The Impact of Policy Initiatives on Credit Spreads during the 2007–09 Financial Crisis

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This paper assesses the impact of the various "unconventional" U.S. Federal Reserve policies and fiscal policies, introduced during the 2007–09 financial crisis period, on credit market spreads. I also examine the impact of the "conventional" monetary policy stance, defined as the difference between the effective federal funds rate and the rate implied by a Taylor rule. Examining policies initiated between July 2007 and January 2009, I find that fiscal policy announcements did not, in general, reduce market spreads. I also find that while the multitude of "unconventional" monetary policy initiatives were effective in reducing market spreads, the effects were relatively modest. Finally, increases in the Taylor-rule residual are associated with an increase in credit market spreads.

JEL Codes: E52, E58, E63, G12, G14.

1. Introduction

This paper assesses the impact of the various "unconventional" policies introduced by the U.S. Federal Reserve, during the 2007–09 financial crisis period, on market spreads. The crisis moved U.S. Federal Reserve policy from a well-established routine of interest rate targeting to a multi-pronged triage that wedded traditional policy tools with new initiatives aimed at reviving an ailing financial system. The triage was controversial on two grounds: firstly, these

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initiatives required discretion over targeting particular markets and firms; and secondly, they created a fear that the liquidity provided may stoke higher inflation, undermining the central bank's macroeconomic objectives. These changes in the operation of central bank policy have been especially jarring following a quarter century of generally quiescent macroeconomic activity and policy, a period often characterized as the "Great Moderation." The timing, size, appropriateness, and effectiveness of the measures taken by the Federal Reserve during the 2007–09 crisis are the subject of much discussion, analysis, and controversy.

The number of studies examining the effectiveness of various policies has grown rapidly, with some studies having examined the effectiveness of the Federal Reserve's Term Auction Facility (TAF), with conflicting findings (Taylor 2011 vs. McAndrews, Sarkar, and Wang 2008). Other papers have assessed the effectiveness of the U.S. dollar swap lines between the Federal Reserve and other central banks in alleviating dislocations in foreign-currency markets (Baba and Packer 2009, McAndrews, Sarkar, and Wang 2008). In contrast to these univariate-policy-centric studies, Aït-Sahalia et al. 2010 found that central bank liquidity support and liability guarantees, along with bank recapitalizations by the public sector, led to a reduction in interbank risk premia.

Given the large number of "unconventional" policy initiatives introduced by the Federal Reserve to combat the crisis—between December 2007 and March 2009 the Federal Reserve initiated sixteen programs—analyzing the efficacy of these programs requires an organizing framework. In this paper, I use the framework developed in Kroszner and Melick 2010, who classify the policy initiatives along three dimensions: (i) an expansion of the type of counterparties receiving support, (ii) a broadening of the collateral eligible for support, and (iii) a lengthening of the maturity of the support. This framework reveals that the various "unconventional" policies complement "conventional" monetary policy, for reasons outlined below.

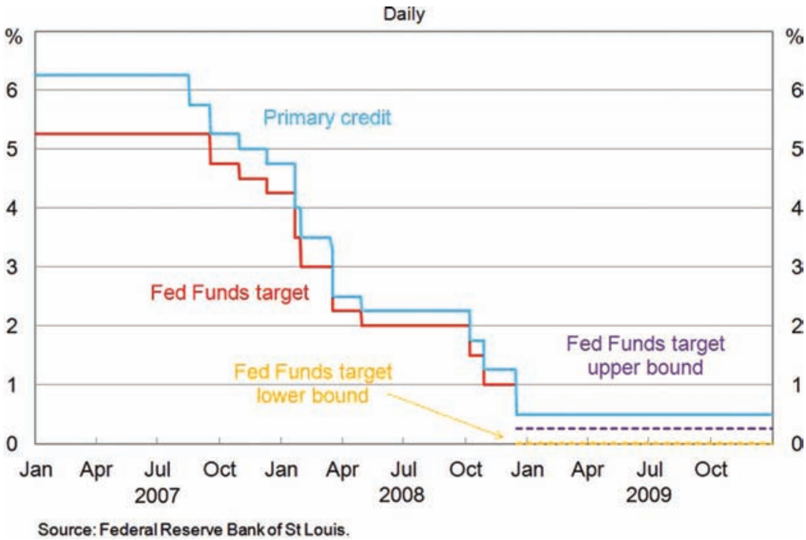
Using this framework, this paper makes six important contributions to the literature. Firstly, I find that all three types of policies were effective in reducing market spreads, with the most effective being policies that broadened the range of collateral eligible for secured funding from the Federal Reserve. Secondly, I find that these policies were more effective in reducing unsecured and secured funding costs than bond spreads. Thirdly, these policies were more effective in reducing the level of spreads than their conditional variances. Fourthly, I find that "implementation effects" and "size" effects—respectively, the effect on spreads at the time policies were implemented, and the effect on spreads from higher amounts loaned from these programs—were an order of magnitude larger than "announcement effects"—the effect on spreads at the time these policies were announced. Fifth, fiscal policy announcements did not reduce market spreads, and in some instances were associated with significant increases in spreads, consistent with Taylor (2011).

Following Rudebusch (2009), I measure the monetary policy stance as the deviation of the actual federal funds interest rate from the interest rate implied by a Taylor rule. Because a Taylor rule relates the level of the federal funds rate to the objectives, as stated in section 2A of the Federal Reserve Act, of price stability and maximum employment, measuring the policy stance as the difference between these two interest rates is more appropriate than using the level of the federal funds rate. Using this measure to define the monetary policy stance, my final finding was that policy contractions were associated with increases in market spreads.

While the Federal Reserve's various "unconventional" policies did reduce financial market strains, these policies were not sufficient to ensure that the Federal Reserve met its macroeconomic objectives, as enshrined in the Taylor rule. This, in turn, exacerbated market strains and reduced the efficacy of the unconventional policies. These findings are akin to the arguments of Friedman and Schwartz (1963) that the Federal Reserve's contractionary policy stance during the 1930s destabilized financial markets and exacerbated the Great Depression, a view subsequently upheld by the U.S. Federal Reserve (Bernanke 2002).

The rest of the paper is organized as follows. Section 2 outlines the key conventional and unconventional Federal Reserve policy responses to the differing crisis events, and section 3 reviews the relevant literature. Section 4 outlines the data used and the estimation of Taylor rules, and section 5 discusses the empirical methodology employed. Section 6 discusses the estimated announcement effects of the various policy initiatives examined in this paper. Section 7 contains the results from the regime-switching VAR, while section 8

Figure 1. Target Federal Funds Rate and Primary Credit Rate



discusses the implementation and size effects of the various Federal Reserve programs on market spreads. Section 9 considers the sensitivity of the results to changes in the maturity of short-term funding. Section 10 concludes with a discussion of avenues for future research.

2. The U.S. Federal Reserve's Policy Initiatives

2.1 "Conventional" Policy Responses

One aspect of the Federal Reserve's response to the crisis involved its traditional tools of changing the target federal funds rate and primary credit rate.[1] Between the reforms to the discount window program in 2003 and the start of the financial crisis in mid-2007, the term of primary credit loans was always overnight, and its interest rate was set 100 basis points above the target federal funds rate (figure 1). However, as the crisis unfolded, lending conditions became

[1] The primary credit rate is the interest rate charged by the Federal Reserve for secured, short-term loans to depository institutions. The lending facility offered by the Federal Reserve is termed the "discount window."

less restrictive: on August 17, 2007, the maximum term was lengthened to thirty days (and the spread lowered to 50 basis points) and then, on March 16, 2008, the maximum term was extended to ninety days (and the spread lowered to 25 basis points).

Kroszner and Melick (2010) note that the Federal Open Market Committee (FOMC) followed "standard" procedure—reducing the federal funds rate and primary credit rate by 25 basis points at each meeting—in easing monetary policy from September 2007 through to the end of the year. As the market turmoil intensified around year-end, the FOMC reduced rates by a total of 125 basis points. Rates were cut an additional 75 basis points at the March 2008 meeting (along with the fall in the spread between the primary credit rate and the federal funds rate). October 2008 saw a further 100-basis-point cut in interest rates, as well as an unprecedented internationally coordinated rate cut of 50 basis points, and another 100-basis-point cut in December when the FOMC moved to targeting the federal funds rate within a range of 0 to 25 basis points (figure 1).

The third traditional tool, reserve requirements, was not used by the Federal Reserve during the early stages of the crisis. However, on October 6, 2008, the Federal Reserve announced it would begin paying interest on depository institutions' required and excess reserve balances. The interest on reserves (IOR) program has allowed the Federal Reserve to maintain the effective federal funds rate within its target range, although some economists have considered it analogous to an increase in reserve requirements and thus contractionary (Beckworth 2008, Woodward and Hall 2009). These economists argue that the IOR program negated some of the stimulus provided by the use of conventional and "unconventional" monetary policy.

2.2 "Unconventional" Policy Responses

By December 2007 it was evident that the Federal Reserve's traditional policy tools were not achieving the desired economic and financial market goals. Kroszner and Melick (2010) note that, between December 2007 and March 2009, the Federal Reserve introduced sixteen "unconventional" programs to combat the crisis. Since even describing, much less assessing, these initiatives can easily get bogged down in a long list of confusing and easily forgotten acronyms, Kroszner and Melick (2010) organize the various policies into one (or more) of three categories: (i) policies that expand the type of counterparties receiving support, (ii) policies that broaden the collateral required to access the support, and (iii) policies that lengthen the maturity of the support. Kroszner and Melick (2010) sort chronologically the various Federal Reserve policies into these three categories, and their table is reproduced below (table 1).

I adopt Kroszner and Melick (2010)'s categorical scheme to analyze the impact of the "unconventional" policies on market pricing. The authors note that their choice of organizing framework reflects the Federal Reserve's modification to their lender-of-last-resort (LOLR) facilities to reflect changes in the financial system over the past few decades. In order for the Federal Reserve to be able to use their LOLR facilities effectively, three changes to pre-existing policies needed to be adopted. First, dealing with new counterparties was critical to extending central bank assistance to important markets and firms in the intermediation chain, due to the interconnectedness of institutions and markets. Second, accepting a wider range of collateral reflected the reality of a financial system that had evolved from bank intermediation towards greater reliance upon securitization and market-based intermediation. Finally, extending the maturity of the support was designed to instill confidence in market participants that institutions and counterparties will have a source of funding for longer periods, reducing the likelihood that negative liquidity shocks force fire sales and compromise solvency.[2]

In this sense, the various unconventional policies can be seen as extensions of the Federal Reserve's traditional toolkit to deal with the architecture of the modern financial system. As noted by Yellen (2012a, 2012b), the complementary nature of the non-traditional and traditional tools means we can gauge the effectiveness of the "unconventional" policies by the extent to which they allowed the Federal Reserve to meet its dual mandate of price stability and full employment. This provides one key justification for why I include

[2]Bernanke (2009) presents an alternative framework that classifies each non-traditional initiative into three descriptive categories: lending to financial institutions, providing liquidity to key credit markets, and purchasing longer-term securities.

Table 1. The U.S. Federal Reserve's "Unconventional" Policy Initiatives (as of November 18, 2009)

	Description					Objectives		
Initiative	**Announced**	**First Used**	**Authorized Until**	**Max. Size[a]**	**Current Size[a]**	**Lengthen Maturity**	**Broaden Collateral**	**Expand C'party**
Term Auction Facility	Dec. 12, 2007	Dec. 17, 2007	Ongoing	493	109	X		
Central Bank Swap Lines	Dec. 12, 2007	Dec. 20, 2007	Jan. 2, 2010	583	28			X
Term Securities Lending Facility	Mar. 11, 2008	Mar. 27, 2008	Jan. 2, 2010[b]	234	0	X		
Maiden Lane (Bear Stearns)	Mar. 14, 2008	June 26, 2008	Ongoing	30	26		X	X
Primary Dealer Credit Facility[c]	Mar. 16, 2008	Mar. 19, 2008[d]	Jan. 2, 2010	148	0			X
Term Securities Lending Facility Options	Jul. 30, 2008	Aug. 27, 2008	Suspended[e]	50	0	X		
American Int'l Group Support								
FRBNY Lending to AIG	Sep. 16, 2008	Sep. 17, 2008[d]	Ongoing	90	45		X	X
Maiden Lane II	Oct. 11, 2008	Dec. 12, 2008	Ongoing	20	16		X	X
Maiden Lane III	Oct. 11, 2008	Nov. 25, 2008	Ongoing	28	23		X	X
Asset-Backed Commercial Paper Money	Sep. 19, 2008	Sep. 24, 2008[d]	Jan. 2, 2010	152	0		X	
Market Mutual Fund Liquidity Facility								
Commercial Paper Funding Facility	Oct. 7, 2008	Oct. 27, 2008	Jan. 2, 2010	351	15		X	X

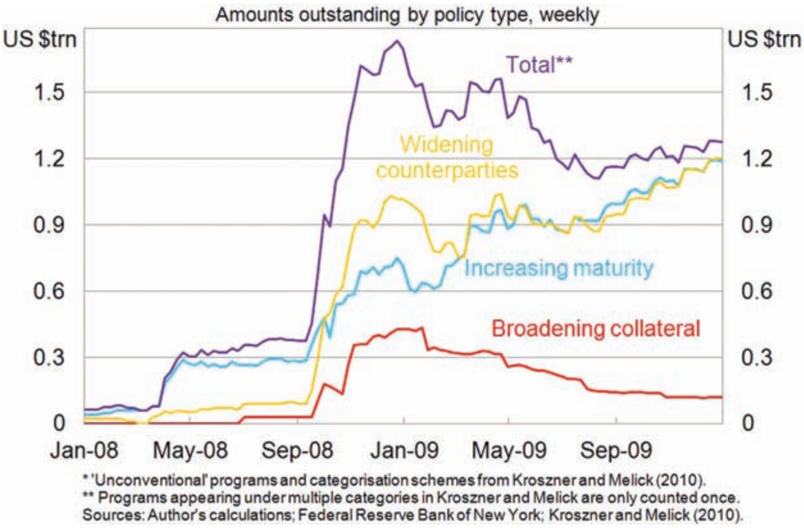
(continued)

Table 1. (Continued)

Initiative	Description					Objectives		
	Announced	First Used	Authorized Until	Max. Size[(a)]	Current Size[(a)]	Lengthen Maturity	Broaden Collateral	Expand C'party
Money Market Investor Funding Facility	Oct. 21, 2008	Unused	Oct. 30, 2009	Unused	0			X
Citigroup Support	Nov. 23, 2008	Unused	Unused	Unused	0			X
Term Asset-Backed Securities Loan Facility	Nov. 25, 2008	Mar. 25, 3009	Mar. 31, 2010 Jun. 30, 2010[f]	44	44	X	X	X
Purchase of MBS Guaranteed by GSEs	Nov. 25, 2008	May 5, 2009	Mar. 31, 2010[g]	847	847	X		X
Purchases of Direct GSE Debt	Nov. 25, 2008	Dec. 5, 2008	Mar. 31, 2009[g]	153	153	X		X
Bank of America Support	Jan. 16, 2008	Unused	Unusued	Unused	0			X
Purchases of Longer-Term U.S. Treasuries	Mar. 18, 2009	Mar. 25, 2009	Oct. 30, 2009[g]	311	311	X		

Source: Kroszner and Melick (2010).
[a]In US$ billions.
[b]Auctions against schedule 1 collateral suspended on January 7, 2009.
[c]Includes transitional support for Goldman Sachs, Morgan Stanley, and Merrill Lynch announced on September 21, 2008.
[d]Based on first appearance in the Federal Reserve Board's H.4.1 statistical release.
[e]Suspended on June 25, 2009.
[f]Loans against newly issued ABS and legacy CMBS authorized through March 31, 2010, loans against newly issued CMBS through June 30, 2010.
[g]Based on FOMC statements.

