Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.

US Monetary Policy and International Bond Markets

Simon Gilchrist, Vivian Yue, and Egon Zakrajšek

2018-014

Please cite this paper as:
Gilchrist, Simon, Vivian Yue, and Egon Zakrajšek (2018). "US Monetary Policy and International Bond Markets," Finance and Economics Discussion Series 2018-014. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2018.014r1.

US Monetary Policy and International Bond Markets

Simon Gilchrist* Vivian Yue† Egon Zakrajšek‡

September 16, 2019

Forthcoming in the *Journal of Money, Credit, and Banking*

Abstract

This paper analyzes how US monetary policy affects the pricing of dollar-denominated sovereign debt. We document that yields on dollar-denominated sovereign bonds are highly responsive to US monetary policy surprises—during both the conventional and unconventional policy regimes—and that the passthrough of unconventional policy to foreign bond yields is, on balance, comparable to that of conventional policy. In addition, a conventional US monetary easing (tightening) leads to a significant narrowing (widening) of credit spreads on sovereign bonds issued by countries with a speculative-grade credit rating but has no effect on the corresponding weighted average of bilateral exchange rates for a basket of currencies from the same set of risky countries; this indicates that an unanticipated tightening of US monetary policy widens credit spreads on risky sovereign debt directly through the financial channel, as opposed to indirectly through the exchange rate channel. During the unconventional policy regime, yields on both investment- and speculative-grade sovereign bonds move one-to-one with policy-induced fluctuations in yields on comparable US Treasuries. We also examine whether the response of sovereign credit spreads to US monetary policy differs between policy easings and tightenings and find no evidence of such asymmetry.

JEL Classification: E4, E5, F3
Keywords: conventional and unconventional US monetary policy; sovereign bond yields; sovereign credit spreads; financial spillovers; asymmetric policy effects; risk-taking channel

We are grateful to two anonymous referees and Ken West (Editor) for many detailed comments and useful suggestions on the initial draft of the paper. We also thank Chris Neely, Argia Sbordone, Mohamed Shaban, Gretchen Weinbach, and participants at the conference on "Macroeconomic Policy Mix in the Transatlantic Economy" organized by the European Commission, Federal Reserve Bank of New York, and CEPR, the 15th Jacques Polak Annual Research Conference organized by the IMF, and the 2017 conference on "Globalization, Development, and Economic and Financial Stability" organized by the Asian Development Bank Institute for helpful comments. Harley Du, Lucas Husted, Gerardo Sanz-Maldonado, Shaily Patel, and Rebecca Zhang provided superb research assistance at various stages of this project. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System, the Federal Reserve Bank of Atlanta, or of anyone else associated with the Federal Reserve System.

*New York University and NBER. Email: sg40@nyu.edu
†Emory University, Federal Reserve Bank of Atlanta, and NBER. Email: vyue@emory.edu
‡Division of Monetary Affairs, Federal Reserve Board. Email: egon.zakrajsek@frb.gov

1 Introduction

Among financially interconnected economies, unanticipated changes in the stance of monetary policy in one country can quickly "spill over" to other countries. While the debate surrounding monetary policy cross-border spillovers has a storied history in international economics (see Fleming, 1962; Mundell, 1963), the 2008–09 global financial crisis and its aftermath—a period during which the Federal Reserve and many other central banks implemented new and unconventional forms of monetary stimulus—has sparked intense interest in such international monetary policy spillovers, in both academic and policy circles (see Bernanke, 2018).

The canonical view of international monetary policy interactions, as exemplified by the Mundell-Fleming model, identifies the exchange rate channel as the primary mechanism through which domestic monetary policy actions affect macroeconomic conditions abroad.[1] At the same time, a monetary policy easing at home will lower domestic longer-term interest rates and raise prices of risky financial assets in the home country. With highly integrated global financial markets, investor portfolio rebalancing efforts will lead to capital flows to foreign countries, putting downward pressure on foreign longer-term yields and upward pressure on foreign asset prices, thereby easing financial conditions abroad.

In this paper, we contribute to the understanding of this so-called financial spillover channel. Specifically, using high-frequency price data on dollar-denominated sovereign bonds, we empirically quantify the transmission of US monetary policy in international bond markets. By focusing on dollar-denominated sovereign bonds, we are able to analyze how US monetary policy affects sovereign yields and spreads, a question that is more difficult to address using bonds denominated in local currencies, an asset class for which policy-induced fluctuations in exchange rates are a direct complicating factor.[2] Compared with sovereign bonds denominated in local currencies, dollar-denominated sovereign bonds are also a more established asset class, which allows us to estimate US monetary policy spillovers in international bond markets using a richer set of countries and

[1] According to this view, a monetary easing at home lowers the domestic interest rate relative to foreign rates, inducing a depreciation of the domestic currency. One key implication of the Mundell-Fleming framework is that a central bank cannot freely adjust its policy rate to stabilize domestic output, while also maintaining a fixed exchange rate and an open capital account—a tradeoff frequently referred to as the "international policy trilemma" (see Obstfeld and Rogoff, 2002). Consistent with this prediction, Obstfeld, Shambaugh, and Taylor (2005), Goldberg (2013), Klein and Shambaugh (2015), and Obstfeld (2015) have shown that short-term interest rates of countries with flexible exchange rates have an appreciably lower correlation with the short-term rate of the "base" country, relative to countries with fixed exchange rates. Recently, however, Rey (2013, 2016) has argued that even floating exchange rates will not suffice to insulate domestic financial conditions from foreign monetary policy shocks—at least not without additional restrictions on capital mobility—thereby, reducing the "trilemma" to a "dilemma."

[2] Fluctuations in exchange rates caused by changes in the stance of US monetary policy can, of course, affect yields and spreads on dollar-denominated sovereign bonds indirectly through balance sheet effects, owing to the presence of a currency mismatch between countries' assets and liabilities (see Céspedes, Chang, and Velasco, 2004; Gertler, Gilchrist, and Natalucci, 2007). As an alternative empirical approach, one could convert local currency bonds into dollar-denominated bonds using FX swap agreements. However, as documented by Du, Im, and Schreger (2018), there is a significant time-varying gap between the FX-swap-implied dollar yield paid by foreign governments and the US Treasury dollar yield, which can confound the measurement of sovereign default risk using local currency bonds. As shown by Hofmann, Shim, and Shin (2017), currency appreciation—vis-à-vis the US dollar—in emerging market economies leads to a narrowing of local currency sovereign bond spreads, with the yield compression primarily reflecting a lower credit risk premium.

over a longer sample period. And finally, compared with most of the literature on monetary policy spillovers, we use a nearly ideal measure of unexpected changes in the stance of US monetary policy to identify policy surprises. Using these surprises, we analyze whether the strength and scope of the cross-border spillover effects differ between the conventional and unconventional US monetary policy regimes.

To compare the transmission of conventional and unconventional US monetary policy actions to international bond markets, we follow Hanson and Stein (2015) and Gertler and Karadi (2015) and use changes in the 2-year nominal US Treasury yield on policy announcement days as a common instrument across the two policy regimes. In contrast to these two papers, we rely on the *intraday* changes in the 2-year Treasury yield within a narrow window bracketing Federal Open Market Committee (FOMC) and other policy announcements to identify unanticipated shifts in the stance of US monetary policy.[3] Implicit in this approach is a highly reasonable identifying assumption that any movement in the 2-year US Treasury yield in a narrow window bracketing policy announcements is due to the unanticipated changes in the stance of US monetary policy or the FOMC's communication regarding the path for policy going forward.

The paper contains two sets of related empirical exercises. In the first set, we analyze the response of yields on sovereign bonds denominated in US dollars to an unanticipated change in the stance of US monetary policy. To do so, we obtained from the Thompson Reuters Datastream daily secondary market prices of dollar-denominated sovereign bonds issued by more than 90 countries, both emerging market and advanced economies, since the early 1990s. We exploit the cross-sectional heterogeneity of these data by constructing sovereign bond portfolios along two key dimensions: duration and credit risk.

Our first set of results documents that conventional US monetary policy is transmitted very effectively to both shorter- and longer-duration yields on dollar-denominated sovereign debt. The spillover effects of conventional US monetary policy across the sovereign bond portfolios of different durations are much more uniform compared with the unconventional policy regime. That said, the extent of spillovers from the US unconventional monetary policy actions to foreign bond yields is, on balance, similar to that estimated during the conventional policy regime. The results also indicate that conventional US monetary policy actions have a differential effect on the yields of sovereign securities of different credit ratings, whereas the unconventional policy actions undertaken by the FOMC in recent years had a similar effect on both investment- and speculative-grade sovereign bond yields.

The second set of empirical exercises focuses on sovereign default risk. An important advantage of building bond portfolios from the "ground up" is that we can construct credit spreads that are not subject to the duration mismatch, which is a common problem plaguing standard sovereign

[3] Hanson and Stein (2015) and Gertler and Karadi (2015) use daily changes in the 2- and 1-year US Treasury yields, respectively, to identify monetary policy surprises. The use of intraday data allows us to rule out the potential reverse causality, a situation in which the daily change in US Treasury yield, even on a policy announcement day, may not solely reflect changes in the stance of monetary policy but may also reflect the endogenous response of policy to changes in the economic outlook or other global macroeconomic or financial shocks.

credit spread indexes, such as the EMBI or EMBI+. Our analysis based on portfolios sorted by credit risk thus allows us to quantify more accurately how US monetary policy affects sovereign default risk across the conventional and unconventional policy regimes, as well as across "high" and "low" risk countries. An additional advantage of our approach is that we can use bilateral exchange rates to construct foreign currency portfolios, using the same weights as those in the sovereign bond portfolios. The response of returns on these matched foreign currency portfolios to US monetary policy surprises allows to examine the extent to which policy-induced fluctuations in sovereign credit spreads are due to indirect effects via the conventional exchange rate channel, as opposed to the direct financial spillover channel.

The results from this set of exercises show that conventional US monetary policy actions have an economically large and statistically significant effect on credit spreads of dollar-denominated bonds of countries with a speculative-grade credit rating. Specifically, credit spreads on risky sovereign debt are estimated to narrow (widen) significantly in response to an unanticipated US policy easing (tightening) during the conventional regime. Interestingly, conventional US monetary policy has no effect on the corresponding weighted average of bilateral exchange rates for a basket of currencies from the same set of risky countries. In combination, these two results indicate that an unanticipated tightening of US monetary policy during the conventional regime widens credit spreads on risky sovereign debt directly through the financial channel, as opposed to indirectly through the deterioration in the quality of risky countries' balance sheets brought about the depreciation of their currencies against the US dollar.

Sovereign credit spreads for investment-grade countries, in contrast, do not respond to conventional US monetary policy; in other words, sovereign bond yields for low-risk countries are estimated to decline (increase) by about as much as the yields on comparable US Treasuries in response to a conventional US monetary policy easing (tightening). At the same time, the weighted average of bilateral exchange rates for a basket of currencies from countries with an investment-grade credit rating responds responds strongly to conventional US monetary policy, with unanticipated easings (tightenings) causing a substantial and statistically significant appreciation (depreciation) of local currencies against the US dollar. These findings indicate that conventional US monetary policy affects macroeconomic and financial conditions in low-risk countries primarily through its impact on bilateral exchange rates.

The US monetary policy spillovers to international bond markets during the unconventional policy regime are somewhat more muted, according to our estimates. An unanticipated easing (tightening) of US monetary policy during this period leads to a decrease (increase) in speculative-grade sovereign bond yields that is commensurate with that of yields on a portfolio of comparable US Treasuries. Similarly, the passthrough of unconventional US monetary policy to sovereign bond yields for investment-grade countries is essentially one-to-one, that is, the same as during the conventional policy regime. At the same time, an unanticipated easing (tightening) of US monetary policy during this period leads to a significant currency appreciation (depreciation) for countries in both investment- and speculative-grade sovereign bond portfolios. In fact, the response coefficients on the currency portfolios are larger by a factor of three—and statistically highly significant—for both sets of countries during the unconventional policy regime, compared with the response coefficients estimated for the conventional regime. Our analysis thus indicates that the unconventional policy actions undertaken by the FOMC between the end of 2008 and the end of 2015 did not systematically affect the level of sovereign credit spreads across the credit quality spectrum, despite the fact that those actions had economically large effects on the bilateral exchange rates of both low- and high-risk countries.

Lastly, we examine whether US monetary policy tightenings and easings have an asymmetric effect on international bond markets. In this exercise, we split the high-frequency US policy surprises according to their sign—that is, positive vs. negative—and then estimate the response of sovereign bond credit spreads to those two surprises. Interestingly, we find no evidence of such asymmetry—for both investment- and speculative-grade bond portfolios—during the conventional and unconventional US monetary policy regimes. Consistent with these results, we find no statistically significant asymmetry in the corresponding response of the weighted average of bilateral exchange rates for the basket of currencies associated with the two sovereign bond portfolios.

