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Lending Share

$$\log\left(\frac{\text{Infra}_{idt}}{\text{Total Loans}_{idt}}\right) = \alpha_{d,t} + \delta_{i,d} + \sum_{\substack{\tau=1999 \\ \tau \neq 2004}}^{2016} \left[\beta_\tau \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}_\tau\right] + \Gamma'_\tau \left[\mathbf{X}_{2004,i} \times \mathbb{1}_\tau\right]\right] + \epsilon_{idt}$$



Notes: This figure shows the event study estimates obtained from fixed-effects panel regressions to assess the relevance of ex-ante investment fluctuation reserves in 2004 for the share of infrastructure lending as described in equation 3.2. The dependent variable is the share of outstanding bank-district level infrastructure loans in total outstanding loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}_\tau$ is an indicator variable which takes the value 1 for year τ, and 0 otherwise (with 2004 being the reference year). Exposure measure $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and they are interacted with the year dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data is winsorized at the 0.1% level. Standard errors are (two-way) clustered at the district and year level. 95% confidence intervals are displayed. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Table C.7: Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans [Triple Clustering]

$$\log(\text{Infra}_{idt}) = \alpha_{d,t} + \delta_{i,d} + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \Gamma' \left[\mathbf{X}_{2004,i} \times \mathbb{1}\{\text{Post}_{2004,t}\}\right] + \epsilon_{idt}$$

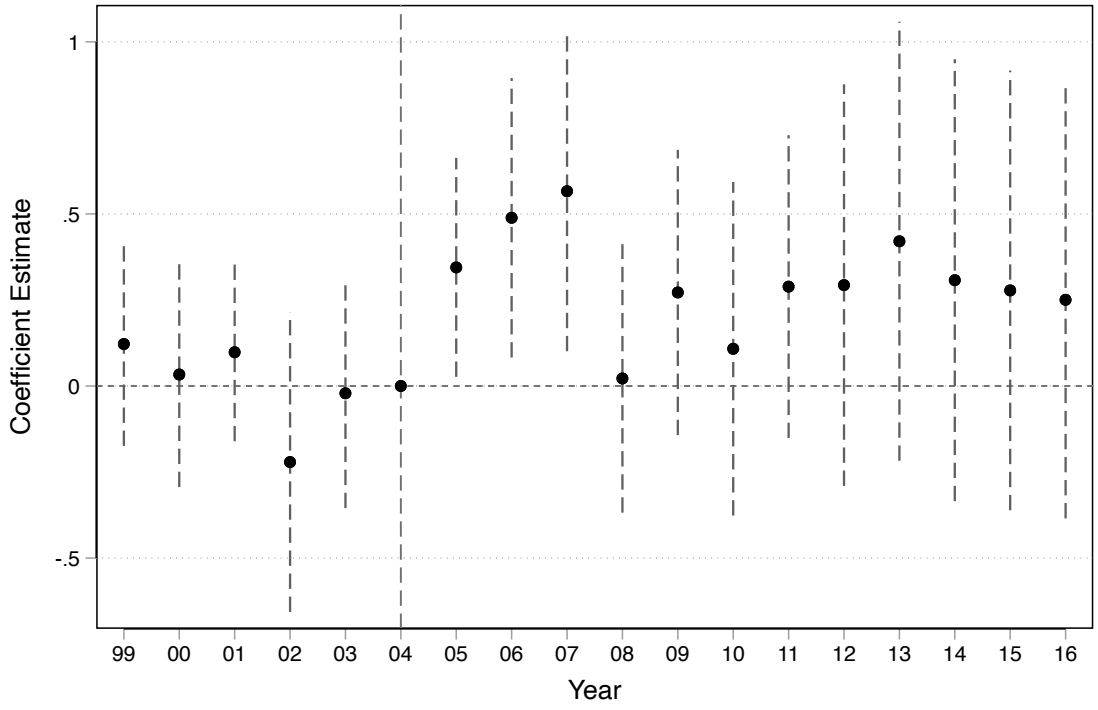
Dependent variable:	log(Infra)		
	(1)	(2)	(3)
$\text{Post}_{2004,t} = 1$	1.013***		
	(0.113)		
High IFR $\text{Ratio}_{2004,i} = 1$	0.092		
	(0.096)		
$\text{Post}_{2004,t} \times$ High IFR $\text{Ratio}_{2004,i} = 1$	0.102	0.223	0.312
	(0.159)	(0.188)	(0.204)
Observations	74765	74765	74765
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	502	502	502
No. of banks	35	35	35
R^2	0.029	0.779	0.780