Figure 2. U.S. Federal Reserve "Unconventional" Programs*



the stance of conventional monetary policy in my analysis. In terms of the size of the "unconventional" monetary policies, the largest were those that widened the counterparties to, and increased the maturity of, Federal Reserve support.[3] Collectively, the size of the Federal Reserve's "unconventional" programs rose the most in September 2008, reflecting the collapse of Lehman Brothers and AIG, the failure of large money-market funds, and the systemic nature of market runs at this time. The stock of securities held reached a high of US$1.73 trillion at the end of 2008, before declining throughout 2009, due to declines in the size of programs that broadened the range of eligible collateral, as market conditions stabilized somewhat (figure 2).

I also consider policy initiatives that did not directly impact the Federal Reserve's balance sheet, such as the Troubled Asset Relief

[3]The sum of the stock of securities held under the individual program categories typically exceeds the stock of securities held under all categories since the various Federal Reserve policy initiatives were typically classified under more than category (see table 1).

Program (TARP), which was created through the Emergency Economic Stabilization Act of 2008. While these policies are more fiscal than monetary in nature, omitting these policies may bias the estimated impact of the various Federal Reserve policies on market pricing. I consider four policies, grouping them under the title "Fiscal Policies":

- (i) TARP;
- (ii) the Temporary Liquidity Guarantee Program (TLGP), under which the Federal Deposit Insurance Corporation (FDIC) guaranteed the senior debt obligations of FDIC-insured depositories and their holding companies;
- (iii) the Capital Purchase Program (CPP), under which the U.S. Department of the Treasury used TARP funds to purchase preferred stock and warrants of financial institutions; and
- (iv) the use of the Exchange Stabilization Fund by the U.S. Treasury to provide a temporary guarantee of $1 per share for money-market fund accounts.

3. Related Literature

The theoretical literature on central banks' LOLR facilities is well established, dating back to Thornton (1802) and Bagehot (1873), so only a summary of the literature's key elements is provided here. As Freixas et al. (1999) note, the key rationale for LOLR facilities is preventing the failure of illiquid but solvent institutions, as failure (or the threat of failure) has negative externalities on the broader financial system and the macroeconomy. The failure of a large institution, or a number of smaller ones, could result in systemwide financial instability, potentially threatening the ability of the financial system to perform its primary functions, such as the provision of the payments system, the efficient pricing of risk, and the allocation of resources. For a discussion of the theoretical literature up to the late 1990s, see Freixas et al. (1999); recent additions to the literature include Caballero and Krishnamurthy (2008) and Holmström and Tirole (2011).

The empirical literature on LOLR facilities is also well established, with the financial crisis of 2007–09 having resulted in numerous studies examining the efficacy of policy initiatives. However, there is little consensus on the impact of the various policies. To a large extent, the different findings across the studies reflect (i) differences in the specification of the dependent variable (levels or first differences), (ii) whether the entire amount of a credit spread should be used or just the liquidity component (the latter generating questions about the methods used to extract this component), (iii) the size of the time window around an event, and (iv) differences in ways of extracting a policy's "announcement effect." These last two points are perhaps the most important.

Limiting the size of the window can prevent a bias in the estimated announcement effects, when other events are erroneously included with a given event. As Frankel (2010) notes, the event-study literature has long established that the event window should be less than one day. However, a longer event window allows for any pre- or post-event "drift," where the former reflects the possibility of information leakage and/or insider trading prior to the event, and the latter allows for any market under- or overreaction at the time of the event. While I follow the literature in using public announcement dates to identify policy events, I focus on the three-day interval around an event to allow for any pre- and post-event drift.

It is worth noting that my econometric estimations also used one one-day event window, and two two-day event windows. The one-day window focused solely on the announcement day; the two two-day windows used, respectively, the announcement day and the prior day, and the announcement day and the proceeding day. I found that the economic and statistical significance of the estimated announcement effects, across the various conditional mean and conditional variance models, were lower for these alternative windows. These results imply that the alternative time intervals omit the behavior of market spreads both preceding and proceeding the various policy announcements, and suggest that pre- and post-event drift were important aspects of the overall "announcement effect." The results for the alternative event windows are available on request.

To estimate the announcement effect, I use a larger set of conditioning variables than the related literature. The majority of the related literature focus on one market spread (typically, the LIBOR-OIS spread) and use lagged values of this variable to estimate the announcement effect of a particular policy. In contrast, as outlined in section 5, I use three spreads and a larger set of conditioning variables to overcome the possibility of omitted-variable bias in the estimates of the announcement effect.

Examining the effects of the Federal Reserve's Term Auction Facility (TAF),[4] Taylor (2011) finds no evidence that the TAF lowered the LIBOR-OIS spread, with only weak evidence that the TAF reduced other short-term debt spreads. In fact, in some instances, the TAF *increased* spreads. In contrast, McAndrews, Sarkar, and Wang (2008) and Wu (2010) document that the TAF did ease market strains. Wu (2010) specifies a step function that equals 0 prior to the TAF being announced and 1 thereafter, whereas Taylor (2011)'s step function equals 1 only at the time the TAF was announced. Wu's specification assumes the TAF has a permanent impact on the LIBOR-OIS spread and allows for post-event drift in spreads. However, as Wu does not control for post-TAF announcements, the estimated coefficient on the TAF event is biased. While the smaller event window (one day) used by Taylor (2011) reduces this bias, it does not allow for any examination of pre- or post-event drift.

Examining unconventional policy initiatives announced by the American, British, European Union, and Japanese authorities, Aït-Sahalia et al. (2010) find that announcements of domestic- and foreign-currency liquidity support were mostly associated with reductions in interbank lending spreads, while fiscal policy announcements had negligible effects. The authors also find that announcements of ad hoc bank bailouts had by far the largest impact, but not in a positive way; bailouts *aggravated* distress in interbank markets, with the negative response spilling over geographic borders. In contrast, systematic financial restructuring measures were more likely to be associated with a reduction in interbank risk premia. Furthermore, liability guarantee announcements had mixed effects, reducing interbank spreads during the subprime crisis, but widening spreads after the crisis deepened. Announcements of asset purchases (e.g., the TARP) were ineffective throughout the crisis, due to problems faced in implementing these measures.

[4]In order to remove the stigma associated with discount window borrowing, the TAF was introduced in December 2007 to allow depository institutions to borrow from the Federal Reserve without needing to disclose this publicly. The TAF was designed to mimic the tenders conducted by the European Central Bank (ECB).

In terms of other policies introduced during the crisis, Fleming, Hrung, and Keane (2009) find that the Term Securities Lending Facility (TSLF)[5] offset some of the spike in short-term funding spreads at the time, partly associated with the failure of Bear Stearns. Adrian, Burke, and McAndrews (2009) find that the Primary Dealer Credit Facility (PDCF),[6] introduced shortly after the TSLF, lowered credit default swap premia on dealers' and banks' senior bonds.

My paper's contribution to the literature is to include other Federal Reserve policy initiatives during the crisis using Kroszner and Melick (2010)'s organizing framework (see table 1), as well as an assessment of the impact of various fiscal policy initiatives. Focusing on the effect of a broad range of monetary and fiscal policy initiatives, aggregated categorically, rather than one particular policy, has three advantages. Firstly, it facilitates a comparison of the effectiveness of the various policy categories; secondly, it allows for a comparison of different fiscal and monetary policies; and thirdly, it minimizes the potential for "omitted policy bias" in the models' coefficients, which can arise in studies of single events, when other events are erroneously included with the given event.

This last point is particularly pertinent when undertaking research on the corporate bond market: in contrast to the equity market, corporate bond market price data are typically available at a daily frequency, while the various policies were typically announced close together—in some instances, in conjunction.[7] Unfortunately,

[5]The TSLF, introduced on March 11, 2008, allowed primary dealers to borrow Treasury securities from the Federal Reserve, for twenty-eight days, secured by a range of private securities. The TSLF was designed to limit the runs in the repo markets for private collateral, by allowing dealers to pledge Treasury securities as collateral in repos, making it easier for them to continue obtaining cash through repos.

[6]The PDCF effectively gave primary dealers discount window access, allowing them to borrow from the Federal Reserve at the primary credit rate. The fact that primary dealers could obtain funding at the same terms as depository institutions generated a large amount of controversy among market participants and in the media.

[7]For example, the Term Asset-Backed Securities Loan Facility (TALF) was announced on the same day—November 25, 2008—as the decision to start purchasing agency-guaranteed mortgage-backed securities and the decision to purchase agency-issued debt. Kroszner and Melick (2010)'s organizational framework can be used to estimate the separate effects of these policies.

data limitations (primarily data on corporate bonds, repo yields, and OIS yields) preclude an intraday investigation of policy announcements. Moreover, limitations in determining the precise time of the various announcements, using publicly available information, means it is impossible to precisely define the announcement time.[8] As intraday data are available for LIBOR futures—which are traded on the Chicago Mercantile Exchange—one extension to this paper is to focus on one yield (the LIBOR futures rate) and thereby conduct an intraday event study of the various policy announcements and implementations.

4. Data

4.1 Financial Market Data

Data on U.S. corporate bond yields are from Thomson Reuters Datastream (and constructed by Bank of America Merrill Lynch). The data are available for six types of corporate bonds: (i) AAA- and AA-rated "vanilla" (i.e., non-asset-backed) bonds; (ii) A- and BBB-rated vanilla bonds; (iii) AAA- and AA-rated asset-backed securities (ABS), backed by automotive loans; (iv) AAA- and AA-rated asset-backed securities, backed by credit cards; (v) AAA-rated mortgage-backed securities (MBS); and (vi) A-rated MBS.

In this paper, I consider one form of secured funding, sale and repurchase agreements ("repos"), and one form of unsecured funding, U.S. interbank loans. I use one-month repo-OIS spreads to measure the cost of secured funding, and the spread between the one-month London Interbank Offered Rate (LIBOR) and the one-month overnight index swap (OIS) rate to measure the cost of unsecured funding.

Data for one-month LIBOR and one-month OIS rates are from Thomson Reuters Datastream. Data for one-month repo yields are kindly provided by Andrew Metrick and used in Gorton (2010) and Gorton and Metrick (2012). The data relate to repos between dealer banks and are daily, from October 3, 2005 to February 2, 2009 (844

[8]Even if this information were available, the vast number of different fiscal and monetary policy announcements means identifying the precise times of these announcements would be an exhaustive exercise.

trading days). The choice of sample period reflects the availability of collateral-specific repo data. Consequently, this paper analyzes those Federal Reserve policies announcements made up to February 2009. The use of collateral-specific repo data allows me to examine the effects of policy announcements on specific segments of the repo market, and is one important innovation of this paper. As certain policies (for example, the Term Asset-Backed Loan Facility) were targeted at specific bond and repo markets (such as the market for ABS, and ABS-backed repos), these policies may have a differential impact on spreads in these markets versus other credit markets.[9]

A disadvantage of the collateral-specific approach is that, due to the limited sample period, it precludes examining the impact of the Federal Reserve's March 2009 announcement of Treasury bond purchases (see table 1). Here, however, using a collateral-specific approach appears less important, due to the broader nature of these asset purchases; indeed, this "general collateral" approach is the methodology used by Gagnon et al. (2011) and Hamilton and Wu (2011).[10] Due to this paper's focus on collateral-specific policy effects, examination of Treasury-bond purchases is beyond the scope of this paper.

4.2 Measuring the Monetary Policy Stance

As noted in section 1, I also consider the impact of "conventional" monetary policy on market pricing and liquidity. I define the stance of monetary policy as the difference between the actual effective federal funds rate and the effective federal funds rate implied by a Taylor rule. Taylor (1993) developed a hypothetical policy rule for the federal funds rate, which closely approximated the target federal funds rate between the late 1980s and early 1990s. The general version of the rule is

$$i_t = \pi_t + r_t^* + a_\pi \left(\pi_t - \pi_t^*\right) + a_y \left(y_t - \bar{y}_t\right), \tag{1}$$

[9]This "segmented markets" view is consistent with that of Woodford (2012) and much of the literature in this area.

