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Financial Crisis and the Global Transmission of U.S. Monetary Policy Surprises

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Abstract

I identify how the Fed's dependence on unconventional monetary policy after the 2007-2008 financial crisis and its return to conventional policy in 2015 have affected the global influence of U.S. monetary policy. I divide the sample into three phases according to the Fed's monetary policy regimes: pre-crisis (Aug 2001 - Nov 2008), crisis (Nov 2008 - Dec 2015), and post-crisis (Dec 2015 - Sep 2017). Daily variations in government bond yields and foreign exchange spot rates for 46 countries on FOMC meeting days show that the influence of U.S. monetary policy surprises intensified after the financial crisis. Responses are stronger in a group of developed economies than in emerging markets. I also find that more flexible exchange rate regimes lead to larger magnitudes of responses to U.S. monetary policy surprises. My results show that the decoupling of interest rates between the U.S. and other countries forced foreign financial markets to respond sensitively to U.S. monetary policy surprises after the financial crisis.

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1 Introduction

When the U.S. sneezes, the world catches a cold.

— Anonymous

As global capital markets integrate, U.S. monetary policy is more likely to affect the economies of other countries. As a result, finance ministers in emerging markets often worry that their economies are influenced by U.S. monetary policy. For example, the Federal Reserve's reduction of the Fed Funds rate to its effective lower bound on December 16, 2008, led to a decrease in government bond yields and an appreciation of local currencies in more than 30 countries for one day. This is why global financial markets pay attention to Fed announcements on the day the Federal Open Market Committee (FOMC) meets.

In this paper, I investigate whether the 2007-2008 U.S. financial crisis changed the influence of the Fed's surprising decisions on foreign financial markets. Specifically, I focus on how the Fed's dependence on unconventional monetary policy after the financial crisis and its return to conventional policy in 2015 affected the global influence of U.S. monetary policy surprises. Using daily variations in government bond yields and foreign exchange spot rates for 46 sample countries on FOMC meeting days, I find that the global influence of U.S. monetary policy surprises intensified after the financial crisis: The widening gap in interest rates between the U.S. and the rest of the world rendered foreign financial markets more sensitive to Fed decisions after the crisis.

The financial crisis led to a global economic downturn and a European debt crisis. The Fed responded aggressively to the crisis by lowering the Fed Funds rate to a range between 0 and 0.25 percent, the lowest in its history. Also, the Fed adopted unconventional policies: forward guidance on future interest rates and quantitative easing (QE) with large-scale asset purchases (LSAP). The Fed eventually escaped the zero lower bound (ZLB) in December 2015 by raising the Fed Funds

rate for the first time since 2006. As of November 2017, the Fed has raised the target range for the Fed Funds rate to between 1.00 and 1.25 percent. I design an empirical model that employs data covering all FOMC meetings from August 2001 to September 2017. I divide this sample into three phases according to Fed monetary policy regimes: pre-crisis, crisis, and post-crisis. I assume that unconventional monetary policies due to the financial crisis began when the Fed's plan for large-scale asset purchases (LSAP-I) was announced (November 25, 2008) and ended when the Fed raised the Fed Funds rate again (December 16, 2015).[1]

I calculate U.S. monetary policy surprises by changes in the response of U.S. financial markets to the Fed's decision. To do so, I use high-frequency tick data for two types of futures, Fed Funds futures and 10-year Treasury futures, around the announcement of the Fed's decision (2:15 pm ET). Fed Funds futures are financial contracts that reflect market views on the likelihood of Fed policy changes. These contracts have a payout based on the average effective Fed Funds rate that prevails over the calendar month specified in the contract. I define a *Fed Funds futures surprise* by the changes in the Fed Funds futures rate between 10 minutes before and 20 minutes after an FOMC announcement. Within this 30-minute window, the Fed Funds futures surprise measures the unanticipated component of the Fed's decision on the Fed Funds rate target (Kuttner (2001)). Ten-year Treasury futures are derivatives whose prices are closely tied to the prices of U.S. Ten-year government bonds and their yields. Ten-year Treasury bonds carry almost zero risk to the principal, and are thus considered to be an important measuring stick for market confidence about the future. I calculate a *Treasury futures surprise* by changes in the 10-year Treasury futures price within a 30-minute window around a FOMC announcement. The Treasury futures surprise captures the

[1]Gilchrist, López-Salido, and Zakrajšek (2015) regard November 25, 2008, as the key date on which the Fed announced its plan for buying the debt obligations of government-sponsored enterprises (GSEs) and mortgage-backed securities (MBS) for the first time. In this study I follow their assumption that the unconventional monetary policy began on November 25, 2008.

future path of expected interest rates contained in the Fed's announcement.

I measure the responses of foreign financial markets to U.S. monetary policy surprises by daily variations in government bond yields and foreign exchange spot rates in 46 countries on FOMC days. I examine how short-term (2-year), midterm (5-year), and long-term (10-year) sovereign bond yields respond to U.S. monetary shocks in pre-crisis, crisis, and post-crisis periods. My estimates indicate that the response of sovereign bond yields to U.S. monetary policy surprises differs not only across maturities, but also across periods. For an unanticipated increase in Fed Funds futures by 100 basis points, the yields on long-term sovereign bonds in the post-crisis period rise by an additional 120 basis points, relative to bond yields in the pre-crisis period. Likewise, an unexpected decrease in Fed Funds futures by 100 basis points leads to a decline in the yield on short-term sovereign bonds by 80 additional basis points in the crisis period compared to the pre-crisis period. Next, I investigate the relationship between foreign exchange spot rates and U.S. monetary policy surprises. My estimates show that a decline in the Fed Funds futures surprise of 100 basis points is associated with an appreciation in the local currencies of an additional 9 percent in the crisis period and an extra 16 percent in the post-crisis period compared to the pre-crisis period. I attribute this to the decoupling of interest rates between the U.S. and other countries. In the face of the financial crisis, the Fed cooperated with other central banks to prevent a deepening of the global credit crisis. However, when the Fed raised the Fed Funds rate in 2015, the policy coordination cracked; Europe and Japan kept their rates near zero. Central banks in emerging markets also didn't pursue premature monetary tightening. The widening interest rate gap between the U.S. and the rest of the world forced foreign financial markets to respond sensitively to the Fed's decision.

In an effort to identify whether emerging markets are more vulnerable to U.S. monetary policy shocks, I divide the sample of countries into two groups: developed economies and emerging mar-

kets. Overall estimates indicate that responses to U.S. monetary policy surprises are stronger in developed economies than in emerging markets. This finding is consistent with those reported by Gilchrist, Zakrajsek, and Yue (2015) and Neely (2015). When taking into account exchange rate regimes (hard pegs, soft pegs, managed float, and free float), I find that free-floating arrangements lead to the larger responses to U.S. monetary policy surprises. Under a free-floating regime, a rise in the Fed Funds futures surprise by 100 basis points leads to an increase in the 10-year government bond yield of 20 additional basis points in the crisis period and 68 extra basis points in the post-crisis period compared to the pre-crisis period. However, the results present no significant response of government bond yields under hard-pegged regimes.

My findings are robust to various additional tests. First, I address the possible nonindependence of error terms by clustering standard errors. While government bond yields and foreign exchange rates change at a country level, U.S. monetary policy surprises vary at an aggregate level in my data. This may lead to the nonindependence of error terms for each FOMC meeting, which would underestimate standard errors. Clustering at the FOMC meeting level confirms that the global influence of U.S. monetary policy surprises intensified after the financial crisis. Second, I isolate the component of changes in the 10-year Treasury futures price that is not related to the Fed Funds futures surprise. I define the *Residual surprise* as the error term from the regression of Treasury futures surprise on the Fed Funds futures surprise. The Residual surprise reflects the expected future path of interest contained in the FOMC announcement that is orthogonal to the movement in Fed Funds futures (Wongswan (2009)). A bootstrapped two-step estimation method suggests that the responses of government bond yields and exchange rates to Fed Funds futures and Residual surprises become stronger after the financial crisis.

This paper contributes to the empirical literature that explores the global spillovers of U.S.

monetary policy in several ways. The first contribution is showing that the financial crisis affected the influence of U.S. monetary policy surprises. The Fed's dependence on QE in the financial crisis led to a voluminous literature on how unconventional U.S. monetary policy affects global economies (Banerjee, Devereux, and Lombardo (2016); Gilchrist, López-Salido, and Zakrajšek (2015); Chen et al. (2016); Gagnon et al. (2017); Meinusch and Tillmann (2016); Bowman, Londono, and Sapriza (2015); Bauer and Neely (2014); Neely (2015); Swanson and Williams (2014)). Banerjee, Devereux, and Lombardo (2016) show that unexpected U.S. monetary policy tightening leads to a fall in GDP, rise in interest rates, and depreciation in exchange rates in emerging market economies. Meinusch and Tillmann (2016) empirically find that QE is associated with higher output and inflation and lower nominal interest rates in U.S. However, Gagnon et al. (2017) find that U.S. unconventional monetary policy weakens the connection between U.S. bond yields and foreign currencies. To my knowledge, my paper is the first to identify different responses to U.S. monetary policy surprises, not only during the crisis but also in the post-crisis period, using high-frequency data.

The second contribution is highlighting the relationship between U.S. monetary policy and exchange rate regimes. Aizenman, Chinn, and Ito (2017) show that the type of exchange rate regime matters for the transmission of shocks. Hausman and Wongswan (2011) show that interest rates in less flexible regimes respond more to U.S. monetary policy. Bowman, Londono, and Sapriza (2015) find that sovereign bond yields in a managed floating currency are more exposed to changes in U.S. financial conditions than those in free-floating currencies. I show empirically that within a 1-day window, the responses of exchange rates and sovereign bond yields to U.S. monetary shocks are greater under the free-floating exchange rate regime than those in fixed exchange rate regimes.

The third contribution is showing that the magnitude of spillovers is different for developed economies and emerging markets. Gilchrist, Zakrajsek, and Yue (2015) find that U.S. monetary

policy has a bigger effect on short- and long-term interest rates for developed economies relative to emerging markets. However, Chen et al. (2016) show that emerging markets are more likely to respond to QE when using monthly data between 2007 and 2013. I add empirical evidence that the responses of developed economies to a U.S. monetary policy surprise became stronger than those of emerging markets after the financial crisis.

The remainder of the paper is organized as follows. Section 2 discusses the background of the study. Section 3 describes the data and methodology. Section 4 presents the results for spillover estimates of U.S. monetary policy surprises. Section 5 tests the robustness of the results, and Section 6 concludes.

2 Background

2.1 Global transmission channels of U.S. monetary policy

Uncovered nominal interest parity explains how exchange rates respond to changes in interest rates caused by monetary policy. The theory states that expected changes in the exchange rate depend on interest rate differentials:

$$E_t s_{t+1} - s_t = i_t - i_t^* \tag{1}$$

where s_t is the nominal exchange rate between two currencies at time t, $E_t s_{t+1}$ is an expected value of s_{t+1} with the information available at time t, and i_t is the nominal interest rate in the home country (similarly, i_t^* is for the foreign country).[2] If the home country has a higher nominal interest

[2] s_t is measured by the price of foreign currency in terms of domestic currency. A rise in s_t implies depreciation of the domestic currency

rate (i.e., $i_t > i_t^*$), its currency is expected to depreciate (i.e., a rise in s) to equalize returns in the two countries. Under rational expectation, the exchange rate at $t+1$ can be expressed as the sum of the expected value of the exchange rate and a forecast error (φ_t):

$$s_{t+1} = E_t s_{t+1} + \varphi_t \tag{2}$$

Thus, uncovered interest parity (UIP) can be written as

$$s_{t+1} - s_t = a + b(i_t - i_t^*) + \varphi_{t+1} \tag{3}$$

where $a = 0$ and $b = 1$. However, empirical evidence shows that $b < 0$: Currencies with high interest rates will appreciate, not depreciate (Boudoukh, Richardson, and Whitelaw (2016)). This suggests that one can profit from using a carry trade. That is, investors borrow in low interest currencies and invest in higher interest currencies.

For example, when the Fed tightens its monetary policy, nominal interest rates in U.S. rise in the short run. According to carry trade activity, carry traders want to buy more U.S. bonds because U.S. bonds pay a higher interest rate than before (Anzuini and Fornari (2012)). As the demand for dollars to buy U.S. bonds increases, the dollar appreciates in the short run.[3] Figures 1 and 2 indicate that foreign government bond yields and exchange rates respond to the Fed's announcement in the direction forecast by carry trade activity. On December 16, 2008, the Fed decided to lower the Fed Funds rate to the range between zero and 0.25 percent. The decrease in the Fed Funds rate instantly led to a decrease in 2-year government bond yields and appreciation of local currencies in more than 30 countries for one day, as shown in Figure 1. After 4.5 years, on

[3]Two main conditions for carry trade are low exchange rate volatility and high interest rate differentials across countries.

