July 8, 2016

Lessons From the Crisis for a Future Monetary Policy Operating Framework[1]

EXECUTIVE SUMMARY

This memo evaluates the performance of the Federal Reserve's monetary policy implementation framework (hereafter referred to as "the framework") during the period of the financial crisis, which we define as August 2007 through May 2009. We begin with the pre-crisis framework and trace the evolution of policy tools in response to three relatively distinct phases of the crisis: the breakdown in bank intermediation (August 2007-March 2008), disruptions to nonbank intermediation via capital markets (March 2008-September 2008), and impairment of corporate and consumer access to capital-market funding after Lehman's failure in September 2008.

Section I provides an overview of the pre-crisis framework, which operated with a relatively low level of reserves and two tools for liquidity provision: (i) open market operations (OMOs) with primary dealers against the limited set of assets permissible under the Federal Reserve Act, and (ii) discount window (DW) lending to depository institutions against a broader set of assets. The size of the SOMA portfolio was driven by currency in circulation, and reductions in the outright holdings of securities and repos in the SOMA portfolio were used to offset, or "sterilize," growth in other assets or unexpected declines in liabilities. Section II documents the stress in financial markets that emerged during the crisis, and discusses the efficacy of some of the policy tools that were used or newly introduced to meet the challenges these market developments presented to the control of overnight rates and the broader transmission of policy into money markets:

- The DW's lack of efficacy in providing liquidity to alleviate market stress, due to the stigma associated with it for U.S. banks and branches, and its inability to address

[1] Authors include Dave Altig, Michael Fleming, Hesna Genay, Susan McLaughlin, Argia Sbordone and Larry Wall. The authors also wish to thank Sriya Anbil, Stephanie Curcuru, Terry Fitzgerald, Frank Keane, Kevin McDonald, Manjola Tase, and Zachary Taylor for their contributions to the memo.

pressures in dollar funding markets stemming from strains outside the United States.[2] The Term Auction Facility (TAF) and the central bank liquidity swap lines (henceforth "FX swap lines") were established to overcome these respective challenges.

- The limitations of repos against government securities with primary dealers as a tool to address broader disruptions to secured funding markets for less-liquid assets. To establish an effective backstop for funding markets for the broader range of less-liquid assets after the collapse of Bear Stearns, it was necessary to invoke 13(3) authority to create both the Primary Dealer Credit Facility and the Term Securities Lending Facility (Schedule 2).
- The difficulty in relying solely upon existing liquidity tools for banks and primary dealers to address the widespread dysfunction in capital markets and impairment of most channels of monetary policy transmission that followed Lehman's demise. The Fed created additional liquidity insurance tools under its 13(3) authority in order to reach counterparties beyond primary dealers and banks, and a broad range of collateral beyond DW-eligible assets, to mitigate unprecedented financial market stress.[3]
- A lack of preparedness to implement monetary policy once the effective lower bound (ELB) was reached in December 2008, which necessitated the real-time creation of large scale asset purchases (LSAP) as the active instrument for policy implementation.

Sections III and IV document the operational challenges associated with implementing the new policy tools just described, and summarize the lessons that we believe are suggested by that experience. Our analysis is informed by academic studies, transcripts of FOMC meetings during the period, and the recollections of Federal Reserve staff actively involved in implementing new policy tools during the crisis. We derived five key lessons from our analysis concerning the limitations of the pre-crisis framework:

---

[2] We use stigma in the traditional sense of "banks' reluctance to approach the DW out of concerns that, if detected, depositors, creditors, or analysts could interpret DW borrowing as a sign of financial weakness." See Armantier (2014).

[3] While a broad range of collateral was accepted at the discount window, following Lehman's demise it became necessary to expand the PDCF to a wider range of assets (including non-investment grade fixed-income securities and equities) than the discount window collateral list.

- A material tension existed between interest rate control and the large-scale liquidity provision that was needed to address protracted financial market stress and safeguard policy transmission. Specifically, expansions of the balance sheet associated with liquidity provision operations created a need to drain reserves in order to maintain funds rate control. Eventually, the scale of the Fed's operations outpaced the Fed's tools and capacity to sterilize these operations.
- The Federal Reserve was not well-positioned to efficiently and effectively provide liquidity insurance in scale. The TAF and FX swap lines were introduced to provide liquidity insurance that the discount window alone could not. Ultimately, 13(3) authority was needed to effect collateral and counterparty expansions in the second and third phases of the crisis to provide liquidity insurance more broadly. Between March and September of 2008, limits on the Fed's draining capacity were described by some of the staff we interviewed as having complicated the implementation of these additional liquidity insurance tools. After the failure of Lehman, the absence of large scale draining capacity, combined with a framework based on reserve scarcity, led to a deterioration of control over the federal funds rate as additional liquidity insurance tools were implemented in response to increasing market stress.
- Bounds on fluctuations in the federal funds rate appeared to fail at many points during the crisis period. Maintenance-period rate control was maintained reasonably well for most of the crisis. However, due to market dynamics described in greater detail below, intraday volatility in the federal funds market was elevated for most of the crisis period. As in the pre-crisis period, the primary credit facility failed to provide a firm ceiling on the level of the funds rate. The TAF could have in principle provided a ceiling on the policy rate, but it was designed to mitigate pressures in term funding markets, not to bound the upper end of the rate's range. Additionally, interest on excess reserves (IOER) failed to provide a firm floor on the funds rate when it was eventually introduced.
- The framework was not sufficiently flexible or robust in the face of significant liquidity stress and disruptions to monetary policy transmission. By "robust," we mean that standard pre-crisis liquidity tools were not equipped to provide the type of liquidity insurance needed to address disruptions to funding streams outside of the U.S. banking system and their corresponding transmission channels. By "flexible" we mean that

adaptation to evolving market conditions requiring expansion of counterparties, funding mechanisms, and so on was difficult and costly to do in real time.

- Operational readiness was insufficient with respect to the analysis, accounting, reporting and operational changes needed to support the execution of LSAPs (particularly agency mortgage-backed securities, or agency MBS) once the federal funds rate had been reduced to its ELB.

We conclude our discussion of each lesson with a set of questions the workgroups that follow may want to consider as they work to develop options for possible revisions to the long-run operating framework. We emphasize that our intention is not to be prescriptive or presumptive about that framework, but rather to highlight for further consideration the central issues and tradeoffs raised by the crisis experience.

I. Overview of monetary policy framework and transmission mechanism prior to the crisis

The monetary policy implementation framework in place prior to the crisis (hereafter, "the framework") had worked well in pre-2007 episodes of financial market stress. These episodes were limited enough that discount window (DW, or primary credit facility) and open market operation (OMO) tools had been adequate to address them without losing control over the policy rate. Policy actions could be accommodated on the balance sheet, with some tolerance for less tight rate control to address financial instability.[4] However, the 2007-2008 crisis presented unprecedented challenges that tested the limits of this framework. We highlight three features of the pre-crisis framework that were particularly relevant during the crisis:[5]

i) Rate control was based on reserve scarcity. The Desk operated with a reserve deficiency, and supplied reserves to meet demand through daily OMOs in order to manage the

[4] Swap lines were made available to several central banks, and used by the ECB, in the days following the 9/11 attacks. This is the first instance of the FOMC establishing foreign exchange swaps for the purpose of liquidity insurance. See the Money Markets group memo for more details on liquidity provision in stress prior to 2007.

[5] For a more extensive discussion of the pre-crisis framework, we refer to the memo of the Money Markets foundational group.

effective federal funds rate to the FOMC's target. The size of the operations varied with changes in demand for reserves and/or autonomous factors. Interest rate control required sterilization of unexpected increases in reserves.

ii) Liquidity was provided through two tools. The Desk conducted interest rate control operations via repurchase agreements with primary dealers against the set of assets permissible under the Federal Reserve Act. These operations were conducted daily and in modest size, to provide an aggregate amount of liquidity that was determined through Desk forecasts of reserve demand and supply, consistent with the FOMC's policy rate directive. Additionally, Reserve Banks made DW loans to individual depository institutions, upon request, that were collateralized by a broad set of assets. In principle, the primary credit rate was intended to contribute to interest rate control by providing ceiling control on the federal funds rate and to cap its volatility, in addition to retaining the DW's long standing role of providing liquidity to solvent (but temporarily illiquid) individual banks. However, stigma associated with borrowing at the discount window limited the willingness of banks to borrow through this facility.[6] Primary credit was the sole tool for providing liquidity insurance to the market in response to a systemic liquidity shock.

iii) The portfolio was not a policy tool. Internal documents such as the System Open Market Account (SOMA) portfolio guidelines show that staff and policymakers viewed the portfolio as a byproduct of the various activities the Fed undertakes in support of its mission. SOMA securities holdings were sized (in par terms) nearly equal to, and grew at the same rate as, the quantity of currency in circulation. The portfolio's size was maintained by reinvesting the proceeds of maturing securities into new issuance; growth occurred through the conduct of coupon passes in the secondary market.[7] As demand for currency increased, so did the size of SOMA holdings.

---

[6] For a discussion of the historical origins of discount window stigma, see Lee and Sarkar (2015).

[7] Outright purchases of Treasuries were conducted within a pre-defined maturity range; the Desk used a relative value model to determine which securities were cheapest on a relative value basis, based on market prices. The completion of a set of operations in all segments across the yield curve was referred to as a coupon pass.

Monetary policy transmission

Traditional channels of transmission work through the structure of interest rates and other asset prices, and through the cost and availability of credit.[8] The "transmission chart" in Appendix 1 illustrates a mapping of the channels through which control of the federal funds rate influenced financial conditions in the pre-crisis operating regime. The chart also illustrates the disruptions in intermediation that emerged in the three phases of the crisis that are described in Section II, and the policy responses designed to address those disruptions. The chart shows that nearly all of the traditional mechanisms of monetary policy were impacted at some point during the crisis. A key takeaway from the chart is that financial market stress affects policy transmission channels in many ways other than the linkage between short-and long-term rates. Liquidity insurance has an important role to play in ensuring that policy transmission continues to work effectively.

II. Challenges to the framework and policy responses during the crisis

Crisis phase 1: Breakdown in bank intermediation (August 2007 – March 2008)

Manifestations of financial market stress. Bank funding costs increased in August 2007, as short-term unsecured funding markets seized up. Foreign banks and their U.S. branches that needed overnight and term dollar funding were particularly affected. Empirical evidence suggests that the cost increase reflected a reduction in market liquidity, a repricing of credit risk, and a decrease in activity in response to counterparty concerns.[9]

As weakness in residential mortgage-backed securities (RMBS) spilled over into broader markets in August, interbank rates shot up, with the spread on the 1-month London Interbank Offered Rate (LIBOR) to the rate on overnight index swaps (OIS) spread increasing from its

[8] See, for example, Mishkin (1995).

