The growing impact of US monetary policy on emerging financial markets: Evidence from India

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Abstract

In this paper we use a time-varying parameter framework to document the growing impact of US monetary policy on the Indian stock market. Using high frequency derivatives data, we construct two measures of US monetary shocks: a shock that captures surprise changes in the future path of the Federal Reserve's policy tool and a shock that captures uncertainty about future policy decisions. While the aggregate Indian stock market was unresponsive to U.S. monetary shocks in the early 1990s, there has been a gradual increase in the responsiveness over the past two decades, with the peak effect felt after the financial crisis. Using firm level stock prices we also show that this increase in the aggregate response is felt uniformly across the stock market and is not driven by the increased exposure of any specific industry to US monetary policy. Instead, our results suggest that it is driven by the portfolio allocations of foreign institutional investors and the exchange rate becoming more sensitive to US monetary policy.

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1 Introduction

The past few decades have seen increasing financial integration of emerging market countries into the global economy. One of the concerns raised by this phenomenon is the potential vulnerability of these emerging economies to monetary policies of advanced countries, especially the United States. In this paper we assess the spillover effects of US monetary policy on emerging economies using the Indian financial markets as a laboratory.[1]

There is a large literature that explores the effects of US monetary policy on foreign countries, including transmission to emerging economies. However, the focus has mainly been on the recent unconventional episode of US monetary policy beginning with the financial crisis. Our analysis expands on this literature along several important dimensions. First, we combine a time-varying parameter approach with data spanning back to the early 1990s and document how there have been gradual but significant changes in the effects of US monetary policy shocks over time. Second, we use high-frequency futures and options data to construct monetary policy shocks that control for financial market expectations to isolate the exogenous variation in US monetary policy decisions. Specifically, we construct two measures of monetary policy shocks: i) a first moment shock that captures the surprise component of current and future path of the Federal Reserve's policy rate and ii) a novel second moment shock that captures changes in uncertainty about that path. We combine this US data with high frequency data from Indian financial markets including a measure of net flows from equity markets attributed to foreign institutional investors. Finally, in addition to analyzing aggregate market data, we also study individual firm level stock prices to help uncover the transmission mechanism of US monetary policy spillovers.

The analysis is carried out using an event study approach following Bernanke and Kuttner (2005) and Gürkaynak, Sack, and Swanson (2005) among others. Monetary policy shocks are calculated by isolating changes in the prices of derivative contracts in a narrow window around the

[1] The focus on India is motivated by its inclusion in the group of countries that have gotten recent attention for being considered the most vulnerable to US monetary policy. The so-called vulnerable "fragile five" countries consists of South Africa, Turkey, India, Indonesia and Brazil.

Federal Open Market Committee's (FOMC) monetary policy decisions. This approach overcomes the endogeneity problem of identifying causal effects by differentiating between expected and unexpected monetary policy actions. The first shock we use (labeled MP surprise) captures surprise changes to the target federal funds rate as well as unconventional policies of forward guidance and announcements about large scale asset purchases (i.e. quantitative easing). This is done by using an extended set of futures data with a variety of maturities up to 2 years ahead.

The second shock we use is novel in this literature and captures uncertainty about monetary policy decisions. This shock is constructed following the approach of Bauer, Lakdawala, and Mueller (2018) which uses options on Eurodollar futures. The options data allows the construction of the conditional, risk-neutral standard deviation of the short-term interest rate at a one year horizon.[2] We use the movement in this standard-deviation around FOMC meetings as our measure of the change in uncertainty resulting from US monetary policy actions (labeled MP Uncertainty). Recent work has highlighted the importance of uncertainty and risk aversion for international asset prices, see for example the work of Rey (2015) and Bruno and Shin (2015). There is also evidence for the substantial effects of US uncertainty on emerging economies, see Bhattarai, Chatterjee, and Park (2017).[3] Our MP uncertainty variable is a high-frequency measure that allows for the identification of the effects of US monetary policy specific uncertainty on the Indian financial markets.

We find time variation in the response of Indian stock prices to US monetary policy shocks with an increase in the intensity of the effect over time. The aggregate Indian stock market was essentially non-responsive to US monetary policy shocks in the early 1990s. Since then there has been a gradual increase in the responsiveness to both MP surprise and MP uncertainty shocks starting from the late 1990s to early 2000s. The effect of the MP surprise turns statistically significant in the early 2000s with a peak effect reached towards the end of the sample that indicates almost a 3% fall in stock prices in response to a 25 basis point shock. Interestingly,

[2]We use a one year horizon, based on the liquidity in the Eurodollar options market.

[3]For recent work exploring the impact of US uncertainty on the Indian economy see Ghosh, Sahu, and Chattopadhyay (2017).

this effect is even larger than the effect of US monetary actions on the US stock market, see for example the recent work of Lakdawala and Schaffer (2017). The effect of the MP uncertainty shock starts increasing a few years later, turning statistically significant around 2007-2008 with a peak effect that is roughly half the size of the MP surprise effect.

Our results provide an important insight in interpreting the literature's findings on the effect of US unconventional policies. Recent work, for example Tillmann (2016) and Bhattarai, Chatterjee, and Park (2015), has found big effects of US quantitative easing on emerging market countries. Our results suggest an important component of the total effect of US monetary transmission since the crisis has worked through the uncertainty channel. Specifically, the Federal Reserve's announcements about quantitative easing (or large scale asset purchases) had big effects on emerging financial markets partly because these announcements lowered uncertainty about future monetary policy decisions.

Next, we explore potential explanations for this increased sensitivity in the aggregate results. Using firm-level stock price data we show that both the monetary policy shock measures have uniform effects across the different industries in the Indian stock market for the full sample period. In other words, the increased responsiveness in the post-crisis sample does not appear to be driven by certain sectors becoming more responsive to US monetary policy shocks. Instead we find suggestive evidence for the reaction of financial flows in driving this sensitivity. Specifically, we explore the role of the equity flows attributed to foreign institutional investors (FII) and the related movements in exchange rates. FII flows and the exchange rate do drive equity prices on non-FOMC meeting days as well, but this relationship becomes much stronger on FOMC days, especially since the financial crisis. Moreover, we show that the total effect of the MP surprise shock on the stock market is almost entirely driven through the nexus between the FII flows and related exchange rate movements. There is an extensive literature that emphasizes the importance of foreign institutional investors for the Indian stock market.[4] Our results highlight the response to US monetary surprise shocks as a specific dimension along which the role of

[4]See Chakrabarti (2001), Samal (1997), Gordon and Gupta (2003), Batra et al. (2003), Jain, Meena, and Mathur (2012), and Mishra, Das, and Pradhan (2010) among many others.

foreign institutional investors and the exchange rate market is especially important. On the other hand, we do not find that FII flows and the exchange rate response play a role in the prorogation of US uncertainty shocks, which appear to have a direct independent effect on the stock market since the financial crisis.

Our work is related to the large literature on the spillover effects of US monetary policy. Within this literature, there is a set of relevant papers that study the effects of US monetary policy on emerging market economies including India, see Eichengreen and Gupta (2015), Aizenman, Binici, and Hutchison (2014), Dedola, Rivolta, and Stracca (2017), Bhattarai, Chatterjee, and Park (2015), Moore, Nam, Suh, and Tepper (2013), Tillmann (2016) and Bowman, Londono, and Sapriza (2015) among others. These papers have mostly focused on the recent unconventional monetary policies conducted by the Federal Reserve, with special attention paid to the tapering of the balance sheet. In contrast, in this paper we are interested in characterizing the response of the stock market over a longer horizon to both monetary policy surprise and uncertainty shocks, in addition to exploring the firm level responses of stock prices. There has also been some work that focuses specifically on the response of Indian financial markets to US monetary policy shocks. The results from this literature are mixed.[5] The key advantage of our approach compared to these studies is the ability to control for expectations effects using the futures market data and the use of the monetary policy uncertainty measure.[6]

The rest of the paper is organized as follows. In the next section we layout the details of the high frequency derivates contracts used to construct our preferred measure of the US monetary policy shocks. This is followed by section 3 where we present the results using aggregate stock market data, including the time-varying parameter estimates. In section 4 we consider potential explanations for the increased sensitivity to US monetary policy shocks. Next, in section 5 we

[5] Prabu, Bhattacharyya, and Ray (2016) and Patra, Khundrakpam, Gangadaran, Kavediya, and Anthony (2016) conduct an event study analysis of Federal Reserve unconventional monetary policy announcements on Indian stock returns. Prabu, Bhattacharyya, and Ray (2016) find no significant effect while Patra, Khundrakpam, Gangadaran, Kavediya, and Anthony (2016) find some effect in initial quantitative episodes of 2008-2009.