June 19, 2013, the Fed announced a tapering of quantitative easing (QE) policies by scaling back its bond purchases. On this day, the global financial market interpreted the announcement as a signal that the Fed would raise the Fed Funds rate in the future. As a result, government bond yields increased and local currencies depreciated in 34 countries for one day, as shown in Figure 2.

Several other channels may also affect spillover of U.S. monetary policy (Rey (2016); Borio and Zhu (2012)). For example, according to the credit channel, when the Fed relaxes its monetary policy, nominal interest rates drop, and this leads to an increase in the equity price. As a result, the net worth of borrowers rises and global banks' lending increases. This could explain the positive correlation between short-term rates in foreign countries and the Fed Funds rate. The risk-taking channel has a similar mechanism. Relaxation of U.S. monetary policy leads to drops in nominal interest rates. As the returns from safe assets decrease, banks apply relatively low credit standards. Accordingly, the global credit supply goes up and short-term rates in foreign countries move downward. Lastly, the balance sheet channel shows that even advanced economies cannot be free from the influence of U.S. monetary policy. When the Fed tightens its monetary policy, a foreign country's domestic currency depreciates. This helps increase the foreign country's exports. However, as banks become more cautious of the rising (dollar-denominated) value of foreign debt, interest rates rise and bank loans may decrease.

The empirical question is whether we can extend the response of foreign government bond yields and exchange rates to the Fed's decision to all FOMC meetings. If so, how much does U.S. monetary policy influence the movement in foreign government bond yields and exchange rates?

2.2 The financial crisis and monetary policy regime

As shown in Figure 3, the 2007-2008 financial crisis was a huge turning point in the Fed's history. Before the crisis, the Fed managed the Fed Funds rate as a key instrument for its monetary policy. For example, on June 25, 2003, the Fed cut the Fed Funds rate by a 0.25 percentage point to 1 percent, the lowest level in 45 years, to overcome the 2001 recession. The very low interest rates led to a housing boom, solid pace of economic expansion, and improved labor market conditions. As a result, the Fed raised the Fed Funds rate to 1.25 percent on June 30, 2004, which was the first increase since 2000.

However, the 2007-2008 financial crisis, triggered by the bursting of the subprime mortgage bubble and the collapse of Lehman Brothers, dramatically changed the Fed's policy regime, as shown in Table 1. On December 16, 2008, the Fed responded aggressively to the crisis by dramatically lowering the Fed funds rate to "between 1/4 points and zero," the lowest rate in its history. Facing the ZLB, the Fed had no room for additional moves in the Fed Funds rate if the economy did not improve soon. As a result, instead of adjusting the Fed Funds rate, the Fed adopted unconventional policies, such as forward guidance on future interest rates and QE with LSAP to stimulate the economy and keep market rates low. It tried to influence expectations for the future path of Federal Funds rates through the FOMC statement, a press release, and the chairperson's public speech. The Fed also cooperated with other central banks to prevent further deepening of the global credit crisis. For example, on October 8, 2008, the Federal Reserve and the central banks of the E.U., U.K., Canada, Sweden, and Switzerland cut their rates by one-half point. One week later, the U.S., E.U., and Japan also adopted a coordinated policy to prevent banks from failing. The unconventional monetary policy regime ended in December 2015, when the Fed raised the Fed Funds rate for the first time since 2006. This action officially marks "the end of an extraordinary

seven-year period during which the Federal Funds rate was held near zero to support the recovery of the economy from the worst financial crisis and recession since the Great Depression."[4] Since then, as of November 2017, the Fed has raised the Fed Funds rate three times to the range of 1.00 to 1.25.

The question is how has the Fed's dependence on unconventional monetary policy after the financial crisis, and its return to conventional policy in 2015, affected the global influence of U.S. monetary policy? To address this question, I divide the sample into three phases: pre-crisis, crisis, and post-crisis. I assume that the financial crisis period began when the Fed's LSAP-I plan was announced (November 25, 2008) and ended when the Fed raised the Fed Funds rate again (December 16, 2015).

3 Empirical Analysis

3.1 Monetary policy surprises

I measure U.S. monetary policy surprises by changes in the response of U.S. financial markets to the Fed's decision. For this, I collect high-frequency tick data for two types of futures: Fed Funds futures and 10-year Treasury futures.

Fed Funds futures are financial contracts that reflect market views of the likelihood of Fed policy changes. The contracts have a payout based on the average effective Fed Funds rate that prevails over the calendar month specified in the contract. The Fed Funds futures rate 10 minutes before ($f_{t,-10}$) the FOMC announcement (2:15 pm, EST) on day d of a month with D days is calculated by the *average* of the effective overnight Fed Funds rate as follows:

[4]Transcript of Fed Chair Janet Yellen's press conference, December 16, 2015.

$$f_{t,-10} = \frac{d(Realized) + (D-d)(Expected_{t,-10})}{D} \tag{4}$$

where *Realized* is the effective Fed Funds rates during the past d days of the relevant month and $Expected_{t,-10}$ is the expectation of the Fed Funds rate for upcoming $D-d$ days of the month 10 minutes before the FOMC announcement. In equation (4), I solve for $Expected_{t,-10}$ to factor out the market's expectation for the Fed's decision before the announcement:

$$Expected_{t,-10} = \frac{D}{D-d}(f_{t,-10}) - \frac{d}{D-d}(Realized) \tag{5}$$

Similarly, I calculate the expected value $Expected_{t,+20}$ for the Fed Funds rate for forthcoming $D-d$ days of the month 20 minutes after the FOMC announcement:

$$Expected_{t,+20} = \frac{D}{D-d}(f_{t,+20}) - \frac{d}{D-d}(Realized) \tag{6}$$

where $f_{t,+20}$ (the Fed Funds future rate 20 minutes after the FOMC announcement) reflects how the financial markets interpreted the Fed's decision ex post.

I define a Fed Funds futures surprise, FF_t, by changes in the expectation for the Fed Funds rate between 10 minutes before ($Expected_{t,-10}$) and 20 minutes after ($Expected_{t,+20}$) the FOMC announcement from equations (5) and (6):

$$FF_t = \frac{D}{D-d}(f_{t,+20} - f_{t,-10}) \tag{7}$$

Within a 30-minute window, the Fed Funds futures surprise (FF_t) measures the unanticipated

component of the Fed's decision on the current Fed Funds rate target (Kuttner (2001); Gertler and Karadi (2015)). If there is no surprise in the Fed's decision, FF_t is zero, because $f_{t,-10}$ and $f_{t,+20}$ have the same value.

However, when the Fed Funds rate dropped to its ZLB in the financial crisis period, changes in the current Fed Funds future rate might be restricted. To address this problem, I employ 10-year Treasury futures that reflect a future path for monetary policy contained in the FOMC statement. Ten-year Treasury futures are derivatives whose prices are closely tied to the prices of U.S. 10-year government bonds and their yields. Ten-year Treasury bonds carry almost zero risk to principal, and thus, are considered to be an important measuring stick for market confidence about the future. For example, when confidence is high, the 10-year Treasury bond's price drops and yields go higher. I calculate a Treasury futures surprise, TYF_t, by changes in the 10-year Treasury futures price between 10 minutes before ($tyf_{t,-10}$) and 20 minutes after ($tyf_{t,+20}$) the FOMC announcement, as follows:

$$TYF_t = tyf_{t,+20} - tyf_{t,-10} \tag{8}$$

Gürkaynak, Sack, and Swanson (2005) find that 75 to 90 percent of variations in 10-year Treasury yields respond to forward guidance in FOMC statements rather than the current Fed Funds rate target. Therefore, changes in the 10-year Treasury futures price within a 30-minute window around an FOMC announcement (TYF_t) capture the future path of expected interest rates contained in FOMC statements.

The sample period in my dataset includes all FOMC meetings from August 2001 to September 2017. The FOMC holds eight regularly scheduled meetings each year. In addition, the FOMC

holds irregular intermeetings as needed. In meetings, the FOMC makes decisions on a target level for the Federal Funds rate and growth of the U.S. money supply. Each decision includes the future direction of U.S. monetary policy. This study covers all FOMC announcements from 130 scheduled meeting decisions. For the financial crisis period (November 25, 2008 - December 15, 2015), I also include important irregular events related to forward guidance, such as the announcement of LSAP, the chairperson's speech in Jackson Hole and conferences in the dataset.[5]

For each FOMC announcement, I calculate the Fed Funds futures surprise and Treasury futures surprise. Figures 4 and 5 display the sequence of each surprise. The large fluctuations in the Fed Funds futures surprise in the early 2000s are associated with the Fed's cutting the Fed Funds rate to fight off a recession, terrorist attacks, and the Iraq war. For example, on November 6, 2002, the market expected a 25 basis points cut before the FOMC announcement. However, the Fed decided to lower its Fed Funds rate target by 50 basis points to 1.25 percent. The larger than expected cut led to a big drop in the Fed Funds futures surprise. The next big ups and downs, in 2007 and 2008, correspond to the financial crisis. The sudden drop in Treasury futures on March 18, 2009, implies why I should consider the Treasury futures surprise along with the Fed Funds futures surprise. On this day, there was no change in the Fed Funds rate target. Instead, the Fed announced that it would purchase long-term Treasuries over the next 6 months and increase the size of purchases of agency debt and MBS. The negative value of the Treasury futures surprise reflects the market's response to the Fed's downward pressure on interest rates and forward guidance for the future path of its monetary policy.

[5]I calculate monetary policy surprises for irregular events by using the times for unconventional monetary policy actions provided by Gilchrist, López-Salido, and Zakrajšek (2015).

3.2 Government bond yields and foreign exchange rates

For each FOMC meeting and irregular event in the dataset, I collect daily variations in government bond yields and foreign exchange rates for 46 countries. As shown in Table 2, the sample countries in my dataset include both developed economies and emerging markets. Changes in an n-year bond yield for country i on FOMC meeting day t within a 1-day period are calculated as

$$\Delta y_{i,t}(n) = y_{i,t}(n) - y_{i,t-1}(n) \tag{9}$$

Figure 6 depicts the time zone of sample countries. Asian and European markets are closed at the time of the scheduled FOMC announcement. I use the 1-day window between t and $t+1$ for these markets to address a time lag.

The dataset on foreign government bond yield consists of 2-, 5-, and 10-year maturities. I investigate how short-term (2-year), midterm (5-year), and long-term (10-year) yields respond differently to U.S. monetary policy surprises. This allows me to compare the different movements at the short and long ends of the yield curve. To test whether the effects of U.S. monetary policy surprises are different across advanced and non-advanced economies, I divide the samples into two groups, developed economies and emerging markets, as shown in Table 3.

I calculate changes in the foreign exchange spot rate for country i on FOMC meeting day t as follows:

$$\Delta s_{i,t+1} = \frac{s_{i,t+1} - s_{i,t}}{s_{i,t}} \times 100 \tag{10}$$

where $\Delta s_{i,t}$ is the percentage changes in the foreign exchange rate (in dollars per unit of non-U.S.

currency) within a 1-day window.

The exchange arrangement in each country plays an important role in the responses of exchange rates to U.S. monetary shocks. For example, when a country opens its financial markets to foreign investors, it can experience sudden inflows and stops of foreign funds (Edwards (2007)). A country may fear a floating exchange regime that can magnify their vulnerability to the sudden outflow or inflow of foreign funds. This explains why some countries (mostly emerging markets) are inclined to peg their currency to the U.S. dollar, which may reduce the spillover of U.S. monetary policy surprises. In order to analyze how U.S. monetary policy surprises affect foreign exchange rates under different exchange rate regime, I categorize sample countries into four groups: hard pegs, soft pegs, managed floating, and free floating, as shown in Table 4. While most developed economies in my dataset adopt a fully floating exchange regime, many emerging market economies run managed float regimes or limited-flexibility regimes.[6]

3.3 Empirical methodology

U.S. monetary policy surprises on FOMC meeting days play a role as exogenous shocks to financial markets in foreign countries. I evaluate the global transmission of U.S. monetary policy surprises to foreign government bond yields and exchange rates using the following panel regression:

$$\begin{aligned}\Delta y_{i,t+1} = \alpha_0 + \beta_1 FF_t + \beta_2 TYF_t + \beta_3 CRISIS + \beta_4 POST + \beta_5 FF_t \cdot CRISIS \\ + \beta_6 TYF_t \cdot CRISIS + \beta_7 FF_t \cdot POST + \beta_8 TYF_t \cdot POST + \mu_i + \varepsilon_{it}\end{aligned} \tag{11}$$

In equation (11), I regress the daily change in country i's financial variables ($\Delta y_{i,t+1}(n)$ for government bond yields and $\Delta s_{i,t+1}(n)$ for exchange rates) around FOMC meeting day t on the

[6]The exchange rate regime is measured by IMF's *Annual Report on Exchange Arrangement and Exchange Restrictions.*

Fed Funds futures surprise (FF_t) and Treasury futures surprise (TYF_t). I include $CRISIS$ and $POST$ dummies to identify changes in the influence of U.S. monetary policy surprises after the U.S. financial crisis. $CRISIS$ is 0 in the pre-crisis period (before November 24, 2008) and 1 in the crisis period (i.e., between November 24, 2008, and December 15, 2015). Likewise, $POST$ has the value of 1 in the post-crisis period (after December 15, 2015). I add country fixed effects (μ_i) to capture country-specific time-invariant elements. ε_{it} captures all nonmonetary policy shocks that can affect movement in country i's government bond yields on the FOMC meeting day t.