[9] Filipović and Trolle (2013), Gefang, Koop, Potter (2011), and King and Lewis (2014) find that both liquidity and credit risk were relevant to banks' LIBOR submissions. The studies do not consider changes in credit lines, but anecdotal information suggests that lines were being reduced.

normal 5-10 basis points to over 88 basis points (bps) on September 10.[10] This increase reflected both a spike in funding demand from banks in response to dramatic reductions in their asset-backed commercial paper subprime RMBS programs and a pull back from investors from banks that had provided explicit or implicit back-up liquidity to the programs. As investors became concerned about banks' ability to meet their obligations, "banking institutions began to hoard cash... and risk spreads for interbank funds… widened sharply."[11] The ensuing liquidity shock hit both U.S. banks and foreign banks, and was especially acute for European banks.[12]

Banks with U.S. charters could tap a variety of domestic dollar funding sources, including the Federal Home Loan Banks.[13] The alternatives for foreign banks, however, were limited to the wholesale funding markets (including unsecured funding market activity that encompassed both federal funds in the U.S., and the offshore Eurodollar market), the private FX swap market (where banks could swap home currency funding for dollar funding), and the discount window. Although activity in the unsecured funding markets grew after August 9, our interviews with staff on the Desk in this period indicate that the market had become extremely bifurcated, with foreign banks paying elevated rates in the morning followed by a drop in rates in the afternoon when U.S. banks would typically access the market.[14] Further, as shown in Appendix 3, the euro-dollar swap basis increased in August, but remained below 40 basis points until the failure of Lehman Brothers in the fall of 2008.[15]

---

[10] As shown in Appendix 2, subsequent spikes in the spread occurred in December 2007 (before the announcement of new facilities), in March 2008 (the Bear Stearns' collapse) and in October 2008 (after Lehman Brothers' failure).

[11] See Covitz, Liang, and Suarez (2013).

[12] McGuire and von Peter (2009) find that over the prior decade, many offshore banks had become large players in USD investment banking services, resulting in significant holdings of AAA-rated USD assets and growing USD funding needs. European banks in particular were subject to considerable funding risk at the start of the crisis, with an estimated funding gap including liabilities to money funds of $2.1 to $2.3 trillion.

[13] Ashcraft, Bech and Frame (2010) compare the cost of 30-day primary credit with the all-in-cost of funding from the FHLB NY and find that the FHLB was a lower cost source of funds into the summer of 2008.

[14] The interviews conducted by the Lessons from the Crisis Foundational Workgroup are summarized in "Master Notes File from Interviews with Key Policy Implementation Players".

[15] The euro-dollar swap basis measures the cost of indirect borrowing in dollars (borrowing euros in the Euribor market and swapping the euros for dollars) relative to direct borrowing in dollars (via the USD-Libor market).

The bifurcation of dollar money market activity between federal funds transactions among US participants and the notably larger volume of Eurodollar transactions among offshore participants posed a challenge for the Desk, as the framework's design was not robust to dislocations in demand and pricing emerging in overnight federal funds trading. The Desk typically conducted one repo operation each morning to supply the day's reserves. Immediately after the BNP Paribas' suspension of redemptions on funds tied to subprime mortgages, the Desk attempted to respond to strong European demand by supplying reserves in excess of the amount forecasted, knowing that extra reserves would cause the rate to soften in the afternoon when European banks were no longer active. The problem could have been addressed by draining reserves later in the day, but interviews with staff indicate that there was little consideration of this approach, given the limits on our capacity to drain through reverse repos (detailed in Section III). While the Desk was able to keep the daily average federal funds rate near the target for most of the period, intraday volatility remained elevated as a result of this bifurcation.

Policy response. On August 17, 2007 the Board of Governors (BoG) narrowed the spread between the primary credit rate and the federal funds rate to 50 bps and increased the maximum term to 30 days. This action was not successful in inducing borrowing to meet the banking system's liquidity needs. Many U.S. branches of foreign banks, like their domestic bank counterparts, were reluctant to use the discount window. European banks that did not have a U.S. branch could not access the discount window at all.

Two new facilities were announced on December 17, 2007 to address demand for term dollar funding: The Term Auction Facility (TAF) and swap lines with foreign central banks. The TAF was designed to overcome the stigma associated with primary credit in two ways. First, a fixed amount of funding was provided through a bi-weekly auction process with a minimum bid rate – so that banks paid a market-determined rate. Second, TAF loans were not for same-day settlement, which helped to avoid a signal that recipients were in desperate need of immediate funding.

Despite the high cost of TAF loans relative to primary credit, TAF was used by a much wider set of banks than those that used the window in this period, and proved effective in providing term

funding to banks that needed it (see Appendix 4).[16] There is also evidence to suggest that TAF helped to reduce the LIBOR-OIS spread.[17]

FX swap lines enabled the Federal Reserve to provide U.S. dollars to foreign central banks so that they could meet the dollar funding needs of banks in their jurisdictions, and thus avoid exacerbating financial strains in the U.S. markets.[18] Empirical analysis of the swap lines suggests that they significantly reduced the volatility but not the level of the European-currency swap basis prior to Lehman's failure, and reduced both the volatility and level of the swap basis significantly after Lehman's failure.[19,20]

Crisis phase 2: Disruptions to nonbank intermediation via capital markets (March 2008 - September 2008)

Manifestations of financial market stress. In early 2008, lenders in the secured funding markets became increasingly concerned about the value of the collateral backing their loans and the credit worthiness of their counterparties. These lenders responded by increasing haircuts, demanding greater compensation for lending against riskier collateral, and even (in some cases) ceasing to lend altogether.[21] Overnight agency MBS repo spreads to Treasury repo widened materially in the second half of 2007, and then again in early 2008 (see Appendix 6). Bear Stearns' inability to access the repo market was an important factor in its near-collapse.

Policy response. To reduce the likelihood that dealers would conduct fire sales of assets they could not finance and to avert a run from the markets by secured lenders, the Fed undertook

[16] Some banks used both the TAF and discount window, as TAF did not address their overnight funding needs. Armantier, Ghysels, Sarkar, and Shrader (2015) compare the costs of primary credit versus the TAF. The choice of discount window or TAF given stigma is modeled by Gauthier, Lehar, Saiz and Souissi (2015).

[17] See Christensen, Lopez, Rudebusch (2014) and McAndrews, Sarkar, Wang (2015).

[18] See Appendix 5 for a chronology of the swap lines.

[19] See Baba and Packer (2009a, b).

[20] The academic literature has not addressed the impact of the TAF and swap line programs on the level and volatility of the federal funds rate.

[21] See Copeland, Martin, and Walker, 2010, 2014; Gorton and Metrick, 2012; and Krishnamurthy, Nagel, and Orlov, 2014).

several actions to address building pressures and improve financial market functioning.[22] On March 7, it announced a series of 28-day single-tranche repos (STRP) under which primary dealers could deliver as collateral any of the securities eligible in its conventional OMOs. On March 11, it announced the Term Securities Lending Facility (TSLF), through which primary dealers could exchange less liquid securities for Treasury securities for terms of 28 days at an auction-determined fee.[23] On March 16, the same day that JP Morgan Chase agreed to acquire Bear Stearns, the Fed used its 13(3) authority to introduce the Primary Dealer Credit Facility (PDCF) through which dealers could borrow at the primary credit rate against the same set of collateral eligible for discount window borrowing. The TSLF offered an advantage over both STRP and PDCF because it was reserve-neutral by design, and could thus be scaled up without concern for rate control. And PDCF was beneficial as it provided cash against a much broader range of collateral, including the assets most subject to stress, than STRP.

The non-13(3) facilities introduced in March 2008 (i.e. STRP and TSLF Schedule 1) helped to narrow spreads on term securities issued by government sponsored agencies (agency debt) and on agency MBS. But their impact was limited, as these programs were confined to OMO-eligible assets, and did not address disruptions in illiquid assets where liquidity pressures were more acute. Moreover, counterparties for these programs were limited to primary dealers because operational arrangements to support trading with these firms were already in place, speeding time to market. As the Fed took steps to address the pressures in secured funding markets, it continued to reduce the federal funds and primary credit rates and further expanded the TAF and swap facilities.[24]

[22] Appendix 7 lists the liquidity programs introduced or expanded during the crisis.

[23] TSLF Schedule 1 operations allowed dealers to pledge collateral eligible for open market operations, whereas Schedule 2 operations, relying on 13(3) authority, allowed dealers to pledge a broader range of collateral.

[24] See Appendix 4 for a full list of program expansions.

Crisis phase 3: Impairment of corporate and consumer access to capital markets for funding (September 2008 – May 2009)

Manifestations of financial market stress. The bankruptcy of Lehman Brothers on September 15, 2008 led to an unprecedented broadening and intensification of market disruptions. On September 16, the Reserve Primary Fund "broke the buck," prompting a widespread flight-to-quality from high-yielding money market mutual funds (MMMFs) to Treasury-only MMMFs. This in turn impeded the ability of commercial paper issuers to roll over their short-term liabilities. The disruptions are illustrated in Appendix 8, which documents the striking rise in term commercial paper rates relative to OIS.

Policy response. The Fed undertook several actions in September and October 2008 to avoid a broader breakdown in financial markets. In addition to expanding the use of its existing liquidity tools, the Fed introduced several new 13(3) programs to get liquidity to intermediaries against a broader range of collateral, involving counterparties and collateral types beyond those that were central to the existing monetary policy framework.[25]

When the policy rate reached the ELB, the Fed began to use the SOMA portfolio as a policy tool to affect monetary policy objectives. On November 25 the Fed announced its first large-scale asset purchases (LSAPs) of agency debt and agency MBS as a means to support the U.S. housing market and to ease policy through a reduction in longer-term rates. This first LSAP program is generally found to have lowered yields on longer-term Treasury and other fixed income securities, and to have improved market functioning.[26]

In principle, the introduction of interest on excess reserves (IOER) on October 6 should have provided a floor on the federal funds rate and other short-term interest rates that would be independent of the quantity of reserves being added to the system. Thus, IOER should have eased the conflict between rate control and balance sheet expansion associated with liquidity provision. However, as noted in the Money Market workgroup's memo, IOER did not provide a

[25] See http://www.federalreserve.gov/monetarypolicy/bst_archive.htm for further details on these facilities.

[26] See, for example, Gagnon, Raskin, Remache, and Sack (2011), Hancock and Passmore (2011), Krishnamurthy and Vissing-Jorgensen (2011), D'Amico, English, Lopez Salido and Nelson (2012), and D'Amico and King (2012).

perfect floor on rates, and the Fed's massive balance sheet expansion throughout the fall of 2008 consistently drove the effective federal funds rate below the policy target until the ELB was reached in December.

