Journal of Economic Perspectives—Volume 23, Number 1—Winter 2009—Pages 51–75

Crisis and Responses: The Federal Reserve in the Early Stages of the Financial Crisis

Stephen G. Cecchetti

In summer 2007, U.S. and global financial markets found themselves facing a potential financial crisis, and the U.S. Federal Reserve found itself in a difficult situation. It was becoming clear that banks and other financial institutions would ultimately lose tens or even hundreds of billions of dollars from their exposure to subprime mortgage market loans. Bank lending is closely tied to bank capital or net worth—specifically, bank regulators require that loans not exceed a certain multiple of capital. Thus, the Federal Reserve faced the danger of a sharp contraction in credit and bank lending in a way that threatened a deep recession or worse.

When this kind of event happens, the job of the central bank is to assure that financial institutions have the necessary funds to conduct their daily business; that they have the "liquidity" they need to make timely payments and transfers. Modern financial institutions need to replenish their funding every day. In the United States alone, literally trillions of dollars are transferred between banks each day to support the $50 trillion credit outstanding in the economy as a whole. Commercial banks require funds to initiate the mortgages, auto loans, and credit card debt they then sell into financial markets, while investment banks finance much of their activity with daily borrowing.

In the early stages of the crisis, the situation often arose in which a well-capitalized bank was forced to make sudden large loans based on previously committed lines of credit. In this circumstance, central bank actions can ease

■ *Stephen G. Cecchetti is Economic Adviser and Head of the Monetary and Economic Department, Bank of International Settlements, Basel, Switzerland. At the time this essay was written, he was Barbara and Richard M. Rosenberg Professor of Global Finance, International Business School, Brandeis University, Boston, Massachusetts, and a Research Associate, National Bureau of Economic Research, Cambridge, Massachusetts. His e-mail address is* ⟨*stephen.cecchetti@bis.org*⟩.

liquidity constraints by supplying banks with the funds they need in the short term. In fall 2007, the Federal Reserve provided short-term funding liquidity by, in effect, allowing banks to exchange their holdings of Treasury securities for cash. This policy enabled the banks to meet the credit line commitments they had outstanding.

However, it became clear in October and November 2007 that traditional central bank tools were of limited use. Realizing these failings, Fed officials created innovative, new lending procedures in the form of the Term Auction Facility and the Primary Dealer Credit Facility, as well as changed their securities lending program, creating the Term Securities Lending Facility. I describe how these new systems work, how each is intended to inject liquidity into the financial system, providing some time for institutions and markets to stabilize.

But before getting into the details, it is important to understand that there is a limit to what central bank tools can accomplish. When losses erode bank capital to the point where regulatory constraints become binding, private lending can only begin to grow again when capital has been replenished. A return to normalcy requires that banks either raise new equity from outside investors or receive a transfer from the fiscal authorities. Since the Fed is fundamentally not in the business of making such transfers, its ability to ease capital constraints is limited. However, as we will see, some of the less-traditional Fed actions taken during the crisis had a fiscal flavor to them and may be interpreted as an indirect attempt to subsidize banks in need.

The paper begins with a discussion of the traditional tools of monetary policy and how they work, using the balance sheet of the Federal Reserve as a device for understanding the conduct of monetary policy. We then turn to the early stages of the financial crisis, describing the symptoms and speculating about the causes, and lay out the early rounds of the policy responses used by the Federal Reserve. This essay was written in Spring 2008 and only describes events and responses through May 2008. While these policies may have helped in reducing the risk of a short-run financial crisis, Federal Reserve policies have not been able to keep the problems in the financial system from having an effect on real economic activity. This outcome is unsurprising. Financial intermediaries did in fact incur substantial losses, and changes in central bank lending practices will not overturn this fact.

The Federal Reserve Balance Sheet and Policy Tools

Monetary policymakers affect the quantity of funds available in the financial system by manipulating the assets and liabilities held by the central bank, which in turn affects the price of those funds—the interest rate. The Federal Reserve publishes balance sheet information weekly on its website. Table 1 reports a stripped-down version of the Federal Reserve System's balance sheet in early July 2007, prior to the onset of the crisis. To highlight the changes that occurred, we start with a whirl-wind tour of the liabilities and the assets as they existed before the crisis began. The discussion then turns to basic principles of managing a balance sheet and how they are related to tools of monetary policy like open-market operations and

Table 1
The Balance Sheet of the Federal Reserve, July 2007
(in billions of dollars)

Assets		*Liabilities*	
Securities		Federal Reserve notes	$781.4
Held outright	$790.6	Commercial bank reserve balances	$16.8
Repurchase agreements	$30.3	Liabilities related to foreign official and U.S. Treasury deposits	$42.4
Loans			
Primary lending	$0.19	Other liabilities	$5.7
Foreign exchange reserves	$20.8		
Gold	$11.0		
Other assets	$27.5		
Total assets	**$880.4**	**Total liabilities**	**$846.3**
	Capital (= Total assets − Total liabilities)	**$34.1**	

Source: Federal Reserve Statistical Release H.4.1, Table 2, ⟨www.federalreserve.gov/releases/h41/⟩; and quarterly *Treasury and Foreign Exchange Report,* April–June 2007, Federal Reserve Bank of New York ⟨www.ny.frb.org/markets/quar_reports.html⟩.
Note: With the exception of the value of foreign exchange reserves, which is for June, 30, 2007, all numbers are as of July 4, 2007.

changes in discount rates. In what follows, I will use the unqualified term "bank" to refer to a commercial bank rather than to the central bank or to an investment bank.

Liabilities: Currency and Reserves

Starting with the liability side of the balance sheet in Table 1, the amount of currency in circulation represents roughly $2,600 per U.S. resident. Even after accounting for the underground economy and amounts of currency held by retailers, this total seems extremely high. But as reported in U.S. Treasury (2006), one-half to two-thirds is held outside the country. Because currency plays no role in the episode at hand, we move to the entry for commercial bank reserve balances. Banks hold reserves at the Fed for three interrelated reasons: 1) they are required to do so; 2) they need them to do business, so they can meet customer demands for withdrawals and make payments to other banks; and 3) it is prudent to do so because reserves act as the bank's emergency fund, ready in case disaster strikes.