2 Related Literature

In part, our paper fits into a rapidly growing empirical literature aimed at quantifying the effects of unconventional policy measures on financial asset prices. Not too surprisingly, much of this research to date has analyzed whether purchases of large quantities of Treasuries, agency MBS, and agency debt by the Federal Reserve and various forms of forward guidance have lowered longer-term US benchmark yields and the associated private interest rates (see Gagnon, Raskin, Remache, and Sack, 2011; Krishnamurthy and Vissing-Jorgensen, 2011; Swanson, 2011; Hamilton and Wu, 2012; Justiniano, Evans, Campbell, and Fisher, 2012; Wright, 2012; D'Amico and King, 2013; Gilchrist and Zakrajšek, 2013; Gilchrist, López-Salido, and Zakrajšek, 2015; Hanson and Stein, 2015). While employing a variety of empirical approaches, a common finding that emerges from these studies is that the unconventional policy measures employed by the FOMC between the end of 2008 and the end of 2015 have led to a significant reduction in US Treasury yields and that this broad-based reduction in longer-term interest rates has been passed fully to lower borrowing costs for businesses and households in the United States.[4]

To gauge the impact of the Federal Reserve's asset-purchase programs beyond US borders, Neely (2015) employs an event-style methodology and finds that these unconventional policy actions substantially lowered the foreign exchange value of the US dollar and reduced longer-term yields yields for a small sample of advanced foreign economies; similar results for emerging market economies are reported by Chen, Mancini Griffoli, and Sahay (2014). In a follow-up paper, Bauer and Neely (2014) use dynamic term structure models to parse out the extent to which the declines in foreign interest rates occurred through the signaling or portfolio rebalancing channels and find evidence

[4] Rogers, Scotti, and Wright (2014), on the other hand, compares the efficacy of unconventional policy measures employed by the Bank of England, European Central Bank, and the Bank of Japan.

that both channels were in operation during the unconventional policy regime. Our paper is also related to the work of Fratzscher, Lo Duca, and Straub (2014) and Bowman, Londono, and Sapriza (2015); the former paper systematically analyzes the global spillovers of the Federal Reserve's asset purchase programs on a broad array of financial asset prices, while the latter study empirically quantifies the spillover effects of US unconventional policies on emerging market economies. The key takeaway of these two papers is that US unconventional monetary policy measures induced a significant portfolio reallocation among investors and led to a notable repricing of risk in global financial markets.[5]

In a recent paper, Albagli, Ceballos, Claro, and Romero (2018) document significant US monetary policy spillovers to international bond markets. The authors identify US monetary policy surprises using changes in short-term US Treasury yields within two days of FOMC meetings and trace the effects of those changes on foreign bond yields using panel regressions. Their key finding is that US monetary policy spillovers to longer-term foreign bond yields have increased substantially after the global financial crisis. The main difference with our paper is that Albagli, Ceballos, Claro, and Romero (2018) analyze sovereign bonds denominated in local currencies, whereas we focus on dollar-denominated sovereign bonds. Importantly, our US monetary policy surprises are much better identified because we use intraday data to compute changes in short-term US Treasury yields in narrow windows bracketing FOMC announcements. Also related is a study by Gagnon, Bayoumi, Londono, Sabarowski, and Sapriza (2017), who analyze the direct effects and cross-border spillovers of asset purchase programs and exchange rate policies employed by the major central banks in response to the global financial crisis. With regards to the unconventional policy measures employed by the Federal Reserve during this period, they find that policy-prompted increases in US bond yields are associated with increases in local currency foreign bond yields and equity prices, as well as with a depreciation of foreign currencies.

Our paper is also related to the research based on small open economy models that feature foreign interest rate shocks and some form of financial market frictions (see Neumeyer and Perri, 2005; Uribe and Yue, 2006). These papers show that movements in sovereign credit spreads are an important driver of business cycles dynamics in emerging market economies and that these spreads are influenced importantly by fluctuations in the world interest rate, namely, the long-term US Treasury yield (see also Kamin and von Kleist, 1999; Eichengreen and Mody, 2010). The analysis of these papers, however, uses monthly or quarterly changes in long-term US interest rates to estimate the spillover effects of US monetary policy to international bond markets. An important advantage of our approach is that we use high-frequency data to identify convincingly unanticipated changes in the stance of US monetary policy and to trace out the causal effect of those changes on sovereign credit spreads.

[5] Earlier work of Bredin, Hyde, and O'Reilly (2010), Ehrmann, Fratzscher, and Rigabon (2011), and Hausman and Wongswan (2011) documents the extent of spillovers in international bond markets resulting from the unanticipated changes in the conventional stance of US monetary policy.

3 Data Sources and Methods

This section lays out the measurement of US monetary policy surprises and the construction of our micro-level data set of dollar-denominated sovereign bonds.

3.1 US Monetary Policy

Central to our approach is the use of *intraday* data, from which we can directly infer monetary policy surprises associated with FOMC announcements. In combination with the daily data on sovereign bond yields, these high-frequency policy surprises allow us to estimate the causal effect of US monetary policy actions on foreign bond interest rates and spreads during both the conventional and unconventional policy regimes. This requires the dating of the two monetary policy regimes over our sample period, which runs from January 2, 1992, to March 29, 2019. We divide this period into two distinct regimes: (*i*) a *conventional* monetary policy regime, a period in which the primary policy instrument was the federal funds rate; and (*ii*) an *unconventional* monetary policy regime, during which the funds rate was stuck at the effective lower bound, and the FOMC primarily conducted monetary policy by altering the size and composition of the Federal Reserve's balance sheet and also by issuing various forms of forward guidance regarding the future trajectory for the federal funds rate.

As in Gilchrist, López-Salido, and Zakrajšek (2015), we assume that the unconventional policy regime began on November 25, 2008, and that prior to that day, the conventional policy regime was in effect.[6] The unconventional policy regime ended on December 16, 2015, with the liftoff of the federal funds rate from its effective lower bound. Thus, the conventional US monetary policy regime is assumed to cover two non-overlapping periods: from February 6, 1992, to December 15, 2008, and from December 17, 2015, to March 29, 2019. Virtually all of the 169 announcements during the conventional policy period followed regularly-scheduled FOMC meetings; only six were associated with the intermeeting policy moves.[7]

The standard analysis of how changes in the stance of conventional US monetary policy affect financial asset prices has historically relied on a single factor—the "target" surprise or the unanticipated component of the change in the current federal funds rate target (see, Kuttner (2001); Cochrane and Piazzesi (2002); and Bernanke and Kuttner (2005)). However, as shown by Gürkaynak, Sack, and Swanson (2005), this characterization is incomplete, and another factor—

[6]On November 25, 8:15 a.m. Eastern Standard Time, the FOMC announced—outside its regular meeting schedule—that it was going to initiate a program to purchase the direct obligations of, and mortgage-backed securities (MBS) issued by, the housing-related government-sponsored enterprises. A mere three weeks later, at the conclusion of its regular meeting on December 16, the FOMC announced that it was lowering the target federal funds rate to a range between 0 to 1/4 percent—its effective lower bound.

[7]As is customary, we excluded from the sample the announcement made on September 17, 2001, which was made when trading on major stock exchanges was resumed after it was temporarily suspended following the 9/11 terrorist attacks. The other six intermeeting moves occurred on April 18, 1994; October 15, 1998; January 3, 2001; April 18, 2001; January 22, 2008; and October 8, 2008. Most of the FOMC announcements took place at 2:15 p.m. (EST); however, announcements for the intermeeting policy moves were made at different times of the day. We obtained all of the requisite times from the Office of the Secretary of the Federal Reserve Board.

that is, changes in the future policy rates that are independent of the current target rate—is needed to capture fully the effect of conventional monetary policy. This second factor, which is commonly referred to as a "path" surprise, is closely associated with the FOMC statements that accompany changes in the target rate and represents a communication aspect of monetary policy that assumed even greater importance after the target rate was lowered to its effective lower bound in December 2008.

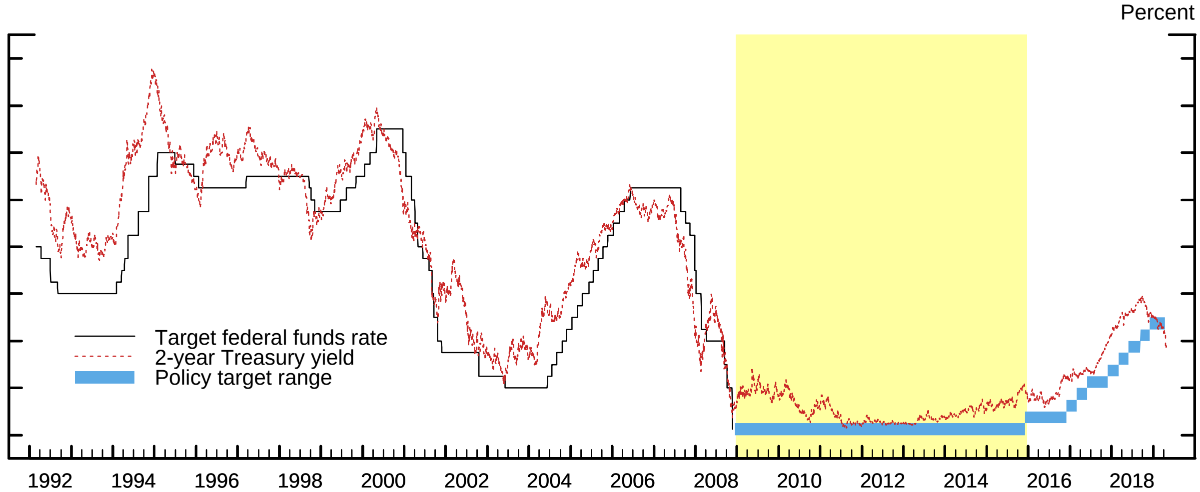
To facilitate the comparison of the spillover effects from conventional and unconventional US monetary policy, we follow Gilchrist, López-Salido, and Zakrajšek (2015) and assume that the change in the 2-year nominal (on-the-run) US Treasury yield over a narrow window bracketing an FOMC announcement—denoted by m_t^{US}—captures both aspects of US monetary policy. During the conventional US policy regime, we calculate the policy surprise m_t^{US} using a *30-minute* window surrounding FOMC announcements (10 minutes before to 20 minutes after). During the unconventional policy regime, the Federal Reserve implemented different forms of forward guidance regarding the future path of the federal funds rate. The FOMC also implemented a number of Large-Scale Asset Purchase programs (LSAPs), the primary goal of which was to influence longer-term yields on US Treasury and agency MBS securities through direct purchases of those assets. These policy actions were introduced to the public via announcements, either following the regularly-scheduled FOMC meetings or in special announcements that were held outside the regular FOMC schedule.

In these instances, we try to capture the information content of announcements that reflects the market participants' interpretation of the statements and speeches—as opposed to conveying information about the precise numerical value of the target funds rate—so we use a wider *60-minute* window bracketing an announcement (10 minutes before to 50 minutes after) to calculate the intraday changes in the 2-year US Treasury yield. The use of a 60-minute window to calculate the policy surprise m_t^{US} during this period should allow the market a sufficient amount of time to digest the news contained in announcements associated with unconventional policy measures.[8]

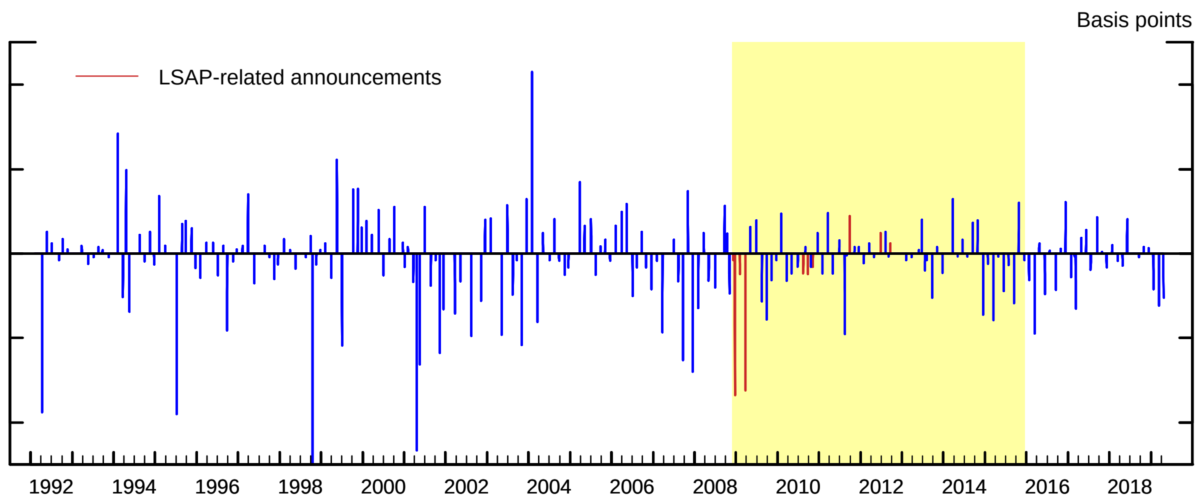
Panel A of Figure 1 shows the path of the target federal funds rate and the 2-year nominal US Treasury yield over the entire sample period. Our sample period is marked by substantial variation in shorter-term interest rates and contains a number of distinct phases of US monetary policy. The early part of the sample features the 1994–95 tightening phase that followed the "jobless" recovery of the early-1990s. Clearly evident is the tightening phase that preceded the bursting of the "tech bubble" in early 2001, and the subsequent easing of policy in response to a rapid slowdown in economic activity and the emergence of substantial disinflationary pressures. The latter part of our sample features the 2003–04 period of very low interest rates, followed by the gradual removal of monetary accommodation that commenced in the spring of 2004. Later on we see the aggressive reduction in the target federal funds rate during the early stages of the 2007–09 financial crisis, and the 2009–15 period when the federal funds rate was stuck at its effective lower bound. And lastly, our sample contains the post-2015 period of policy normalization, when the

[8]To separate the effect of balance sheet policies from other forms of unconventional policy, we also consider a subsample of the unconventional policy period that excludes the 12 announcements listed in Table A-1, which are most closely identified with the asset purchase programs. These results are available from the authors upon request.

Figure 1 – The Stance of US Monetary Policy



A. Selected interest rates



B. Monetary policy surprises

Note: Sample period: daily data from 01/02/1992 to 03/29/2019. The black line and the shaded band in Panel A depict the stance of US monetary policy, while the red line shows the daily 2-year Treasury yield. Panel B depicts unanticipated changes in the stance of monetary policy, as measured by the narrow-window changes in the 2-year Treasury yield bracketing FOMC announcements (see the text for details). The shaded region represents the unconventional US monetary policy regime (see Table A-1 in the Data Appendix for the list of LSAP-related announcements).
Source: For Panel A, Board of Governors of the Federal Reserve System, Statistical Release H.15, "Selected Interest Rates." For Panel B, Bloomberg Finance LP.

FOMC begun to raise gradually the range for target federal funds rate from its effective lower bound.