III. Evaluating the framework's performance in the crisis

Conflict between rate control and liquidity provision[27] in a "reserves scarcity" framework

In the Fed's pre-crisis framework, increases in reserves resulting from Fed liquidity provision activities had to be sterilized in order to control the level of the federal funds rate.[28] Balance sheet sterilization became increasingly challenging as the crisis wore on, in several respects.

Sterilization was largely passive, not active. Beginning in 2000 the SOMA Manager asked Desk staff to write down guidelines, to be reviewed and updated periodically, that described the principles and practices used to manage the domestic SOMA portfolio, including how sterilization of balance sheet changes would be effected. Our study of the 2006 guidelines document revealed that the preferred approach to balance sheet sterilization was to use maturity liquidity (i.e. "redeeming" holdings, or the practice of contracting the portfolio by foregoing reinvestment of the proceeds of maturing securities holdings) to passively sterilize increases in reserves. A benefit of this passive approach was that sterilization could be done without transactions that could affect secondary market liquidity or pricing. The disadvantage of this approach was a lack of flexibility, since the size and pace of sterilization that could be achieved depended entirely on the size and maturity distribution of portfolio holdings.

Prior to March 2008, in accordance with these guidelines, the Fed's liquidity insurance operations were sterilized solely through the use of redemptions of Treasury securities. However, by early March 2008, the Fed's capacity for passive sterilization had diminished even as the Fed began to dramatically expand liquidity insurance operations in response to growing market

[27] We define liquidity provision to include liquidity provided both through open market operations (as was done in the days following the 9/11 attacks) and through other types of operations. Both types of liquidity provision increase reserves and require sterilization for the purpose of interest rate control.

[28] For further details on the reserves scarcity framework, please refer to the Money Markets Workgroup memo.

strains. At the beginning of March 2008, the securities held in the SOMA portfolio provided passive sterilization capacity of no more than $10 to $15 billion per week, or $50 billion per month. This capacity subsequently diminished further, as more and more securities holdings were redeemed.

Available tools were inadequate to support a more active approach to sterilization. Though policy considerations were the primary driver in the design of various liquidity insurance tools, the passive approach to balance sheet sterilization described above appears to have operated as a second-order constraint on liquidity insurance during the period from the failure of Bear Stearns in March 2008 to the collapse of Lehman in the fall. Our interviews with Desk staff indicate that prior to March 2008, there was a reluctance to deploy sterilization tools other than redemptions of Treasury securities, due to the perceived limitations and disadvantages of other more active tools that were available. Each of these tools is discussed briefly below.

Sales of securities. Sales of assets had the greatest scope among these alternatives, but had not been conducted since 1991. Staff interviews revealed several recollections about what was behind the reluctance to engage in outright sales. One was that sales, as permanent adjustments to the monetary base, were appropriate to sterilize declines in currency in circulation but not suited to offset movements in net autonomous factors of a more temporary nature. Another was that sales were viewed as potentially problematic as they could tighten conditions by permanently reducing reserves. Additionally, some noted that sales were subject to uncertainty about the impact on market pricing and liquidity conditions, and the risk of capital loss that could (if large enough) erode the capital of a small Reserve Bank and impair market confidence.[29] Some staff also noted operational considerations that made sales cumbersome and risky to use. For example, the lack of a pricing model to support simultaneous sales of multiple security issues required that operations be conducted in one issue at a time, further diminishing their appeal and capacity relative to redemptions.

[29] We found some email traffic indicating that avoidance of capital losses was one of several factors in the Desk's decisions about which coupon securities to sell in March 2008.

Despite these shortcomings, sales became important as a tool to sterilize growth in TAF and swap activity in March 2008. Sales were initially limited to bills, but quickly extended to coupon securities as TAF and swap operations grew in size and the single-tranche repo program and the PDCF were implemented. Sales of bills and coupons peaked following the failure of Bear Stearns, but continued until early June 2008 as TAF auction rollovers continued to increase. A total of $89 billion in bills and $55 billion in coupons--representing 45% of the bills and 12% of the nominal coupons held in the portfolio as of March 6, 2008[30]-- were sold into the market between March and May 2008.[31] Further sales were constrained by a lack of short-dated securities, reluctance to sell longer-dated securities, and the existence of $200 billion in TSLF claims on SOMA Treasury holdings.

Repo reductions. Reductions in the book of outstanding repos were another way to sterilize lending operations, but offered much less capacity than sales. The book of repos outstanding averaged between $20 and $30 billion in the months preceding the crisis, and represented a mix of overnight and term repos out to 28 days. Given the need to maintain some level of outstanding repos to manage short term and seasonal fluctuations in autonomous factors, a complete wind-down of the repo book would probably not have been advisable. Additionally, it would have taken up to a month to run down the portion of the book that could be used, given that repos of up to 28 days remaining maturity were being executed. Some reductions of the repo book were done between May and July 2008, but the Desk reached the limit on its capacity to further reduce the repo book that summer.

***Reverse repos*.** Capacity to conduct reverse repos (RRPs) with primary dealers was even more limited. Primary dealers are structural seekers of funding and usually have relatively little capacity to provide cash to the Fed.[32] Moreover, RRP operations were extremely manual to execute at the time. And the Desk had no collateral management system with which to track

---

[30] See the March 6, 2008 H.4.1 report at http://www.federalreserve.gov/Releases/h41/20080306/.

[31] In addition to these bill sales, another $75.2 billion in bills were redeemed between March and May 2008, shrinking the bill portfolio by about 82 percent in total over that period.

[32] Prior to the crisis, RRPs had been used only infrequently, to drain reserves on days when the forecast had overestimated demand, generally for amounts under $5 billion.

collateral earmarked for regular overnight securities lending, TSLF, RRPs and other operations and ensure that sufficient collateral was reserved for those uses. A lack of scale, operational risk, and collateral management challenges were all cited in our interviews with staff as reasons why RRPs had been a last-resort type of tool in the early stages of the crisis. Nevertheless, the need for additional tools became so great in the spring of 2008 following Bear Stearns' demise that RRPs were used to sterilize liquidity operations as liquidity insurance programs eclipsed the amount of liquidity available from redemptions or sales on any given day.[33]

After Lehman's failure, the Desk conducted daily RRP operations of $25 billion throughout October and November, in an effort to sterilize the massive increase in liquidity insurance operations as the third phase of the crisis began. On some of these days, the Desk chose to scale back planned RRP operation sizes to the amount of funding that primary dealers were able to provide at rates in line with the policy target.[34]

Ultimately, the Fed did not have sufficient capacity to sterilize the liquidity insurance provided to markets in a prolonged stress event, particularly after Lehman's demise. Though the pre-crisis framework did contemplate the possibility of elevated sterilization requirements in periods of stress, the amount of sterilization capacity built into the SOMA portfolio's design was based on an analysis of past balance sheet shocks, the largest of which had been associated with discount window borrowing.[35] The SOMA portfolio guidelines called for holdings of at least $80 billion in securities (about 10 percent of the SOMA portfolio holdings) maturing within a 3-month timeframe, and $208 billion in securities (about 25 percent of the SOMA portfolio holdings) maturing within a 12-month timeframe.[36]

---

[33] The Desk conducted four RRP operations between March 19 and April 2, ranging between $3.75 billion and $7.25 billion.

[34] For example, on September 25, 2008, the range of rates at which RRP propositions were submitted ranged from 1.43 percent to 5 percent. The Desk accepted only $2 billion in propositions, to achieve a stop out rate of 2 percent, in line with the policy target at that time.

[35] See Appendix 9 for a brief summary of this analysis.

[36] These requirements were not additive; the 3-month buffer of $80 billion was part of the $208 billion 12-month buffer.

These buffers were adequate to support sterilization of the TAF operations and swap lines as originally sized in December 2007. However, as noted above, the need for sterilization capacity increased sharply with the advent of the second phase of the crisis in March 2008 as stress in the secured funding markets emerged and the Fed implemented several new liquidity insurance tools in an effort to keep these markets operating. For example, the STRP was announced as a series of $20 billion weekly operations, in order to ease term MBS funding pressures before TSLF could be implemented. Interviews with staff involved indicated that while Desk staff viewed $20 billion as smaller than what was needed to be effective, this was the maximum operation size that could be done with the sterilization capacity on hand at the time.

Once the TSLF was implemented, it was more effective than the STRP as a reserve-neutral way to ease secured funding market stress. TSLF's design as a bond-for-bond exchange avoided the need for sterilization, which meant greater scalability (the initial operation size for TSLF was $75 billion, as compared with the $20 billion for STRP.) In this respect, TSLF was a valuable complement to the growing number of programs that were being established as liquidity backstops for market stress that required sterilization.

By May 2008, the SOMA portfolio's holdings of short-dated securities had nearly been exhausted. At this time, the SOMA Manager asked Desk staff to begin studying the possibility of Fed issuance of bills as a means to add additional capacity to sterilize operations. This issue was tabled in 2008 given that implementation would have required legislative change, but a Board-NY paper on Fed bills was presented to the FOMC in June 2009.[37]

After Lehman, the framework proved completely inadequate to maintain rate control in the face of massive new liquidity insurance programs, and additional attempts to augment the Fed's sterilization capacity became necessary. In September 2008, shortly after Lehman fell, the Desk reached an agreement with the U.S. Treasury Department under which Treasury issued a series of Special Financing Program (SFP) bills and held the proceeds in the Treasury's Fed account. The program was implemented in cooperation with Treasury following that agreement, and was

[37] See June 12, 2009 staff memo to the FOMC, "Implementation Strategies for the Issuance of Federal Reserve Discount Note Obligations."

scaled up very quickly, providing as much as $560 billion in additional sterilization capacity at its peak in October 2008. However, the Federal Reserve did not have complete control over the SFP and the program was subject to Treasury debt ceiling constraints.[38] In October 2008, the Federal Reserve obtained accelerated authority to pay interest on reserves (which had been legislated to take effect in September 2011). IOER was implemented in an attempt to establish a floor on rates to improve rate control.[39]

Even these additional tools did not provide enough capacity to maintain control of the federal funds rate in the wake of Lehman. Ultimately, the conflict between liquidity provision and interest rate control became moot as the federal funds rate target moved to the ELB, IOER became the de facto policy-rate instrument, and the focus of policy implementation shifted to the first LSAP program (and the attendant, and intentional, expansion of the balance sheet).

The Fed's normal tools for liquidity provision proved inadequate to address severe financial market stress

As noted in Section I, the pre-crisis framework relied on open market operations to provide liquidity to the market in aggregate and the discount window to provide targeted credit to depository institutions that were experiencing temporary funding problems. Both of these tools proved inadequate to conduct the type of large-scale liquidity insurance that was needed to respond to acute financial market stress in 2007 and 2008, particularly once banks had stopped providing credit to nonbank firms that were experiencing disruptions to market funding sources.