Table 1 shows that in July 2007 the level of reserve balances was $16.8 billion. This total is relatively small—approximately one-tenth the level held by European banks in the national central banks of the Eurosystem. U.S. banks keep reserve balances as low as possible because they traditionally receive no interest on such reserves, while European banks are paid something close to the overnight interbank lending rate.[1]

[1] On October 13, 2006, the U.S. Congress passed the Financial Services Regulatory Relief Act of 2006 (Public Law 109-351), authorizing the Federal Reserve to pay interest on reserves beginning on October 1, 2011. The Federal Reserve Board has not yet announced whether it will do so, but there is a strong suspicion it will.

Two additional liabilities appear on the balance sheet in Table 1. The first concerns deposit accounts that belong either to the U.S. Treasury or to foreign governments and central banks. These institutions need bank accounts just like any other person or business, and the Federal Reserve offers them this service. Finally, the very modest category of "other liabilities" includes deposit balances of international organizations like the International Monetary Fund and the United Nations, as well as those of federal government agencies such as Fannie Mae and Freddie Mac.

Assets: Securities Holdings, Loans, and Foreign Exchange Reserves

Moving to the asset side of the balance sheet, the Fed holds securities both outright and as part of repurchase agreements, or "repos" for short. Securities that the Fed owns directly are composed entirely of U.S. Treasury bills, notes, and bonds. Before the financial crisis began, these outright securities holdings comprised about 90 percent of the Fed's assets.

In July 2007, repos accounted for $30.3 billion, or just 3.4 percent, of total Fed assets. However, repurchase agreements are extremely important, because they are the method the Fed uses to adjust the level of reserves in the banking system from day to day. For example, when one reads that the Federal Reserve Bank of New York's Open Market Desk put $38 billion into the banking system on August 10, 2007, it was done with repurchase agreements.

A dictionary-style description of a repurchase agreement goes something like this: it is a short-term collateralized loan in which a security is exchanged for cash with the agreement that the parties will reverse the transaction on a specific future date at an agreed upon price, as soon as the next day. In more intuitive terms, perhaps the easiest way to think about a repo is as an overnight mortgage (because a mortgage, like a repo, is fully collateralized). In the same way that you pledge your house to the bank in exchange for a loan, a financial institution pledges a bond to the Federal Reserve in exchange for funds—and also promises to reverse the transaction and provide cash for the bond in the near future.

The Fed carries out these transactions through the Federal Reserve Bank of New York's Open Market Desk. The desk engages in repurchase agreements every morning (usually at 8:30 a.m. or 9:40 a.m.). The quantities normally range from $2 billion to $20 billion dollars. The desk sends out a message to 19 "primary dealers," most of which are investment banks, stating the term of the repo and the type of collateral that it will accept. The primary dealers, the only parties qualified to participate in these daily operations, send their offers—quantities, prices, and collateral—and then the New York Fed decides how much to accept. (For a current list of the primary dealers see ⟨http://www.ny.frb.org/markets/pridealers_current.html⟩). Three types of collateral are allowed under law: U.S. Treasury Securities, U.S. agency securities (issued by entities like Fannie Mae and the Small Business Administration), and AAA-rated and insured mortgage-backed securities. The total quantity of securities offered by the primary dealers (at all interest rates) averages roughly five times what is accepted for Treasury securities, ten times for

agency securities, and 15 times for mortgage-backed securities. While most offers are overnight, it is standard to engage in repos with maturities as long as 14 days.

By conducting repos on a daily basis, the Fed accomplishes two things. First, it keeps a fraction of its assets very short term, ensuring flexibility to expand and contract the quantity quickly. This allows policymakers to add or drain reserves from the system immediately if the need arises. Second, by operating every day, the Fed is in contact with market participants on a regular basis. If short-term funding markets start to experience strains, the Fed will find out immediately through the offers it receives from primary dealers in its daily operations.

Loans are the next entry on the asset side of the balance sheet. Historically, banks have been extremely reluctant to borrow from the central bank. Prior to the start of the crisis, borrowings averaged less than $200 *million* per day. Even for the first seven months of the crisis, from August 2007 through mid-March 2008, the quantity of discount window borrowing averaged just over $1 billion.

The stigma attached to borrowing from the Fed probably arises from several sources. Prior to 2003, banks could be admonished by the Fed for overuse of discount window borrowing, which created a distinct disincentive. Over the years, the Fed has tried to emphasize that borrowing from the central bank should be a normal part of business. Even so, banks continue to fear that if they borrow from the central bank, other banks and financial institutions will draw negative conclusions about their financial strength. Artuç and Demirlap (2007) provide a useful overview of the modest literature on discount window borrowing.

Continuing on the asset side, foreign exchange reserves are the next entry. As of June 30, 2007, the Fed held $13.1 billion in euro-denominated assets and $7.7 billion in Japanese yen in a combination of marketable securities and deposit accounts at foreign institutions. The Federal Reserve holds half of the foreign exchange reserves of the United States, with the other half on the balance sheet of the U.S. Treasury's Exchange Stabilization Fund. In the rare event of an intervention in the foreign exchange market, the quantity is evenly split between the two.

The next entry is gold. This item represents the Treasury's gold stock held in Fort Knox, which is carried on the books at a fixed value of $42.22 per troy ounce. Finally, the sizeable "other assets" category includes a variety of items: the land, physical premises, and operating equipment of the Federal Reserve banks; special drawing rights certificates issued by the International Monetary Fund; coins issued by the U.S. Treasury; accrued interest on U.S. Treasury securities held outright; as well as items in process of collection associated with the Fed's check clearing business.

Two General Principles of Balance Sheet Management

Two general principles are associated with the management of a central bank's balance sheet. First, policymakers control its size. If the Federal Reserve wishes, it can create liabilities to purchase additional assets. Open market operations work in this way: To purchase a security, the Fed creates a reserve liability, crediting the deposit account of a commercial bank. The central bank can expand its liabilities without limit—although an expansion of liabilities will reduce the price of those

liabilities, which is the interest rate. In other words, a change in the quantity of liabilities and assets can affect the level of the risk-free interest rate by altering the quantity of reserves supplied to the banking system.

Second, the central bank controls the composition of the assets on its balance sheet. Given the overall quantity of assets it wishes to hold, the Federal Reserve can decide whether it wants to hold Treasury securities, foreign exchange reserves, or other assets. Changes in the composition of central bank assets will not affect the risk-free interest rate, but they have the potential to influence relative prices—one currency relative to another or one bond relative to another—by changing the relative supply or desirability of holding one specific asset over another. Within certain legal limits, the Fed can adjust the composition of its assets along various dimensions like the maturity structure of its portfolio and the exact bonds that it owns. Sterilized foreign exchange intervention, where a central bank sells a bond denominated in one currency and uses the proceeds to buy a bond denominated in another currency, is a classic example of a decision related to the composition, but not the quantity, of the assets that the central bank holds.