[6] There is also some work that tries to identify the effects of Indian monetary policy on the stock market (see for example Agrawal (2007), Sasidharan (2009), Panwar and Nidugala (2017) and Prabu, Bhattacharyya, and Ray (2016)) but does not find significant effects.

report the panel regression results from using individual stock price data. Section 6 concludes by offering some closing remarks.

2 Data

2.1 Constructing U.S. Monetary Policy Shocks from Financial Markets Data

To identify the effect of monetary policy on stock prices, one cannot directly regress stock prices on the monetary policy instrument (for example the short-term interest rate). The endogenous reaction of both stock prices and the central bank's policy instrument to common economic conditions leads to the classic simultaneous equation bias. Thus the literature has tried to isolate exogenous variation in the policy instrument to overcome this problem. In this paper we follow the work of Kuttner (2001) and Bernanke and Kuttner (2005), which isolates monetary shocks using high-frequency identification and financial market data. In this section we explain the construction of our two preferred measure of monetary shocks. First, we construct a popular measure of monetary policy shock using the change in the level of futures rates based on the work of Kuttner (2001) and Bernanke and Kuttner (2005) among others. This shock is labeled MP Surprise and captures a first moment shock to the expected future path of the FOMC's policy rate. We complement this shock by constructing a second measure that reflects a second moment shock to the expected future path of the FOMC's policy rate. This shock labeled MP Uncertainty is constructed from options on Eurodollar futures contracts following the work of Bauer, Lakdawala, and Mueller (2018).

2.1.1 MP Surprise Let $p_t^{(h)}$ be the price of a futures contract at time t that matures in $t+h$, where the underlying asset is the short rate. Assuming no arbitrage, this futures contract should capture the market's expectation of the federal funds rate expected in the future. Specifically we can write

$$p_t^{(h)} = E_t i_{t+h} \tag{2.1}$$

where $E_t i_{t+h}$ is the expected rate at $t+h$ conditional on information availabe at time t.[7] The monetary shock is then calculated as the change in the futures price in a window around the FOMC meeting. Let e_t represent the monetary shock ε represent the length of the window, then

$$e_t^{(h)} = p_t^{(h)} - p_{t-\varepsilon}^{(h)} \tag{2.2}$$

The original work by Kuttner (2001) used the current month's futures contract ($h = 0$) to calculate the monetary shock. This measure captured surprise changes in the federal funds rate target. But these monetary shock measures can be constructed for different values of h, i.e. using contracts that expire in different months. The idea behind using these contracts is to capture FOMC announcements about future policy changes, including forward guidance about the future path of the federal funds rate and announcements about large scale asset purchases.

In this paper we use futures contracts expiring up to 2 years ahead. This is based on the arguments of Swanson and Williams (2014) and Hanson and Stein (2015) that the Fed's forward guidance operates at roughly a 1 to 2 year horizon. Specifically, we use the eight Eurodollar futures contracts, expiring one quarter ahead (ED1) to one expiring 8 quarters ahead (ED8). Eurodollar futures are contracts with payoffs tied to the three-month LIBOR rate which is highly correlated with the federal funds rate.[8] In the online appendix, we show the robustness of the results for using a variety of different measures to construct the monetary policy shock, including using federal funds futures data and futures contracts expiring up to just 1 year ahead. For the baseline results, the surprise in each contract is measured as the change in the futures rate in a daily window around FOMC policy decisions. Taken together, the eight contracts contain rich information about the short and medium term path of expected interest rates.

To summarize this information in a parsimonious way we perform a principal components

[7] There may also be a risk-premium term but this is not crucial to our analysis and moreover Piazzesi and Swanson (2008) find that fed funds futures risk-premia are slow-moving and do not change much around FOMC announcements.

[8] Futures markets also exist for contracts with the federal funds rate as the underlying instrument. However, using fed funds options is impractical for our purpose because their market is much less liquid and the data availability much more limited, both in terms of historical time span and length of horizons of the derivative contracts.

analysis. Let X denote a T x 8 matrix of the change in the price of the 5 futures contracts, where T is the number of FOMC meetings. We can then perform a principal components analysis of the futures price changes

$$X = F\Lambda + \widetilde{\eta}$$

where F are factors, Λ are factor loadings, and $\widetilde{\eta}$ is an error term. The first principal component of F explains more than 85% of the total variation across all the contracts. We therefore use this first principal component as our baseline measure of monetary policy shock [9], and label this measure mps_t.

The top panel of Figure 1 plots the MP Surprise measure. Our sample runs from January 1991 to June 2018. There are 243 total FOMC policy decisions over this time frame. This includes both scheduled and unscheduled FOMC meetings. In the online appendix, we show that the main results are similar if we remove the unscheduled meetings from our sample. A full list of the FOMC meeting dates used in the construction of the monetary policy shock is provided in the appendix. To facilitate interpretation of our results below, we normalize the policy shock such that its effect on the 1 year ahead Treasury yield is equal to 0.25. Thus the coefficient from a regression of stocks on the monetary policy shock will measure the effect on the stock market of a 25 basis point shock rise in interest rates over the next year.

2.1.2 MP Uncertainty

We follow Bauer, Lakdawala, and Mueller (2018) in constructing the uncertainty measure from prices of Eurodollar futures and options. The futures prices are from Bloomberg and the option prices are directly from the Chicago Mercantile Exchange. The approach uses the model-free estimate of implied volatility proposed by Jiang and Tian (2005). They show that the integrated return variance between t (when the derivatives prices are measured) and $t + \tau$ (when the contract matures) is given by

$$IRV_{t,\tau} = E\left[\int_t^{t+\tau} \left(\frac{dF_j}{F_j}\right)^2\right],$$

[9] This is similar to the measure used in Nakamura and Steinsson (2015) which they call the "policy news shock".

where F_t is the futures price at time t. This return variance can be estimated in a straightforward fashion using observable option prices. The estimation approach does not require any parametric assumptions, and is valid for general jump-diffusion processes. We use the formula given in equation (6) of Jiang and Tian (2005) and a smooth call-price function fitted to the options data. The measure of monetary policy uncertainty equals $F_t\sqrt{IRV_{t,\tau}}$, which captures the risk-neutral standard deviation of the short-term interest rate at $t+\tau$ conditional on prices at t. We calculate MP Uncertainty for a 1 year horizon based on the longest availability of options data. To obtain data for a fixed horizon from the available option and futures prices, which have expirations at fixed dates and therefore varying horizons, we follow Wright (2017) and linearly interpolate prices to fixed horizons based on available expirations.

As the above equations make clear, the uncertainty measure has a level effect, i.e. it depends on the level of the futures rate. Thus in our empirical results we will first purge this level effect from our measure. Specifically we first regress the change in uncertainty on the MP surprise measure detailed above. Then we use the residual from this regression as our preferred measure of monetary policy uncertainty, labeled MP Uncertainty. The bottom panel of Figure 1 displays the this measure from 1991 to 2018.

2.2 Indian Stock and Financial Market Data

To measure the response of the Indian stock market we use the Nifty 50 and NSE 500 aggregate indices, as well as price quotes on individual stocks that are included in the NSE 500. The data are obtained from Bloomberg. The FOMC monetary policy decision is typically announced around 2pm EST on a Wednesday. Since the Indian stock markets are closed at this time, we use closing stock prices on the next business day to measure the reaction of the stock market. The stock return is then calculated comparing this price to the closing price on the calendar day of the FOMC meeting. For example, for the FOMC meeting that occurred on June 13th 2018, we construct the return of Indian equities by comparing the closing price on June 14th with the closing price on June 13th. For the Nifty 50 index we have data starting in January 1991, while the NSE 500 data is only available from February 1995 onwards. In addition to the stock market data, we use daily data on the Indian

Rupee - US Dollar exchange rate that is measured at the close of the trading day in India, the 10 year government bond rate and net investment of foreign institutional investors into Indian equity markets. The source for these three variables is also Bloomberg.

