This paper aims to document and explain patterns in the spillovers from U.S. monetary policy to emerging markets (EMs). It poses three primary questions: first, do U.S. monetary policy shocks have significant effects on capital inflows (to both equities and bonds) and asset price movements (equity prices, bond yields and exchange rates) in emerging market economies? Second, do these effects differ across different phases of U.S. monetary policy from conventional to unconventional? Third, do the effects of U.S. monetary policy shocks depend on the domestic economic conditions of EMs?

Central banks in advanced economies had to respond to the global financial crisis on a scale commensurate with the shock to those economies. As the period of accommodation continued, policy makers in EMs noted that the monetary expansion in advanced economies had spilled over across the globe and into their economies. There was a surge in capital inflows, especially towards debt instruments, their currencies appreciated, and their asset prices rose rapidly. EMs' policymakers worried about painful sectoral adjustments due to large shifts in the exchange rate and balance sheet mismatches, as well as rising vulnerabilities in their financial systems as equity and bond prices boomed, credit bubbles built up, and corporates built excessive leverage. When the possibility of reining in unconventional monetary policies was first mentioned by former Fed Chairman Bernanke in May 2013, there was a spike in market volatility in EMs.

This recent episode rekindled longstanding debates on the optimal policy reactions. Various proposals have been put forward. One focuses on dampening the original shock, through clearer communication from central banks in advanced economies. Another one highlights the strengthening of fundamentals and the resilience of the financial systems in EMs to external shocks with appropriate macroeconomic policies and prudential regulations. Third, there is growing recognition that foreign exchange interventions in some cases capital flow management measures may be useful to complement macro-economic adjustments. Last, but not least, the episodes rekindled the debate on international policy cooperation, to internalize the negative spillovers from unilateral policy action, and maximize global welfare.

The authors use an event study methodology to isolate the impact and direct effects of U.S. monetary policy shocks on asset prices and capital flows in EMs. Event studies offer a simple identification strategy. The dominant shock on event days is taken to be the monetary policy announcement in advanced economies, and the impact effect on financial markets is assumed to be felt within a 2-day window, as adopted in this paper. A longer window would pick up the effects of other shocks on financial markets, while a shorter window might not pick-up the full effect of the monetary policy shock, given non-overlapping market opening hours around the world. A shortcoming of event studies is that they are not able to capture persistence effects. Testing for persistence would require a more fully specified econometric analysis, which, in the case of financial variables, usually suffers from a low fit.

A central ingredient to the event analysis is the
surprise component of monetary policy announcements. If an announcement albeit substantial is fully anticipated, it will have no effect on market prices or portfolio reallocation. But it would be wrong to conclude that policy is ineffective, based on the absence of impact effect. To correctly estimate the effects of monetary policy, it is imperative to measure the surprise component of announcements, and not just to use dummy variables to isolate event days.

The monetary policy surprise is often defined as the difference between the yield of the next expiring futures on Federal Funds, taken just before an FOMC announcement, and the target Federal Funds rate actually announced. But, announcements are not just about punctual changes in interest rates, which by themselves have little impact on economic behavior. Announcement affect longer term rates more relevant for economic decisions through the signals they provide about future policy intentions. This is done through various means, such as verbal statements and accompanying forecasts or other official publications.

In addition to information on current rates and short-term policy intentions, monetary policy announcements can convey information about the supply of bonds that will be available to private investors, and longer-term risks to (or uncertainty about) growth, inflation and changes to central bank preferences and objectives. This is especially relevant for the unconventional monetary policy followed in recent years, where the instruments of monetary policy were expanded to include forward guidance and bond purchases. Surprises along these dimensions are likely to be reflected in longer-term bond rates.

The event analysis carried out in this paper attempts to pick up the additional dimensions of monetary policy announcements by extracting two factors from changes in U.S. bond yields across the yield curve from 1 year to 30-year maturities. These two factors explain 99 per cent of the variation in U.S. bond yields, with a third factor adding very little. The first factor is named by the authors as the market factor. Given its high correlation with longer-term bonds, this factor is viewed as encompassing the portfolio rebalancing channel of monetary policy, as well as any other information the Fed communicates about the supply of bonds that will be available to private investors, and longer-term risks to (or uncertainty about) growth, inflation and changes to central bank preferences and objectives. The second factor is named as the signal factor, which is assumed to be correlated to the more traditional signaling channel of monetary policy.