Open Market Operations and Discount Rates

A textbook treatment of monetary policy focuses on three traditional tools, each of which is based directly on actions related to the central bank's balance sheet: open market operations, balance sheet size, and the federal funds interest rate target; lending to commercial banks, the fraction of assets held as loans, and the discount rate; and the level of commercial bank reserves, the composition of liabilities, and the reserve requirement. As I describe in Cecchetti (2008, p. 420), changes in reserve requirements are not a tool used by the Federal Reserve in the twenty-first century, so we focus here on the other two tools. The descriptions that follow describe the state of the world before the financial crisis of 2007–2008 began.

In the case of open market operations, the Federal Reserve's policymaking body, the Federal Open Market Committee (FOMC) sets a target for the federal funds rate—the (market-determined) rate banks charge each other for overnight loans of the excess reserves they hold at the Fed. Then, through a daily adjustment of the securities holdings and repurchase agreements on its balance sheet, the Open Market Desk, as the monopoly supplier of bank reserves, works to keep the federal funds rate near its desired target.

Commercial banks can borrow from the Fed at what is technically called the "primary lending rate" and is more commonly known as the "discount rate." Each of the 12 Federal Reserve banks has a standing offer to lend to the banks in their district that they deem to be sound (as measured by supervisory ratings). Before 2003, the primary lending rate was set below the target federal funds rate. From January 2003 up to the start of crisis in 2007, the primary lending rate was one percentage point, or 100 basis points, above the target federal funds rate. As long as a bank is financially sound and willing to pay the penalty interest rate, it can receive a loan. A borrowing bank can re-lend the borrowed funds to another bank, if it wishes to do so.

Lending through the "discount window" is designed both to provide funds at the end of the day, allowing banks to meet their payment obligations without

overdrawing their reserve account, and also to enable institutions to borrow against collateral that the market will not otherwise finance. The second of these purposes is associated with the classic lender-of-last-resort function.

Discount borrowing is collateralized, which means that the borrowing bank must have assets of sufficient value that, in the event of default, the Federal Reserve will not suffer a loss. The Federal Reserve will accept virtually anything as collateral. In one case in 1985, the Fed lent the Bank of New York $23 billion and took the entire bank—buildings, furniture, and all—as collateral (Cecchetti, 2008, p. 336). For details on the pledging and valuation of collateral, see ⟨http://www.frbdiscountwindow.org/index.cfm⟩.

Since both open market operations and discount lending involve changes in the Fed's balance sheet that result in expansion or contraction of commercial bank reserves, they are often presented as different tools with identical effects. But there are two important practical differences between them. First, any bank can borrow, while only 19 primary dealers can participate in open market operations. Second, the Federal Reserve allows a discount loan to be collateralized by a very broad range of assets, while only a narrow set of very high quality securities qualify for repurchase in regular open market operations.

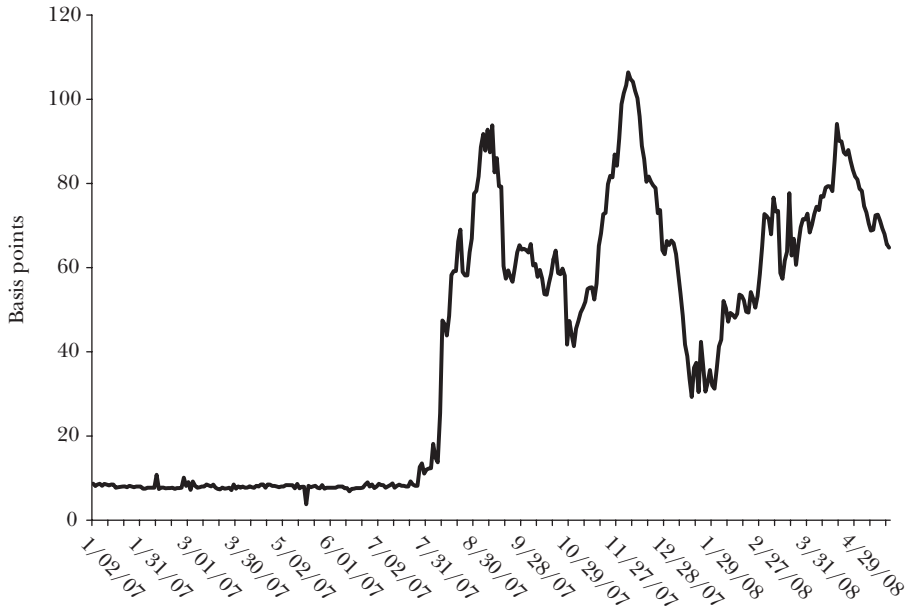
The Crisis Hits

A complete chronology of the recent financial crisis might start in February 2007, when several large subprime mortgage lenders started to report losses. It might then describe how spreads between risky and risk-free bonds—"credit spreads"—began widening in July 2007. But the definitive trigger came on August 9, 2007, when the large French bank BNP Paribas temporarily halted redemptions from three of its funds because it could not reliably value the assets backed by U.S. subprime mortgage debt held in those funds. When one major institution took such a step, financial firms worldwide were encouraged to question the value of a variety of collateral they had been accepting in their lending operations—and to worry about their own finances. The result was a sudden hoarding of cash and cessation of interbank lending, which in turn led to severe liquidity constraints on many financial institutions.

The contraction in the supply of short-term funds caused overnight interest rates in Europe to shoot up, and the European Central Bank responded the same day with the largest short-term liquidity injection in its nine-year history—€94.8 billion ($130 billion at the time) worth of overnight repos. The following day, as these overnight repurchase agreements expired, the operation to renew them was two-thirds the size—a still very large €61.1 billion. Meanwhile, the Open Market Trading Desk of the Federal Reserve Bank of New York used one-day repurchase agreements to inject $24 billion in reserves into the U.S. banking system on Thursday; and when those expired on Friday, the desk upped the amount to $38 billion for the weekend.