[10]Other papers that look at the impact of Treasury bond purchases on credit markets include D'Amico and King (2010) and Krishnamurthy and Vissing-Jorgensen (2011).

where i_t is the target federal funds rate, π_t is the inflation rate, π_t^* is the desired inflation rate, r_t^* is the assumed equilibrium (Wicksellian) real interest rate, y_t is the natural logarithm of the level of real gross domestic product (GDP), and $\bar{y}_t$ is the natural logarithm of potential GDP, at time t. The Taylor rule thus specifies that i_t should respond to the divergence of the actual rate of inflation from the target inflation rate and also to the divergence of actual real GDP from potential GDP.

The main issues associated with estimating equation (1) are estimating potential GDP and specifying a target inflation rate. Over my period of analysis, the Federal Reserve did not have an explicit inflation rate target, unlike central banks like the Bank of England and the ECB, so specifying the value of π_t^* is not clear-cut. More importantly, estimating $\bar{y}_t$ is not straightforward. The most common practice is the use of statistical filters, such as that proposed by Hodrick and Prescott (1997) (henceforth, HP). However, the use of an HP filter has been strongly criticized by Cogley and Nason (1995), as the filter can generate spurious cycles in non-cyclical data. Furthermore, equation (1) embodies a contemporaneous (or backward) Taylor rule, which is inconsistent with the forward-looking nature in which the Federal Reserve and other central banks set monetary policy. In addition, the GDP series have historically been subject to more revisions than other series, such as the unemployment rate (Koenig 2005).

For these reasons, I estimate a forward-looking Taylor rule based on inflation forecasts and an unemployment rate gap. The specification is

$$i_t = \alpha + \beta\hat{\pi}_t^{t+T} + \delta\left(u_t - n_t\right), \tag{2}$$

where $\hat{\pi}_t^{t+T}$ is the expected inflation rate at time $t+T$, with the expectation formed at time t, u_t is the unemployment rate, and n_t is the natural unemployment rate. The unemployment terms appear due to the use of Okun's law in equation (1). This version of the Taylor rule more closely embodies the Federal Reserve's dual objectives of low and stable inflation, and maximum employment. It is possible to obtain (1) from (2) under the assumption that π_t^* and r_t^* are both constant.

Equation (2) is partly based on the model used in Rudebusch (2009), as I also use the Congressional Budget Office (CBO)'s estimate of the natural unemployment rate.[11] However, in contrast to Rudebusch (2009), I use inflation expectations, not realized inflation. I use two measures of inflation expectations, setting $T = 5$ in equation (2): (i) the Federal Reserve Bank of Cleveland's measure of inflation expectations[12] and (ii) the difference between the yield on a five-year Treasury bond and the yield on a five-year Treasury Inflation-Protected Security (TIPS).[13]

The inclusion of an "unemployment gap" in the Taylor rule reflects the Federal Reserve's dual mandate as embodied in section 2A of the Federal Reserve Act. Using this specification for the Taylor rule for the post-December 2008 period (i.e., the period during which the zero lower bound has been binding), rather than a "pure inflation" targeting framework with $\delta = 0$, is consistent with recent comments by Federal Reserve officials on the importance of the unemployment aspect of the statutory mandate (Board of Governors of the Federal Reserve System 2012; Kotcherlakota 2012).

I estimate equation (2) between January 2, 2003 and December 15, 2008, the latter date reflecting the day prior to the commencement of the targeting of the federal funds rate within the 0- to 25-basis-point range. I use the estimated coefficients to estimate the Taylor-rule implied federal funds rate between December 17, 2008 and December 31, 2009. Figure 3 reveals the actual and Taylor-rule implied effective federal funds rates, based on the Federal Reserve Bank of Cleveland's measure of inflation expectations, while appendix 1 contains the corresponding graphs using the five-year Treasury bonds-TIPS spread. The profiles of the series are broadly the same under both measures.

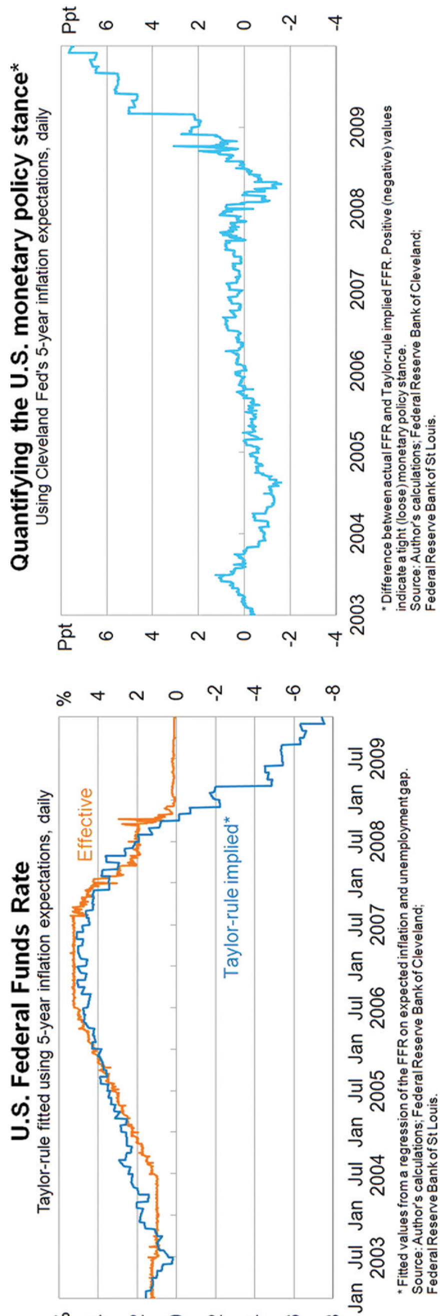
The Taylor rule closely approximated the actual effective federal funds rate between January 2003 and November 2008 (the $\bar{R}^2$ is

[11] The data are obtained from the Federal Reserve Bank of St Louis.

[12] Inflation expectations are derived from an affine model, driven by state variables including the short-term real interest rate, expected inflation, and volatility factors that follow GARCH processes. The parameters are estimated using data on inflation swap rates, nominal yields, and survey forecasts of inflation, in contrast to much of the existing literature which tends to use only the latter two variables. For more details, see Haubrich, Pennacchi, and Ritchken (2011).

[13] In order to test the sensitivity of the results, I set $T = 1$ and $T = 10$ in (2) for both measures of inflation expectations. While the coefficient estimates of (2) differ between each of the chosen maturities, the Taylor-rule estimates of i_t are broadly unchanged.

Figure 3. U.S. Federal Funds Rate



0.87), but the approximation error became increasingly large once the zero lower bound began to be a binding constraint (left panel, figure 3). The Taylor-rule implied rate continued to decline during 2009, reflecting a decrease in inflation expectations and a rise in the unemployment gap, reaching a low of –7.5 percent during November 2009.

The consensus in macroeconomics, summarized in Mishkin (2009), is that monetary policy retains its potency and ability to achieve a central bank's macroeconomic objectives even at the zero bound. I use these arguments as justification for defining the stance of U.S. monetary policy as the difference between the actual and Taylor-rule implied federal funds rate. The binding zero constraint on the federal funds rate suggests that monetary policy became increasingly contractionary from July 2008, with the difference between the implied Taylor-rule rate and the effective federal funds rate reaching a high of 7.5 percent in late 2008 (right panel, figure 3).

As negative federal funds rates are clearly infeasible, once the federal funds rate hit the zero lower bound, the Federal Reserve engaged in various "unconventional" policy measures to try to fulfill its dual mandate. If these policies had been successful in achieving the Federal Reserve's dual mandate, the Taylor-rule implied federal funds rate would have been much higher. It is likely that this counterfactual rate would have exceeded zero; I estimate that the effective federal funds rate consistent with a zero unemployment gap would have been, on average, 3.57 percent between December 2008 and December 2009, with a corresponding expected average inflation rate of 2.33 percent.[14] The counterfactual federal funds rate would have been consistent with the Federal Reserve's dual mandate.

Hence, figure 3 reveals that the Federal Reserve's unconventional policies failed to achieve their dual mandate. Focusing solely on the level of the effective federal funds rate obscures this finding and may lead to "the fallacy of identifying tight money with high interest rates and easy money with low interest rates" (Friedman 1998).

[14]The counterfactual expected inflation rate is estimated from a regression of the unemployment gap on the expected five-year inflation rate (from Haubrich, Pennacchi, and Ritchken 2011), setting the unemployment gap to zero. I use this counterfactual inflation rate in equation (2) to estimate the counterfactual federal funds rate.

5. Empirical Methodology

To examine the relationship between bond spreads and conventional and "unconventional" monetary policy, I use a first-order vector autoregression (VAR):

$$\mathbf{X}_t = \alpha + \beta \mathbf{X}_{t-1} + \Theta D_t^{Fiscal} + \Gamma \mathbf{D}_t^{Unconv} + \eta Stance_t + \boldsymbol{\epsilon}_t, \quad (3)$$

where $\mathbf{X}_t$ is a 3x1 vector containing bond spreads, one-month repo-OIS spreads, and one-month LIBOR-OIS spreads; $\mathbf{D}_t^{Unconv}$ is a 1x3 vector of dummy variables for each of the three types of "unconventional" monetary policies. Each element of $\mathbf{D}_t^{Unconv}$ equals 1 if a policy from the respective category was announced on day t, $t-1$, or $t+1$; or 0. D_t^{Fiscal} is a scalar dummy variable equal to 1 if a fiscal policy announcement was made on day t, $t-1$, or $t+1$; or 0. The specifications for $\mathbf{D}_t^{Unconv}$ and D_t^{Fiscal} reflect the use of a three-day interval around an event, to allow for pre- and post-event drift.

The use of a VAR reflects the fact that the three spread variables Granger-cause each other (see appendix 2). For the AR terms, a one-day lag is chosen on the basis of the Akaike and Schwartz-Bayesian information criterion, as well as a desire for parsimony.

The various LOLR facilities introduced by the Federal Reserve were typically aimed at alleviating strains in short-term funding markets, reflecting these markets' greater susceptibility to investor runs, compared with longer-term funding markets. Hence, I include the cost of short-term funding in the VAR. These policies were also aimed at limiting fire sales of assets like corporate bonds and asset-backed securities, in response to liquidity problems in the secured and unsecured markets. Consequently, the VAR also includes spreads on those corporate bonds and asset-backed securities outlined in section 4.

The inclusion of conditioning variables—lagged values of the dependent variables, the monetary policy stance, and various policy dummy variables—means that I focus on the surprise component of the separate policy announcements. This treatment is similar to that used by Aït-Sahalia et al. (2010), who focus on the three-month LIBOR-OIS spread and use a pure random-walk model to extract the residual return. In contrast, I use a larger set of conditioning variables, since I focus on three key market spreads, and specify a stationary model, since there is no theoretical basis for a unit root in market spreads.

$Stance_t$ is defined as the difference between the effective and Taylor-rule implied federal funds rates (see figure 3), and is measured using five-year inflation expectations from Haubrich, Pennacchi, and Ritchkin (2011). α, β, Γ, Θ, and η are parameters to be estimated, while $\boldsymbol{\epsilon}_t$ is a 3x1 vector of residuals, on day t.

During the crisis, some unconventional monetary policies involved the Federal Reserve purchasing risky assets. For example, on November 25, 2008, the Federal Reserve announced it would purchase MBS guaranteed by housing-related U.S. government-sponsored enterprises (GSEs),[15] and purchase the senior debt of these GSEs. These policies blurred the distinction between monetary and fiscal policy, since traditional monetary policy has revolved around investments in (risk-free) U.S. Treasury securities. Christiano, Eichenbaum, and Rebelo (2011) show that government spending has a large multiplier when the zero interest rate lower bound is binding, and thus it is important to distinguish between monetary policy and fiscal policy announcements in order to properly identify the effects of these policies on market spreads.

In order to control for the effect of fiscal policy on market spreads, I include key fiscal policy announcements in the D_t^{Fiscal} variable. The dates of fiscal policy announcements are from Federal Reserve Bank of St. Louis (2012). The dates are (i) September 19, 2008; (ii) September 29, 2008; (iii) October 3, 2008; (iv) October 14, 2008; and (v) November 12, 2008. The events relating to these dates are detailed in appendix 3.

These dates correspond to events that may have had both stabilizing and destabilizing effects on spreads. Mishkin (2011) argues that the initial rejection of the Troubled Asset Relief Program (TARP) bill (on September 23, 2008), its subsequent delay in finally being passed, and the various "Christmas-tree" provisions that were included in the bill in order for it to pass through both houses of Congress, were all events that aggravated market spreads. Taylor (2011) argues that the lack of detail in the original TARP bill (a total of $2\frac{1}{2}$ pages, with no mention of oversight and few restrictions on the use of funds) created significant uncertainty about the TARP's stated aims and likely effects, which destabilized market spreads. On the

[15]The Federal National Mortgage Association (Fannie Mae), Federal Home Loan Mortgage Corporation (Freddie Mac), and the Federal Home Loan Banks.

other hand, Aït-Sahalia et al. (2010) find that announcements of systematic bank recapitalization policies, such as the eventual passage of the TARP bill on October 3, 2008, had a stabilizing influence on interbank loan spreads. My inclusion of all dates related to the TARP announcements is designed to estimate the average impact of the TARP on market spreads.

The announcement dates for the various "unconventional" monetary policies are from Kroszner and Melick (2010) (see table 1). To this, I add two dates associated with announcements of extensions to these policies, from Federal Reserve Bank of St. Louis (2012):

- December 2, 2008: extension of three key LOLR facilities (PDCF, AMLF,[16] and TSLF) through to April 30, 2009, and
- February 3 2009: extension, to October 30, 2009, of those liquidity facilities scheduled to expire on April 30, 2009.