As noted in section II, the inefficacy of the discount window as a tool to counteract stress in U.S. dollar funding markets first became apparent in the fall of 2007 when rate reductions, narrowing the spread to the federal funds rate, and expansion to term funding proved ineffective in relieving signs of stress. This was due both to stigma and to the presence of significant offshore USD financial intermediation activity among firms without direct access to the discount window. The TAF and swap lines were ultimately needed to provide the liquidity that could not be provided

[38] See Appendix 10 for a chart showing SFP issuance over the period between September 2008 and March 2011.

[39] See the money market workgroup's July 2016 memo to the FOMC for further details limits on the ability of the failure of the IOER to provide a floor on rates.

through the discount window. TAF seemed to largely overcome the stigma barrier for U.S. banks and branches, and the swaps were a means to provide global dollar liquidity needs that could not be addressed by funding domestically-based institutions via the DW or TAF.

Similarly, the Fed's repo and securities lending operations proved insufficient in addressing broad pressures in financing markets, as they were limited to primary dealers as counterparties and the collateral in Fed repo operations included only Treasury, agency debt and agency MBS. In the days surrounding the failure of Bear Stearns, repo and securities lending were expanded to a wider set of collateral through the PDCF and TSLF programs as a means to relieve the stress in secured funding markets. Following Lehman's failure, as financial market stress spread to intermediaries beyond the Fed's traditional counterparties lending activities were expanded beyond banks and primary dealers to address stress in a wider set of funding markets and market-based intermediation processes. All of these programs were aimed at backstopping financial intermediation; in so doing, they had the ancillary effect of supporting monetary policy transmission.

New tools were needed to provide accommodation at the effective lower bound

In the fall of 2008, as we approached the ELB and needed an alternative to rate cuts as a way to provide policy accommodation, the Federal Reserve initiated a program of large-scale purchases of both agency debt and agency MBS, both to ease longer-term rates and to ease stress in housing-related financial markets. However, while agency debt and agency MBS were permissible investments for the SOMA under the Federal Reserve Act, the Desk had not previously been tasked to develop the operational capabilities and market expertise required for such purchases, and was ill prepared to respond quickly.

The Desk had not purchased agency debt for the SOMA since 1997, and had never purchased agency MBS.[40] Desk and other Federal Reserve staff had conducted an extensive exploration of

[40] The FOMC began purchasing agency debt in 1971, as a means of supporting the development of the agency market, and decided to stop purchasing newly issued agencies in 1981, although some maturing agency holdings continued to be invested in agency securities in the secondary market until 1997. The last pre-crisis agency security in the SOMA portfolio matured in December 2003. The decision to cease purchases appears to have reflected concerns about political and financial stability risk associated with owning agency securities not subject to an explicit U.S. Government guarantee, given their importance to the housing sector and the risk that ownership might

GNMA MBS purchases in 2004 at the FOMC's direction, and determined that it would take three years, and between $5.5 and $12 million in startup costs, to hire external vendors for back office processing and prepayment forecasting, and train Desk staff in executing agency MBS purchases, in order to support the buildup of a relatively modest portfolio of GNMA MBS.[41] Given the time, risks and costs involved, and subsequent deterioration in the fiscal outlook that removed the urgency associated with diversifying beyond Treasuries, the Committee chose at its January 2004 meeting not to invest further in developing agency MBS purchase capacity.

Policy implementation and transmission was vulnerable to an interruption to financial intermediation

The breakdown of financial intermediation activity and term funding markets in the fall of 2007 was unprecedented, and weakened the Fed's ability to transmit policy simply by controlling the operating target, requiring additional tools to support transmission. The swap lines and the various liquidity facilities that were implemented under Section 13(3) authority were created to alleviate stress in financial markets. By easing financial conditions, these programs had the effect of supporting policy transmission in the face of a disruption to the normal intermediation and arbitrage process.

IV. Lessons for the future operating framework for monetary policy

In this section we summarize the essential lessons from the 2007-2008 financial crisis, and consider their implications for the design of a future long-run operating framework. Our intention is to avoid being prescriptive or presumptive about that framework, and instead to highlight the central issues and tradeoffs raised by the crisis experience.

---

signal some implicit guarantee for these assets. More detail on these concerns can be found on pages 1-2 through 1-5, 1-10 through 1-11 and 2-14 of "Alternative Instruments for Open Market and Discount Window Operations," Federal Reserve System Study Group on Alternative Instruments for System Operations, December 2002. (http://www.federalreserve.gov/monetarypolicy/files/FOMC20021201memo01.pdf)

[41] See Memo to FOMC from Dino Kos, SOMA Manager, "Evaluation of GNMA securities for SOMA", January 21, 2004.

Lesson 1: The pre-crisis "reserve scarcity" framework set up a tension between interest rate control to achieve monetary policy objectives and the large-scale liquidity provision needed to address episodes of protracted financial market stress.

As noted in section I, the pre-crisis framework relied on reserve scarcity as the fundamental mechanism for rate control. As suggested in section II, several tools within the boundaries of "normal" (i.e. non-13(3)) authorities proved to be effective liquidity backstops for markets that exhibited signs of stress (these included TAF, FX swap lines, and TSLF Schedule 1). With the exception of TSLF Schedule 1, expanded use of these tools naturally increased the size of the balance sheet and the quantity of excess reserves, requiring temporary sterilization of their balance sheet effects in order to maintain rate control.

A key message of our analysis in section III is that the System lacked adequate means and preparation to effectively drain reserves in the face of large-scale liquidity insurance operations that were needed to mitigate market dysfunction and support monetary policy transmission. While there were multiple reasons for the relatively tentative pace at which liquidity insurance tools were deployed in the pre-Lehman phase of the crisis – including uncertainty about the magnitude of the necessary interventions and aversion to moving outside of the existing framework for policy reasons–the lack of sterilization tools was cited by a number of the staff we interviewed as a constraint on the pace and size of liquidity insurance operations, particularly in the period between March and September 2008.

In principle IOER, which was not available in the pre-crisis framework, provides a way to maintain rate control independent of the size or type of open market and/or lending operations. In other words, an effective floor system in which reserves are not scarce would allow an effective separation of policy-rate control from actions taken to provide liquidity insurance in scale (or engage in a large quantity of targeted lending through, for example, the primary credit facility). How effective IOER may be as a floor, perhaps in conjunction with ongoing use of RRPs with an extended set of counterparties, remains an open question. We also note that IOER would not obviate the need for robust sterilization tools if the FOMC chose an operating framework along the lines of the quota systems described in the Foreign Experience workgroup's memo, since those systems feature a limit on the quantity of excess reserves held in any period.

As a general observation, an OMO counterparty framework that consists solely of broker dealers who are structurally short financing may not be capable of supporting large-scale drains of reserves. Options to increase draining capacity exist, but involve tradeoffs:

1. The Treasury's Supplementary Financing Program (SFP) was an effective and scalable option to increase draining capacity as liquidity provision scaled up in September 2008 with an expansion of liquidity insurance operations, and then again in November 2008 with the implementation of LSAPs. However, the SFP was controlled by the Treasury, not the Federal Reserve, and proved vulnerable to debt ceiling pressures. This tool may also raise questions about the boundaries between fiscal and monetary policy, and the political independence of the central bank.
2. ON RRPs that are either fixed quantity or fixed rate can be implemented to reach a broader set of money market participants beyond the traditional broker-dealer firms that are primary dealers. We note that the current infrastructure for these operations has served to limit participation to banks, GSEs and money market mutual funds, which has raised concerns that these types of firms have a special type of access to the Fed's balance sheet that others lack.[42] Furthermore, RRPs are collateralized liabilities that require a stock of unencumbered government securities collateral.[43]
3. The term deposit facility (TDF) is an option that currently operates through banks. The optimal design of rate, maturity, and other parameters needed to implement effective TDFs in large scale is uncertain at this point. However, we note that some of the TDF test operations conducted in the last quarter of 2014 for 1-week maturities successfully drained several hundred billion in reserves, with a peak operation size of $402 billion on December 1, 2014.
4. Fed bills were often mentioned in our interviews as an ideal draining tool. Benefits cited include (a) a theoretically high degree of liquidity and transferability among a wide range of market participants that makes them arguably less impactful on incentives than

[42] We note that this concern could be mitigated with a program that was open to a much broader range of parties that invest cash in the repo market.

[43] See the Money Markets workgroup's memo for further details.

operations with nonbank participants, such as ON RRPs; (b) their status as uncollateralized liabilities, which means they do not require earmarking of specific balance sheet assets (unlike the ON RRP), and (c) Federal Reserve control (unlike the SFP). However, authority to issue Fed bills would require changes to the Federal Reserve Act and could be seen to conflict with Treasury's debt-management interests. We, however, note that expanding the current ON RRP program to a much broader set of counterparties would look a lot like implementing Fed bills.

Questions for the framework workgroups to consider:

- *Should the long-run framework be designed to avoid or mitigate conflicts between the Fed's interest rate control and liquidity provision objectives, in a range of market environments? What liability-side tools would be best to have operational for daily use that can be scaled up when needed?*

Lesson 2: The pre-crisis framework did not position the Federal Reserve to efficiently and effectively provide liquidity insurance in scale

As documented in sections II and III, though the primary credit program was expanded early in the crisis in an attempt to address strains in term funding supply, stigma appears to have materially constrained its effectiveness as a tool for providing liquidity to the banking system. The TAF was successful in overcoming the stigma problem for entities that were eligible to participate in the primary credit facility. However, because the TAF was available only to domestic institutions with access to the discount window, it alone was insufficient to address broader global demand for dollar term funding. As a result, FX swaps were established and expanded as a separate means of addressing stress in term funding markets.

The scales of both the TAF and FX swap lines were initially limited. In addition to policy considerations and the issues related to restraining reserve liability growth discussed in Lesson 1,

the sizes of the TAF and FX swap programs were constrained by the substantial time needed to put in place the legal and operational arrangements needed to execute the programs.[44]

A great deal of time was required to establish the legal and operational arrangements to support the FX swap lines. And while the TAF was developed using much of the existing infrastructure to support discount window lending, time was required to develop the operational and technological arrangements to support an auction process involving bids from twelve Reserve Banks and to book loans with conventions that differed from regular discount window loans. As evidenced by bid-to-cover ratios that persistently exceeded one, there is a reasonable argument that the TAF was not initially implemented in sufficient size to fully address liquidity needs in the early phases of the crisis.[45] Similarly, some of those interviewed suggested that the swap program could have been even more effective if done sooner and in bigger size.

