

Brave, Scott A.; Genay, Hesna

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## Federal reserve policies and financial market conditions during the crisis

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Federal Reserve Bank of Chicago

## **Federal Reserve Policies and Financial Market Conditions during the Crisis**

*Scott A. Brave and Hesna Genay*

WP 2011-04

# **Federal Reserve Policies and Financial Market Conditions during the Crisis**

**Scott A. Brave†**

**Federal Reserve Bank of Chicago\***

**Hesna Genay†**

**Federal Reserve Bank of Chicago\***

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## **Abstract**

During the recent financial crisis, the Federal Reserve implemented a series of extraordinary and unconventional policies to alleviate the impact of the crisis on financial markets and the economy. In this paper, we examine the effects of these policies on broad financial market conditions, explicitly taking into account that policy was endogenously determined in response to prevailing financial market and economic conditions. We find that the Fed was more likely to initiate or expand new programs when financial market conditions were tighter than usual and economic conditions deteriorating. We also find that the Fed's policies improved broad financial market conditions significantly at announcement and that the improvements were associated primarily with program initiations and expansions.

*Keywords: Financial crisis, Federal Reserve policies, liquidity programs, credit programs, monetary policy*

JEL: G01, E58, E65, G18, G28, G21

† [scott.a.brave@chi.frb.org](mailto:scott.a.brave@chi.frb.org) and [hesna.genay@chi.frb.org](mailto:hesna.genay@chi.frb.org)

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## I. Introduction

From the beginning of the financial crisis in August 2007, the Federal Reserve (the Fed) took a series of aggressive policy actions in order to alleviate the adverse effects of the crisis on financial markets and economic activity.<sup>1</sup> In addition to lowering the target federal funds rate by over 500 basis points and purchasing long-term securities on a large scale, the Fed eased the terms of its conventional liquidity facilities and introduced a number of unconventional programs aimed at specific segments of financial markets, often under its authority in Section 13(3) of the Federal Reserve Act to extend loans to “any individual, corporation, or partnership.”<sup>2</sup> As financial conditions stabilized and began to improve in the summer of 2009, the Fed first tightened the terms of some of the programs, then terminated all but two of its unconventional programs.<sup>3</sup> These policies had a significant effect on the Fed’s balance sheet – not only changing the composition of assets, but also increasing the overall size from around 6.5 percent to 16 percent of nominal GDP.

A number of previous studies have examined the effects of specific Fed programs on financial conditions in market segments at which these programs were aimed. While most of these studies find that the Fed policies had a positive impact on market conditions, a few studies find no significant impact. We add to the existing literature by considering the effects of a collection of Fed programs on broad financial market conditions. Previous studies have focused

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<sup>1</sup> For an exposition on the Federal Reserve’s policy response to the crisis, see Bernanke (2009).

<sup>2</sup> Section 13(3) of the Federal Reserve Act gives the Board of Governors of the Federal Reserve System the authority to lend to “any individual, partnership, or corporation” in “unusual and exigent circumstances” when such lending is “indorsed or otherwise secured to the satisfaction of the Federal Reserve bank: *Provided*, That ... the Federal reserve bank shall obtain evidence that such individual, partnership, or corporation is unable to secure adequate credit accommodations from other banking institutions.”

<sup>3</sup> As of April 2011, the dollar swap lines with major foreign central banks and the second round of large-scale asset purchases were the only two Federal Reserve programs still operating.

primarily on the impact of specific Fed facilities on the particular market segments in which they were implemented. However, as stated in press releases announcing the establishment of new policies and other Fed communications, the overarching goal of all of the programs was to improve the functioning and stability of financial markets as a whole in order to promote economic growth. Therefore, a logical extension of the literature on the impact of the programs in individual financial markets is to examine how the collection of Fed policies affected financial markets broadly considered.

In this paper, we construct a comprehensive dataset of actions taken by the Federal Reserve and measure their impact on a financial conditions index that is a weighted average of 100 financial indicators. We estimate the impact of policy announcements on the financial conditions index in the period between January 2007 and August 2010 using an event-study methodology. In addition to focusing on a broad measure of financial market conditions, we also explicitly model the response function of the Federal Reserve to financial and economic conditions. Clearly, in undertaking the various conventional and unconventional policies, the Fed acted in response to the deterioration in underlying conditions. We explicitly take into account the endogeneity of policy actions in examining their impact on overall financial conditions.

Our results show that the announcements of Fed policies during the crisis were associated with significant improvements in broad financial market conditions. Furthermore, the timing of the announcements are significantly correlated with prevailing financial market and economic conditions, and taking the policy-response function explicitly into account has a significant impact on the size of the estimated impact of these policy actions. The remainder of the paper is organized as follows. Section II gives a brief overview of the Fed programs we examine in the

paper, as well as the results of previous studies that examine their impact. Section III describes our data and methodology and Section IV presents our results. Section V concludes with the policy implications of our results.

## **II. Federal Reserve Policy Actions during the Financial Crisis**

Beginning in August 2007, the Federal Reserve (the Fed) took a series of aggressive policy actions in order to alleviate the adverse effects of the developing financial crisis on financial markets and economic activity. Table 1 provides an overview of these actions, organized chronologically and grouped by the primary counterparty involved in each program.

One of the earliest manifestations of the crisis occurred in unsecured short-term funding markets, as financial institutions increased their demand for liquid funds and retrenched their lending in interbank markets. The initial set of Federal Reserve policy actions were designed to alleviate liquidity problems in these markets and deployed the traditional tools of a central bank implemented through its traditional counterparties. On August 17, 2007, a day after injecting an inordinately large \$12 billion in reserves via the federal funds market, the Fed lowered the spread on loans provided through the discount window over the target fed funds rate from 100 basis points to 50 basis points and extended the maximum maturity of these loans from overnight to 30 days. However, the apparent stigma associated with the use of the discount window discouraged depository institutions from borrowing, despite further increases in the interbank loan rates and a dearth of funding beyond overnight maturities.<sup>4</sup> To overcome the perceived stigma, in December 2007, the Fed introduced an auction delivery system for discount window loans. The

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<sup>4</sup> For evidence on the extent of stigma associated with the discount window loans, see Armantier et al. (2011).

Term Auction Facility (TAF) offered fixed amounts of collateralized loans where the interest rate on the loans at each auction was determined through competitive bidding.<sup>5</sup>

To ease dollar funding liquidity shortages in European markets, the Fed also established dollar swap lines with the European Central Bank (ECB) and the Swiss National Bank (SNB) on the same day the TAF was announced. Under these swap agreements, the Fed would swap dollars for the relevant foreign currency at market interest rates and receive interest payments (set at OIS plus 100 basis points) during the term of the swap. Foreign central banks would offer the dollars they received from the Fed through dollar funding auctions they conducted for financial institutions in their own jurisdictions. At the end of the swap agreement, the foreign central banks would return the dollars they borrowed in exchange for their own currency at the exchange rate set in the first leg of the transaction.<sup>6</sup>

Early in 2008, it became apparent that the traditional liquidity facilities were not sufficient to address financial market strains and more policy action was needed. Consequently, the Fed established a number of programs under the “unusual and exigent circumstances” authority given to it in Section 13(3) of the Federal Reserve Act. Under these programs, the Fed provided liquidity to a broader set of financial institutions than under its conventional programs and supplied credit directly to certain financial markets.

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<sup>5</sup> For a description of TAF and its operations, see Armantier, Krieger, and McAndrews (2008). Additional information on TAF can be found at: <http://www.federalreserve.gov/monetarypolicy/taf.htm>.

<sup>6</sup> For a description of developments in offshore dollar markets, the details of the swap lines, and the relationship between the swap lines and TAF auctions, see Coffey et. al. (2009), Fleming and Klagge (2010), and Goldberg, Kennedy, and Miu (2010). Additional information on the swap agreements can be found at: [http://www.federalreserve.gov/monetarypolicy/bst\\_liquidityswaps.htm](http://www.federalreserve.gov/monetarypolicy/bst_liquidityswaps.htm).

In the weeks leading up to the eventual sale of Bear Stearns to JP Morgan Chase, strains began to appear in secured short-term funding markets.<sup>7</sup> To ease disruptions in repo markets, the Federal Reserve introduced two programs in March 2008. The Primary Dealer Credit Facility (PDCF) – established under authority granted in Section 13(3) of the Federal Reserve Act -- provided overnight discount window loans to primary dealers as a back-up source of funding. The Term Securities Lending Facility (TSLF) was also created by the Fed at this time to alleviate liquidity pressures in secured short-term funding markets. The facility, another Section 13(3) program, allowed primary dealers to borrow up to \$200 billion in Treasury securities for a term of 28 days by pledging less liquid securities (such as agency debt, agency securities, highly-rated residential and commercial mortgage-backed securities (MBS) and other asset-backed securities (ABS), and all other investment-grade debt securities).<sup>8</sup>

Commercial paper markets were another market segment that came under significant stress at the onset of the crisis. With the deterioration in housing markets in summer 2007, the risks associated with assets used to collateralize asset-backed commercial paper (ABCP) increased significantly and investors became reluctant to roll over ABCP, yields on new issues increased, and new issuance declined significantly. As a result, a large fraction of asset-backed securities that were funded through the ABCP market moved to sponsoring institutions' balance sheets, exacerbating the short-term funding needs of commercial banks and other financial

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<sup>7</sup> For a description of repo markets and developments in these markets in 2008, see Fleming, Hrungr, and Keane (2009, 2010) and Adrian, Burke, and McAndrews (2009).

<sup>8</sup> For a detailed description of TSLF and its operations, see Fleming et. al. (2009 and 2010).



institutions and increasing their reliance on unsecured commercial paper markets and other unsecured money markets.<sup>9</sup>

The bankruptcy of Lehman Brothers in September 2008 disrupted commercial paper markets even further.<sup>10</sup> The day after Lehman's bankruptcy, a major money market fund – the Reserve Fund – announced that it “broke the buck” (i.e. its net asset value fell below \$1 per share) when it had to write-down the value of its holdings of Lehman securities to zero. In the next few days following the Reserve Fund's announcement, redemptions in prime money market funds that invest in commercial paper and other short-term securities increased sharply as investors shifted toward Treasury-only funds. Faced with heightened uncertainty regarding redemptions and liquidity needs, money market funds became very reluctant to purchase commercial paper, or were willing to commit only to purchasing paper with overnight maturity.<sup>11</sup> As a result, both liquidity and roll-over risk in commercial paper markets and liquidity concerns for money market mutual funds increased significantly.

Concerned with these risks and the potential impact on other market segments should they materialize, the Federal Reserve established three programs during the four weeks following Lehman Brothers' bankruptcy. On September 19, 2008, the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) was created. The facility provided

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<sup>9</sup> Covitz et. al. (2009) describe the events in ABCP markets in the fall of 2007 and find evidence of runs on commercial paper programs that were linked to credit and liquidity exposure of individual programs. In addition, they find that investors did not necessarily run on programs based solely on their credit and liquidity characteristics, but were also indiscriminate in deciding which types of paper not to roll over.

<sup>10</sup> For more details regarding the developments in commercial paper markets and money market mutual funds in the wake of the Lehman bankruptcy, see Adrian et. al. (2010), Anderson and Gascon (2009), and Duygan-Bump et. al. (2010).

<sup>11</sup> Adrian et. al. (2010) note that in the period between the bankruptcy of Lehman Brothers on September 15, 2008 and the start of the Commercial Paper Funding Facility on October 7, 2008, the total outstanding amount of commercial paper dropped from \$1.8 trillion to \$1.3 trillion. They also note that by the end of September 2008, more than 75 percent of commercial paper financing was rolled over each day.

indirect discount window access to money market mutual funds (which do not have direct access to the discount window) to finance their purchases of asset-backed commercial paper (ABCP). Under AMLF, the Fed provided discount window loans to depository institutions which pledged purchases of high-quality ABCP from money market mutual funds. However, the terms of AMLF loans were non-recourse and no haircuts were imposed on the pledged collateral.<sup>12</sup> Moreover, only funds that qualified as money market mutual funds under SEC rule 2a-7 were eligible to borrow from the AMLF. On the same day the AMLF was established, the Treasury established the money market mutual fund guarantee program, which provided voluntary insurance for the value of mutual fund shares held as of September 18, 2008.

