

Should Emerging Markets Worry about U.S. Monetary Policy Announcements?

Poonam Gupta
Oliver Masetti
David Rosenblatt



WORLD BANK GROUP

Development Economics Vice Presidency
Operations and Strategy Team
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Abstract

This paper analyzes the spillover effects of U.S. monetary policy announcements on emerging market economies since end-2008, the period coinciding with the use of unconventional policy measures. Monetary policy surprises are measured by changes in two-year Treasury yields in short windows of time around the Federal Reserve Board's policy announcements. The analysis finds that U.S. monetary policy surprises have a significant impact on emerging economies'

exchange rates, equity prices, and bond yields. The impact is larger for surprise tightening of policy than for surprise easing. The impact is disproportionately larger for large surprises, implying that emerging markets are relatively insulated from anticipated policy announcements. The spillover effects of policy announcements of other advanced economies, such as the euro area, Japan, and United Kingdom, are found to be much weaker than those of the United States.

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Should Emerging Markets Worry about U.S. Monetary Policy Announcements?¹

Poonam Gupta, Oliver Masetti, and David Rosenblatt

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¹ Comments are welcome at pgupta5@worldbank.org; omasetti@worldbank.org; and drosenblatt@worldbank.org
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1. Introduction

Financial markets in advanced as well as emerging countries are routinely affected by monetary policy announcements in the US. This was starkly evident in the summer of 2013, when on May 22, Federal Reserve Chairman Ben Bernanke first spoke of the possibility of the Federal Reserve Board tapering its security purchases. This “tapering talk” had a sharp negative impact on financial conditions in emerging markets in the following months, when exchange rates depreciated, bond spreads increased, and equity prices fell. Some of the countries seemed to be on the verge of experiencing a full-fledged balance of payments crisis. The event helps explain why issues related to the spillover of US monetary policy have gained prominence in recent contributions to the literature and in policy discussions.²

In this paper, we analyze the spillover of US monetary policy announcements on emerging countries’ equity prices, exchange rates, and bond yields. Using event study methodology, we analyze the experience of 20 of the largest emerging countries, those with readily available daily data, from October 1, 2008 to September 1, 2016.

During this period, monetary policy was conducted primarily through unconventional means. Conventional monetary policy was confined to the earlier part of the period, when the Federal Open Market Committee (FOMC) lowered the federal funds target rate to 1.5 percent in an intermeeting announcement on October 8, 2008, to 1 percent on October 29, 2008; and again to its lower bound between zero and 0.25 percent on December 16, 2008. Thereon the monetary policy was conducted primarily through direct asset purchases, altering the size and composition of the Federal Reserve’s balance sheet.³ The first announcement toward unconventional policy was made on November 25, 2008 when the Federal Reserve Board announced a plan to purchase \$ 600 billion of mortgage-backed securities and agency debt. Forward guidance on the future path of the federal funds rate is believed to have played an important role as well during this period.

Our empirical approach rests on identifying the surprises associated with the policy announcements during this period of unconventional monetary policy. The standard practice in the literature is to use the data in a short period of time, either intraday, or over a one or two-day period around the announcements, to estimate the surprise inherent in these policy announcements. For conventional monetary policy, a standard practice is to use the difference between the policy expectation built into federal funds futures right before the announcement and the policy rate after the announcement as a measure of the surprise. For unconventional policy, changes in Treasury yields of tenors ranging from one year to 30 years are used; changes in 2-year or 10-year yields being

² The prominence this issue gained in policy circles was evident when the Brazilian Finance Minister Guido Mantega warned against “currency wars” in 2010, and when the Indian central bank governor Raghuram Rajan (Rajan, 2014) spoke about the need for policy coordination among central banks in a lecture at the Brookings Institution.

³ Conventional policy was resumed only years later when on December 16, 2015 the federal funds target rate was increased to between 0.25 to 0.50 percent. A year later, on December 14, 2016 the federal funds target rate was raised to between 0.50 to 0.75 percent and on March 16, 2017 it was raised by another 25 bps to a range of 0.75 to 1.00 percent.

most commonly used. Once the policy surprise is thus estimated, the observed cross border spillover can be interpreted as the causal effects of the US policy on foreign markets.

Following the literature, we use changes in the 2-year Treasury yield on FOMC announcement days as an indicator of the surprise in the policy announcement. As for using higher frequency, intra-day changes, it has been noted (see e.g. Hanson and Stein (2015)) that a one or two-day period is more appropriate for bond yields to react fully to policy announcements during the period of unconventional policy. Besides, most FOMC announcements during this period were made in the afternoon (EST time), when financial markets in the majority of emerging countries in our sample are closed. Hence, they typically react to the US policy announcements on the following day. Nevertheless, we confirm that our results are robust to using changes in yields over a two-day period; as well as to changes in the Treasury yields of different tenors.

Our results show that a surprise monetary tightening, estimated by an increase in 2-year Treasury yield on the day of the FOMC announcement, results in exchange rate depreciation, decline in equity prices, and increase in bond yields in emerging economies. A surprise easing on the other hand, similarly estimated by a decrease in 2-year Treasury yield, has an opposite effect. The magnitude of spillover is larger for surprise tightening than for surprise easing; and the spillover is disproportionately larger for large policy surprises, defined as those in which changes in the Treasury yields exceed two standard deviations around the mean change. We find weaker spillover of monetary policy surprises in other advanced economies such as the euro area, Japan and UK, presumably because of their weaker financial links with emerging economies.⁴

The effect of FOMC announcements on emerging markets is seemingly economically significant. Our results show that the probability that asset prices in emerging economies will experience large daily movements is almost twice as large following an FOMC announcement than on non-FOMC days.⁵ If FOMC announcements result in a large change in US Treasury yields, the probability that emerging economies' asset prices move sharply increases by a factor of 3 to 5.

Results are robust to several variations and robustness tests, including: (1) dropping specific events from the analysis, such as the FOMC announcements at the onset of the Global Financial Crisis in 2008, or the tapering episode in 2013; (2) not including inter-meeting policy announcements, which may be indicative of deteriorating US or global economic conditions; (3) accounting for specific economic news, such as the new payroll or inflation numbers; and (4)

⁴ The approach used in the paper does not distinguish between the channels whereby the spillover occurs—i.e. the portfolio balance channel or the signaling channel. In our view, decomposing the impact into different channels is not necessarily of interest from the emerging market perspective. Hausman and Wongswan (2011) document the impact of the target and path surprises in US monetary policy announcements on equity indexes, interest rates, and exchange rates in emerging countries. They find that different asset classes respond to different components of the monetary policy surprises: Global equity indexes respond mainly to the target surprise, exchange rates and long-term interest rates respond to the path surprise, and short-term interest rates respond to both surprises.

⁵ Large movements are defined as daily percent changes that exceed the sample mean by at least two standard deviations.

dropping very large values of the dependent variables (e.g. top 1 percent and bottom 1 percent of the observations).

The paper contributes to the literature on the impact of US monetary policy on asset prices. This literature has evolved in stages. The earliest literature, dating back to the early 2000s, primarily focused on the impact of US monetary policy on domestic equity prices, and established that surprise changes in monetary policy have a large and significant impact on equity prices.⁶ The literature was then extended to the impact of surprise US policy on other asset prices within the US; and to its cross-border impacts. Evidence showed stronger within country impact and within the asset class. While the impact of policy on asset prices within the euro area, and from the US to other economies is estimated to be strong; there are only weak linkages from other countries to the US.⁷ Evidence also shows weaker albeit significant international spillovers across asset classes.

We contribute to this literature by focusing on the entire period of unconventional monetary policy, a large set of emerging economies, and an array of asset prices. One novelty of the paper is to analyze the asymmetric reaction of asset prices in emerging countries to the surprise policy easing and tightening in the US. Another contribution is to compare the impact of the US policy announcements with that of other advanced economies, namely the euro area, Japan, and UK. The paper also relates to the literature and the policy discussion that proliferated after the Taper Tantrum episode of summer 2013, which triggered financial sector volatility across emerging economies.⁸

There are a number of possible areas in which this analysis may be extended. First, one could extend the sample of countries and ask if the impact varied across countries, and if it did, across which specific country characteristics, e.g. the trade or financial linkages with the US; dependence on external capital markets; the size and liquidity of their financial markets; or their recent economic performance. Second, while we focus only on the short-term impact of the US policy, primarily because of our interest in establishing a causal link, equally interesting from a policy perspective is its medium-term impact on the cost of financing in emerging economies. Third, one

⁶ Kuttner (2001), Ehrmann and Fratzscher (2004), Bernanke and Kuttner (2005), and Gürkaynak, Sack and Swanson (2005) have contributed to this literature. Bernanke and Kuttner (2005) estimate that equity prices react strongly to monetary policy shocks in the US—a surprise 25 bps decline in federal funds rate results in a 1 percentage point increase in equity prices, while there is little impact of an anticipated change in the federal funds rate. Bredin et al. (2007) document similar findings for the impact of U.K. monetary policy surprises on its stock market. Bredin et al. (2009) estimate the impact of unexpected changes in the UK and euro area policy rates on the UK and German equity returns. They find that UK surprises have a significant negative influence on returns in both countries.

⁷ Ehrmann, Fratzscher, and Rigobon (2011) show that US financial markets on average explain around 30% of euro area financial market movements in the period 1989–2008, whereas euro area markets account for about 6% of the variance in US asset prices.

⁸ This literature documents the impact of the tapering announcements on emerging economies and explains the heterogeneity in their experiences. See Chen, Mancini-Griffoli, and Sahay (2014), Eichengreen and Gupta (2014), Basu, Eichengreen and Gupta (2015), and Aizenmann, Binici, and Hutchison (2016).

could ask whether emerging economies undertake specific policies in response, and which ones of these are considered relatively more effective in countering the spillover impacts.⁹

The rest of the paper is organized as follows. In Section 2 we describe the identification strategy used, putting it in context with the existing literature. In Section 3 we discuss the regression framework and present our main regression results. In Section 4 we present results from extensions to the benchmark specification; and in Section 5 results from the robustness exercises are presented. We conclude and discuss avenues for future research in the last section.

2. Estimating the Surprise in FOMC Announcements

Following contemporary literature, our empirical approach rests on identifying the surprises associated with the Federal Reserve Board's monetary policy announcements. As per the efficient market hypothesis, financial markets are forward looking and internalize all expected events well. When these anticipated events actually take place, they should not have an additional impact. Only the unanticipated component should be news to the financial markets and have an effect (see e.g. Bernanke and Kuttner (2005) and Borio et al (2016)).

FOMC meetings, which take place roughly every six weeks, set the stance of US monetary policy. During the period of our analysis, October 1, 2008 to September 1, 2016, 65 FOMC meetings took place, of which 63 were scheduled meetings and two were held outside the regular schedule. While we include all FOMC meeting announcement days in our analysis, we do not include days when the orientation of the future path of policy was conveyed in speeches delivered by the governor or by the members of the Federal Reserve Board, or when the minutes of the FOMC meetings were released, setting the expectations further. We do so to avoid any subjectivity in the events we analyze.¹⁰

For identification, we seek to estimate unanticipated changes in policies in a very short period of time after the announcement, in order to rule out the possibility that any other events or news affected the markets during that period. The standard practice in the literature is to use either intra-day changes in the relevant variables, or changes on the day of the announcement, or over a two-day period around the FOMC announcements to estimate the surprise inherent in policy announcements.