The authors look for patterns across three general phases of U.S. monetary policy: the conventional monetary policy phase, or CMP (from January 2000 to July 2007), the UMP phase coinciding with announcements of bond purchase programs (November 2008 to May 2013), and the UMP phase from May 2013 until March 2014 when talk of tapering started. The first is referred as UMP phase as UMP-P (“P” for purchases), and to the second as UMP-T (“T” for tapering). Market surprises grow to be noticeably larger during the UMP-P and UMP-T phases, and signal surprises shrink to levels smaller even than market surprises, suggesting that unconventional monetary policies primarily conveyed information affecting longer-term bonds and term premia. UMP-P surprises, as expected, have a negative skew, since announcements aimed to loosen monetary conditions, sometimes aggressively. UMP-T surprises are much more balanced, with the May and June 2013 announcements representing strong tightening shocks, countered by the September 2013 decision...
to postpone tapering having surprised markets on the dovish side. Lastly, average and maximum UMP-T surprises are smaller than UMP-P surprises, for both signal and market factors. This last result is surprising, as it goes counter to the general perception following the May 2013 tapering announcement.

To further explore the distribution of surprises, the authors have dwelled on a few well known announcements. They observe that market surprises are larger in the UMP phase, and surprises of more aggressive easing (or less aggressive cuts) are negative, while those of less aggressive easing (or more aggressive hikes) are positive. Even some of the announcements meant to ease the policy stance at the heart of the crisis had positive surprises, to the extent that a more aggressive announcement was expected. The exercise confirms the importance of controlling for the surprise component of monetary policy announcements, and investigating the market factor in addition to the more common signal factors.

The paper then tries to ascertain whether correlations between U.S. monetary policy surprises and EM market reactions in the UMP phases differed substantially to those in the CMP phase, first to gauge whether the effects of U.S. monetary policy shocks on the rest of the world differ according to the policy instruments used to provide more or less accommodation, and secondly, to see whether tapering shocks differ from shocks associated with the expansion of UMP programs. Results suggest that U.S. monetary policy surprises did not have significant spillover effects during the CMP phase.

The next questions arising are: Why did spillovers per unit of surprise change over phases of U.S. monetary policy? And why did they become larger during the UMP-T phase relative to the other phases? According to the authors, there are at least two hypotheses that can be put forward. The first has to do with the type of shocks. Monetary policy shocks that mark turning points in the monetary policy stance may be associated with larger spillovers. Another possibility is that positive shocks have larger spillovers than negative shocks. Alternatively, larger shocks might have disproportionately larger spillovers. The authors investigate the turning point hypothesis but results are inconclusive.

A second hypothesis that may explain the larger spillovers in the UMP-T phase is that other factors might have amplified or dampened the effects of monetary policy shocks. The main candidate for such factors is volatility in financial markets, which the authors further investigate in their analysis. Two results remain unchanged. The first is that whatever the phase, signal surprises nearly always lead to larger spillovers than market surprises. And the second is that spillovers were larger and more significant during the UMP period, as opposed to the CMP period. The result is robust to controlling for the type of monetary policy shocks (first hypothesis) and for market factors (second hypothesis). It therefore seems that there may be a structural explanation for this result. One possibility is that instruments of policy matter; a loosening (or tightening) coming from asset purchases has greater spillovers than one coming from changes in interest rates.

Movements in asset prices and capital flows following U.S. monetary policy announcements differed significantly across countries. The authors investigate whether emerging market characteristics explain this cross-sectional (cross-country) variation, hypothesizing that countries with stronger macroeconomic fundamentals will experience smaller spillovers. As per the analysis, in
the CMP phase, there are few instances when country characteristics seem to matter. On the other hand, in the UMP phase, higher real GDP dampens spillovers for bond yields and foreign exchange. Moreover, a higher current account surplus (lower deficit), lower inflation and lower share of local debt held by foreigners dampen spillovers for all asset prices: equity prices, bond yields and foreign exchange. Market variables also play some role in determining cross-country differentiation in the UMP phase. A larger market size tends to amplify spillovers on foreign exchange, after controlling for market liquidity. The result makes sense as larger markets have two effects of opposite sign: they attract more foreign investors, thus expose themselves to greater volatility, but are also more liquidity, and thus dampen volatility. Results suggest that countries with less liquid markets have larger spillovers on equity prices.

Summarizing, the authors state that unconventional monetary policies had larger spillovers per unit of surprise than conventional policies. The reason seems to be structural, tied to the particular instruments used during the UMP period, and perhaps to the liquidity that was created. This finding seems to underscore another cost of hitting the zero lower bound, and thus another reason to adopt policies in good times, such as appropriate prudential regulation, so as to minimize risks of hitting the zero lower bound in bad times. Some evidence also points to the conjunctural cycle of emerging market economies as affecting spillovers; these are greater the weaker the growth prospects in EMs, and in particular in China. Thus, countries and investors should monitor the external economic environment to prepare themselves for potential spillovers.