The Money Market Investor Funding Facility (MMIFF) was also designed to alleviate pressures in commercial paper markets and among money market mutual funds. It was established on October 21, 2008 under Section 13(3) authority of the Fed and allowed loans to privately established special-purpose vehicles that would purchase certain highly-rated short-term debt instruments from eligible investors. The program did not begin to operate until November 24, 2008 and there was no activity in the facility until it was allowed to expire on October 30, 2009. In contrast, a third program, the Commercial Paper Funding Facility (CPFF), was also established under Section 13(3) authority to provide funding *directly* to investors in commercial paper markets. A special-purpose entity created by the Federal Reserve Bank of New York directly purchased highly-rated (A-1/P-1/F1 or higher) commercial paper with three-month maturity from eligible issuers. The special-purpose entity financed the commercial paper purchases through discount window loans from the Federal Reserve Bank of New York at the

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<sup>12</sup> For a detailed explanation of the terms of AMLF loans, see Duygan-Bump et. al. (2010).

target federal funds rate and acted as a back-stop source of funding for commercial paper issuers.<sup>13</sup>

One of the financial market segments that suffered the most from the financial crisis were the asset-backed securities markets. As the value of collateral pledged for these securities declined and valuation models for the securities performed worse than anticipated, issuance of asset-backed securities even outside the troubled residential mortgage market came to a standstill during certain periods. The issuance of commercial mortgage-backed securities that peaked at \$230 billion in 2007 and non-mortgage asset-backed security issuance that peaked at \$292 billion in 2005 dropped to less than \$1 billion per month in late 2008 (Sack, 2010). Because securitization played a critical role in funding bank and non-bank lending, the disruptions in the securitization channel increased the funding needs of lenders from other sources, putting additional pressure on already-distressed funding markets. As a result of these pressures, some lenders tightened underwriting standards and terms on loans to customers and businesses sharply, reducing the flow of credit to these sectors.

On November 25, 2008, the Fed announced the creation of the Term Asset-Backed Securities Loan Facility (TALF) with the goal of helping “market participants meet the credit needs of households and small businesses by supporting the issuance of asset-backed securities (ABS) collateralized by student loans, auto loans, credit card loans, and loans guaranteed by the Small Business Administration (SBA).”<sup>14</sup> The program authorized the Federal Reserve Bank of New York to lend up to \$200 billion to holders of certain AAA-rated newly issued ABS. TALF

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<sup>13</sup> For details of the pricing structure of CPFF and the factors that influenced it, see Adrian et. al. (2010).

<sup>14</sup> The initial press release announcing the creation of TALF: Board of Governors of the Federal Reserve System press release, “The Federal Reserve announces the creation of Term Asset-Backed Securities Loan Facility (TALF)” November 25, 2008. Available at: <http://www.federalreserve.gov/newsevents/press/monetary/20081125a.htm>.

loans were non-recourse and had significantly longer maturities than other loans through the Fed facilities – three to five years depending on the type of security being financed.<sup>15</sup> From February 2009 through May 2009, the Fed expanded the types of securities that could be pledged to TALF a number of times, eventually including newly issued and legacy commercial mortgage backed securities (CMBS), non-agency residential MBS, auto dealer floor plans, etc.

The last program initiated by the Federal Reserve was the large-scale asset purchases (LSAPs). From the beginning of the crisis through November 2008, the Federal Open Market Committee (FOMC) lowered the target federal funds rate by 425 basis points to 1 percent. As the target and effective fed funds rates approached zero, the FOMC had little room to further deploy its traditional monetary policy tool of targeting short-term interest rates. As economic and financial conditions continued to deteriorate in the winter of 2008, the FOMC switched to the unconventional policy tool of large scale asset purchases, with the aim of lowering term premiums and long-term interest rates.<sup>16</sup> On November 25, 2008, the FOMC announced that the Fed would begin to purchase up to \$100 billion in direct obligations of housing-related government-sponsored enterprises and up to \$500 billion in residential MBS guaranteed by these agencies in order to “reduce the cost and increase the availability of credit for the purchase of houses, which in turn should support housing markets and foster improved conditions in financial markets more generally.”<sup>17</sup> On March 18, 2009, the program was expanded to up to \$200 billion in agency debt, \$1.25 trillion in agency MBS, and \$300 billion in longer term

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<sup>15</sup> For details of the TALF terms and conditions, see [http://www.newyorkfed.org/markets/talf\\_terms.html](http://www.newyorkfed.org/markets/talf_terms.html).

<sup>16</sup> For a discussion of the unconventional monetary policy tools employed by the Fed and their effectiveness, see Yellen (2011).

<sup>17</sup> The Federal Reserve press release “Federal Reserve announces it will initiate a program to purchase the direct obligations of housing-related government-sponsored enterprises and mortgage-backed securities backed by Fannie Mae, Freddie Mac, and Ginnie Mae.” November 25, 2008. Available at: <http://www.federalreserve.gov/newsevents/press/monetary/20081125b.htm>

Treasury securities. Between December 2008 and March 2010 when the first round of LSAPs ended, the Fed purchased \$1.725 trillion worth of securities, representing about 22 percent of the stock of agency debt, agency MBS, and Treasury securities outstanding at the start of the program (Gagnon et. al., 2010).

In August 2010, in response to the slow-down in the pace of economic recovery and the decline in the underlying measures of inflation, the FOMC announced that it would reinvest the principal payments on agency MBS and agency debt into longer-term Treasury securities. As a result, the decline in the Fed's holdings of securities that would have occurred as these securities matured was halted, providing additional monetary accommodation to the economy. In the months following the August decision, the communications of Federal Reserve officials raised the possibility that the Fed's portfolio could be expanded further through additional purchases of securities. Indeed, in early November 2010, the FOMC announced that it would expand its security holdings through additional purchases of \$600 billion in longer-term Treasury securities.

The policy actions described above were not the only policies taken by the Fed, nor do they include many of the major policy actions of the U.S. Treasury and other regulators during this period, some of which were made in conjunction with the Fed. Most notably during the crisis, the Federal Reserve lowered the target federal funds rate by about 500 basis points; extended special assistance in the acquisition of Bear Stearns by JP Morgan Chase; provided assistance to Citigroup and Bank of America; and conducted stress tests of the nineteen largest banking organizations in conjunction with the Treasury, FDIC, and other banking regulators. Furthermore, Fannie Mae and Freddie Mac first received additional government support and the promise of discount window access, and then were placed under conservatorship by the Treasury in September 2008.

In the weeks following the bankruptcy of Lehman Brothers alone, the Treasury and the FDIC introduced a host of policy actions, some of which were aimed at alleviating pressures in the same markets as the Fed policies described above. For instance, as mentioned previously, on September 19, 2008, the Treasury established a temporary guarantee of money market mutual funds. On the same day, Secretary Paulson called for the use of government funds to purchase troubled assets from financial institutions and the SEC banned the short selling of nearly 800 financial stocks. On October 3, 2008, Congress approved the TARP program and raised the limit on FDIC deposit insurance to \$250,000. On October 14, 2008, the Treasury announced that it would be injecting \$250 billion to financial institutions and the FDIC announced that it would provide guarantees on senior debt of regulated financial institutions.

In the following months, additional policies were implemented by government agencies, and existing policies were expanded and refined. The global reach of the crisis also necessitated numerous policy actions by government agencies outside the United States that were similar to actions taken by the Fed, the U.S. Treasury, and the FDIC: expansion of liquidity facilities available to depository institutions, government guarantees of bank liabilities, large scale purchases of securities by central banks, injection of government capital to financial institutions in distress, etc. Hence, at the height of the crisis, the Federal Reserve was not alone in implementing policies aimed at reducing the adverse effects of the crisis on financial markets and economic activity.

As financial conditions began to stabilize in summer 2009, the Federal Reserve began to reduce the amount of funds available through the individual programs and increase the prices at which the funds were available. As the improvements in financial market conditions were sustained for several months, the Fed announced the eventual termination of its facilities in early

2010. Only the international swap lines with other central banks and the second round of LSAPs were still in effect as of May 2011, the former of which has been only sparingly used and the latter set to end in June 2011.

### *Previous Literature*

There is an emerging literature that examines the impact of the programs initiated during the financial crisis by the Fed. Most of these studies focus on individual programs and their impact on specific measures of financial conditions. For instance, Christensen et. al. (2009), McAndrews, et. al. (2008), Taylor and Williams (2009), and Wu (2008) examine the impact of TAF on the liquidity premium imbedded in the Libor/OIS spreads. With the exception of Taylor and Williams (2009), these papers find that TAF announcements were associated with lower liquidity premiums in interbank markets. Baba and Packer (2009) examine the effects of the swap lines and the dollar term auctions on the FX swap market dislocations and deviations from covered interest rate parity. They find that central bank actions lowered both the level and the volatility of the deviations from covered interest-rate parity in the post-Lehman bankruptcy period, and lowered the volatility of the deviations in the pre-Lehman bankruptcy period.

Fleming, Hrung, and Keane (2010) relate the amount of collateral available under TSLF to the repo spreads between Treasury securities and less liquid collateral. They find that TSLF was associated with significantly lower spreads, primarily by raising the Treasury repo rates, and that most of the effects were driven by fully subscribed operations and operations where a broad set of collateral was accepted. Wu (2008) looks at the impact of PDCF and TSLF on the

interbank liquidity premiums early in the programs' implementation and finds no discernible effects.

Duygan-Bump et. al. (2010) examine the impact of AMLF on the asset-backed commercial paper market and money market mutual funds using loan-level information from the facility and other micro-level data on all commercial paper transactions. The authors find that the facility helped stabilize asset outflows from money funds; helped lower ABCP spreads on collateral eligible for AMLF, but not on similarly rated unsecured paper that could not be pledged to the facility; and that money managers with large exposure to prime funds with ABCP holdings experienced higher stock returns than other fund managers with less exposure on the initial announcement of AMLF.

Campbell et. al. (2011) focus on the effects of TALF and find that it lowered spreads for some types of asset-backed securities but had little impact on pricing of individual securities. The authors interpret the results as suggesting that TALF stabilized ABS markets without subsidizing individual securities.

D'Amico and King (2010), Gagnon et. al. (2010), Hancock and Passmore (2011), Krishnamurthy and Vissing-Jorgensen (2011), and Stroebe and Taylor (2009) examine the effects of the Fed's large-scale asset purchases (LSAPs) on long-term security yields. Stroebe and Taylor (2009) find no significant relationship between the volume of purchases by the Fed and mortgage and agency debt spreads. In contrast, the other papers that focus on LSAPs find that yields and term premiums in Treasury securities and risk premiums in MBS yields were lower after the initiation of the programs.



Several papers (Bayazitova and Shivdasani, 2010; Dunchin and Sosyura, 2009; Ng et. al., 2011; Veronesi and Zingales, 2010) focus on the characteristics of banks that applied for, and received, capital infusions through the Treasury's Troubled Asset Relief Program (TARP) , and the valuations of securities issued by these banks. The results of these papers are somewhat mixed. Bayazitova and Shivdasani (2010), Ng et al (2010), and Taliaferro (2009) find that, compared to banks that did not receive funding, TARP-recipient banks were larger, more liquidity-constrained, and had lower capital ratios but healthier loan portfolios. However, Duchin and Sosyura (2010) and Li (2010) find that TARP recipients were less profitable, but more politically connected than non-recipients. Veronesi and Zingales (2010) examine the security valuations of the 19 large banks that received the first round of TARP funding and find that while the value of the 19 banks' preferred equity and debt went up at announcement, their equity values declined. Similarly, Ng et. al. (2010) find that a larger group of TARP banks had lower stock returns than non-TARP banks during the initiation period of TARP, but valuations were adjusted up in the following quarters. On the other hand, Bayazitova and Shivdasani (2010) find that banks that ultimately received TARP funding showed valuation gains when the program was initiated, and not when they received approval for the funding. Taliaferro (2009) and Li (2010) find that about two-thirds of the funds injected to TARP banks were used to increase capital ratios, with smaller amounts (13% to 33%) being allocated to new lending.

### **III. Data and Methodology**

Like most of the previous papers, we use an event-study research design to evaluate the impact of Fed policies on financial markets. However, we add to the existing literature in a

number of ways: (1) Instead of focusing on announcements for a particular program as previous studies do, we broaden the policy actions examined to include all announcements related to Fed policies during the crisis; (2) We examine the impact of these announcements on a broad measure of financial market conditions, instead of focusing on a few financial indicators; (3) We explicitly take into account the reaction function of the Fed to prevailing financial market and economic conditions in setting policy, instead of assuming policy decisions were pre-determined or exogenous; and (4) We allow our model to have a richer dynamic structure than the models in previous event studies.

### *Event Sets*

As mentioned above, most of the previous event studies have focused on the effects of announcements related to a particular Fed program. We examine the collection of all Fed policies implemented in the period from January 1, 2007 through August 13, 2010. We construct a comprehensive dataset of major Fed actions during the financial crisis based on the press releases, speeches, and the crisis timelines maintained on the New York and St. Louis Fed websites.<sup>18</sup> The final set of actions includes the Fed programs listed in Table 1 (e.g. discount window loans, TAF, PDCF, TALF, LSAPs, etc.), as well as FOMC decisions on the target fed funds rate, and supervisory actions that allowed a number of financial institutions to become bank holding companies. Appendix A lists all the events.

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<sup>18</sup> In an earlier version of the paper, we also considered the effects of actions taken by other US agencies and the major central banks in Europe. The results with such a broad set events that included all U.S. and major European policy actions were similar to those we report below.