Traditionally, the literature has used changes in short-term federal funds futures to identify monetary policy surprises (e.g. Kuttner (2001), Gürkaynak, Sack and Swanson (2005), and Bernanke and Kuttner (2005)). An empirical innovation of this literature consisted of extracting the surprise

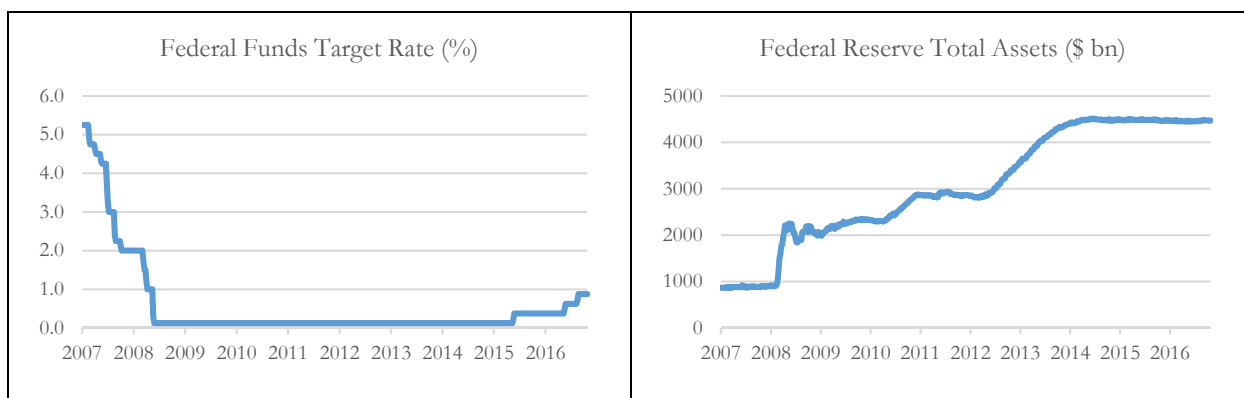
⁹ In this context, Fratzscher, Lo Duca and Straub (2013) ask whether foreign exchange or capital account policies help insulate countries from the spillovers of the US policy. Their evidence does not support the hypothesis that these policies have a bearing on the spillover.

¹⁰ Wright (2012) on the other hand includes in the analysis the days when the policy intent was conveyed through specific speeches, but leaves out some of the FOMC days when no major announcements were made.

component of monetary policy actions from changes in the federal funds futures around the announcement. This approach works well for the period until 2008 when for most part the Federal Reserve Board conducted conventional monetary policy, using the target federal funds rate as the main policy instrument.

The policy framework changed starting on November 25, 2008, when the FOMC announced a program to purchase the direct obligations and mortgage-backed securities (MBS) of housing agencies. Subsequently, at its regular meeting on December 16, 2008, the FOMC lowered the target federal funds rate to its effective lower bound, i.e. to a range between 0 to 0.25 percent. This marked the end of the period of conventional monetary policy, and the onset of what came to be known as the period of unconventional monetary policy, as per Chart 1 below. The subsequent period consisted of a program of direct asset purchases, commonly known as the Large-Scale Asset Purchase Program (LSAP), as well as of forward guidance regarding the path of monetary policy.

Chart 1: The Period of Unconventional Monetary Policy



Source: Federal Reserve Board

Since the federal funds futures rate no longer provided a meaningful basis to identify monetary policy surprises during the unconventional monetary policy phase, the literature used high frequency changes in longer term Treasury yields instead to identify policy surprises. The identifying assumption is similar to the one used for the conventional monetary policy period: movements in Treasury yields in a narrow window around the policy announcements are due to unanticipated changes in the stance of the US monetary policy. Different researchers prefer yields of different tenors, and during different durations of periods around FOMC announcements.¹¹

Hanson and Stein (2015) e.g. use changes in 2-year Treasury yield as the proxy for monetary policy news, but obtain similar results when they use alternatives to estimate revisions in policy. They choose a two-day window over which to measure the change in Treasury yields, and argue that a window of two days, rather than a shorter one, better captures the full market response to

¹¹ As per Financial Times, February 1, 2017, “Two year yields are among the most sensitive to changes in monetary policy....”

unconventional policy announcements. This is evidently because investors update their beliefs as they observe trading volumes, the price process and reactions in the financial media. Gilchrist et al (2014) on the other hand prefer intraday changes, in a 60-minute window, in 2-year Treasury yields to estimate policy surprises. Gagnon et al (2010) use a one-day window to measure the impact of the LSAP announcements and prefer it to an intra-day change. They argue that a wider window is suitable since given the novelty of the LSAP program, these were likely to get absorbed in yields more slowly than a typical monetary policy shock. As for which yields to look at, they consider 2- and 10-year Treasury yields, 30-year MBS, 10-year agency debt, and several other yields, and find changes in all of these yields to be highly correlated.

Gertler and Karadi (2015) use 1-year as well as 2-year Treasury yields and find that the results are quite similar with either of them. Chen et al (2014) on the other hand argue that surprises related to forward guidance and asset purchase announcements are likely to be reflected in the yields of longer term bonds (since the LSAP program was geared toward lowering the long-term interest rates), and use factors extracted from 1-year to 30-year Treasury bonds. Similarly, Wright (2012) estimates that the monetary policy shocks had a significant effect on 10-year yields.

In accordance with the literature, our identification of unexpected policy announcements depends on the reaction of Treasury yields around FOMC meetings. We use changes in 2-year Treasury yield on FOMC announcement day as an indicator of the surprise change in the policy, calculated as the percent change in the yield from the closing level on the day prior to the announcements to the closing level on the day of the announcement.¹² As for using the intra-day changes, we note that during the period considered, most announcements of the FOMC meetings were made in the afternoon, when financial markets in most emerging countries in our sample are closed. They would have reacted to FOMC announcements only on the following day.

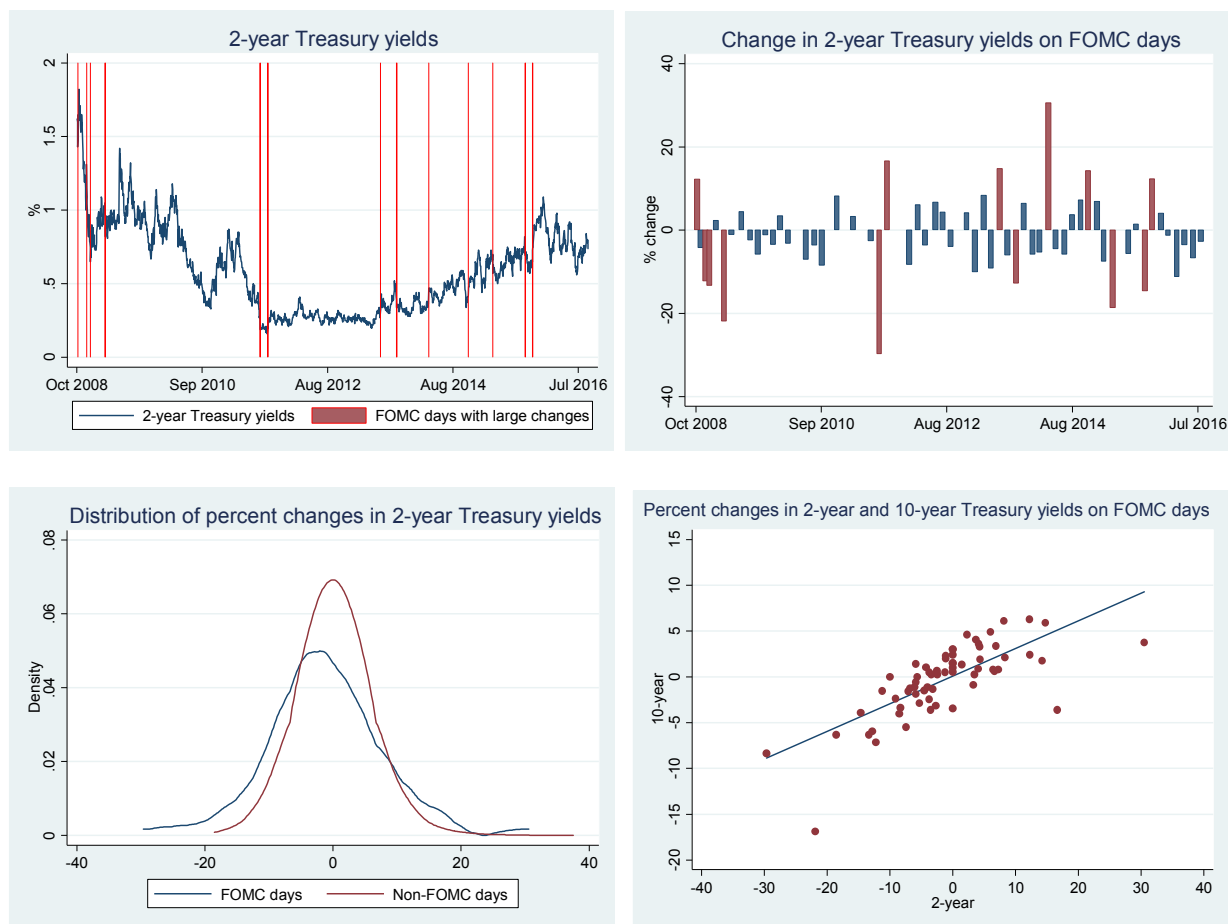
As for the tenor of the Treasury bonds, the results are insensitive to whether we use 2-year or 10-year yields. This is unsurprising since the yields correlate strongly--the correlation between percentage changes in 2-year and 10-year bonds is 0.73 on FOMC days, and 0.65 on all FOMC and non FOMC days (see Appendix A for a list of all FOMC meetings, the announcements made and percent change in 2-year and 10-year Treasury yields on the day of the announcements). Nevertheless, in robustness analysis we consider changes over a two-day period, or changes in the bond yields of different tenors, or alternative ways to measure the policy surprise, and find the results to be similar.

The next choice we need to make is the sample of countries and the time period analyzed. This choice is dictated by the availability of data and our interest in analyzing relatively contemporary experiences. Thus, we analyze the experience of 20 of the largest emerging countries

¹² The approach that we use here allows for policy announcements made that were unanticipated, as well as for instances when the markets anticipated a specific policy announcement, but it was not made (as discussed e.g. in Gürkaynak et al (2005), and Chari et al (2016)).

with readily available data.¹³ While extending the sample to other countries could provide more diverse narratives, the availability of data starts getting scarce. Even within the current sample of large countries, while the data on daily exchange rate are available for all 20 of them, equity prices are available for 19 countries, and bond yields are available for just 17 of them. The exchange rates are in local currency per USD; equity prices are in local currency; and bond yields are 10-year sovereign yields in local currency (see Appendix B for the sample of countries, Appendix C for data sources, and Appendix D for their summary statistics).

Chart 2: Treasury yields on the days of the FOMC Announcements



Two-year Treasury yields are depicted in the first panel of Chart 2. The period is marked by medium term trends, whereby yields declined between 2008 and 2011; stayed low during 2012-2013 and increased thereafter; as well as by short term movements at higher frequency. The vertical lines mark the FOMC days when day-to-day percentage change in yields was below or above the period average by 2 standard deviations.

¹³ Our country sample includes Brazil, Chile, China, Colombia, Czech Republic, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Peru, Philippines, Poland, Russian Federation, South Africa, the Republic of Korea, Taiwan, China, Thailand, and Turkey. Of these, we do not have daily equity prices for Israel, and bond yields for Israel, Peru and Brazil.

The second panel depicts percentage change in the yields on each of the FOMC dates. The ones marked in red are those when day-over-day changes after FOMC announcements exceeded the two standard deviation band around the average changes.¹⁴ The third panel compares the distribution of daily percentage change in yields on FOMC days with those on all other days in the sample period. It shows that on average Treasury yields declined on FOMC days, compared to non-FOMC days; and that the former had more tail events, when yields increased or declined sharply.