Table 1 reports the summary statistics for the return on the stock indices and the U.S. monetary shocks separately for days corresponding to FOMC meetings and non-FOMC meeting days. The summary statistics are presented for four samples in addition to the full sample. We see a few interesting patterns. In the overall sample the standard deviation of stock returns on FOMC days is roughly similar to the standard deviation on non-FOMC days. But this belies important differences in the subsamples. In the 1990s, the standard deviation of stock returns on non-FOMC days is actually higher relative to FOMC days, implying that FOMC days are not major news events for the stock market. This pattern reverses sometime in the early 2000s, after which the standard deviation on FOMC days is higher. This suggests that Indian stock markets have been reacting more to FOMC meetings starting around the turn of the century. We also notice that the standard deviation of the Nifty 50 and NSE 500 stock indices has fallen since the 2008 crisis relative to the pre-crisis period for both FOMC and non-FOMC days.

3 Aggregate Stock Index Results

The identification strategy relies on measuring the stock returns and monetary shocks in a narrow window around FOMC meetings. The assumption is that no other major news event is systematically driving financial prices in this window. As discussed above, we use a daily window for the results in this paper. The baseline results are then just an ordinary least squares regression of the Indian stock market index return on the U.S. monetary policy shocks. Let ΔS_t denote the return on the stock index, the MP surprise is denoted by mps_t and MP uncertainty by mpu_t.

$$\Delta S_t = \alpha + \beta mps_t + \gamma mpu_t + \varepsilon_t \tag{3.1}$$

The MP surprise measure is a composite measure based on various futures contracts, constructed from the principal component analysis as outlined in section 2.1.1. Thus its scale is arbitrary. Following the literature, we scale the MP surprise such that the regression coefficient can be interpreted as the percentage point change in the stock market indices in response to an unexpected 25 basis point increase in the 1 year ahead federal funds rate. The MP uncertainty measure is the change in a standard deviation as explained in section 2.1.2. Since this measure is new, there is no guidance available in the literature. We choose to normalize the MP uncertainty measure to have unit standard deviation, i.e. its coefficient can be interpreted as the percentage point change in the stock market indices in response to a one standard deviation uncertainty shock. However, it is not straightforward to compare the size of the effects of the two monetary policy shocks from the coefficients. As a guide, we note that the standard deviation of the changes in the 1 year Treasury yield on FOMC days in our sample is a little under 7 basis points. Thus a 25 basis point MP surprise shock reflects roughly a 4 standard deviation effect. Thus one simple rule of thumb is to divide the MP surprise coefficient by 4 before comparing to the MP uncertainty coefficient.

The baseline estimates from this regression are presented in table 2 for the 2 stock market indices. Our sample runs from 1991 to 2018 but we exclude the FOMC meetings in the peak of the financial crisis from July 2008 through June 2009. This approach is common in the literature (see for example Nakamura and Steinsson (2015)), but our results are very similar if we include these dates. The first column shows the results using the full available sample. These results suggest roughly a 0.9% fall in the Nifty 50 in response to a 25 basis point MP surprise tightening. While the size of the response is non-negligible, the effect is not statistically significant. However, there are interesting differences when we focus on specific subsamples. For the first nine years of the sample from January 1991 to January 2000 (results shown in column 2) the response of stock prices to MP surprise is small and insignificant. suggesting essentially no role for US monetary policy in determining Indian stock prices in this sample. However, for the 2000-2018 sample (shown in column 3) stock prices have responded more strongly to MP surprise, with a 2.2%

fall that is statistically significant (p-value less than 0.01). Columns 4 and 5 split the post-2000 sample into a pre-crisis and a post-crisis sample. These results show that stock prices have been responding even more strongly (2.9% fall) since the crisis relative to before the crisis (2% fall). The reaction of the NSE 500 is broadly similar to the Nifty 50 with small differences in the early sample as the NSE 500 data is only available starting in 1995.

Table 2 also shows the response of stocks to MP uncertainty shocks. The first column which shows the full sample results implies that a one standard deviation increase in MP uncertainty increases stock prices by .015 percentage points, a negligible effect that is also statistically insignificant. Similar to the story with MP surprise, we see that in the early part of the sample, Indian stocks did not react much to MP uncertainty shocks. Even in the 2000 to 2008 sample (column 4) there is essentially a zero response of stocks to MP uncertainty. But in the post-crisis sample of 2009 to 2018, there is a 0.3 percentage point fall in stock prices in response to a one standard deviation increase in MP uncertainty, and which is statistically significant (p-value less than 0.01). For comparing the size of this coefficient to the MP surprise one, in terms of standard deviation effects it amounts to roughly half the size of the MP surprise effect. It is worth highlighting that Indian stocks are responding to news about the uncertainty of the future monetary policy decisions even when we control for unexpected changes to the level of the future path of interest rates (i.e. the MP surprise. Finally, looking at the fit of the regression, we see that the R^2 for the for the early part of the sample is low and around 0.02. But the R^2 for the post-2000 sample is substantially larger at around 0.15.

Our results provide an important insight in interpreting the literature's findings on the effect of US unconventional policies. Recent work, for example Tillmann (2016) and Bhattarai, Chatterjee, and Park (2015), has found big effects of US quantitative easing on emerging market countries. Our results suggest an important component of the total effect of US monetary transmission since the crisis has worked through the uncertainty channel. Specifically, the Federal Reserve's announcements about QE had big effects on emerging financial markets partly because these announcements lowered uncertainty about future monetary policy decisions.

The use of high-frequency futures and options data is important for obtaining these precise effects of US monetary policy on the Indian stock market. An alternative to the derivatives based measures used here is to proxy the US monetary policy shocks with Treasury rates; the most common one being the 10 year Treasury rate. In the online appendix, we show that using the 10 year Treasury yield leads to finding insignificant effects of US monetary policy actions. In the online appendix we also show several robustness checks where we include the FOMC meetings around the financial crisis, exclude unscheduled FOMC meetings and use different combinations of futures contracts to construct our monetary policy shock measures. Overall, there is clear evidence for the growing importance in recent years of both level (or first moment) shocks and uncertainty (or second moment) shocks about the expected path of the Federal Reserve's policy rate for Indian stock prices.

3.1 Time Variation in Stock Market Response

In this section we explore the time variation in the stock response in more detail. Specifically, we are interested in investigating whether the stock market response exhibited sudden discrete changes or whether the response is better described by a gradually changing process.

To test for discrete jumps in the stock market response we use the structural break tests recommended by Bai and Perron (1998). We treat the break point(s) as unknown and use the Bayesian Information Criterion and a modified Schwarz criterion in addition to the sequential procedure outlined in Bai and Perron (2003) to find the break points and test for their significance. All three procedures fail to reject the null of no break.[10] But the regressions in table 2 do point towards instability in the response coefficient. Thus, next we explore whether there has been a gradual change in the stock market response. We do this by setting up a time-varying parameter framework. We posit a flexible random walk process for the evolution of the time varying response

[10]These results are excluded here for brevity.

coefficients. Thus the model can now be written in state space form as follows

$$\Delta S_t = \alpha + \beta_t mps_t + \gamma_t mpu_t + u_t \tag{3.2}$$

$$\beta_t = \beta_{t-1} + \varepsilon_{\beta,t} \tag{3.3}$$

$$\gamma_t = \gamma_{t-1} + \varepsilon_{\gamma,t} \tag{3.4}$$

In this system we make the additional assumption that the error terms are normally distributed, $u_t \sim N(0, R)$, $\varepsilon_{\beta,t} \sim N(0, Q_\beta)$ and $\varepsilon_{\gamma,t} \sim N(0, Q_\gamma)$. With the normal errors and linear structure this model can be estimated using the Kalman Filter. Specifically the likelihood function can be evaluated using the prediction error decomposition method. The parameters $\{\alpha, R, Q_\beta, Q_\gamma\}$ can then be estimated with maximum likelihood. Using the estimated parameters we can construct an estimate of the time-varying parameters β_t and γ_t. Specifically we will consider the so-called smoothed value given by $E[\beta_t|\Omega_T]$ and $E[\gamma_t|\Omega_T]$ where Ω_T is information available in the full sample $1, 2, ...T$.