β_1, β_2, β_3, and β_4 are commonly referred to as the direct effect of FF_t, TYF_t, $CRISIS$, and $POST$ on $\Delta y_{i,t+1}(n)$, respectively. The coefficients β_5, β_6, β_7, and β_8 for interaction terms between monetary policy surprises and dummies help estimate how the effects of monetary policy surprises differ by period.

For example, the net impact of FF_t on $\Delta y_{i,t+1}(n)$ is defined by

$$E[\Delta y_{i,t+1}] = \alpha_0 + \beta_3 CRISIS + \beta_4 POST + (\beta_1 + \beta_5 CRISIS + \beta_7 POST)FF_t \tag{12}$$

The first derivative of equation (12) with respect to FF_t is

$$\frac{\delta E[\Delta y_{i,t+1}]}{\delta FF_t} = \beta_1 + \beta_5 CRISIS + \beta_7 POST \tag{13}$$

In equation (13), β_1 represents the impact of FF_t on $\Delta y_{i,t+1}$ conditional on the value of $CRISIS$ and $POST$ being zero. β_5 indicates whether the effect of FF_t on $\Delta y_{i,t+1}$ is systematically different when $CRISIS$ has the value of 1. For example, a positive β_5 implies that the impact of the Fed Funds futures surprise on the daily change in sovereign bond yields grows more positive in the crisis period compared to the pre-crisis period. Likewise, β_7 allows me to compare differences in the effect of FF_t on $\Delta y_{i,t+1}$ between the pre-crisis and post-crisis period.

Along with the net effect in equation (13), the total effect of FF_t on $\Delta y_{i,t+1}(n)$ in each period is calculated by

$$E[\Delta y_{i,t+1} \mid FF_t \neq 0, CRISIS = 1, POST = 0] = \alpha_0 + \beta_1 + \beta_3 + \beta_5 \tag{14}$$

$$E[\Delta y_{i,t+1} \mid FF_t \neq 0, CRISIS = 0, POST = 1] = \alpha_0 + \beta_1 + \beta_4 + \beta_7 \tag{15}$$

In equation (14), a positive value of $\alpha_0 + \beta_1 + \beta_3 + \beta_5$ implies that a change in the Fed Funds futures surprise (FF_t) is positively associated with a daily change in foreign government bond yields ($\Delta y_{i,t+1}(n)$) in the crisis period.

4 Results

Table 5 shows that the response of sovereign bond yields to U.S. monetary policy surprises differs not only across maturities of bonds, but also across periods. For a decrease in the Fed Fund futures surprise of 100 basis points, yields on short-term sovereign bonds in the crisis period would be expected to decline by 80 basis points more than bond yields in the pre-crisis period. A surprise cut in the Fed Fund futures and Treasury futures surprise has a stronger positive association with movement of midterm and long-term sovereign bond yields in the post-crisis period compared to the pre-crisis period. For example, a rise in the Fed Funds futures surprise of 100 basis points leads to an increase of 120 additional basis points in long-term foreign government bond yields in the post-crisis period relative to the pre-crisis period. The Treasury futures surprise also begins to influence the movement of 5-year and 10-year government bond yields in the post-crisis period. For an unanticipated increase in Treasury futures by 100 basis points, foreign government bond

yields increase by 5 to 6 additional basis points in the post-crisis period relative to the pre-crisis period. Column (4) in Table 5 shows the relationship between foreign exchange spot rates and U.S. monetary policy surprises. My estimates indicate that a decline in the Fed Funds futures surprise of 100 basis points is associated with an appreciation in the local currencies of an additional 9 percent in the crisis period and an extra 16 percent in the post-crisis period, compared to the pre-crisis period.

I attribute these results to the decoupling of interest rates between the U.S. and other countries. In the face of the financial crisis, the Fed lowered the Fed Funds rate to the ZLB. It also cooperated with other central banks to prevent a deepening of the global credit crisis. Although the Fed has continued to raise interest rates since 2015, Europe and Japan have kept their rates near zero, as shown in Figure 7. Central banks in emerging markets also did not pursue premature tightening. As a result, the widening gap in interest rates between the U.S. and the rest of the world has caused foreign financial markets to respond sensitively to Fed decisions after the financial crisis.

Table 6 shows how sovereign bond yields in a group of developed economies and emerging markets react to U.S. monetary policy surprises. In the crisis period, government bond yields in developed economies significantly respond to unexpected changes in Fed Fund futures across all maturities. For example, the 100 basis points decrease in the Fed Fund futures leads to a drop in government bond yields by 24 to 84 additional basis points in the crisis period, compared to the pre-crisis period. In the post-crisis period, the Treasury futures surprise affects the movement in government bond yields across all maturities. An unexpected increase in Treasury futures by 100 basis points leads to marginal increases in foreign government bond yields by 3 to 7 basis points in the post-crisis period, relative to the pre-crisis period. For emerging market countries, only short-term bond yields significantly respond to U.S. monetary policy surprises. For example, an

unanticipated decrease in the Fed Fund futures of 100 basis points is associated with an additional 80 basis points decrease in short-term bond yields in the crisis period, compared to the pre-crisis period. In the post-crisis period, a rise in the Fed Fund futures surprise by 100 basis points is connected to marginal increases in midterm and long-term foreign bond yields, compared to the pre-crisis period. However, only the response of midterm bond yields shows a statistical significance.

The results suggest that developed economies' responses to U.S. monetary policy surprises became stronger than those of emerging markets after the financial crisis. This finding is consistent with those reported by Gilchrist, Yue, and Zakrajsek (2018) and Neely (2015). Central banks exert greater control over short-term bond yields by their own benchmark interest rates (Caceres et al. (2016)). Monetary policy coordinations on short-term interest rates among developed economies during the financial crisis may explain why the response of 2-year bond yields is greater than those of 5- and 10-year bond yields in the crisis period. On the other hand, long-term bond yields are relatively free to respond to external shocks. For example, the Fed managed to put downward pressure on interest rates under ZLB by purchasing long-term securities. In the post-crisis period, central banks in developed economies are reluctant to raise their short-term target interest rates. This may lead to a larger effect of U.S. monetary policy surprises on the long end of the yield curve in developed economies rather than the short end.[7]

Table 7 shows how the influence of U.S. monetary policy surprises on foreign exchange rates depends on exchange rate arrangements in specific countries. First, there is no exchange rate response to U.S. monetary policy surprises in hard-peg counties. Hard-peg countries, such as Hong Kong, Bulgaria, and Lithuania, have fixed their exchange rates to minimize the vulnerability of their currency to exogenous shocks.[8] In contrast, exchange rates in other regimes significantly

[7]See Appendix A for country-level regressions.

[8]However, a hard-peg country must keep its monetary policy and interest rates in line with the other country. For

respond to unexpected changes in U.S. monetary policy. A surprise decline of 1 percent in Fed Fund futures is associated with an appreciation in local currencies by an additional 6 to 12 percent in the crisis period and an extra 14 to 19 percent in the post-crisis period, compared to the pre-crisis period.

Table 8 presents the analysis for how the responses of 10-year government bond yields depend on the exchange rate regime. I find no significant reactions to U.S. monetary policy surprises in hard-pegging countries. However, the movement of interest rates in countries with a free-floating regime is positively associated with both U.S. monetary policy surprises. For example, a rise in the Fed Fund futures surprise by 100 basis points leads to an increase in the yield by 20 additional basis points in the crisis period and 68 extra basis points in the post-crisis period under the free-floating exchange regime, relative to the pre-crisis period. These results imply that the more flexible exchange arrangement leads to larger magnitudes of responses in sovereign bond yields to U.S. monetary policy surprises. In general, a floating exchange regime magnifies vulnerability to sudden outflows of foreign funds made by carry trade activity in the short run. However, when a country pegs its currency to another or intervenes in exchange markets to stabilize the value of its currency, it can reduce sensitivity to the volatility of capital flow. This explains why hard-pegged exchange regimes do not respond actively to U.S. monetary policy surprises. Also, since my data contain changes within a 1-day window, hard-pegging countries may have a delayed reaction by interest rates to a U.S. monetary policy shock.

example, the Hong Kong dollar is pegged to USD, and Bulgaria and Lithuania pegged their currencies to EUR.

5 Robustness

5.1 Clustering standard errors

In my empirical model, government bond yields ($\Delta y_{i,t+1}$) and foreign exchange rates ($\Delta s_{i,t+1}(n)$) change at the country level (i). However, U.S. monetary policy surprises, such as FF_t and TYF_t, vary at the aggregate level, as follows:

$$\begin{aligned}\Delta y_{i,t+1} = \alpha_0 + \beta_1 FF_t + \beta_2 TYF_t + \beta_3 CRISIS + \beta_4 POST + \beta_5 FF_t \cdot CRISIS \\ + \beta_6 TYF_t \cdot CRISIS + \beta_7 FF_t \cdot POST + \beta_8 TYF_t \cdot POST + \mu_i + \varepsilon_{it}\end{aligned} \tag{16}$$

As a result, I may not assume independence of error terms across countries for each FOMC meeting. The correlation within each FOMC meeting comes from a common error component(ν_t):

$$\varepsilon_{it} = \nu_t + \eta_{it} \tag{17}$$

The nonindependence of error terms (i.e., $\mathbf{E}[\varepsilon_{it}\varepsilon_{jt}] = \rho_\varepsilon \sigma_\varepsilon^2 \neq 0$) may underestimate standard errors with

$$\rho_\varepsilon = \frac{\sigma_\nu^2}{\sigma_\nu^2 + \sigma_\eta^2} \tag{18}$$

which is called a Moulton problem (Moulton (1986)).

I address the possible Moulton problem by clustering standard errors with a block-diagonal in $\hat{\Omega}$:

$$Var(\hat{\beta}) = (X'X)^{-1} X' \hat{\Omega} X (X'X)^{-1} \tag{19}$$

by ordering observations by group.

Table 9, with clustering of standard errors, confirms that the global influence of U.S. monetary policy surprises intensified after the financial crisis. A surprise 100 basis point decrease in the Fed Funds futures leads to a drop in government bond yields by 40 to 70 additional basis points across maturities of bonds in the crisis period, compared to the pre-crisis period. In the post-crisis period, for an unexpected rise in Fed Funds futures by 100 basis points, 10-year foreign government bond yields increase by 180 extra basis points, compared to the pre-crisis period. The responses of foreign exchange rates show almost similar results. For an unexpected decrease in the Fed Funds futures by 100 basis points, local currencies appreciate by an additional 9 percent in the crisis period and an extra 16 percent in the post-crisis period, compared to the pre-crisis period.