Finally, in the last panel we compare changes in 2-year Treasury yields against changes in 10-year yields on the days of the FOMC announcements. The chart indicates that the changes in 2-year and 10-year yields on FOMC days were strongly correlated. There were only a couple of instances when the close synchronicity in the yields broke. One, during Operation Twist on September 21, 2011, which was aimed at flattening the yield curve, lowering them at the longer end and raising them at the shorter end. The policy resulted in an increase of 17% in 2-year yields and a decline of about 3.6% in 10-year yields on the announcement day. The other instance was on March 19, 2014, when while the Federal Reserve Board continued to taper the pace of security purchases at a pre-announced pace, and adhered to the federal funds rate of 0-0.25 percent, but seemingly changed the forward guidance, indicating an increase in the federal funds rate going forward. The 2-year yields increased by 30%, while 10-year yields increased by less than 5% on the day of the announcement.

3. Estimation Results

In this section, using an event study approach, we ask how the surprise US monetary policy announcements affect the exchange rate, sovereign bond yields and equity prices in emerging economies.

To start out we estimate Equation 1, using Ordinary Least Square estimates. In Equation 1, $e_{i,t}$ is the exchange rate, equity price, or bond yield in country i on day t , r_t is the 2-year Treasury yield on day t , t being the day of the FOMC announcement. Regressions include country-fixed effects, denoted by θ_i , to account for country-specific, time invariant elements; and $\varepsilon_{it,k}$ is the stochastic disturbance term capturing the effect of all other information and developments happening during period t and $t+k$. We regress changes in emerging market variables between day $t+k$ and $t-1$ on changes in the Treasury yield between t and $t-1$, where k ranges from one to three days.

$$\frac{e_{i,t+k} - e_{i,t-1}}{e_{i,t-1}} = \alpha_k + \beta_{1,k} \frac{r_t - r_{t-1}}{r_{t-1}} + \theta_i + \varepsilon_{it,k} \quad (1)$$

¹⁴ In Section 5.3 below we repeat the analysis with changes in yields in basis points rather than in percent.

We first examine asset price returns over a one to three-day window after the FOMC announcements, but consider longer windows later in extensions. Our first set of results is in Table 1, which shows that the US monetary policy has a significant effect across asset classes in emerging economies. A surprise policy tightening in the US results in exchange rate depreciation, decline in equity prices, and increase in sovereign yields in emerging economies. Specifically, a 10 percent increase in Treasury yield results in a nearly 0.5 percent exchange rate depreciation, 1 percent decline in equity prices, and 1 percent increase in sovereign yields of emerging economies.¹⁵ The impact persists for all three days considered in the analysis. The effect on exchange rates is similar in one to three days after the policy announcement, while the impact on equity prices and bond yields increases in days after the announcements.

Table 1: The Effect of the surprise US Monetary policy on Emerging Economies' Financial Variables

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
2yr Treasury yield	0.044*** [7.00]	0.048*** [7.25]	0.047*** [8.74]	-0.061*** [-8.02]	-0.094*** [-10.90]	-0.101*** [-10.27]	0.072*** [4.66]	0.094*** [6.57]	0.097*** [6.13]
Constant	-0.042*** [-5.04]	-0.007 [-0.78]	-0.009 [-1.32]	0.313*** [32.77]	0.330*** [29.69]	0.456*** [36.50]	-0.111*** [-6.17]	-0.133*** [-7.31]	-0.101*** [-5.12]
Observations	1,300	1,300	1,300	1,194	1,200	1,197	1,049	1,052	1,053
R-squared	0.087	0.076	0.064	0.047	0.067	0.068	0.051	0.061	0.057
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1. The independent variable is percent change in 2-year Treasury yield between t and t-1, t being the day of the FOMC announcements. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

There are two channels whereby changes in Treasury yields could affect capital flows and asset prices in emerging economies. As per the portfolio balance channel, investors in search of higher yield buy foreign assets when Treasury yields decline (and vice versa); and as per the signaling channel a decline in Treasury yields implies a decline in the risk-neutral component of bond yields, widening the interest rate differentials with respect to emerging market economies, and thus triggering carry trades and capital flows into emerging market economies. The approach used here does not distinguish between the channels whereby the spillover occurs—i.e. the portfolio balance channel or the signaling channel. In our view, decomposing the impact into various channels is not necessarily of interest from the emerging market perspective.

¹⁵ Or a one standard deviation increase in Treasury yields on FOMC days results in about a 0.4 percent exchange rate depreciation, 0.6 percent decline in equity prices, and 0.7 percent increase in sovereign yields of emerging economies.

As noted earlier, some papers consider changes in longer term Treasury yields as a measure of the surprise element in policy announcements. Next, we estimate Equation 1 with changes in 10-year Treasury yields as the measure of surprise policy announcement. We obtain larger spillover coefficients for changes in 10-year Treasury yields, Table 2. This is consistent with Gilchrist et al (2014) who similarly find a larger spillover for changes in longer term yields. Again, the spillover persists for all three days, and increases for equity prices and bond yields over longer horizons.

Table 2: Effect of surprise US Monetary policy (change in 10-year yields) on Emerging Economies' Financial Variables

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
10yr Treasury yield	0.068*** [5.76]	0.085*** [6.15]	0.074*** [6.44]	-0.060*** [-3.50]	-0.104*** [-4.84]	-0.134*** [-7.06]	0.157*** [3.52]	0.223*** [5.54]	0.241*** [5.35]
Constant	-0.077*** [-19.79]	-0.042*** [-9.19]	-0.046*** [-12.22]	0.370*** [66.68]	0.414*** [54.54]	0.538*** [81.73]	-0.148*** [-11.06]	-0.175*** [-12.66]	-0.144*** [-9.76]
Observations	1,300	1,300	1,300	1,194	1,200	1,197	1,049	1,052	1,053
R-squared	0.035	0.040	0.027	0.008	0.014	0.020	0.039	0.057	0.059
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1. The independent variable is percent change in 10-year Treasury yield between t and t-1, t being the day of the FOMC announcements. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

We ask a number of ancillary questions: is the spillover impact symmetric for an unanticipated tightening and an unanticipated easing of policy? Is the effect proportionate to percent changes in Treasury yield, or is it particularly large for large changes in yields? In other words, is the impact disproportionately larger for tail events? Do emerging economies react in a similar fashion to monetary policy announcements by other advanced economies, such as the euro area, Japan, or the UK, as they react to announcements by FOMC?

In order to ask whether the spillover is symmetric for unanticipated policy tightening and easing, we define a dummy variable, $Tight_t$, which takes the value 1 if 2-year Treasury yield increases after an FOMC meeting, and zero if it declines. We estimate Equation 2 below by including the interaction between this dummy and the change in Treasury yield in the regression. The regression specification and other variables remain the same as in Equation 1.¹⁶

¹⁶ Out of the 65 FOMC announcements in our sample, 22 events are classified as Tightening and 35 as Easing. The remaining 8 announcements cannot be classified as either since the 2-year Treasury yields did not change following the announcement. We drop these 8 announcements in estimating Equation 2.

$$\frac{e_{i,t+k}-e_{i,t-1}}{e_{i,t-1}} = \alpha_k + \beta_{1,k} \frac{r_t-r_{t-1}}{r_{t-1}} + \beta_{2,k} \frac{r_t-r_{t-1}}{r_{t-1}} * Tight_t + \theta_i + \varepsilon_{i,t,k} \quad (2)$$

The results, reported in Table 3, show that the coefficient of the interaction between the change in 2-year Treasury yield and dummy for tight policy is positive and significant for exchange rate, negative and significant for equity prices, and indistinguishable from zero for bond yields. The results convey that the spillover to exchange rates and equity prices is larger for a surprise tightening of the US policy than for a surprise easing; while the spillover to bond yields is symmetric for surprise policy tightening and for surprise easing; and seemingly equity prices in emerging economics do not react to surprise policy easing.

Table 3: The Differential Effect of Surprise US Monetary Policy Tightening on Emerging Economies' Financial Variables

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
2yr Treasury yield	0.028*** [4.15]	0.030*** [4.40]	0.028*** [6.03]	0.018 [0.97]	0.000 [0.02]	-0.032 [-1.65]	0.068** [2.66]	0.083*** [3.51]	0.070*** [3.36]
2yr Treasury yield* Dummy Tight	0.034*** [3.02]	0.039** [2.75]	0.040*** [3.49]	-0.166*** [-5.12]	-0.196*** [-5.09]	-0.143*** [-3.58]	0.007 [0.19]	0.020 [0.46]	0.053 [1.24]
Constant	-0.167*** [-4.01]	-0.152*** [-2.98]	-0.180*** [-4.53]	0.996*** [7.65]	1.134*** [7.47]	1.084*** [7.00]	-0.215 [-1.39]	-0.303* [-1.81]	-0.420** [-2.61]
Observations	1,140	1,140	1,140	1,048	1,056	1,052	921	928	926
R-squared	0.098	0.084	0.071	0.083	0.099	0.084	0.063	0.078	0.072
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1. The independent variable is percent change in 2-year Treasury yield between t and t-1, t being the day of FOMC announcements. Dummy variable Tight takes a value 1 when 2-year Treasury yield increases between t and t-1, and 0 otherwise. The 8 FOMC announcement dates when 2-year Treasury yields remained unchanged are exclude from the regression. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

The more pronounced market reaction to tightening announcements is consistent with the financial literature, which shows that financial markets tend to react more strongly to negative news than to positive news (e.g. Brown, Harlow and Tinic (1988), and Veronesi (1999)). In terms of our analysis here, a policy tightening in the US is “negative news” when it comes to the asset price valuations in emerging economies. In addition, investors may react more sharply to policy tightening by rebalancing their portfolios away from a few large emerging markets, the kind we have

considered here; than to policy easing, in response to which they may reallocate their portfolios more gently toward a larger number of emerging markets.¹⁷

Next, we ask whether emerging market economies experience particularly large movements in financial variables after the FOMC meetings in which Treasury yields increase or decline sharply, or in other words do they react non-linearly to tail events. The criteria used for large changes in Treasury yields is that they exceed or are below the average by at least two standard deviations. Specifically, we define a dummy for large tightening announcements, when the change in 2-year Treasury yield exceeds the average of the sample period by two standard deviations, and zero on all other days. Similarly, we define a dummy for large easing announcements, when the change in 2-year Treasury yields is below the average of the sample period by two standard deviations, and zero on all other days (see Equation 3). There are 6 FOMC days when Treasury yields increased by more than 2 standard deviations, we call them the episodes of large tightening, and 8 FOMC days when Treasury yields declined by 2 standard deviations, the episodes of large easing. We include the interaction effects between these dummies and 2-year Treasury yields in our benchmark regressions.

$$D_{itk, \text{ large tightening}} = 1 \text{ if } \frac{r_t - r_{t-1}}{r_{t-1}} > \text{mean} \left(\frac{r_t - r_{t-1}}{r_{t-1}} \right) + 2 * \text{std} \left(\frac{r_t - r_{t-1}}{r_{t-1}} \right) \text{ and } 0 \text{ otherwise}$$

and (3)

$$D_{itk, \text{ large easing}} = 1 \text{ if } \frac{r_t - r_{t-1}}{r_{t-1}} < \text{mean} \left(\frac{r_t - r_{t-1}}{r_{t-1}} \right) - 2 * \text{std} \left(\frac{r_t - r_{t-1}}{r_{t-1}} \right) \text{ and } 0 \text{ otherwise}$$

The results are reported in Table 4 where it is evident that the effect on emerging economies is particularly large for large perceived surprises in the US policy stance. The effect on exchange rate and equity prices is stronger for large perceived tightening than for large easing of policy, while the impact on emerging market bond yields is quite similar for large perceived tightening and large easing.¹⁸ Evidently, the average effect seen in the data around all FOMC meetings is driven in a large part by these tail events--the coefficients of 2-year Treasury yields are smaller and less significant after we control for large surprises separately in the regression.