One theme from those our interviews was the belief that providing substantially more liquidity up front – that is, larger TAF and FX swap programs sooner -- would have been preferable to repeatedly increasing program scale in response to new developments. The belief of several interview participants was that more aggressive programs earlier could have bolstered market confidence, been more effective at easing market stress, and might have obviated the Fed's need to repeatedly increase its policy response. In contrast, other interviewees noted that the ultimate magnitude of the crisis was difficult to gauge in real time and that outsized policy actions might have sent negative signals that at the time would have exacerbated the crisis. In their view this uncertainty justified incremental policy steps.[46] Irrespective of the feasibility of earlier and more aggressive activation of the TAF and swap programs, the series of changes to program size and

---

[44] An example of the policy considerations is illustrated by the December 2007 FOMC discussion around establishing the ECB and SNB FX swap lines, contained in the transcript of that meeting. Policymakers noted several issues: concern that the heightened level of interbank spreads might represent a rational re-pricing of counterparty risk rather than a sign acute liquidity stress; concern that the TAF and the swap lines would interfere with efficient price discovery; and concern about potential adverse selection and moral hazard that might be associated with the facilities.

[45] See Appendix 4.

[46] Some interviewees also noted that for the swap lines, Fed principals were not the only decision makers and that the Fed's ability to size the swap lines was in part dependent on the willingness of foreign central banks to accept lines of a certain size.

terms were viewed by several respondents as having complicated program implementation and communication to the public about these programs.

The essential questions arising from this experience, to be taken up by the framework and options workgroups, emanate from the observation that liquidity insurance tools like the TAF can be structured as either on-the-shelf tools to be deployed at times of stress (as in the crisis) or as part of a broader monetary policy operating framework. A cost of not actively maintaining such operations may be that programs that are only activated in times of stress can become stigmatized -- stigma is less likely to be a problem for programs that are part of the normal operating framework and are in production at all times and in all market environments. Further, the experience of the crisis suggests that tools not frequently used can be difficult to maintain at a high level of readiness. A narrow framework, therefore, would likely increase the time required to deploy the necessary response in times of stress, impairing the effectiveness of both liquidity provision and monetary policy transmission.

A separate issue is whether liquidity provision tools might be broadened beyond the purpose of alleviating funding stress and utilized as supplements to OMOs in adding reserves to the banking system. The costs and benefits of such a framework are part of the more general issue of whether it is desirable to have a broad set of counterparties as the main source of changing the level of reserves in the system in non-crisis times. Though the experience of the crisis does not really speak to that issue specifically, it does suggest that operational readiness of important liquidity provision tools belongs on the benefit side of the ledger in such an analysis.

Questions for the framework workgroups to consider:

- *If policymakers wish to return to a framework characterized by scarce or constrained reserves, how can the framework be designed to ensure flexibility in implementing liquidity insurance tools that may be needed in future stress events? Should liquidity insurance tools be included in a new framework? If so, in what scale, and for what purpose? More generally, should the future operating framework seek a wider set of counterparties for adding reserves?*
- *Should overcoming stigma be a goal in the design of liquidity insurance facilities (whether standing or on-the-shelf)?*

Lesson 3: Bounds on fluctuations in the federal funds rate appeared to fail at many points during the crisis period: Neither the pre-crisis framework nor tools developed over the course of the crisis provided a sound ceiling and floor to help control the level or intraday volatility of the federal funds rate vis a vis the policy target.

IOER may be a key element of the ultimate policy framework regardless of the future operating regime chosen. It could serve as the foundation for a floor on short-term interest-rate swings in a reserve-scarce, corridor-type system or, as currently, the key rate for implementing policy when the quantity of reserves is "large" relative to the stock of currency in circulation.

The Money Market Workgroup's memo discusses the limitations of IOER as a floor on interest rates, specifically as they relate to the limited set of counterparties to which IOER applies. Experience will reveal whether these limitations are substantial enough to impede interest rate control in a material way. If they do, the framework and options workgroups may wish to weigh the costs and benefits of solutions that expand the operational set of standard counterparties (along the lines of ON RRP).

Just as IOER should in theory set a floor on the level of, and swings in, the federal funds rate, the primary credit facility should provide a ceiling. In reality, the primary credit facility has not proven to be an effective upper bound. This was true prior to the crisis, but as noted above became more acute as the timing of demand for funds elevated intraday volatility in the federal funds rate.

While the TAF addressed the stigma problem that limited the effectiveness of the primary credit facility as a liquidity provision tool, and was effective in providing liquidity to the banking system, its design limited its ability to provide a ceiling for the federal funds rate. As a weekly auction with delayed settlement, TAF could not respond to higher frequency spikes in the demand for credit. Moreover, the reliance on a market-determined auction meant the rate could vary from auction to auction. Thus, even if the facility had provided a firm ceiling on a per auction basis, the ceiling rate would not have been consistent. These were, of course, design features that presumably helped to make the TAF an effective tool for overcoming stigma. As a consequence, the framework workgroups may have to consider the costs and benefits of using a tool like the TAF for rate control vis-à-vis liquidity insurance.

Questions for the framework workgroups to consider:

- *What premium should be put on limiting intraday policy rate volatility and control in the cost-benefit analysis of alternative long-run frameworks?*
- *Should tools be designed to provide firmer boundaries to interest rate swings, by expanding the counterparties to which they extend (as in the case of ON RRP support for the policy rate floor, for example) or redesigning their operational parameters (such as altering the frequency and settlement features of an ongoing TAF)?*

Lesson 4: The pre-crisis framework was not sufficiently flexible or robust in the face of significant liquidity stress and disruptions to monetary policy transmission

While Fed staff were innovative in designing and implementing new tools with which to respond to the crisis, the need to do so on the fly was challenging, slowed time to market for these tools, and yielded a sharp increase in the Fed's exposure to operational risk. The Fed began the crisis period with very limited knowledge of collateral beyond the types of assets routinely accepted at the discount window or in open market operations, or counterparties beyond banks and primary dealers. As staff ventured beyond the pre-crisis operating framework to develop new monetary policy and liquidity tools, more legwork had to be done to understand and define the type of market stress that was arising and how it could be relieved, the set of counterparties and/or collateral types that would be most relevant for achieving program goals, and the types of risk management features that would be most effective in balancing program efficacy with mitigating risk to the Fed's balance sheet. Additionally, these new tools required a longer lead time to implement and increased the importance of clear communication to the public about why the tools were being created. The Fed assumed additional operational and reputational risks in setting these up in an ad hoc, rapid manner.

In retrospect, the pre-crisis framework was not as flexible or robust to significant financial market stress as it could have been. Its design did not account for the significant increase in offshore intermediation of US dollar credit that had taken place in the prior decade. And it was designed in an era when the bulk of financial intermediation occurred through banks, rather than nonbank intermediaries or capital market-based mechanisms. For these reasons, the framework was not completely *robust* to the stress in financial markets that developed during the crisis period. By "robust," we mean that standard liquidity provision tools were not equipped to deal

with disruptions to funding streams outside of the U.S. banking system and their corresponding transmission channels. Further, the pre-crisis framework was not as *flexible* as it could have been: Adaptation to evolving needs that required an expansion of counterparties and funding mechanisms was difficult and time- and resource-consuming. Notably, the FOMC has already decided to retain standing swap arrangements with the Bank of England, Bank of Canada, Bank of Japan, the European Central Bank (ECB), and the Swiss National Bank (SNB), and has used them since the crisis period; swap lines with these central banks have become part of the FOMC's normal framework, and represent an increase in robustness to offshore market developments.

We believe it is useful to distinguish between robustness and flexibility (as we have defined these terms). In thinking about the design features of a future long-run framework, it is possible that some degree of robustness can be sacrificed if the framework is sufficiently flexible. For example, even assuming the limited set of OMO and bank-lending arrangements that were in place prior to the crisis, the implementation of the crisis response may have been more effective had the framework contemplated the need for, and been prepared for the deployment of, the more extensive tools that were eventually put into place.

We also conclude that a number of facilities implemented under 13(3) authority during the crisis were necessary responses to specific breakdowns in market functioning and the corresponding impediments to the transmission of monetary policy. Based on this experience, we assume that in a future crisis it may be necessary to respond to unusual and exigent circumstances with tools that would not be considered appropriate features of a standard long-run monetary policy implementation framework. That is, while the Committee may want to consider a framework that is robust to a large set of stress events, it is unlikely that an acceptable framework – defined in terms of specific market presence, counterparty relationships, and so on -- can be constructed to anticipate every type of stress to which a central bank intervention would be necessary. An important question for the design of a long-run framework is the degree to which the Committee wants to be proactive in building flexibility to address extreme or unusual financial market events.

Questions for the framework workgroups to consider:

- *How robust should the long-run framework aim to be? How might robustness best be added to the framework? For example, could the use of multiple operating targets (focusing on both secured and unsecured rates) help to improve the robustness of policy transmission to a range of stress scenarios? Could a broader set of counterparties beyond primary dealers provide additional robustness in some way?*
- *What are the relevant tradeoffs between robustness and flexibility?*
- *What are the relevant tradeoffs between relying on ad hoc development of tools when needed, and ex ante development of tools that are in operation or on the shelf when needed?*
- *Should the Federal Reserve institutionalize a process for thinking about stress scenarios and periodically assess the operating framework's ability to address the hypothetical developments? How could such an exercise maintain its integrity in light of the evolution of the financial system?*

Lesson 5: The pre-crisis framework was not easily adaptable to monetary policy at the effective lower bound

As discussed in section III, the Desk was not adequately prepared to implement LSAPs, particularly agency MBS, once the federal funds rate had been reduced to its ELB (then, as now, zero). There are, of course, a range of options that the workgroups might consider should the ELB become a binding constraint in the future—such as asset purchases, extending portfolio duration, forward guidance, or extending the ELB through negative interest rate policies. The key lesson of the crisis is a simple one: Management of monetary policy at the ELB can be enhanced if alternative tools, and the infrastructure necessary to support them, are planned in advance.

Questions for the framework workgroups to consider:

- *What set of policies should be considered as active options should the ELB constraint bind in the future? How can the infrastructure required to deploy these instruments be constructed and maintained in advance of the need, and how important is it for the market to understand the range and structure of such tools on an ex ante basis?*

References

Adrian, Tobias, Christopher R. Burke, and James J. McAndrews, 2009, "The Federal Reserve's Primary Dealer Credit Facility," Federal Reserve Bank of New York *Current Issues in Economics and Finance* 15, no. 4 (August).

Adrian, Tobias. Karin Kimbrough, and Dina Marchioni, 2011, "The Federal Reserve's Commercial Paper Funding Facility," Federal Reserve Bank of New York *Economic Policy Review* 17, No. 1 (May), 25-39.

Armantier, Olivier, 2014, "Discount Window Stigma," Federal Reserve Bank of New York *Liberty Street Economics* (January 13).

Armantier, Olivier, Eric Ghysels, Asani Sarkar, and Jeffrey Shrader, 2015. "Discount window stigma during the 2007–2008 financial crisis." Journal of Financial Economics 118, no. 2: 317-335.