In our baseline model, we examine all announcements relating to initiations, expansions, extensions, reductions, and terminations of each policy. However, we exclude announcements related to actual operations of these programs, such as the announcements of TAF auction terms, TALF auction dates, etc. The first policy action occurred at the onset of the crisis on August 9, 2007 with the injection by the Fed of the then unusually large amount of \$12 billion of reserves in the federal funds market. From August 2007 to June 2009, all of the announcements involved initiations, expansions, and extensions of programs; reductions in the target fed funds rate; and conversions of some financial institutions into bank holding companies. Between June 2009 and August 10, 2010, as financial market conditions stabilized and improved, the majority of announcements relate to reductions in the scope and terms of existing programs and their expiration. The only programs established between June 2009 and August 2010 were the resumption of dollar swap lines with major foreign central banks in June 2010 and the FOMC announcement regarding the reinvestment of proceeds from holdings of agency MBS holdings in long-term Treasury securities on August 10, 2010. Our analysis excludes the announcements related to the second round of large-scale asset purchases in the fall of 2010. In total, 56 of the 185 weeks in our sample period had policy announcements.

We conduct robustness checks on our baseline analysis with three alternative sets of events. In the first alternative, we focus only on announcements related to the initiations, expansions, and extensions of policies. It is possible that both the policy-response of the Fed and the effects of announcements were asymmetric; that is, the factors and the process determining the initiations and expansions of policies, as well as the effects of these announcements, might be different than those involving reductions and terminations of existing programs. By focusing only on initiations of programs and excluding program reductions and terminations, we take this

possibility into account in our analysis. Under this alternative definition, our sample period ends in June 2009 and the event set includes 44 (out of 125) event weeks.

At the height of the crisis, when financial markets came under severe stress and business conditions deteriorated sharply, it was not unusual to have policy initiatives announced not only by the Federal Reserve, but also by the U.S. Treasury, the FDIC, and other government agencies. Our baseline analysis characterizes such weeks with announcements by multiple agencies as Fed policy events. As a result, our baseline analysis attributes the possible changes in financial market conditions that occurred in those weeks to Fed policies. However, it is possible that the changes in those weeks were due to actions taken by other agencies and not the Fed. To account for this possibility, we run a counter-factual experiment and assume that all weeks in which there were announcements by multiple agencies were “non-policy” weeks. Clearly, this is a highly restrictive assumption that misidentifies the weeks in which there were numerous policy announcements as non-event weeks. However, by stripping from our analysis any possible confounding events, such a restrictive and counterfactual assumption allows us to put a lower bound on our estimated policy effects that can be attributed to the Fed. As before, we consider two sets of events under this alternative assumption: all events (including those relating to the reductions and terminations of programs), which includes 35 policy event weeks out of 185 total weeks in the sample; and only announcements relating to the initiations, expansions, and extensions of policies through the end of June 2009, which reduces the number of policy event weeks to 24 out of 125 total weeks.

### *A Broad Measure of Financial Market Conditions*

We consider the impact of these announcements on a broad measure of financial market conditions. The various Fed communications (press releases, speeches, etc.) about the policies implemented during the crisis suggest that while the policy actions were aimed at specific market segments, their ultimate goal was to stabilize financial market conditions and support economic growth. Given this goal, it seems appropriate to look at all actions taken by the Fed during the crisis collectively and evaluate their impact on a broad measure of financial conditions. The measure we use in our analysis is the Chicago Fed's adjusted National Financial Conditions Index (ANFCI), which is constructed using a methodology similar to that used in Hatzius et. al. (2010) and Hakkio and Keeton (2009).<sup>19</sup> The index represents a single common factor which best explains 100 financial indicators and is estimated by means of the EM algorithm using the large approximate dynamic factor methods of Doz, Giannone, and Reichlin (2006). The index has a history which extends back to the first week of January 1973.

The ANFCI is somewhat similar to the index produced by Hatzius et. al. (2010), but differs in several key respects. First, the ANFCI has a weekly frequency of observation as opposed to quarterly. Incorporation of high frequency variability is what allows us to use the index in a traditional event study design. Second, ANFCI captures a much broader set of financial variables (100 vs. 44) including finer detail of asset-backed security, derivative, and repo markets that played a crucial role in the crisis and in the design of several of the above mentioned Fed programs. The variables in the ANFCI include measures of liquidity risk, term premia, counterparty risk, equity prices, price volatility, outstanding amounts of credit, volume of

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<sup>19</sup> See Brave and Butters (2010) and <http://www.chicagofed.org/webpages/publications/nfci/index.cfm> for more information on the index and its construction.

transactions in various market segments, and survey measures. Individual financial indicators are weighted in the index according to their ability to explain the total variation of the data, lending the weights a systemic interpretation. Furthermore, because ANFCI incorporates a dynamic process, it is capable of including measures of leverage, which are typically procyclical in nature (Adrian and Shin, 2009), as well as data of lower frequencies than the index that are known to be useful measures of financial conditions, i.e. Call Report, Senior Loan Officer Opinion Survey, and Flow of Funds data. Given this feature, ANFCI can be interpreted as a systemic measure of conditions across both time and financial markets broadly considered.

As business conditions deteriorate, so too typically do financial conditions. If we want to consider the impact of Fed policy on financial conditions alone, this fact must be taken into account. The ANFCI does so by regressing each financial indicator on current and lagged measures of the business cycle and inflation prior to estimation of the index, similar to Hatzius et. al. (2010). Making this adjustment at the level of the individual financial variables instead of at the index level is advantageous because it allows for heterogeneity in the response of each of the variables to the business cycle and inflation. The common factor that is extracted through the dynamic factor model underlying the index will be more robust to these influences than if we were to instead regress the unadjusted index on macroeconomic variables. The adjustment process also ascribes an interpretation to the index as a measure of financial conditions relative to macroeconomic conditions. This is noteworthy, because in this light we can view Fed policy actions as responding to financial and macroeconomic conditions separately.

The ANFCI is constructed so as to have a mean of zero and a standard deviation of one. This normalization is necessary given that the estimation methods used to arrive at an index value are only identified up to an unknown scale parameter. However, it also makes

interpretation of the index values easier. For instance, a positive value of the ANFCI denotes that financial conditions are “tighter” on average than typically suggested by contemporaneous economic conditions over the last 37 years. Figure 1 demonstrates that during the recent crisis, financial conditions were tighter than at any other time than during the 1970’s and early 1980’s according to the ANFCI. Similarly, a negative value of the index indicates “looser” than average financial conditions relative to contemporaneous macroeconomic conditions. The transition from a high positive value, where high is measured in units of standard deviation from the index’s historical mean, back to zero or even below zero then gives us a sense of improvement in financial conditions consistent with the Fed’s stated goal to promote financial conditions supportive of economic growth and against which we can judge Fed policy actions.

There are two additional things to note with respect to our event sets and measure of financial conditions. First, the events are recorded on a daily basis, while the ANFCI is a weekly series. To overcome the fact that we cannot precisely assign policy actions to financial variables on the day in which the policies took place, we developed a timing convention in relation to ANFCI. The ANFCI can be viewed as a weekly average of daily financial conditions. As such, if a policy action took place early in the week, we would expect to see its full impact in that same week. However, if a policy action took place near the end of a week, it is likely that the full impact of the action could not be observed until the following week. Therefore, based on a Wednesday convention for the date of the policy action, we assigned the impact of each action to a particular weekly observation of the ANFCI.

Second, by broadening the set of events and by considering their impact on a broad measure of financial market health, we set a higher threshold than previous studies for finding significant policy effects. It is possible that even if a particular Fed program generated improvements in

specific financial indicators, when evaluated together with all Fed programs, its positive effects might be diluted with the possibly insignificant effects of other programs. It is also possible that even if the Fed programs collectively improved a few financial indicators, such as liquidity or risk premiums in specific markets, the improvements did not spillover to broader measures. In either of these cases, previous studies that focus on particular programs and specific financial indicators would find significant improvements as a result of policy actions; our analysis, in contrast, would show no significant changes in financial market conditions.

#### *A Joint Model of Financial Conditions and Fed Policy*

In addition to broadening the scope of the analysis, our paper explicitly takes into account the policymakers' reaction function. Methodologies used in previous papers assume that policy actions were either pre-determined or exogenous. However, it seems likely that the Fed responded to deteriorating economic and financial conditions. Indeed, such a pattern is evident in Figure 2, which shows the ANFCI (red line), the weekly business conditions index of Arouba, Diebold, and Scotti (2009) (ADSBCI, blue line), and the weeks in which Fed policy actions took place (the shaded bars). During the crisis, as financial market conditions deteriorated (ANFCI increased) and business conditions weakened (ADSBCI declined), the frequency with which the Fed took policy action increased markedly.

To examine the impact of the collection of Federal Reserve policies during the financial crisis on overall financial conditions, we estimate a treatment effect model in line with previous event studies and the large literature on program evaluation. We include as policy actions both announcements affiliated with the ongoing operation and end of Fed programs. It is possible that



announcements dealing with the existence versus the end of a program could have differential effects on financial conditions. For instance, an announcement that a program will be ending could be taken as either a sign that the Fed anticipates financial conditions will continue to improve and allay uncertainty in financial markets, or it could be seen as a sign that policy support will be withdrawn prematurely and trigger a tightening of financial conditions.

To account for possible heterogeneity by type of announcement, we also considered an abbreviated sample period as a robustness check on our results, ending the sample the week prior to the first reduction in a Fed program in late June 2009.<sup>20</sup> We took this approach rather than specifying multiple policy types, because there exist only a handful of observations with which to estimate their impact. Furthermore, there exist five cases in our data where a program end coincides with an extension of another program, requiring that we take a stand on the policy actions taken during these weeks. Rather than subjectively categorize these weeks, we allow the data to do so in our full sample results, so that our results may provide a lower bound on the efficacy of Fed policy. By eliminating these events in the shortened sample, we also omit a handful of ongoing program announcements so that here, too, our results potentially provide a lower bound.

Our model in its most general form is given by the following system of equations and definitions, where  $I_t$  is an indicator variable denoting weeks where Fed policy actions occurred and ADSBCI is the Aruoba-Diebold-Scotti business conditions index. It can be estimated by

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<sup>20</sup> The first reduction is in the size of the TAF auction amount in week 26 of 2009.

maximum likelihood methods given a suitable parameterization of the variance-covariance matrix of correlated shocks,  $V$ .<sup>21</sup>

$$(1) \quad \Delta \text{ANFCI}_t = \alpha + \sum_k \beta_k \Delta \text{ANFCI}_{t-k} + \sum_k \beta_k \Delta \text{ADSBCI}_{t-k+1} + \gamma I_t + \varepsilon_t$$

$$(2) \quad I_t^* = \mu + \delta I_{t-1} + \theta \text{ANFCI}_{t-1} + \rho \text{ADSBCI}_{t-1} + \kappa (-\text{ANFCI}_{t-1} * \text{ADSBCI}_{t-1}) + v_t$$

$$\varepsilon_t, v_t \sim N(0, V)$$

$$V = \begin{bmatrix} \sigma^2 & \lambda \\ \lambda & 1 \end{bmatrix}$$

$$(3) \quad I_t = \begin{cases} 1 & \text{if } I_t^* > 0 \\ 0 & \text{o.w.} \end{cases}$$

We are primarily interested in the coefficient  $\gamma$  in equation (1), which is the “average treatment effect” or, ATE, of Fed policy on the change in financial conditions. A negative value for the ATE indicates that Fed policy actions resulted, on average, in an improvement in financial conditions relative to weeks where no policy actions took place. The degree of improvement is measured in units of standard deviations of the ANFCI, so that a value of -1 for  $\gamma$  equates with a difference of one standard deviation between the mean of the index in policy and non-policy event weeks. For ATE to be consistently estimated, we require that Fed policy be the sole driver of the weekly change in the ANFCI during policy event weeks.

$$(4) \quad \text{ATE} = E(\Delta \text{ANFCI}_t | I_t = 1) - E(\Delta \text{ANFCI}_t | I_t = 0) = \gamma$$

Clearly, it will often not be the case that Fed policy is the sole driver in any given week when the US Treasury, FDIC, and other agencies and foreign central banks also took policy actions during many of the same weeks. To evaluate the potential bias that results from this fact, we also estimate ATE on an alternative sample which recodes as non-policy events weeks where

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<sup>21</sup> Using STATA, the appropriate command is `treatreg` which uses a probit link by default.

other domestic agencies took actions that were uncoordinated with the Fed actions taken during the same week. This very restrictive sample of policies measure the degree to which non-Fed actions influence our results by explicitly introducing a form of misspecification that could serve to potentially weaken them. Therefore, they provide another robustness check on our model and a lower bound on the efficacy of Fed policy during the crisis.

We focus in equation (1) on the change in the ANFCI to avoid any issues with the non-stationarity of the index over the sample period we examine.<sup>22</sup> We include the ADSBCI as an explanatory variable for the weekly change in the ANFCI to allow for the influence of the business cycle on financial conditions. Given that the ANFCI is already expressed relative to the business cycle, this may seem surprising. However, the adjustment that underlies the ANFCI is made on the full history of the index dating back to 1973. By including the contemporaneous and lagged changes in the ADSBCI in equation 1) we allow for the possibility that during our sample period some correlation remains. Inspection of figure 2 supports this decision as it demonstrates a small, but clear negative correlation from January 2007 through August 2010. Furthermore, to allow for serial correlation of changes in financial conditions, we include its lags in equation (1). We set the number of lags ( $k$ ) for  $\Delta ANFCI_{t-k}$  and  $\Delta ADSBCI_{t-k+1}$  to four and three weeks, respectively, including the contemporaneous value of the change in the ADSBCI as well. This specification for equation (1) was chosen based on tests of model fit, and we fix this dynamic specification across estimated variants of the model.