5.2 Isolating the monetary policy surprise component

In this study, I use two kinds of monetary policy surprises: the Fed Funds futures surprise and the Treasury futures surprise. However, these two surprises may contain overlapping information on the market's response to the Fed's decision, because they are measured within the same time window. I isolate the component of changes in the 10-year Treasury futures price that is not related to the Fed Funds futures surprise. The isolated component reflects the expected future path of interest rates contained in the FOMC announcement, which is orthogonal to the movement in Fed Funds futures (Wongswan (2009)). I define the isolated surprise component as the *Residual surprise* ($\widehat{Residual}_t$) by the error term from the regression of the Treasury futures surprise on the Fed Funds futures surprise:

$$TYF_t = a_0 + a_1 FF_t + Residual_t \tag{20}$$

Then, I estimate the effects of FF_t and $\widehat{Residual_t}$ on changes in foreign government bond yields ($(\Delta y_{i,t+1})$) and exchange rates ($(\Delta s_{i,t+1})$), as follows:

$$\begin{aligned}\Delta y_{i,t+1} = \alpha_0 + \beta_1 FF_t + \beta_2 \widehat{Residual_t} + \beta_3 CRISIS + \beta_4 POST + \beta_5 FF_t \cdot CRISIS \\ + \beta_6 \widehat{Residual_t} \cdot CRISIS + \beta_7 FF_t \cdot POST + \beta_8 \widehat{Residual_t} \cdot POST + \mu_i + \varepsilon_{it}\end{aligned} \tag{21}$$

This type of two-step OLS regression with a generated regressor ($\widehat{Residual_t}$) may cause inconsistent estimates of standard errors (Pagan (1984)). To address this problem, I employ a bootstrapping method. Table 10 suggests that the responses of government bond yields and exchange rates to Fed Funds futures and Residual surprises become stronger after the financial crisis. For example, an unanticipated decrease by 100 basis points in the Fed Funds futures rate causes foreign government bond yields to decline by 40 to 80 additional basis points in the crisis period, relative to the pre-crisis period. In particular, the Residual surprise plays a significant role in the movement in foreign government bond yields across all maturities after the financial crisis. A hypothetical 100 basis points cut in the Residual surprise leads to an extra 5 to 12 basis points decrease in government bond yields in both the crisis and post-crisis period, compared to the pre-crisis period.

6 Conclusion

In this study, I investigated how the Fed's dependence on unconventional monetary policy after the financial crisis and its return to conventional policy in 2015 have affected the global influence of U.S. monetary policy. To address this question, I divided sample periods into three phases according to the Fed's monetary policy regimes: pre-crisis, crisis, and post-crisis. I found that the financial crisis significantly strengthened transmission of U.S. monetary policy surprises to foreign

government bond yields and exchange rates. My results showed that developed economies became more sensitive to U.S. monetary policy surprises than emerging markets after the crisis.

Overall, my results demonstrate the consequences of the chasm between U.S. monetary policies and those of other countries. While the Fed departed from the ZLB by raising the Fed Funds rate in 2015, central banks in many countries maintained low interest rates and dependence on QE. The global monetary policy divergence forced foreign financial markets to respond elastically to changes in the Fed Funds rate. My findings can help foreign policymakers account for the strengthened influence of post-crisis U.S. monetary policy shocks as they attempt to stabilize their economies.

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7 Figures

Figure 1: Changes in foreign governement bond yields and exchange rates on Dec 16, 2008

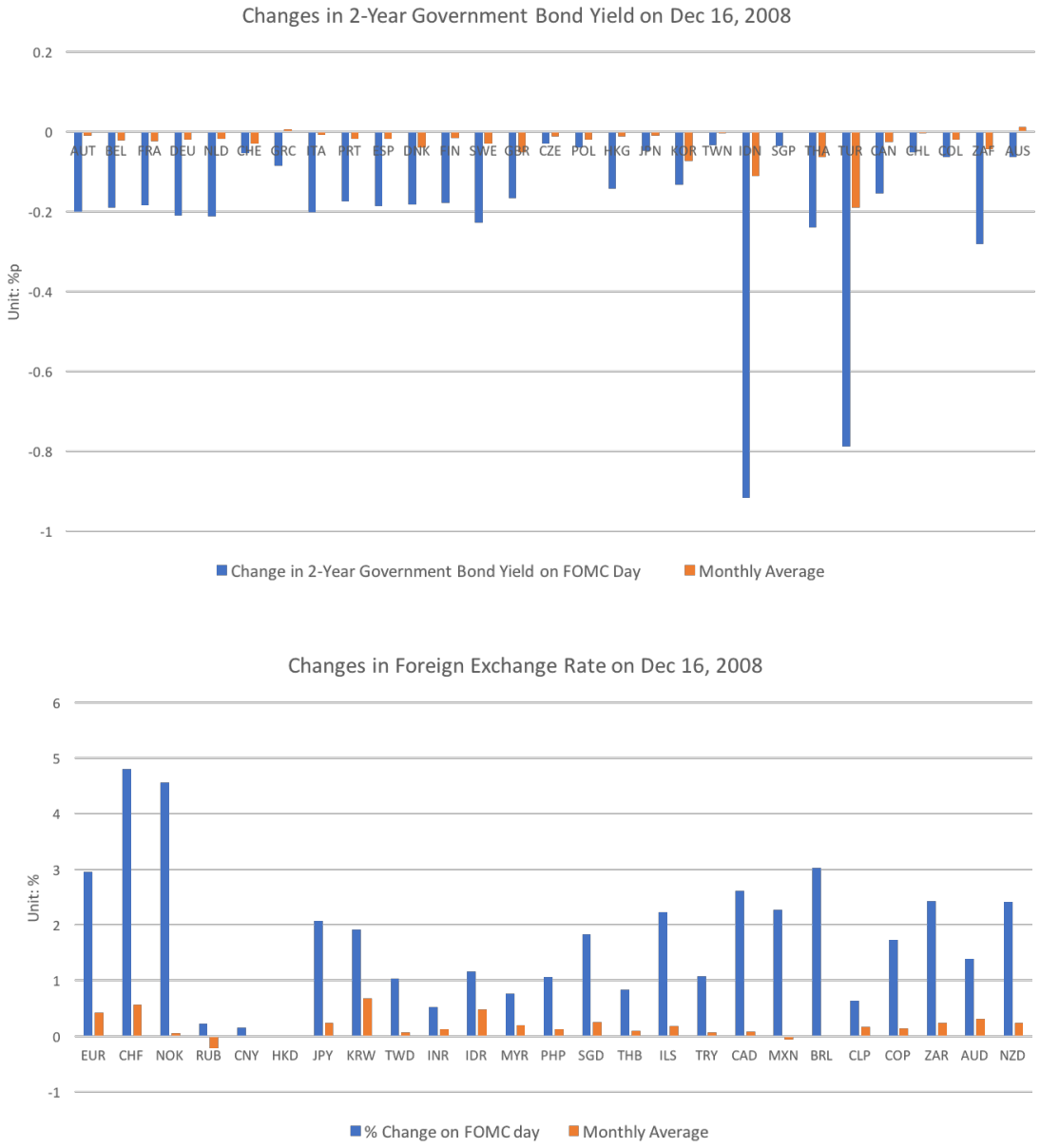


Figure 2: Changes in foreign governement bond yields and exchange rates on June 19, 2013

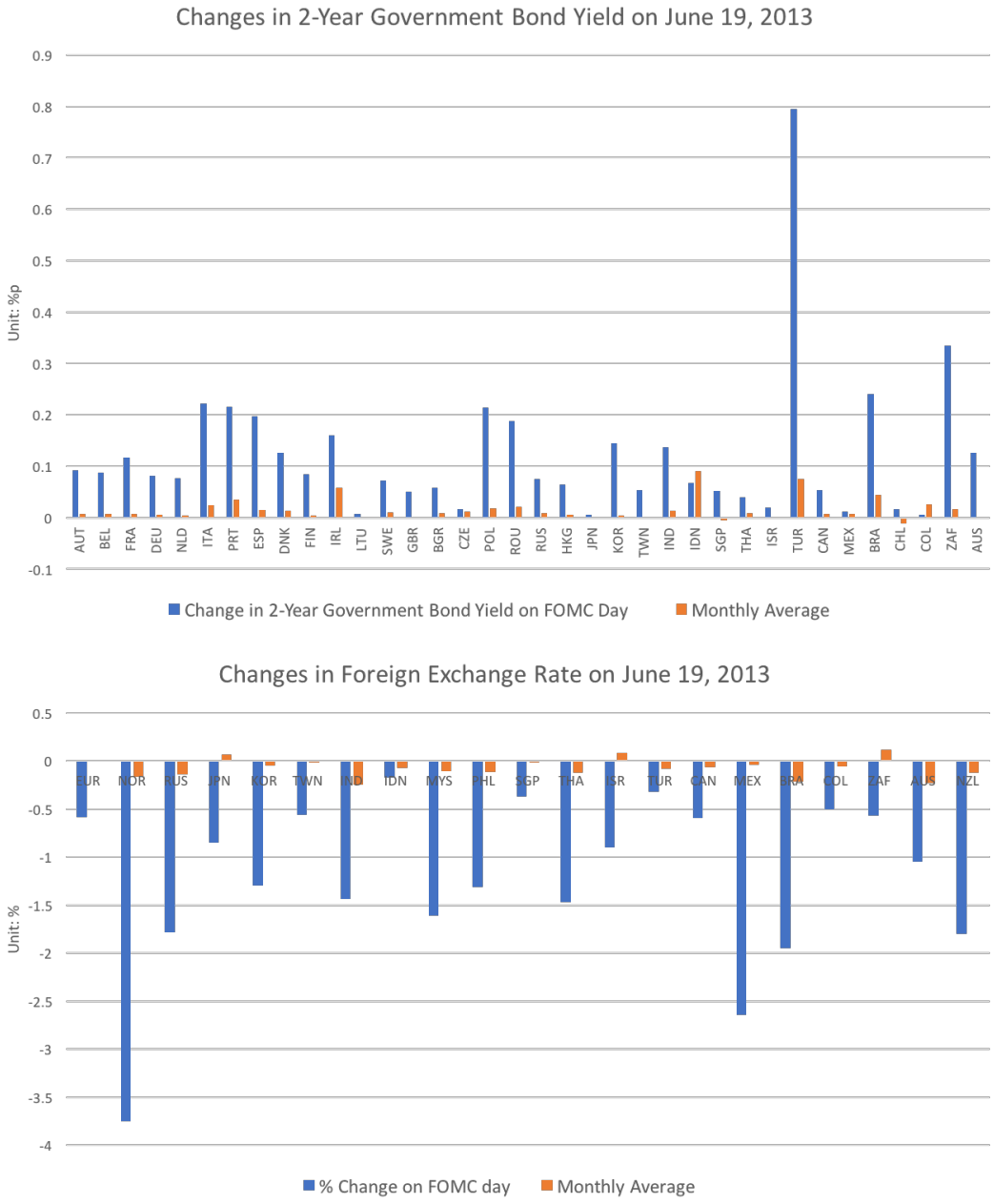


Figure 3: Movement of effective Fed Funds rate

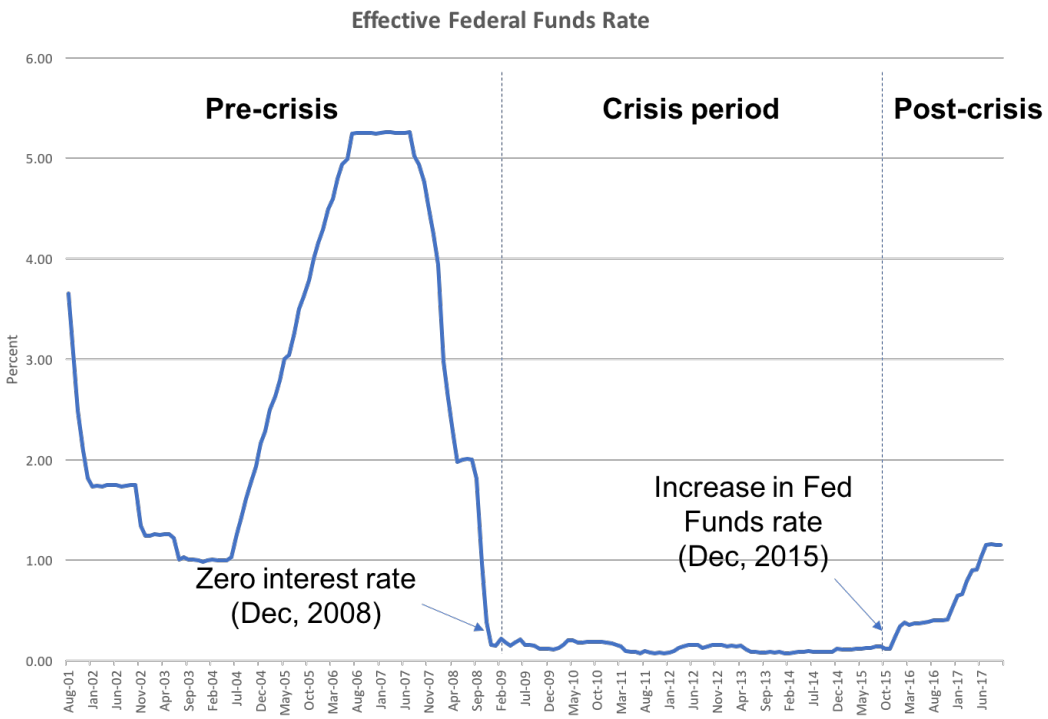


Figure 4: Fed Funds Future surprise (Aug, 2001 - September, 2017)