Symptoms of the turmoil in financial markets that began in August 2007 are

Figure 1
Spread between 3-month LIBOR and 3-month Expected Federal Funds Rate, January 2007 to May 2008, Daily



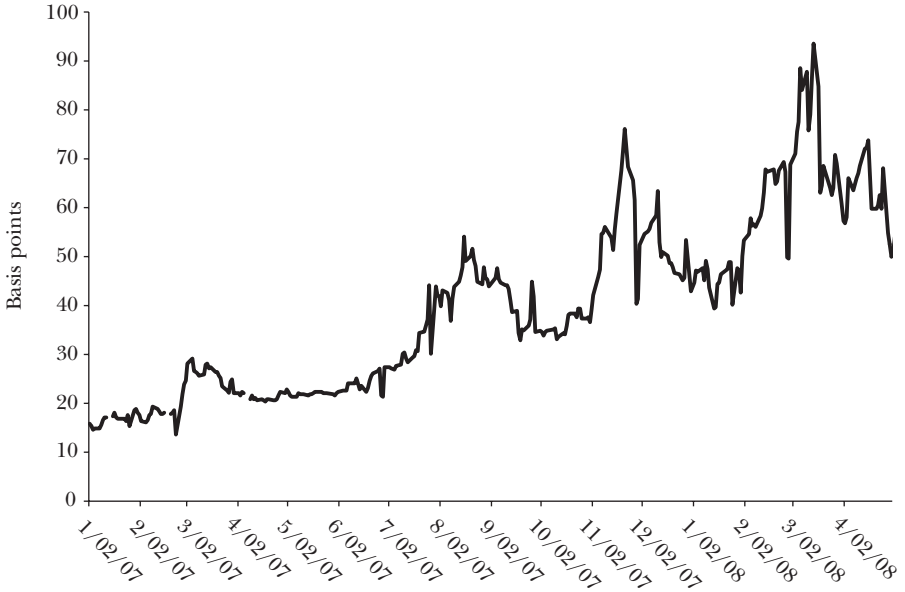
Source: LIBOR data are from the British Bankers' Association ⟨www.bba.org.uk⟩. The expected federal funds rate data are from Exhibit 2.10 of Greenlaw, Hatzius, Kashyap, and Shin (2008). Note that because the LIBOR rate is determined at 11a.m. U.K. time, which is 5 a.m. Eastern U.S. time, I plot the expected federal funds rate on date t minus LIBOR at $t - 1$. This avoids spurious spikes that would occur on dates when the Federal Open Market Committee made unexpected, inter-meeting changes in the target federal funds rate.

evident in a variety of places. One place to look is the interbank lending market. U.S. commercial bank borrowing exceeds $2 trillion. To remain flexible in adjusting the size and composition of assets they hold, banks tend to keep most of this short term. As a result, if banks suddenly become unwilling to lend, problems arise.

Distress in this market is evident from the behavior of the London Inter-Bank Offered Rate. LIBOR is the benchmark rate on interbank lending set by a group of 16 large banks each morning. It is a key interest rate used to price various consumer and business loans, including various kinds of mortgages.

LIBOR can be compared to the federal funds market because both involve uncollateralized loans. Figure 1 plots the difference between the three-month fixed-rate LIBOR and the expected interest rate that would accrue from repeatedly rolling over a loan at the overnight federal funds rate for three months (known as an Overnight Indexed Swap or "OIS"). The divergence between these two rates is typically less than 10 basis points. This small gap arises from an arbitrage that allows a bank to borrow at LIBOR, lend for three months, and hedge the risk that the overnight rate will move in the federal funds futures market, leaving only a small residual level of credit and liquidity risk that accounts for the usually small spread.

Figure 2
Spread between U.S. Agency and Treasury Securities, January 2007 to May 2008, Daily



Source: Citigroup, Inc.
Note: Based on averages across a broad spectrum of available maturities of large, liquid, issues of government-sponsored enterprise and agency debt.

But on August 9, 2007, the difference between these two interest rates jumped to 40 basis points. The "LIBOR spread" then fluctuated between 25 and 106 basis points through fall 2007.[2]

A second symptom of the financial crisis comes from looking at the average difference between U.S. government agency securities—those issued by Fannie Mae, Freddie Mac, and the like—and U.S. Treasury securities of equivalent maturity plotted in Figure 2. Normally the securities from government agencies are viewed as only very slightly more risky and less liquid than Treasury issues themselves. But again, starting in August 2007, the gap doubled from its typical range of 15 to 25 basis points to more than 40 basis points. As the crisis intensified through the fall and winter, the so-called "agency spread" exploded to more than 90 basis points in March 2008. The change represented a "flight to quality," in which

[2] This arbitrage is imperfect for an important reason that could explain at least a part of the increased spread. The problem is that the federal funds futures market allows a potential lender to hedge movements in what is known as the "effective" federal funds rate—that is, the quantity-weighted average of transactions in the overnight interbank lending market during the day. A bank cannot, however, guarantee that it will be able to borrow at the effective rate. Importantly, since August 9, 2007 the intra-day volatility of the federal funds rate has risen by a factor of four—from 5 to 20 basis points. As a result, the risk of financing a three-month loan by borrowing overnight for three months rose substantially, suggesting that this "term spread" would rise as well.

investors and financial institutions shunned everything but U.S. Treasury securities themselves.