The smoothed response coefficients for the Nifty 50 index are reported in Figure 2 with the solid blue lines. The dashed blue lines depict the one standard deviation confidence intervals. The results for NSE 500 index are very similar and these figures are relegated to the online appendix. The top panel of Figure 2 shows that there is a clear downward trend in the stock market response to US MP surprise shocks. In the early 1990s there is a small and insignificant effect on the stock market. From the late 1990s up unitl 2008, there is a slow and gradual increase in the size of the coefficient with a trough around -3%. Then the response stabilizes around this 3% mark. The response turns statistically significant around the early 2000s. The pattern is similar for the response to MP uncertainty shocks with two main differences. The trend downwards (i.e a more negative response) does not start until the early 2000s and becomes significant only in the post-financial crisis sample.

These results suggest that US monetary policy decisions started becoming more important for Indian financial markets starting in the early 2000s with the peak effect in the post-crisis sample. The gradual increase in the response rules out any sudden institutional or economic factors as being the likely driving factors. We explore potential explanations in the next section.

4 Understanding the stock market response

Overall there is clear evidence of a negative effect of contractionary U.S. monetary policy decisions on the Indian stock market, that has gotten stronger over time. This raises two natural questions. First, what explains the transmission of U.S. monetary policy shocks to the Indian stock market? Second, what factors drive the increased sensitivity of the Indian stock market to U.S. monetary shock?

There are various channels through which US monetary policy can affect emerging markets. First, by conducting expansionary monetary policy and spurring economic growth in the US, it can boost the demand for emerging country exports to the US. Second, an expansionary shock typically depreciates the dollar and can make emerging country exports less competitive. Third, an expansionary shock typically lowers US rates, which can promote carry trades and capital flows into emerging economies bidding up their asset prices and lowering yields. Finally, an effect which is more pertinent for unconventional policies such as quantitative easing can work through the portfolio balance channel that affects term premia.[11]

All these factors are potentially relevant for the Indian economy. Clearly there are important changes happening to the Indian economy in the sample period considered here. There is a prominent upward trend over time in amount goods and services trade conducted by India with advanced countries, especially with the United States. This increase in trade is a natural candidate for explaining the increased responsiveness we have found. In the next section, using firm level stock data we show some suggestive evidence that the trade story is unlikely to be main reason behind the increased responsiveness. At the same time there has been a substantial, albeit gradual, increase in the level of financial integration experienced by India as well.[12] In this

[11] See for example, Hamilton and Wu (2012).

[12] While de jure measures of capital account openness for India have not changed dramatically (see for example Chinn and Ito (2008)), there have potentially been large de facto changes (see for example Mishra, Montiel, and

section we provide some evidence that points to the role of financial flows and related exchange rate movements as the likely source of the explanation.

In this paper, since we are using a high frequency event study approach, we focus on three important financial market variables that can help us understand the transmission channels listed above. These three variables are the Indian Rupee to US Dollar exchange rate (INR/USD), the 10 year Indian government bond rate and the net flows into equity markets from foreign institutional investors (FII flows).[13]

Table 3 shows the summary statistics for the exchange rate, FII flows and the 10 year government bond rate. The data for the FII flows and the 10 year bond rate are available only since 1999, thus our full sample is 1999 to 2018. For the full sample we notice that the standard deviation of all three variables is larger on FOMC days relative to non-FOMC days. The next two panels show a pre-crisis (1999 to 2008) and post-crisis (2009 to 2018) sample which highlight some interesting differences. For the net FII flows, the standard deviation is higher on FOMC days for both the samples with a bigger difference in the post-crisis sample. Similarly for the exchange rate, the standard deviation is substantially higher on FOMC days in the post-crisis sample but roughly the same as that on non-FOMC days in the pre-crisis sample. On the other hand, the 10 year government bond rate has roughly the same standard deviation on FOMC days for both the samples.

In Table 4, we also present the correlation among these three financial variables and with the stock return. The top panel shows the pre-crisis (1999 to 2008) sample while the bottom panel shows the post-crisis (2009 to 2018) sample. As expected, the correlation between stock returns and the 10 year rate is negative, while the correlation between net FII flows and stock returns is positive (implying that net flows into the stock market are related to increase in stock prices). Finally, the correlation between the exchange rate and stock returns in negative, suggesting that a depreciation of the Rupee is related to a fall in stock prices. More pertinently,

Sengupta (2016)). There has also been recent work that has argued that liberalization of the capital account in India has happened at a gradual pace, see for example Sen Gupta and Sengupta (2014).

[13] In the online appendix, we show that the general pattern of the cumulative FII flows mirrors the total gross capital flows into India. Thus we see can treat the FII flows as good proxies for overall capital flows.

a few other interesting observations regarding differences between the correlations on FOMC days and non-FOMC days are worth mentioning. In the pre-crisis sample the correlations among these variables on FOMC days is mostly insignificant, while it is significant on non-FOMC days. Additionally, there is no consistent theme regarding the strength of the correlation on FOMC vs. non-FOMC days. On the other hand, in the post-crisis sample a clear pattern emerges. The correlations are significant on FOMC days and they are all larger in magnitude relative to non-FOMC days. Moreover, the correlations on FOMC days are larger in the post-crisis sample relative to the pre-crisis sample, while this is not true for the correlations on non-FOMC days. Overall, we view these correlations as providing suggestive evidence for the idea that there is a common factor amplifying the correlation between these variables on FOMC days, and especially so in the post-crisis sample. Next we try to explore the specific role of the US monetary policy shocks in detail.

We first investigate how the US monetary policy shocks affect each of the three variables introduced in this section. Table 5 presents these results for the pre-crisis and post-crisis samples. The first two columns show the effects on the exchange rate, which is defined in terms of rupees per dollar so an increase in the exchange rate implies a depreciation of the Indian rupee. Neither US monetary shocks have a large or statistically significant effect on the exchange rate in the pre-crisis sample. In the post-crisis sample, a 25 basis point MP surprise tightening leads to a 1.5 percentage point depreciation in the Rupee, with a corresponding p-value of less than 0.01. This is consistent with what is typically found in the literature, see for example Hnatkovska, Lahiri, and Vegh (2016). The, 10 year government bond yield responds significantly to US MP surprises in both the samples, however the effect in the pre-crisis sample is small (8 basis point rise) relative to the post-crisis sample (15 basis point rise). Finally, net FII flows also show a similar response, with a bigger and statistically significant fall in the post-crisis sample in response to a MP surprise tightening. Interestingly, the MP Uncertainty has small and insignificant effects on all three variables, even in the post-crisis sample.

Overall the US MP Uncertainty shocks do not seem to affect the three variables much in either of the samples whereas the MP surprise has a strong effect on all three variables in the post-crisis period. The regressions for all three variables also show that the R^2 goes up considerably (more than doubling) for the post-crisis sample, consistent with the story that emerged from the stock market regressions that Indian financial variables are being more strongly affected by US monetary shocks in the more recent years. Next, we explore to what extent the effects of US monetary shocks are transmitted to the Indian stock markets through these three variables.

We take the following simple approach to gauge the role of these three financial variables in driving the responsiveness of Indian stock prices to US monetary policy shocks. In the baseline results presented in Table 2, we regressed the stock returns on the monetary policy shocks. Here we add the three financial variables as controls to the baseline regression. Then we compare the coefficients on the US monetary policy shocks from the baseline regressions to these extended regressions. If US monetary policy transmission is working entirely through the USD/INR exchange rate, the 10 year government bond rate and the net FII flows then we should expect the coefficient on the policy shocks in the extended regressions to go to zero. On the other hand, if US monetary policy does not work primarily through these variables then the coefficient on the policy shocks should be similar to the baseline case.