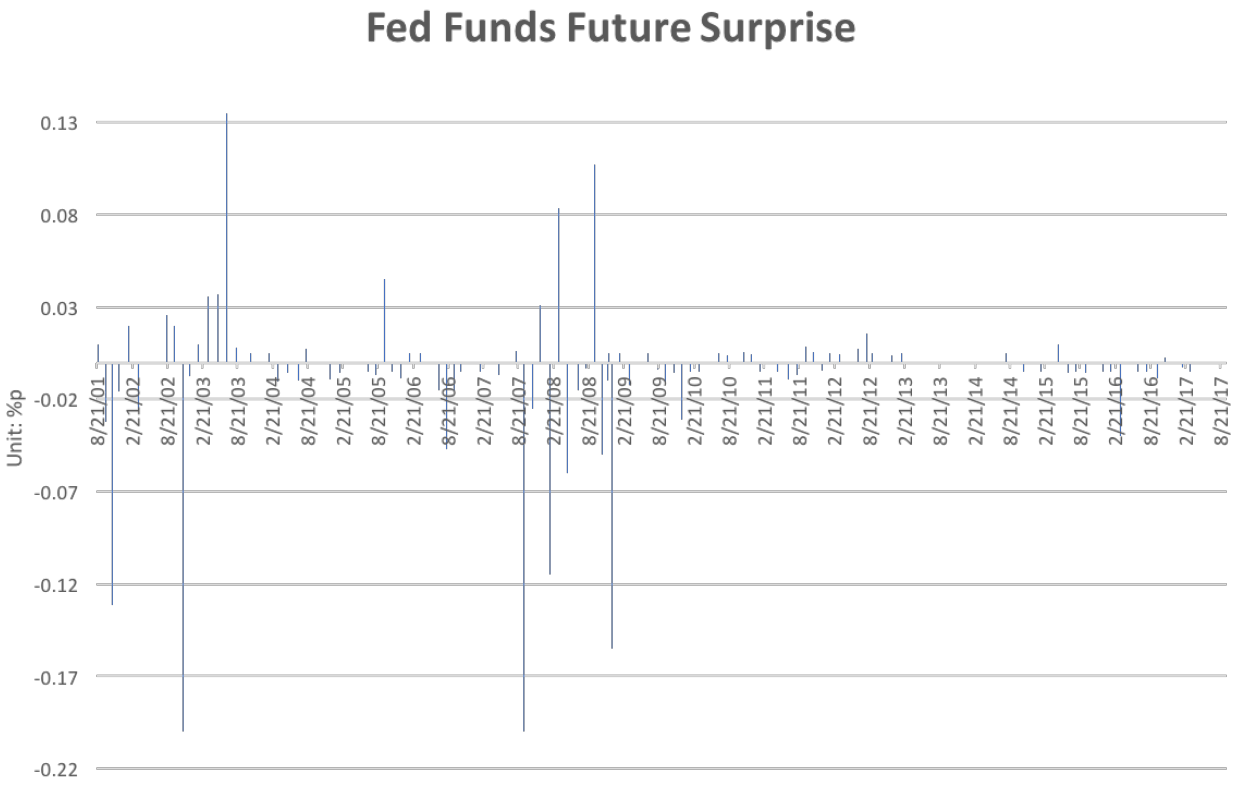


Figure 5: Treasury Future surprise (Aug, 2001 - September, 2017)

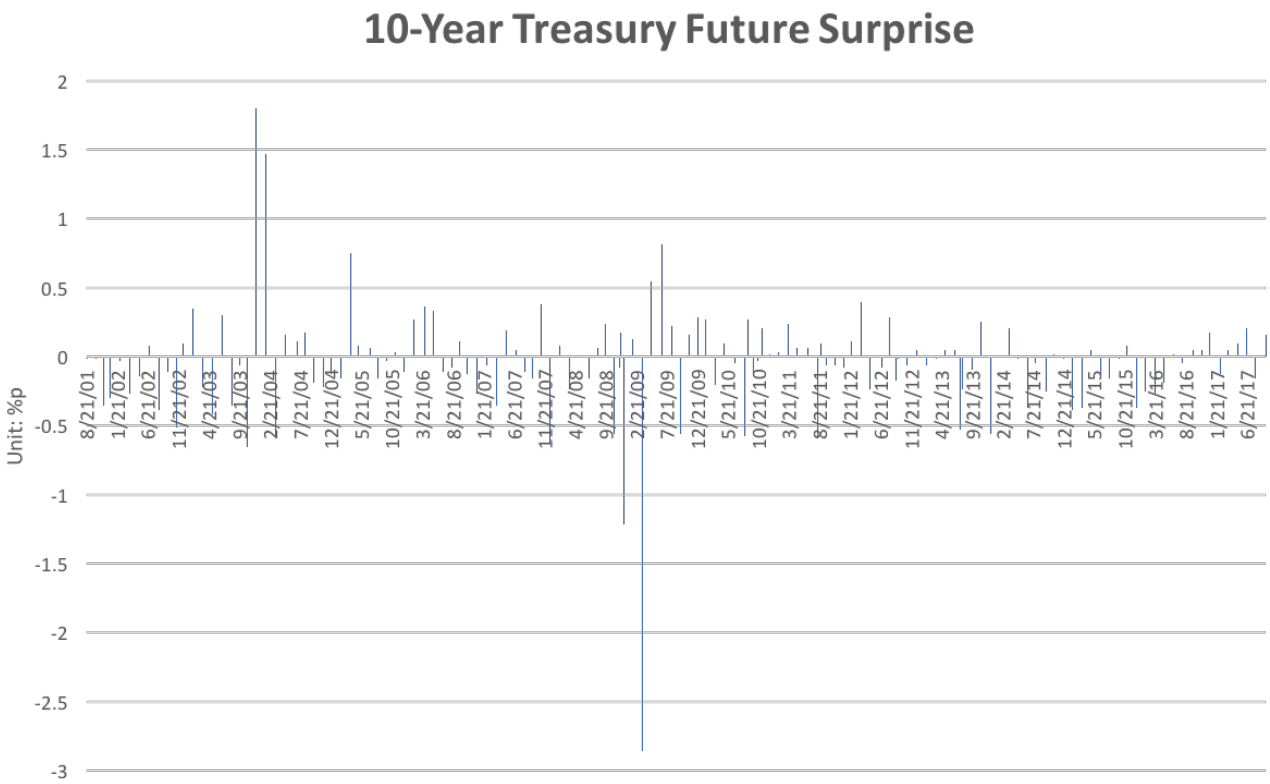


Figure 6: Time zone of sample countries

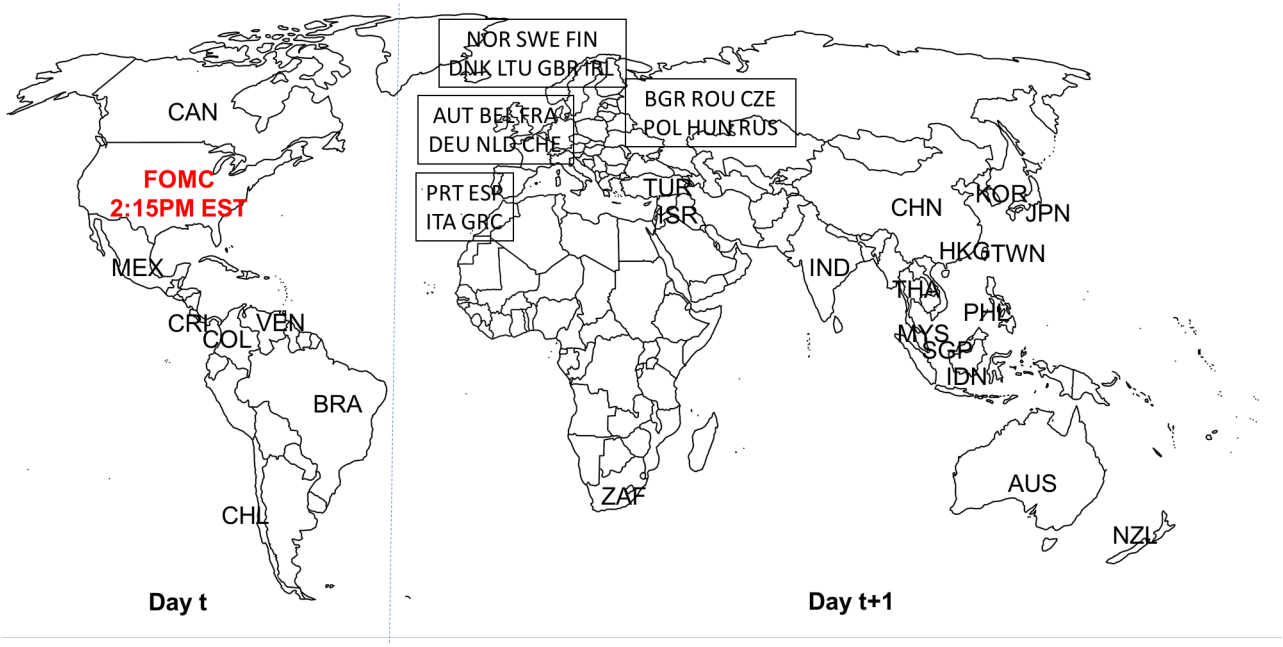
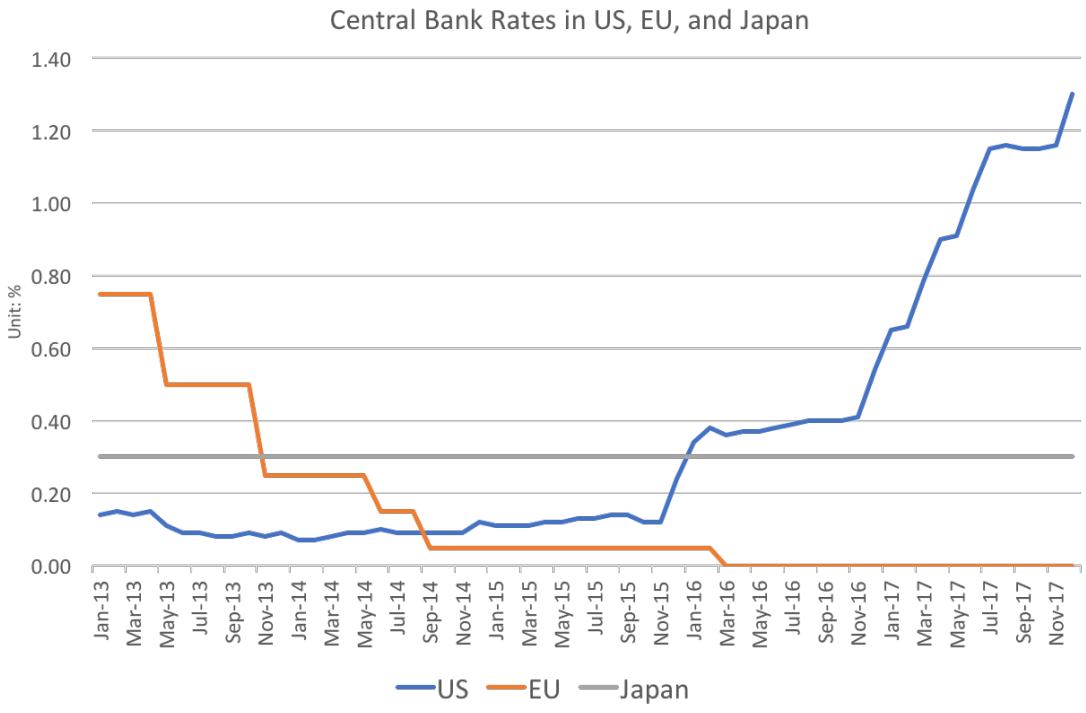


Figure 7: Central Bank Rates



8 Tables

Table 1: Time line of the financial crisis

Time	Event
Feb-07	Home sales peak
Mar-07	Hedge funds housing losses spread Subprime misery
Apr-07	Help for homeowners not enough
Aug-07	Fed lowers rate to 4.75%
Sep-07	LIBOR rate unexpectedly diverges
Nov-07	Treasury creates $75 billion superfund
Dec-07	Foreclosure rates double
Jan-08	Fed tries to stop housing bust
Mar-08	Fed begins bailouts
Apr-08	Fed lowers rate to 2%
Sep-08	Lehman Brothers bankruptcy triggered global panic
Sep-08	Paulson and Bernanke submit bailout to Congress
Oct-08	Global stock markets collapse despite central bank action
Oct-08	Central Banks coordinate global action
Nov-08	Announcement of Large Scale Asset Purchase (LSAP-I)
Dec-08	Zero Interest rates
Nov-10	Announcement of LSAP-II
Sep-12	Announcement of LSAP-III
Jun-13	Announcement of "tapering"
Dec-15	Increase in the Fed Funds rate for the first time since 2006