Characteristics of recipient countries also matter for spillovers. Better fundamentals and more liquid markets help dampen the effects of U.S. monetary policy shocks. This suggests a shared responsibility in minimizing negative spillovers, and should encourage EMs to improve their fundamentals as much as possible before considering more intrusive and distortion-creating measures such as foreign exchange interventions and capital controls, even though they may be effective in the short run.

Spillovers are more ubiquitous and larger if stemming from signal surprises. The result is robust across measures of asset prices and capital flows, across phases of monetary policy, and to controls such as the VIX. This is good news, as the signaling channel is better understood by central banks, and can be better managed through clear communication. The U.S. Fed and other influential central banks should, therefore, be able to minimize the source of shocks that lead to global spillovers.

At the same time, even though market surprises have smaller spillovers, their effects are less differentiated across countries and thus more unpredictable. To minimize the effects of market surprises, the U.S. Fed and other advanced economy central banks should focus on minimizing shocks to long-term bond yields when they exit from unconventional monetary policies. This might be done, for instance, by not selling outright the assets they have accumulated, or at least doing so in a very predictable and mechanical fashion.

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This paper adopts linear, non-linear time series models along with forecast combination (of linear and non-linear) for forecasting major macroeconomic variables (Monthly series of Index of Industrial production IIP and quarterly series of GDP) in respect of India. Forecasting is an integral part of policy making for the Central Bank and a robust forecasting framework is the backbone of any policy foundation. A robust forecasting methodology depends on underlying data generating process (DGP) using various time series models. In case of macroeconomic variable, the DGP depends on continuous changes in macro-foundation which, sometimes, affect the forecast accuracy adversely. Taking this problem in consideration, the paper applied different time series forecasting models linear (like ARIMA), non-linear models (threshold models STAR, SETAR) and combination of linear and non-linear (Median). Generally linear models like ARIMA have been used extensively for forecasting purpose, but these linear models fail to identify many macroeconomic phenomenon namely asymmetric business cycles, volatility of stock exchange, inherent regime switching and others.

Evaluating forecasting performance of Linear, Non-Linear and Combination (Median) models on parameters of forecasting accuracy, and dependency on forecast horizon, the paper found that long memory property (measured by Hurst Exponent) and variation nature (measured by coefficient of variation) affect forecasting accuracy through data generating processing. The series having high long memory property and lesser variability are considered to be much more stable and hence can be easily tractable in nature. The performance of different linear and non-linear models can be different depending upon GDP and period of consideration. Comparing the forecast performance of linear and non-linear models, it was found that non-linear dynamics are present in many non-economic series (including exchange rate), but the forecast performance of non-linear models are relatively worse than linear models for exchange rate. The combination of different forecasts (using different techniques like simple average, weighted average, median etc.) may not be optimal in case of non-Gaussian forecast error and can be distorted due to presence of out-of-the-place forecast.

The forecasting performance of naïve models (linear and non-linear) when compared with respect to RMSE of rolling forecast mechanism, indicates no clear improvement of using non-linear models compared to linear models. Using Y/Y growth in IIP (monthly data since April 2006) and GDP (quarterly since 1997-98:Q1) including sub-sector growth, the paper found that majority of IIP having low Hurst exponent values and high CV values which attributes to high volatility and mean reverting nature and consequently higher RMSE indicating lack of fit. While the GDP of IIP having lower volatility and long memory property is better estimated through time series models compared to others. Compared to IIP series, majority of GDP series are found to be having lesser volatility and long memory property indicating better predictability. The rolling RMSE for GDP forecasts are lesser in magnitude than IIP series. The paper also found that the linear models are found to be

Forecasting Major Macroeconomic Variables in India: Performance Comparison of Linear, Non-Linear Models, and Forecast Combinations, RBI Working Paper by Anirben Sanyal & Indrajit Roy
having higher RMSE than non-linear and median forecasts, indicating lack of fit.

The empirical findings show that the forecast combinations (median) are marginally better performing than that of linear and non-linear modeling framework in short horizon (1 - 6 months) in case of forecasting of IIP, while in 7 -12 months horizon, the non-linear models perform relatively better than the linear models and the combination forecast. However for GDP (and its sub component) forecast, the median forecast has been found to be out-performing than linear and non-linear models in 1-2 quarter ahead forecast horizon, while the non-linear models are found to be performing marginally better than median forecast in 3-4 quarter ahead forecast for some series, while median forecast is performing better for almost all series.

Though non-linear models and combination forecast are found to be performing better than linear models for some variables, the same can't be generalized across all series for all forecast horizons mainly due to significantly high out-of-sample forecast error raising the question of overall forecast accuracy. In summary, the combination of forecast (median) may be used instead of standalone forecast obtained either from linear or non-linear models for better tracking the macroeconomic series, but in overall performance measurement, the combination forecast (median) has been found to be consistently performing better than other models in most instances.

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