The various fiscal and monetary policies were motivated on the basis of returning markets to "normal" functioning, with a desired reduction in both the level and volatility of spreads. I follow Frank and Hesse (2009) and estimate a multivariate (trivariate) first-order GARCH model of the following form:

$$\mathbf{H}_t = \mathbf{C}\mathbf{C}' + \mathbf{A}\boldsymbol{\epsilon}_{t-1}\boldsymbol{\epsilon}'_{t-1}\mathbf{A}' + \mathbf{B}\mathbf{H}_{t-1}\mathbf{B}' + \mathbf{E}D_t^{Fiscal} + \mathbf{F}\mathbf{D}_t^{Unconv} + \mathbf{G}Stance_t, \quad (4)$$

where $\mathbf{H}_t$ is the 3x3 covariance matrix of the VAR model's residuals at time t; $\boldsymbol{\epsilon}_{t-1}$ is a 3x1 matrix of the VAR residuals (at time $t-1$); and $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{E}$, $\mathbf{F}$, and $\mathbf{G}$ are parameter matrices to be estimated. $\mathbf{D}_t^{Unconv}$, D_t^{Fiscal}, and $Stance_t$ are the same as in equation (3).

Equation (4) is the popular BEKK GARCH (1,1) model, developed by Engle and Kramer (1995), augmented with the policy variables as exogenous regressors. Even without including the

[16]The Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) was announced on September 19, 2008, under which nonrecourse loans were made to banks at the primary credit rate, to finance purchases of asset-backed commercial paper (ABCP) from money-market funds (MMFs) at above-market prices. The cash obtained by the MMFs could then be used to meet redemption requests, thereby increasing their willingness to continue providing short-term secured funding, primarily via repos, to banks.

parameters on the policy variables, a drawback of the BEKK model is the large number of parameters (twenty-four) that need to be estimated.[17] However, its advantage over other multivariate GARCH models is that it ensures $\mathbf{H}_t$ is positive definite.[18] In order to avoid overfitting, I test whether the full BEKK model can be reduced to a "diagonal" BEKK model, in which $\mathbf{A}$ and $\mathbf{B}$ are both diagonal, such that $\sigma_{jk,t} := Cov_{t-1}(\epsilon_{j,t}, \epsilon_{k,t})$ depends only on $\sigma_{jk,t-1}$ and $\epsilon_{j,t-1}, \epsilon_{k,t-1}$.

In addition to the guarantee of $\mathbf{H}_t$ being positive definite, I choose the BEKK model in order to compare my results with Frank and Hesse (2009). While the choice of VAR and GARCH models are the same as Frank and Hesse (2009), I consider the contemporaneous impact of the policies on the level and volatility of spreads, while Frank and Hesse allow for one- and two-day lagged effects. However, Frank and Hesse (2009) provide no justification for why lagged effects might be more important than contemporaneous effects.

In contrast to Frank and Hesse (2009), my construction of $\mathbf{D}^{Unconv}$ and $\mathbf{D}^{Fiscal}$ allows for both lagged and contemporaneous (and leading) effects, as I consider the three-day window around each type of fiscal and "unconventional" monetary policy announcement. The results of this VAR(1)-GARCH(1,1) model are discussed in section 6.

6. Non-State-Dependent VARs

6.1 All Corporate Bonds

Table 2 contains the parameter estimates from equation (3), with three important findings. Firstly, Federal Reserve policy announcements had modest impacts on spreads, with statistically significant (at the 5 percent level) announcement effects observed only for LIBOR-OIS spreads. For LIBOR-OIS spreads, Federal Reserve policies that broadened the eligibility of collateral (D^{Collat}) and the type

[17] Excluding the policy variables, equation (4) requires estimating $(p+q)\,N^2 + N\,(N+1)\,\frac{1}{2}$ parameters, where p and q are the number of lags of $\boldsymbol{\epsilon\epsilon}'$ and $\mathbf{H}$, respectively, and N is the number of dependent variables. Here, $N = 3$ and $p = q = 1$.

[18] Bauwens, Laurent, and Rombouts (2006) and Silvennoinen and Teräsvirta (2009) survey the extensive literature on multivariate GARCH models.

Table 2. VAR Parameter Estimates—All Bonds

This table reports the parameter estimates from equation (3), with multivariate GARCH(1,1) corrected z-statistics in brackets. The multivariate GARCH model is equation (4). *LIB-OIS* is the spread between the one-month LIBOR and the one-month OIS rate, *Repo* is the one-month repo-OIS spread, and *Bond* is the spread between duration-matched U.S. corporate bonds and U.S. Treasuries. D^{Fiscal} is a dummy variable that equals 1 when a fiscal policy announcement is made (or one day preceding or proceeding the announcement), while D^{Mat}, D^{Cpart}, and D^{Collat} are dummy variables relating to a three-day window around Federal Reserve policies to, respectively, lengthen the maturity of open-market operations, expand the type of counterparties, and broaden the type of collateral eligible for secured lending. Finally, *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	*LIB-OIS*(−1)	*Repo*(−1)	*Bond*(−1)	D^{Fiscal}	D^{Mat}	D^{Cpart}	D^{Collat}	*Stance*	Adj. R^2
LIB-OIS	0.953	0.001	0.001	0.023	−0.005	−0.011	−0.015	0.047	0.98
	[19.1]	[11.1]	[5.32]	[2.19]	[−1.55]	[−2.04]	[−2.19]	[2.21]	
Repo	0.018	0.972	0.004	0.135	−0.003	−0.019	0.008	0.007	0.98
	[0.52]	[0.11]	[8.21]	[0.14]	[−0.89]	[0.25]	[1.31]	[2.16]	
Sprd	0.051	0.026	0.971	0.006	−0.040	0.069	0.083	0.037	0.98
	[0.52]	[0.11]	[8.21]	[0.14]	[−0.89]	[0.25]	[1.31]	[2.16]	

of counterparties (D^{Cpart}) were more effective in reducing spreads than policies that increased the maturity of support (D^{Mat}). However, the economic significance was modest, with spreads falling only around 1 basis point on each of the three days around each announcement (i.e., the cumulative effect is a 3- to 4-basis-point decline in spreads).[19]

Secondly, fiscal policy announcements were associated with no significant change in bond spreads, but significant—though increasing—changes in repo and LIBOR-OIS spreads. In response to fiscal policy announcements, repo spreads and LIBOR-OIS spreads rose by around 40 basis points and 7 basis points, respectively, over the three-day event window. This finding is consistent with Taylor (2011).

Finally, the monetary policy stance is found to have adversely affected credit spreads: a one-standard-deviation rise in *Stance* (a rise of 92 basis points) increased bond and interbank loan spreads by around 3 basis points, and repo spreads by 1 basis point. In contrast, a proportionate rise in D^{Collat} lowered repo spreads by a total of 1 basis point over the three-day event window. These results suggest that the efficacy of the Federal Reserve's unconventional policies was reduced by the contractionary stance of conventional policy (as measured by the difference between the Taylor rule and the effective federal funds rate).

Likelihood-ratio tests suggest that the full BEKK model is more appropriate than a diagonal BEKK model. For the sake of brevity, I report only the parameter coefficients and Bollerslev-Wooldridge robust z-statistics corresponding to the policy variables in equation (4) with the full output available upon request.[20]

[19]In terms of the AR coefficients, I generally cannot reject the null hypothesis that spreads contain a unit root. However, I do not allow for non-stationarity in spreads, as there is no theoretical justification for a unit root in spreads; one of the implications of an $I(1)$ process is that $Prob(s_t < |R| = 0)$ as $t \to \infty \forall R \leq \infty$, for each of the three types of spreads (s). The reliance on theory here reflects the low power of unit-root tests: in any finite sample, a "true" trend-stationary process can be arbitrarily well approximated by a difference-stationary process.

[20]Bollerslev and Wooldridge (1992) provide an adjustment to the covariance matrix which ensures that QML estimators of the parameters in equation (4) remain consistent and asymptotically normally distributed even when the residual conditional distribution is non-Gaussian.

Table 3. BEKK Multivariate GARCH Model Estimates—All Bonds

This table reports selected parameter estimates from equation (4), with Bollerslev-Wooldridge adjusted z-statistics in brackets. $\sigma^2_{LIB-OIS}$, σ^2_{Repo}, and σ^2_{Bond} is the conditional variance of residuals from equation (3) for, respectively, *LIB-OIS, Repo,* and *Bond.* D^{Fiscal} is a dummy variable that equals 1 when a fiscal policy announcement is made (or one day preceding or proceeding the announcement), while D^{Mat}, D^{Cpart}, and D^{Collat} are dummy variables relating to a three-day window around Federal Reserve policies to, respectively, lengthen the maturity of open-market operations, expand the type of counterparties, and broaden the type of collateral eligible for secured lending. Finally, *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	D^{Fiscal}	D^{Mat}	D^{Cpart}	D^{Collat}	*Stance*
$\sigma^2_{LIB-OIS}$	−0.002	0.000	−0.006	−0.001	0.001
	[−0.64]	[1.59]	[−4.82]	[−2.20]	[5.54]
σ^2_{Repo}	0.017	−0.019	−0.036	0.000	0.001
	[2.78]	[−0.16]	[−3.72]	[0.38]	[4.05]
σ^2_{Sprd}	0.081	0.034	−0.049	−0.088	−0.12
	[0.05]	[0.10]	[−0.18]	[−0.27]	[−0.05]

Collectively, the results reveal that the policy announcements had a weak impact on market volatility (table 3). Announcements of policies that extended the counterparties to Federal Reserve support had a statistically significant (at the 1 percent level) negative effect on the conditional variance of LIBOR-OIS and repo spreads, but no significant impact on the conditional variances of bond spreads. Fiscal policy announcements led to a rise in the conditional variance of repo spreads, similar to the evidence in table 2, but had no impact on other conditional variances. Fiscal policy announcements were associated with a 60 percent (13-basis-point) rise in the conditional volatility of repo spreads, an economically and statistically significant (at the 1 percent level) result.

Notably, a rise in the value of *Stance* led to a rise in both $\sigma^2_{LIB-OIS}$ and σ^2_{Repo}, with these effects statistically significant at the 1 percent level. A one-standard-deviation positive shock to *Stance* raised the conditional volatility of LIBOR-OIS and repo spreads by

3 basis points (7 percent and 3 percent, respectively). These findings are similar to those in table 2.

6.2 Individual Bond Segments

The discussion in the previous subsection was based on the impact of policy initiatives on all six bond markets. However, it is possible that the impact of these initiatives differs across the various bond markets, since certain policies (such as the Term Asset-Backed Loan Facility) were targeted at specific bonds (such as asset-backed securities, or ABS), and so these policies may have had a greater impact on alleviating strains in these markets. The targeting of the ABS market reflected the fact that securitization markets experienced greater stresses than vanilla bond markets, due to investors' loss of confidence in the valuation and ratings methodology of these securities, and the subsequent rise in "model risk" (Coval, Jurek, and Stafford 2009).

To examine potential bond-specific heterogeneity, I group all ABS into one category (labeled "All ABS") and all non-ABS into another ("Non-ABS"). The aggregation of all types of ABS reflects the fact that even for those Federal Reserve policies (like the TALF) which targeted securitization markets, a wide range of ABS were eligible for support. I estimate equation (3) for each of these two categories, reporting the results in table 4.

Table 4 reveals some evidence of bond-specific heterogeneity. While fiscal policy announcements were associated with a rise in spreads on ABS and ABS repos, these policy announcements did not affect vanilla bond spreads. In addition, while all types of unconventional monetary policy announcements are insignificant for bond spreads, there are differences in announcement effects for repo-OIS spreads. Policies that expanded the type of counterparties have highly statistically significant (at the 1 percent level) announcement effects for spreads on ABS repos, with spreads declining by one-seventh (18 basis points) over the three-day window (panel A). These announcement effects are double in size of those for spreads on non-ABS repos, which decline by 7 percent (6 basis points), and are also less statistically significant (panel B).

The monetary policy stance remains a statistically significant influence on the spreads of both bond categories, though the

Table 4. VAR Parameter Estimates—Bond Categories

This table reports the parameter estimates from equation (3), with multivariate GARCH(1,1) corrected z-statistics in brackets. The multivariate GARCH model is equation (4). *LIB-OIS* is the spread between the one-month LIBOR and the one-month OIS rate, *Repo* is the one-month repo-OIS spread, and *Bond* is the spread between duration-matched U.S. corporate bonds and U.S. Treasuries. D^{Fiscal} is a dummy variable that equals 1 when a fiscal policy announcement is made (or one day preceding or proceeding the announcement), while D^{Mat}, D^{Cpart}, and D^{Collat} are dummy variables relating to a three-day window around Federal Reserve policies to, respectively, lengthen the maturity of open-market operations, expand the type of counterparties, and broaden the type of collateral eligible for secured lending. Finally, *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). Panels A and B report the results for all asset-backed bonds and non-asset-backed bonds, respectively. The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	***LIB-OIS*(−1)**	***Repo*(−1)**	***Bond*(−1)**	D^{Fiscal}	D^{Mat}	D^{Cpart}	D^{Collat}	***Stance***
A. All Asset-Backed Bonds								
LIB-OIS	0.991	0.003	0.000	0.015	−0.001	−0.011	−0.002	0.005
	[10.5]	[3.48]	[1.69]	[6.36]	[−1.55]	[−7.40]	−0.002	0.005
Repo	0.005	0.956	0.002	0.250	−0.004	−0.062	−0.003	0.007
	[0.19]	[51.6]	[4.41]	[15.6]	[−1.12]	[−6.54]	[−0.96]	[1.97]
Sprd	0.028	−0.011	0.994	0.207	0.074	0.138	0.158	0.022
	[1.15]	[−0.97]	[36.9]	[4.39]	[0.83]	[0.53]	[1.07]	[4.67]
B. All Non-Asset-Backed Bonds								
LIB-OIS	0.945	0.008	−0.007	0.137	−0.027	−0.027	0.004	0.009
	[32.7]	[0.34]	[−3.10]	[4.09]	[−2.85]	[−2.85]	[1.09]	[3.54]
Repo	−0.002	0.974	−0.002	0.200	−0.018	−0.022	−0.036	0.008
	[0.57]	[31.1]	[−1.02]	[5.16]	[−1.54]	[−1.81]	[−1.92]	[2.81]
Sprd	−0.041	0.127	0.083	−0.011	−0.016	0.037	0.020	0.008
	[−1.86]	[2.41]	[18.8]	[−0.31]	[−0.81]	[1.29]	[0.33]	[2.10]

economic significance remains modest. A 100-basis-point rise in *Stance* raises spreads on ABS and repos collateralized by ABS by 1–2 basis points, about the same as the increase in non-ABS spreads. In summary, the evidence in table 4 suggests that while there is some evidence of bond-specific heterogeneity, reflecting the fact that some unconventional monetary policies were targeted at idiosyncratic segments of the bond market, these policies' effects were felt across the broader bond market.