¹⁷ This interpretation is consistent with Eichengreen and Gupta (2014) who established that foreign investors rebalanced primarily out of the larger financial markets following the tapering talk episode.

¹⁸ The coefficients of the interaction terms are significantly different at the 6% level for exchange rates and at the 2% level for equity prices.

Table 4: The Effect of *Large* surprises in US Monetary Policy on Emerging Economies' Financial Variables

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
2yr Treasury yield	0.020** [2.31]	0.024** [2.33]	0.030*** [3.40]	-0.003 [-0.28]	-0.017 [-1.36]	-0.023 [-1.56]	0.039** [2.59]	0.037* [2.04]	0.032* [1.82]
2yr T-yield* Dummy Large Tight	0.040*** [5.22]	0.043*** [4.43]	0.033*** [3.89]	-0.134*** [-10.49]	-0.168*** [-13.74]	-0.145*** [-7.83]	0.040 [1.50]	0.073** [2.50]	0.100*** [3.30]
2yr T-yield* Dummy Large Ease	0.021*** [3.32]	0.021** [2.32]	0.013 [1.62]	-0.022 [-1.18]	-0.036 [-1.60]	-0.059** [-2.73]	0.044* [1.98]	0.071** [2.48]	0.068** [2.39]
Constant	-0.092*** [-5.70]	-0.063*** [-3.42]	-0.057*** [-4.13]	0.555*** [13.31]	0.621*** [13.10]	0.662*** [12.66]	-0.126* [-1.81]	-0.173** [-2.62]	-0.201*** [-3.16]
Observations	1,300	1,300	1,300	1,194	1,200	1,197	1,049	1,052	1,053
R-squared	0.095	0.083	0.068	0.079	0.098	0.085	0.054	0.067	0.065
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1. The independent variable is percent change in 2-year Treasury yield between t and t-1, t being the day of the FOMC announcements. Large Tight is a dummy that takes a value 1 when there is a large increase in 2-year Treasury yield between t and t-1, i.e. the increase in yield exceeds the average daily change by 2 standard deviations; and 0 otherwise. Large Ease is a dummy that takes a value 1 when there is a large decline in 2-year Treasury yield between t and t-1, i.e. the decline in yield is larger than the average daily change by 2 standard deviations. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

4. Extensions

In this section, we carry out extensions to the analysis presented above. In the previous section, we established that the US monetary surprises have a significant spillover on emerging economies. Here we ask whether the extent of spillover is economically large from the emerging economies' perspective. We also ask whether emerging economies are equally sensitive to the surprise policy announcements in other advanced economies, such as the euro area, Japan or UK. Finally, we extend the time horizon considered from 1 to 3 days to 5, 10 and 15 days and ask whether the spillover persisted over a longer period. In the latter, admittedly though, it may be difficult to attribute the impact on emerging economies solely to the US policy announcements over longer horizons, since the likelihood of occurrence of other factors affecting the financial markets in emerging economies increases.

4.1 Are spillover impacts economically significant?

We ask whether FOMC announcements are correlated with unduly large financial volatility in emerging economies. We do so by asking whether large changes in asset prices in emerging economies coincide with the FOMC announcements, particularly those yielding large policy surprises. We note that a significant proportion of very large, and potentially disruptive, changes in emerging market asset prices coincide with the FOMC announcements that result in large changes in Treasury yields.

Table 5: Probability of large (more than 2 standard deviations around mean) Asset Price Changes (in t-1 and t+1) in Emerging Economies

	I	II	III	IV
	Non-FOMC days	All FOMC	FOMC with large changes in Treasury yields	Other FOMC
Exchange rate	4.2% (=1,640/39,540)	7.9%*** (=103/1,300)	21.2%*** (=55/260)	4.6% (=48/1,040)
Equity prices	5.7% (=2,259/39,540)	9.7%*** (=126/1,300)	18.5%*** (=48/260)	7.5%** (=78/1,040)
Bond yields	6.7% (=2,638/39,540)	11.5%*** (=150/1,300)	22.3%*** (=58/260)	8.9%* (=92/1,040)

Notes: The table presents the percent of total observations when there is a large change in exchange rates, equity prices, and bond yields over two consecutive days. These are recoded separately for non-FOMC days, Column 1; on FOMC days, Column 2; on FOMC days that exhibited large changes in Treasury yields (larger than 2 standard deviations around mean), Column 3; and on FOMC days that do not result in large changes in Treasury yields, Column 4. *, ** and *** indicate significant differences in means compared to Non-FOMC days at the 10, 5, and 1 percent level.

As noted in Table 5, there is an average 4.2 to 6.7 percent probability that an emerging economy will experience a large change, one that exceeds two standard deviations around the mean, in its exchange rate, stock prices or bond yields over any two consecutive days in the entire sample period. This probability increases after an FOMC announcement. The probability of a large change in emerging economies asset prices is almost twice as large in the days after the FOMC meetings than otherwise--it increases from 4.2% to 7.9% for exchange rates, from 5.7% to 9.7% for equity prices and from 6.7% to 11.5% for bond yields.

Evidently, a large proportion of these episodes of large changes in emerging economies' asset prices coincide with the FOMC announcements resulting in large changes in Treasury yields. Quantitatively, the probability of large asset price movements in emerging economies is about two and a half times to five times as large following an FOMC announcement that results in a large change in US Treasury yields, compared to those on non-FOMC days or when the FOMC announcements do not result in large changes in Treasury yields. There is nearly a 20 percent probability that emerging economies will experience a large spillover on their asset prices following an announcement that is considered a large surprise.

We establish the significance of this phenomenon in an alternative way. We construct a dummy variable that takes a value 1 when there is a large movement in emerging market asset prices (larger than two standard deviations around mean) and zero otherwise in any consecutive k days, where k varies between 1 and 10 days:

$$D_{itk} = 1 \text{ if } \left| \frac{(e_{i,t+k} - e_{i,t-1})}{e_{i,t-1}} \right| > \text{mean} \left(\left| \frac{(e_{i,t+k} - e_{i,t-1})}{e_{i,t-1}} \right| \right) + 2 * \text{std} \left(\left| \frac{(e_{i,t+k} - e_{i,t-1})}{e_{i,t-1}} \right| \right) \text{ and 0 otherwise}$$

with k=1, 2, ...10 (4)

We estimate a probit model using this dummy variable as the dependent variable, and regressing it on the dummy variable $FOMC_t^{large\ change}$ that takes the value 1 if the absolute change of 2-year Treasury yields following a FOMC meeting on day t exceeds the average absolute change by at least two standard deviations, and 0 if not; and on $FOMC_t^{no\ large\ change}$ that takes the value 1 if a FOMC meeting takes place on day t, but 2-year Treasury yields do not react strongly. The model is estimated for all business days, not just for days around the FOMC meetings. The model estimated is given by:¹⁹

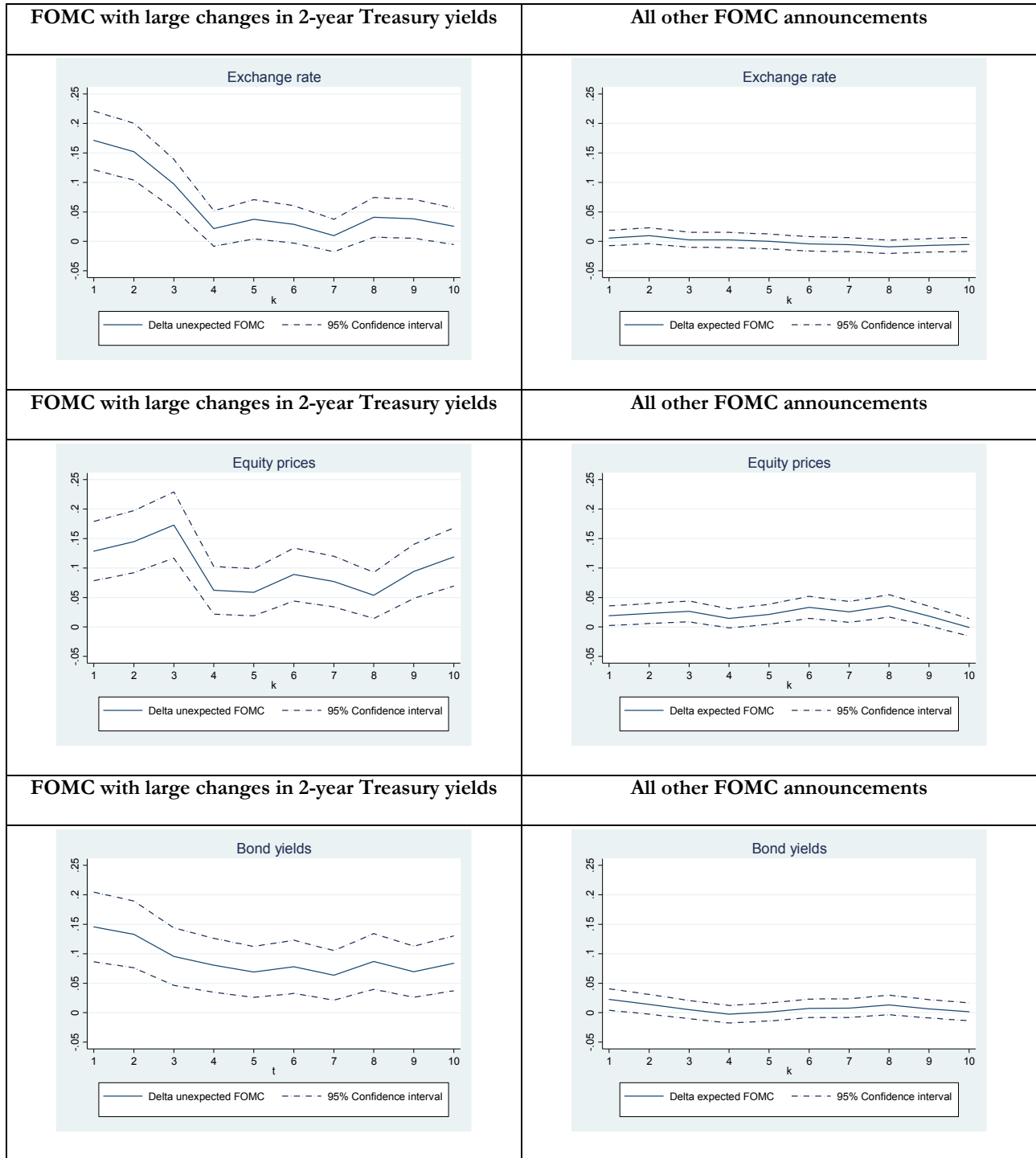
$$Prob(D_{itk} = 1) = \Phi(\alpha + \beta_1 FOMC_t^{large\ change} + \beta_2 FOMC_t^{no\ large\ change} + \varepsilon_{itk}) \quad (5)$$

These regressions help us ask whether emerging economies experience exceptionally large movements in financial variables after each FOMC meeting in anywhere between a one to ten-day period; and whether the probability increased in the days after the FOMC meetings that were associated with a large surprise announcement.