Table 6 shows these extended regressions together with the baseline specification for the pre-crisis and post-crisis samples. The top panel shows the results for the Nifty 50 and the bottom panel for the NSE 500 index. For the pre-crisis sample, the coefficient on MP surprise falls from -1.8 to -1.5 but remains statistically significant. Thus for this sample, it appears that US MP surprise shocks have a direct effect on Indian stock prices that is not transmitted through the exchange rate, interest rates or investment decisions of foreign institutional investors. Note that from the three variables only the 10 year bond rate has a statistically significant effect on stock prices in the pre-crisis sample. In the post-crisis sample, the results change dramatically. The coefficient on MP surprise is -2.9 and significant in the pre-crisis sample but falls to a precisely estimated zero once we control for the three variables. The coefficients on both the exchange rate and net FII flows is strongly significant.[14] This suggests that US MP surprise shocks are entirely transmitted to the Indian stock markets through the nexus between the exchange rate and net FII flows.[15]

The story is quite different for the effects of US MP uncertainty shocks. Recall that the effects of MP uncertainty in the pre-crisis sample were not significant in the baseline results presented in Table 6. The coefficient remains insignificant and of essentially the same size when we add the controls. In the post-crisis sample the effect of MP uncertainty is significant with a coefficient of $-.39$. Adding the controls, does not change this coefficient or its significance. Thus for MP uncertainty the effects do not appear to be transmitted through either bond yields or the exchange rate-FII flows nexus.

5 Firm Level Stock Results

To complement the aggregate stock market index results from section 3 we also explore the response of individual stock prices to U.S. monetary shocks. We have data on the firms that make up the NSE 500 index as of August 2018. The combined market capitalization of these 500 companies accounts for more than 90% of the total stock market capitalization. Our data is limited in two noteworthy dimensions. First, from 1995 onwards various firms were removed from the NSE 500 index. We do not have data on the stock price for these firms. Second, various new firms have been added in the recent years to the sample and thus for some firms we have relatively fewer observations. In the online appendix we list all the firms and the corresponding availability of data for each firm. In that table we also list the industry classification of the firms that we will explore in more detail below.

Columns 1 and 3 of Table 7 presents the panel regression of the individual stock returns on the U.S. monetary policy shocks. Since the monetary shock measures does not vary across individual stocks in a given time period, the standard errors are clustered along the time dimension. T-

[14] However the coefficient on the 10 year bond is not significant in the post-crisis sample.

[15] This is consistent with Table 4 above that shows that the correlation between the exchange rate and FII flows has gotten significantly stronger on FOMC days in the post-crisis sample.

statistics based on these clustered standard errors are reported in the brackets. We have also run these panel regressions with a firm fixed effect and the estimated coefficients were very similar to the OLS coefficients reported here. The regression is separated into 2 samples following table 2. The response coefficients in both samples are broadly consistent with to the overall NSE 500 index results.[16] There is an increase in the response (i.e more negative) of stock prices to U.S. MP surprise shocks in the post-crisis sample. For the MP uncertainty shocks the response is also more negative and larger in magnitude in the post-crisis sample. However, These coefficients are all significant at the 1% level.

There are two reasons we might have expected the coefficients to be somewhat different compared tooverall NSE 500 index results. First, the NSE 500 index is a weighted index, while the panel regression here effectively weights the individual stocks equally. Second, we do not have data for firms that were dropped from the NSE 500 index. Thus differences resulting from this issue should be more pronounced in the earlier sample period, which is exactly what Table 7 shows. Overall, the results from the firm level and NSE 500 index regressions are similar enough that we can conclude that the panel data is reasonably representative of the NSE 500 index. We next explore whether there is any heterogeneity in the response of individual stock returns and importantly if changes in this heterogeneity can explain the growing importance of the stock response to US monetary policy shocks.

We start by exploring whether there are any noteable differences in the stock response by industry. Table 8 shows the summary statistics when we group the firms by sectors according to the Global Industry Classification Standard (GICS). This table also has detail on the number of firms in each sector, average market capitalization (in billions of US$) over the full sample (1999 to 2018) and mean return and standard deviation for a pre-crisis and post-crisis sample.[17] There is an interesting difference in the pre-crisis and post-crisis samples. The mean and standard deviations are substantially higher on FOMC days in the pre-crisis sample relative to the post-crisis sample. The standard deviations across industries are fairly uniform with the "Real Estate"

[16] As expected, the R^2 for this regression with the individual stocks is lower than for the index.

[17] The mean and standard deviations are calculated by averaging across firms and over time.

sector being the most volatile while the "Health Care" sector being the least volatile. The "Consumer Discretionary" and "Financials" sectors have the most firms but the average market cap is higher for the "Energy" and "Telecommunication Services" sector. However there have been changes in the relative share of market caps across industries over time. In the online appendix, we show these trends over time. The "Financials" sector contributed to 7% of the total market cap in 1999 but almost 25% by 2018. To a lesser extent the share of the "Consumer Discretionary" sector has gone up as well. While the "Consumer Staples" and "Energy" sectors have experienced the biggest falls. Finally, the "Information Technology" sector's share has also gone up relative to its level in 1999, but only by around 2%.

Next, we run regressions of firm level stock returns on U.S. monetary shock separately for each sector. The results are presented in figure 3 with 90% confidence intervals represented with the vertical lines. Again, the standard errors are clustered along the time dimension. In the pre-crisis sample, the MP surprise responses across industries are all remarkably close to the pooled estimate from Table 7 of -1.75. The response of the Real Estate and Utilites sectors is slightly more negative at around -4 but with larger confidence intervals. Thus there appears to be an increased responsiveness to MP surprise shocks across all industries going from the pre-crisis to the post-crisis sample.[18] This is the case for the MP uncertainty variable as well. In the pre-crisis sample, the response of all the sectors is clustered around .3, this is slightly larger than the baseline pooled coefficient from Table 7, most likely due to the effective firms changing in our sample as discussed above. In the post crisis-sample, when the sample issue should be a less of concern, we see the industry responses are bunched around $-.3$, which is close to the pooled baseline coefficient.

An important point emerges from this industry level analysis. The increased responsiveness in the post-crisis sample does not appear to be driven by certain sectors becoming more responsive to US monetary policy shocks. Rather, the increased responsiveness is a phenomenon that

[18] We have also tried running a regression with dummies for each sector interacted with the monetary policy shock and we found that the almost all the interaction coefficients are insignificant, regardless of which sector we choose as the baseline sector.

affects all industries in the Indian economy. The regression analysis from section 4 argues that this aggregate factor works through the nexus of the exchange rate market and the portfolio decisions of Foreign Institutional Investors (or FIIs).

6 Conclusion

In this paper we analyze the effect of US monetary policy on the Indian stock market. We use high frequency financial market data to construct two measures of monetary policy shocks. The first one is a first moment shock that captures surprises to path of future rates, while the other shock is a second moment shock that captures changes in uncertainty about future monetary policy decisions. Using a time-varying parameter framework we find a gradual increase in the sensitivity of the aggregate Indian stock market to US monetary shocks, with a peak effect felt after the financial crisis. Using firm level stock return data we show that the increased sensitivity is not isolated to certain sectors but felt widely throughout the stock market. Finally, using daily financial flows data we explored the potential role of foreign institutional investors and the exchange rate movements in driving the increased sensitivity.

The framework used in this study can be easily extended to study the effects on a wider range of emerging economies. While this paper has focused on the financial market response, a natural extension is to study the effects of the two US monetary shocks on macroeconomic variables in emerging economies. Another promising approach involves merging detailed firm level balance sheet data with the high frequency financial market data used here to explore if certain characteristics make firms more or less susceptible to US monetary policy shocks.