Panel B depicts the sequence of monetary policy surprises—the values of m_t^{US}—associated with the FOMC's actions during this period. Not too surprisingly, the largest (absolute) policy surprises during the conventional policy regime are associated with the intermeeting policy actions. Similarly, as shown by the red spikes, the largest (absolute) surprises during the unconventional policy regimes correspond to the early LSAP announcements. The key takeaway from this figure is our assumption that movements in the 2-year US Treasury yield in narrow windows bracketing FOMC announcements are entirely due to the unanticipated changes in the stance of US monetary policy. By any measure, this is a reasonable assumption because we are virtually certain that no other important economic news was released within that interval of time.[9]

3.2 Dollar-Denominated Sovereign Bonds

As noted above, our focus is on sovereign debt denominated in US dollars. To obtain a comprehensive coverage of this asset class, we downloaded from Thompson Reuters Datastream daily secondary market prices of dollar-denominated sovereign bonds issued by 95 countries, both advanced and emerging market economies (see Table A-2 in Appendix A for further details). We limit our sample to securities with a fixed coupon schedule and no embedded options. The variables include time-invariant bond characteristics such as the issuance and maturity dates, issue amount, coupon structure, as well as the daily time series of secondary market prices.

In addition to the large number of countries in our sample, our data set also appears to have a reasonable coverage of the countries' total dollar-denominated external debt. Specifically, for 34 major developing countries in our data set, World Bank's International Debt Statistics provide sufficient data to calculate their year-end outstanding dollar-denominated long-term debt issued by the public sector. For this set of countries, we computed the aggregate par value of dollar-denominated sovereign bonds at year-end in our sample, expressed as a share of the corresponding total outstanding dollar-denominated long-term debt issued by that country's public sector. For each country, we then computed the time-series average of this ratio, yielding a sample of 34 country-specific average shares. The average (median) share for this set of countries was 36 percent (34 percent), an indication that our data set likely captures a meaningful fraction of borrowing in dollar-denominated sovereign debt markets.

The micro-level aspect of our data allows us to compute bond yields at the security level. As a result, we can construct credit spreads that are free of the duration mismatch, which is a common problem in many of the standard sovereign credit spread indexes. Specifically, in our analysis, we follow the methodology outlined in Gilchrist and Zakrajšek (2012) and construct a synthetic US Treasury security that exactly replicates the cash-flows of the corresponding sovereign debt

[9]It is possible that other economic or political news or policy actions by foreign central banks might coincide with the US monetary policy surprises, especially during the unconventional policy regime; see Greenlaw, Hamilton, Harris, and West (2018) for a detailed analysis of major news events on the day when the US bond market had a big move during the unconventional policy regime. However, as documented by Albagli, Ceballos, Claro, and Romero (2018), while US monetary policy news is not always the only event moving US Treasury yields on FOMC announcement days, this is the case much more often than not—the overlap frequency between FOMC meetings and all other major country events is only about seven percent at the daily frequency. Our measure of US monetary policy surprises is based on yield changes over the 30- or 60-minute window bracketing FOMC announcements and thus is even less affected by such news. In our case, the impact of other news on international bond markets gets impounded in the error terms of our regressions, which would affect the precision of our estimates but not their consistency.

Table 1 – Selected Sovereign Bond Characteristics
(*Dollar-Denominated Bonds*)

Bond Characteristic	Mean	StdDev	Min	P50	Max
No. of bonds per country	18.40	47.64	1	8	454
Maturity at issue (years)	15.06	8.39	1.34	10.25	33
Term to maturity (years)	8.22	6.35	1	6.68	30
Duration (years)	6.05	3.54	0.91	5.51	18.87
Par amount ($millions)[a]	564.83	879.62	1.09	57.27	11,209
Sovereign credit rating (Moody's)	-	-	Ca	A1	Aaa
Coupon rate (pct.)	4.62	3.27	0.00	5.00	13.63
Nominal yield to maturity (pct.)	4.97	2.98	0.11	4.46	36.57
Credit spread (bps.)	224	255	−50	142	3,000

Note: Sample period: daily data from 01/02/1992 to 03/29/2019. No. of bonds = 1,748; No. of countries = 95; Observations = 1,888,320; see Table A-2 in Appendix A for the list of countries included in the sample. All reported statistics are based on trimmed data (see the text for details).
[a] The par amount issued is deflated by the US CPI (2005 = 100).

instrument. Formally, we consider a dollar-denominated sovereign bond k (issued by country i) that at time t is promising a sequence of cash-flows denoted by $\{C(s) : s = 1, 2, \dots, S\}$.[10] The price of this bond at time t is given by

$$P_{it}[k] = \sum_{s=1}^{S} C(s) D(t_s),$$

where $D(t_s) = \exp(-r_{t_s} t_s)$ denotes the discount function in period t. To calculate the price of the corresponding synthetic US Treasury security—as denoted by $P_t^{US}[k]$—we discount the cash-flow sequence $\{C(s) : s = 1, 2, \dots, S\}$ using continuously-compounded zero-coupon US Treasury yields in period t, which are obtained from the daily estimates of the US Treasury yield curve based on the methodology of Gürkaynak, Sack, and Wright (2007). The resulting price $P_t^{US}[k]$ can then be used to calculate the yield—denoted by $y_t^{US}[k]$—of a hypothetical US Treasury security with exactly the same cash-flows as the underlying sovereign bond. The resulting credit spread $s_{it}[k] = y_{it}[k] - y_t^{US}[k]$, where $y_{it}[k]$ denotes the yield of the sovereign bond k, is therefore free of the bias that would occur if the spreads had been computed simply by matching the sovereign yield to the estimated yield of a US Treasury security of the same maturity.

Table 1 contains the summary statistics for the key characteristics of bonds in our sample.[11] An average country in our sample has more than 18 sovereign bond issues outstanding at any point in time. However, this distribution is skewed significantly to the right by a few countries that have a

[10] The cash-flow sequence $\{C(s) : s = 1, 2, \dots, S\}$ consists of the regular coupon payments and the repayment of the principle at maturity.

[11] To ensure that our results are not driven by a small number of extreme observations, we have eliminated observations with credit spreads of less that -50 basis points and more than $3,000$ basis points. In addition, we dropped from our sample very small sovereign debt issues (par value of less than $1 million in 2005 dollars) and all observations with a remaining term-to-maturity of less than one year or more than 30 years.

very large number of issues trading in the secondary market at a point in time. In fact, the median country has only eight such issues trading in any given day.

The size distribution of the sovereign bond issues is similarly skewed, with the range running from \$1.1 million to more than \$11 billion. The maturity of these debt instruments is fairly long, with the average maturity at issue of about 15 years. In terms of default risk—as measured by the Moody's sovereign credit ratings—our sample spans a significant portion of the credit-quality spectrum. However, at "A1," the median observation is well within the investment-grade category. An average sovereign bond in our sample has an expected return of 224 basis points more than a comparable US Treasury security, while the standard deviation of 255 basis points is indicative of the wide range of sovereign credit risk—as perceived by the market—in our sample.

4 Empirical Methodology and Results

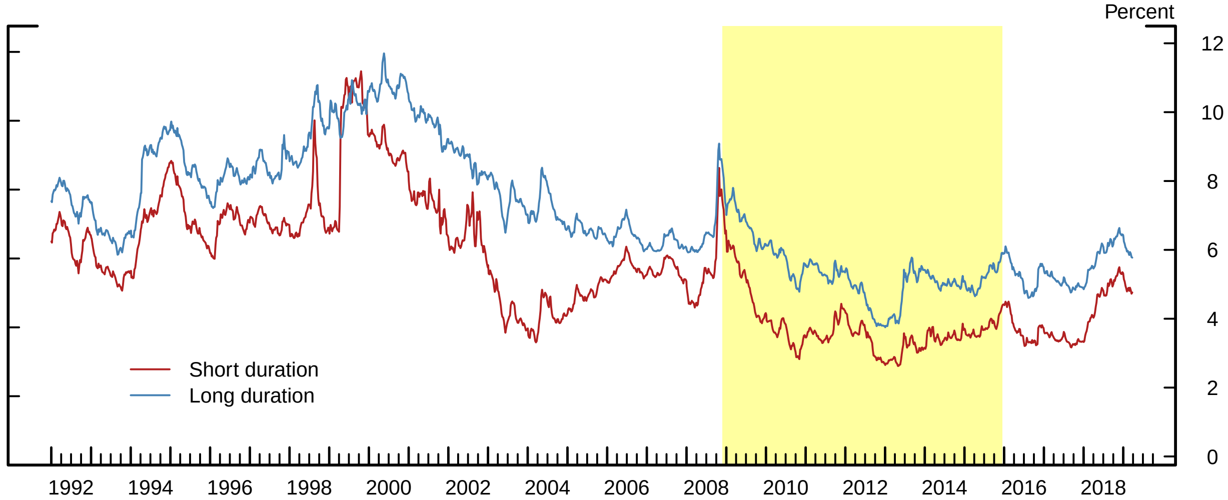
4.1 Sovereign Bond Portfolio Yields

We exploit the cross-sectional heterogeneity of our data by constructing sovereign bond portfolios, based on duration and credit risk. To construct the duration-specific portfolios, we sort bonds into short- and long-duration categories, based on whether the bond's duration (on day $t-1$) is above or below five years, a cutoff corresponding roughly to the median duration in our sample (see Table 1). In the case of sovereign credit risk, we sort bonds based on whether the issuing country has an investment- or speculative-grade credit rating (on day $t-1$). For each type of sovereign bond portfolio, the h-day change in the portfolio yield is then computed as a weighted average of the corresponding h-day changes of security-level yields in each portfolio, using market values of individual bond issues from day $t-1$ as weights. While finer gradations are possible, our sorting captures the salient differences that we observe in the data, while maintaining a significant number of bonds in each portfolio.[12]

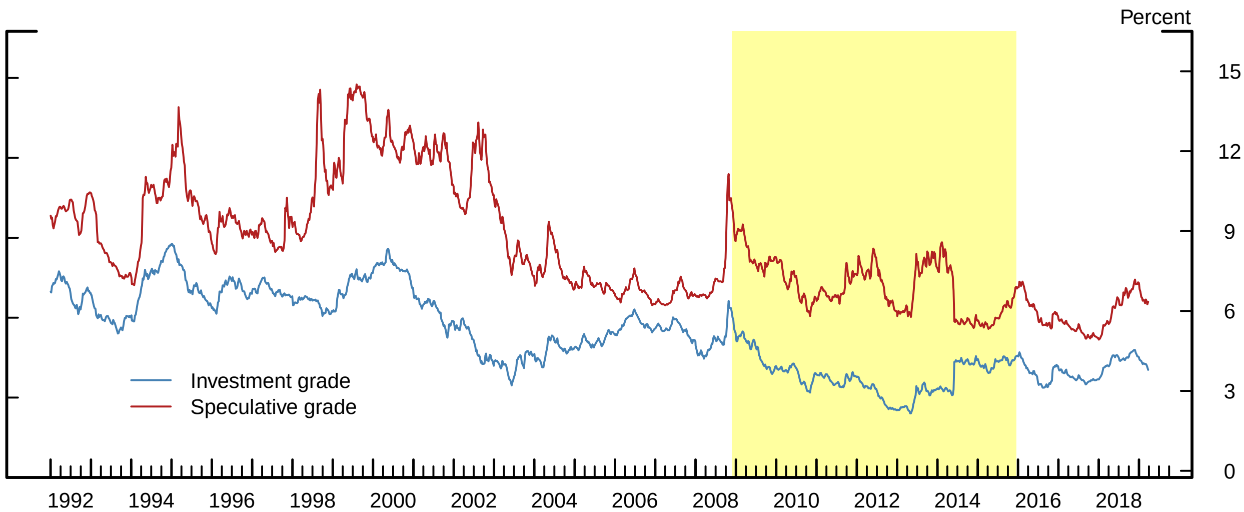
The solid line in Panel A of Figure 2 depicts the weighted average of bond yields across the short- and long-duration sovereign bond portfolios; the same information for the investment- and speculative-grade bond portfolios is shown in Panel B. Clearly there is considerable time-series variation in the yields of our sovereign bond portfolios. Panel A shows that sovereign bonds with longer duration have, in general, higher yields than those in our short-duration portfolio, except

[12] In Table A-2 of Appendix A, we report in column "Weight" the country-specific average share of the market value of bonds in our sample. The distribution varies considerably across our sample of countries, with the minimum (average) share of less than 0.01 percent for Thailand and the maximum (average) share of more than 10 percent for Brazil and Italy. And while a significant proportion of our sample of sovereign bonds is accounted for by securities issued by Israel, the Israel's average share is only about 2.5 percent. More generally, with the sample average of only 1.7 percent and standard deviation of 2.3 percent, it is clear that the dynamics of portfolio yields are not driven by a few countries who hold a disproportionate fraction of the market value of dollar-denominated sovereign bonds in our sample. In column "% in IG" of the same table, we report the fraction of time that each country in our sample spends in the investment-grade portion of the credit-quality spectrum. Reflecting the fact that sovereign credit ratings tend to be quite persistent, "0" or "100" are by far the most likely values of this variable. Nevertheless, sovereign credit ratings are not static, and the median country in our sample has an investment-grade rating for only about one-half of its tenure in the panel.