It is also worth noting that equation (4) was estimated separately for all ABS and all non-ABS. Similar to table 4, I found little evidence of bond-specific heterogeneity in the significance of the policy variables, with the results omitted for the sake of brevity, though available on request.

7. State-Dependent VAR

While the categorical analysis used above helps to make the model fairly parsimonious, it assumes that individual policies within each category had the same effect on market spreads. It also assumes that the three-day event window is appropriate for each policy announcement; that is, it assumes that each policy had, at most, only one day of pre- or post-event "drift." These assumptions may not be realistic, as some policies may have been anticipated by the market more than one day prior to the announcement, while some other policies may have taken longer to affect spreads. For example, announcements of new programs, as opposed to extensions of existing programs, may have been considered "untested" by market participants, which may have both reduced the announcement-day effect and increased the post-event drift, as agents considered the pricing implications of these policies. In contrast, announcements of program extensions may not have had a drawn-out effect on spreads, as these announcements, while possibly being "news," were not novel.

To perform this "policy-specific" analysis, I estimate a Markov-switching VAR (MSVAR) model. For the sake of simplicity, I use a model in which two possible regimes exist, with fixed transition probabilities. The Markov-switching model differs from models with imposed breaks in that the timing of breaks is entirely endogenous. Indeed, breaks are not explicitly imposed, but inferences are drawn on the basis of probabilistic estimates of the most likely state prevailing at each point in time.[21]

A regime-switching approach is superior to alternative approaches like value-weighting policies, or focusing on those periods in which credit spreads fell sharply. Value-weighting policies assumes that the largest policies are likely to have the greatest announcement effects—an assumption that contradicts the finding in section 6 that the policies with the largest announcement effects were not the biggest in size. Conditioning on the drop in spreads raises the question of how to define a "sharp" decline in spreads—it is not obvious that focusing on decline in the levels of spreads would be better than focusing on proportionate declines. The regime-switching approach used here overcomes the limitations of these two approaches, as the change in state is determined endogenously.

Incorporating regime shifts in the VAR model leads to the state-contingent version of equation (3):

$$\mathbf{X}_t = \alpha\left(s_t\right) + \beta\left(s_t\right)\mathbf{X}_{t-1} + \eta Stance_t + \boldsymbol{\epsilon}\left(s_t\right), \tag{5}$$

where $\boldsymbol{\epsilon}\left(s_t\right) \sim NIID\left(0, \Sigma\left(s_t\right)\right)$, and $\alpha\left(s_t\right)$, $\beta\left(s_t\right)$, and $\Sigma\left(s_t\right)$ are parameter shift functions describing the dependence of the parameters α, β, λ, η, and Σ on the existing regime, s_t. s_t denotes a latent state variable, which follows a continuous-time Markov chain with two different regimes ($s_t \in \{0, 1\}$) and transition probabilities:

$$P = \begin{bmatrix} p_{00} & 1 - p_{00} \\ 1 - p_{11} & p_{11} \end{bmatrix}.$$

To make the model fairly parsimonious, equation (5) is estimated allowing for regime shifts only in α (the intercept vector) and the conditional covariance matrix of $\boldsymbol{\epsilon}$ ($\mathbf{H}_t$). In the interest of parsimony,

[21] Technical details regarding Markov-switching models can be found in Hamilton (1994). A BDS test of the VAR models' residuals rejects the null (at the 1 percent level) that a linear specification is appropriate, providing further justification for examining non-linear models. In addition, Andrews' (1993) test for regime change strongly rejects the null of no structural break in the estimated parameter coefficients.

Table 5. MSVAR Parameter Estimates—All Bonds

This table reports the quasi-maximum likelihood parameter estimates of the intercept terms (denoted by α) from equation (5), with robust t-statistics in brackets. *LIB-OIS* is the spread between the one-month LIBOR and the one-month OIS rate, *Repo* is the one-month repo-OIS spread, and *Bond* is the spread between duration-matched U.S. corporate bonds and U.S. Treasuries. The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

	LIB-OIS		**Repo**		**Bond**	
Parameter	**Regime 1**	**Regime 2**	**Regime 1**	**Regime 2**	**Regime 1**	**Regime 2**
α	−0.143 [−1.25]	0.564 [2.89]	−0.197 [−1.69]	0.723 [3.57]	−0.242 [−1.90]	2.811 [3.11]

I do not estimate a Markov-switching version of equation (4).[22] The output is contained in table 5.

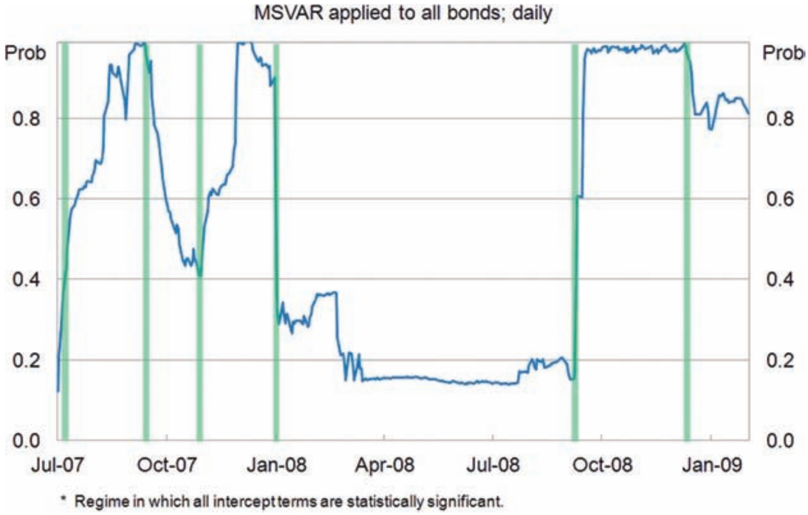
The output reveals a strong presence of two regimes, one in which the intercept terms are statistically insignificant (at the 5 percent level), and another regime in which the intercept terms are statistically significant (at the 1 percent level). I dub the former regime a "lower-spread" regime, reflecting the lower unconditional spreads in this regime, relative to the latter, "higher-spread" regime.

In order to assess the effectiveness of the various fiscal and monetary policies, I calculate the unconditional probability of being in the second regime on each day, $p^{highsprd}$, and then examine whether there were any fiscal or monetary policies announcements associated with key turning points in $p^{highsprd}$. The unconditional probability arising from estimating equation (5) for all six corporate bond types is shown in figure 4, with the key turning points shaded.

$p^{highsprd}$ rose sharply between July and September 2007, and then fell between late September and October 2007 before again rising sharply in November 2007. $p^{highsprd}$ fell significantly in 2008

[22] Allowing for regime shifts in only the intercept terms and the residual covariance matrix reduces the number of parameters to be estimated from fifty-two to thirty-four. The MSVAR is estimated using the algorithm of Perlin (2011). I estimate the standard errors using the "sandwich" estimator (i.e, the outer products of the gradient vectors), which is robust to a failure of the assumption that the residuals are conditionally normally distributed.

Figure 4. Probability of Being in "Higher-Spread" Regime*



and stabilized at low levels (around 0.2) during most of 2008, until a dramatic spike in September 2008. Following this, it remained at elevated levels close to 1.0 for the next three months and then fell slightly during end-2008 and early 2009. The six shaded areas correspond to the following periods: (i) early July 2007, (ii) mid-September 2007, (iii) late October 2007, (iv) early January 2007, (v) early September 2008, and (vi) December 2008.

July–September 2007. There were no fiscal or unconventional monetary policy announcements associated with the movements in $p^{highsprd}$ between July and September 2007 (table 10, appendix 2). Instead, the fall in $p^{highsprd}$ between late September and October 2007 likely reflected the use of conventional monetary policy: a reduction in the federal funds rate (figure 1). However, during the second half of 2007, the Taylor-rule measure of the stance implied that U.S. monetary policy was modestly contractionary; the effective federal funds rate was, on average, around 60 basis points higher than the Taylor-rule implied rate, over this period. This contractionary stance may have partly contributed to the rise in $p^{highsprd}$ between July and December 2007 (the correlation between *Stance* and $p^{highsprd}$ during this period was 0.17).

November 2007–January 2008. $p^{highsprd}$ rose sharply between early November and December 2007, reaching a peak of 1.0 on December 4 before falling slightly from December 12, 2007, with an even larger decline observed in early January 2008. The initial drop in $p^{highsprd}$ likely reflected the announcement, on December 12, 2007, of the Term Auction Facility (TAF) and U.S. dollar swap lines between the Federal Reserve and, respectively, the ECB and Swiss National Bank.[23] These policies were implemented on December 17 and December 20 (both in 2007), respectively.

These policies had a modest impact on $p^{highsprd}$, which fell slightly over December 2007. The larger decline in early January 2008 may also have been due to these policies, though this would have required a drawn-out response (over ten trading days). McAndrews, Sarkar, and Wang (2008) and Wu (2010) document that the bulk of the TAF's impact on market spreads occurred during the TAF's operation, rather than upon its announcement, although, as noted in section 3, these papers do not control for the influence of intervening fiscal and monetary policies.

September 2008. After stabilizing at around 0.2 during most of 2008, $p^{highsprd}$ spiked sharply in September 2008, following the failure of Lehman Brothers and AIG, and runs on large U.S. money-market funds. Mishkin (2011) and Taylor (2011) argue that fiscal policy aggravated, rather than stabilized, market strains during this time, an argument consistent with my empirical analysis (see tables 2–4). Furthermore, the October 3, 2008 announcement that the TARP bill was passed into law did not appear to lead to a decrease in $p^{highsprd}$, which remained elevated throughout October 2008. In addition, the U.S. monetary policy stance—as measured by the Taylor-rule residual—became increasingly contractionary during this period (see figure 3), another contributor to market instability. The elevated value of $p^{highsprd}$ between September 2008 and early December 2008 suggests that fiscal and "unconventional" monetary policies announced during this time[24] were largely ineffective in reducing market strains.

[23]Under these swap lines, the Federal Reserve sold U.S. dollars to foreign central banks and bought euros and Swiss dollars, respectively, at prevailing market exchange rates, with the transactions reversed at a prespecified time (between one day and three months) in the future.

December 2008. $p^{highsprd}$ declined from 1.0 to 0.8 between early and mid-December 2008. While there were no new fiscal or monetary policies announced at this time, the decline may have reflected the announcement, on December 2, 2008, that three LOLR facilities were being extended to the end of April 2009. The decline may also have been due to the implementation of those LOLR programs introduced in November 2008. For example, the program of buying GSE-issued debt was implemented from December 5, 2008, and the purchase of RMBS from AIG was implemented from December 12, 2008.

In summary, instances where $p^{highsprd}$ fell were typically not associated with fiscal or monetary policy announcements. In fact, falls in $p^{highsprd}$ typically occurred during periods in which policies were implemented so that, if the various fiscal and monetary policy initiatives were important in reducing market strains, the effect came after these policies were announced. Furthermore, instances where large errors in fiscal and monetary policy occurred—such as the failures to pass the TARP bill in September 2008 and adhere to optimal monetary policy rules during the second half of 2007 and the final quarter of 2008—were instances in which $p^{highsprd}$ rose sharply.

These findings are consistent with the statistical analysis in section 6, which found that the efficacy of these LOLR policies was partly undermined by the stance of conventional monetary policy.

8. Implementation Effects

The discussion in sections 6 and 7 focused largely on the announcement effects of the various fiscal and monetary policies. The examination of announcement effects assumes a degree of informational efficiency, in that each of the LOLR programs only affect market spreads upon announcement, with no effect upon each program's implementation, which may be a restrictive assumption.

There are two reasons for considering "implementation effects." The first concerns the framing of "conventional" monetary policy as

[24]For example, the Federal Reserve announced, in November 2008, plans to purchase residential mortgage-backed securities (RMBS) and collateralized debt obligations (CDOs) from AIG, and to purchase RMBS guaranteed by GSEs and GSE-issued debt.

the targeting of overnight interbank interest rates on the basis of open-market operations in low-risk assets. Policies based on longer-term and riskier assets, in an environment of a virtually zero federal funds rate, were viewed as “unconventional” since they were outside the traditional paradigm, even though these policies, in essence, augmented the Federal Reserve’s traditional toolkit. Thus, there may have been a large degree of uncertainty about the potential effect of these policies on market spreads, at the time of announcement.

Secondly, there may have been doubts about the Federal Reserve’s credibility in implementing these policies, which also may have muted their announcement effects. On the one (extreme) hand, if the unconventional policies were deemed completely credible, spreads should have fallen upon announcement of these policies, such that subsequent implementation was not required. Hence, the mere fact that these policies were implemented suggests the announcements lacked complete credibility. On the other hand, as noted above, the perceived “unconventional” nature of these policies may have muted their announcement effects, such that subsequent implementation was required.