We plot the marginal effects obtained from these regressions below in Chart 3. The interpretation of marginal effects is the increase in probability, compared to that on non-FOMC days, that emerging economies experience a large asset price swing on FOMC days that result in a large change in Treasury yields (LHS panels); and the increase in probability that emerging economies experience a large asset price swing on all other FOMC days (RHS panels). We plot these differences in probabilities for windows of 1 to 10 days along with their respective 95% confidence intervals. The graphs show large differences in the magnitude, significance and persistence of the spillover effects of FOMC announcements that yielded a large surprise outcome and those that did not. The effect is short lived for exchange rates, lasting for about four days, but persistent for equity prices and bond yields, lasting for all ten days that we have considered.

¹⁹ The panel probit model is estimated with random effects. Results are insensitive to alternative regression models or to estimating with country fixed effects.

Chart 3: Impact of FOMC announcements on the probability of large changes in Emerging Market's asset prices



Notes: The left hand panels show the difference in the probability of large asset price changes in emerging economies around FOMC announcements, which resulted in large changes in 2-year Treasury yields, compared to non-FOMC days. The right hand panels show the difference in the probability of large asset price changes in emerging economies on days when FOMC announcements did not result in large changes in Treasury yields compared to non-FOMC days. The effect is plotted for different windows of time k , with $k \in (1,10)$. The dashed lines indicate the 95% confidence interval.

4.2 Do monetary surprises in other advanced economies have a similar spillover impact on emerging economies?

We use the same framework as in Equation 1 above to analyze the impact of policy announcements by the Bank of England (BoE), European Central Bank (ECB), and the Bank of Japan (BoJ) on emerging economies' asset prices. Incidentally, all these central banks adopted a broad range of measures during and in the aftermath of the global financial crisis. An important component of their policy response was the unconventional monetary policy, when the central banks significantly expanded their balance sheets.²⁰

As before, we estimate the surprise component of monetary policy announcements in these countries by the changes in their respective long-term sovereign yields on the day of the announcements. Short term bond yields in the Euro Area and Japan were close to zero, and even negative, for a substantial part of the period, hence we use 10-year yields rather than 2-year yields. For BoJ and BoE we consider 10-year sovereign yields denominated in yen and British pounds, respectively, and for the ECB we use a weighted average of yields of 10-year Euro Area sovereign bonds (the data for which is provided by the ECB).

As before, we estimate the spillover impact on emerging economies exchange rates, equity prices and bond yields over a one to three-day period. For the sake of brevity, however these results are produced below only for one day after the policy announcements (Table 6), while noting that similar patterns are obtained over longer horizons. Interestingly, there is weaker spillover of ECB, BoE or the BoJ's policy announcements on emerging countries' exchange rates, equity prices or bond yields. One reason for the weaker spillover could be that these central banks' balance sheets and changes therein were smaller, thus having a more muted impact on emerging markets; another could be their weaker financial integration with the emerging economies in our sample.

We consider emerging economies' exchange rates with respect to the euro, yen and pound in the regressions, and notice that these depreciated following an increase in the 10-year yields of the respective countries. The extent of depreciation is largest for the ECB announcements, followed by the BoE announcements. We separately estimate the impact on the exchange rates with respect to US dollar (as well as on the dollar exchange rate with the euro, yen and pound, results of which are not shown here).

While we do see a significant impact of the policy announcements by the euro area, Japan and United Kingdom on the exchange rates of emerging economies, the impact is primarily reflected in the movement of the euro, yen and pound with respect to dollar. The emerging economies'

²⁰ See Borio and Zabai (2016) for a summary of the policies taken by the ECB, BoJ and BoE during this period.

exchange rates with the dollar are rather insulated from the policy announcements.²¹ For emerging economies in our sample, it is perhaps the exchange rate with respect to the US dollar that is more important, since a large part of their trade and capital flows are denominated in US dollars.

Equity prices in emerging economies are not sensitive to the policy announcements by the ECB, and the BoJ; while bond yields are not sensitive to the BoJ announcements, but are sensitive to the announcements made by the ECB and BoE. Over all, the impact of the announcements made by the Federal Reserve Board dwarfs those of the other central banks.

Table 6: The Effect of Monetary Policy Changes in the Euro Area, Japan, and U.K. on Emerging Economies Financial Variables

	Exchange rates						Equity prices			Bond yields		
	LC/EUR	LC/USD	LC/JPY	LC/USD	LC/GBP	LC/USD						
EU 10yr yield	0.084*** [4.49]	0.017 [0.92]					-0.016 [-1.04]			0.146*** [3.16]		
JP 10yr yield			0.027*** [16.03]	-0.002 [-1.17]				-0.003 [-1.58]			0.015 [1.41]	
UK 10yr yield					0.031*** [3.07]	-0.010 [-0.97]			0.042*** [4.70]			0.045* [1.81]
Constant	-0.152*** [-32.80]	-0.015*** [-4.11]	0.095*** [39.51]	-0.069*** [-31.72]	-0.124*** [-111.62]	0.009*** [5.64]	0.048*** [14.96]	0.218*** [75.03]	0.027*** [19.31]	0.070*** [7.17]	-0.224*** [-15.14]	-0.067*** [-17.54]
Observations	1,620	1,660	2,000	2,140	1,800	1,840	1,558	1,998	1,729	1,364	1,749	1,518
R-squared	0.026	0.001	0.021	0.000	0.007	0.001	0.000	0.000	0.005	0.019	0.004	0.004
# of countries	20	20	20	20	20	20	19	19	19	17	17	17

Notes: Regressions have been estimated using a specification similar to that in Equation 1. Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of monetary policy announcements of respective countries and 1 day after that (k=1). The independent variable is percent change in the respective 10-year sovereign yield between t and t-1, t being the day of the announcements. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

²¹ As Rey (2016) has pointed out, the dollar is the most important international currency, playing an important role in invoicing, issuance of financial assets, used as a funding currency for banks and asset managers, and as a vehicle currency in foreign exchange markets and commodity trade. To the extent that the emerging countries' exchange rates with respect to the dollar are mostly unaffected by the policy surprises in other advanced countries, this indicates the weaker spillover impact of the latter.

4.3 How long does the effect last?

Thus far we have analyzed the spillover impacts over short horizons of one to three days. While in principle we could extend the analysis to beyond three days, but the possibility of omitted variable bias, or that of an endogenous policy response by emerging economies, monetary or otherwise, increases as we lengthen the time period analyzed. Nevertheless, below we ask whether the spillover impact persists over periods beyond the first three days. We estimate regressions similar to those in Equation 1 for 5, 10 and 15 day periods. Results in Table 7 show that the impact of surprise US policy announcements on emerging economies' exchange rate, equity price and bond yields persists for periods as long as 15 days.

Table 7: Spillover Estimates over Longer Windows of 5, 10, and 15 days

	Exchange rates			Equity prices			Bond yields		
	k=5	k=10	k=15	k=5	k=10	k=15	k=5	k=10	k=15
2yr Treasury yield	0.043*** [5.77]	0.065*** [7.14]	0.066*** [8.11]	-0.083*** [-7.85]	-0.116*** [-7.97]	-0.160*** [-8.84]	0.098*** [5.83]	0.114*** [5.99]	0.105*** [4.43]
Constant	-0.006 [-0.58]	0.300*** [25.04]	0.304*** [28.49]	0.646*** [47.70]	0.579*** [31.66]	0.800*** [36.41]	-0.178*** [-8.44]	-0.328*** [-13.68]	-0.625*** [-21.14]
Observations	1,300	1,300	1,300	1,202	1,193	1,192	1,058	1,051	1,052
R-squared	0.041	0.056	0.046	0.035	0.052	0.062	0.039	0.030	0.017
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1, where k=5, 10, 15. The independent variable is percent change in 2-year Treasury yield between t and t-1, t being the day of the FOMC announcements. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that coefficients are significant at 10, 5, and 1 percent levels.

5. Robustness Analysis

We conduct three kinds of robustness tests below. First, we ask if the spillover effects are stronger during, or perhaps even limited, to a few specific events, such as the FOMC announcements in 2008 when the global financial crisis had just erupted; or to the tapering event, which triggered a sharp sell-off in emerging economies. Second, we ask if the estimates are sensitive to including any potential omitted variables such as the VIX or oil prices that may affect Treasury yields as well as emerging economies' asset prices. Third, we carry out additional tests to ensure that our results are not dependent on the identification strategy that we have chosen to deploy.

5.1 Excluding potentially influential events or outliers

As a robustness check we ask whether our results could be driven by a few specific events, e.g. by the FOMC announcements in 2008 when the global financial crisis had just started. It turns out that this is not the case. We drop the FOMC meetings held during October-December 2008 from the analysis, thus starting our period from January 2009. Our results, not reported here for brevity but available on request, show that the spillover impact is not driven by the few FOMC announcements during this time.

We also drop the FOMC announcement days when the meetings were held out of schedule, as these might be indicative of rapidly deteriorating economic conditions in the US or globally. In addition, in order to ensure that our results are not driven by a few influential country-specific observations we drop extreme values of emerging economies' asset prices, e.g. top 1 percent and bottom 1 percent of the respective observations, from the regressions. Again, the results, not shown for brevity, are not affected by these adjustments to the sample.

Spillover effects from US monetary policy to emerging economies gained specific attention during the taper tantrum episode in summer 2013. Following the Federal Reserve Board's Chairman Bernanke's remarks about potential reductions in LSAP, emerging economies asset prices came under substantial downward pressure (see Eichengreen, Gupta (2014)). We ask whether emerging market asset prices experienced a stronger sensitivity to US policy during this period; and whether the average impact seen in the regressions above could be driven primarily by reactions to this particular episode.

In order to test these hypotheses, we construct a dummy variable, which takes a value 1 for the FOMC meetings that were held between May 2015, when the possibility of tapering was first mentioned, and mid-September 2013, when the uncertainty around tapering had receded (the period includes three FOMC meetings on June 19, July 31 and September 18, 2013), and 0 for all other days. We add an interaction variable between the tapering dummy and change in 2-year Treasury yield in the benchmark regressions in Equation 1.

Table 8: The effect of the US Monetary policy on Emerging Economies Financial Variables—Controlling for FOMC meetings during the 2013 Tapering event

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
2yr Treasury yield	0.039*** [6.12]	0.045*** [6.53]	0.043*** [7.65]	-0.053*** [-6.67]	-0.087*** [-9.68]	-0.090*** [-8.91]	0.054*** [3.59]	0.072*** [5.51]	0.068*** [5.11]
2yr T-yield* Tapering Dummy	0.064*** [5.19]	0.049*** [3.92]	0.049*** [3.81]	-0.127*** [-6.14]	-0.096*** [-5.32]	-0.143*** [-6.13]	0.270*** [6.27]	0.286*** [5.36]	0.387*** [6.19]
Constant	-0.044*** [-5.28]	-0.008 [-0.96]	-0.011 [-1.53]	0.321*** [32.99]	0.333*** [29.62]	0.461*** [36.54]	-0.129*** [-7.39]	-0.144*** [-8.28]	-0.112*** [-6.01]
Observations	1,300	1,300	1,300	1,194	1,200	1,197	1,049	1,052	1,053
R-squared	0.099	0.081	0.069	0.059	0.072	0.077	0.096	0.101	0.122
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1. The independent variable is percent change in 10-year Treasury yield between t and t-1, t being the day of the FOMC announcements. Tapering Dummy takes the value 1 for the three FOMC meetings on June 19, July 31 and September 18, 2013, and 0 for all other days. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

Results, in Table 8, show a larger spillover of the FOMC announcements for a given change in Treasury yields during the period of the tapering event. The average impact across all FOMC announcements, however, does not seem to be driven solely by these meetings—since the coefficients of changes in 2-year Treasury yield remain significant, with the same sign as before, even after controlling for their interaction with the dummy for tapering. Even though the empirical exercise conducted here reaffirms that emerging economies reacted significantly to US policy outside of the tapering event; the event exemplifies the kind of disruptive reaction one could see in emerging economies to a large surprise policy announcement in the US.