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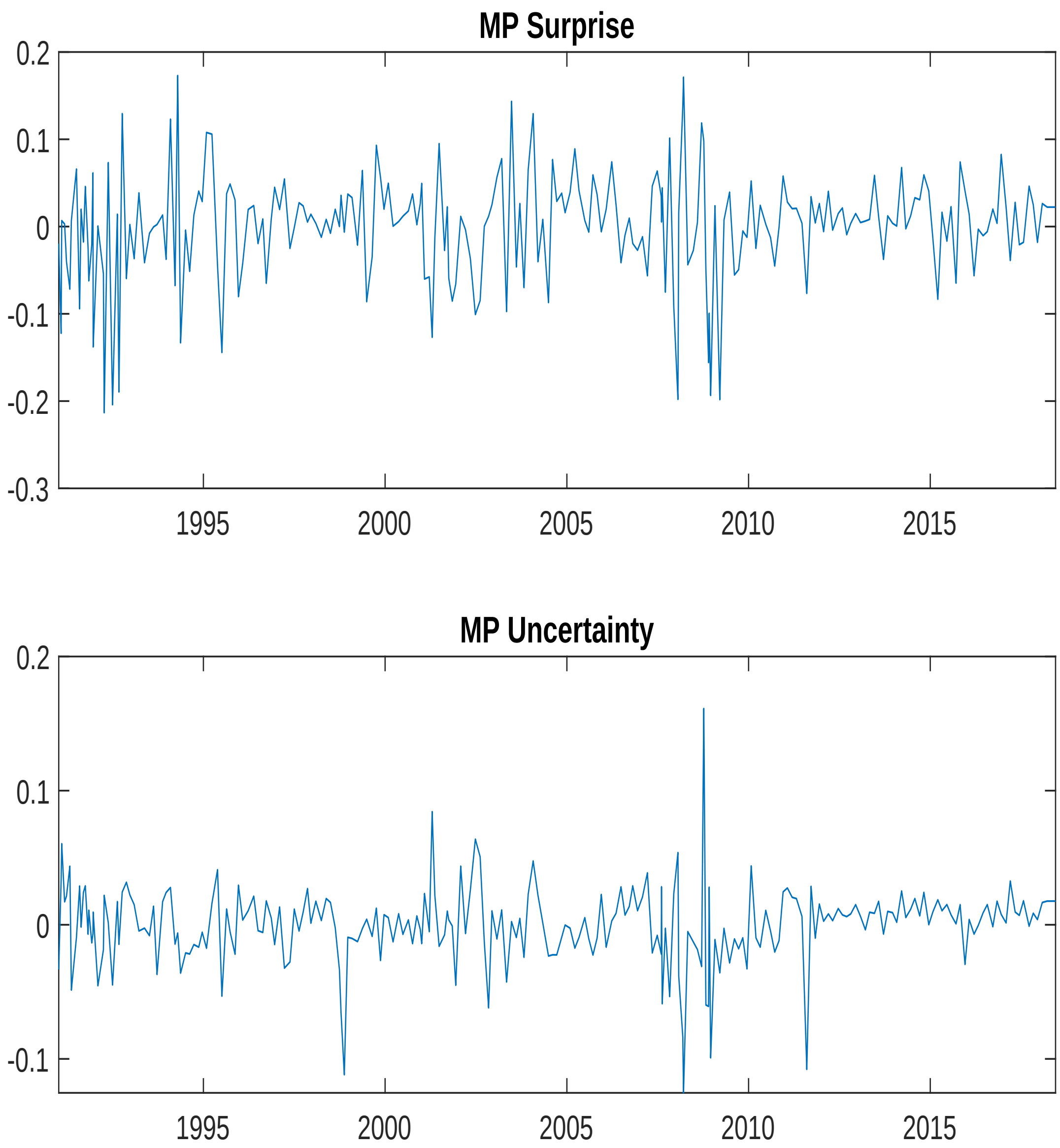
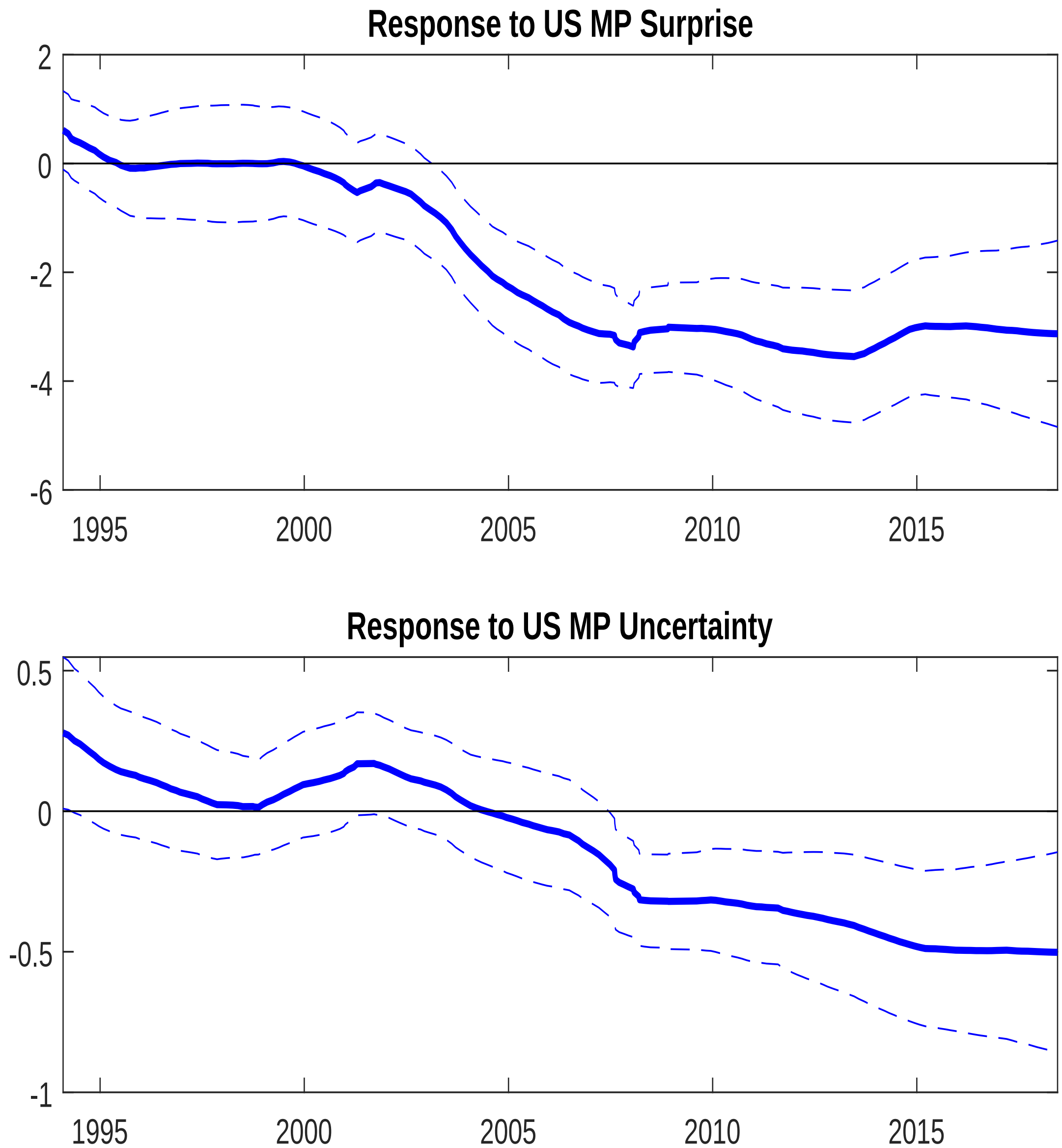
Figure 1: U.S. Monetary Policy Shocks