The key distinction of our framework from other event study evaluations of Fed actions during this crisis is that it allows for the endogeneity of Fed policy. It may be the case that we

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<sup>22</sup> We tested the stationarity of the ANFCI using several conventional tests in the literature (Augmented Dickey-Fuller, Phillips and Perron, and a modified GLS procedure). In each case, we were unable to reject a unit root over our sample period given a reasonable number of lags.

only see policy actions take place during periods where financial conditions are already deteriorating. We capture this possibility by estimating the degree to which shocks to financial conditions,  $\varepsilon_t$ , co-vary with shocks to the Fed's reaction function,  $v_t$ , in the parameter  $\lambda$ . If this parameter is zero, then equation (1) can be independently consistently estimated. This would be the case if Fed policy actions were plausibly exogenous to changes in financial conditions, and is the identifying assumption underlying most other event studies of the efficacy of Fed policies during the financial crisis.

On the contrary, the apparent endogeneity we observe in figure 2 is a common problem that plagues program evaluation. Ideally, what we would want to capture in our framework are shocks to financial conditions that are orthogonal to the policy process. To do so, we specify a reaction function for Fed policy, equation (2), which depends on a one-period lag of the Fed policy event indicator, the ANFCI, the ADSBCI, and their interaction. This joint system of equations follows the outcome/treatment methodology of the program evaluation literature and explicitly makes the change in the ANFCI a function of policy decisions which are endogenously determined based on the Fed's observed pattern of decision-making.

A long line of literature dating back to the 1980's has argued that traditional Fed policy has a predictable component, i.e. the "Taylor rule". We extend this line of reasoning to nontraditional Fed policies put in place during the crisis. These include the Fed's liquidity and credit facilities and the first round of large-scale asset purchases (LSAPs). The overall degree of policy accommodation representing the union of changes in the federal funds rate and nontraditional policy actions is captured in the latent variable  $I_t^*$ . Equation (3) then relates our

indicator of Fed policy to this latent variable under the assumption that policy actions taken during the crisis were made with the goal of increasing the level of policy accommodation.<sup>23</sup>

This framework captures the essential point that the probability of a Fed policy intervention is likely to vary depending on the “tightness” of financial conditions, the state of the business cycle, and the interaction between financial and economic conditions. This can be seen by taking partial derivatives of equation (2) with respect to the lagged level of the ANFCI and ADSBCI. Policy accommodation is likely to be increasing in the tightness of financial conditions and the weakness of business conditions. Given the inclusion of the interaction term ( $-\text{ANFCI} \cdot \text{ADSBCI}$ ) in equation (2) and the observed negative correlation of the two indexes, this is likely to be more true when the ANFCI is looser than average ( $<0$ ) and the ADSBCI is contracting ( $<0$ ), respectively. In addition, we include the lagged policy indicator,  $I_{t-1}$ , in the Fed’s reaction function to address the fact that policy actions tend to be clustered.

When we consider the abbreviated sample period ending in June 2009, the brevity of the sample requires that we alter the model above slightly to avoid a degrees of freedom problem. To do so, we ran a series of model specification tests to determine a parsimonious specification of the Fed reaction function that retains the ability to capture Fed policy decisions through the end of June 2009 without severely compromising the ability of the model to predict the richness of Fed policy over the full sample period we consider. The model that poses Fed policy as a function of the lagged level of the ANFCI alone best fit this criterion and was used solely for this purpose.

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<sup>23</sup> It is in this sense that our results offer a lower bound on the efficacy of Fed policy when we include as policy actions announcements relating to ends of programs which could plausibly be thought of as leading to a more restrictive stance of Fed policy.

These complicated dynamics allow for a broader set of conditions under which the Fed may be operating to influence financial conditions. This is important, because to achieve identification in this model requires that an exclusion restriction be made in the information sets of equations (1) and (2). We identify the model in two ways: first with the timing restriction that Fed policy responds to lagged financial and economic conditions; and by modeling the Fed policy as a function of the level, not the change in, these variables. For the first, we are assuming that a “time to act” feature exists between the real-time evolution of financial and business conditions and policy. In some instances, one could argue that this restriction is too strong given the rapidity of the response during the height of the crisis. We rely on the use of weekly data and our timing convention of assigning policy actions across weeks to overcome this problem. The second formalizes the notion that it is the persistent deviation of the ANFCI and ADSBCI from their long-run averages that matters for Fed policy, not the potentially transient changes in the indices.

## **Results**

Table 2 presents the results of our baseline analysis. The first panel shows the average treatment effects when we explicitly model the policy reaction function of the Fed in the January 2007 – August 2010 period. The second panel shows the estimated effects of policy actions on the change in the ANFCI when policy is assumed to be determined exogenously. The bottom of the table shows the number of weeks we classify as containing a Fed policy action; the number of observations; and, in the case of endogenous policy, our estimates of the covariance between shocks to financial conditions and Fed policy.

### *All Fed Actions – Full Sample*

The first column in the first panel of table 2 shows the estimates of equations (1) –(3) when we consider the full set of actions taken by the Fed during the January 2007–August 2010 period as one homogenous set of events. The set of rows in the middle shows the parameter estimates for the policy response function. As was hinted by the patterns in figure 2, our estimates show that, in a given week, the Fed was more likely to take a policy action during the crisis when financial conditions in the previous week were tighter than their historical average ( $ANFCI > 0$ ). The coefficient on the lagged level of  $ANFCI$  is positive and statistically significant at the 5 percent level. The coefficient on the interaction term between  $ANFCI$  and  $ADSBCI$  is also positive and significant. Therefore, the propensity to take policy action increases further when both financial conditions are tight and business conditions are weak.

The coefficient on the lagged level of  $ADSBCI$  is positive but insignificant. This suggests that, during our sample period, business conditions had little direct effect on the likelihood of the Fed taking a policy action; rather, business conditions affected Fed decisions to the extent that they reinforced the tightness in underlying financial conditions. The coefficient on the lagged policy response is negative but not statistically significant, suggesting that over the entire sample period, whether there was a policy action taken in the previous week or not did not significantly affect the likelihood of action in the current period.

The marginal effects of each of these variables on the probability of the Fed taking a policy action depend on their initial level. If we assume that both business and financial conditions in the prior week were one standard deviation away from their historical averages and there was no policy action in the previous week, then the probability of a policy announcement is

38 percent. Starting at these conditions, a one standard deviation tightening of financial conditions increases the probability of a Fed policy action by 15 percent. If, instead, we assume that financial and business conditions in the previous week were much weaker (two standard deviations away from their historical averages), the probability of a Fed policy action, at 68 percent, is significantly higher. Note that the initial conditions considered in this alternative scenario, where financial and business conditions are two standard deviations away from historical levels, correspond approximately to the financial and economic conditions that prevailed late in 2007 (figure 2). An additional one-standard-deviation deterioration in ANFCI from the alternative initial conditions (i.e. if  $ANFCI_{t-1} = -3$ ;  $ADSBCI_{t-1} = 2$ ; and  $I_{t-1} = 0$ ) raises the probability of policy action by 17 percent to 85 percent. While our policy response function is relatively simple, it appears to capture the policy reaction of the Fed relatively well. The top panel of figure 3 makes this clear as it shows the estimated probability of a Fed policy action (red line) during every week of the sample with the shaded periods representing weeks where policy events actually took place. The estimated probability of policy action rises markedly during weeks where there were actual policy announcements.

Given the estimated policy response function, the first row shows the average impact of Fed policy on financial conditions, when changes in financial conditions are assumed to depend on the policy indicator, changes in financial conditions in the previous four weeks, and changes in business conditions in the current and previous three weeks. The coefficient on the policy indicator variable is negative (-0.34) and statistically significant at the 5 percent level, indicating that on average policy announcements of the Fed during the crisis improved broad financial conditions significantly.



Moreover, explicitly taking into account the endogenous nature of policy makes a significant difference in the estimated policy effects. Note that the estimated covariance between the shocks to financial conditions and the shocks to the Fed's reaction function ( $\lambda$ ) is positive and significant, indicating that policy announcements were not determined exogenously. Hence, assuming that policy actions were exogenous would have biased the policy effects we estimate. We can get a sense of the magnitude of this bias by estimating our model under the assumption that policy was exogenously determined. The first column in the second panel of table 1 shows the average treatment effects under this assumption. The coefficient on the policy indicator is positive and not statistically different from zero. Hence, had we assumed that policy was exogenous, our model would have indicated that policy had no impact on broad financial conditions.

Figure 4 shows the clear differences in estimated effects across the two models. The blue line in each panel shows the weekly changes in ANFCI during our sample period. The green line shows the average estimated change in ANFCI in weeks with no policy announcements; the red line shows the average estimated changes in ANFCI during policy announcement weeks. The left panel shows the estimated changes under the assumption that policy actions were pre-determined or exogenous. Both the red line and the green line are very close to zero and it is difficult to distinguish the two lines. The right panel in figure 4 shows the estimated changes in ANFCI under our baseline model, where the policy response function is explicitly modeled. The red line, showing changes in financial conditions during weeks of policy announcements, is negative and markedly below the blue line showing the changes in non-policy weeks.

While our analysis focuses on changes in a broad measure of financial conditions in response to policy, we can also determine the impact of policy on specific, individual financial

variables that are used in the construction of the ANFCI. Table 3 shows some of the key financial indicators used in the construction of ANFCI, their standard deviation during our sample period, and the estimated effects of policy announcements on these indicators. Based on the weights the individual indicators get in the construction of the ANFCI, our results indicate that Fed policy announcements during the crisis were, on average, associated with a 16 basis points (bp) decline in the spread between the three-month LIBOR and Treasury rates (TED spread); a 14 bp decline in the three-month LIBOR/OIS spread; a 14 bp decline in the spread between the A2P2 and AA nonfinancial commercial paper rates; a 4 basis point decline in the Moody's BAA corporate bond and ten-year Treasury spread; a 12 basis point decline in Citigroup's Asset-Backed Bond Index and 5-year Treasury spread; 3 percent decline in the MOVE index; and a 1 percent decline in the VIX index. Moreover, the estimated effects on individual indicators are large relative to their variation during the sample period, ranging from 0.9 standard deviations for the BAA corporate bond spread to 0.47 standard deviations for the LIBOR/OIS spread. Hence, the Fed policy announcements were associated with marked improvements in key measures of liquidity in interbank funding markets, credit risk spreads for short- and long-term corporate debt, and the volatility in the Treasury and equity markets.

#### *Announcements of Program Initiation, Expansion, and Extension*

Our baseline model assumes that the likelihood of all policy announcements by the Fed – whether they were announcements of new programs, their expansion and extension, or the reduction or the termination of existing programs – and their effects on broad financial conditions were determined similarly. However, it is possible that the Fed's reaction function for

initiating and expanding new programs was not the same as its decision to reduce the policy accommodation provided through these programs or end them. It is also possible that financial markets reacted differently to announcements of program initiations than to announcements of program reductions or terminations. To take this possibility into account, we estimate our model by focusing only on announcements made through the end of June 2009, which excluded all announcements relating to program reductions and terminations. The results under this assumption are presented in table 4 – they are notably more significant than our results in the baseline model.

As noted above, in order to get the best fit while maintaining sufficient degrees of freedom in our analysis, we conducted goodness-of-fit tests for the Fed's policy reaction function to determine which specification of equation (2) best fits the announcements related to program initiations and expansions. These tests indicated that business conditions – whether by themselves or in interaction with the financial conditions – were not statistically important in determining the likelihood of program introductions or expansions through June 2009. Broad financial conditions appear to best explain the Fed's response function during this period. This result is perhaps not that surprising given that June 2009 represents the business cycle trough, and for much of the early part of the sample in figure 2 the ADSBCI and ANFCI move very closely in inverse relation to each other. Specifically, as was the case in our baseline specification, when financial market conditions were tight, the Fed was more likely to initiate new programs or expand existing ones. Moreover, the impact of financial conditions on the likelihood of policy action and its statistical significance is much stronger in this alternative specification. This can be seen by comparing the top and bottom panels of figure 3 through June

2009, where the estimated probability of a policy action is generally slightly higher for this specification.

Our estimates of the average treatment effect of Fed policy on financial conditions are also slightly larger (-0.37) and significant at the 5 percent level when we focus on program initiations and expansions. As before, modeling the endogenous nature of policy actions has a significant effect on the estimated effects of these actions. The covariance term in this sample is even slightly higher than before (0.28 vs. 0.26). Had we assumed policy was pre-determined or exogenous, we would have found that policy actions had no discernible effects on broad financial market conditions, as shown in the right-hand panel in table 4.

#### *Only Fed Actions – a counterfactual experiment*

At the height of the crisis, when financial and economic conditions deteriorated sharply, the Fed was not the only agency that took action to alleviate the impact of the crisis. Given that these policy actions were sometimes announced during the same weeks as the Fed announcements, our baseline results show the combined effects of all policy actions in those weeks with announcements by multiple agencies and attribute them to policy actions by the Fed. We cannot separate the effects of Fed actions from those by other agencies. However, we can get a lower-bound estimate on the effects of Fed policies by focusing on weeks where there were announcements only by the Fed and treating the weeks with multiple-agency announcements as “non-event” weeks. This is clearly a mis-classification of events – we are taking the weeks with the most policy announcements and treating them as non-policy weeks. Nonetheless, it allows us to determine at a minimum what the effects of Fed actions were on broad financial conditions.