5.2 Data releases and other information

Next, we strive to ensure that there are no other policy announcements, data releases, or developments that could affect the estimates of the spillover of FOMC announcements on financial markets in emerging economies.

In deciding the stance of monetary policy, the Federal Reserve Board is guided by its dual mandate of price stability and employment. Hence it is possible that the US non-farm payroll and the CPI data releases may shift expectations about monetary policy outside of FOMC meetings. Comfortingly, however, nearly all FOMC meetings are scheduled on Tuesdays and Wednesdays and are unlikely to overlap with the employment reports which are released on Fridays (see Wright

(2013)). There may, however, be some overlap of FOMC announcements with the CPI data release, as the latter is announced on Wednesdays or Fridays.

Indeed, in our sample, while the payroll data releases do not coincide with FOMC meetings, there is some overlap between CPI data releases and FOMC announcements--there are 7 occasions when CPI data releases and FOMC announcements are on the same day. We include dummies for CPI data releases in our benchmark regressions in Equation 1. The results, not reported here for brevity, indicate that the spillover coefficients of unexpected FOMC announcements on emerging economies are not sensitive to CPI data releases.

We also ask, as an extension, whether financial markets in emerging economies react to the employment and CPI data releases, and specifically to the surprises inherent in them. For this we estimate regressions similar to those in Equation 1, but instead of focusing on days around FOMC meetings we now focus on days around the payroll or CPI data releases. Our exact specification is given in Equation 6, where, as before, $e_{i,t}$ is the exchange rate, equity price, or bond yield in country i on day t ; *Data surprise* is the difference between the actual payroll data or CPI inflation and their consensus forecasts (in thousands for payroll surprises, and in percentage points for CPI surprises); t is the day of the respective data release; θ_i indicates country-fixed effects, included to account for country-specific, time invariant elements; and $\varepsilon_{it,k}$ is the stochastic disturbance term capturing the effect of all other information and developments happening during period t and $t+k$. And, as before, we regress changes in emerging economies exchange rate, equity prices and bond yields between day $t+k$ and $t-1$, where k ranges from one to three days, as per Equation 6.

$$\frac{e_{i,t+k} - e_{i,t-1}}{e_{i,t-1}} = \alpha_k + \beta_{1,k} \text{Data Surprise}_t + \theta_i + \varepsilon_{it,k} \quad (6)$$

Results are in Table 9A for payroll surprises and in Table 9B for surprises on inflation data. Results indicate that positive payroll surprises, i.e. when actual payroll figures exceed the consensus forecast, do not have a significant impact on exchange rates, have a small positive effect on equity prices, and a definite positive effect on bond yields in emerging economies. Positive CPI surprises, i.e. when actual inflation data exceeds the consensus forecast, on the other hand imply that emerging economies' exchange rate appreciates, equity prices increase, but there is no definite impact on bond yields. These results indicate a less uniform impact of payroll and CPI data releases on emerging economies, compared to that of FOMC announcements; and the direction of impact seems consistent with the positive data releases indicating robust economic activity in the US, rather than being a harbinger of tighter monetary policy per se.

Table 9A: The Effect of Payroll data releases on Emerging Economies' Financial Variables

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
Payroll surprise	0.001** [2.56]	0.001 [1.49]	0.000 [0.45]	0.001*** [2.99]	0.001** [2.29]	0.001 [1.40]	0.005*** [4.64]	0.004*** [5.13]	0.003*** [3.55]
Constant	0.051*** [225.38]	0.051*** [151.73]	0.038*** [104.32]	0.050*** [82.64]	0.008*** [11.32]	0.014*** [14.12]	0.040*** [38.50]	0.008*** [9.21]	-0.118*** [-140.30]
Observations	1,860	1,860	1,860	1,718	1,727	1,731	1,515	1,516	1,524
R-squared	0.002	0.001	0.000	0.002	0.001	0.001	0.024	0.015	0.006
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent changes in exchange rate, equity prices, or bond yields, between the day of a payroll data release and k days after that. The variable payroll surprise is the difference between the actual payroll data release and the consensus forecast (measured in thousands). Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

Table 9B: The Effect of Inflation data releases in Emerging Economies' Financial Variables

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
CPI surprise	-0.694*** [-3.23]	-0.392 [-1.67]	-1.361*** [-4.85]	1.720*** [4.75]	1.743*** [4.10]	2.833*** [6.79]	1.189* [1.81]	1.229 [1.56]	0.859 [1.07]
Constant	0.037*** [11.68]	0.062*** [18.02]	0.112*** [26.99]	-0.067*** [-13.20]	0.031*** [4.75]	0.036*** [5.90]	-0.033*** [-3.42]	-0.069*** [-5.93]	-0.056*** [-4.68]
Observations	1,900	1,900	1,900	1,778	1,777	1,785	1,558	1,560	1,567
R-squared	0.004	0.001	0.009	0.008	0.007	0.012	0.004	0.003	0.001
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent changes in exchange rate, equity prices, or bond yields, between the day of a CPI data release and k days after that. The variable CPI surprise is the difference between the actual CPI data release and the consensus forecast (measured in percentage points). Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

Obviously emerging economies' asset prices may react to many factors other than the US monetary policy. As the objective of this paper is to analyze specifically the impact of FOMC announcements and not to model emerging economies' asset prices per se, including other potential explanatory variables, especially the domestic ones, is not of paramount interest. Nevertheless, as a robustness check we expand the regression specification by including percent changes in VIX and

Brent oil prices to Equation 1.²² By including these additional control variables, we ensure that the effects of monetary policy in earlier regressions were not biased by the omission of these variables. The results with these additional variables however need to be interpreted with caution since FOMC announcements may affect not just Treasury yields but presumably also VIX and oil prices.²³

Table 10: The effect of the US Monetary policy on Emerging Economies Financial Variables—Adding changes in VIX and Oil prices

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
2yr Treasury yield	0.041*** [5.96]	0.043*** [6.02]	0.043*** [6.98]	-0.056*** [-8.21]	-0.088*** [-9.52]	-0.097*** [-8.73]	0.069*** [4.65]	0.086*** [6.01]	0.089*** [5.63]
VIX, % change	0.021*** [3.41]	0.029*** [3.54]	0.025** [2.80]	-0.041*** [-3.58]	-0.047*** [-3.89]	-0.038*** [-3.57]	0.016 [1.36]	0.035* [2.02]	0.033* [1.93]
Brent, % change	-0.101*** [-4.79]	-0.104*** [-4.83]	-0.118*** [-5.41]	0.292*** [4.51]	0.368*** [6.13]	0.368*** [7.70]	-0.050 [-1.38]	0.006 [0.13]	0.007 [0.17]
Constant	0.036* [2.07]	0.088*** [3.87]	0.082*** [3.69]	0.125*** [4.54]	0.101*** [3.97]	0.252*** [10.36]	-0.060 [-1.62]	-0.060 [-1.35]	-0.033 [-0.76]
Observations	1,300	1,300	1,300	1,194	1,200	1,197	1,049	1,052	1,053
R-squared	0.134	0.121	0.107	0.135	0.152	0.136	0.054	0.066	0.061
# of countries	20	20	20	19	19	19	17	17	17

Notes: Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level. Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1. The independent variable is percent change in 10-year Treasury yield between t and t-1, t being the day of the FOMC announcements. Brent and VIX are percentage changes between t-1 to t.

Results of the extended model are presented in Table 10. Increases in VIX result in a significant depreciation of emerging economies' exchange rates; a drop in equity prices; and some increase in bond yields, albeit the impact on bond yields is not consistently significant. Similarly, an increase in oil prices results in a significant appreciation of the exchange rates, and an increase in equity prices, but does not impact bond yields in emerging markets. Importantly, coefficients of 2-year Treasury yields remain significant and have the same signs as in the baseline specification, indicating that the effect of monetary policy surprises is robust to the inclusion of these additional control variables.

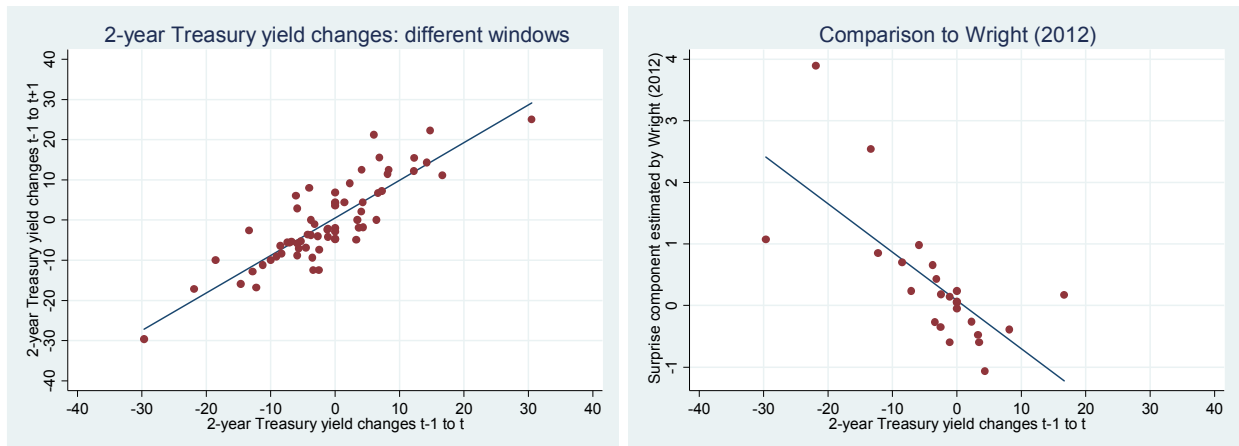
²² As far as any other omitted variables are concerned, we could not think of any relevant global shocks in short window around FOMC meetings, to confound the correlation between US policy announcements and emerging economies' financial variables during this period. Brexit was one event that had a seemingly large spillover on emerging economies, but it did not coincide with the FOMC announcements in the sample and is therefore not considered here separately. See Eichengreen, Gupta, and Ospino (2016) for the impact of Brexit on emerging economies' exchange rates and equity prices.

²³ Glick and Leduc (2011), for example, show that the US asset purchase announcements lowered the 10-year US Treasury yield and depreciated the dollar, but also resulted in a decline in commodity and oil prices. They interpreted these results as LSAP announcements signaling lower expected future economic growth in the US.

5.3 Identification

In the baseline specification above, the distinction between expected and unexpected FOMC meetings was based on the reaction of the US Treasury yields in a one-day window around the FOMC announcements (i.e. between t and $t-1$, where t is the date of the announcement). As noted earlier, some researchers (e.g. Hanson and Stein (2015)) argue that a one-day window is too short since Treasury yields could take time to adjust to the surprise inherent in the monetary policy. Hence as an alternative, we identify surprise policy announcements by changes in Treasury yields in two days around the FOMC announcements. As it turns out, changes in yields over a one-day or two-day period are highly correlated (see left panel of Chart 4). Thus unsurprisingly, when we include changes over a two-day period as the independent variable in the regressions we obtain estimates that are quite similar to those with one-day changes.