Ashcraft, Adam, Morten L. Bech, and W. Scott Frame, 2010. "The Federal Home Loan Bank System: The Lender of Next-to-Last Resort?" Journal of Money, Credit and Banking 42, no. 4: 551-583.

Ashcraft, Adam, Nicolae Garleanu, and Lasse H. Pedersen, 2010, "Two Monetary Tools: Interest Rates and Haircuts," *NBER Macroeconomics Annual*, 25, 143-80.

Ashcraft, A., Malz A., Pozsar Z., 2012, "The Federal Reserve's Term Asset-Backed Securities Loan Facility," Federal Reserve Bank of New York *Economic Policy Review*, (November).

Ashcraft, Adam, James McAndrews, and David Skeie, 2011. "Precautionary reserves and the interbank market." Journal of Money, Credit and Banking 43, no. s2: 311-348.

Baba, Naohiko, and Frank Packer. 2009a. "Interpreting deviations from covered interest parity during the financial market turmoil of 2007–08." Journal of Banking & Finance 33, no. 11: 1953-1962.

Baba, Naohiko, and Frank Packer, 2009b. "From turmoil to crisis: dislocations in the FX swap market before and after the failure of Lehman Brothers." Journal of International Money and Finance 28, no. 8: 1350-1374.

Campbell, Sean, Daniel Covitz, William Nelson, and Karen Pence, 2011, "Securitization Markets and Central Banking: An Evaluation of the Term Asset-Backed Securities Loan Facility," *Journal of Monetary Economics* 58, 518-31.

Christensen, Jens HE, Jose A. Lopez, and Glenn D. Rudebusch, 2014. "Do Central Bank Liquidity Facilities Affect Interbank Lending Rates?" Journal of Business & Economic Statistics 32, no. 1: 136-151.

Copeland, A., Martin, A., and M. Walker, 2010, The Tri-party Repo Market before the 2010 Reforms, Federal Reserve Bank of New York Staff Reports, 477.

Copeland, A., Martin, A., and M. Walker, 2014, Repo Runs: Evidence from the Tri-Party Repo Market, Journal of Finance, 69, 6, 2343-2380.

Covitz, Daniel, Nellie Liang, and Gustavo A. Suarez, 2013. "The Evolution of a Financial Crisis: Collapse of the Asset-Backed Commercial Paper Market." The Journal of Finance 68, no. 3: 815-848.

Duygan-Bump, Burcu, Patrick Parkinson, Eric Rosengren, Gustavo A. Suarez, and Paul Wilken, 2012, "How Effective Were the Federal Reserve Emergency Liquidity Facilities? Evidence from the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility," *Journal of Finance*.

Filipović, Damir, and Anders B. Trolle, 2013. "The term structure of interbank risk." Journal of Financial Economics 109, no. 3: 707-733.

Fleming, M.J., Hrung, W.B., and F.M. Keane, 2009, The Term Securities Lending Facility: Origin, Design, and Effects, Federal Reserve Bank of New York Current Issues in Economics and Finance, 15, 2.

Fleming, M.J., Hrung, W.B. and F.M. Keane, 2010, Repo Market Effects of the Term Securities Lending Facility: Origin, Design, and Effects, American Economic Review: Papers & Proceedings, 100, 591-596.

Gauthier, Céline, Alfred Lehar, Héctor Pérez Saiz, and Moez Souissi, 2015. Emergency Liquidity Facilities, Signalling and Funding Costs. No. 15-44. Bank of Canada.

Gefang, Deborah, Gary Koop, and Simon M. Potter, 2011. "Understanding liquidity and credit risks in the financial crisis." Journal of Empirical Finance 18, no. 5: 903-914.

Goldberg, Linda, Craig Kennedy, and Jason Miu, 2011. "Central bank dollar swap lines and overseas dollar funding costs." Economic Policy Review May: 3-20.

Gorton, G. and A. Metrick, 2012, Securitized Banking and the Run on Repo, Journal of Financial Economics, 104, 425-451.

King, Thomas B., and Kurt F. Lewis, 2014. "What Drives Bank Funding Spreads?" Federal Reserve Bank of Chicago Working Paper WP 2014-23.

Krishnamurthy, A., Nagel, S. and D. Orlov, 2014, Sizing up Repo, Journal of Finance, 69, 6, 2381-2417.

McAndrews, James, Asani Sarkar, and Zhenyu Wang, 2015. "The effect of the term auction facility on the London interbank offered rate." Available at SSRN 2662108.

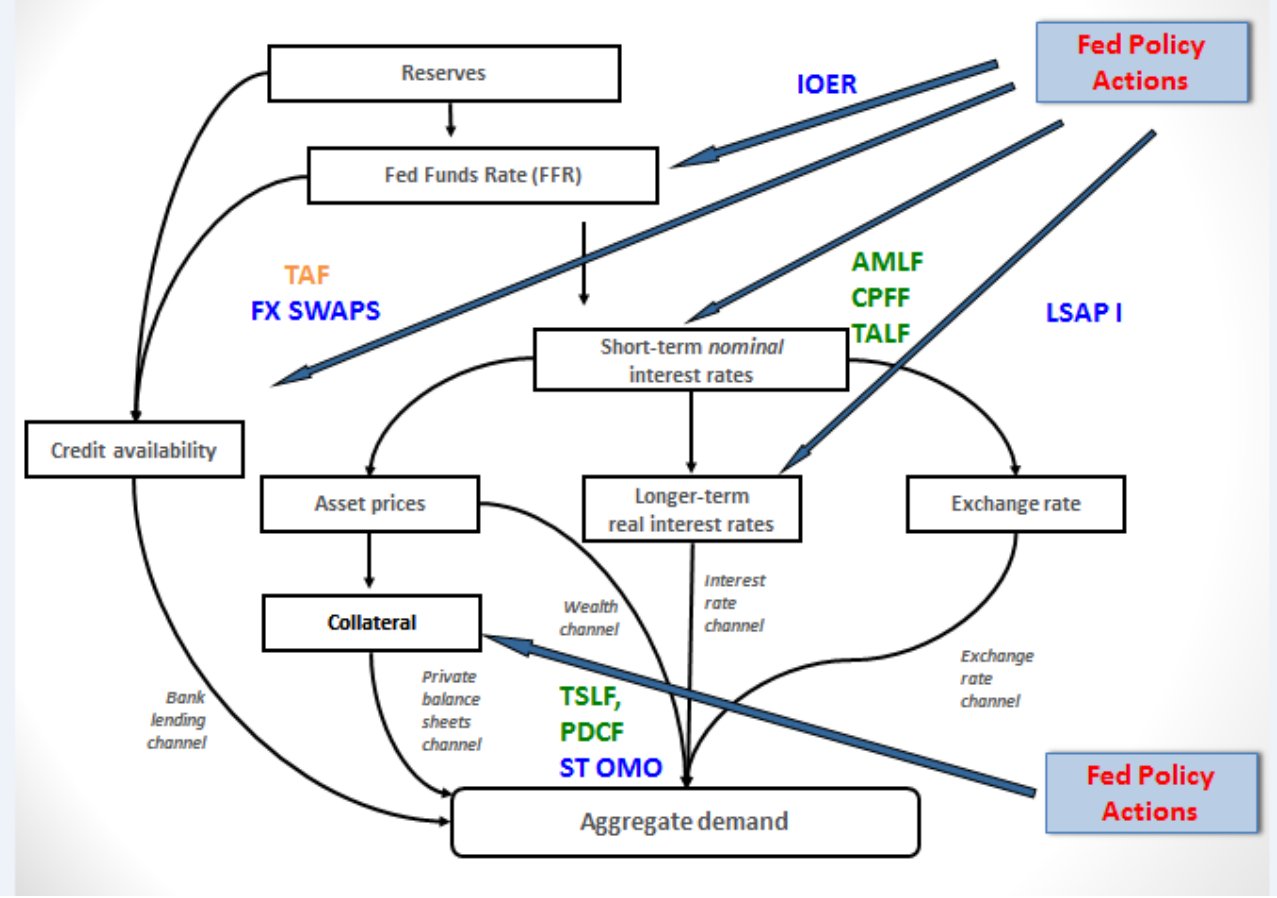
McGuire, Patrick, and Goetz Von Peter, 2009. "The US dollar shortage in global banking and the international policy response." BIS Quarterly Review, March 47-63.

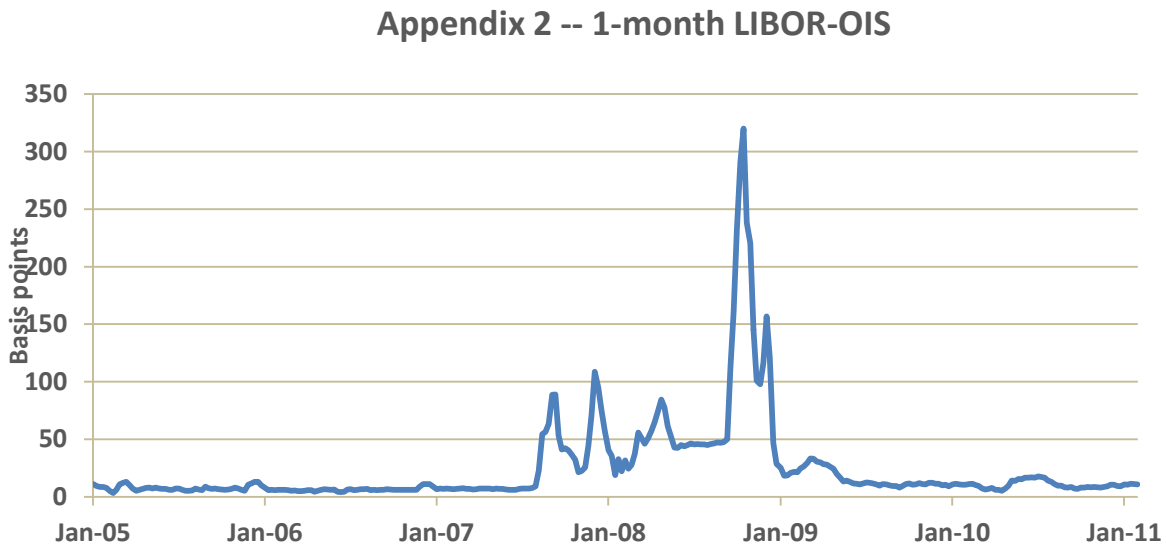
Mishkin, Frederick S. 1995 "Symposium on Monetary Transmission Mechanism." Journal of Economic Perspectives 9 (4): 3-10.