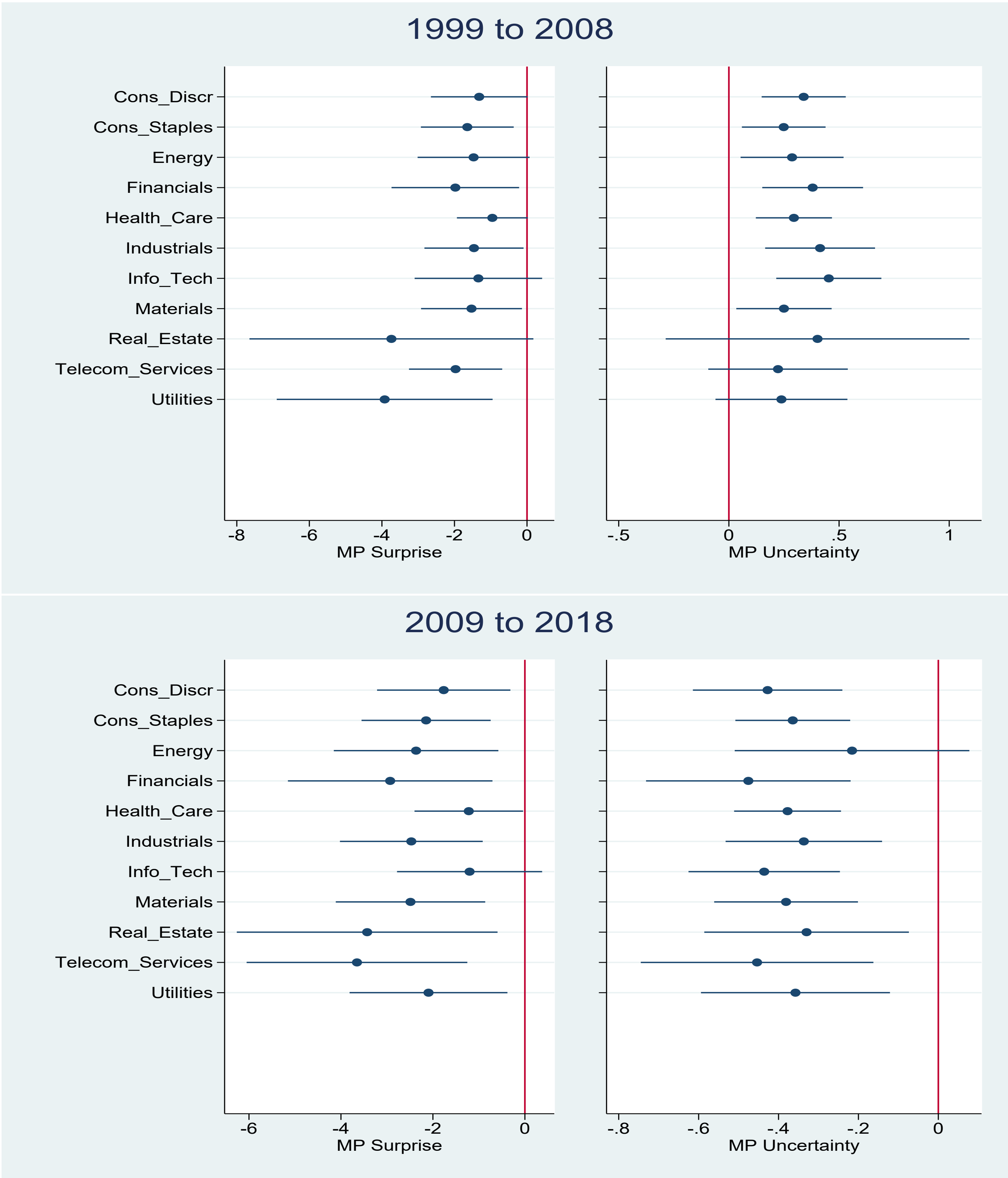
This figure plots the monetary shocks constructed from Eurodollar futures data around FOMC announcements from 1991 to 2018. The top panel shows the MP surprise and the bottom panel shows the MP uncertainty measure, see sections 2.1.1 and 2.1.2 for details.

Figure 2: Time-varying response of Indian stock returns to US monetary shocks



Smoothed estimates of the response of the Nifty 50 index to US MP surprise and US MP uncertainty shocks from the time-varying parameter estimation, detailed in section 3.1. The dashed blue lines show the one standard deviation confidence bands.

Figure 3: Response of Indian stock returns to US monetary shocks by industry



Regression coefficients of individual Indian stock returns grouped by sectors according to the Global Industry Classification Standard (GICS) on U.S. monetary policy shocks for the two samples 1999 to 2008 (top panel) and 2009-2018 (bottom panel). 90% confidence intervals calculated using robust standard errors clustered along the time dimension are represented with the horizontal bars.

Table 1: Summary statistics for Indian stock returns and U.S. monetary policy shocks

Sample: Jan 1991 to Jun 2018 (Feb 1995 to Jun 2018 for NSE 500)

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
Nifty 50	0.33	1.69	-7.13	6.53	0.03	1.69	-13.94	15.07
NSE 500	0.36	1.50	-7.43	6.40	0.03	1.52	-13.75	13.96
U.S. MP Surprise	0.00	0.25	-0.85	0.69	N/A			
U.S. MP Uncertainty	0.00	0.03	-0.13	0.16	N/A			

Sample: Jan 1991 to Jan 2000 (Feb 1995 to Jan 2000 for NSE 500)

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
Nifty 50	0.20	1.83	-5.22	5.34	0.03	2.04	-13.34	11.38
NSE 500	0.41	1.27	-2.29	3.93	0.04	1.60	-7.63	7.06
U.S. MP Surprise	-0.02	0.27	-0.85	0.69	N/A			
U.S. MP Uncertainty	0.00	0.03	-0.11	0.06	N/A			

Sample: Feb 2000 to Jun 2018

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
Nifty 50	0.39	1.61	-7.13	6.53	0.03	1.48	-13.94	15.07
NSE 500	0.35	1.55	-7.43	6.40	0.02	1.50	-13.75	13.96
U.S. MP Surprise	0.01	0.23	-0.79	0.68	N/A			
U.S. MP Uncertainty	0.00	0.03	-0.12	0.16	N/A			

Sample: Feb 2000 to Dec 2008

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
Nifty 50	0.61	1.84	-7.13	6.53	-0.01	1.75	-13.94	7.66
NSE 500	0.51	1.80	-7.43	6.40	-0.02	1.80	-13.75	7.41
U.S. MP Surprise	0.00	0.29	-0.79	0.68	N/A			
U.S. MP Uncertainty	0.00	0.04	-0.11	0.17	N/A			

Sample: Jul 2009 to Jun 2018

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
Nifty 50	0.13	1.17	-4.26	3.53	0.04	1.03	-6.29	3.67
NSE 500	0.14	1.13	-3.92	3.23	0.04	1.00	-7.19	3.57
U.S. MP Surprise	0.03	0.13	-0.33	0.33	N/A			
U.S. MP Uncertainty	0.00	0.02	-0.09	0.04	N/A			

Table 2: Regressions of Indian stock returns on US monetary policy shocks

	Nifty 50				
	1991 - 2018	1991 - 2000	2000 - 2018	2000 to 2008	2009 - 2018
U.S. MP Surprise	-0.870	0.525	-2.239	-2.010	-2.899
	[-1.39]	[0.60]	[-3.28]	[-2.61]	[-2.75]
U.S. MP Uncertainty	0.015	0.183	-0.159	-0.015	-0.265
	[0.12]	[0.80]	[-1.49]	[-0.10]	[-2.35]
Constant	0.347	0.208	0.468	0.721	0.215
	[3.47]	[1.07]	[4.40]	[4.65]	[1.66]
Observations	234	85	149	77	72
R-squared	0.02	0.02	0.14	0.14	0.16

	NSE 500				
	1995 - 2018	1995 - 2000	2000 - 2018	2000 to 2008	2009 - 2018
U.S. MP Surprise	-1.793	-0.026	-2.203	-2.014	-2.742
	[-3.02]	[-0.04]	[-3.27]	[-2.63]	[-2.71]
U.S. MP Uncertainty	-0.106	-0.140	-0.114	0.058	-0.292
	[-1.34]	[-0.96]	[-1.30]	[0.49]	[-2.61]
Constant	0.434	0.410	0.430	0.642	0.218
	[4.64]	[2.11]	[4.18]	[4.27]	[1.77]
Observations	190	41	149	77	72
R-squared	0.09	0.01	0.14	0.15	0.17

Regressions of Indian stock returns on US MP surprise and US MP uncertainty measures for different samples. The MP surprise is normalized to reflect a 25 basis point increase in the expected 1 year ahead federal funds rate, while the MP uncertainty measure is normalized to have unit standard deviation. t-statistics based on robust standard errors are reported in parentheses.