Figure 2 – Sovereign Bond Yields



A. By duration



B. By credit risk

Note: Sample period: weekly averages of daily data from 01/02/1992 to 03/29/2019. In Panel A, the two lines depict the yields on portfolios of dollar-denominated sovereign bonds of short (< 5 years) duration and long (≥ 5 years) duration. In Panel B, the two lines depict the yields on portfolios of dollar-denominated sovereign bonds with an investment- and speculative-grate ratings. The shaded region represents the unconventional US monetary policy regime.
Source: Authors' calculations using data from Thompson Reuters, Datastream Professional.

during the late 1990s and in 2008, when yields in both duration portfolios spiked to similar levels. According to Panel B, bonds issued by countries with a speculative-grade credit rating carry a substantially higher yield than their investment-grade counterparts. This difference reflects the additional risk premium for bonds with a lower credit rating, as well as possible differences in liquidity between investment- and speculative-grade sovereign securities, arising from ratings-based

Table 2 – The Effect of US Monetary Policy on Sovereign Bond Yields
(*h-day Changes in Duration-Based Bond Portfolio Yields*)

	Conventional MP[a]		Unconventional MP[b]	
Regressor	SD	LD	SD	LD
A. 2-day changes ($h = 2$)				
m_t^{US}	0.93***	0.85***	1.27***	1.19***
	(0.11)	(0.17)	(0.25)	(0.28)
$\Pr > E_p$[c]	<.01	<.01	<.01	<.01
R^2	0.23	0.17	0.27	0.25
B. 6-day changes ($h = 6$)				
m_t^{US}	1.21***	1.25***	1.46***	1.53**
	(0.21)	(0.32)	(0.48)	(0.58)
$\Pr > E_p$[c]	<.01	<.01	0.01	<.01
R^2	0.10	0.10	0.16	0.13

Note: The dependent variable is $\Delta_h y_{p,t+h-1}$, an h-day change (from day $t-1$ to day $t+h-1$) bracketing an FOMC announcement on day t in the specified bond portfolio yield: SD = portfolio of short duration (< 5 years) sovereign bonds; and LD = portfolio of long duration ($\geq$ 5 years) sovereign bonds. The explanatory variable in all specifications is m_t^{US}, an FOMC-induced surprise in the 2-year US Treasury yield. All specifications include a constant (not reported) and are estimated by OLS. Heteroskedasticity-consistent asymptotic standard errors are reported in parentheses: * $p < .10$; ** $p < .05$; and *** $p < .01$.
[a] 169 FOMC announcements (02/06/1992–12/15/2008 and 12/17/2015–03/20/2019).
[b] 65 FOMC announcements (12/16/2008–12/16/2015).
[c] p-value for the Doornik and Hansen (2008) test of the null hypothesis of normality of the OLS residuals.

market segmentation.[13]

We begin our empirical analysis by estimating the effect of US monetary policy surprises on sovereign bond yields in our portfolios. It is well known that during the conventional US monetary policy regime, an easing of policy is associated with declining US short-term market interest rates and a steepening of the yield curve. In contrast, during the unconventional regime, an easing of monetary policy is associated with a flattening of the yield curve, as short-term rates are anchored at their effective lower bound. Thus, a natural starting point is to document the extent to which US monetary policy affects foreign yields of different duration.

Specifically, we use OLS to estimate the following regression specification:

$$\Delta_h y_{p,t+h-1} = \alpha_p m_t^{US} + \epsilon_{p,t+h-1},$$

where $\Delta_h y_{p,t+h-1}$ denotes an h-day change in the sovereign bond portfolio yield associated with short- and long-duration sovereign bonds (i.e., $p =$ SD (short duration) and $p =$ LD (long duration)). The h-day yield change is calculated as the change in yield from day $t-1$ to day $t+h-1$, where

[13]To ameliorate conflicts of interests that are inherent in delegated asset management, many institutional investors face portfolio restrictions on speculative-grade debt instruments, which can lead to ratings-based market segmentation.

the yield is quoted at the market closing time of the relevant country. Given that our sample of countries covers many different time zones—and thus closing times differ across countries—we compute the h-day yield changes from day $t-1$ to day $t+h-1$, which ensures that the US policy surprise m_t^{US} occurred within that time interval. Our baseline horizon is two days (i.e., $h = 2$), but given the potentially illiquid nature of sovereign bonds, which would lead to a delayed yield response to US monetary policy announcements, we also consider the effect of policy surprises at the 6-day horizon (i.e., $h = 6$).

Table 2 presents the results for our duration-based bond portfolios. Panel A shows the results for the 2-day changes, and Panel B shows the corresponding results for the 6-day changes. According to the entries in Panel A, US monetary policy surprises impact sovereign bond yields across the duration spectrum. Our estimates imply that a policy action by the FOMC that raises the 2-year US Treasury yield 100 basis points leads to increases in dollar-denominated sovereign bond yields that are slightly less than 100 basis points during the conventional policy regime and somewhat more than 100 basis points during the unconventional regime. The results, however, do not imply significant differences in the sovereign bond yield responses across the two duration categories.

Regressions using the 6-day changes (Panel B) produce slightly bigger estimates. In our view, this increased responsiveness likely reflects the relative illiquidity of the dollar-denominated sovereign bond market. Again, the estimated effects are very similar across the two duration categories and imply larger point estimates of the response coefficients during the unconventional policy regime relative to the conventional regime, though these differences are not statistically significant. In broad terms, the results in Table 2 imply a robust and economically large response of foreign bond yields to US monetary policy and showcase a "level" effect, whereby sovereign yields are rising essentially one-for-one with a policy-induced increase in the 2-year US Treasury yield. In addition, we do not observe substantial differences in responses across the two US monetary policy regimes.[14]

The estimates of the spillover effects on sovereign bonds with different durations reflect not only the impact of the US monetary policy on the yield curve, but also the effects of policy changes on the risk premiums. To examine whether lower credit quality portfolios respond more or less than higher credit quality portfolios, we now consider the sovereign yield response for the portfolios sorted by credit risk. Table 3 reports OLS estimates of the coefficients measuring the effect of a US monetary policy surprise on sovereign bond yields of portfolios with investment- and speculative-grade credit ratings (i.e., p = IG (investment grade) and p = SG (speculative grade)). As before, Panel A of Table 3 shows the results at the 2-day horizon, and Panel B reports the results for the 6-day horizon.

In comparison to the portfolios sorted by duration, sorting by credit risk implies much larger differences in yield responses across credit risk categories and across monetary policy regimes. Specifically, during the conventional policy regime, the response coefficient on the portfolio of

[14]It is worth noting that Albagli, Ceballos, Claro, and Romero (2018) find that US monetary policy spillovers to long-term foreign yields have increased substantially after the global financial crisis. However, they study sovereign bonds denominated in local currencies, and their evidence evidence is thus consistent with the standard exchange rate channel, according to which foreign central banks face a tradeoff between narrowing policy rate differentials, or experiencing currency movements against the US dollar. Our analysis, in contrast, focuses on sovereign bonds denominated is US dollars, an asset class where the exchange rate channel does not have a direct effect.

TABLE 3 – The Effect of US Monetary Policy on Sovereign Bond Yields
(*h-day Changes in Credit-Risk-Based Bond Portfolio Yields*)

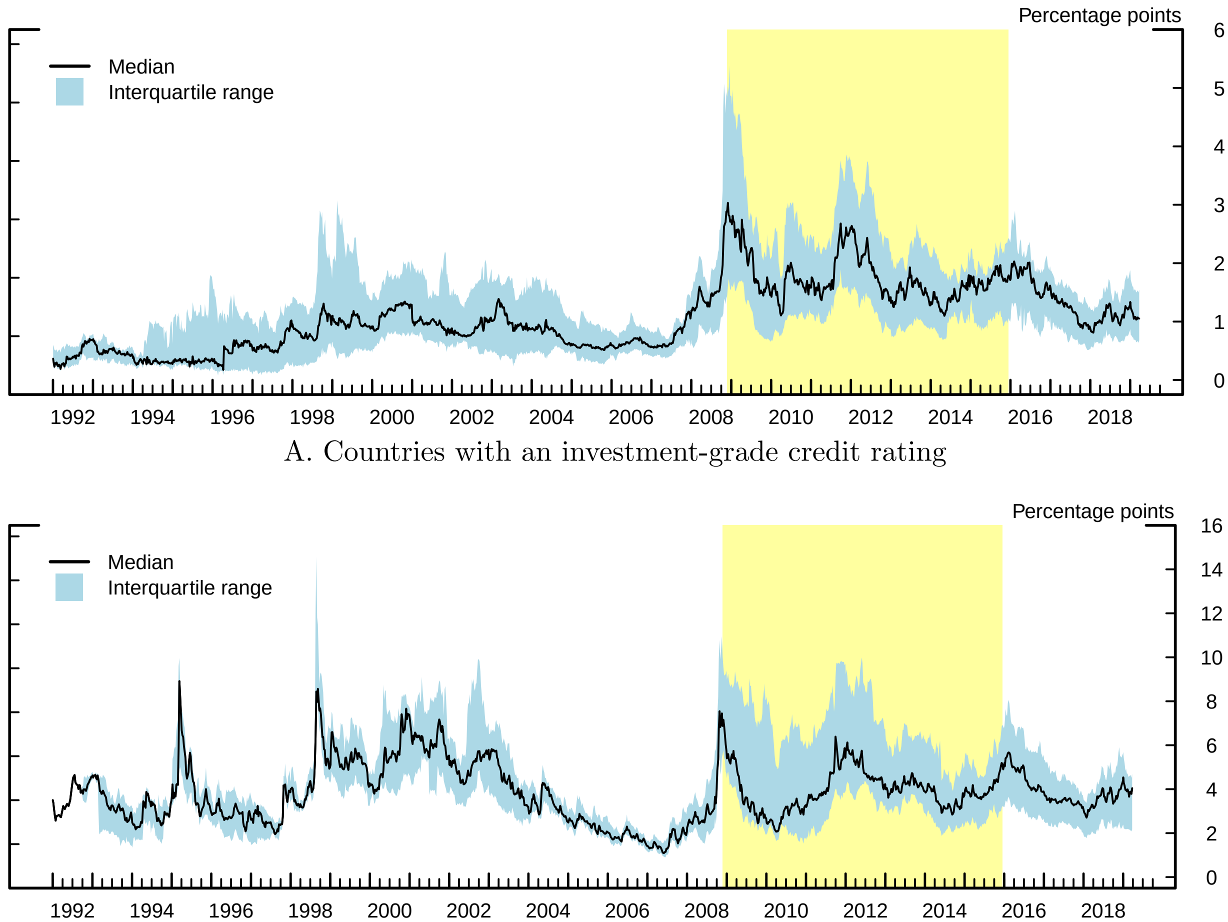
	Conventional MP[a]		Unconventional MP[b]	
Regressor	IG	SG	IG	SG
A. 2-day changes ($h = 2$)				
m_t^{US}	0.75***	1.07***	1.27***	1.13***
	(0.10)	(0.19)	(0.20)	(0.41)
$\Pr > E_p$[c]	<.01	<.01	<.01	<.01
R^2	0.25	0.15	0.38	0.12
B. 6-day changes ($h = 6$)				
m_t^{US}	0.77***	1.91***	1.60***	1.09
	(0.14)	(0.49)	(0.36)	(0.92)
$\Pr > E_p$[c]	<.01	<.01	<.01	0.01
R^2	0.10	0.09	0.23	0.03

NOTE: The dependent variable is $\Delta_h y_{p,t+h-1}$, an h-day change (from day $t-1$ to day $t+h-1$) bracketing an FOMC announcement on day t in the specified bond portfolio yield. IG = portfolio of sovereign bonds with an investment-grade credit rating; and SG = portfolio of sovereign bonds with a speculative-grade credit rating. The explanatory variable in all specifications is m_t^{US}, an FOMC-induced surprise in the 2-year US Treasury yield. All specifications include a constant (not reported) and are estimated by OLS. Heteroskedasticity-consistent asymptotic standard errors are reported in parentheses: * $p < .10$; ** $p < .05$; and *** $p < .01$.
[a] 169 FOMC announcements (02/06/1992–12/15/2008 and 12/17/2015–03/20/2019).
[b] 65 FOMC announcements (12/16/2008–12/16/2015).
[c] p-value for the Doornik and Hansen (2008) test of the null hypothesis of normality of the OLS residuals.

investment-grade sovereign bonds is estimated to be 0.75, implying that lower-risk sovereign bond yields respond significantly less than one-for-one to policy-induced changes in the 2-year US Treasury yield. In contrast, the estimated response coefficient on the portfolio of speculative-grade sovereign bonds is considerably larger, especially at the 6-day horizon; in that case, our estimates imply that a US monetary policy action that raises the 2-year Treasury yield 100 basis points leads to an increase of almost 200 basis points in the speculative-grade bond portfolio yield.

During the unconventional policy regime, however, this pattern reverses itself, as yields on speculative-grade sovereign bonds appear less responsive to US monetary policy, compared with yields on investment-grade sovereign bonds. Likely reflecting the smaller sample size, the response coefficients based on this sample period are estimated with considerably less precision, especially for the 6-day changes in speculative-grade sovereign bond yields. Moreover, the clear pattern that speculative-grade sovereign bond yields are more responsive to US monetary policy actions than their investment-grade counterparts that was seen during the conventional policy regime no longer appears to hold during the unconventional US monetary policy regime.

Figure 3 – Sovereign Credit Spreads



A. Countries with an investment-grade credit rating

B. Countries with a speculative-grade credit rating

Note: Sample period: weekly averages of daily data from 01/02/1992 to 03/29/2019. The solid line in Panel A depicts the median credit spread across country-specific portfolios of dollar-denominated sovereign bonds with an investment-grade credit rating, while the shaded bands denotes the corresponding interquartile (P75–P25) range. Panel B shows the same information for countries with a speculative-grade sovereign credit rating. The shaded region represents the unconventional US monetary policy regime.
Source: Authors' calculations using data from Thompson Reuters, Datastream Professional.

4.2 Sovereign Bond Portfolio Credit Spreads

The above analysis shows that during the conventional US monetary policy regime, yields on speculative-grade sovereign bonds respond more to US monetary policy surprises than the yields on investment-grade sovereign bonds and that this pattern does not hold during the unconventional regime. These findings suggest that, at least during the conventional policy regime, US monetary policy may have a strong impact on sovereign credit risk, especially for emerging market economies, which are frequently in the speculative-grade portion of the credit-quality spectrum.

To further analyze this issue, we now exploit our rich micro-level data to construct duration-matched portfolios of corresponding synthetic US Treasury securities, once again conditional on the sovereign's credit rating. The difference between these portfolio yields provides a measure of the spread on the sovereign yield relative to the yield on US Treasuries with matched payout characteristics. The solid line in Panel A of Figure 3 depicts the cross-sectional median of sovereign credit spreads across the investment-grade country portfolios, while the shaded band represents the corresponding interquartile range; the same information for the speculative-grade country portfolios is shown in Panel B.