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a difference-in-differences regression to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.1. The dependent variable is outstanding bank-district level infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{Post}_{2004,t}\}$ is an indicator variable which takes the value 1 for years post 2004, and 0 otherwise. Exposure measure takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and these are also interacted with the post period dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data are winsorized at the 0.1% level. Standard errors are triple-clustered at the bank, district and year level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Figure C.12: Investment Fluctuation Reserve in 2004 and Outstanding Infrastructure Loans [Triple Clustering]

$$\log(\text{Infra}_{idt}) = \alpha_{d,t} + \delta_{i,d} + \sum_{\substack{\tau=1999 \\ \tau \neq 2004}}^{2016} \left[\beta_\tau \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\} \times \mathbb{1}_\tau\right] + \Gamma'_\tau \left[\mathbf{X}_{2004,i} \times \mathbb{1}_\tau\right]\right] + \epsilon_{idt}$$



Notes: This figure shows the event study estimates obtained from fixed-effects panel regressions to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.2. The dependent variable is the outstanding bank-district level infrastructure loans in a given year in logarithms. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}_\tau$ is an indicator variable which takes the value 1 for year τ, and 0 otherwise (with 2004 being the reference year). Exposure measure $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ takes the value 1 for banks with above median share of investment fluctuation reserves to total assets in 2004, and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls and they are interacted with the year dummy variable. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. Bank-district and district-year fixed effects are included as indicated. The data are annual and cover 35 Indian commercial banks from 1999 to 2016 in an unbalanced panel. The data is winsorized at the 0.1% level. Standard errors are triple-clustered at the bank, district and year level. 95% confidence intervals are displayed. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

Table C.8: IFR in 2004 and Infrastructure Lending: Growth between 2004 and 2007 [Clustering by bank and district]

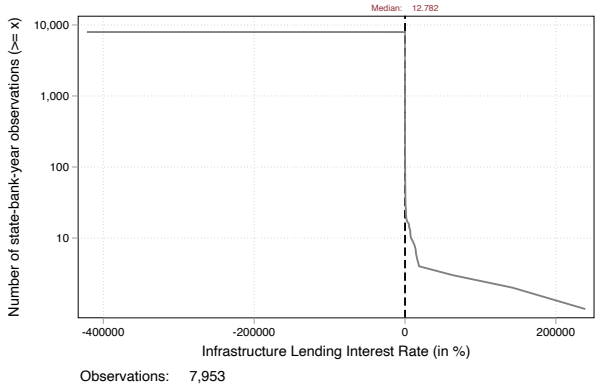
$$\Delta \text{Log}(\text{Infra}_{2007\text{–}2004,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}\right] + \Gamma' \mathbf{X}_{2004,i} + \epsilon_{id}$$

Dependent variable:	Δ log(Infra$_{2007\text{–}2004}$)		
	(1)	(2)	(3)
High IFR Ratio$_{2004,i}$ = 1	0.123	0.205	0.446*
	(0.243)	(0.228)	(0.252)
Observations	2769	2769	2769
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	386	386	386
No. of banks	33	33	33
R^2	0.001	0.141	0.160

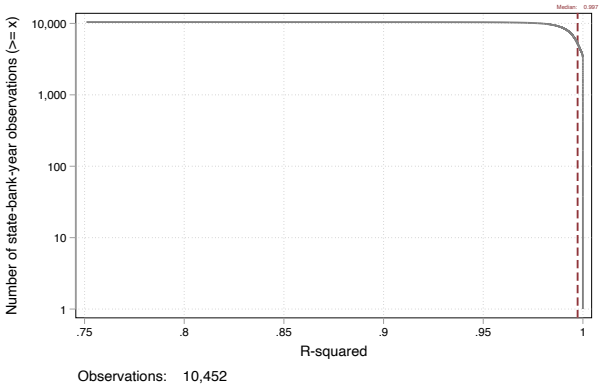
Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a regression specification to assess the relevance of ex-ante investment fluctuation reserves in 2004 for infrastructure lending as described in equation 3.7. The dependent variable is the change in the log of outstanding infrastructure credit in 2007 relative to the log of outstanding infrastructure credit in 2004. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 for banks with above median investment fluctuation reserves as a percentage of total assets and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. District fixed effects are included as indicated. The data are winsorized at the 0.1% level. Standard errors are (two-way) clustered at the bank and district level. The data on infrastructure lending is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.