APPENDIX 1

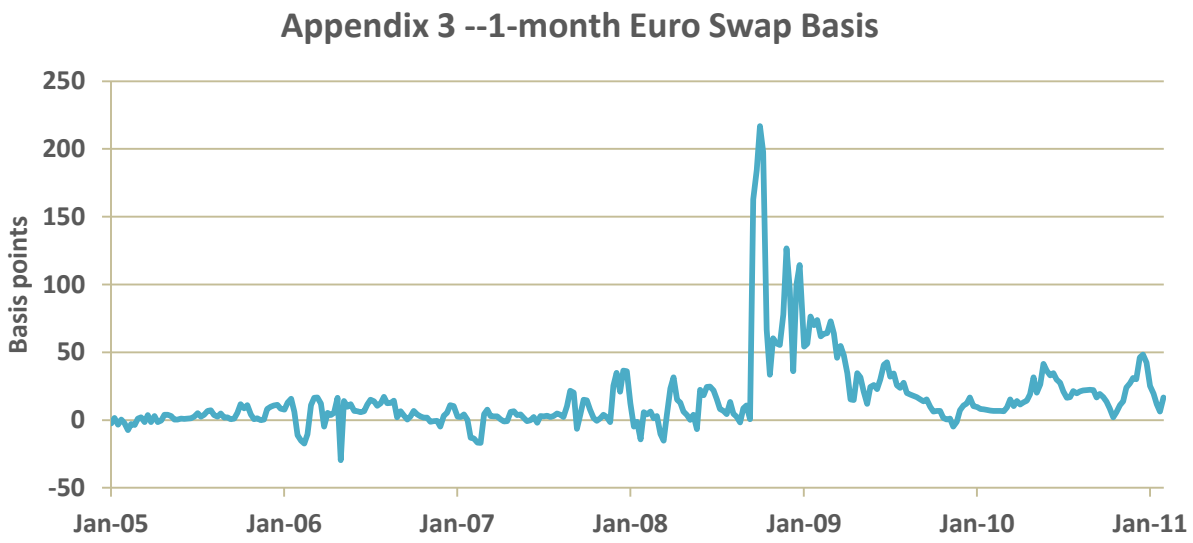
Monetary Policy Transmission Channels and Crisis Policy Tools

August 2007 – May 2009





Source: Haver database. The chart shows the difference between the one-month dollar London Interbank Offered Rate (Libor) and the rate on the 1-Month Dollar Overnight Interest Rate Swap (OIS).



Source: Haver database. The basis is derived from the covered interest rate parity and is the premium paid by investors to purchase dollars through the foreign exchange swap market (as measured by the one-month euro Libor rate and the spot and the one-month forward euro-dollar exchange rate) over the cost of direct unsecured borrowing as measured by the one-month Libor.

Appendix 4: Term Auction Facility Auctions

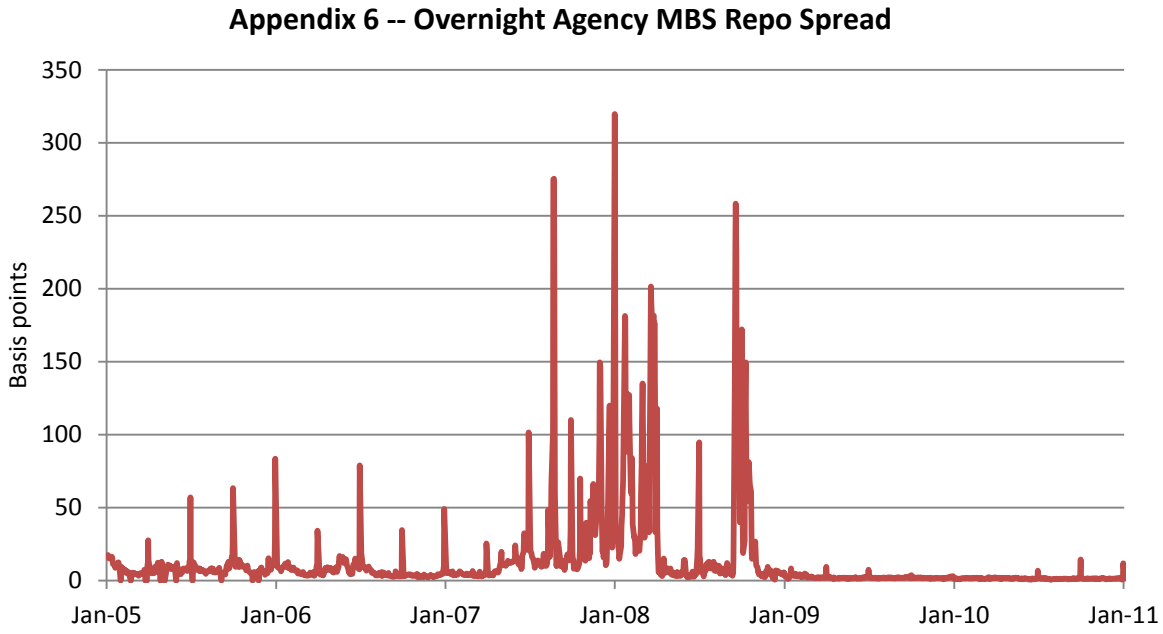
Auction Date	Term in days	Offering Amount (Billions of dollars)	Propositions submitted (Billions of dollars)	Number of bidders	Bid/cover ratio	Stop-out rate
December 17, 2007	28	$20.000	$61.553	93	3.08	4.650
December 20, 2007	28	$20.000	$57.664	73	2.88	4.670
January 14, 2008	28	$30.000	$55.526	56	1.85	3.950
January 28, 2008	28	$30.000	$37.452	52	1.25	3.123
February 11, 2008	28	$30.000	$58.400	66	1.95	3.010
February 25, 2008	28	$30.000	$67.958	72	2.27	3.080
March 10, 2008	28	$50.000	$92.595	82	1.85	2.800
March 24, 2008	28	$50.000	$88.869	88	1.78	2.615
April 7, 2008	28	$50.000	$91.569	79	1.83	2.820
April 21, 2008	28	$50.000	$88.288	83	1.77	2.870
May 5, 2008	28	$75.000	$96.618	71	1.29	2.220
May 19, 2008	28	$75.000	$84.438	75	1.13	2.100
June 2, 2008	28	$75.000	$95.914	73	1.28	2.260
June 16, 2008	28	$75.000	$89.377	76	1.19	2.360
June 30, 2008	28	$75.000	$90.881	77	1.21	2.340
July 14, 2008	28	$75.000	$93.344	82	1.24	2.300
July 28, 2008	28	$75.000	$90.555	70	1.21	2.350
August 11, 2008	84	$25.000	$54.800	64	2.19	2.754
August 12, 2008	28	$50.000	$75.462	65	1.51	2.450
August 25, 2008	28	$75.000	$84.168	66	1.12	2.380
September 8, 2008	84	$25.000	$31.638	38	1.27	2.670
September 9, 2008	28	$25.000	$46.237	53	1.85	2.530
September 22, 2008	28	$75.000	$133.562	85	1.78	3.750
October 6, 2008	85	$150.000	$138.092	71	0.92	1.390
October 20, 2008	28	$150.000	$113.271	74	0.76	1.110
November 3, 2008	84	$150.000	$138.939	89	0.93	0.600
November 10, 2008	17	$150.000	$12.629	16	0.08	0.528
November 17, 2008	28	$150.000	$104.478	80	0.70	0.510
November 24, 2008	13	$150.000	$31.075	16	0.21	0.380
December 1, 2008	84	$150.000	$66.471	80	0.44	0.420
December 15, 2008	28	$150.000	$63.014	71	0.42	0.280
December 29, 2008	83	$150.000	$102.979	72	0.69	0.200
January 12, 2009	28	$150.000	$107.747	97	0.72	0.250
January 26, 2009	84	$150.000	$136.051	102	0.91	0.250
February 9, 2009	28	$150.000	$142.448	117	0.95	0.250
February 23, 2009	84	$150.000	$111.683	96	0.74	0.250
March 9, 2009	28	$150.000	$117.872	116	0.79	0.25
March 23, 2009	84	$150.000	$101.642	103	0.68	0.250
April 6, 2009	28	$150.000	$106.251	105	0.71	0.250
April 20, 2009	84	$150.000	$83.830	98	0.56	0.250
May 4, 2009	28	$150.000	$131.562	124	0.88	0.250
May 18, 2009	84	$150.000	$55.570	96	0.37	0.250

Appendix 5: Timeline of Central Bank Dollar Swap Announcements

Date	Event	New Participants	Total Authorization (Billions of Dollars)	Terms Extended	Expiration Extended
2007 December 12	Federal Reserve establishes six-month dollar swap agreements with ECB ($20 billion) and SNB ($4 billion); auction tenors are twenty-eight days.		24		
2008					
March 11	Lines are expanded with ECB (to $30 billion) and SNB (to $6 billion).		36		
May 2	Lines are expanded with ECB (to $50 billion) and SNB (to $12 billion); agreement is extended to January 30, 2009.		62		X
July 30	Line is expanded with ECB (to $55 billion); ECB and SNB add eighty-four-day auctions.		67	X	
September 18	Lines are expanded with ECB and SNB (to $110 billion and $27 billion, respectively). Facilities are established with BoJ, BoE, and BoC (in amounts of $60 billion, $40 billion, and $10 billion, respectively).	X	247		
September 24	Dollar swap is established with RBA ($10 billion), Danmarks Nationalbank ($5 billion), Sveriges Riksbank ($10 billion), and Norges Bank ($5 billion).	X	277		
September 26	Lines are expanded with ECB and SNB (to $120 billion and $30 billion, respectively).		290		X
September 29	Lines are expanded with ECB (to $240 billion), SNB (to $60 billion), BoC (to $30 billion), BoE (to $80 billion), BoJ (to $120 billion), Danmarks Nationalbank (to $15 billion), Norges Bank (to $15 billion), RBA (to $30 billion), and Sveriges Riksbank (to $30 billion). Agreements are extended until April 30, 2009.		620		X
October 13	Dollar swaps are expanded with ECB, SNB, and BoE to accommodate quantity demanded; BoJ considers doing the same.		No prespecified limit		
October 14	Dollar swap is expanded with BoJ to accommodate quantity demanded.		No prespecified limit		
October 28	Swap line is extended to RBNZ ($15 billion).	X	No prespecified limit		
October 29	Lines are extended to Brazil, Mexico, Korea, and Singapore (up to $30 billion each); lines are authorized until April 30, 2009.	X	No prespecified limit		
2009 February 3	Swap agreements are extended until October 30, 2009.		No prespecified limit		X

Source: Goldberg, Kennedy, and Miu (2011)

Notes: The four central banks with no prespecified limit as of October 2008 offered dollar liquidity at a fixed price, which, along with collateral constraints, served to limit demand. ECB is European Central Bank, SNB is Swiss National Bank, BoJ is Bank of Japan, BoE is Bank of England, BoC is Bank of Canada, RBA is Reserve Bank of Australia, and RBNZ is Reserve Bank of New Zealand.