Clearly there is considerable cross-sectional and time-series variation in the sovereign bond portfolios in both credit rating categories. Sovereign credit spreads for riskier countries spiked up during the Mexican peso crisis that started in December 1994, as investors fled, not only Mexico, but emerging markets in general. In contrast, the jump in spreads during the Asian financial crisis in mid-1997 was noticeably less severe. The Russian financial crisis during the late summer of 1998 also led to "financial contagion," in the sense that sovereign spreads of speculative-grade countries increased sharply. Note that during these international financial crises, credit spreads on dollar-denominated sovereign bonds issued by countries with an investment-grade rating barely budged.

The collapse of Lehman Brothers on September 15, 2008, an event that sparked a world-wide financial panic, sent spreads sharply higher for both investment- and speculative-grade sovereign credits. Consistent with previous international financial crises, the cross-sectional dispersion of credit spreads also widened significantly and remained high in both credit rating categories for the remainder of our sample period. The effects of the European debt crisis that started at the end of 2009 and intensified in early 2010 and thereafter are especially evident in the elevated and volatile investment-grade sovereign spreads, as it took some time for the periphery eurozone countries at the center of the crisis to be downgraded to "junk" status. Especially during this period, the impact of US unconventional monetary policy on advanced and emerging market economies became a hotly debated topic in global and national policy circles.

We begin the analysis by estimating the effect of a US monetary policy surprise on sovereign yields and the yields for the matched US Treasury portfolios. Specifically, we use OLS to estimate the following system of equations:

$$\begin{aligned} \Delta_h y_{p,t+h-1} &= \alpha_p m_t^{US} + \epsilon_{p,t+h-1}; \\ \Delta_h y_{p,t+h-1}^{US} &= \beta_p m_t^{US} + \nu_{p,t+h-1}, \end{aligned}$$

where $\Delta_h y_{p,t+h-1}$ denotes an h-day change (from day $t-1$ to day $t+h-1$) in the sovereign bond portfolio yield associated with credit quality $p = \text{IG}$ (investment grade) and $p = \text{SG}$ (speculative grade), and $\Delta_h y_{p,t+h-1}^{US}$ is the corresponding h-day change in the yield on a matched portfolio of synthetic US Treasuries. The response of the sovereign credit spreads to US monetary policy surprises may then be directly inferred from the difference in response between these two portfolio yields; that is, $\alpha_p - \beta_p$, for $p = \text{IG}$ and SG.

To better understand the channels through which US monetary policy affects sovereign credit

Table 4 – The Effect of US Monetary Policy on Sovereign Credit Risk
(*2-day Changes in Bond Portfolio Yields*)

	Conventional MP[a]		Unconventional MP[b]	
Dependent Variables	m_t^{US}	R^2	m_t^{US}	R^2
Credit spread – IG	0.05		0.03	
	(0.09)		(0.28)	
Credit spread – SG	0.53***		−0.28	
	(0.18)		(0.48)	
Memo:				
Sovereign yield – IG	0.75***	0.25	1.27***	0.38
	(0.10)		(0.20)	
Sovereign yield – SG	1.07***	0.15	1.13***	0.18
	(0.19)		(0.41)	
US Treasury yield – IG	0.69***	0.16	1.24***	0.27
	(0.10)		(0.27)	
US Treasury yield – SG	0.53***	0.10	1.41***	0.28
	(0.12)		(0.31)	
Exchange rate – IG	3.96***	0.13	12.68***	0.33
	(0.86)		(2.71)	
Exchange rate – SG	0.58	0.00	4.44***	0.16
	(1.29)		(1.27)	

Note: The dependent variables are 2-day changes (from day $t-1$ to day $t+1$) bracketing an FOMC announcement on day t in the specified financial indicator: Sovereign yield – IG = 2-day change in the yield on the portfolio of sovereign bonds with an investment-grade (IG) credit rating; and Sovereign yield – SG = 2-day change in the yield on the portfolio of sovereign bonds with a speculative-grade (SG) rating. US Treasury yield (IG/SG) corresponds to a 2-day change in the yield on the portfolio of synthetic US Treasury securities of identical duration as the sovereign bonds in the (IG/SG) portfolios. Exchange rate (IG/SG) corresponds to a 2-day return on the portfolio of currencies (against the US dollar), with identical weights as those in the sovereign bond (IG/SG) portfolios. The entries denote the OLS estimates of the portfolio-specific response coefficients to m_t^{US}, an FOMC-induced surprise in the 2-year US Treasury yield. The response of the sovereign credit spreads for the IG and SG credit risk categories is computed as the difference between the estimated response of sovereign bond yields and the estimated response of US Treasury yields in the matched portfolio of US Treasuries in that credit risk category. All specifications include a constant (not reported). Heteroskedasticity-consistent asymptotic standard errors are reported in parentheses: * $p < .10$; ** $p < .05$; and *** $p < .01$.

[a] 169 FOMC announcements (02/06/1992–12/15/2008 and 12/17/2015–03/20/2019).

[b] 65 FOMC announcements (12/16/2008–12/16/2015).

risk, we also construct the corresponding investment- and speculative-grade foreign currency portfolios. Specifically, we compute portfolio currency returns, denoted by $\Delta_h e_{p,t+h-1}$, as a weighted average of the h-day changes (from day $t-1$ to day $t+h-1$) in the logarithm of bilateral exchange rates for the same set of countries that are in the sovereign bond portfolio of credit quality p = IG and SG, where the weights are equal to the corresponding market values of individual bond issues on day $t-1$. The response of returns on these matched foreign currency portfolios to US monetary policy surprises allows to examine the extent to which policy-induced fluctuations in sovereign credit spreads are due to indirect effects through the conventional exchange rate channel as opposed to the direct financial spillover channel.

Table 4 documents the effect of a policy-induced increase in the 2-year US Treasury yield on the 2-day changes in the investment- and speculative-grade sovereign credit spreads (Credit spread – IG/SG). In the *Memo* items, we report the estimated responses of the corresponding bond portfolio yields (Sovereign yield – IG/SG), their matched US Treasury equivalents (US Treasury yield – IG/SG), and the matched foreign currency returns (Exchange rate – IG/SG). We again conduct a separate analysis for the conventional and unconventional US monetary policy regimes.

According to the entries in the table, a conventional policy-induced increase in the 2-year US Treasury yield of 100 basis points leads to an increase of 107 basis points in the speculative-grade bond portfolio yield and an increase of 75 basis points in the investment-grade bond portfolio yield; both of these effects are statistically significant at the 1 percent level. Over the same two days, the respective yields on the matched portfolios of US Treasuries are estimated to increase 53 basis points for the speculative-grade portfolio and 69 basis points for the investment-grade portfolio. The implied credit spread response is thus 53 basis points for the speculative-grade portfolio and a mere 5 basis points for the investment-grade portfolio. The standard errors associated with these responses indicate that the credit spread response for speculative-grade sovereign bonds is statistically different from zero at the 5 percent level, while the response for their investment-grade counterparts is statistically indistinguishable from zero. Thus, during the conventional policy regime, a US monetary policy easing that induces a decrease (increase) in the 2-year US Treasury yield of 100 basis points narrows (widens) credit spreads on speculative-grade sovereign bonds by about 50 basis points, but has essentially no effect on investment-grade sovereign credit spreads.

Interestingly, conventional US monetary policy has no effect on the corresponding weighted average of bilateral exchange rates for a basket of currencies from the same set of speculative-grade countries. The results in Table 4 thus indicate that an unanticipated tightening of US monetary policy during the conventional regime widens credit spreads on risky sovereign debt directly through the financial channel, as opposed to indirectly through the deterioration in the quality of risky countries' balance sheets brought about the depreciation of their currencies against the US dollar. All told, these results are consistent with the notion that conventional US monetary policy has a direct impact on international bond markets by changing foreign investment-grade yields one-for-one with US Treasury yields and has an additional impact on the riskier sovereigns through its effect on the credit risk premium.

Turning to the effects of unconventional US monetary policy actions, we again observe an economically important and statistically significant response in the 2-day change of both sovereign and matched US Treasury portfolio yields to US monetary policy surprises. Consistent with our earlier findings, the responses of the sovereign bond portfolio yields and the yields on comparable US Treasuries are substantially greater than those we estimate for the conventional policy regime. Because during the unconventional regime, an unanticipated US monetary policy easing reduces US longer-term yields more than their short-term counterparts, this finding reflects the fact that the portfolios of US Treasury securities with matched payout characteristics of investment- and speculative-grade sovereign bond portfolios are of significantly longer duration than the 2-year

US Treasury note.

Taking the difference of responses between the sovereign bond portfolio yields and the matched US Treasury yields allows us to infer the response of sovereign credit spreads to an unanticipated change in the unconventional stance of US monetary policy. In contrast to the conventional policy regime, there is no statistically significant response in the credit spread on speculative-grade sovereign bonds during the unconventional policy regime. As before, the estimated response of the credit spread for investment-grade sovereign bonds is zero, both economically and statistically. Thus, during the unconventional policy regime, US monetary policy had a direct effect on both investment- and speculative-grade sovereign debt by reducing yields on comparable US Treasuries, which were then transmitted one-for-one to yields on dollar-denominated sovereign bonds. Those policy actions, however, had no additional effect on the credit risk premium in the sovereign bond market. In addition, while unconventional easings (tightenings) of US monetary policy led to a significant depreciation (appreciation) of currencies in the two sovereign bond portfolios, those policy-induced fluctuations in bilateral exchange rates did not appear to affect the pricing of sovereign default risk during this period.

Given the potentially illiquid nature of dollar-denominated sovereign bonds, which would likely lead to a delayed yield response to US monetary policy announcements, we now consider the effect of a US monetary policy surprise using 6-day changes in the sovereign bond portfolio yields and the yields on the matched portfolios of US Treasuries; we also examine the response of foreign currency portfolio returns over the same 6-day horizon. These results are summarized in Table 5.

During the conventional policy regime, the response of speculative-grade sovereign yields is substantially greater at the 6-day horizon than at the 2-day horizon (the point estimate of 1.91 vs. 1.07). In contrast, the response of investment-grade sovereign yields is essentially the same at both horizons. This suggests that there is some price discovery that takes place over the 6-day horizon, or that it takes several days for illiquidity in the speculative-grade segment of the sovereign debt market to dissipate. The response of yields on the matched portfolios of US Treasury securities, by contrast, is attenuated at the 6-day horizon relative to the 2-day horizon. Consequently, when we allow for the longer horizon, the response of credit spreads to a conventional US monetary policy surprise becomes larger in absolute value, and it is statistically significant for both investment- and speculative-grade sovereign bonds. In this case, a policy-induced decrease (increase) of 100 basis points in the 2-year US Treasury yield implies a narrowing (widening) of credit spreads on speculative-grade sovereign bonds of about 150 basis points and a decrease (increase) of about 30 basis points in credit spreads on investment-grade sovereign bonds; note that both of these estimates are statistically significant at the 1 percent level.[15]

These findings likely reflect the confluence of two factors. First, a decline in benchmark risk-free interest rates could lead to narrower sovereign credit spreads because it improves the creditworthi-

[15] Note that the response of currency returns in the two portfolios also show attenuation to conventional US policy surprises at the 6-day horizon. This result likely reflects the greater efficiency of foreign currency markets, where new information is impounded into prices almost instantaneously, compared with the dollar-denominated sovereign bond market, where price discovery occurs over several days.

Table 5 – The Effect of US Monetary Policy on Sovereign Credit Risk
(*6-day Changes in Bond Portfolio Yields*)

	Conventional MP[a]		Unconventional MP[b]	
Dependent Variables	m_t^{US}	R^2	m_t^{US}	R^2
Credit spread – IG	0.29***		0.21	
	(0.09)		(0.38)	
Credit spread – SG	1.53***		−0.59	
	(0.47)		(0.87)	
Memo:				
Sovereign yield – IG	0.77***	0.10	1.60***	0.23
	(0.14)		(0.36)	
Sovereign yield – SG	1.91***	0.09	1.09	0.03
	(0.49)		(0.90)	
US Treasury yield – IG	0.49***	0.05	1.39***	0.18
	(0.14)		(0.22)	
US Treasury yield – SG	0.38**	0.02	1.67***	0.23
	(0.15)		(0.21)	
Exchange rate – IG	0.49	0.00	6.94**	0.07
	(1.29)		(3.27)	
Exchange rate – SG	1.52	0.01	3.77	0.04
	(1.56)		(2.74)	

Note: The dependent variables are 6-day changes (from day $t-1$ to day $t+5$) bracketing an FOMC announcement on day t in the specified financial indicator: Sovereign yield – IG = 6-day change in the yield on the portfolio of sovereign bonds with an investment-grade (IG) credit rating; and Sovereign yield – SG = 6-day change in the yield on the portfolio of sovereign bonds with a speculative-grade (SG) rating. US Treasury yield (IG/SG) corresponds to a 6-day change in the yield on the portfolio of synthetic US Treasury securities of identical duration as the sovereign bonds in the (IG/SG) portfolios. Exchange rate (IG/SG) corresponds to a 6-day return on the portfolio of currencies (against the US dollar), with identical weights as those in the sovereign bond (IG/SG) portfolios. The entries denote the OLS estimates of the portfolio-specific response coefficients to m_t^{US}, an FOMC-induced surprise in the 2-year US Treasury yield. The response of the sovereign credit spreads for the IG and SG credit risk categories is computed as the difference between the estimated response of sovereign bond yields and the estimated response of US Treasury yields in the matched portfolio of US Treasuries in that credit risk category. All specifications include a constant (not reported). Heteroskedasticity-consistent asymptotic standard errors are reported in parentheses: * $p < .10$; ** $p < .05$; and *** $p < .01$.

[a] 169 FOMC announcements (02/06/1992–12/15/2008 and 12/17/2015–03/20/2019).

[b] 65 FOMC announcements (12/16/2008–12/16/2015).

ness of riskier countries. Second, international investors' attempts to enhance portfolio returns in a low interest rate environment—by increasing their credit risk exposure—could also put downward pressure on credit spreads on sovereign debt issued by riskier countries. While intuitive, our results stand in sharp contrast to those from the earlier literature, which found than an increase (decrease) in US shorter-term interest rates led to a narrowing (widening) of sovereign credit spreads, especially for the emerging market economies (see Kamin and von Kleist, 1999; Eichengreen and Mody, 2010; Uribe and Yue, 2006). Importantly, papers in this literature rely on monthly or quarterly changes in US interest rates to estimate the spillover effects of US monetary policy to international bond markets. Our analysis, in contrast, highlights the importance of using high-frequency data to identify the unanticipated changes in the conventional stance of US monetary policy and to trace out the causal effect of these changes on sovereign credit spreads.