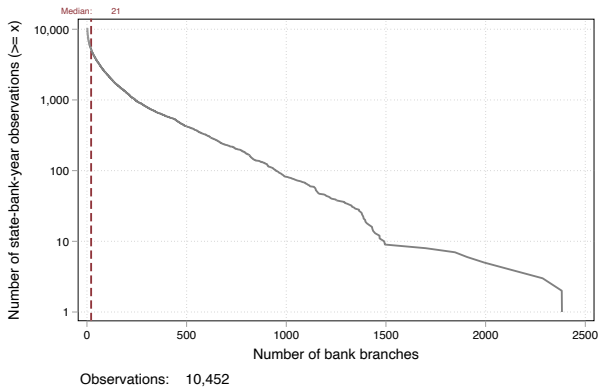
Figure C.13: Additional details on estimation of infrastructure lending interest rates, 1999-2016



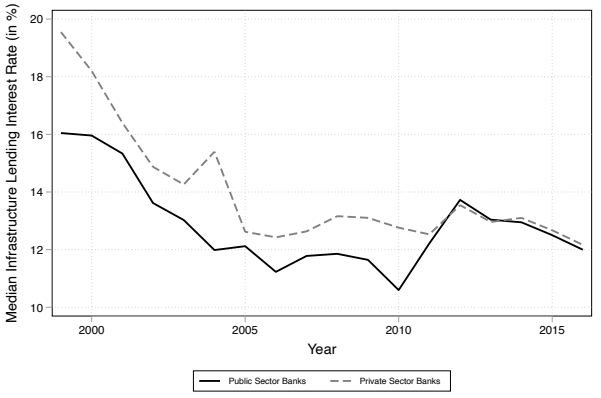
(a) Distribution of estimated infrastructure lending rates (in % p.a)



(b) Distribution of R^2 from regressions



(c) Distribution of sample size from regressions



(d) Median lending interest rate by ownership

Notes: This figure documents the distribution of key variables from estimating Equation 3.3 at the bank-state-year level in our sample of banks in India. We restrict focus to banks which reported positive Investment Fluctuation Reserves (IFR) on 31st March 2004. All data is from the Reserve Bank of India's Basic Statistical Returns. Data between March 1999 and March 2016 is used in the analysis. In particular: (i) the complementary cumulative distribution function of estimated raw interest rates on outstanding infrastructure loans, (ii) the complementary cumulative distribution function of R^2 from these regressions, (iii) the complementary cumulative distribution function of the sample size (number of branches) from these regressions and (iv) the time series of median estimated infrastructure lending interest rates for public and private sector banks. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are also excluded from the sample.

Table C.9: Distribution of estimated infrastructure lending interest rates, 1999-2016

Statistic	Infrastructure Lending Interest Rate (in %)
Mean	-14.5639
Std. Dev.	6155.6348
P1	-156.2768
P5	-3.1244
P10	6.4618
P25	10.7075
Median	12.7823
P75	15.3943
P90	20.9537
P95	33.0200
P99	200.7282
Observations	7953

Notes: This table documents the distribution of estimated interest rates on outstanding infrastructure loans computed by estimating Equation 3.3 at the bank-state-year level in our sample of banks in India. We restrict focus to banks which reported positive Investment Fluctuation Reserves (IFR) on 31st March 2004. All data is from the Reserve Bank of India's Basic Statistical Returns. Data between March 1999 and March 2016 is used in the analysis. Infrastructure loans refer to outstanding bank loans towards construction, mining, and electricity, gas & water sectors. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are also excluded from the sample.

rates was outlined in Section 3.5.2. Some additional details from this estimation procedure are reported in Figure C.13 and Table C.9.

While the median of the estimated interest rates on outstanding infrastructure loans at the bank-state-year level is 12.7%, there are a small number of cases with implausibly large and implausibly small estimated interest rates. Approximately 5.9% of estimated coefficients were negative, with small sample size being an important factor affecting these estimates.[4] The median sample size in these regressions to estimate the infrastructure lending rates was about 21, with a high median R^2 of about 0.997. At the 10% level, measured using a z-score, 89.29% of all estimated coefficients were statistically significant. Consistent with the supply side explanation for infrastructure lending, there was a steady decline in median interest rates charged for infrastructure loans by both public sector and private sector banks. However, the median was slightly higher for private sector banks compared to public sector banks, except in the last few years of our sample where they converged to similar levels.