The results under this specification are reported in columns 2 and 4 of tables 2 and 4, respectively, for all policy actions taken during the full sample period and for program initiations and expansions through June 2009. The results are qualitatively similar to our baseline specifications. While the estimated effects of policy are smaller – not surprising given that we eliminate 21 policy actions from our estimates and these actions occurred at the height of the crisis – they are still statistically significant. In particular, the estimated policy response function of the Fed is very similar to our baseline specification, with the exception that the interaction of financial and business conditions plays less of a role. The estimated average effect of Fed policy actions declines from -0.34 to -0.22 in the full sample, but remains significant at the 5 percent level. Similarly, the estimated effect of policy action is slightly smaller (-0.31 versus -0.37) but remains significant when we focus only on announcements made through the end of June 2009. Moreover, as before, the policy response function has a significant effect on the estimated effects of a policy action on financial conditions, albeit smaller. If policy were assumed to be exogenous, the estimated effects on broad financial conditions are not different from zero, as was the case in our baseline model.

### *Simulating the Model*

Given the large changes in financial conditions during the crisis (figure 2), the magnitude of the estimates above at first glance might appear economically small. However, note that, the coefficient measures the average improvement in financial market conditions across all of the weeks of policy announcements. Because the Fed took numerous policy actions at the height of the crisis, the overall impact on financial conditions was likely to have been relatively large. Moreover, as we noted above and as is evident in figure 2, there is a high degree of serial correlation in the ANFCI – i.e. an improvement in financial conditions in a given week is likely to persist for some time.

We can get a sense of these effects by assuming specific initial conditions for the ANFCI and the ADSBCI and tracing the paths of the policy indicator variable and the ANFCI over time using the parameters estimated in our model.<sup>24</sup> Figure 5 shows these simulated paths for 500 simulations of the model over a period of 53 weeks. We consider two scenarios in this figure:

Scenario 1: Simulates a circumstance under which the ANFCI and ADSBCI deteriorate from their historical averages at an equal pace of 1 standard deviation per week for two consecutive weeks during which policy does not respond. At the end of the initialization period both indexes are two standard deviations worse than their historical averages.

Scenario 2: Simulates a circumstance under which the ADSBCI deteriorates in a similar fashion to above, but in which the ANFCI worsens by two standard deviations in the second week and policy does not respond. At the end of the initialization period, the ANFCI is 3 standard deviations and the ADSBCI is 2 standard deviations worse than its historical average.

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<sup>24</sup> This simulation also requires that we estimate an auxiliary regression for the weekly change in the ADSBCI in order to complete the model. This regression takes a similar form to that for the weekly change in the ANFCI, including three lags of each variable but omitting the policy indicator variable.

The initial conditions in scenario 1 are not grave enough for the Fed reaction function to generate a significant probability of a policy action in the first period, causing the ANFCI to worsen by nearly two standard deviations in the first week and peak at nearly 3.5 standard deviations above its starting value by the 4<sup>th</sup> week. The ADSBCI falls briefly by 0.5 standard deviations, and then improves by one standard deviation from its starting point by the 4<sup>th</sup> week. These conditions predict an almost definite policy response (over 80% likelihood) until week 6. After this period of intense policy intervention, the ANFCI falls dramatically back to the starting value, and after a brief spike around week twelve, asymptotically settles about 0.5 standard deviations below its starting value. The ADSBCI settles in a similarly improved position. As both financial and business conditions improve the Fed reaction function generally predicts policy actions around 30-40% of the time for the remaining weeks.

Scenario 2 we believe closely replicates the most extreme movements in both indexes during our sample period, reflective of conditions that prevailed in the period after the bankruptcy of Lehman Brothers. Initial conditions for scenario 2 prove bad enough for the Fed's reaction function to generate a policy action with very high probability between weeks 0 and 6. Consequently, the ANFCI jumps to only about one standard deviation above its initial value before falling dramatically and eventually settling at two standard deviations below its starting point. Conversely, the ADSBCI deteriorates by 1.5 standard deviations during the first 4 weeks, and settles there for the remaining weeks. The Fed reaction function, itself, follows a similar pattern to that of Scenario 1 after the first 6 weeks.

The model captures the fact that Fed policy announcements acted to counter the significant financial shocks during the crisis to keep conditions from worsening further, and that these actions were likely to build on each other as financial and economic conditions

deteriorated. The simulations above also demonstrate an ultimate improvement in financial conditions resulting from Fed policy that was likely to have lasted well beyond the weeks in which policies were announced, suggesting that Fed policy actions during the crisis had medium- as well as short-term effects on broad financial conditions.

### *Additional Robustness Checks*

We also performed several additional tests on the model. First, we tested whether further nonlinearities in the Fed policy response function could be captured by including powers of the ANFCI and ADSBCI. Their inclusion did not significantly alter the fit of equation (2). Second, we examined the impact of omitting the change in the ADSBCI from equation (1). Our results in this case were slightly larger than what is reported in tables 2 and 4. To assess the degree to which our results are based on conventional Fed policy, we also tried excluding as policy events weeks where only changes in the federal funds rate target were announced. Our estimates did not measurably change in this case, although their standard errors increased making them significant at the 90% instead of the 95% significance level. In this respect, conventional policy actions by the Fed during the crisis do seem to have been important. Finally, we constructed an alternative version of the ANFCI that used only data beginning in 1985. This alternative version of the ANFCI captures the lower volatility in macroeconomic and financial variables post-1984. Estimating the model with this version of the index produced results that were larger than reported here (roughly twice the magnitudes in tables 2 and 4), as the movements in this alternative index that corresponded with Fed policy actions were much larger when measured over this shorter sample period.



## Conclusion

During the financial crisis that began in August 2007, the Federal Reserve implemented a series of aggressive policies, both conventional and unconventional, in order to alleviate the effects of the crisis on financial markets and economic activity. Some of the previous studies that examined the efficacy of the Fed programs have found that individual programs were successful in improving conditions in specific market segments.

In this paper, we add to the existing literature by examining the effects of Fed actions during the crisis on broad financial market conditions. Our analysis treats all the policies under study as a series of homogeneous events and measures their impact on broad financial conditions. In addition, we explicitly take into account the endogenous nature of the Federal Reserve's response to the crisis. Our results indicate that: (1) consistent with our expectations, the Fed was more likely to take a policy action during weeks where financial and economic conditions deteriorated; and (2) these policy actions were associated with an improvement in broad financial conditions.

Our results indicate that the Federal Reserve's actions during the crisis resulted in improvements not only in the specific market segments in which these programs operated, but spilled over to other market segments, resulting in broader improvements. These improvements persist even when we run a counterfactual experiment and look at the effects of policy only during weeks when there were no confounding events, such as announcements of policy actions by other agencies. While a full social welfare analysis of Fed actions is outside the scope of our analysis, our results indicate that financial market and business conditions would have been markedly worse had the Fed not taken action during the crisis. Moreover, because financial and

economic conditions exhibited strong serial correlation during the crisis – bad conditions today were associated with bad conditions in the future, -- the failure to take policy action would have had persistent adverse effects on the economy.

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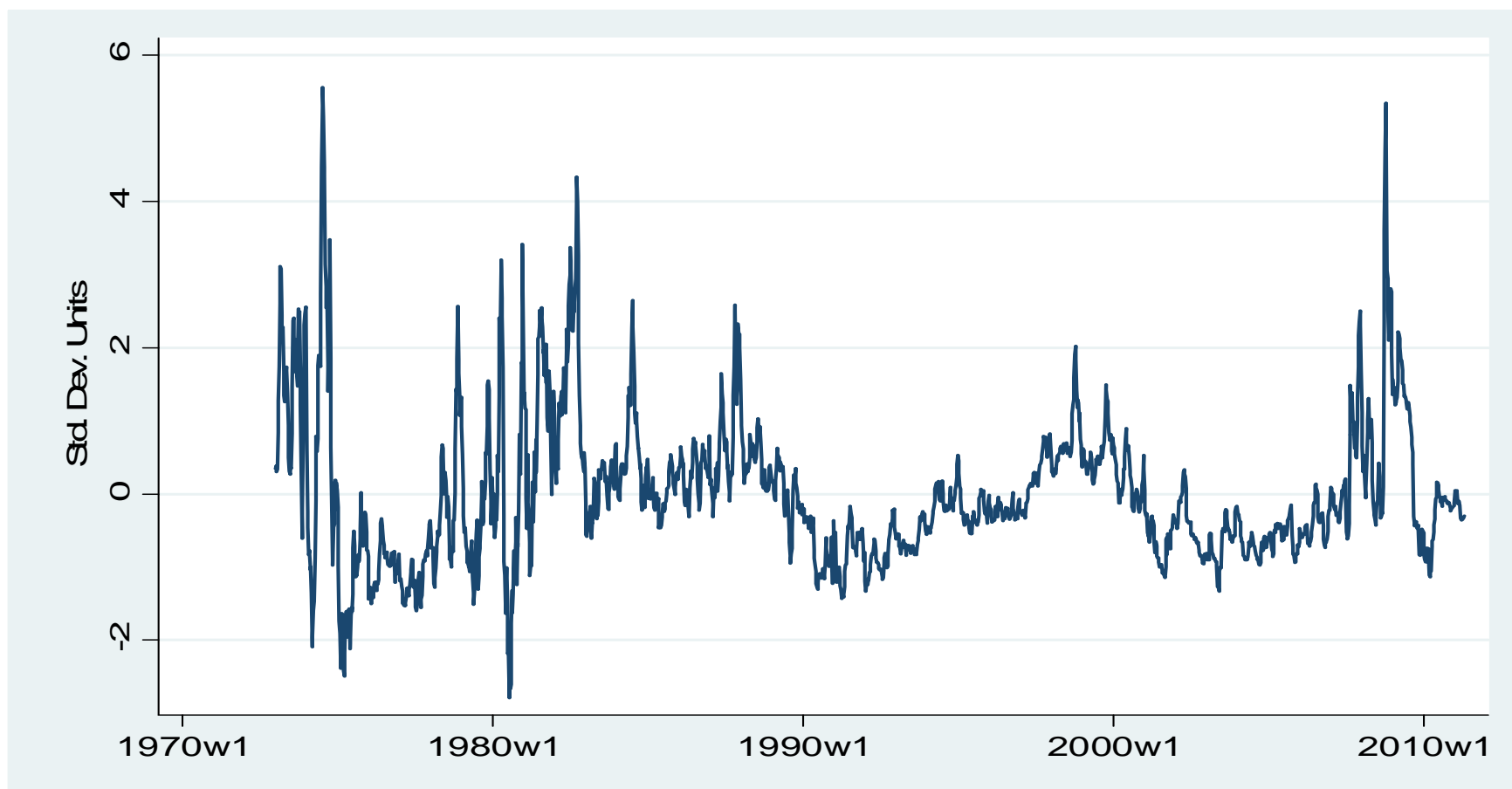
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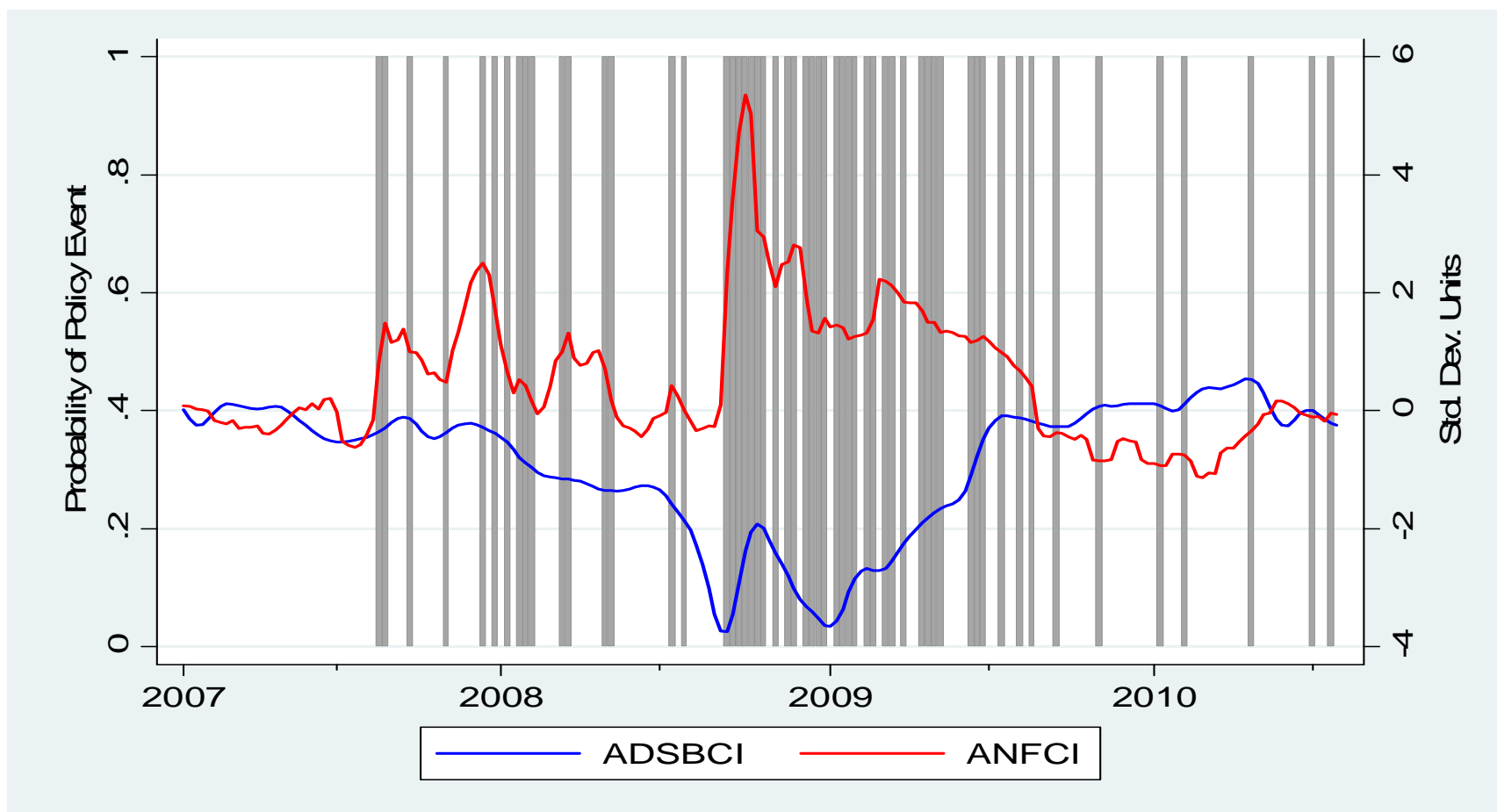
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**Figure 1: The Chicago Fed Adjusted National Financial Conditions Index (ANFCI), 1973-2011**