During the unconventional policy regime, our coefficient estimates imply a modest increase in the response of both investment- and speculative-grade sovereign bond yields at the 6-day horizon compared with the 2-day horizon. In contrast, there is a substantially more pronounced response of portfolio yields on comparable US Treasuries over the 6-day horizon relative to the 2-day horizon. The combination of these two forces again implies no statistically significant effect of a US monetary policy surprise on sovereign credit spreads during the unconventional policy regime. These estimates reinforce the finding that US monetary policy easings (tightenings) do not lead to a statistically significant narrowing (widening) of sovereign credit spreads during the unconventional policy regime.

Although we do not offer a full explanation for why the response of sovereign credit spreads to US monetary policy differs across the conventional and unconventional policy regimes, we suggest two possible reasons why there may be attenuation in the response of credit spreads to unconventional policy actions. The first is the recognition that there is a substantially greater cross-country dispersion in sovereign credit spreads during the unconventional regime (see Figure 3). This heightened dispersion suggests that country-specific idiosyncratic factors may have played a larger role in determining sovereign credit risk during this period. In turn, this implies an attenuation of the response of sovereign credit spreads to unconventional US monetary policy actions.

A second concern, discussed by Greenlaw, Hamilton, Harris, and West (2018), is the fact that unconventional monetary policy primarily relies on forward guidance to convey its policy stance. Implementation of monetary policy through forward guidance may lead to greater scope for policy announcements to convey both the policy stance, as well as the monetary authority's perception of the state of the economy. To the extent that rising yields partly capture positive outlook conveyed by the monetary authority regarding the state of the economy, we expect to see an increase in risky asset prices in response to rising US Treasury yields during FOMC announcements. Such a mechanism also implies an attenuation of the response of sovereign credit spreads to policy-prompted changes in US Treasury yields on FOMC announcement days.[16]

4.3 Micro-Level Sovereign Credit Spreads

To further examine the response of sovereign credit spreads to US monetary policy actions, we now consider estimates of the response coefficients based on the micro-level data, an approach that allows us to directly control for potential liquidity concerns by including an interaction between the monetary policy surprise and bond characteristics that influence liquidity premiums. In addition to explicitly controlling for observable liquidity characteristics, the panel data analysis may be viewed as providing the equivalent of an equally-weighted portfolio analysis.

[16]The possibility that high-frequency policy surprises contain information about both the stance of monetary policy and the central bank's assessment of the economic outlook is explored in a recent paper by Jarociński and Karadi (2019). How US monetary policy surprises that are purged of such "information shocks" affect foreign interest rates is an interesting question that we leave for future research.

Formally, we estimate the following regression specification:

$$\Delta_h s_{i,t+h-1}[k] = \beta_{IG} m_t^{US} \times \mathbf{1}[\text{RTG}_{i,t-1} \in \text{IG}] + \beta_{SG} m_t^{US} \times \mathbf{1}[\text{RTG}_{i,t-1} \in \text{SG}] \\ + \boldsymbol{\theta}' \mathbf{x}_{i,t}[k] \times m_t^{US} + \epsilon_{i,t+h-1}[k],$$

where $\Delta_h s_{i,t+h-1}[k] \equiv \Delta_h y_{i,t+h-1}[k] - \Delta_h y_{t+h-1}^{US}[k]$, is the h-day change in the credit spread on sovereign bond k (issued by country i). The 0/1-indicator variable $\mathbf{1}[\text{RTG}_{i,t-1} \in p]$ equals 1 if country i's sovereign credit rating at $t-1$ falls into the $p = \text{IG}$ and SG credit rating category and 0 otherwise, and $\mathbf{x}_{i,t}[k]$ is a vector of (pre-determined) bond characteristics that likely influence the liquidity of the bond issue k. Specifically, $\mathbf{x}_{i,t}[k]$ consists of $\ln \text{PAR}_i[k]$, $\ln(1 + \text{AGE}_{i,t}[k])$, $\ln(1 + \text{COUP}_i[k])$, and $\ln \text{DUR}_{i,t-1}[k]$, where $\text{PAR}_i[k]$ is the inflation-adjusted size of the sovereign bond issue, $\text{AGE}_{i,t}[k]$ is the age (in days) of the issue, $\text{COUP}_i[k]$ is the fixed coupon rate, and $\text{DUR}_{i,t}[k]$ is the bond's duration. These characteristics are interacted with the policy surprise m_t^{US} and thus control for the fact that a portion of the credit spread response may reflect movements in liquidity premium that is a function of the specified observable bond characteristics.

We use OLS to estimate the response coefficients β_{IG} and β_{SG}. To take into account cross-sectional dependence in the disturbance term $\epsilon_{i,t+h-1}[k]$ arising from the fact that our sample consists of FOMC announcement days only, as well as the fact that error terms of bonds issues by the same country are likely to be correlated, we report asymptotic standard errors clustered across time (t) and countries (i), which are computed according to Cameron, Gelbach, and Miller (2011). Panels A and B of Table 6 reports the estimated effects of US monetary policy surprises for the 2- and 6-day changes in sovereign credit spreads, respectively.

Consistent with the view that a portion of the credit spread response to US monetary policy surprises may be attributed to a liquidity premium that varies with issue size and other bond characteristics, the panel-data estimates imply a smaller response of credit spreads to policy surprises during the conventional regime relative to those obtained from the aggregate portfolio analysis. The point estimate of the response coefficient on the 2-day changes in speculative-grade credit spreads (column 1 in Panel A) declines from 0.53, when estimated at the portfolio level, to 0.37 when estimated using the bond-level data. Similarly, the point estimate of the response coefficient on the 6-day changes in speculative-grade sovereign credit spreads (column 1, Panel B) falls from 1.53 to 0.88. Note that in both cases, the estimates of the response coefficients remain statistically highly significant. As shown in column (2), these estimates are robust to the inclusion of country fixed effects, which control for the unobservable (time-invariant) country-specific factors that may influence the response of speculative-grade sovereign credit spreads to US monetary policy surprises (e.g., geographic proximity to the United States).

In summary, the panel-data estimates reported in Table 6 do not change our earlier conclusion that unanticipated changes in the stance of conventional US monetary policy have an economically and statistically significant effect on speculative-grade sovereign credit spreads, but that these policy changes do not affect investment-grade sovereign credit spreads. The results reported in the table also confirm our above finding that during the recent unconventional policy regime, US monetary

Table 6 – The Effect of US Monetary Policy on Sovereign Credit Risk
(*h-day Changes in Bond-Level Credit Spreads*)

	Conventional MP[a]		Unconventional MP[b]	
Regressor	(1)	(2)	(3)	(4)
A. 2-day changes ($h = 2$)				
$\beta_{IG} m_t^{US} \times \mathbf{1}[\text{RTG}_{i,t-1} \in \text{IG}]$	0.06	0.07	−0.20	−0.19
	(0.09)	(0.09)	(0.21)	(0.22)
$\beta_{SG} m_t^{US} \times \mathbf{1}[\text{RTG}_{i,t-1} \in \text{SG}]$	0.37**	0.37**	−0.39	−0.42
	(0.15)	(0.15)	(0.27)	(0.28)
Country FE	N	Y	N	Y
$\Pr > W$[c]	0.03	0.03	0.07	0.05
R^2	0.01	0.02	0.01	0.02
B. 6-day changes ($h = 6$)				
$\beta_{IG} m_t^{US} \times \mathbf{1}[\text{RTG}_{i,t-1} \in \text{IG}]$	0.21	0.21	−0.06	−0.05
	(0.22)	(0.21)	(0.20)	(0.24)
$\beta_{SG} m_t^{US} \times \mathbf{1}[\text{RTG}_{i,t-1} \in \text{SG}]$	0.88**	0.93**	−0.53	−0.56
	(0.38)	(0.37)	(0.39)	(0.42)
Country FE	N	Y	N	Y
$\Pr > W$[c]	0.01	<.01	0.05	0.05
R^2	0.02	0.06	0.01	0.01

Note: The dependent variable is $\Delta_h s_{i,t+h-1}[k]$, an h-day change (from day $t-1$ to day $t+h-1$) bracketing an FOMC announcement on day t in the credit spread on sovereign bond k issued by country i. The explanatory variables are m_t^{US}, a US policy-induced surprise in the 2-year US Treasury yield, interacted with the country's sovereign credit rating indicator: IG = investment grade and SG = speculative grade. The response coefficients on m_t^{US} are evaluated at the sample mean of the bond-specific characteristics. All specifications include a constant (not reported) and are estimated by OLS. Robust asymptotic standard errors reported in parentheses are clustered in the i and t dimensions (see Cameron, Gelbach, and Miller, 2011): * $p < .10$; ** $p < .05$; and *** $p < .01$.
[a] 169 FOMC announcements (02/06/1992–12/15/2008 and 12/17/2015–03/20/2019). No. of bonds = 992; No. of countries = 80; and Observations = 27,890.
[b] 65 FOMC announcements (12/16/2008–12/16/2015). Panel dimensions: No. of bonds = 1,237; No. of countries = 89; and Observations = 36,546.
[c] p-value for the test of the null hypothesis that the response coefficients on m_t^{US} are equal across the IG and SG credit risk categories.

policy surprises had, on average, no effect on sovereign credit spreads.

4.4 Asymmetric Spillovers of US Monetary Policy

An important concern among policymakers across the globe is the extent to which an easing of monetary policy may lead to increased risk taking in the form of compression of spreads on risky debt. This concern became especially acute in the years immediately following the 2008–09 global financial crisis, a period marked by a surge in capital flows to emerging market economies. At that time, a number of policymakers, academic economists, and financial market participants argued that these flows were contributing to loose financial conditions, excessive credit growth, and undesired exchange rate appreciation in the recipient countries. Because those flows were occurring against a backdrop of aggressive expansion of balance sheets by central banks in major advanced economies, a narrative emerged, arguing that these unconventional monetary policy measures were an especially important and potentially destabilizing driver of capital flows to emerging market economies (see Rajan, 2016).

In this section, we investigate whether US monetary policy easings and tightenings have an asymmetric effect on sovereign credit risk. As a matter of theory, it is not clear whether an unanticipated easing of US monetary policy should result in a larger or smaller (absolute) move in credit spreads on risky sovereign bonds relative to a surprise policy tightening of the same magnitude (see Bruno and Shin, 2015a,b; Hofmann, Shim, and Shin, 2017). However, systematic empirical evidence of asymmetric US monetary policy spillovers in international bond markets may be be useful to researchers seeking to develop the next generation of models of the risk-taking channel of monetary policy as well as to policymakers in countries most affected by such asymmetric shocks. To examine whether US monetary tightenings and easings have an asymmetric effect on international bond market, we split our policy surprises based on their sign—that is, positive ($m_t^{US,(+)}$) and negative ($m_t^{US,(-)}$)—and then re-estimate the response of portfolio yields to those two surprises. Tables 7 and 8 present our findings regarding whether the conventional and unconventional US monetary policy actions have asymmetric effects on sovereign bond credit spreads at the 2- and 6-day horizons, respectively.

As shown in Table 7, during the conventional policy regime, the 2-day change in yields for both speculative- and investment-grade bond portfolios responds significantly more to an unanticipated monetary tightening then to a monetary easing. However, the yields on synthetic US bond portfolios also display a similarly heightened response to such policy tightenings. Consequently, the resulting effect on credit spreads is the same regardless of the direction of a policy move. Notably, the point estimates for the response of credit spreads on speculative-grade bonds are unchanged across tightening and easing actions and are entirely in line with the estimated response of 50 basis points—in reaction to a policy-induced movement in the 2-year US Treasury yield of 100 basis points—documented in Table 4. During the unconventional policy regime, only monetary policy easings have a significant effect on either sovereign yields or their US matched portfolio equivalents. In part, this result reflects the fact that unanticipated policy tightenings were relatively infrequent during the unconventional policy regime. Again, there is no evidence to suggest that US monetary policy has asymmetric effects on international bond markets.

The results for the 6-day horizon reported in Table 8 reinforce this conclusion. We again find that unanticipated monetary policy tightenings have substantially larger effects on sovereign bond yields than policy easings of the same magnitude. As before, we find that the credit spread response for speculative-grade sovereign bonds is economically large and statistically significant across both easing and tightening policy actions. Nonetheless, we find no difference in the magnitude of the response for speculative-grade credit spreads to policy easings versus tightenings, with both estimates implying a change of 150 basis points in speculative-grade credit spreads in response to a

Table 7 – The Asymmetric Effects of US Monetary Policy on Sovereign Credit Risk
(2-day Changes in Portfolio Bond Yields)

	Conventional MP[a]			Unconventional MP[b]		
Dependent Variables	$m_t^{US,(+)}$	$m_t^{US,(-)}$	R^2	$m_t^{US,(+)}$	$m_t^{US,(-)}$	R^2
Credit spread – IG	0.17	−0.01		0.41	−0.09	
	(0.19)	(0.11)		(0.73)	(0.34)	
Credit spread – SG	0.51	0.54**		0.53	−0.53	
	(0.43)	(0.21)		(1.76)	(0.49)	
Memo:						
Sovereign bond yield – IG	1.30***	0.45***	0.29	1.15*	1.31***	0.38
	(0.27)	(0.10)		(0.65)	(0.23)	
Sovereign bond yield – SG	1.54***	0.81***	0.15	1.19	1.12**	0.12
	(0.35)	(0.22)		(1.47)	(0.43)	
US Treasury yield – IG	1.12***	0.46***	0.18	0.74	1.40***	0.29
	(0.21)	(0.15)		(0.77)	(0.33)	
US Treasury yield – SG	1.03***	0.26*	0.13	0.66	1.64***	0.27
	(0.23)	(0.15)		(0.84)	(0.37)	
Exchange rate – IG	2.26*	4.87***	0.14	6.38	14.64***	0.34
	(1.25)	(1.33)		(6.75)	(3.06)	
Exchange rate – SG	−1.26	1.64	0.01	4.33	4.48**	0.16
	(3.77)	(1.12)		(4.79)	(1.09)	

Note: The dependent variables are 2-day changes (from day $t-1$ to day $t+1$) bracketing an FOMC announcement on day t in the specified financial indicator: Sovereign yield – IG = 2-day change in the yield on the portfolio of sovereign bonds with an investment-grade (IG) credit rating; and Sovereign yield – SG = 2-day change in the yield on the portfolio of sovereign bonds with a speculative-grade (SG) rating. US Treasury yield (IG/SG) corresponds to a 2-day change in the yield on the portfolio of synthetic US Treasury securities of identical duration as the sovereign bonds in the (IG/SG) portfolios. Exchange rate (IG/SG) corresponds to a 2-day return on the portfolio of currencies (against the US dollar), with identical weights as those in the sovereign bond (IG/SG) portfolios. The entries denote the OLS estimates of the portfolio-specific response coefficients to $m_t^{US,(+)}$ and $m_t^{US,(-)}$, a positive and negative FOMC-induced surprises in the 2-year US Treasury yield, respectively. The response of the sovereign credit spreads for the IG and SG credit risk categories is computed as the difference between the estimated response of sovereign bond yields and the estimated response of US Treasury yields in the matched portfolio of US Treasuries in that credit risk category. All specifications include a constant (not reported). Heteroskedasticity-consistent asymptotic standard errors are reported in parentheses: * $p < .10$; ** $p < .05$; and *** $p < .01$.