Chart 4: Different Identification Strategies and changes in 2-year Treasury Yields



Notes: The left-hand panel displays the correlation between percentage changes in 2-year Treasury yields across different time windows. The x-axis shows changes between $t-1$ and t and the y-axis changes between $t-1$ and $t+1$, with t being the day of the FOMC announcement. The right-hand panel displays the correlation between percentage change in 2-year Treasury yields (x-axis) and the surprise component of monetary policy announcements estimated by Wright (2012) (y-axis).

Our results are also robust to alternative methodologies to estimate the surprise elements of the policy announcements. Wright (2012) e.g. measures the effects of monetary policy shocks during the period of unconventional monetary policy by using a structural vector auto regression (VAR) model in financial variables and using heteroscedasticity in daily frequency data. As it turns out, this measure of surprise in monetary policy is closely correlated with the change in Treasury yields that we have used here (see right panel of Chart 4). The correlation between Wright's estimate and changes in 2-year Treasury yield is 0.70; and the correlation between Wright's estimate and changes in 10-year Treasury yield is 0.85. Our results are again not sensitive to the specific methodology used to identify policy surprises.

In our baseline specifications, we estimated the surprise component of FOMC announcements by *percentage changes* in 2-year Treasury yields as done by Fischer (2016). An alternative approach would be to use *basis points changes* in the yields instead. Percentage changes and basis points changes of 2-year Treasury yields around FOMC announcements exhibit a high correlation of 0.85. However, during the period of exceptionally low yields between August 2011 and January 2014, when 2-year Treasuries were generally below 0.4%, FOMC announcements resulted in relatively small basis point changes, but due to the low denominator, these reflected in sizeable changes in percentage terms. Whereas three FOMC announcements during that period, the “Operation Twist” in September 2011 and the “Taper Tantrum” events in May and September 2013, resulted in percentage changes of Treasury yields exceeding their mean by at least two standard deviations, no announcement during that period saw basis point changes in yields exceed their sample mean by that same margin. This observation leads to the conjecture that the surprise component of FOMC announcements is not fully captured by basis point changes alone, but also depends on the prevailing yield level. To formally test this hypothesis, we regress changes in emerging economies’ asset prices on basis point changes in 2-year Treasury yields and the interaction between those yield changes and a dummy that takes the value 1 if the level of 2-year Treasuries is below 0.4%.

Table 11: Changes and Level Effects

	Exchange rates			Equity prices			Bond yields		
	k=1	k=2	k=3	k=1	k=2	k=3	k=1	k=2	k=3
2-year Treasury yield (bps)	0.071*** [6.38]	0.085*** [6.54]	0.071*** [6.67]	-0.128*** [-9.51]	-0.194*** [-10.25]	-0.189*** [-8.23]	0.075** [2.45]	0.120*** [3.79]	0.115*** [3.42]
2-year T-yield*Dummy Low Yield	0.074*** [5.11]	0.062*** [4.73]	0.071*** [4.28]	-0.058 [-0.99]	-0.137** [-2.28]	-0.193** [-2.84]	0.284*** [6.66]	0.295*** [5.02]	0.352*** [5.93]
Observations	1,300	1,300	1,300	1,194	1,200	1,197	1,049	1,052	1,053
R-squared	0.112	0.107	0.072	0.089	0.131	0.117	0.055	0.070	0.067
# of countries	20	20	20	19	19	19	17	17	17

Notes: Dependent variables are percent change in exchange rate, equity prices, or bond yields, between the day of FOMC announcements and k days after that, as per Equation 1. The independent variable is the basis point (bps) change in 2-year Treasury yield between t and t-1, t being the day of the FOMC announcements. Low Yield is a dummy variable that takes the value 1 if the level of 2-year Treasury yields is below 0.4% and 0 otherwise. Regressions include country fixed effects. Robust t statistics are in parentheses. *, **, *** indicate that the coefficients are significant at 10, 5, and 1 percent level.

The results in Table 11 clearly indicate that the impact of a given basis point change in Treasury yields on emerging economies assets is not independent of the level of the yield. It was significantly higher in times when yields were very low. Given the importance of both, changes and levels of US

yields, we feel that our approach of using percentage changes in yields, which relates the size of the change to the prevailing yield level, is appropriate.

6. Conclusion

In this paper, we estimated the spillover effect of US monetary policy on emerging economies, during October 1, 2008 to September 1, 2016—the period when the US primarily conducted unconventional monetary policy. Using event study methodology, we ask what was the impact of the FOMC announcements on emerging economies' exchange rates, equity prices, and bond yields. Our empirical approach rests on identifying the surprises associated with monetary policy announcements of the Federal Reserve Board. In accordance with the literature we use changes in 2-year Treasury yield on the FOMC announcement day as an indicator of the surprise change in the policy.

We find a large and significant impact of the surprise US policy announcements on asset prices in emerging economies. Our estimates show that a surprise monetary easing, estimated by a decline in 2-year Treasury yield on the day of the FOMC announcement, results in exchange rate appreciation, increase in equity prices, and a decline in bond yields in emerging economies. A surprise tightening on the other hand, similarly estimated by an increase in 2-year Treasury yield, has an opposite effect.

The effect is larger for a surprise policy tightening than for an easing. The more pronounced market reaction to tightening announcements is consistent with the financial literature which shows that financial markets tend to react more strongly to negative news than to positive news. The results possibly also imply that investors react more sharply to a rise in the Treasury yield by concentrating the rebalancing of their global portfolios away from a few large emerging economies, than to easing when they reallocate to a larger number of countries. The extent of spillover is larger for large policy surprises, defined as those in which changes in Treasury yields exceed two standard deviations of the mean change.

The impact of FOMC announcements on emerging markets is also economically significant. Our results show that the probability of emerging economies experiencing large daily movements in asset prices is almost three to five times larger following FOMC announcements that result in large changes in US Treasury yields than on non-FOMC days.

Evidence shows that the spillover of monetary policy surprises in other advanced economies such as the euro area, Japan and UK is smaller, presumably because of their weaker financial integration with emerging economies.

The results are robust to a number of methodological choices, including estimating policy surprise in alternative ways. Results are not driven by a few specific events such as the tapering

event, or the FOMC announcements made at the onset of the global financial crisis. Results are also not biased by any potential omitted variables such as VIX or oil prices.

There are several avenues in which this research could be extended. First, by extending the sample of countries, one could ask if the impact varied across countries, and if so across which country characteristics: their trade or financial linkages with the US; dependence on external capital markets; the size and liquidity of their financial markets; or recent economic performance. Second, primarily because of our interest in establishing a causal link, we focused only on the short-term spillover impact in the paper. Equally interesting from a policy perspective would be the more medium-term impact of the US policy on the cost of financing in emerging economies. Third, while it was beyond the scope of this paper to ask what policies do emerging economies implement in response, and which ones are seen to be more effective in countering the spillover, this is an issue that may be undertaken in future research.²⁴

The US policy announcements may affect emerging economies via the signaling effect, or the portfolio rebalance effect. The approach used in the paper does not distinguish between the channels whereby the spillover occurs. In our view decomposing the impact into various channels is not necessarily of interest from the perspective of emerging economies. Future research endeavors may however find it worthwhile to extend the work in this direction.²⁵

Results signify the importance of surprise US monetary policy announcements for emerging economies and lend credence to the concerns raised by emerging market policy makers in recent years. They point to the continued caution that emerging economies need to observe around the US policy changes. It was in this context that Rajan (2014) talked about the coordination of policies across central banks. A counterargument (see e.g. Eichengreen (2017)) runs that the central banks, not just in the US but across the world, are primarily mandated to fulfill their respective domestic objectives, and are unlikely to be amenable to international policy coordination.

Our findings indicate that an important middle ground may be that the US, and to a lesser extent other advanced countries' central banks, prepare the markets well in advance through clear guidance, especially if a policy tightening is in the offing. The effect would then be dissipated over a longer period until the day of the announcement, and is unlikely to cause unduly large short-run financial disruption in emerging economies. Lately, the Federal Reserve Board in fact does seem to be doing exactly that, as it raised the federal fund rate three times over the past two years without inciting much reaction in the emerging economies' financial markets.

²⁴ Using an approach of estimating surprise policy announcements similar to ours, but a longer period from January 2, 1992, to May 30, 2014, Gilchrist et al (2014) show that the same identification strategy used here is broadly applicable to both conventional and unconventional phases of the US monetary policy, and the results are similar across both phases of the policy periods.

²⁵ Gagnon et al (2010) established that the LSAPs caused reductions in longer-term interest rates on a range of securities, including on securities that were not included in the purchase programs; and that these reductions in interest rates primarily reflected lower risk premiums rather than lower expectations of future short-term interest rates.

References

- Aizenman, J., M. Binici, and M. Hutchison (2016), “The Transmission of Federal Reserve Tapering News to Emerging Financial Markets”, *International Journal of Central Banking*, 12(2), pp. 317-356.
- Basu, K, B. Eichengreen, and P. Gupta (2015), “From Tapering to Tightening: The Impact of the Fed’s Exit on India”, *India Policy Forum*, 11(1), pp. 1-66.
- Bauer, M. D. and G. D Rudebusch (2013), “The signaling channel for Federal Reserve bond purchases”, *Federal Reserve Bank of San Francisco*.
- Bernanke, B. S. and K. N. Kuttner (2005), “What Explains the Stock Market’s Reaction to Federal Reserve Policy?” *Journal of Finance*, 60(3), pp. 1221–1257.
- Borio C. and A. Zabai (2016), “Unconventional Monetary Policies: A Re-Appraisal”, Working Paper No. 570, *Bank for International Settlements*.
- Bredin, D., S. Hyde, G. O’Reilly, and D. Nitzsche (2007), “U.K. stock returns and the impact of domestic monetary policy shocks”, *Journal of Business, Finance and Accounting*, 34, pp. 872–888.
- Bredin, D., S. Hyde, G. O’Reilly, and D. Nitzsche (2009), “European monetary policy surprises: the aggregate and sectoral stock market response”, *International Journal of Finance and Economics*, 14, pp. 156–171.
- Brown K., W.V. Harlow and S.M. Tinic (1988), “Risk Aversion, Uncertain Information and Market Efficiency”, *Journal of Financial Economics* 22, pp. 355-385.
- Chari, A., K. D. Stedman and C. Lundblad (2016), “Taper tantrums: QE, its aftermath and emerging market capital flows”, *Mimeo*.
- Chen, Q., A. J. Filardo, D. He and F. Zhu (2012), “International Spillovers of Central Bank Balance Sheet Policies”, Discussion Paper No. 66, *Bank for International Settlements*.
- Chen, J., T. Mancini-Griffoli, and R. Sahay (2014), “Spillovers from United States Monetary Policy on Emerging Markets: Different This Time?” IMF Working Paper, WP/14/240.
- Ehrmann M, Fratzscher M (2004), “Taking stock: monetary policy transmission to equity markets”, *Journal of Money, Credit and Banking*, 36(4), pp. 719–737.
- Ehrmann, M., M. Fratzscher, and R. Rigabon (2011), “Stocks, Bonds, Money Markets, and Exchange Rates: Measuring International Financial Transmission”, *Journal of Applied Econometrics*, 26(6), pp. 948–978.

Eichengreen, B. (2017), “International Policy Coordination and Emerging Market Economies”, in Chetan Ghate and Kenneth Kletzer ed. *Monetary Policy in India* (Springer).

Eichengreen, B. and P. Gupta (2014), “Tapering Talk: The Impact of Expectations of Reduced Federal Reserve Security Purchases on Emerging Markets”, *Emerging Markets Review*, Vol 25 (C), pp. 1-15.