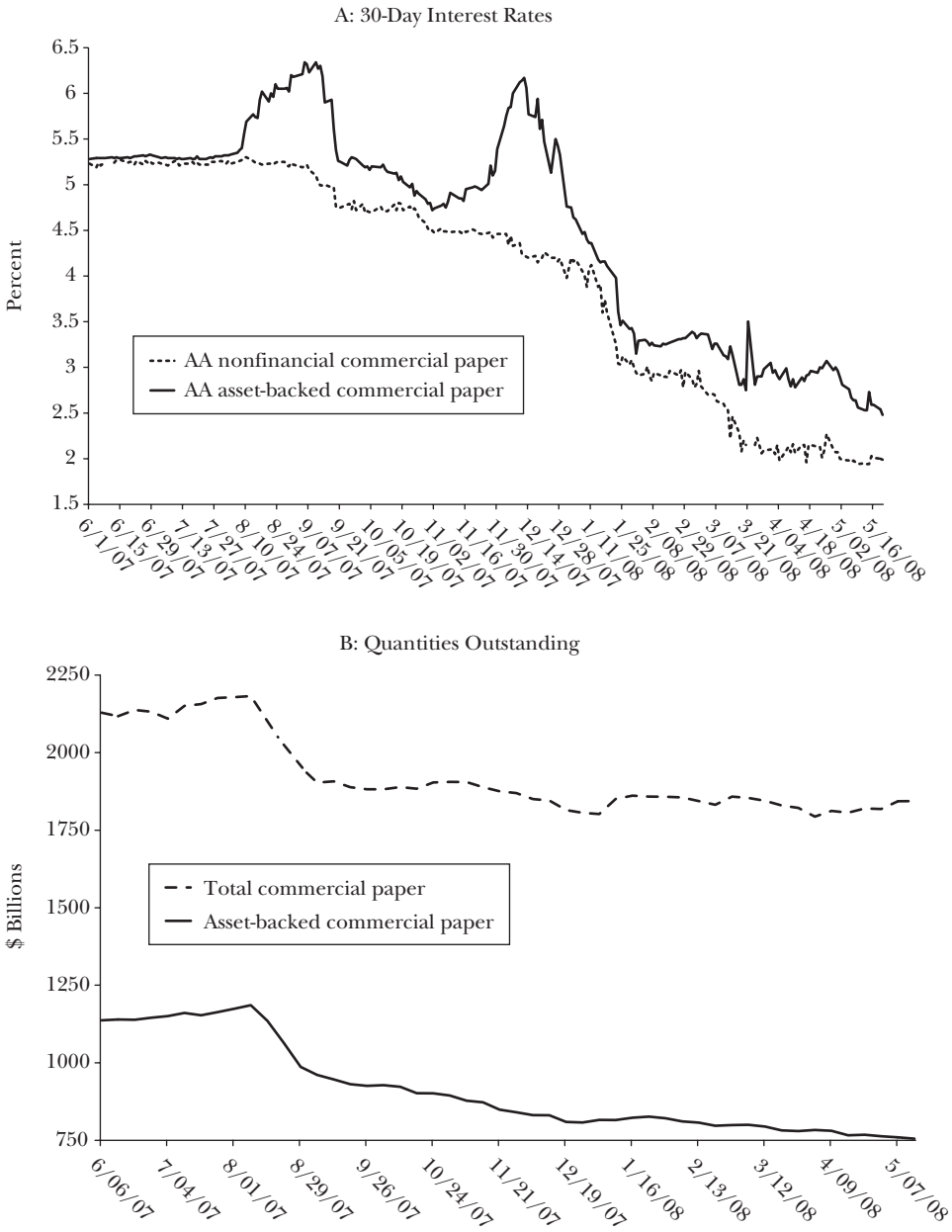
In both of these examples—the LIBOR spread and the U.S. government agency spread—the relevant market threatened to become almost functionally illiquid. The banks that participate in what is called "fixing" the LIBOR rate have no obligation to borrow or lend at those rates. No data exists on the quantity of interbank lending, but anecdotal evidence strongly suggests that few loans were actually occurring at these rates. Similarly, the market for securities of U.S. government agencies threatened to become illiquid.

In one market, the market for commercial paper, data on both prices and quantities are available. Figure 3 plots the behavior of 30-day commercial paper interest rates and quantities outstanding beginning in June 2007. Panel A compares the evolution of the rate on high-grade, AA-rated, nonfinancial commercial paper, issued by large corporations like General Electric and Coca Cola, with that of asset-backed commercial paper (often abbreviated as "ABCP"). Asset-backed commercial paper is issued by firms that hold things like the securities backed by mortgage pools as assets—and thus the risk premium on asset-backed commercial paper can give us a sense of beliefs about losses that may occur in real estate markets. By June and July 2007, asset-backed commercial paper was commanding a premium of 5 basis points. In mid-August 2007, the premium on asset-backed commercial paper had risen to 86 basis points, and in early December 2007, it peaked at more than 150 basis points.

In terms of quantities, the amount of commercial paper grew at a nearly 10 percent average annual rate from 2002 to 2007, reaching $2.2 trillion at the start of the crisis. Asset-backed commercial paper accounted for more than half of this total in August 2007, peaking at nearly $1.2 trillion. On any given day, more than two-thirds of all outstanding commercial paper has a maturity of five business days or less. Starting in mid-August, borrowers had trouble rolling over maturing issues. The quantity of commercial paper outstanding dropped precipitously, falling by nearly $300 billion in the first two months of the crisis and by a total of $400 billion by the end of 2007. Panel B of Figure 3 shows that the decline is entirely accounted for by the fall in asset-backed commercial paper outstanding. To guard against short-term illiquidity of specific institutions, issuers of commercial paper typically have available to them backup lines of credit with banks. During the last five months of 2007, total commercial bank credit extended rose by $575 billion (according to the Federal Reserve Board's H8 statistical release, page 2, line 5), more than offsetting the fall in commercial paper, as issuers called upon these bank credit lines.

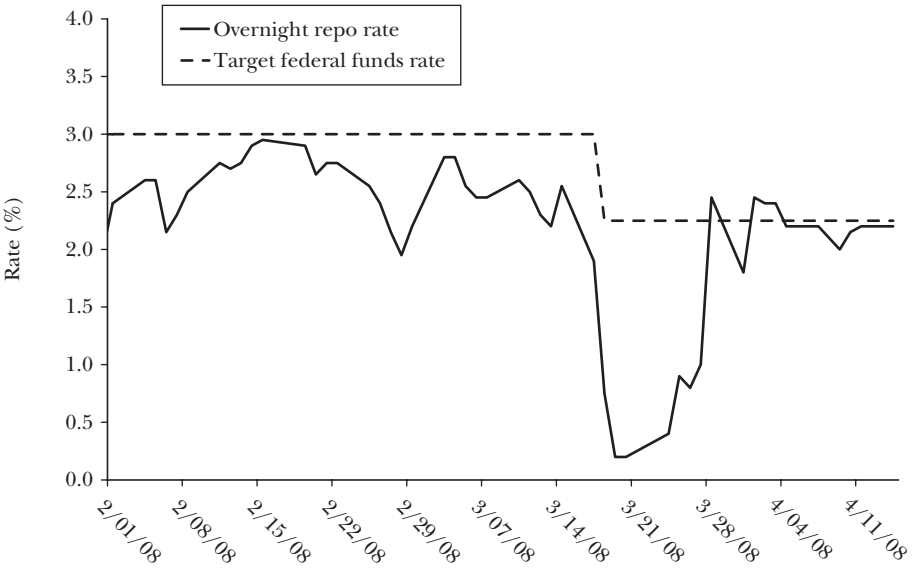
Finally, the market for repurchase agreements also exhibited symptoms of the financial crisis. Large financial institutions that hold various types of assets use repos to finance their short-term liquidity needs—and those needs have grown astronomically. For the 19 investment banks that serve as primary dealers, repos outstanding rose by a factor of four over the last decade, reaching $4 trillion at the dawn of the crisis in August of 2007. As the crisis moved into early 2008, this repo market began experiencing severe disruptions. The overnight rate on Treasury securities plotted in Figure 4 illustrates the change. This interest rate is what a

Figure 3
Commercial Paper, June 2007 to May 2008



Source: Board of Governors of the Federal Reserve System, ⟨www.federalreserve.gov/releases/cp/⟩.
Note: Interest rate data are daily, and quantity data are weekly. The data are not seasonally adjusted.