Table 3: Summary statistics for the exchange rate, 10 year bond and FII flows

Sample: Aug 1999 to Jun 2018

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
INR/USD	-0.01	0.29	-1.61	1.24	0.00	0.21	-2.21	2.62
10 yr bond	-0.01	0.07	-0.48	0.21	0.00	0.06	-0.77	0.80
Net FII	0.55	2.44	-8.62	15.58	0.38	1.63	-8.53	26.00

Sample: Aug 1999 to Dec 2008

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
INR/USD	-0.02	0.12	-0.55	0.34	0.00	0.13	-1.02	1.17
10 yr bond	-0.01	0.08	-0.48	0.21	0.00	0.06	-0.43	0.35
Net FII	0.21	2.19	-8.62	14.32	0.19	1.17	-8.08	9.82

Sample: Jul 2009 to Jun 2018

	FOMC Days				Non-FOMC Days			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
INR/USD	-0.01	0.40	-1.61	1.24	0.00	0.27	-2.21	2.62
10 yr bond	0.00	0.05	-0.18	0.18	0.00	0.05	-0.51	0.54
Net FII	0.94	2.66	-4.75	15.58	0.58	1.99	-8.53	26.00

Table 4: Correlation Coefficients

	1999 to 2008			
	FOMC Days		Non-FOMC Days	
	Coef	p-value	Coef	p-value
Corr(USD/INR, Nifty 50)	-0.182	0.10	-0.292	0.00
Corr(10yr, Nifty 50)	-0.289	0.01	-0.077	0.00
Corr(FII, Nifty 50)	0.022	0.84	0.282	0.00
Corr(USD/INR,10yr)	-0.057	0.61	0.029	0.17
Corr(USD/INR,FII)	-0.137	0.22	-0.230	0.00
Corr(10yr,FII)	0.167	0.14	0.042	0.05

	2009 to 2018			
	FOMC Days		Non-FOMC Days	
	Coef	p-value	Coef	p-value
Corr(USD/INR, Nifty 50)	-0.709	0.00	-0.450	0.00
Corr(10yr, Nifty 50)	-0.329	0.00	-0.077	0.00
Corr(FII, Nifty 50)	0.486	0.00	0.246	0.00
Corr(USD/INR,10yr)	0.533	0.00	0.104	0.00
Corr(USD/INR,FII)	-0.370	0.00	-0.195	0.00
Corr(10yr,FII)	-0.189	0.11	0.024	0.27

Correlation coefficients of the Nifty stock return, USD/INR exchange rate, 10 year government bond rate and net FII flows together with the corresponding p-values.

Table 5: Regressions of exchange rate, 10 year bond and FII flows on US monetary shocks

	INR/USD		10 year bond		Net FII	
	1999 - 2008	2009 - 2018	1999 - 2008	2009 - 2018	1999 - 2008	2009 - 2018
U.S. MP Surprise	0.059	1.356	0.083	0.145	1.468	-6.362
	[0.96]	[4.03]	[3.49]	[3.49]	[1.41]	[-3.49]
U.S. MP Uncertainty	0.026	-0.011	0.009	-0.001	0.069	-0.249
	[1.35]	[-0.25]	[1.30]	[-0.33]	[0.43]	[-0.67]
Constant	-0.019	-0.044	-0.015	-0.008	0.188	1.122
	[-1.52]	[-0.99]	[-1.69]	[-1.59]	[0.79]	[3.72]
Observations	81	72	81	72	81	72
R-squared	0.07	0.21	0.08	0.16	0.03	0.11

Regressions of the INR/USD exchange rate, 10 year government bond and net FII flows on US MP surprise and US MP uncertainty measures for different samples. The MP surprise is normalized to reflect a 25 basis point increase in the expected 1 year ahead federal funds rate, while the MP uncertainty measure is normalized to have unit standard deviation. t-statistics based on robust standard errors are reported in parentheses.

Table 6: Regressions of Indian stock returns on US monetary policy shocks, controlling for financial variables

	Nifty 50			
	1999 - 2008		2009 - 2018	
U.S. MP Surprise	-1.880	-1.478	-2.899	0.238
	[-2.47]	[-2.07]	[-2.75]	[0.29]
U.S. MP Uncertainty	0.034	0.122	-0.265	-0.260
	[0.22]	[0.81]	[-2.35]	[-4.18]
INR/USD Exchange Rate		-2.102		-1.968
		[-1.41]		[-6.43]
10 year bond		-4.380		1.329
		[-2.91]		[0.65]
Net FII flows		0.059		0.104
		[0.79]		[3.81]
Constant	0.745	0.627	0.215	0.022
	[4.72]	[3.91]	[1.66]	[0.22]
Observations	81	81	72	72
R-squared	0.12	0.20	0.16	0.61

	NSE 500			
	1999 - 2008		2009 - 2018	
U.S. MP Surprise	-1.864	-1.450	-2.742	0.118
	[-2.46]	[-2.09]	[-2.71]	[0.15]
U.S. MP Uncertainty	0.108	0.185	-0.292	-0.292
	[0.89]	[1.51]	[-2.61]	[-4.80]
INR/USD Exchange Rate		-1.514		-1.831
		[-1.16]		[-6.15]
10 year bond		-4.945		0.863
		[-3.73]		[0.42]
Net FII flows		0.058		0.079
		[0.80]		[2.81]
Constant	0.665	0.550	0.218	0.055
	[4.32]	[3.50]	[1.77]	[0.53]
Observations	81	81	72	72
R-squared	0.12	0.21	0.17	0.57

Regressions of Indian stock returns on US MP surprise and US MP uncertainty measures for different samples, controlling for INR/USD exchange rate, 10 year government bond and net FII flows. The MP surprise is normalized to reflect a 25 basis point increase in the expected 1 year ahead federal funds rate, while the MP uncertainty measure is normalized to have unit standard deviation. t-statistics based on robust standard errors are reported in parentheses.

Table 7: Pooled regressions of individual Indian stock returns on US monetary policy shocks

	Individual NSE 500 Stock Returns			
	1999 to 2008		2009 to 2018	
	(1)	(2)	(3)	(4)
U.S. MP Surprise	-1.750	-1.542	-2.255	-0.184
	[-2.028]	[-2.086]	[-2.423]	[-0.205]
U.S. MP Uncertainty	0.328	0.332	-0.391	-0.397
	[2.762]	[2.869]	[-3.526]	[-4.846]
USD/INR Exchange Rate		0.733		-1.423
		[0.616]		[-4.029]
10 year bond		-3.538		0.255
		[-2.254]		[0.104]
Net FII flows		0.031		0.025
		[0.435]		[0.844]
Constant	0.518	0.471	0.182	0.090
	[3.48]	[3.052]	[1.533]	[0.77]
Observations	22911	22911	31475	31475
R-squared	0.035	0.044	0.039	0.083

Pooled regressions of individual stock returns in the NSE 500 on US MP surprise and US MP uncertainty measures for different samples, controlling for INR/USD exchange rate, 10 year government bond and net FII flows. The MP surprise is normalized to reflect a 25 basis point increase in the expected 1 year ahead federal funds rate, while the MP uncertainty measure is normalized to have unit standard deviation. t-statistics based on standard errors clustered along the time dimension are reported in parentheses.

Table 8: Summary statistics for firm level stock returns

			1999 to 2008		2009 to 2018	
Sector	No. of firms	Avg. Mkt. Cap	Mean	Std. Dev	Mean	Std. Dev
Consumer Discretionary	86	13.4	0.35	3.42	0.12	2.32
Consumer Staples	38	21.4	0.25	3.07	0.05	2.14
Energy	14	99.5	0.46	3.12	0.04	2.32
Financials	86	25.8	0.74	3.56	0.18	2.39
Health Care	41	13.8	0.41	2.59	0.13	2.02
Industrials	83	12.6	0.35	3.17	0.09	2.40
Information Technology	30	36.6	0.57	3.30	0.16	2.44
Materials	81	13.4	0.49	3.29	0.03	2.32
Real Estate	15	13.8	0.93	5.01	0.08	2.63
Telecommunication Services	6	76.6	0.93	3.26	-0.09	2.51
Utilities	21	37.0	0.73	3.37	0.03	2.11

Note: The table shows the summary statistics for individual stock returns grouped by sectors according to the Global Industry Classification Standard (GICS). The market cap is measured in billions of US$. The mean and standard deviations are calculated by first averaging over time and then averaging across firms within a sector.