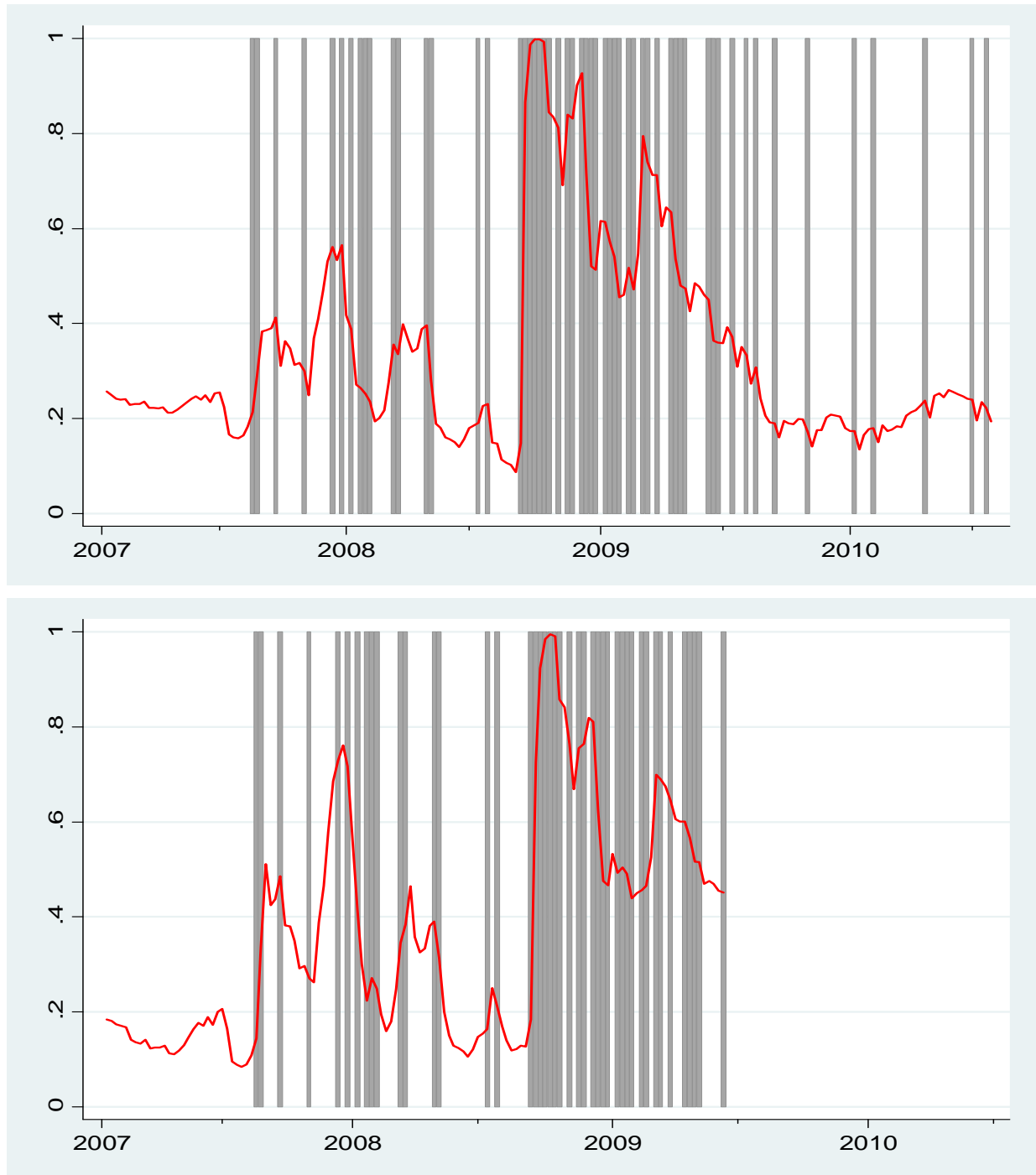
Figure 1 displays the history of the Chicago Fed's Adjusted National Financial Conditions Index (ANFCI) from the first week of 1973 through April 2011. The vertical axis is displayed in standard deviation units of the index relative to its historical mean. A positive value of the ANFCI represents financial conditions that are tighter on average than would typically be suggested by contemporaneous economic conditions. Thus, a worsening of financial conditions relative to economic conditions is represented by an increase in the ANFCI.





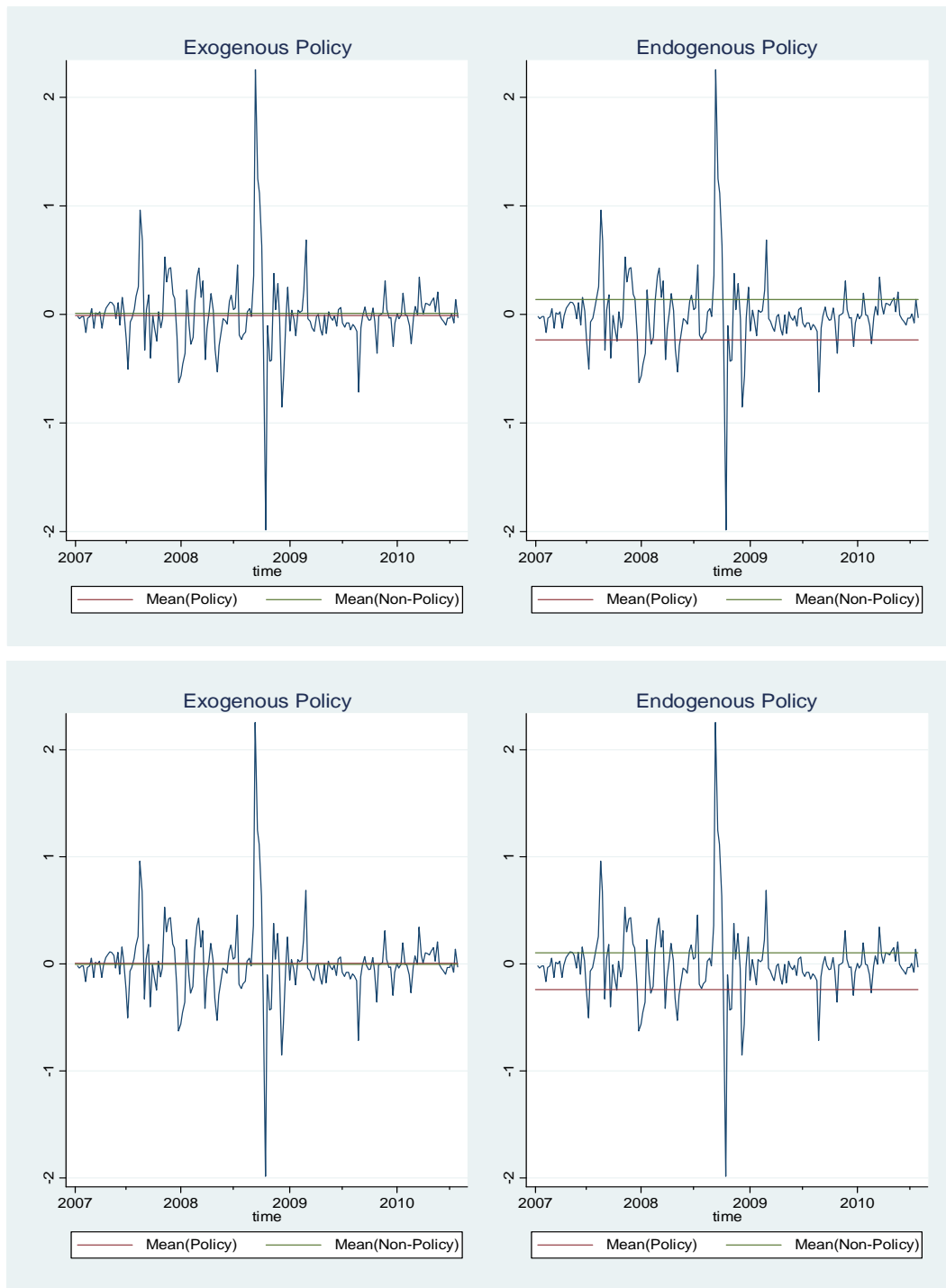
**Figure 2: Financial and Business Conditions and Fed Policy During the Crisis**

Figure 2 shows the ANFCI (in red), and the Aruoba-Diebold-Scotti Business Conditions Index (ADSBCI) maintained by the Philadelphia Fed (in blue) over the period from January 2007 to mid-August 2010. Both indexes are expressed in standard deviation units, with a negative value for the ADSBCI representing below-average economic activity. The grey bars represent weeks during the sample where a Fed policy action occurred.



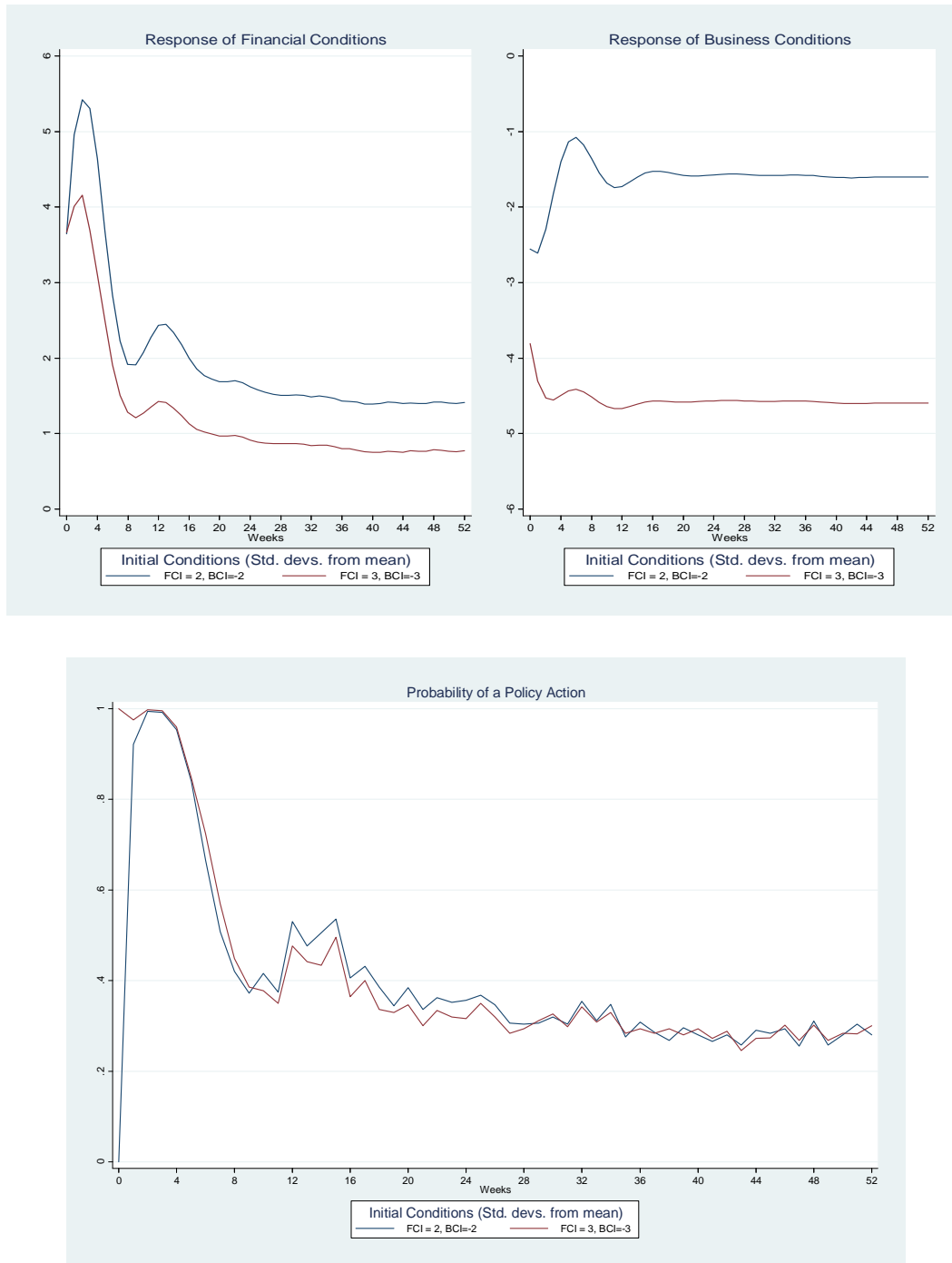
**Figure 3: Predicted Probability of Policy Action (Top: Full Sample, Bottom: Through June '09)**

Figure 3 shows the probability of a Fed policy action, along with grey bars to indicate weeks where policy events occurred. The probabilities are based on financial and business conditions in the previous week and whether there was a policy action during the previous week.