Figure 4
Overnight Treasury Securities Repo Rate



Source: Federal Reserve Bank of New York.

borrower has to pay for an overnight loan collateralized by a U.S. Treasury security. Because a repo is collateralized and a federal funds loan is not, the repo rate is normally between 5 and 10 basis points below the federal funds interest rate. But at the end of February 2008, with the federal funds rate target at 3 percent, the Treasury repo rate fell to 1.95 percent—a difference of 105 basis points. On March 19, 2008, investors and financial institutions became so desperate to get their hands on U.S. Treasury securities that they were willing to hold them with virtually no compensation at all, and the repo rate fell to 0.20 percent.

These pieces of evidence suggest a chronology: Starting in early August 2007, fear led to hoarding of cash and a broad increase in risk premia. Matters then seemed to improve from late September until the end of November, when it became clear that financial institutions were experiencing large losses. A compilation of these losses from news reports in late 2007 suggested that commercial and investment bank losses in the subprime mortgage market had surpassed a combined total of $150 billion, while estimates several months later exceeded $400 billion (Greenlaw, Hatzius, Kashyap, and Shin, 2008). Risk spreads widened again in December 2007 and continued to deteriorate with investors' and institutions' continued flight to safe securities into the winter of 2008.

Why did the interbank lending market dry up? There are two possible explanations for the unwillingness to lend. One is that lenders perceived a substantial increase in *credit risk*—that is, an increased risk that more borrowers will default. The alternative is that banks that normally would have been willing to lend faced a combination of uncertainties and constraints related to the size of their own balance

sheets. This concern could have arisen from fears about both involuntary lending that banks might be forced to make because of prior commitments on credit lines, and fears of the declines in the value of assets that the banks were holding.

It is difficult to gauge the relative importance of these explanations. However, evidence in both McAndrews, Sarkar, and Wang (forthcoming) and Bank of England (2008) suggest that, through the end of 2007, funding problems associated with concerns over bank capital were the dominant concern, but that starting in early 2008 concerns over borrower creditworthiness were the cause of the continued high risk premia.

Consistent with this conclusion is that, through fall 2007, banks increased credit extensions dramatically—from August 8 to December 26, 2007, bank credit rose $544 billion, or more than 6 percent. After that time, bank credit outstanding increased only $60 billion over the first eight weeks of 2008. Although we only have anecdotal evidence to back this up, it is plausible that the burst of lending in the fall of 2007 was associated with lines of credit that banks had extended as insurance to the entities that had been issuing asset-backed commercial paper but who were not able to issue such paper because of a lack of buyers after August 9.

Added to the pattern of bank lending is the fact that by mid-2007, severe difficulties were arising in valuing a broad array of complex securities. Subprime mortgages had been combined into broader securities and then carved up into complex financial products. Investors had relied on the ratings agencies such as Moody's and Standard and Poor's to certify that parts of resulting asset pools had lower or higher risks. However, starting in fall 2007, rating agencies steadily downgraded their views on the credit quality of these instruments. For example, on January 30, 2008, Standard and Poor's issued a single report in which it downgraded over 8,000 securities backed by assets of various kinds (at ⟨http://www2.standardandpoors.com/spf/pdf/media/subprime_action_rmbs_cdo.pdf⟩). This pattern of uncertain and diminishing values is characteristic of a financial crisis, and it has important consequences. Bankers that do not know the value of their own balance sheets are also unsure of their lending capacity. In addition, increased volatility in markets drove up conventional measures of risk, forcing banks to move toward less risky assets and to contract the overall size of their balance sheets.

As the financial crisis progressed into winter and spring 2008, previous lending commitments must have eventually exhausted their limited lifetimes, hence the drop in bank credit growth. In addition, problems with asset valuations must have been to some extent resolved—or at least were coming into clearer focus. Thus, at some point, the overriding consideration in the refusal of banks to lend to one another must have become the concern over credit risk—that is, the risk that borrowers would fail to repay.

Federal Reserve Interventions

Under the Federal Reserve Act (section 2A, at ⟨http://www.federalreserve.gov/GeneralInfo/fract/⟩), "The Board of Governors of the Federal Reserve System

and the Federal Open Market Committee shall maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." What tools did Federal Reserve policymakers have to "maintain long run growth of the monetary and credit aggregates" starting in fall 2007? Is there anything that the Fed can do to bring the LIBOR spread down or to help provide banks with financing at maturities of roughly three months? Can officials prevent liquidity constraints from causing asset sales that further depress prices and cause the crisis to broaden and deepen?

Table 2 divides the policy actions taken by the Fed between August 9, 2007, and May 2, 2008, into two groups: those that fit the conventional textbook definitions of aggressive monetary policy and those that do not. The first group, listed in the top panel of the table, is comprised of the seven cuts in the target federal funds rate totaling 3¼ percentage points. Each of these comes with a cut in the primary (discount) lending rate.

It would seem that the standard monetary tools—the cut in the cost of discount borrowing and the increase in the term of the loans announced on August 17, 2007, followed by cuts in the federal funds rate target starting in mid-September 2007—should have addressed the problem. After all, offering discount loans of up to 30 days at an interest rate only 50 basis points above the federal funds target should have given banks access to the liquidity they needed to carry on their day-to-day operations. Lowering the federal funds rate should help banks profit from their "maturity transformation" business of issuing short-term liabilities and making longer-term loans.