To examine the potential for implementation effects, I use the dates given in Kroszner and Melick (2010) (see table 1), and augment equations (3) and (4) with three dummy variables relating to the three types of unconventional monetary policies. These dummy variables equal 1 on the implementation date of the various policies, and 0 otherwise. The VAR(1)-GARCH(1,1) model becomes

$$\begin{aligned}\mathbf{X}_t = \alpha + \beta\mathbf{X}_{t-1} + \Theta D_t^{Fiscal} + \Gamma\mathbf{D}_t^{Unconv,Ann} + \eta Stance_t \\ + \mu\mathbf{D}_t^{Unconv,Imp} + \boldsymbol{\epsilon}_t,\end{aligned} \tag{6}$$

where $\mathbf{X}_t$, D_t^{Fiscal}, and $Stance_t$ are the same as in equation (3). $\mathbf{D}_t^{Unconv,Ann}$ is a 1x3 vector of dummy variables that equal 1 when an “unconventional” monetary policy announcement occurs at time t, $t-1$, or $t+1$, and 0 otherwise. $\mathbf{D}_t^{Unconv,Imp}$ is a 1x3 vector of dummy variables that equal 1 when one of the three types of unconventional monetary policies are implemented, and 0 otherwise. $\boldsymbol{\epsilon}_t$ is a 3x1 vector of residuals, with $\boldsymbol{\epsilon}_t|\Sigma_{t-1} \sim N(0, \mathbf{H}_t)$. The conditional covariance matrix $\mathbf{H}_t$ is given by

$$\mathbf{H}_t = \mathbf{C}\mathbf{C}' + \mathbf{A}\boldsymbol{\epsilon}_{t-1}\boldsymbol{\epsilon}'_{t-1}\mathbf{A}' + \mathbf{B}\mathbf{H}_{t-1}\mathbf{B}' + \mathbf{E}D_t^{Fiscal} + \mathbf{F}\mathbf{D}_t^{Unconv,Ann} + \mathbf{G}\mathbf{D}_t^{Unconv,Imp} + \mathbf{J}Stance_t. \qquad (7)$$

For the sake of brevity, I report only the parameter coefficients corresponding to the policy variables. The results for equations (6) and (7) are given in tables 6 and 7, respectively.

All three categories of "unconventional" monetary policy initiatives had significant implementation effects on LIBOR-OIS and repo spreads, with less significant effects for bond spreads (table 6). For all spreads, implementation effects greatly dominated announcement effects, across all three types of monetary policies. This finding is consistent with the graphical analysis of regime probabilities in section 7, which revealed that the periods in which $p^{highsprd}$ declined were typically those periods in which monetary policies were implemented rather than announced.

The implementation effects were greatest for programs that widened the collateral eligible for Federal Reserve liquidity support, with spreads falling between 10 and 26 basis points upon the programs' implementation (table 6). Announcement effects are statistically significant only for LIBOR-OIS spreads, and only for two of the three policy categories, which fell by 7.5 basis points over the three-day window. The second largest implementation effects were observed for programs that broadened the range of counterparties to Federal Reserve support, with spreads declining by 5–20 basis points upon the programs' implementation.

Finally, fiscal policy announcements were typically associated with increases in spreads, while the monetary policy stance remains a significant influence on spreads, as was the case in table 2.

Table 7 reveals that significant implementation effects occur only for the conditional variance of LIBOR-OIS and bond spreads, and only for Federal Reserve policies that expanded the range of counterparties and eligible collateral ($D^{Cpart,Imp}$ and $D^{Coll,Imp}$, respectively). In terms of announcements, the only policies with significant effects were those that increased the maturity of Federal Reserve support (for the LIBOR-OIS spread) and policies that expanded the range of counterparties (for bond spreads).

In sum, the evidence in tables 6 and 7 suggests that the implementation effects of Federal Reserve policies outweighed the announcement effects, with the statistical significance of these effects

Table 6. VAR Parameter Estimates–All Bonds

This table reports the parameter estimates from equation (6), with multivariate GARCH(1,1) corrected z-statistics in brackets. The multivariate GARCH model is equation (7). *LIB-OIS* is the spread between the one-month LIBOR and the one-month OIS rate, *Repo* is the one-month repo-OIS spread, and *Bond* is the spread between duration-matched U.S. corporate bonds and U.S. Treasuries. D^{Fisc} is a dummy variable that equals 1 when a fiscal policy announcement is made (or one day preceding or proceeding the announcement), while $D^{Mat,Ann}$, $D^{Cpart,Ann}$, and $D^{Coll,Ann}$ are dummy variables relating to a three-day window around announcements of the three types of Federal Reserve policies. $D^{Mat,Imp}$, $D^{Cpart,Imp}$, and $D^{Coll,Imp}$ are dummy variables equal to 1 on days when the respective Federal Reserve policy types are implemented. Finally, *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	D^{Fisc}	$D^{Mat,Ann}$	$D^{Cpart,Ann}$	$D^{Coll,Ann}$	***Stance***	$D^{Mat,Imp}$	$D^{Cpart,Imp}$	$D^{Coll,Imp}$
LIB-OIS	0.069	0.003	−0.025	−0.021	0.003	−0.021	−0.037	−0.085
	[4.62]	[0.59]	[−2.78]	[−2.07]	[2.31]	[−4.07]	[−4.93]	[−5.62]
Repo	0.105	0.003	−0.009	0.004	0.020	−0.033	−0.053	−0.117
	[4.25]	[0.25]	[−0.54]	[0.24]	[2.14]	[−2.77]	[−2.33]	[−4.92]
Sprd	0.107	−0.025	0.068	−0.032	0.048	0.013	−0.207	−0.258
	[3.17]	[−0.39]	[0.28]	[−1.53]	[1.96]	[1.32]	[−2.84]	[−2.97]

Table 7. BEKK Multivariate GARCH Model Estimates—All Bonds

This table reports selected parameter estimates from equation (4), with Bollerslev-Wooldridge adjusted z-statistics in brackets. $\sigma^2_{LIB-OIS}$, σ^2_{Repo}, and σ^2_{Bond} is the conditional variance of residuals from equation (6) for, respectively, *LIB-OIS, Repo,* and *Bond*. D^{Fisc} is a dummy variable that equals 1 when a fiscal policy announcement is made (or one day preceding or proceeding the announcement), while $D^{Mat,Ann}$, $D^{Cpart,Ann}$, and $D^{Collat,Ann}$ are dummy variables relating to a three-day window around announcements of the three types of Federal Reserve policies. $D^{Mat,Imp}$, $D^{Cpart,Imp}$, and $D^{Collat,Imp}$ are dummy variables equal to 1 on days when the respective Federal Reserve policy types are implemented. Finally, *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	D^{Fisc}	$D^{Mat,Ann}$	$D^{Cpart,Ann}$	$D^{Coll,Ann}$	***Stance***	$D^{Mat,Imp}$	$D^{Cpart,Imp}$	$D^{Coll,Imp}$
$\sigma^2_{LIB-OIS}$	0.008	−0.021	0.001	0.002	0.003	−0.001	−0.013	−0.029
	[0.92]	[−2.72]	[0.93]	[0.62]	[3.91]	[−0.27]	[−3.40]	[−6.85]
σ^2_{Repo}	0.010	−0.004	0.006	0.000	0.017	−0.003	−0.023	0.036
	[0.46]	[−0.20]	[0.37]	[−0.01]	[1.77]	[−0.16]	[−0.87]	[1.27]
σ^2_{Sprd}	[−0.32]	[−0.16]	[−3.34]	[−0.09]	0.001	−0.201	−0.197	−0.317
	[−0.32]	[−0.16]	[−3.34]	[−0.09]	[0.92]	[−0.61]	[−4.11]	[−2.98]

greater for conditional means. All three types of "unconventional" monetary policies were important in reducing market strains, though the most important were policies that expanded the range of eligible collateral in the Federal Reserve's open-market operations, followed by policies that broadened the range of counterparties. The size and significance of the estimated implementation effects are especially surprising considering that implementation dates were determined at the time the various policy initiatives were announced so, unlike the announcement dates, there was no uncertainty about when the Federal Reserve would implement its policies. This finding appears inconsistent with the ideas of informational efficiency and rational, forward-looking expectations.

Furthermore, both fiscal policy announcements and the monetary policy stance continued to exert destabilizing influences on conditional means, with the latter also exerting a destabilizing influence on conditional variances.

8.1 Size Effects

The above discussion focused on the effects of the Federal Reserve's "unconventional" policies at the time these policies started (so-called implementation effects). However, it is possible that these policies also had "size" effects; market strains may not have eased until the Federal Reserve began lending sufficient amounts of funds to troubled institutions.

In this section, I examine size effects by considering the correlation between market spreads and the outstanding value of the various Federal Reserve LOLR programs. A key empirical limitation with this analysis is that data on the size of the various programs are weekly, which makes it impossible to examine higher-frequency impacts of the Federal Reserve's programs on market spreads. It also precludes examination of announcement and implementation effects, as the weekly dates typically do not coincide with the announcement and implementation dates in table 1.[25] Consequently, the results

[25]Even if announcement or implementation dates coincided with the dates of the weekly lending data, the dummy variable specification would presume the effects last for one week. Using a one-week event window would bias the estimated effects, since other events occurring during a particular week are erroneously included with the given policy event.

below should be treated with some caution, since an inability to control for high-frequency announcement and implementation effects may bias the estimated size effects.

One possible way to include size effects into the prior analysis is to include them as exogenous variables in the VAR(1)-GARCH(1,1) model. However, I find strong evidence—on the basis of the test of Hausman (1978)—that $\mathbf{Stock}_t$ is endogenous. Hence, I formulate a multivariate model in which the instrumental variable for $\mathbf{Stock}_t$ is its one-period lagged value, such that the model resembles the previous VAR(1)-GARCH(1,1), but with AR terms relating to the stock of Federal Reserve programs (in trillions of U.S. dollars) appearing as exogenous regressors:

$$\mathbf{X}_t = \alpha + \beta \mathbf{X}_{t-1} + \eta Stance_t + \nu \mathbf{Stock}_{t-1} + \boldsymbol{\epsilon}_t, \tag{8}$$

where $\mathbf{X}_t$ and $Stance_t$ are the same as in equation (3) (though observed at a weekly frequency), while $\mathbf{Stock}_{t-1}$ is a 1x3 vector related to the weekly outstanding value of the three types of "unconventional" monetary policies. $\boldsymbol{\epsilon}_t$ is again a 3x1 vector of residuals, with $\boldsymbol{\epsilon}_t|\Sigma_{t-1} \sim N(0, \mathbf{H}_t)$. The conditional covariance matrix $\mathbf{H}_t$ is given by

$$\mathbf{H}_t = \mathbf{CC}' + \mathbf{A}\boldsymbol{\epsilon}_{t-1}\boldsymbol{\epsilon}'_{t-1}\mathbf{A}' + \mathbf{BH}_{t-1}\mathbf{B}' + \mathbf{J}Stance_t + \mathbf{K}Stock_{t-1}. \tag{9}$$

The output of equations (8) and (9) is presented in tables 8 and 9, respectively.

Table 8 reveals that there are highly statistically significant "size" effects on bond spreads, with less significant effects on LIBOR-OIS and repo spreads. A US$1 trillion rise in the stock of securities obtained through the Federal Reserve's "unconventional" policies leads to a 62-basis-point (12 percent) fall in bond spreads, an economically significant result, but has no significant effect on LIBOR-OIS and repo spreads (panel A).[26]

While the size effects are, in aggregate, insignificant for LIBOR-OIS and repo spreads, there are significant effects for specific policies. In particular, those Federal Reserve programs that expanded

[26]The U.S. dollar values chosen for the comparative static analysis are based on the stock of securities held under the three Federal Reserve program categories (see figure 2).