Hence, to reduce the influence of outliers, we exclude negative estimates for the lending rate, log-transform the variable and winsorize it at the 1% level.

C.10 DiD analysis of IFR in 2004 and NPAs between 2004 and 2016

In Table 3.4, we presented results on the relationship between the level of NPA exposure in 2016 and ex-ante exposure to mark-to-market losses. In this section, we also consider the relationship between the change in the level of NPA exposure between 2004 (just before the start of the infrastructure lending boom) and 2016 and ex-ante mark-to-market loss exposure. For this purpose, we estimate the following specification:

$$\Delta\text{Log}(\text{NPA}_{2016\text{–}2004,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}\right] + \Gamma'\mathbf{X}_{2004,i} + \epsilon_{id} \tag{C.1}$$

where $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 if the bank has an above median value of investment fluctuation reserves as a share of total assets in March 2004. The dependent variable, $\Delta\text{Log}(\text{NPA}_{2016\text{–}2004,id})$, refers to the increase in the share of non-performing loans in total loans by bank i in district d from 2004 to 2016, as measured in logs, $\text{Log}(\text{NPA}_{2016,id})$- $\text{Log}(\text{NPA}_{2004,id})$. α_d refers to district fixed effects and is included to control for demand side effects. Controls, symbolised by $\mathbf{X}_{2004,i}$, include size of the banks, fraction of total deposits raised in metropolitan cities, and ownership category of the banks.

The results from this specification are considered in Table C.10. Unlike in Table 3.4, we do not find any evidence for a positive relationship between ex-ante mark-to-market exposure and the change in non-performing asset performance between 2004 and 2016, even when we do not control for other bank-level characteristics. However, once we do control for other bank-level characteristics, we find that the results, displayed in Column (3), are very similar to the results from our main specification in Table 3.4, with government ownership being a much more significant determinant of asset quality than other bank characteristics.

[4] In more than 50% of these cases, there were 10 or fewer observations available for estimating the coefficients.

Table C.10: IFR in 2004 and change in NPAs from 2004 to 2016

$$\Delta \text{Log}(\text{NPA}_{2016\text{–}2004,id}) = \alpha_d + \beta \left[\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}\right] + \Gamma' \mathbf{X}_{2004,i} + \epsilon_{id}$$

Dependent variable:	$\Delta \log(\text{NPA}_{2016\text{–}2004})$		
	(1)	(2)	(3)
High IFR Ratio$_{2004,i}$ = 1	–0.082	–0.024	–0.378***
	(0.053)	(0.054)	(0.059)
High Assets$_{2004,i}$ = 1			0.775***
			(0.114)
High Metro Deposits$_{2004,i}$ = 1			0.420***
			(0.068)
Public Sector Bank$_i$ = 1			0.922***
			(0.130)
Observations	4235	4235	4235
Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
No. of districts	470	470	470
No. of banks	30	30	30
R^2	0.001	0.150	0.207

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$;

Notes: This table provides estimates of a regression specification to assess the relevance of ex-ante investment fluctuation reserves in 2004 for the change in bank NPAs between 2004 and 2016 as described in equation C.1. The dependent variable is the change in non-performing loans as a share of total loans in bank i in district d (expressed in logarithms) between 2004 and 2016. $\mathbb{1}\{\text{High IFR ratio}_{2004,i}\}$ is an indicator variable which takes the value 1 for banks with above median investment fluctuation reserves as a percentage of total assets and 0 otherwise. $\mathbf{X}_{2004,i}$ refers to bank level controls. Controls take the form of indicator variables which indicate whether the following bank level variables are above or below median: total assets in 2004, share of metropolitan deposits to total deposits in 2004, and they also include an indicator variable for state or private ownership. District fixed effects are included as indicated. The data are winsorized at the 0.1% level. Standard errors are clustered at the district level. The data on non-performing loans is obtained from Basic Statistical Returns (BSR) of the Reserve Bank of India. Total assets refer to the sum of all loans and investments. The data on total assets and investment fluctuation reserve are sourced from CMIE Prowess. Control variables are sourced from RBI's BSR and CMIE Prowess. Jammu and Kashmir Bank, State Bank of Patiala, Central Bank of India and IDBI Bank are excluded from the sample.