**Figure 4: Policy and the Change in the ANFCI (Top: Full Sample, Bottom: Through June '09)**

The above graphs depict the conditional mean of the weekly change in the ANFCI (blue line) during policy (red line) and non-policy (green line) event weeks assuming that policy decisions were exogenously determined (left panel) and that they were endogenously determined according to the probability model underlying figure 3 (right panel).



**Figure 5: Model Simulations of Fed Policy and Response of Financial and Business Conditions**

Figure 5 shows the results of a pair of simulated responses of financial and business conditions to Fed policy based on the estimates in table 2. We simulate a response in policy, financial conditions and business conditions over the course of 53 weeks given a set of initial conditions. The blue lines suggest a scenario in which both business and financial conditions deteriorate at an equal pace in the four weeks preceding the simulation (ANFCI: 100, 100, 101, 102; ADSBCI: 100, 100, 99, 98). The red lines indicate a differing scenario, in which business conditions follow a similar path, but financial conditions worsen at a faster rate (ANFCI: 100, 100, 101, 103; ADSBI: 100, 100, 99, 98).

**Table 1. An Overview of the Federal Reserve Policies during the Crisis<sup>1</sup>**

| Liquidity Facilities with Traditional Counterparties |  |                       | Liquidity/Credit Facilities with Other Investors and Borrowers |                                    | Portfolio Purchases  | Other                           |
|--|--|-----------------------|--|------------------------------------|--|---------------------------------|
| Depository Institutions                              | Other Central Banks                          | Primary Dealers       | Money Market Mutual Funds and Commercial Paper Markets         | Consumer and Small Business Credit | Treasury, GSEs, and Residential Mortgages  | Specific Institutions           |
| <b>Discount window (8/2007)</b>                      | <b>Foreign Exchange Swap Lines (12/2007)</b> | <b>PDCF* (3/2008)</b> | <b>AMLF* (9/2008)</b>  | <b>TALF* (11/2008)</b>             | <b>Large scale purchases of Treasury securities, GSE debt, and agency MBS (11/2008; 11/2010)</b> | <b>Bear Stearns* (3/2008)</b>   |
| <b>TAF (12/2007)</b>                                 |  | <b>TSLF* (3/2008)</b> | <b>CPFF* (10/2008)</b>   |                                    |  | <b>AIG* (9/2008)</b>            |
| <b>Interest on reserves (10/2008)</b>                |  | <b>TOP* (7/2008)</b>  | <b>MMIFF* (10/2008)</b>  |                                    |  | <b>Bank of America (1/2009)</b> |
|  |  |                       |  |                                    |  | <b>Citigroup (11/2008)</b>      |

<sup>1</sup> The table does not include actions taken with respect to the target federal funds rate. The bold-faced actions in the table are those that are examined in this paper. The dates in parentheses indicate the date of the first action associated with a particular program. Appendix A provides a table of all significant dates related to these programs and related policies implemented by other U.S. agencies and foreign central banks.

\*authorized under Section 13(3) of the Federal Reserve Act – “unusual and exigent circumstances.”

For a more comprehensive timeline of policy actions, see Federal Reserve Bank of New York, “Financial Turmoil Timeline” at:

[http://www.newyorkfed.org/research/global\\_economy/Crisis\\_Timeline.pdf](http://www.newyorkfed.org/research/global_economy/Crisis_Timeline.pdf). For the details of the individual programs and related documents, see Board of Governors of the Federal Reserve System, “Credit and Liquidity Programs and the Balance Sheet” at: <http://www.federalreserve.gov/monetarypolicy/bst.htm>.

**Table 2. Estimated Effects of Policy Announcements on Financial Conditions – Full Sample**

|   | <b>Endogenous Policy</b> |                                     | <b>Exogenous Policy</b> |                                     |
|---|--------------------------|-------------------------------------|-------------------------|-------------------------------------|
|   | <b>All Fed Actions</b>   | <b>Only Fed Actions<sup>a</sup></b> | <b>All Fed Actions</b>  | <b>Only Fed Actions<sup>a</sup></b> |
| <b><i>Weekly change in the ANFCI</i></b>  |                          |                                     |                         |                                     |
| Average Treatment Effect  | -0.34*<br>(0.16)         | -0.22*<br>(0.09)                    | 0.01<br>(0.06)          | -0.09<br>(0.07)                     |
| # of Lags of $\Delta$ ANFCI   | 4                        | 4                                   | 4                       | 4                                   |
| Current plus # of Lags of $\Delta$ ADSBCI   | 4                        | 4                                   | 4                       | 4                                   |
| <b><i>Policy Indicator</i></b>  |                          |                                     |                         |                                     |
| Lagged Policy Indicator   | -0.14<br>(0.23)          | 0.12<br>(0.27)                      |                         |                                     |
| Lagged Level of ANFCI   | 0.32*<br>(0.15)          | 0.53**<br>(0.16)                    |                         |                                     |
| Lagged Level of ADSBCI  | 0.12<br>(0.16)           | 0.09<br>(0.14)                      |                         |                                     |
| Interaction ANFCI & ADSBCI  | 0.18*<br>(0.08)          | -0.12<br>(0.09)                     |                         |                                     |
| Number of Event Weeks   | 56                       | 35                                  | 56                      | 35                                  |
| Number of Observations  | 185                      | 185                                 | 185                     | 185                                 |
| Lambda  | 0.26*<br>(0.11)          | 0.08*<br>(0.04)                     |                         |                                     |
| Heteroskedasticity-robust standard errors in parentheses, $p < 0.05^{**}$ $p < 0.01^{**}$   |                          |                                     |                         |                                     |
| <sup>a</sup> Only Fed Actions treats Fed policy weeks where other domestic agencies also made a policy announcement as non-policy events. |                          |                                     |                         |                                     |

**Table 3. Estimated Effects of Policy Announcements on Individual Financial Indicators – All Events, Full Sample**

|   | <b>Weight in the ANFCI</b> | <b>Standard Deviation</b> | <b>Average Treatment Effect</b> |
|---|----------------------------|---------------------------|---------------------------------|
| 3-month LIBOR-Treasury Spread (bp)                        | 0.12                       | 44                        | -16                             |
| 3-month LIBOR-OIS Spread (bp)                             | 0.16                       | 30                        | -14                             |
| 1-month Nonfinancial A2P2/AA Commercial paper Spread (bp) | 0.09                       | 54                        | -14                             |
| Moody's Baa Corporate Bond -- Treasury Spread (bp)        | 0.03                       | 43                        | -4                              |
| Citigroup ABS -- 5-year Treasury Spread (bp)              | 0.10                       | 39                        | -12                             |
| MOVE Index (%)  | 0.05                       | 21                        | -3                              |
| VIX Index (%)   | 0.05                       | 7                         | -1                              |

Standard deviations are calculated over the period from January 2007 through August 2010 after each variable has first been adjusted for the business cycle and inflation.

**Table 4. Estimated Effects of Policy Announcements on Financial Conditions – Through June 2009**

|  | <b>Endogenous Policy</b>   |   | <b>Exogenous Policy</b>    |   |
|--|----------------------------|---|----------------------------|---|
|  | <b>All Fed<br/>Actions</b> | <b>Only Fed<br/>Actions<sup>a</sup></b> | <b>All Fed<br/>Actions</b> | <b>Only Fed<br/>Actions<sup>a</sup></b> |
| <b><i>Weekly change in the ANFCI</i></b>   |                            |   |                            |   |
| Average Treatment Effect   | -0.37*<br>(0.18)           | -0.31*<br>(0.12)                        | -0.02<br>(0.08)            | -0.16<br>(0.09)                         |
| # of Lags of $\Delta$ ANFCI  | 4                          | 4                                       | 4                          | 4                                       |
| Current plus # of Lags of $\Delta$ ADSBCI  | 4                          | 4                                       | 4                          | 4                                       |
| <b><i>Policy Indicator</i></b>   |                            |   |                            |   |
| Lagged Level of ANFCI  | 0.67**<br>(0.13)           | 0.26*<br>(0.10)                         |                            |   |
| Number of Event Weeks  | 44                         | 24                                      | 44                         | 24                                      |
| Number of Observations   | 125                        | 125                                     | 125                        | 125                                     |
| Lambda   | 0.28*<br>(0.12)            | 0.09*<br>(0.04)                         |                            |   |
| Heteroskedasticity-robust standard errors in parentheses, $p < 0.05^{**}$ $p < 0.01^{**}$<br><sup>a</sup> Only Fed Actions treats Fed policy event weeks where other domestic agencies also made a policy announcement as non-policy events. |                            |   |                            |   |



## Appendix A. Significant Dates for Federal Reserve Policies

| DATE                               | INITIAL/EXPANSION | REDUCE/END | FED ONLY | NOTES   |
|------------------------------------|-------------------|------------|----------|---|
| <b>Discount window lending</b>     |                   |            |          |   |
| 8/17/2007                          | X                 |            | X        | 30-day discount window lending added and spread with funds rate narrowed to 50 bps    |
| 3/16/2008                          | X                 |            | X        | 90 day discount window lending added and spread with funds rate narrowed to 25 bps    |
| 11/17/2009                         |                   | X          | X        | Discount window maximum maturity to be reduced to 28 days from 90 days                |
| 2/18/2010                          |                   | X          |          | Spread with funds rate is widened to 50 bps   |
| 2/18/2010                          |                   | X          |          | Discount window maximum maturity to be reduced to overnight from 28 days              |
| <b>Term Auction Facility (TAF)</b> |                   |            |          |   |
| 12/12/2007                         | X                 |            | X        | TAF is first established with auction amount of \$20 billion                          |
| 12/21/2007                         | X                 |            | X        | Announcement that bi-weekly TAF auctions will be conducted for as long as necessary   |
| 1/4/2008                           | X                 |            | X        | TAF auction amount increased to \$30 billion  |
| 2/1/2008                           | X                 |            | X        | Minimum bid size reduced to \$5 million from \$10 million                             |
| 3/7/2008                           | X                 |            | X        | TAF auction amount increased to \$50 billion  |
| 5/2/2008                           | X                 |            | X        | TAF auction amount increased to \$75 billion  |
| 7/30/2008                          | X                 |            | X        | 84-day TAF credit introduced  |
| 9/29/2008                          | X                 |            |          | 84-day auction amount increased to \$150 billion, two forward TAF auctions announced  |
| 10/6/2008                          | X                 |            |          | Total offered TAF credit increased to \$300 billion, \$150 billion for 28- and 84-day |
| 6/24/2009                          |                   | X          | X        | TAF auction amounts reduced to \$125 billion  |
| 7/24/2009                          |                   | X          | X        | TAF auction amounts reduced to \$100 billion  |
| 8/28/2009                          |                   | X          | X        | TAF auction amounts reduced to \$75 billion   |
| 9/24/2009                          |                   | X          | X        | Announcement that 84-day TAF auctions will end and 28-day phased out                  |
| 1/27/2010                          |                   | X          | X        | FOMC statement confirms last TAF auction will be in March for \$25 billion            |
| 2/18/2010                          |                   | X          |          | Minimum bid rate raised .25 to .50  |