Table 8. VAR Parameter Estimates—All Bonds

This table reports the parameter estimates from equation (8), with multivariate GARCH(1,1) corrected z-statistics in brackets. The multivariate GARCH model is equation (9). *LIB-OIS* is the spread between the one-month LIBOR and the one-month OIS rate, *Repo* is the one-month repo-OIS spread, and *Bond* is the spread between duration-matched U.S. corporate bonds and U.S. Treasuries. *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). $Stock^{All}$ is the outstanding value (as of the end of each Wednesday) of securities held under all the various Federal Reserve LOLR programs. $Stock^{Mat}$, $Stock^{Cpart}$, and $Stock^{Collat}$ are the weekly stock of securities held under Federal Reserve programs that, respectively, increase the maturity of support (*Mat*), widen the counterparties to the support (*Cpart*), and broaden the types of collateral eligible for secured funding (*Collat*). All outstanding values are in trillions of U.S. dollars. The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	***Stance***	$Stock^{All}(-1)$	$Stock^{Mat}(-1)$	$Stock^{Cpart}(-1)$	$Stock^{Collat}(-1)$
A. All "Unconventional" Federal Reserve Programs					
LIB-OIS	−0.001	−0.012			
	[−0.26]	[−1.32]			
Repo	−0.001	−0.036			
	[−0.03]	[−1.56]			
Sprd	0.181	−0.617			
	[11.7]	[−10.4]			
B. Individual Types of "Unconventional" Federal Reserve Programs					
LIB-OIS	0.044		−0.017	−0.176	−0.108
	[2.35]		[−0.78]	[−1.70]	[−2.44]
Repo	0.022		0.160	−0.256	−0.167
	[−1.37]		[0.96]	[−3.89]	[−3.56]
Sprd	0.191		−1.292	0.100	−0.585
	[1.81]		[−2.11]	[1.36]	[−2.05]

the range of counterparties (*Cpart*) and eligible collateral (*Collat*) led to significant declines in LIBOR-OIS and repo spreads. A US$0.3 trillion rise in the stock of securities acquired under *Cpart* led to a decline in LIBOR-OIS and repo spreads of 5 basis points and 8 basis points, respectively, while a similar rise in the stock of securities acquired under *Collat* led to a decline of 3 and 5 basis points, respectively (panel B). In terms of bond spreads, policies that increased the

Table 9. BEKK Multivariate GARCH Model Estimates—All Bonds

This table reports selected parameter estimates from equation (4), with Bollerslev-Wooldridge adjusted z-statistics in brackets. $\sigma^2_{LIB-OIS}$, σ^2_{Repo}, and σ^2_{Bond} are the conditional variance of residuals from equation (8) for, respectively, *LIB-OIS, Repo,* and *Bond*. *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). $Stock^{All}$ is the outstanding value (as of the end of each Wednesday) of securities held under all the various Federal Reserve LOLR programs. $Stock^{Mat}$, $Stock^{Cpart}$, and $Stock^{Collat}$ are the weekly stock of securities held under Federal Reserve programs that, respectively, increase the maturity of support (*Mat*), widen the counterparties to the support (*Cpart*), and broaden the types of collateral eligible for secured funding (*Collat*). All outstanding values are in trillions of U.S. dollars. The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	***Stance***	$Stock^{All}(-1)$	$Stock^{Mat}(-1)$	$Stock^{Cpart}(-1)$	$Stock^{Collat}(-1)$
A. All "Unconventional" Federal Reserve Programs					
$\sigma^2_{LIB-OIS}$	0.008	−0.014			
	[7.73]	[−3.48]			
σ^2_{Repo}	0.018	0.022			
	[2.57]	[1.31]			
σ^2_{Sprd}	0.013	−0.001			
	[1.72]	[−0.14]			
B. Individual Types of "Unconventional" Federal Reserve Programs					
$\sigma^2_{LIB-OIS}$	0.004		−0.008	−0.023	0.006
	[4.89]		[−1.98]	[−1.32]	[0.95]
σ^2_{Repo}	0.018		0.001	−0.013	0.018
	[3.21]		[1.55]	[−0.71]	[0.46]
σ^2_{Sprd}	0.570		−0.081	0.543	−0.048
	[20.4]		[−1.63]	[0.29]	[−0.82]

maturity of support (*Mat*) had the largest size effects; a $0.3 trillion rise in the stock of assets obtained under *Mat* led to a 38-basis-point decline in bond spreads.

The policies with the largest size effects are not necessarily the biggest policies by U.S. dollar value; for example, although *Collat* was the smallest of the three policy categories (see figure 2), it had greater size effects on LIBOR-OIS and repo spreads than the larger *Mat* programs.

The size effects are weaker for conditional variances than for conditional means. Collectively, the Federal Reserve's LOLR programs only had a significant impact on the conditional variance of LIBOR-OIS spreads (panel A, table 9). A US$1 trillion dollar rise in the stock of securities held by the Federal Reserve led to a 12-basis-point (11 percent) fall in LIBOR-OIS spreads' conditional volatility. Individually, only programs that increased the maturity of Federal Reserve support had a size effect, with the only dependent variable affected being the conditional variance of LIBOR-OIS spreads (panel B, table 9). While this effect is statistically significant (at the 5 percent level), its economic significance is modest; a US$0.3 trillion dollar rise in *Mat* leads to an 8-basis-point (7 percent) fall in conditional volatility. The lack of economic significance in the size of the estimated coefficients is consistent with Frank and Hesse (2009), though they focus on one policy (the Term Auction Facility) and one spread (the LIBOR-OIS spread).

These findings are consistent with the possibility that the Federal Reserve faced a time-consistency problem when announcing their policies. Moreover, since these programs may have been viewed as "unconventional," there may have been uncertainty about their efficacy in reducing market spreads. It may also suggest that investors' expectation formation evolved in an adaptive, non-rational manner, as well as evidence of informational inefficiency, since any time-consistency issues would have been resolved once the Federal Reserve implemented their policies. Consequently, if investors were forming rational expectations and markets were informationally efficient, the policies' effects on spreads should have occurred at the time of implementation; subsequent amounts loaned through these programs should not have constituted new information. Since these alternative views have observationally equivalent implications for market spreads, it is not clear which, if any, of these views were the dominant forces during this period.

Baba and Packer (2009) note that there were large and sustained deviations from covered interest rate parity during the crisis, which suggests a large degree of informational inefficiency in the foreign exchange market. Baba and Packer find that U.S. dollar funding from the ECB, supported by U.S. dollar swap lines with the Federal Reserve, lowered the volatility (though not the level) of deviations from covered interest parity. Disentangling the separate effects of policy credibility, non-rational expectations, and informational inefficiency on the estimated announcement, implementation, and size effects is outside the scope of this paper and is an important, though challenging, exercise for future research.

9. Choice of Maturity

In this section, I extend the previous analysis by considering repo-OIS and LIBOR-OIS spreads of different short-term maturities.[27] The reason for considering different maturities is as follows. As a time lag exists between the Federal Reserve's LOLR policy announcements and implementations—from table 1, this lag ranges from one day up to $5\frac{1}{2}$ months—the estimated announcement and implementation effects for interbank loans and repos that existed at the announcement date but expired before the implementation date may differ from the estimated effects for instruments that existed at *both* dates.

That said, the correlations between LIBOR-OIS spreads of different maturities and repo-OIS spreads of different maturities are, generally speaking, in excess of 0.5. High correlation values imply that this paper's conclusions (which are based on short-term spreads with one-month maturity) are robust to the choice of short-term maturity.

In this section, I consider overnight and one-week spreads, as the correlations between these two maturities and one-month spreads (0.58 and 0.86, respectively, for LIBOR-OIS spreads; 0.38 and 0.69, respectively, for repo-OIS spreads) are the smallest of the various

[27] I am grateful to Jialin Yu for suggesting this extension.

short-term maturities.[28] For the sake of brevity, I focus only on the parameter estimates from the conditional mean models, equations (6) and (8); the findings for the conditional variance models are broadly the same as above. For ease of illustration, the parameter estimates are provided in appendix 4, with the findings discussed here.

In general, the estimated announcement and implementation effects are smaller in magnitude for the shorter maturities than for the one-month maturity reported above, with implementation effects again dominating announcement effects. Furthermore, the measure of the monetary policy stance—the Taylor-rule residual—remains statistically significant. While these findings suggest that the estimated policy effects are broadly insensitive to the choice of maturity, there are differences in the estimated announcement and implementation effects across maturities. For example, announcements of collateral-broadening programs have economically larger effects on overnight interbank spreads than on one-week or one-month interbank spreads.

One potential reason for this difference in estimated effects could be that funding pressures became most acute at the shortest maturities, which meant that collateral-broadening policy announcements had the largest effects on overnight spreads. For example, while LIBOR-OIS spreads are typically increasing in loan maturity, in the two-week period following the collapse of Lehman Brothers and AIG, overnight LIBOR-OIS spreads were, on average, 52 basis points *higher* than one-month spreads.[29] Banks able to borrow at longer maturities had lower asset-funding liquidity mismatches and thus were better able to absorb higher interbank rates than banks funded on overnight loans, which were more likely to have to engage in fire sales to meet creditors' claims. The higher risk of fire-sale-associated losses may have resulted in relatively higher spreads on overnight loans. A deeper analysis of the reasons for these maturity-varying

[28]For example, the correlation between one-month LIBOR-OIS spreads and two-week (three-month) LIBOR-OIS spreads is 0.92 (0.90). As may be expected, the pairwise correlations with one-month spreads are larger for longer maturities than shorter maturities.

[29]In contrast, over the entire July 2007–February 2009 sample, overnight LIBOR-OIS spreads were, on average, 34 basis points lower than one-month spreads.

policy effects is outside this paper's scope but is an important topic for future research.

10. Conclusion

In this paper I assessed the impact of the various "unconventional" policies, introduced by the U.S. Federal Reserve during the 2007–09 financial crisis period, on market spreads. I also examined the impact of key fiscal policy announcements made by the U.S. federal government. This paper has a key differentiating feature from the related literature—rather than focusing on one or two policy initiatives, I examined the market impact of all major fiscal and unconventional monetary policies announced between mid-2007 and early 2009. Due to the large number of policies—between December 2007 and March 2009 the Federal Reserve initiated sixteen programs—I used Kroszner and Melick (2010)'s organizing framework to classify the various policies into three categories: (i) an expansion of the type of counterparties receiving support, (ii) a broadening of the collateral eligible for support, and (iii) a lengthening of the maturity of the support.

Using this framework, this paper presented six key findings. Firstly, all three types of Federal Reserve policies were effective in reducing market spreads, with the most effective being policies that broadened the range of collateral eligible for secured funding from the Federal Reserve. Gorton (2010) argues that asset markets—especially the markets for bonds securitized by U.S. residential mortgages—rather than specific institutions, precipitated the onset of the global financial crisis. Thus, policies that broadened the range of eligible collateral to include broader segments of securitized bond markets were more effective in alleviating market strains than either of the other two types of policies.

Secondly, I find that these policies were more effective in reducing short-term unsecured and secured funding costs, rather than spreads on longer-term bonds. This finding is consistent with Ericsson and Renault (2006), who find that liquidity risk represents the largest component of short-term debt spreads, with the opposite true for longer-term securities. To the extent that Federal Reserve liquidity support was more effective in reducing liquidity risk premia than credit risk premia, these policies may have had a larger impact on funding costs than bond spreads.

Thirdly, these policies were more effective in reducing the level of spreads rather than their conditional variances. These findings contrast those of Baba and Packer (2009), who, focusing on the effects of one particular policy initiative (U.S. dollar swap lines between central banks), find greater effects on conditional variances than conditional means. One point of difference between my findings and those of Baba and Packer (2009) is that I focus on the effect of all key unconventional policies, as well as fiscal policy announcements, rather than individual policies.

Fourthly, I find that "implementation effects" and "size" effects—respectively, the effect on spreads at the time policies were implemented, and the effect on spreads from higher amounts loaned from these programs—were an order of magnitude larger than "announcement effects"—the effect on spreads at the time these policies were announced. These findings have three key implications.

Firstly, these findings suggest that the Federal Reserve may have faced a time-consistency issue at the time their LOLR policies were announced. Secondly, as these policies were outside the typical framing of monetary policy, these policies were perceived as "unconventional," creating uncertainty about these policies' effects on market spreads. Thirdly, the findings may imply investor irrationality (in the form of myopia) and/or markets' informational inefficiency. Disentangling these separate effects and identifying which, if any, dominate(s) is an important exercise for future research.

Fifth, fiscal policy announcements resulted in either no change or a rise in market spreads. Taylor (2011) found that the Troubled Asset Relief Program (TARP) bill created greater market uncertainty and exacerbated market strains. In contrast to Taylor (2011), I examined a broader range of fiscal policies but reached a similar conclusion.

Following Rudebusch (2009), I measured the monetary policy stance as the deviation of the actual federal funds interest rate from the interest rate implied by a Taylor rule. This measure of the policy stance suggested that policy became increasingly contractionary during the crisis, and this was associated with higher spreads, offsetting some of the effect of the various unconventional policies and thereby limiting the effectiveness of the Federal Reserve's overall response to the crisis.

These findings have two additional research extensions, the first being an examination of the impact of the monetary policy stance on U.S. equity markets, commodities, and other assets sensitive to growth expectations. Secondly, because this paper focused on U.S. monetary policy and U.S. credit markets, a cross-country analysis should be undertaken, examining the effect of both local central bank and foreign central banks' monetary policy settings on asset prices. Krugman (2008) argues that the "international finance multiplier"—the process by which changes in asset prices are transmitted internationally through their effects on the balance sheets of leveraged financial institutions—played a key role in transmitting the U.S. crisis to a systemic run, in addition to international trade linkages. As Krugman notes, an implication of a large international finance multiplier is that monetary and fiscal policy initiatives have positive cross-border externalities. To investigate the importance of these externalities, the analysis undertaken in this paper should be extended to consider the various fiscal and monetary policy initiatives on global credit markets.

Appendix 1. Alternative Taylor Rules

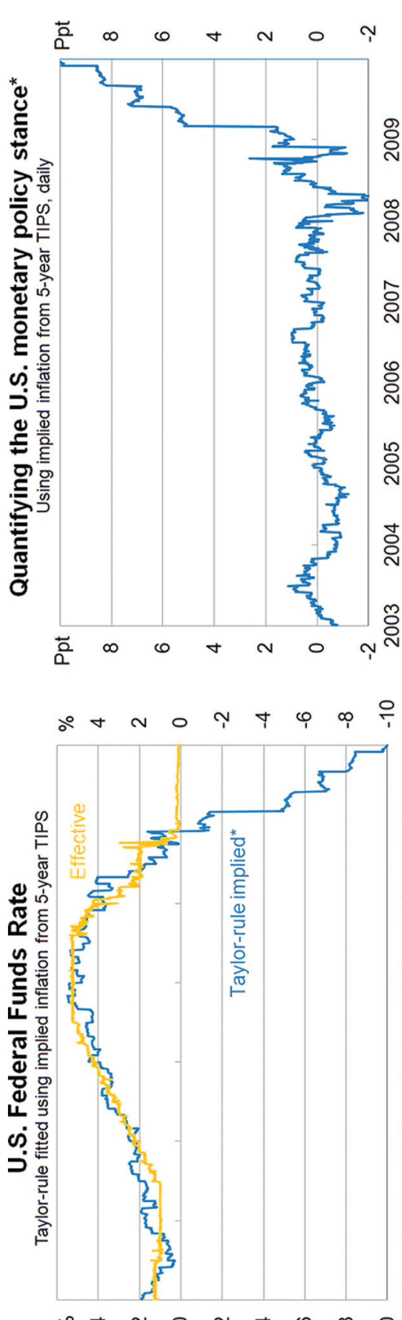
Unemployment-Based Taylor Rules

I estimated equation (2) using the difference between T-year Treasury bond yields and T-year TIPS yields. I first set $T = 5$ and then $T = 10$. The implied Taylor rule and associated monetary policy stance are presented below. It is notable that the levels of the two alternative monetary policy stances differ, particularly after December 15, 2008 (when the zero lower bound was reached); between December 15, 2008 and December 31, 2009, the ten-year series was, on average, around two-fifths below the five-year series (figures 5 and 6).