Eichengreen, B., P. Gupta, and A. Ospino (2016), “The Brexit Surprise and Emerging Markets”, *Vox Column*.

Financial Times, February 1, 2017, “Fed stays the course on interest rates as outlook improves”.

Fischer, E. (2016), “US Monetary Expectations and Emerging Market Debt Flows”, *Mimeo*.

Fratzscher, M., M. Lo Duca, and R. Straub (2013), “On the International Spillovers of US Quantitative Easing”, Working Paper No. 1557, *European Central Bank*.

Gagnon, J.E., M. Raskin, J. Remache, and B.P. Sack (2010), “Large-scale asset purchases by the Federal Reserve: did they work?” *FRB of New York Staff Report* No. 441.

Gertler, M., and P. Karadi (2015), “Monetary Policy Surprises, Credit Costs, and Economic Activity”, *American Economic Journal: Macroeconomics*, 7(1), pp. 44-76.

Gilchrist S., E. Zakrajšek, and V. Z. Yue (2014), “The response of sovereign bond yields to US monetary policy”, paper presented at the IMF annual research conference.

Glick, R., and S. Leduc (2012), “Central bank announcements of asset purchases and the impact on global financial and commodity markets”, *Journal of International Money and Finance*, 31(8), pp. 2078-2101.

Gürkaynak R.S., B. Sack, and E. Swanson (2005), “Do Actions Speak Louder than Words? The Response of Asset Prices to Monetary Policy Actions and Statements”, *International Journal of Central Banking*, 1(1), pp. 55-93.

Hanson, S. G., and J. C. Stein (2015), “Monetary Policy and Long-Term Real Rates”, *Journal of Financial Economics*, 115(3), pp. 429-448.

Hausman, J., and J. Wongswan (2011), “Global Asset prices and FOMC Announcements”, *Journal of International Money and Finance*, 30(3), pp. 547–571.

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

Neely, C. J. (2010), “The Large-Scale Asset Purchases had Large International Effects”, Working Paper No. 2010-018, *Federal Reserve Bank of St. Louis*.

Rajan, Raghuram (2014), “Competitive Monetary Easing: Is It Yesterday Once More?” *Remarks at the Brookings Institution*, Washington DC, http://rbi.org.in/scripts/BS_SpeechesView.aspx?Id=886.

Rey, Helene (2016), “International Channels of Transmission of Monetary Policy and the Mundellian Trilemma”, *IMF Economic Review*, Vol. 64, No. 1.

Veronesi, P. (1999), “Stock Market Overreaction to Bad News in Good Times: A Rational Expectations Equilibrium Model”, *Review of Financial Studies*, 12(5), pp. 975-1007.

Wright, J. H. (2012), “What Does Monetary Policy do to Long-Term Interest Rates at the Zero Lower Bound?” *The Economic Journal*, 122, pp. 447-466.

Appendix A: List of FOMC meetings

Date of Statement	Key announcements	2-yr Treasury yield change	10-yr Treasury yield change
October 8, 2008 ^{intermeeting}	FOMC reduces FFR target rate to 1.5%	12.2	6.3
October 29, 2008	FOMC reduces FFR target rate to 1%	-4.2	1.0
November 25, 2008 ^{intermeeting}	FOMC announces plans to purchase USD 600bn in MBS and agency debt	-12.2	-7.2
December 16, 2008	FOMC reduces FFR target rate to 0 to 0.25%	-13.3	-6.3
January 28, 2009		2.3	4.6
March 18, 2009 (QE 1 announcement)	FOMC announces increasing purchases of USD 750bn in MBS, USD 100bn in agency debt and the purchase of USD 300bn in longer-term Treasuries	-21.9	-16.9
April 29, 2009		-1.1	2.3
June 24, 2009		4.4	1.9
August 12, 2009		-2.5	0.3
September 23, 2009		-5.9	-0.6
November 4, 2009	FOMC completes purchases of agency debt	-1.1	2.0
December 16, 2009		-3.4	0.3
January 27, 2010		3.4	0.3
March 16, 2010		-3.1	-1.3
April 28, 2010		0.0	2.4
June 23, 2010		-7.0	-1.6
August 10, 2010		-3.7	-2.4
September 21, 2010		-8.5	-4.0
November 3, 2010 (QE 2 announcement)	FOMC intends to purchase a further USD 600bn in longer term Treasuries	0.0	1.5
December 14, 2010		8.2	6.1
January 26, 2011		0.0	3.0
March 15, 2011		3.3	-0.9
April 27, 2011		0.0	1.5
June 22, 2011		-2.5	0.7
August 9, 2011		-29.6	-8.3
September 21, 2011 (Operation Twist announcement)	FOMC announces plan of purchasing USD 400bn in longer-dated securities by selling shorter-dated ones.	16.7	-3.6
November 2, 2011		0.0	1.0
December 13, 2011		0.0	-3.4

Date of Statement	Key announcements	2-yr Treasury yield change	10-yr Treasury yield change
January 25, 2012 (Fed sets an explicit inflation target)		-8.3	-3.4
March 13, 2012		6.1	4.9
April 25, 2012		-3.7	0.5
June 20, 2012		6.7	0.6
August 1, 2012		4.3	3.3
September 13, 2012(QE 3 announcement)	FOMC announces increasing purchases of MBS by USD 40bn per month	-4.0	-1.1
October 24, 2012		0.0	0.6
December 12, 2012	FOMC announced additional purchase of USD 45bn of longer-term Treasuries per month	4.2	3.6
January 30, 2013		-10.0	0.0
March 20, 2013		8.3	2.1
May 1, 2013		-9.1	-2.4
June 19, 2013 (Taper-Tantrum)		14.8	5.9
July 31, 2013		-6.1	-1.1
September 18, 2013 (Taper-Tantrum)		-12.8	-5.9
October 30, 2013		6.5	0.8
December 18, 2013 (Tapering announcement)	FOMC announces reduction of monthly MBS purchases to USD 35bn and of monthly Treasury purchases to USD 40bn	-5.9	1.4
January 29, 2014	FOMC announces reduction of monthly MBS purchases to USD 30bn and of monthly Treasury purchases to USD 35bn	-5.3	-2.9
March 19, 2014	FOMC announces reduction of monthly MBS purchases to USD 25bn and of monthly Treasury purchases to USD 30bn	30.6	3.7
April 30, 2014	FOMC announces reduction of monthly MBS purchases to USD 20bn and of monthly Treasury purchases to USD 25bn	-4.5	-1.5

Date of Statement	Key announcements	2-yr Treasury yield change	10-yr Treasury yield change
June 18, 2014	FOMC announces reduction of monthly MBS purchases to USD 15bn and of monthly Treasury purchases to USD 20bn	-5.9	-1.9
July 30, 2014	FOMC announces reduction of monthly MBS purchases to USD 10bn and of monthly Treasury purchases to USD 15bn	3.7	4.0
September 17, 2014	FOMC announces reduction of monthly MBS purchases to USD 5bn and of monthly Treasury purchases to USD 10bn	7.3	0.8
October 29, 2014	FOMC announces end of its asset purchase program	14.3	1.7
December 17, 2014		6.9	3.4
January 28, 2015		-7.4	-5.5
March 18, 2015		-18.6	-6.3
April 29, 2015		0.0	3.0
June 17, 2015		-5.6	0.0
July 29, 2015		1.4	1.3
September 17, 2015 (Lift-off delay)		-14.6	-3.9
October 28, 2015		12.3	2.4
December 16, 2015 (rate hike announcement)	FOMC announces increase in the FFR target range to 0.25 to 0.5%	4.1	0.9
January 27, 2016		-1.2	0.5
March 16, 2016		-11.2	-1.5
April 27, 2016		-3.5	-3.6
June 15, 2016		-6.8	-1.2
July 27, 2016		-2.7	-3.2

Notes: All changes are expressed in %. Events are written in bold if the absolute change in 2-yr Treasury yields around the event is large than the absolute average move plus two standard deviations.

Appendix B: Country Sample

Brazil, Chile, China, Colombia, Czech Republic, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Peru, Philippines, Poland, the Russian Federation, South Africa, the Republic of Korea, Taiwan, China, Thailand, and Turkey.

Appendix C: Variables and Data Sources

Indicator	Source	Description
10-yr Treasury yields	Haver Analytics	US Treasury bond, daily frequency
2-yr Treasury yields	Haver Analytics	US Treasury bond, daily frequency
Exchange rates	Haver Analytics	US Dollar Exchange Rate (Local currency/USD), daily frequency
Equity index	Haver Analytics	Equity price index, daily frequency
Bond yields, emerging countries	Haver Analytics, Bloomberg	10-year government bond yields (%), local currency, daily frequency
FOMC meeting dates	Board of Governors of the Federal Reserve System	
Payroll data, US	Bureau of Labor Statistics	Non-farm Payrolls (in '000s)
CPI data, US	Bureau of Labor Statistics	CPI inflation (% change m/m)
VIX	Bloomberg	daily frequency
Brent oil price	Bloomberg	USD/bbl, daily frequency
ECB meeting dates	European Central Bank	
10-yr Euro Area bond yields	European Central Bank	Government bond, nominal, all issuers all ratings included, Euro Area, daily frequency
Bank of Japan meeting dates	Bank of Japan	
10-yr Japanese bond yields	Haver Analytics	Government bond, daily frequency
Bank of England meeting dates	Bank of England	
10-yr UK bond yield	Haver Analytics	Government bond, daily frequency

Appendix D: Summary Statistics

Full sample

Variable	Day	Mean	Std. dev	Min	Max
% change in t and t+k					
Exchange rates	k=1	0.03	1.07	-15.40	25.87
Exchange rates	k=2	0.05	1.31	-18.47	30.06
Exchange rates	k=3	0.06	1.51	-22.67	32.38
Equity prices	k=1	0.08	2.03	-22.96	35.99
Equity prices	k=2	0.12	2.47	-31.01	41.62
Equity prices	k=3	0.16	2.82	-34.65	42.51
Bond yields	k=1	-0.05	2.19	-24.53	40.00
Bond yields	k=2	-0.07	2.65	-27.99	50.00
Bond yields	k=3	-0.09	3.05	-28.41	50.00
% change in t and t+k					
2-yr Treasury yield	t-1 to t	0.12	5.62	-29.63	37.50
VIX	t-1 to t	0.12	7.64	-29.57	50.00
Brent	t-1 to t	-0.01	2.27	-10.37	13.55

Only on FOMC days

Variable	Day	Mean	Std. dev	Min	Max
% change in t and t+k, t is the date of FOMC announcement					
Exchange rates	k=1	-0.09	1.39	-15.40	7.90
Exchange rates	k=2	-0.07	1.63	-18.46	12.83
Exchange rates	k=3	-0.07	1.72	-22.60	9.44
Equity prices	k=1	0.38	2.68	-13.91	35.99
Equity prices	k=2	0.45	3.41	-18.63	36.84
Equity prices	k=3	0.58	3.66	-12.59	28.80
Bond yields	k=1	-0.19	3.03	-19.33	40.00
Bond yields	k=2	-0.25	3.57	-18.33	50.00
Bond yields	k=3	-0.22	3.83	-19.27	50.00
% change in t and t+k, t is the date of FOMC announcement					
2-yr Treasury yield	t-1 to t	-1.31	9.39	-29.62	30.55
VIX	t-1 to t	-2.35	7.61	-26.95	18.69
Brent	t-1 to t	0.32	2.37	-6.63	8.59
Payroll surprise*	t	0.94	73.61	-208	175
CPI surprise*	t	-0.01	0.10	-0.4	0.2

* on days of Payroll and CPI releases, respectively.