## Appendix A. Significant Dates for Federal Reserve Policies

| DATE                            | INITIAL/EXPANSION | REDUCE/END | FED ONLY | NOTES  |
|---------------------------------|-------------------|------------|----------|--|
| <b>International Swap Lines</b> |                   |            |          |  |
| 12/12/2007                      | X                 |            | X        | Swap lines of \$20 bil. with ECB and \$4 bil. with Swiss National Bank (SNB) are established for a six-month period  |
| 3/11/2008                       | X                 |            | X        | Increases to \$30 bil. (ECB) and \$6 bil.(SNB) and extensions through September 2008   |
| 5/2/2008                        | X                 |            | X        | Increases to \$50 bil. (ECB) and \$12 bil. (SNB) and extensions through January 2009   |
| 7/30/2008                       | X                 |            | X        | Increase to \$55 bil. In line with ECB   |
| 9/18/2008                       | X                 |            |          | Increases to \$110 bil. (ECB), \$27 bil. (SNB), new lines of \$60 bil. with Bank of Japan (BOJ), \$40 bil. with Bank of England (BOE), and \$10 bil. with Bank of Canada (BOC) |
| 9/24/2008                       | X                 |            |          | Swap lines opened with Australia, Denmark, Norway, and Sweden  |
| 9/26/2008                       | X                 |            |          | Increases to \$120 bil. with ECB and \$30 bil. with SNB  |
| 9/29/2008                       | X                 |            |          | Swap lines increased by \$330 bil. and extended through April 2009   |
| 10/13/2008                      | X                 |            |          | Swap lines with the ECB, BoE, and SNB uncapped   |
| 10/14/2008                      | X                 |            |          | Swap line with the BoJ uncapped  |
| 10/28/2008                      | X                 |            |          | Swap line of \$15 bil. opened with New Zealand   |
| 10/29/2008                      | X                 |            |          | Swap lines of \$30 bil. opened with Brazil, Mexico, Korea, and Singapore   |
| 2/3/2009                        | X                 |            | X        | Swap lines extended through October 2009   |
| 3/19/2009                       | X                 |            |          | ECB and Fed to continue conducting US dollar liquidity-providing operations  |
| 4/6/2009                        | X                 |            |          | Fed swap lines created to insure foreign currency liquidity to US financial institutions   |
| 6/24/2009                       | X                 |            | X        | Swap lines extended through January 2010   |
| 1/27/2010                       |                   | X          | X        | FOMC statement confirms that swap lines will close on February 1, 2010   |
| 5/9/2010                        | X                 |            | X        | Previous swap lines re-opened with BOC, BOE, ECB, and SNB through January 2011   |
| 5/10/2010                       | X                 |            | X        | Previous swap line re-opened with BOJ also through January 2011  |

## Appendix A. Significant Dates for Federal Reserve Policies

| DATE   | INITIAL/EXPANSION | REDUCE/END | FED ONLY | NOTES   |
|--|-------------------|------------|----------|---|
| <b>Term Securities Lending Facility (TSLF)</b>                                   |                   |            |          |   |
| 3/11/2008  | X                 |            | X        | TSLF announced  |
| 5/2/2008   | X                 |            | X        | Schedule 2 TSLF auctions expanded to include AAA ABS  |
| 7/30/2008  | X                 |            | X        | Extended through January 2009, \$50 bil. option program (TOP) created   |
| 9/14/2008  | X                 |            |          | Schedule 2 auctions made weekly, amount increased to \$75 bil., and all investment grade debt securities accepted as collateral |
| 12/2/2008  | X                 |            | X        | TSLF extended through April 2009  |
| 2/3/2009   | X                 |            | X        | Extended again through October 2009   |
| 6/24/2009  | X                 | X          | X        | Schedule 2 auctions extended through January 2010, Schedule 1 and TOP suspended   |
| 9/24/2009  |                   | X          | X        | Auction amount reduced to \$50 bil. In October and \$25 bil. thereafter through January   |
| 1/27/2010  |                   | X          | X        | FOMC statement confirms that TSLF will close on February 1, 2010  |
| <b>Primary Dealer Credit Facility (PDCF)</b>                                     |                   |            |          |   |
| 3/16/2008  | X                 |            | X        | PDCF created  |
| 7/30/2008  | X                 |            | X        | Extended through January 2009   |
| 9/14/2008  | X                 |            |          | PDCF collateral expanded to include all tri-party repo system securities  |
| 12/2/2008  | X                 |            | X        | PDCF extended through April 2009  |
| 2/3/2009   | X                 |            | X        | Extended again through October 2009   |
| 6/24/2009  | X                 |            | X        | Extended again through January 2010   |
| 1/27/2010  |                   | X          | X        | FOMC statement confirms that the program will close on February 1, 2010   |
| <b>Asset-backed Commercial Paper Money Market Fund Liquidity Facility (AMLF)</b> |                   |            |          |   |
| 9/19/2008  | X                 |            |          | AMLF created and announced that it will run through January 2009  |
| 12/2/2008  | X                 |            | X        | AMLF extended through April 2009  |
| 2/3/2009   | X                 |            | X        | Extended again through October 2009   |
| 6/24/2009  | X                 |            | X        | Extended through January 2010   |
| 1/27/2010  |                   | X          | X        | FOMC statement confirms that the program will close on February 1, 2010   |

## Appendix A. Significant Dates for Federal Reserve Policies

| DATE  | INITIAL/EXPANSION | REDUCE/END | FED ONLY | NOTES  |
|---|-------------------|------------|----------|--|
| <b>Commercial Paper Funding Facility (CPFF)</b>       |                   |            |          |  |
| 10/7/2008   | X                 |            |          | CPFF created and announced that it will run through April 2009                                       |
| 10/14/2008  | X                 |            |          | Announcement that CPFF will be in operation beginning October 27                                     |
| 1/23/2009   | X                 |            |          | NY Fed announces changes to eligibility requirements for ABCP issuers                                |
| 2/3/2009  | X                 |            | X        | Extended through October 2009  |
| 6/24/2009   | X                 |            | X        | Extended again through January 2010  |
| 1/27/2010   |                   | X          | X        | FOMC statement confirms that the program will close on February 1, 2010                              |
| <b>Money Market Investor Funding Facility (MMIFF)</b> |                   |            |          |  |
| 10/21/2008  | X                 |            | X        | MMIFF created and announced it will run through April 2009   |
| 1/7/2009  | X                 |            |          | MMIFF expanded to other money market investors and minimum yield lowered                             |
| 2/3/2009  | X                 |            | X        | Extended through October 2009  |
| 6/25/2009   |                   | X          | X        | MMIFF was not extended with other programs   |
| <b>Term Asset-backed Loan Facility (TALF)</b>         |                   |            |          |  |
| 11/25/2008  | X                 |            | X        | TALF announced and will run through December 2009  |
| 2/6/2009  | X                 |            |          | TALF terms revised   |
| 2/10/2009   | X                 |            |          | Willingness to expand TALF to include CMBS and private MBS announced                                 |
| 3/3/2009  | X                 |            | X        | Terms of first TALF operation announced  |
| 3/19/2009   | X                 |            |          | Set of TALF eligible ABS collateral expanded   |
| 5/1/2009  | X                 |            | X        | Set of TALF eligible collateral expanded to newly issued CMBS  |
| 5/19/2009   | X                 |            |          | Set of TALF eligible collateral expanded to include legacy CMBS                                      |
| 8/17/2009   | X                 |            | X        | TALF extended through March 2010 for ABS and legacy CMBS and through June 2010 for newly issued CMBS |
| 7/20/2010   |                   | X          | X        | FRB and Treasury announce reduction of TALF credit protection from \$20 bil to \$4.3 bil             |

## Appendix A. Significant Dates for Federal Reserve Policies

| DATE  | INITIAL/EXPANSION | REDUCE/END | FED ONLY | NOTES   |
|---|-------------------|------------|----------|---|
| <b>Large Scale Asset Purchases (LSAPs)</b>              |                   |            |          |   |
| 7/30/2008   | X                 |            | X        | Housing and Economic Recovery Act of 2008 authorizes Treasury to purchase GSE obligations   |
| 11/25/2008  | X                 |            |          | Purchases of agency MBS up to \$500 bil. and debt up to \$100 bil. announced  |
| 12/1/2008   | X                 |            | X        | Agency debt purchases begin, Chairman Bernanke first mentions long-term Treasury purchases as a possibility in a speech   |
| 12/15/2008  | X                 |            | X        | FOMC statement first mentions possible purchases of long-term Treasuries  |
| 12/30/2008  | X                 |            |          | FRB announces that it expects to begin purchasing agency MBS in early January   |
| 1/28/2009   | X                 |            |          | FOMC statement announces willingness to begin purchases of long-term Treasuries   |
| 3/18/2009   | X                 |            |          | Purchases of agency MBS and debt increased to \$1.25 tril. and \$200 bill., plans to purchase \$300 bil. of long-term Treasuries announced                      |
| 7/21/2010   |                   | X          | X        | Bernanke announced that the Fed was not currently reinvesting principal repayments of agency debt and MBS, but was doing so for longer-term Treasury securities |
| 8/10/2010   | X                 |            | X        | FOMC announced that it will reinvest principal repayments on agency debt and MBS holdings in longer-term Treasury securities                                    |
| <b>Other Significant Fed and Non-Fed Policy Actions</b> |                   |            |          |   |
| 3/14/2008   | X                 |            | X        | Fed provides emergency lending to Bear Stearns via JP Morgan Chase  |
| 7/13/2008   | X                 |            |          | Announcement by Fed that loans will be made available to the housing GSEs at primary credit rate if necessary and upon request; supplements a Treasury program  |
| 9/16/2008   | X                 |            |          | Two year secured loan to AIG made by the Fed  |
| 9/17/2008   | X                 |            |          | Treasury and Fed announce Supplementary Financing Program   |
| 9/19/2008   | X                 |            |          | Fed announces it will purchase short-term Agency obligations  |
| 9/21/2008   | X                 |            |          | Fed allows Goldman Sachs and Morgan Stanley to become bank holding companies  |
| 10/8/2008   | X                 |            |          | Fed authorizes the borrowing of securities from AIG in return for cash  |

## Appendix A. Significant Dates for Federal Reserve Policies

| Other Significant Fed and Non-Fed Policy Actions (continued) |   |   |   |  |
|--|---|---|---|--|
| 11/10/2008   | X |   |   | AIG loan restructured, \$40 bil. capital injection made by Treasury, terms of existing Fed credit facilities eased and new lending facilities created for MBS and CDO portfolios |
| 11/10/2008   | X |   |   | Fed allows American Express to become a bank holding company   |
| 11/23/2008   | X |   |   | Citigroup assistance package announced with support from the Fed, Treasury, and FDIC   |
| 12/22/2008   | X |   |   | Fed allows CIT Group to become a bank holding company  |
| 12/24/2008   | X |   |   | Fed allows GMAC to become a bank holding company   |
| 1/16/2009  | X |   |   | Bank of America assistance package announced with similar terms to Citigroup, and FDIC announces intent to extend maturity of TGLP to 10 years from 3 years                      |
| 2/23/2009  | X |   |   | Treasury, FDIC, Comptroller, Office of Thrift Supervision, and FRB issue statement that government stands behind banking system  |
| 2/25/2009  | X |   |   | Stress tests (SCAP) announced in joint statement of regulatory institutions  |
| 2/27/2009  | X |   | X | Citigroup assistance package expanded  |
| 3/2/2009   | X |   | X | Further restructuring of AIG credit facilities takes place by Fed and Treasury   |
| 4/24/2009  | X |   | X | Stress test (SCAP) methodologies announced   |
| 5/7/2009   |   | X | X | Stress test (SCAP) results announced   |
| 6/25/2009  | X |   | X | AIG bailout restructured. Debt to NY FED reduced by \$25 bil. in exchange for preferred interests  |
| 7/8/2009   | X |   | X | Treasury, Fed, FDIC release details of PPIP  |
| 2/23/2010  | X |   |   | Treasury increases the balance in the Supplementary Financing Account from \$5 bil. to \$200 bil.  |

**Table A1 (continued). Significant Dates for Federal Reserve Policies**

| DATE  | INITIAL/EXPANSION | REDUCE/END | FED ONLY | NOTES  |
|---|-------------------|------------|----------|--|
| <b>Federal Funds Rate Movements</b>         |                   |            |          |  |
| 9/18/2007                                   | X                 |            | X        | Fed funds rate cut 50 basis points to 4.75                               |
| 10/31/2007                                  | X                 |            | X        | Fed funds rate cut 25 basis points to 4.50                               |
| 12/11/2007                                  | X                 |            | X        | Fed funds rate cut 25 basis points to 4.25                               |
| 1/22/2008                                   | X                 |            | X        | Fed funds rate cut 75 basis points to 3.5                                |
| 1/30/2008                                   | X                 |            | X        | Fed funds rate cut 50 basis points to 3                                  |
| 3/18/2008                                   | X                 |            | X        | Fed funds rate cut 75 basis points to 2.25                               |
| 4/30/2008                                   | X                 |            | X        | Fed funds rate cut 25 basis points to 2                                  |
| 10/8/2008                                   | X                 |            |          | Fed funds rate cut 50 basis points to 1.50                               |
| 10/29/2008                                  | X                 |            |          | Fed funds rate cut 50 basis points to 1                                  |
| 12/16/2008                                  | X                 |            | X        | Fed funds rate target set at between 0 and 0.25                          |
| <b>International Events Excluding Swaps</b> |                   |            |          |  |
| 8/9/2007                                    | X                 |            | X        | ECB injects €95 billion overnight. Fed injects \$12 billion of reserves. |
| 10/8/2008                                   | X                 |            |          | Coordinated interest rate cuts of 0.5% (includes BoE, Fed, ECB)          |

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