Table 2: The sample countries

	Division	Country
Europe (23)	Eastern Europe (6)	Bulgaria, Czech Republic, Hungary, Poland, Romania, Russia
	Northern Europe (7)	Denmark, Finland, Ireland, Lithuania, Norway, Sweden, U.K.
	Sothern Europe (4)	Greece, Italy, Portugal, Spain
	Western Europe (6)	Austria, Belgium, France, Germany, Netherland, Switzerland
Asia (13)	East Asia (5)	China, Hong Kong, Japan, South Korea, Taiwan
	South and Southeast Asia (6)	India, Indonesia, Malaysia, Philippines, Singapore, Thailand
	Western Asia (2)	Israel, Turkey
America (7)	North America (2)	Canada, Mexico
	Central and South America (5)	Brazil, Chile, Colombia, Costa Rica, Venezuela
Africa (1)	Africa	South Africa
Oceania (2)	Oceania	Australia, New Zealand

Table 3: The division of groups

	Country
Developed Economies	CAD, DEU, FRA, GBR, ITA, JPN, AUT, BEL, NLD, CHE, GRC, PRT, ESP, DNK, FIN, IRL, NOR, SWE, CZE, HUN, POL, KOR, ISR, TUR, MEX, CHL, AUS, NZL
Emerging Markets	LTU, BGN, ROU, RUS, CHN, HKG, TWN, IND, IDN, MYS, PHL, SGP, THA, BRA, COL, CRI, VEN, ZAF

Table 4: Exchange rates arrangement

	Country
Hard Pegs	LTU, BGR, HKG
Soft Pegs	DNK, CZE, HUN, ROU, RUS, CHN, IND, IDN, MYS, SGP, THA, ISR, CRC, VEF
Managed Floating	CHF, KOR, PHL, TUR, BRA, COL, ZAF
Free Floating	EUR, IRL, NOR, SWE, GBR, POL, JPN, CAN, MEX, CHL, AUS, NZL

Table 5: Response of government bond yields and exchange rates to U.S. monetary policy surprises

VARIABLES	(1) GOV2	(2) GOV5	(3) GOV10	(4) FX
FF	0.301***	0.307***	0.277***	-1.026***
	(0.0435)	(0.0355)	(0.0411)	(0.235)
TYF	0.0418***	0.0431***	0.0307***	-0.273***
	(0.00974)	(0.0105)	(0.00502)	(0.0379)
FF × CRISIS	0.845***	0.296**	0.400*	-9.089***
	(0.249)	(0.115)	(0.236)	(1.300)
TYF × CRISIS	-0.0278**	-0.00839	0.00669	0.174***
	(0.0123)	(0.0106)	(0.00739)	(0.0620)
FF × POST	-0.198	0.473	1.281**	-16.37***
	(0.282)	(0.285)	(0.496)	(2.689)
TYF × POST	0.0286	0.0534***	0.0656***	-0.116
	(0.0202)	(0.0158)	(0.0162)	(0.124)
CRISIS	0.00199	0.000842	-0.0101***	-0.170***
	(0.00901)	(0.00591)	(0.00364)	(0.0251)
POST	0.00260	0.00271	0.00870*	0.0663***
	(0.0143)	(0.00429)	(0.00458)	(0.0228)
CONSTANT	-0.00291	-0.00275	0.00215	0.0471***
	(0.00362)	(0.00345)	(0.00216)	(0.0118)
Country FE	YES	YES	YES	YES
Observations	4,479	4,436	4,627	4,885
Number of Country	46	45	46	36
Adjusted R-squared	0.00123	0.0293	0.0587	0.0763

NOTE: The dependent variable is daily change in 2-year (GOV2), 5-year (GOV5), 10-year (GOV10) ahead government bond yield and daily percentage change in foreign exchange spot rate in dollars per unit of non US currency (FX) bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Comparison of responses to U.S. monetary policy surprises

	Developed Economies			Emerging Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	GOV2	GOV5	GOV10	GOV2	GOV5	GOV10
FF	0.307***	0.325***	0.219***	0.291**	0.265**	0.420***
	(0.0404)	(0.0354)	(0.0287)	(0.123)	(0.0957)	(0.124)
TYF	0.0328***	0.0375***	0.0279***	0.0657**	0.0568*	0.0383***
	(0.00614)	(0.00896)	(0.00588)	(0.0297)	(0.0291)	(0.00934)
FF × CRISIS	0.842**	0.334**	0.247***	0.861*	0.193	0.712
	(0.312)	(0.136)	(0.0799)	(0.433)	(0.214)	(0.739)
TYF × CRISIS	-0.00745	-0.00636	0.0102	-0.0778**	-0.0133	-0.00233
	(0.00995)	(0.0119)	(0.00945)	(0.0344)	(0.0223)	(0.00971)
FF × POST	-0.496**	0.0986	0.809***	0.335	1.218*	2.086
	(0.220)	(0.292)	(0.242)	(0.721)	(0.594)	(1.399)
TYF × POST	0.0329**	0.0726***	0.0738***	0.0207	0.0172	0.0511
	(0.0127)	(0.0163)	(0.0176)	(0.0550)	(0.0310)	(0.0326)
CRISIS	0.00374	-0.00354	-0.0125***	-0.000995	0.0115	-0.00461
	(0.0125)	(0.00725)	(0.00368)	(0.00734)	(0.00965)	(0.00875)
POST	-0.00849	0.00526	0.00692	0.0233	-0.00222	0.0118
	(0.0192)	(0.00632)	(0.00414)	(0.0207)	(0.00350)	(0.0106)
Constant	0.00300	0.00172	0.00480**	-0.0162***	-0.0136*	-0.00386
	(0.00473)	(0.00400)	(0.00220)	(0.00352)	(0.00647)	(0.00542)
Country FE	YES	YES	YES	YES	YES	YES
Observations	3,053	3,029	3,141	1,426	1,407	1,486
Number of Country	28	28	28	18	17	18
Adjusted R-squared	0.000358	0.0265	0.0663	-0.000881	0.0351	0.0551

NOTE: The dependent variable is daily change in 2-year (GOV2), 5-year (GOV5), and 10-year (GOV10) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Response of foreign exchange rate to U.S. monetary policy surprises by exchange rate regime

Exchange Regime	Hard Peg	Soft Peg	Managed Float	Free Float
VARIABLES	FX	FX	FX	FX
FF	-0.350	-0.768*	-1.043	-1.556***
	(0.152)	(0.377)	(0.787)	(0.338)
TYF	-0.253	-0.133***	-0.407***	-0.379***
	(0.153)	(0.0307)	(0.107)	(0.0674)
FF × CRISIS	-3.363	-6.744***	-12.90***	-11.47***
	(6.056)	(1.744)	(2.934)	(2.446)
TYF × CRISIS	0.103	0.0340	0.396*	0.233
	(0.106)	(0.0656)	(0.186)	(0.131)
FF × POST	-17.97	-14.04***	-19.06*	-18.36***
	(13.07)	(3.364)	(8.462)	(4.988)
TYF × POST	0.491	-0.347**	0.166	-0.121
	(0.316)	(0.139)	(0.451)	(0.198)
CRISIS	-0.160	-0.130***	-0.155*	-0.238***
	(0.0849)	(0.0351)	(0.0682)	(0.0480)
POST	0.0944	0.0146	0.114	0.0910**
	(0.0533)	(0.0356)	(0.0642)	(0.0400)
Constant	0.0363	0.0402**	0.0740*	0.0384
	(0.0299)	(0.0151)	(0.0356)	(0.0244)
Country FE	YES	YES	YES	YES
Observations	408	1,899	951	1,493
Number of Country	3	14	7	11
Adjusted R-squared	0.0461	0.0645	0.0621	0.111

NOTE: The dependent variable "FX" is daily percentage change in foreign exchange spot rate (in dollars per unit of non US currency) bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury futures. Robust standard errors in parentheses. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Response of government bond yields to U.S. monetary policy surprises by exchange rate regime

Exchange Regime	Hard Peg	Soft Peg	Managed Float	Free Float
VARIABLES	GOV10	GOV10	GOV10	GOV10
FF	0.546***	0.328**	0.346	0.230***
	(1.29e-09)	(0.112)	(0.248)	(0.0287)
TYF	0.0770***	0.0460**	0.0282**	0.0255***
	(0)	(0.0161)	(0.0108)	(0.00555)
FF × CRISIS	0.106	0.911	0.206	0.214**
	(0.130)	(0.893)	(0.279)	(0.0898)
TYF × CRISIS	-0.0204	-0.0230	0.0129	0.0193***
	(0.0217)	(0.0284)	(0.00863)	(0.00384)
FF × POST	0.385	1.470	2.767**	0.684***
	(0.895)	(1.585)	(0.919)	(0.166)
TYF × POST	-0.0448	0.0978***	0.0207	0.0727***
	(0.0277)	(0.0247)	(0.0699)	(0.0206)
CRISIS	0.00423	-0.0132	0.0187	-0.0159***
	(0.00212)	(0.0117)	(0.0110)	(0.00292)
POST	0.00154	0.0163	-0.00877	0.00999*
	(0.00218)	(0.0120)	(0.00760)	(0.00495)
Constant	-0.00308***	0.00246	-0.0165*	0.00597***
	(7.68e-05)	(0.00807)	(0.00780)	(0.00149)
Country FE	YES	YES	YES	YES
Observations	207	1,214	606	2,513
Number of Country	3	14	7	21
Adjusted R-squared	0.245	0.0419	0.0525	0.0852

NOTE: The dependent variable is daily change in 10-year (GOV10) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Clustering and the responses to U.S. monetary policy surprises

VARIABLES	(1) GOV2	(2) GOV5	(3) GOV10	(4) FX
FF	0.301***	0.307***	0.277**	-1.026**
	(0.104)	(0.112)	(0.112)	(0.491)
TYF	0.0418**	0.0431*	0.0307**	-0.273***
	(0.0196)	(0.0221)	(0.0154)	(0.0788)
FF × CRISIS	0.845***	0.296**	0.400***	-9.089***
	(0.262)	(0.136)	(0.134)	(2.370)
TYF × CRISIS	-0.0278	-0.00839	0.00669	0.174
	(0.0214)	(0.0231)	(0.0172)	(0.185)
FF × POST	-0.198	0.473*	1.281**	-16.37***
	(0.392)	(0.278)	(0.589)	(5.458)
TYF × POST	0.0286	0.0534**	0.0656	-0.116
	(0.0469)	(0.0252)	(0.0448)	(0.717)
CRISIS	0.00199	0.000842	-0.0101	-0.170**
	(0.0119)	(0.00813)	(0.00693)	(0.0670)
POST	0.00260	0.00271	0.00870	0.0663
	(0.0197)	(0.00715)	(0.00967)	(0.101)
CONSTANT	-0.00291	-0.00275	0.00215	0.0471
	(0.00578)	(0.00513)	(0.00407)	(0.0363)
Observations	4,479	4,436	4,627	4,885
Adjusted R-squared	0.00412	0.0337	0.0587	0.0890

NOTE: The dependent variable is daily change in 2-year (GOV2), 5-year (GOV5), 10-year (GOV10) ahead government bond yield and daily percentage change in foreign exchange spot rate in dollars per unit of non US currency (FX) bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 10: Residual surprise and the responses to U.S. monetary policy surprises

VARIABLES	(1) GOV2	(2) GOV5	(3) GOV10	(4) FX
FF	0.479***	0.498***	0.374***	-1.891***
	(0.0928)	(0.0968)	(0.0447)	(0.343)
Residual	-0.0828**	-0.0930**	-0.0408***	0.372***
	(0.0367)	(0.0406)	(0.0128)	(0.121)
FF × CRISIS	0.783***	0.395***	0.614***	-9.045***
	(0.277)	(0.149)	(0.233)	(1.405)
Residual × CRISIS	0.0967***	0.128***	0.0782***	-0.470***
	(0.0359)	(0.0423)	(0.0135)	(0.127)
FF × POST	0.0398	0.917***	1.827***	-17.34***
	(0.280)	(0.293)	(0.500)	(2.719)
Residual × POST	0.0285	0.0534***	0.0656***	-0.116
	(0.0197)	(0.0151)	(0.0154)	(0.123)
CRISIS	0.00338	0.00101	-0.0108***	-0.171***
	(0.00773)	(0.00644)	(0.00367)	(0.0258)
POST	0.00120	0.000161	0.00558	0.0718***
	(0.0138)	(0.00401)	(0.00441)	(0.0218)
Constant	-0.00487	-0.00451	0.00120	0.0522***
	(0.00475)	(0.00528)	(0.00221)	(0.0180)
Observations	4,479	4,436	4,627	4,885
Number of Country	46	45	46	36
Adjusted R-squared	-0.00886	0.0222	0.0473	0.0655