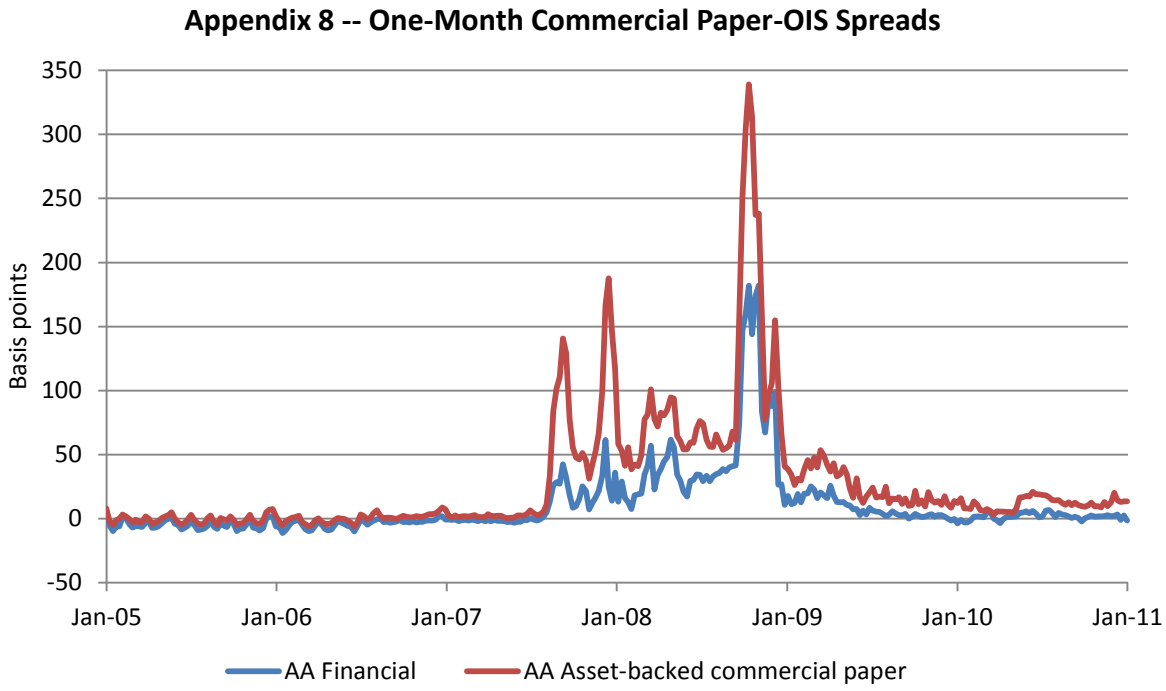
Source: Federal Reserve Bank of New York. The chart shows the difference between the overnight agency MBS repo rate and the overnight Treasury repo rate.

Appendix 7 -- Federal Reserve Liquidity Operations during the Crisis

Facility	Date Announced	13(3)?	Eligible Borrowers	Maximum Amount Outstanding
Discount window	August 17, 2007: term extended to 30 days, spread over federal funds reduced to 50 bps March 16, 2008: term extended to 90 days; spread over federal funds reduced to 25 bps	No	Banks	111
Term Auction Facility	December 12, 2007	No	Banks	493
Central bank liquidity swaps	December 12, 2007	No	Banks	583
Single-tranche repos	March 7, 2008	No	Primary dealers	80
Term Securities Lending Facility	March 11, 2008	Yes (Sched 2)	Primary dealers	236[47]
Primary Dealer Credit Facility	March 16, 2008	Yes	Primary dealers	147
Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility	September 18, 2008	Yes	Banks	152
Commercial Paper Funding Facility	October 7, 2008	Yes	CP issuers	351
Money Market Investor Funding Facility	October 21, 2008	Yes	Money market investors	0
Term Asset-Backed Securities Loan Facility	November 25, 2008	Yes	ABS investors	48

Notes: Maximum amounts outstanding in billions of dollars based on weekly data as of Wednesday. Primary Dealer Credit Facility includes other broker-dealer credit. Central bank liquidity swaps are conducted with foreign central banks which then lend the dollars acquired through the swap to banks in their jurisdiction.

[47] Includes loans related to TSLF option operations as well as TSLF Schedule 1 and 2 loans.



Sources: Bloomberg, Federal Reserve Board of Governors. The chart shows the difference between the indicated one-month commercial paper rates and the one-month overnight index swap rate.

APPENDIX 9

Pre-crisis estimates of portfolio contraction needed to accommodate balance sheet shocks

A review of the SOMA portfolio guidelines and supporting documentation for the period 2002-2006 indicates that Fed staff attempted at several points during the 1990s and 2000s to estimate the potential for growth in non-SOMA assets and the magnitude of portfolio contraction that would be needed to accommodate it. However, the approach to generating these estimates was inconsistent over time, and was heavily influenced by historical experience. Notably, these studies focused only on the possible magnitude of a funding need for a single large US bank; they did not contemplate the potential for liquidity provision to multiple financial institutions in an episode of severe financial market stress, and were not updated over time to reflect the growing potential demand for US dollar funding stemming from the globalization of financial markets and usage of the US dollar in banking and capital market activity overseas. The studies are summarized briefly below.

1. 1995 Meulendyke study[48]

This study looked at a range of balance sheet shocks experienced in the past and estimated size of each. The study assumed all shocks do not occur simultaneously.

Asset-side shocks		Liability-side shocks	
Large-scale DW borrowing by one or more banks	$120 billion	Sharp drop in currency in circulation (due to financial innovation reducing demand for cash, or decline in currency held outside the US)	$20 billion
FX intervention to purchase foreign currency	$30 billion	Decline in reserves holdings due to reduction in reserve requirement and/or transactions deposits	$10 billion
Revaluation of Fed holdings of gold certificates from book ($42.22/oz.) to market	$95 billion		

[48] "Liquidity Needs of the Federal Reserve's Securities Portfolio", https://marketsource.ny.frb.org/soma/analysis/MeulendykeLiquidityStudy.html

2. 1999 Santoro/Sims study[49]

This study considered a smaller set of shocks to liabilities, and made the conservative assumption of simultaneity of all shocks. This estimate was used as the basis for the SOMA portfolio liquidity buffer beginning in 2003.

Liability-side shocks over 12-month horizon		
	Low-growth scenario	High-growth scenario
Growth in currency in circulation	$45.9 billion	$201.8 billion
Decline in operating balances	-$ 1.5 billion	$ 1.6 billion
Decline in foreign RP pool	--	$ 5.0 billion
TOTAL	$44.4 billion	$208.4 billion

3. Board-NY estimate of 3-month liquidity buffer approved by FOMC in 2006[50]

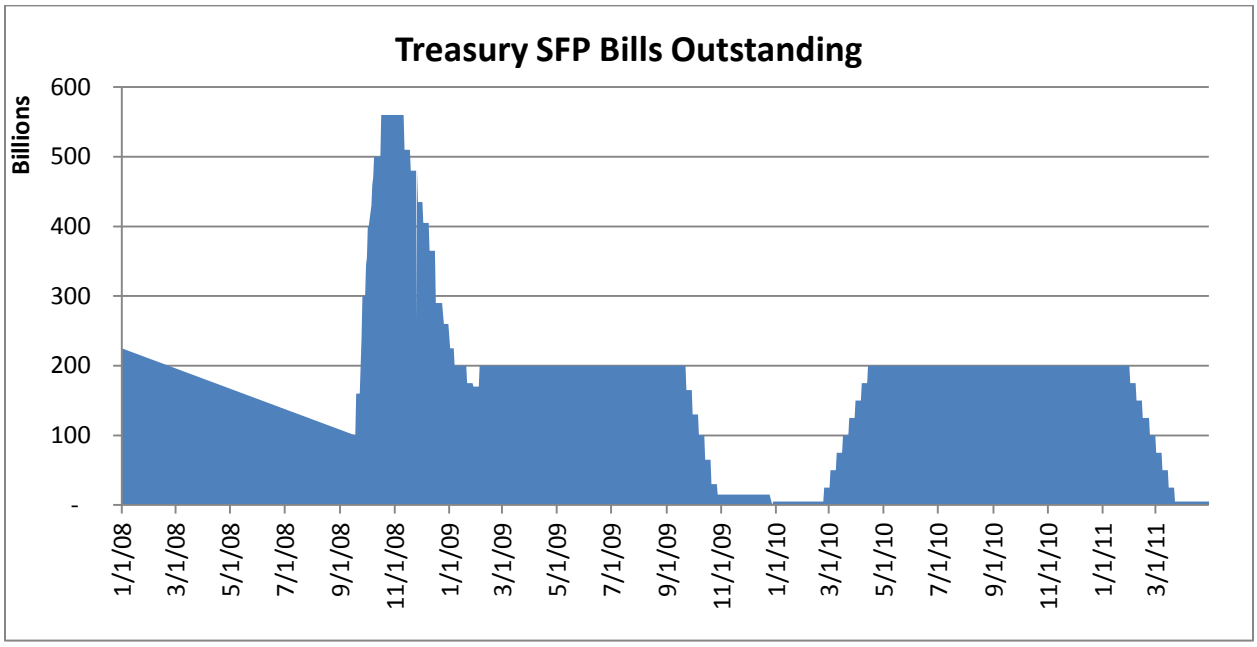
Prolonged discount window borrowing by Continental Illinois during its resolution by the FDIC, in 1984, was the largest balance sheet shock that had been experienced to date. In 2005, staff from FRBNY Markets, Research and Bank Supervision and Board Monetary Affairs conducted a study to re-estimate the size of a comparable borrowing by a single bank, in light of the banking industry consolidation that had taken place since Continental Illinois' failure. A three-month horizon was selected as this corresponded to the planning horizon banks were using for their contingency funding plans.

Call report data were used to estimate the potential liquidity needs of the 4 largest U.S. banks over a 3-month horizon in the event each experienced a run as a result of a reputational or operational (not solvency) problem. The probability of such a run some time in the next three years was assumed to be 100 percent. Based on this analysis, a guideline of $80 billion over 3 months was proposed to the FOMC for the SOMA portfolio, as a complement to the existing 12-month liquidity guideline of $208 billion.

[49] "Prospects for Growth in the Size of the SOMA Domestic Portfolio", https://marketsource.ny.frb.org/soma/analysis/DMSOMAGROWTH063099.html

[50] See Appendix 1, Memo to Dino Kos from Clifford Chu, September 25, 2006. See also transcript of October 24-25, 2006 FOMC meeting, page 5.

APPENDIX 10



SFP: Supplementary Financing Program. A description of the program can be found here: http://www.federalreserve.gov/monetarypolicy/bst_frliabilities.htm

Source: Federal Reserve Bank of New York.