However, the correlation is very high (0.98). Similar correlations apply when comparing the five-year and ten-year TIPS measures against five-year inflation expectations from Haubrich, Pennacchi, and Ritchken (2011).

This implies that although the size of the VAR model's estimated coefficients would differ across the two measures, the statistical

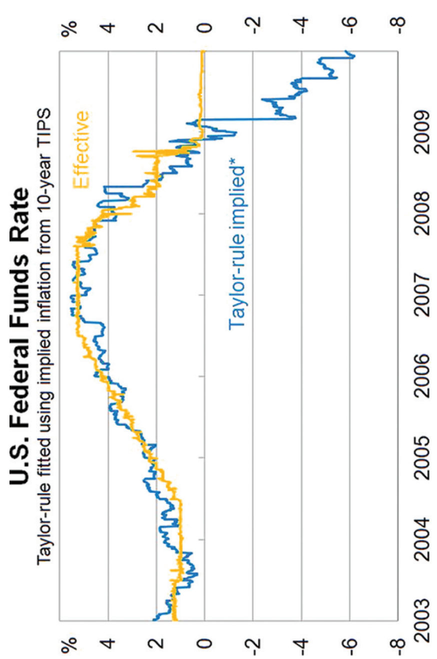
Figure 5. Effective Federal Funds Rate Based on Five-Year TIPS Yields



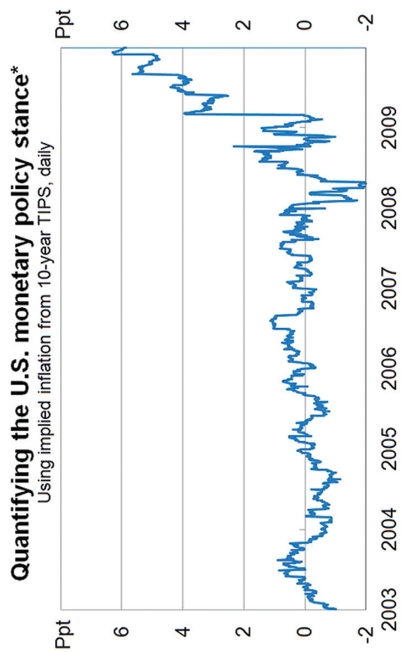
* Fitted values from a regression of the FFR on implied inflation and unemployment gap.
Source: Author's calculations; Federal Reserve Bank of St Louis.

* Difference between actual FFR and Taylor-rule implied FFR. Positive (negative) values indicate a tight (loose) monetary policy stance.
Source: Author's calculations; Federal Reserve Bank of St Louis.

Figure 6. Federal Funds Rate Based on Ten-Year TIPS Yields



* Fitted values from a regression of the FFR on implied inflation and unemployment gap.
Source: Author's calculations; Federal Reserve Bank of St Louis.



* Difference between actual FFR and Taylor-rule implied FFR. Positive (negative) values indicate a tight (loose) monetary policy stance.
Source: Author's calculations; Federal Reserve Bank of St Louis.

significance of these estimates, and the size of impulse response functions (whose values are standardized), would be largely unchanged. Thus, the findings of the paper are insensitive to the choice of TIPS tenor or the choice of tenor from Haubrich, Pennacchi, and Ritchken (2011)'s inflation expectations.

Output-Gap-Based Taylor Rule

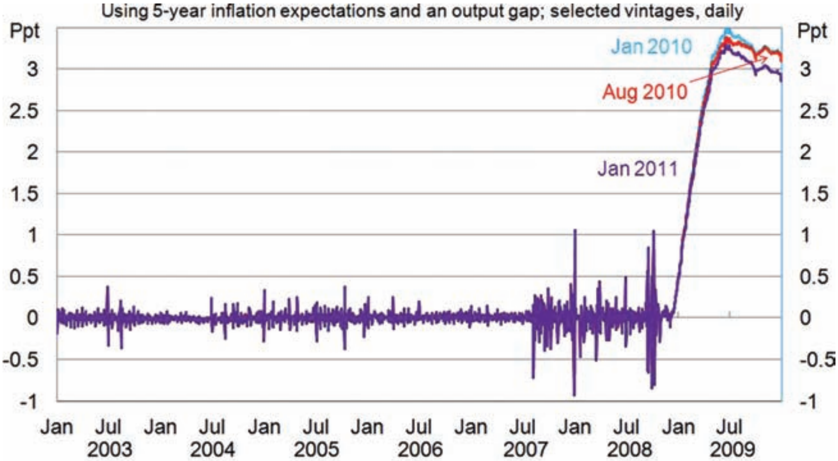
Since Taylor (1993)'s original formulation is based on output gaps, in this section I estimate Taylor rules using an output gap defined as the difference between real GDP and the Congressional Budget Office (CBO)'s estimate of real potential GDP. I use Haubrich, Pennacchi, and Ritchken (2011)'s estimate of five-year inflation expectations, and I also include an AR(1) term in equation (1) in order to improve the explanatory power of the Taylor rule.[30] Since estimates of actual and potential real GDP estimates are both subject to larger revisions than estimates of actual or natural unemployment rates, output-gap-based Taylor rules (and the associated monetary policy stance) differ across the different published GDP vintages.

Focusing on three randomly selected data publications—August 2010, January 2011, and January 2012—all three estimates of the policy stance are highly positively correlated with each other, with pairwise correlations close to 1. However, there are some differences in the levels of the series, particularly from late 2008, reflecting the differences in the output-gap estimates between these three publications. Despite these differences, these three measures all suggest that the U.S. monetary policy stance became increasingly contractionary in late 2008; by June 2009, the actual federal funds rate was around 3.5 percentage points above the Taylor-rule implied rate (figure 7).

Notably, the pairwise correlations between the output-gap and unemployment-gap estimates of the policy stance are around 0.94. This implies that though the magnitude of the VAR model's estimated coefficients may differ between the output-gap and unemployment-gap measures, the statistical significance of these

[30]Excluding an AR(1) term, the $\bar{R}^2$ is around 0.5 for each of the three models estimated in this section. With an AR(1) term, the $\bar{R}^2$ rises to 0.99. In contrast, adding an AR(1) term to equation (2) increases the model's $\bar{R}^2$ from 0.87 to 0.99.

Figure 7. The Stance of U.S. Monetary Policy*



* Output gap based on CBO's estimates of potential output, described in their August 2010, January 2011, and January 2012 publications.
Sources: Author's calculations; Congressional Budget Office; Federal Reserve Bank of Cleveland.

estimates would be unchanged. Combining the results from the previous section, this suggests that this paper's findings are largely insensitive to the choice of inflation expectations measure, as well as the choice of an output-gap or unemployment-gap measure of the policy stance.

Appendix 2. Granger Causality Tests

Bivariate Granger causality tests between the three financial market variables were performed, with the test statistics in table 10.

Appendix 3. Fiscal Policy Announcements

- September 19, 2008: The Troubled Asset Relief Program (TARP) is first proposed by U.S. Treasury Secretary Paulson. The U.S. Treasury Department announces a temporary guarantee program that will make available up to US$50 billion from the Exchange Stabilization Fund to guarantee investments in participating money-market funds.
- September 29, 2008: The TARP bill is rejected by the U.S. House of Representatives.

Table 10. Granger Causality Tests

Repo is the one-month repo-OIS spread, *Bond* is bond spreads to U.S. Treasuries, and *LIB-OIS* is the one-month LIB-OIS spread. The sample period is July 2, 2007 to December 31, 2009 (626 trading days), and all data are daily. The null hypothesis tested is that the variable in a particular row does not Granger-cause the variable in a particular column ("dependent variable"). For each test, the number of lags is equal to 1. $*$, $**$, and $***$ denote rejection of the null at the 10 percent, 5 percent, and 1 percent significance levels, respectively.

	Dependent Variable		
	Repo	***Bond***	***LIB-OIS***
Repo		14.59***	5.30***
Bond	1.23		3.73**
LIB-OIS	1.15	15.56***	

- October 3, 2008: The TARP bill, called the Emergency Economic Stabilization Act of 2008, is passed into law.
- October 14, 2008: The Capital Purchase Program (CPP), under which the U.S. Treasury would use TARP funds to buy preferred stock and warrants of nine financial institutions, is announced.[31]
- October 14, 2008: The Federal Deposit Insurance Corporation (FDIC) guarantees senior debt obligations of depository institutions and their holding companies under the Temporary Liquidity Guarantee Program (TLGP).
- November 12, 2008: U.S. Treasury Secretary Paulson announces that the U.S. Treasury will not use TARP funds to buy mortgage-related assets from financial institutions.

Appendix 4. Additional Regressions for Different Spread Maturities

Equations (6) and (8) are estimated for two repo-OIS and LIBOR-OIS spread maturities: (i) overnight and (ii) one week. The parameter estimates for overnight spreads are reported first (in table 11), followed by the parameter estimates for the one-week maturity (table 12).

[31] The nine financial institutions are Citigroup, Wells Fargo, JP Morgan, Bank of America, Goldman Sachs, Morgan Stanley, State Street, Bank of New York Mellon, and Merrill Lynch.

Table 11. VAR Estimates Using Overnight Repo-OIS and LIBOR-OIS Spreads

This table reports the parameter estimates from equation (6), with multivariate GARCH(1,1) corrected z-statistics in brackets. The multivariate GARCH model is equation (7). $LIB\text{-}OIS^{on}$ is the overnight LIBOR-OIS spread, $Repo^{on}$ is the overnight repo-OIS spread, and *Sprd* is the spread between duration-matched U.S. corporate bonds and U.S. Treasuries. D^{Fisc} is a dummy variable that equals 1 when a fiscal policy announcement is made (or one day preceding or proceeding the announcement), while $D^{Mat,Ann}$, $D^{Cpart,Ann}$, and $D^{Coll,Ann}$ are dummy variables relating to a three-day window around announcements of the three types of Federal Reserve policies. $D^{Mat,Imp}$, $D^{Cpart,Imp}$, and $D^{Coll,Imp}$ are dummy variables equal to 1 on days when the respective Federal Reserve policy types are implemented. Finally, *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 trading days).

Dep. Var.	D^{Fisc}	$D^{Mat,Ann}$	$D^{Cpart,Ann}$	$D^{Coll,Ann}$	***Stance***	$D^{Mat,Imp}$	$D^{Cpart,Imp}$	$D^{Coll,Imp}$
$LIB\text{-}OIS^{on}$	0.164	0.040	−0.026	−0.171	0.090	−0.027	−0.047	−0.112
	[4.07]	[0.77]	[−0.53]	[−3.77]	[7.59]	[−0.74]	[−0.61]	[−1.27]
$Repo^{on}$	0.005	−0.006	−0.027	−0.024	0.023	1.370	−0.458	−0.528
	[0.21]	[−0.27]	[−1.49]	[−1.02]	[3.48]	[4.26]	[−6.46]	[−7.66]
Sprd	0.222	0.087	0.135	−0.256	0.092	0.131	0.157	−0.172
	[1.75]	[0.93]	[0.13]	[−1.79]	[3.01]	[1.18]	[1.59]	[−2.41]

Table 12. VAR Estimates Using One-Week Repo-OIS and LIBOR-OIS Spreads

This table reports the parameter estimates from equation (6), with multivariate GARCH(1,1) corrected z-statistics in brackets. The multivariate GARCH model is equation (7). $LIB\text{-}OIS^{1-wk}$ is the one-week LIBOR-OIS spread, $Repo^{1-wk}$ is the one-week repo-OIS spread, and *Sprd* is the spread between duration-matched U.S. corporate bonds and U.S. Treasuries. D^{Fisc} is a dummy variable that equals 1 when a fiscal policy announcement is made (or one day preceding or proceeding the announcement), while $D^{Mat,Ann}$, $D^{Cpart,Ann}$, and $D^{Coll,Ann}$ are dummy variables relating to a three-day window around announcements of the three types of Federal Reserve policies. $D^{Mat,Imp}$, $D^{Cpart,Imp}$, and $D^{Coll,Imp}$ are dummy variables equal to 1 on days when the respective Federal Reserve policy types are implemented. Finally, *Stance* is the monetary policy stance, defined as the difference between the actual effective federal funds rate and the effective rate implied by a Taylor rule (equation (2)). The estimations are based on daily data from July 1, 2007 to February 2, 2009 (397 tradingdays).

Dep. Var.	D^{Fisc}	$D^{Mat,Ann}$	$D^{Cpart,Ann}$	$D^{Coll,Ann}$	***Stance***	$D^{Mat,Imp}$	$D^{Cpart,Imp}$	$D^{Coll,Imp}$
$LIB\text{-}OIR^{1-wk}$	0.176	0.063	0.100	−0.076	0.078	0.015	0.024	−0.165
	[2.41]	[0.83]	[1.56]	[−1.02]	[2.96]	[0.11]	[0.16]	[−2.34]
$Repo^{1-wk}$	−0.071	0.052	−0.039	−0.068	0.049	0.204	0.005	−0.253
	[−1.07]	[0.66]	[−0.68]	[−1.23]	[3.23]	[1.14]	[0.05]	[−1.99]
Sprd	0.155	0.119	−0.074	−0.086	0.066	0.168	0.178	−0.329
	[2.26]	[1.47]	[−0.93]	[−0.87]	[2.63]	[1.23]	[1.54]	[−2.18]

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