NOTE: The dependent variable is daily change in 2-year (GOV2), 5-year (GOV5), 10-year (GOV10) ahead government bond yield and daily percentage change in foreign exchange spot rate in dollars per unit of non US currency (FX) bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "Residual" denote a 30-minute change in the 10-year Treasury Futures that is orthogonal to "FF". "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Appendix A Country-level regressions

Table A1: Response of 2-year government bond yield to U.S. monetary policy surprises

Country	CAN	CHL	COL	ZAF	AUS	NZL
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2
FF	0.487**	-0.284	0.234	0.382***	0.386*	0.209
	(0.208)	(0.418)	(0.141)	(0.121)	(0.199)	(0.177)
TYF	0.0507**	0.00397	-0.0451	0.00896	0.0428**	-0.00559
	(0.0201)	(0.0397)	(0.0348)	(0.0362)	(0.0173)	(0.0125)
FF × CRISIS	0.278	0.879*	0.465**	0.981***	-0.444*	-3.372
	(0.246)	(0.514)	(0.226)	(0.260)	(0.229)	(2.981)
TYF × CRISIS	-0.0296	-0.0200	0.0152	0.0272	0.0195	-0.139
	(0.0212)	(0.0412)	(0.0375)	(0.0394)	(0.0211)	(0.183)
FF × POST	0.0672	-2.353***	1.131	3.472***	1.144**	4.443
	(0.410)	(0.354)	(2.601)	(0.476)	(0.478)	(3.047)
TYF × POST	-0.0296	-0.0292	0.0654	0.278***	0.0152	0.161
	(0.0514)	(0.0334)	(0.0885)	(0.0359)	(0.0522)	(0.189)
CRISIS	-0.00219	0.00485	0.00657	0.0187	-0.00997	-0.00981
	(0.00923)	(0.0214)	(0.0115)	(0.0231)	(0.0107)	(0.0137)
POST	-0.00552	-0.0167	0.00988	-0.00139	-0.0152	0.00120
	(0.00887)	(0.0111)	(0.0138)	(0.0218)	(0.0120)	(0.0148)
Constant	0.00515	-0.00860	-0.0155	-0.0174	0.0157*	0.00720
	(0.00781)	(0.0202)	(0.00951)	(0.0108)	(0.00826)	(0.00759)
Observations	136	75	104	88	136	91
Adjusted R-squared	0.222	-0.0270	0.0258	0.207	0.191	0.0208

NOTE: The dependent variable is daily change in 2-year (GOV2) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A1 (Continued): Response of 2-year government bond yield to U.S. monetary policy surprises

Country	AUT	BEL	FRA	DEU	NLD	CHE	GRC	ITA	PRT	ESP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2
FF	0.442**	0.448**	0.318*	0.378*	0.295*	-0.542	0.364**	0.352**	0.454**	0.360**
	(0.182)	(0.225)	(0.170)	(0.194)	(0.175)	(0.573)	(0.158)	(0.170)	(0.211)	(0.171)
TYF	0.0276	0.0348	0.0323	0.0457***	0.0334	-0.175	-0.0538**	0.0381*	0.0368*	0.0318
	(0.0227)	(0.0221)	(0.0218)	(0.0168)	(0.0218)	(0.131)	(0.0205)	(0.0222)	(0.0216)	(0.0226)
FF × CRISIS	0.725***	0.431	0.709***	0.874***	0.907***	0.981*	8.525	0.425	0.0774	0.193
	(0.219)	(0.317)	(0.195)	(0.213)	(0.207)	(0.577)	(11.95)	(0.423)	(0.610)	(0.491)
TYF × CRISIS	-0.0181	-0.0270	-0.0234	-0.0421**	-0.0276	0.157	0.309	-0.0283	0.0209	-0.0219
	(0.0260)	(0.0235)	(0.0250)	(0.0210)	(0.0263)	(0.131)	(0.281)	(0.0248)	(0.0443)	(0.0266)
FF × POST	-1.092***	-0.884***	-1.470***	-1.184***	-1.251***	0.00267	-4.236	-1.182**	-0.747	-0.949*
	(0.177)	(0.312)	(0.256)	(0.167)	(0.187)	(0.374)	(13.09)	(0.475)	(2.007)	(0.545)
TYF × POST	0.0569***	0.0483**	0.0509**	0.0573**	0.0482**	0.00464	-0.0319	0.0647	0.112	0.0446*
	(0.0194)	(0.0211)	(0.0244)	(0.0247)	(0.0232)	(0.0288)	(0.496)	(0.0498)	(0.182)	(0.0257)
CRISIS	-0.0254***	-0.0181*	-0.0201**	-0.0240***	-0.0193**	0.0344	0.628	-0.0205	0.0158	-0.0314**
	(0.00889)	(0.00928)	(0.00866)	(0.00888)	(0.00872)	(0.0447)	(0.834)	(0.0133)	(0.0303)	(0.0143)
POST	0.0219***	0.0125	0.0150**	0.0168**	0.0162**	0.00582	-0.672	0.0133	0.0248	0.0248*
	(0.00670)	(0.00815)	(0.00747)	(0.00692)	(0.00662)	(0.00715)	(0.837)	(0.0142)	(0.0550)	(0.0136)
Constant	0.00928	0.00427	0.00365	0.00975	0.00470	-0.0418	0.00467	0.00749	0.00581	0.00662
	(0.00649)	(0.00618)	(0.00646)	(0.00686)	(0.00661)	(0.0445)	(0.00992)	(0.00622)	(0.00654)	(0.00605)
Observations	134	135	136	136	135	91	62	136	136	136
Adjusted R-squared	0.252	0.175	0.197	0.267	0.219	0.157	-0.135	0.0554	-0.0169	0.0511

NOTE: The dependent variable is daily change in 2-year (GOV2) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A1 (Continued): Response of 2-year government bond yield to U.S. monetary policy surprises

Country	DNK	FIN	IRL	NOR	SWE	GBR	CZE	HUN	POL	CHN
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2
FF	0.377**	0.187	0.0411	-0.0305	0.347*	0.236	0.121	0.525	0.204**	-0.136
	(0.164)	(0.130)	(0.0740)	(0.0265)	(0.204)	(0.198)	(0.0874)	(0.560)	(0.101)	(0.0974)
TYF	0.0250	0.0285	0.0295	-0.0478	-0.0597**	0.00751	0.0185	0.499	0.00316	0.00638
	(0.0205)	(0.0193)	(0.0321)	(0.0296)	(0.0253)	(0.0171)	(0.0218)	(0.371)	(0.0396)	(0.0191)
FF × CRISIS	0.571***	0.783***	0.407	0.398	1.011***	0.639***	-0.0484	0.277	-0.0585	0.445***
	(0.197)	(0.162)	(3.780)	(1.161)	(0.270)	(0.221)	(0.162)	(0.651)	(0.156)	(0.132)
TYF × CRISIS	-0.0112	-0.0181	0.0183	0.0759**	0.0567*	0.00331	-0.0197	-0.450	0.0169	-0.00259
	(0.0248)	(0.0228)	(0.0713)	(0.0342)	(0.0299)	(0.0189)	(0.0229)	(0.371)	(0.0410)	(0.0195)
FF × POST	0.114	-0.782***	-0.489	2.714	-0.811**	-0.846**	-0.597**	-0.164	-0.170	0.993***
	(0.285)	(0.199)	(3.783)	(5.758)	(0.341)	(0.331)	(0.297)	(1.191)	(0.373)	(0.137)
TYF × POST	-0.0161	0.0435*	-0.00308	-0.0812	0.00835	0.102**	0.0556	0.0760	0.0694**	-0.0997***
	(0.0297)	(0.0256)	(0.0656)	(0.0795)	(0.0362)	(0.0427)	(0.0346)	(0.120)	(0.0276)	(0.0184)
CRISIS	-0.0171**	-0.0143*	-0.0130	0.0150	-0.0231**	-0.0130	-0.0249**	0.0585	0.00565	0.0105
	(0.00842)	(0.00807)	(0.0314)	(0.0159)	(0.0115)	(0.00924)	(0.0118)	(0.0417)	(0.0105)	(0.00941)
POST	0.0216***	0.0181**	0.0160	0.0188	0.0121	0.0189**	0.0136	-0.00577	-0.00615	-0.0115**
	(0.00745)	(0.00695)	(0.0304)	(0.0207)	(0.00876)	(0.00894)	(0.00915)	(0.0207)	(0.00745)	(0.00558)
Constant	0.00315	-8.65e-05	-0.000915	-0.0191***	0.0122	0.00326	0.0129	-0.0614	0.000440	-0.00466
	(0.00601)	(0.00557)	(0.00890)	(0.00660)	(0.00920)	(0.00686)	(0.0101)	(0.0391)	(0.00850)	(0.00815)
Observations	136	125	101	39	92	136	91	91	136	81
Adjusted R-squared	0.200	0.154	-0.0701	-0.116	0.178	0.104	-0.0265	0.181	-0.00991	-0.0130

NOTE: The dependent variable is daily change in 2-year (GOV2) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A1 (Continued): Response of 2-year government bond yield to U.S. monetary policy surprises

Country	HKG	JPN	KOR	TWN	IND	IDN	MYS	SGP	THA	TUR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2	GOV2
FF	0.727***	0.0146	0.138	0.206*	0.0232	1.508	0.0564	0.0325	0.249**	1.079*
	(0.208)	(0.0350)	(0.123)	(0.115)	(0.0822)	(1.648)	(0.0636)	(0.0955)	(0.103)	(0.599)
TYF	0.0771*	0.00374	0.0265**	0.00868	0.0240	0.232	0.00925	0.0661	0.0210	0.511**
	(0.0426)	(0.00493)	(0.0124)	(0.0116)	(0.0229)	(0.219)	(0.0110)	(0.0441)	(0.0137)	(0.197)
FF × CRISIS	-0.117	0.238***	0.543**	0.686	-0.717*	3.711**	0.535***	0.157	1.067***	3.169***
	(0.230)	(0.0566)	(0.248)	(0.637)	(0.421)	(1.740)	(0.0923)	(0.103)	(0.260)	(0.837)
TYF × CRISIS	-0.0433	-0.00349	-0.0133	-0.0642	0.00293	-0.218	-0.000740	-0.0565	-0.0155	-0.464**
	(0.0434)	(0.00551)	(0.0273)	(0.0463)	(0.0430)	(0.221)	(0.0123)	(0.0443)	(0.0174)	(0.199)
FF × POST	2.589***	0.343***	0.191	-0.279	0.785	-5.193***	0.351	1.919***	-0.413	2.821***
	(0.746)	(0.119)	(0.354)	(0.636)	(0.555)	(0.831)	(0.239)	(0.391)	(0.482)	(0.680)
TYF × POST	-0.0244	0.00159	-0.0547	0.0789	0.0398	0.146	-0.00860	0.0534	0.0439	-0.0116
	(0.120)	(0.0111)	(0.0345)	(0.0519)	(0.0640)	(0.104)	(0.0311)	(0.0687)	(0.0575)	(0.0595)
CRISIS	-0.00338	-0.00214	0.0147	-0.00151	-0.0103	0.0537	0.00638	-0.0105	-0.00700	-0.0240
	(0.0105)	(0.00221)	(0.0112)	(0.0149)	(0.0253)	(0.0889)	(0.00728)	(0.00803)	(0.0112)	(0.0802)
POST	-0.00866	0.00149	-0.00971	0.0144	0.0218	0.0366	0.00522	0.000202	-0.00767	0.0776**
	(0.0156)	(0.00246)	(0.00931)	(0.0125)	(0.0244)	(0.0250)	(0.00634)	(0.0119)	(0.00926)	(0.0360)
Constant	0.00241	0.000700	-0.0129	-0.00711	-0.0105	-0.0823	-0.00760	0.0130*	0.00927	-0.0148
	(0.00942)	(0.00194)	(0.00795)	(0.00914)	(0.0111)	(0.0871)	(0.00644)	(0.00753)	(0.00847)	(0.0726)
Observations	130	136	120	96	110	115	119	91	118	89
Adjusted R-squared	0.290	0.0856	0.0342	0.00727	-0.0614	0.0535	0.0681	0.190	0.145	0.0817