While these steps may have aided banks a bit, there was no return to normalcy. Moreover, the problems of risk and credit shortage—as illustrated by the rising spread between U.S. agency and Treasury securities in Figure 2—worsened through late fall 2007 and early winter 2008. Thus, Fed officials began a series of less conventional actions that are not in the current textbook descriptions of monetary policy (although they will presumably be in future textbooks!). These actions include reducing the premium on primary (discount) lending from 100 to 50 and then to 25 basis points above the federal funds rate target, as well as an increase in the term of the lending from overnight to 30 and then 90 days; the creation and then enlargement of the Term Auction Facility (TAF); the extension of $24 billion in credit to the European Central Bank and the Swiss National Bank, eventually raised to $62 billion; the change in the pre-existing securities lending program to initiate the Term Securities Lending Facility (TSLF); extension of credit to primary dealers through the newly created Primary Dealer Credit Facility (PDCF); and the authorization of lending to support the JPMorgan Chase purchase of Bear Stearns. To appreciate how each of these policies works, we need to link each one to the Fed's balance sheet and toolbox discussed earlier.

Term Auction Facility

By late 2007, it was clear that the changes in the discount lending policy put in place in mid-August were not working. Banks continued to be unwilling to borrow

Table 2
Major Federal Reserve Policy Actions, August 9, 2007 to May 2, 2008

Conventional actions: Simultaneous cuts in the target federal funds rate and primary lending rate	
September 18	50 basis point cut at regularly scheduled FOMC meeting
October 31	25 basis point cut at regularly scheduled FOMC meeting
December 11	25 basis point cut at regularly scheduled FOMC meeting
January 21	75 basis point cut at an unscheduled FOMC meeting
January 30	50 basis point cut at regularly scheduled FOMC meeting
March 18	75 basis point cut at regularly scheduled FOMC meeting
April 30	25 basis point cut at regularly scheduled FOMC meeting
Unconventional actions	
August 9	Increase in the level of temporary open market operations
August 17	Cut in primary lending rate from 100 to 50 basis points above the federal funds rate target; an increase in the term of discount lending from overnight to a maximum of 30 days
December 12	Announced creation of the Term Auction Facility (TAF) and the swap lines with the European Central Bank and the Swiss National Bank of $20 billion and $4 billion, respectively.
December 17	First TAF auction: $20 billion, 98 bidders
March 2	Announced intention to conduct 28-day repos cumulating to $100 billion.
March 7	Announced an increase in the size of the TAF from $60 billion to $100 billion outstanding at any given time.
March 11	Announced creation of Term Securities Lending Facility (TSLF) and the intention to lend $200 billion worth of Treasury Securities to primary dealers. Increase in the swap lines with the European Central Bank and the Swiss National Bank to $30 billion and $6 billion, respectively.
March 14	Announced approval of loan to Bear Stearns through JPMorgan Chase.
March 16	Announced creation of Primary Dealer Credit Facility (PDCF); announced approval of $30 billion loan to JPMorgan Chase for the purposes of purchasing Bear Stearns; cut in primary lending rate from 50 to 25 basis points above the federal funds rate target; an increase in the term of discount lending from a maximum of 30 days to a maximum of 90 days.
May 2	Increase in the size of the TAF to $150 billion. Increase in the swap lines with the European Central Bank and the Swiss National Bank to $50 billion and $12 billion, respectively. Expansion in the collateral that can be pledged in the TSLF to include AAA-rated asset-backed securities including student loans, credit card debt, and auto loans, as well as securities backed by residential and commercial mortgages.

Source: Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York, various press releases. The FMOC is the Federal Open Market Committee.

from the Fed. As a result, problems in the interbank funding market continued. Figure 1 showed that, through fall 2007, the spread between three-month LIBOR and the three-month expected federal funds rate continued to rise.

As Federal Reserve officials searched for alternative mechanisms to inject funds into the banking system, they found themselves reconsidering some procedures first discussed in 2001. During 1999 and 2000, the annual federal budget was operating in surplus, reducing the quantity of Treasury securities outstanding. Long-term forecasts at the time suggested that the level of government debt might

decline in a way that there would be an insufficient supply of federal government securities to supply the assets of the Federal Reserve. Federal Reserve System staff undertook a study of possible alternative operating procedures. One of the suggestions was to supply reserves through an auction mechanism (Federal Reserve System Study Group on Alternative Instruments for System Operations, 2002, Chapter 3). In December, this procedure was implemented in the form of the Term Auction Facility.

The idea behind the Term Auction Facility was to remove the stigma associated with discount borrowing and in that way to get reserves to banks that needed them. As the name suggests, the TAF auctions funds for a certain term. Through it, the Fed started lending reserves in substantial quantities for relatively long periods—initially $20 or $30 billion, then $50 billion, and then $75 billion per auction for terms of 28 or 35 days. Importantly, as the Fed increased lending, it reduced its outright securities holdings in equal measure, leaving the total size of the Fed balance sheet unaffected.

Here is how the Term Auction Facility works: Any of the more than 7,000-plus commercial banks in the country can bid in the auction, stating what interest rate it will pay for what quantity of funds. The minimum bid rate is determined by the expected federal funds rate in the market over the term of the auction. An individual bank's bid cannot exceed 50 percent of the value of the collateral that it has available for discount window borrowing. A bank receiving funds cannot prepay, so if the loan turns out to be expensive because interest rates fall during the term of the loan, the borrower is stuck with it (for a description, see ⟨http://www.newyorkfed.org/markets/Understanding_Fed_Lending.html⟩).

The procedures of the Term Auction Facility—including the choice of a uniform- or single-price auction, the restriction that no bidder can be allocated more than 10 percent of the total being auctioned, and the fact that settlement occurs two days after the date of the auction—helps to ensure anonymity for the banks and that the bidders will not be branded as being in desperate need of immediate funds (Armantier, Kreiger, and McAndrews, 2008). As a result, banks have been willing to make use of the auction in a way they have refused to do with the more traditional "discount window" or primary credit facility.

Starting in December 2007, the auctions were held twice a month, with total reserves supplied rising to $150 billion by the beginning of May 2008. Between 52 and 93 banks participated in the first dozen auctions and the total quantity bid was just less than twice the total quantity of funds offered. With only a few exceptions, the interest rate paid was near or below the expected primary lending rate.[3]

There is some evidence that the Term Auction Facility helped at first to reduce the spread shown in Figure 1. The Term Auction Facility started its auctions in mid-December. Figure 1 shows that the difference between the three-month

[3] The Federal Reserve's weekly balance reports Term Auction Facility lending separately by Federal Reserve District. Roughly two-thirds of the loans are going to banks in the New York district, the location of most U.S. subsidiaries of foreign banks. This outcome is at least consistent with the possibility that the Term Auction Facility loans are going primarily to European banks. See the line labeled "Term Auction Credit" in Table 3 of the H.4.1 weekly release.