[a] 169 FOMC announcements (02/06/1992–12/15/2008 and 12/17/2015–03/20/2019).

[b] 65 FOMC announcements (12/16/2008–12/16/2015).

TABLE 8 – The Asymmetric Effects of US Monetary Policy on Sovereign Credit Risk
(*6-day Changes in Portfolio Bond Yields*)

	Conventional MP[a]			Unconventional MP[b]		
Dependent Variables	$m_t^{US,(+)}$	$m_t^{US,(-)}$	R^2	$m_t^{US,(+)}$	$m_t^{US,(-)}$	R^2
Credit spread – IG	0.32	0.27**		−0.18	0.34	
	(0.25)	(0.10)		(0.95)	(0.47)	
Credit spread – SG	1.44*	1.58**		−2.85	0.12	
	(0.83)	(0.75)		(2.89)	(0.86)	
Memo:						
Sovereign bond yield – IG	1.33***	0.48***	0.12	1.86	1.52***	0.23
	(0.41)	(0.15)		(1.25)	(0.39)	
Sovereign bond yield – SG	2.49***	1.61**	0.10	−0.75	1.66*	0.05
	(0.72)	(0.77)		(3.15)	(0.88)	
US Treasury yield – IG	1.01***	0.21	0.06	2.04**	1.19***	0.19
	(0.34)	(0.17)		(0.90)	(0.31)	
US Treasury yield – SG	1.05***	0.03	0.06	2.10**	1.54***	0.23
	(0.35)	(0.17)		(0.94)	(0.31)	
Exchange rate – IG	0.32	0.58	0.00	−6.61	11.16***	0.11
	(2.44)	(2.04)		(8.33)	(3.22)	
Exchange rate – SG	2.43	0.99	0.01	−1.85	5.25*	0.05
	(2.43)	(2.25)		(8.26)	(2.83)	

NOTE: The dependent variables are 6-day changes (from day $t-1$ to day $t+5$) bracketing an FOMC announcement on day t in the specified financial indicator: Sovereign yield – IG = 6-day change in the yield on the portfolio of sovereign bonds with an investment-grade (IG) credit rating; and Sovereign yield – SG = 6-day change in the yield on the portfolio of sovereign bonds with a speculative-grade (SG) rating. US Treasury yield (IG/SG) corresponds to a 6-day change in the yield on the portfolio of synthetic US Treasury securities of identical duration as the sovereign bonds in the (IG/SG) portfolios. Exchange rate (IG/SG) corresponds to a 6-day return on the portfolio of currencies (against the US dollar), with identical weights as those in the sovereign bond (IG/SG) portfolios. The entries denote the OLS estimates of the portfolio-specific response coefficients to $m_t^{US,(+)}$ and $m_t^{US,(-)}$, a positive and negative FOMC-induced surprises in the 2-year US Treasury yield, respectively. The response of the sovereign credit spreads for the IG and SG credit risk categories is computed as the difference between the estimated response of sovereign bond yields and the estimated response of US Treasury yields in the matched portfolio of US Treasuries in that credit risk category. All specifications include a constant (not reported). Heteroskedasticity-consistent asymptotic standard errors are reported in parentheses: * $p < .10$; ** $p < .05$; and *** $p < .01$.

[a] 169 FOMC announcements (02/06/1992–12/15/2008 and 12/17/2015–03/20/2019).

[b] 65 FOMC announcements (12/16/2008–12/16/2015).

100 basis point policy-induced increase in the 2-year US Treasury yield.

Another way to examine this question is to ask whether the credit spread differential between speculative- and investment-grade sovereign bonds responds more to unanticipated monetary tightenings relative to easings. This can be seen by computing the differential response of credit spreads on speculative- and investment-grade sovereign bonds. The 6-day change results reported in Table 8 imply the same point estimates for both investment- and speculative-grade bond portfolios across monetary easings and tightenings. Specifically, the point estimates of 150 basis points for speculative-grade bonds and 30 basis points for investment-grade bonds imply that the sovereign credit curve widens by 120 basis points in response to an unanticipated monetary tightening and narrows by the same amount in response to a monetary easing. Therefore, we see no evidence of credit spread compression in response to US policy easings in this dimension either.

All told, these results clearly show that during the conventional policy regime, US monetary policy causes an economically important change in credit spreads for speculative-grade sovereign credits that is on the order of 50 basis points—for a 100 basis point policy-induced change in the 2-year US Treasury yield—over a 2-day horizon and 150 basis points over a 6-day horizon. However, we find no evidence to suggest an asymmetric effect across policy easings versus policy tightenings.

5 Conclusion

Our analysis of US monetary policy cross-border spillovers employs a large micro-level data set at the daily frequency, consisting of almost 1,800 individual dollar-denominated sovereign securities traded in the secondary market, which were issued by more than 90 countries since the early 1990s. Using this rich data set, we analyze how US monetary policy affects sovereign bond portfolio yields and credit spreads—where portfolios are defined by duration and default risk—as well as bond-level credit spreads. We also compare the effects of conventional US monetary policy actions with those of the unconventional measures employed after the target federal funds rate hit the effective lower bound.

According to our findings, sovereign bond yields are highly responsive to unanticipated changes in the stance of US monetary policy during both the conventional and unconventional policy regimes. Conventional US monetary policy is transmitted very effectively to both shorter- and longer-duration yields on dollar-denominated sovereign bonds. The spillover effects of conventional US monetary policy across the portfolios of different durations are much more uniform compared with the unconventional policy regime. Overall, however, the extent of spillovers from the US unconventional monetary policy actions to foreign bond yields is roughly similar to that estimated for the conventional policy regime.

We also document that conventional US monetary policy measures have an economically large and statistically significant effect on credit spreads of dollar-denominated debt of countries with a speculative-grade credit rating. Specifically, credit spreads on risky sovereign bonds are estimated to narrow (widen) significantly in response to an unanticipated US policy easing (tightening) during the conventional regime. At the same time, conventional US monetary policy has no effect on the corresponding weighted average of bilateral exchange rates for a basket of currencies from the same set of risky countries. Together, these two results indicate that an unconventional tightening of US monetary policy increases credit spreads on risky sovereign debt directly through the financial channel, as opposed to indirectly through the deterioration in the quality of risky countries' balance sheets brought about the depreciation of their currencies against the US dollar. Sovereign credit spreads for investment-grade countries do not respond to conventional US monetary policy, according to our result.

During the unconventional policy regime, an unanticipated easing (tightening) of US monetary policy induces a decrease (increase) in sovereign bond yields that is commensurate with that of yields on a portfolio of comparable US Treasuries. Our analysis thus indicates that the unconventional policy actions undertaken by the FOMC during the 2008–15 period did not systematically affect the level of sovereign credit spreads across the credit quality spectrum, despite the fact that those actions had economically large effects on the bilateral exchange rates of both low- and high-risk countries. Lastly, we find no evidence that US monetary policy tightenings and easings have an asymmetric effect on sovereign credit spreads.

References

Albagli, E., L. Ceballos, S. Claro, and D. Romero (2018): "Channels of US Monetary Policy Spillovers to International Bond Markets," Forthcoming *Journal of Financial Economics.* Available at https://doi.org/10.1016/j.jfineco.2019.04.007.

Bauer, M. D., and C. J. Neely (2014): "International Channels of the Fed's Unconventional Monetary Policy," *Journal of International Money and Finance*, 44(C), 24–46.

Bernanke, B. S. (2018): "Federal Reserve Policy in an International Context," *IMF Economic Review*, 65(1), 1–32.

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

Bowman, D., J. M. Londono, and H. Sapriza (2015): "U.S. Unconventional Monetary Policy and Transmission to Emerging Market Economies," *Journal of International Money and Finance*, 55(C), 27–29.

Bredin, D., S. J. Hyde, and G. P. O'Reilly (2010): "Monetary Policy Surprises and International Bond Markets," *Journal of International Money and Finance*, 29(6), 988–1002.

Bruno, V., and H. S. Shin (2015a): "Capital Flows and the Risk-Taking Channel of Monetary Policy," *Journal of Monetary Economics*, 71(C), 119–132.

——— (2015b): "Cross-Border Banking and Global Liquidity," *Review of Economic Studies*, 82(2), 535–564.

Cameron, A. C., J. B. Gelbach, and D. L. Miller (2011): "Robust Inference with Multi-Way Clustering," *Journal of Business and Economic Statistics*, 29(2), 238–249.

Céspedes, L. F., R. Chang, and A. Velasco (2004): "Balance Sheets and Exchange Rate Policy," *American Economic Review*, 94(4), 1183–1193.

Chen, J., T. Mancini Griffoli, and R. Sahay (2014): "Spillovers from United States Monetary Policy on Emerging Markets: Different This Time?," IMF Working Paper No. 14-240.

Cochrane, J., and M. Piazzesi (2002): "The Fed and Interest Rates: A High-Frequency Identification," *American Economic Review, Papers and Proceedings*, 92(2), 90–95.

D'Amico, S., and T. B. King (2013): "Flow and Stock Effects of Large-Scale Treasury Purchases: Evidence on the Importance of Local Supply," *Journal of Financial Economics*, 108(2), 425–448.

Doornik, J. A., and H. Hansen (2008): "An Omnibus Test for Univariate and Multivariate Normality," *Oxford Bulletin of Economics and Statistics*, 70(s1), 927–939.

Du, W., J. Im, and J. Schreger (2018): "The U.S. Treasury Premium," *Journal of International Economics*, 112(C), 167–181.

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), 948–978.

Eichengreen, B., and A. Mody (2010): "What Explains Changing Spreads on Emerging-Market Debt: Fundamentals or Market Sentiment?," in *The Economics of International Capital Flows*, ed. by S. Edwards, pp. 107–134. The University of Chicago Press, Chicago.

Fleming, M. J. (1962): "Domestic Financial Policies Under Fixed and Under Floating Exchange Rates," *International Monetary Fund Staff Papers*, 9(November), 369–380.

Fratzscher, M., M. Lo Duca, and R. Straub (2014): "On the International Spillovers of U.S. Quantitative Easing," *Economic Journal*, 128(608), 330–377.

Gagnon, J., M. Raskin, J. Remache, and B. Sack (2011): "The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases," *International Journal of Central Banking*, 7(1), 3–43.

Gagnon, J. E., T. Bayoumi, J. M. Londono, C. Sabarowski, and H. Sapriza (2017): "Direct and Spillover Effects of Unconventional Monetary and Exchange Rate Policies," *Open Economies Review*, 28(2), 191–232.

Gertler, M., S. Gilchrist, and F. M. Natalucci (2007): "External Constraints on Monetary Policy and the Financial Accelerator," *Journal of Money, Credit, and Banking*, 39(2-3), 295–330.

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

Gilchrist, S., D. López-Salido, and E. Zakrajšek (2015): "Monetary Policy and Real Borrowing Costs at the Zero Lower Bound," *American Economic Journal: Macroeconomics*, 7(1), 77–109.

Gilchrist, S., and E. Zakrajšek (2012): "Credit Spreads and Business Cycle Fluctuations," *American Economic Review*, 102(4), 1692–1720.

——— (2013): "The Impact of the Federal Reserve's Large-Scale Asset Purchase Programs on Corporate Credit Risk," *Journal of Money, Credit, and Banking*, 45(s2), 29–57.

Goldberg, L. S. (2013): "Banking Globalization, Transmission, and Monetary Policy Autonomy," NBER Working Paper No. 19497.

Greenlaw, D., J. D. Hamilton, E. Harris, and K. D. West (2018): "A Skeptical View of the Impact of the Fed's Balance Sheet," NBER Working Paper No. 24687.

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), 55–93.

Gürkaynak, R. S., B. Sack, and J. H. Wright (2007): "The U.S. Treasury Yield Curve: 1961 to the Present," *Journal of Monetary Economics*, 54(8), 2291–2304.

Hamilton, J. D., and J. C. Wu (2012): "The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment," *Journal of Money, Credit, and Banking*, 44(s1), 3–46.

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

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

Hofmann, B., I. Shim, and H. S. Shin (2017): "Sovereign Yields and the Risk-Taking Channel of Currency Appreciation," BIS Working Paper Series No. 538.

Jarociński, M., and P. Karadi (2019): "Deconstructing Monetary Policy Surprises: The Role of Infomation Shocks," Forthcoming *American Economic Journal: Macroeconomics.*

Justiniano, A., C. L. Evans, J. R. Campbell, and J. D. Fisher (2012): "Macroeconomic Effects of FOMC Forward Guidance," *Brookings Papers on Economic Activity*, 44(Spring), 1–80.