NOTE: The dependent variable is daily change in 2-year (GOV2) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2: Response of 10-year government bond yield to U.S. monetary policy surprises

Country	CAN	BRA	CHL	COL	ZAF	AUS	NZL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10
FF	0.207	0.872***	-2.088***	2.459***	0.184	0.360	0.249
	(0.127)	(0.135)	(0.218)	(0.269)	(0.237)	(0.234)	(0.170)
TYF	0.0511***	0.429***	0.186***	-0.193**	0.0325	0.0783***	0.00475
	(0.0161)	(0.0869)	(0.0520)	(0.0885)	(0.0502)	(0.0178)	(0.0188)
FF × CRISIS	0.0781	-6.277	2.460***	-1.480***	0.924**	-0.393	-0.589***
	(0.167)	(3.771)	(0.769)	(0.330)	(0.443)	(0.269)	(0.214)
TYF × CRISIS	0.0204	-0.174	-0.160	0.179**	0.0105	0.0202	0.0508**
	(0.0182)	(0.114)	(0.111)	(0.0902)	(0.0601)	(0.0205)	(0.0213)
FF × POST	0.100	9.403**	-0.0260	0.746	4.455***	1.702**	2.221**
	(0.474)	(4.484)	(0.747)	(1.357)	(0.902)	(0.839)	(0.923)
TYF × POST	-0.0827	-0.416*	-0.0258	-0.00953	0.314***	-0.0782	-0.0763
	(0.0670)	(0.241)	(0.101)	(0.0981)	(0.0751)	(0.0845)	(0.0884)
CRISIS	0.00103	0.105***	-0.00398	0.0300	-0.00411	-0.0114	-0.0109
	(0.00887)	(0.0304)	(0.0213)	(0.0453)	(0.0176)	(0.0128)	(0.0114)
POST	-0.0233*	-0.0471	0.0164	0.0160	-0.000888	-0.0282	-0.0187
	(0.0126)	(0.0393)	(0.0134)	(0.0195)	(0.0191)	(0.0185)	(0.0185)
Constant	0.00257	-0.0641**	-0.00825	-0.0409	0.00158	0.0154*	0.0116
	(0.00564)	(0.0243)	(0.0173)	(0.0442)	(0.0108)	(0.00882)	(0.00736)
Observations	136	57	40	91	126	136	136
Adjusted R-squared	0.269	0.229	0.304	0.122	0.169	0.267	0.0724

NOTE: The dependent variable is daily change in 10-year (GOV10) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A2 (Continued): Response of 10-year government bond yield to U.S. monetary policy surprises

Country	AUT	BEL	FRA	DEU	NLD	CHE	GRC	ITA	PRT	ESP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10
FF	0.304	0.215	0.288	0.283	0.262	-0.123	0.0623	0.270	0.200	0.265
	(0.194)	(0.188)	(0.200)	(0.196)	(0.179)	(0.177)	(0.199)	(0.185)	(0.194)	(0.190)
TYF	0.0273	0.0343	0.0331	0.0319	0.0329	-0.0407*	-0.0693**	0.0310	0.0269	0.0333
	(0.0208)	(0.0213)	(0.0215)	(0.0216)	(0.0209)	(0.0211)	(0.0307)	(0.0215)	(0.0217)	(0.0221)
FF × CRISIS	0.324	0.283	0.273	0.207	0.276	0.362	-0.499	0.306	0.171	0.208
	(0.244)	(0.221)	(0.238)	(0.259)	(0.232)	(0.222)	(1.065)	(0.330)	(0.355)	(0.347)
TYF × CRISIS	0.0130	0.00839	0.0108	0.0211	0.0155	0.0735***	0.0775	0.0139	0.0327	0.0191
	(0.0228)	(0.0232)	(0.0233)	(0.0243)	(0.0235)	(0.0234)	(0.0618)	(0.0242)	(0.0311)	(0.0269)
FF × POST	0.424	0.851	0.852	0.878	0.682	0.444	1.938	0.268	1.103	0.964
	(0.636)	(0.657)	(0.630)	(0.757)	(0.707)	(0.583)	(1.646)	(0.672)	(1.046)	(0.609)
TYF × POST	0.164***	0.0973**	0.101**	0.139***	0.129***	0.0402	0.128	0.0935*	0.0893	0.0430
	(0.0528)	(0.0427)	(0.0433)	(0.0439)	(0.0429)	(0.0321)	(0.151)	(0.0539)	(0.0952)	(0.0499)
CRISIS	-0.0242**	-0.0249**	-0.0234**	-0.0240**	-0.0253**	0.000114	-0.0557	-0.0172	-0.0207	-0.0144
	(0.0101)	(0.0105)	(0.0102)	(0.0111)	(0.0108)	(0.0112)	(0.0470)	(0.0137)	(0.0190)	(0.0149)
POST	0.0311**	0.0165	0.0171	0.0202*	0.0214*	0.00819	0.0668	0.00997	0.0337	0.0122
	(0.0154)	(0.0108)	(0.0106)	(0.0122)	(0.0115)	(0.00891)	(0.0521)	(0.0156)	(0.0291)	(0.0159)
Constant	0.00684	0.00778	0.00702	0.00790	0.00770	-0.00393	-0.000223	0.00789	0.00570	0.00717
	(0.00698)	(0.00701)	(0.00713)	(0.00685)	(0.00683)	(0.00940)	(0.0133)	(0.00709)	(0.00784)	(0.00700)
Observations	135	136	136	136	136	90	91	136	131	136
Adjusted R-squared	0.195	0.174	0.195	0.194	0.191	0.0790	-0.0826	0.0889	0.0232	0.0736

NOTE: The dependent variable is daily change in 10-year (GOV10) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2 (Continued): Response of 10-year government bond yield to U.S. monetary policy surprises

Country	DNK	FIN	IRL	NOR	SWE	GBR	CZE	HUN	POL	CHN
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10
FF	0.308	0.307	0.434***	0.166	0.129	0.283	0.0879	0.411	0.232**	-0.0441
	(0.197)	(0.190)	(0.163)	(0.239)	(0.212)	(0.180)	(0.152)	(0.416)	(0.103)	(0.0654)
TYF	0.0260	0.0325	0.0322	-0.101**	-0.0599**	0.0103	-0.153	0.417	-0.0249	0.0212
	(0.0209)	(0.0213)	(0.0219)	(0.0470)	(0.0250)	(0.0228)	(0.114)	(0.307)	(0.0425)	(0.0252)
FF × CRISIS	0.747	0.239	0.285	0.904***	1.100***	0.502*	0.452**	0.892	0.108	0.382***
	(1.385)	(0.244)	(0.221)	(0.278)	(0.252)	(0.264)	(0.188)	(0.727)	(0.191)	(0.114)
TYF × CRISIS	0.0206	0.0148	-0.00454	0.140***	0.0978***	0.0313	0.159	-0.518	0.0503	-0.0176
	(0.0236)	(0.0239)	(0.0245)	(0.0484)	(0.0277)	(0.0296)	(0.114)	(0.315)	(0.0444)	(0.0261)
FF × POST	0.631	0.703	0.603	1.020***	0.637	-0.00735	-1.090***	0.214	0.0782	-0.642
	(1.504)	(0.675)	(0.598)	(0.382)	(0.723)	(0.911)	(0.332)	(1.187)	(1.002)	(0.400)
TYF × POST	0.110**	0.125***	0.113**	0.124***	0.0534	0.221***	0.127***	0.203*	0.209**	0.133**
	(0.0426)	(0.0380)	(0.0491)	(0.0297)	(0.0560)	(0.0610)	(0.0272)	(0.106)	(0.0938)	(0.0654)
CRISIS	-0.0224*	-0.0249**	-0.00471	-0.00755	-0.0157	-0.0122	-0.0286*	0.0696*	0.0114	-0.00647
	(0.0114)	(0.0108)	(0.0136)	(0.0175)	(0.0119)	(0.0130)	(0.0156)	(0.0388)	(0.0131)	(0.00776)
POST	0.0180	0.0178	0.00753	0.0143	0.0142	0.0122	0.00573	-0.0112	-0.0198	0.0154
	(0.0118)	(0.0111)	(0.0157)	(0.0101)	(0.0122)	(0.0146)	(0.00855)	(0.0226)	(0.0152)	(0.0125)
Constant	0.00870	0.00776	0.00410	0.00338	0.00712	0.00739	0.0247*	-0.0539	0.000158	0.00102
	(0.00690)	(0.00692)	(0.00708)	(0.0151)	(0.00897)	(0.00766)	(0.0143)	(0.0339)	(0.00785)	(0.00620)
Observations	128	136	119	91	92	136	91	91	128	83
Adjusted R-squared	0.147	0.195	0.111	0.212	0.246	0.112	0.161	0.147	0.0427	0.0608

NOTE: The dependent variable is daily change in 10-year (GOV10) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2 (Continued): Response of 10-year government bond yield to U.S. monetary policy surprises

Country	HKG	JPN	KOR	TWN	IND	IDN	MYS	PHL	SGP	THA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10	GOV10
FF	0.546***	-0.125*	-0.00882	0.139	0.320***	-0.0530	0.195**	0.0566	0.238***	0.380
	(0.176)	(0.0698)	(0.218)	(0.0847)	(0.109)	(0.398)	(0.0952)	(0.182)	(0.0571)	(0.247)
TYF	0.0770***	0.00952	0.0573**	0.0189	0.0448***	0.0709	-0.00974	0.0267	0.0288	0.0167
	(0.0157)	(0.0108)	(0.0243)	(0.0125)	(0.0156)	(0.0541)	(0.0305)	(0.0190)	(0.0258)	(0.0217)
FF × CRISIS	0.0131	0.467***	0.125	0.359**	0.565***	7.943***	0.412***	-0.304	-0.370*	0.668**
	(0.219)	(0.0792)	(0.248)	(0.137)	(0.160)	(0.798)	(0.114)	(0.684)	(0.191)	(0.278)
TYF × CRISIS	-0.00440	0.00369	0.00552	-0.0151	-0.0363*	0.0469	0.0318	0.0246	0.0238	0.0481*
	(0.0199)	(0.0112)	(0.0275)	(0.0151)	(0.0185)	(0.0645)	(0.0308)	(0.0235)	(0.0332)	(0.0260)
FF × POST	1.375*	-1.270***	1.106**	2.708	0.282	-4.936***	1.353***	19.48*	3.813***	0.911*
	(0.704)	(0.228)	(0.523)	(5.582)	(0.497)	(1.546)	(0.401)	(11.10)	(0.554)	(0.464)
TYF × POST	-0.0696	0.00304	-0.0725	-0.0529	0.113*	0.0618	0.0473	0.0721	0.0435	-0.0800
	(0.110)	(0.0259)	(0.0554)	(0.0659)	(0.0638)	(0.155)	(0.0528)	(0.167)	(0.0814)	(0.0588)
CRISIS	0.00613	-0.00368	0.0261*	-0.00151	-9.40e-05	0.00148	0.0116	0.0218*	-0.0335**	-0.00451
	(0.0106)	(0.00474)	(0.0134)	(0.00700)	(0.0108)	(0.0311)	(0.0105)	(0.0128)	(0.0132)	(0.0141)
POST	-0.000567	0.00278	-0.0216*	-0.00662	0.0193	0.00515	0.00480	-0.00715	-0.00391	-0.00839
	(0.0237)	(0.00527)	(0.0116)	(0.0193)	(0.0130)	(0.0278)	(0.0106)	(0.0237)	(0.0139)	(0.0122)
Constant	-0.00406	-0.000615	-0.0237**	0.000875	-0.00678	-0.0225	-0.00891	-0.0171	0.0269**	0.00210
	(0.00724)	(0.00400)	(0.0116)	(0.00566)	(0.00868)	(0.0233)	(0.00965)	(0.0118)	(0.0112)	(0.0115)
Observations	132	136	119	87	134	115	99	59	91	119
Adjusted R-squared	0.313	0.0969	0.138	0.0614	0.115	0.502	0.211	-0.0427	0.230	0.237

NOTE: The dependent variable is daily change in 10-year (GOV10) ahead government bond yield bracketing an FOMC announcement. The entries labeled "FF" denote a 30-minute window change in the Fed Fund Futures around an FOMC announcement. The entries labeled "TYF" denote a 30-minute change in the 10-year Treasury Futures. "CRISIS" is 1 in the sample period between Nov 2008 and Dec 2015. "POST" is 1 in the sample period after Dec 2015. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1