Kamin, S. B., and K. von Kleist (1999): "The Evolution and Determinants of Emerging Market Credit Spreads in the 1990s," *BIS Quarterly Review*, November, 36–44.

Klein, M. W., and J. C. Shambaugh (2015): "Rounding the Corners of the Policy Trilemma: Sources of Monetary Policy Autonomy," *American Economic Journal: Macroeconomics*, 7(4), 33–66.

Krishnamurthy, A., and A. Vissing-Jorgensen (2011): "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy," *Brookings Papers on Economic Activity*, Fall, 215–265.

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

Mundell, R. A. (1963): "Capital Mobility and Stabilization Policy Under Fixed and Flexible Exchange Rates," *Canadian Journal of Economic and Political Science*, 29(November), 475–485.

Neely, C. J. (2015): "Unconventional Monetary Policy Had Large International Effects," *Journal of Banking and Finance*, 52(March), 101–111.

Neumeyer, P. A., and F. Perri (2005): "Business Cycles in Emerging Markets: The Role of Interest Rates," *Journal of Monetary Economics*, 52(2), 345–380.

Obstfeld, M. (2015): "Trilemma and Tradeoffs: Living with Financial Globalization," BIS Working Paper Series No. 480.

Obstfeld, M., and K. Rogoff (2002): "Global Implications of Self-Oriented National Monetary Rules," *Quarterly Journal of Economics*, 117(2), 503–535.

Obstfeld, M., J. C. Shambaugh, and A. M. Taylor (2005): "The Trilemma in History: Tradeoffs Among Exchange Rates, Monetary Policies, and Capital Mobility," *Review of Economics and Statistics*, 97(3), 423–438.

Rajan, R. (2016): "Towards Rules of the Monetary Game," Speech at the IMF/Government of India Conference on "Advancing Asia: Investing for the Future," New Delhi, India, March 12, 2016. Available at https://www.bis.org/review/r160316a.htm.

Rey, H. (2013): "Dilemma Not Trilemma: The Global Financial Cycle and Monetary Policy Independence," Federal Reserve Bank of Kansas City, *Proceedings – Economic Policy Symposium – Jackson Hole*.

——— (2016): "International Channels of Transmission of Monetary Policy and the Mundellian Trilemma," *IMF Economic Review*, 64(1), 6–35.

Rogers, J. H., C. Scotti, and J. H. Wright (2014): "Evaluating Asset-Market Effects of Unconventional Monetary Policy: A Cross-Country Comparison," *Economic Policy*, 29(80), 749–799.

Swanson, E. T. (2011): "Let's Twist Again: A High-Frequency Event-Study Analysis of Operation Twist and Its Implications for QE2," *Brookings Papers on Economic Activity*, Spring, 151–188.

Uribe, M., and V. Yue (2006): "Country Spreads and Emerging Countries: Who Drives Whom?," *Journal of International Economics*, 69(1), 6–36.

Wright, J. H. (2012): "What Does Monetary Policy Do to Long-Term Interest Rates at the Zero Lower Bound?," *Economic Journal*, 122(546), F447–F466.

Appendices – For Online Publication

A Data Appendix

Table A-1 – LSAP-Related Unconventional Monetary Policy Actions

Date	Time[a]	FOMC[b]	Highlights
11/25/2008	08:15	N	Announcement that starts LSAP-I.
12/01/2008	08:15	N	Announcement indicating potential purchases of Treasury securities.
12/16/2008	14:20	Y	Target federal funds is lowered to its effective lower bound; statement indicating that the Federal Reserve is considering using its balance sheet to further stimulate the economy; first reference to forward guidance: "... economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time."
01/28/2009	14:15	Y	"Disappointing" FOMC statement because of its lack of concrete language regarding the possibility and timing of purchases of longer-term Treasuries.
03/18/2009	14:15	Y	Announcement to purchase Treasuries and increase the size of purchases of agency debt and agency MBS; also, first reference to extended period: "interests rates are likely to remain low for an extended period."
08/10/2010	14:15	Y	Announcement that starts LSAP-II.
09/21/2010	14:15	Y	Announcement reaffirming the existing reinvestment policy.
11/03/2010	14:15	Y	Announcement of additional purchases of Treasury securities.
09/21/2011	14:15	Y	Announcement of the Maturity Extension Program (MEP).
06/20/2012	12:30	Y	Announcement of continuation of the MEP through end of 2012.
09/13/2012	12:30	Y	Third "calendar-based" forward guidance: "likely maintain the Federal funds rate near zero at least through mid-2015." In addition, first forward guidance regarding the pace of interest rates after lift-off: "likely maintain low rates for a considerable time after the economic recovery strengthens," and announcement of LSAP-III (flow-based; $40 billion per month of agency MBS).
12/12/2012	12:30	Y	Announcement of an increase in LSAP-III (from $40 billion to $85 billion per month); first "threshold-based" forward guidance: maintain the funds rate near zero for as long as unemployment is above 6.5%, inflation (1–2 years ahead) is below 2.5%, and long-term inflation expectations remain well-anchored.

[a] All announcements are at Eastern Standard Time.

[b] Y = an announcement associated with a regularly-schedule FOMC meeting; N = an intermeeting policy announcement.

Table A-2 – Sample Composition

Country Name	Country Code	Start Date	End Date	Bonds	Obs.	Weight[a]	% in IG[b]
United Kingdom	GBR	07/30/2009	03/06/2013	7	2,636	1.28	100
Austria	AUT	05/19/2004	05/30/2014	15	10,258	0.86	100
Belgium	BEL	01/02/1992	03/29/2019	23	28,624	3.17	83.2
Denmark	DNK	07/30/2009	05/30/2014	8	2,976	1.37	100
Italy	ITA	01/02/1992	03/29/2014	50	59,319	14.77	82.3
Netherlands	NLD	02/24/2012	05/30/2014	4	1,986	1.91	100
Norway	NOR	01/02/1992	04/12/1996	2	1,990	5.95	100
Sweden	SWE	01/02/2001	03/29/2019	54	29,119	1.23	77.0
Canada	CAN	02/14/2012	03/29/2019	5	2,078	0.49	100
Japan	JPN	01/02/1992	05/30/2014	75	92,718	8.04	100
Finland	FIN	01/02/1992	03/29/2019	29	25,979	3.69	100
Greece	GRC	05/24/1994	09/12/2011	21	9,406	0.62	75.6
Iceland	ISL	01/02/2001	05/30/2014	6	3,902	0.32	100
Ireland	IRL	01/02/1992	07/14/2009	6	8,550	1.36	100
Portugal	PRT	09/08/1999	03/29/2019	5	5,367	0.88	41.7
Spain	ESP	09/23/1992	05/30/2014	15	13,720	2.49	100
Turkey	TUR	05/05/1992	03/29/2019	45	61,581	4.49	10.2
Australia	AUS	07/30/2009	05/30/2014	1	1,208	0 4	100
New Zealand	NZL	01/02/1992	05/30/2014	10	15,203	0.90	100
South Africa	ZAF	12/12/1994	03/29/2019	18	28,796	1.85	80.1
Argentina	ARG	10/01/1992	03/29/2019	29	23,548	4.04	0
Bolivia	BOL	10/29/2012	03/29/2019	6	2,190	0.21	0
Brazil	BRA	04/18/1994	03/29/2019	33	62,820	10.36	18.8
Chile	CHL	10/16/2001	03/29/2019	8	8,379	0.71	100
Colombia	COL	10/11/1996	03/29/2019	24	48,541	2.88	47.4
Costa Rica	CRI	07/30/2009	03/29/2019	9	9,066	0.47	38.5
El Salvador	SLV	10/25/2002	03/29/2019	7	8,302	0.41	43.0
Guatemala	GTM	06/06/2012	05/30/2014	4	1,638	0.38	0
Honduras	HND	03/15/2013	05/30/2014	4	834	0.21	0
Mexico	MEX	03/01/1993	03/29/2019	30	43,750	5.81	73.1
Panama	PAN	03/11/1997	03/29/2019	15	27,731	1.58	39.9
Paraguay	PRY	01/25/2013	03/29/2019	4	2,988	0.27	0
Peru	PER	11/26/2002	03/29/2019	9	17,068	1.43	56.8b
Uruguay	URY	11/18/2005	03/29/2019	6	6,813	0.63	49.8
Venezuela	VEN	01/02/1992	03/29/2019	29	46,946	3.25	0
Bahamas	BHS	11/20/2009	05/30/2014	4	2,446	0.13	100
Barbados	BRB	01/02/2001	05/30/2014	5	2,078	0.10	89.3
Bermuda	BMU	07/20/2010	05/30/2014	6	3,292	0.33	100
Jamaica	JAM	12/19/2001	03/29/2014	10	15,355	0.47	0
Trinidad & Tobago	TTO	01/02/2009	03/29/2019	5	2,904	0.10	100
Cayman Islands	CYM	11/24/2009	05/30/2014	2	2,255	0.13	100
South Korea	KOR	04/09/1998	03/29/2019	62	66,626	4.42	96 .0
Cyprus	CYP	01/29/1998	06/25/2001	1	854	0.34	100
Lebanon	LBN	06/02/2014	03/29/2019	15	12,194	1.89	0
Israel	ISR	03/10/2000	03/29/2019	454	492,385	2.65	100
Bahrain	BHR	06/02/2014	03/29/2019	14	13,162	2.02	0
Jordan	JOR	11/12/2010	03/29/2019	10	7,799	0.50	0
Quatar	QAT	04/09/2009	03/29/2019	27	27,873	3.61	100
Kuwait	KWT	03/20/2017	03/29/2019	4	2,032	1.61	100
Saudi Arabia	SAU	10/26/2016	03/29/2019	18	6,898	5.64	0
Oman	OMN	06/15/2016	03/29/2019	16	7,648	2.11	0
Iraq	IRQ	06/02/2014	03/29/2019	5	3,782	0.77	0
Egypt	EGY	07/02/2001	03/29/2019	25	16,834	0.84	0
Sri Lanka	LKA	11/04/2010	03/29/2019	21	18,445	1.29	0
Hong Kong, China	HKG	07/22/2004	07/31/2013	2	4,516	0.84	100

Table A-2 – Sample Composition (continued)

Country Name	Country Code	Start Date	End Date	Bonds	Obs.	Weight[a]	% in IG[b]
India	IND	02/25/2004	05/30/2014	14	13,163	0.58	23.8
Indonesia	IDN	03/10/2004	03/29/2019	63	75,691	6.09	47.8
Malaysia	MYS	05/28/1999	07/14/2010	2	4,505	1.59	100
Pakistan	PAK	02/12/2004	03/29/2019	11	12,507	0.48	0
Philippines	PHL	11/23/1996	03/29/2019	25	44,461	3.46	24.5
Thailand	THA	12/23/2005	09/28/2012	1	1,694	<.01	100
Viet Nam	VNM	11/03/2005	03/29/2019	6	8,629	0.52	0
Angola	AGO	11/12/2015	03/29/2019	6	2,576	0.56	0
Ghana	GHA	07/26/2013	03/29/2019	10	7,666	0.66	0
Gabon	GAB	06/02/2014	03/29/2019	2	2,414	0.41	0
Ethiopia	ETH	12/11/2014	03/29/2019	2	2,148	0.26	0
Kenya	KEN	06/24/2014	03/29/2019	6	3,466	0.66	0
Ivory Coast	CIV	03/03/2015	03/29/2019	4	2,934	0.36	0
Nigeria	NGA	02/16/2017	03/29/2019	14	3,834	0.99	0
Morocco	MAR	11/12/2012	03/29/2019	2	3,148	0.45	76.7
Senegal	SEN	05/06/2011	03/29/2019	7	3,627	0.25	0
Namibia	NAM	11/03/2011	05/30/2014	2	1,282	0.18	100
Zambia	ZMB	06/02/2014	03/29/2019	4	4,246	0.50	0
Fiji	FJI	07/30/2009	05/30/2014	2	1,083	0.04	0
Belarus	BLR	08/03/2010	05/30/2014	2	1,792	0.29	0
Albania	ALB	11/01/2010	05/30/2014	1	894	0.02	0
Azerbaijan	AZE	06/02/2014	03/29/2019	4	3,196	0.42	0
Georgia	GEO	10/06/2010	05/30/2014	3	1,946	0.20	0
Kazakhstan	KAZ	12/11/1996	03/29/2019	13	13,183	0.84	59.6
Bulgaria	BGR	04/10/2002	01/14/2014	2	5,884	1.07	67.0
Russian Federation	RUS	11/22/1996	03/29/2019	37	51,946	7.15	71.1
People's Republic of China	PRC	07/05/1996	03/29/2019	8	7,419	0.70	90.8
Ukraine	UKR	11/20/2001	03/29/2019	55	43,950	2.18	0
Latvia	LVA	06/16/2011	05/30/2014	6	3,344	0.65	100
Hungary	HUN	02/03/2005	03/29/2019	9	12,911	1.24	82.3
Lithuania	LTU	10/15/2009	03/29/2019	9	15,017	1.81	100
Mongolia	MNG	12/05/2012	03/29/2019	4	3,898	0.30	0
Croatia	HRV	02/12/1997	03/29/2019	13	20,577	1.56	54.1
Slovenia	SVN	07/25/1996	03/29/2019	11	7,419	0.79	89.6
Slovakia	SVK	06/02/2014	03/29/2019	2	2,414	0.47	100
Poland	POL	06/30/1995	03/29/2019	11	19,366	1.01	100
Serbia	SRB	07/15/2013	03/29/2019	7	5,904	1.09	0
Romania	ROU	02/07/2012	03/29/2019	10	12,018	1.61	100

Note: No. of bonds = 1,748; No. of countries = 95; Obs. = 1,888,320. Bonds in default are excluded.

[a] Average of the country-specific weights (in percent)—based on the market value of outstanding bonds—used in the construction of portfolios.

[b] Percent of the sample period that a country has an investment-grade (IG) sovereign debt rating; by construction, $100-\%$ in IG is the percent of the sample period that a country has a speculative-grade (SG) sovereign debt rating.