LIBOR and the three-month Treasury bill rate declines sharply from early December 2007 until mid-February 2008.

It may seem surprising that the Term Auction Facility would succeed, because all the auctions do is change the composition of the Fed's assets leaving the quantity unaffected. Specifically, the Term Auction Facility involves a shift from securities, held either outright or in repurchase agreements, to loans. Such a shift carries no implication at all for the federal funds target rate. A widespread belief, built on past experiences, has been that changes in the composition of the Fed's assets have little or no real effect.[4] For example, during the early 1960s, the Fed attempted to reduce the gap between short-term and long-term interest rates (that is, flatten the yield curve) by selling short-term Treasury bills and buying long-term Treasury bonds in what came to be called "Operation Twist." As Volcker (2002) discusses, this seemed to have little or no effect. Sterilized foreign exchange intervention, whereby the central bank sells securities denominated in one currency and buys securities in another—something the United States has not done since September 22, 2000—is another example of a policy where there is a broad consensus that such portfolio shifts in and of themselves have little or no effect.

But during fall 2007, central banks became aware of something on which they had not previously focused. While well-established mechanisms existed for injecting reserves into a country's financial system, officials had no way to guarantee that the reserves would reach the banks that needed them. In the United States, standard open market operations can put reserves into the hands of 19 primary dealers—but this does not mean that the funds will then be distributed across the banking system. The problem turns out to be particularly acute when the banks that are short dollar reserves are not American banks. This insight provided the rationale for the foreign exchange swaps in which the Fed supplied the European Central Bank and Swiss National Bank with dollars, which those two central banks went on to auction to their banks. Thus, perhaps the Term Auction Facility operated to reduce the difficulties of specific institutions that were having particularly acute problems.

But the Term Auction Facility does more than merely distribute funding to the banks that need it. The rules of the Term Auction Facility allow banks to pledge collateral that might otherwise have little market value. Under the rules of the auctions, TAF loans must be over-collateralized by at least a factor of two, but in reality the Fed is taking collateral at a price that is almost surely above its actual market price (Tett, 2008). The result is two-fold. First, liquidity reaches places where it wasn't going on its own, which helps to address potential liquidity constraints on individual institutions; and second, banks gain the time they need to value the assets they have. This action has a fiscal policy flavor, as it has the potential to provide a capital subsidy to borrowing banks.

Recalling that the officials implemented the Term Auction Facility in the

[4] Taylor and Williams (2008) argue that the Term Auction Facility has been ineffective as they find no impact on the LIBOR–expected federal funds rate spread on the day of banks' bid for funds in the auction. By contrast, McAndrews, Sarkar, and Wang (forthcoming) suggest that there was an impact, but it was on the day of the auction announcement.

hopes of reducing the gap between the three-month LIBOR and the three-month expected federal funds rate, we can see from Figure 1 that it had a limited impact. After the spread fell from over 100 basis points in early December 2007 to less than 30 basis points in late January 2008, stress increased again in February 2008. By March 2008, this spread once again exceeded 70 basis points. The Federal Reserve then increased the size of the Term Auction Fund, but as of spring 2009, this particular spread remained elevated.

Term Securities Lending Facility

In winter 2008, a simmering problem hit the financial system with full force: U.S. Treasury securities of all varieties became extremely scarce. The primary symptom of this is the dramatic decline in the interest rate on repurchase agreements collateralized by U.S. Treasury securities plotted in Figure 4. As noted earlier, in mid-March 2008 this rate fell to 0.20 percentage points. Investors were willing to hold U.S. Treasury securities with virtually no compensation.

In response to this extreme flight to quality, the Federal Reserve showed its capacity for innovation yet again by creating the Term Securities Lending Facility (TSLF). For several decades, going back to 1969, the Fed has lent Treasury securities to primary dealers on an overnight basis (Fleming and Garbade, 2007). This lending seeks to reduce the number of failed securities transactions. Treasury dealers routinely sell and promise to deliver securities that they do not own, counting on their ability to procure the right Treasury bill, note, or bond in time to complete the transaction. Sometimes they miscalculate. However, when a primary dealer is unable to obtain the specific issue it has promised to deliver, that dealer can go to the Fed in the early afternoon and borrow what it needs. There is a small fee, and the borrower is expected to return the security the next day. Since the Fed holds some of nearly every Treasury issue, it can lend whatever is needed, thereby ensuring that markets function smoothly. In February 2008, for example, the Federal Reserve held 210 of the 238 distinct Treasury issues outstanding (exact Fed holdings are available at ⟨http://www.ny.frb.org/markets/soma/sysopen_accholdings.html⟩).

The Term Securities Lending Facility takes this existing lending program and transforms it in three ways. First, while the traditional program lends overnight, the new one provides securities for 28 days. Second, the Term Securities Lending Facility dramatically broadens the collateral accepted. Until March 2008, lending meant swapping one Treasury security for another. By contrast, the Term Securities Lending Facility explicitly allows dealers to obtain Treasury securities in exchange for "AAA/Aaa-rated private-label residential MBS [mortgage-backed securities] not on review for downgrade" (as announced at ⟨http://www.ny.frb.org/newsevents/news/markets/2008/rp080311.html⟩).[5]

[5] Broadening the allowable collateral beyond that accepted in standard open market operation required that the Federal Reserve Board invoke Section 13(3) of the Federal Reserve Act, cited in the discussion of Bear Stearns below.

Finally, the Fed announced its willingness to loan up to $200 billion through the Term Securities Lending Facility.

Operationally, the Term Securities Lending Facility is an auction where primary dealers bid for Treasury securities. Potential borrowers of the securities bid the fee (the interest rate) they are willing to pay, with a minimum that depends on the collateral acceptable in the auction. In the first auction on March 27, 2008, the Federal Reserve offered $75 billion face value of securities, received $86.1 billion in bids and the winning bid was 33 basis points. Thus, for 33 basis points, a dealer could exchange a residential mortgage-backed security. In mid-March, the benefit of this was obvious as the repo rate on Treasury's was several hundred basis points below that on the mortgage-backed securities. The majority of the succeeding weekly auctions have been undersubscribed, with the amount offered exceeding the total quantity for which primary dealers are bidding. Fed officials view this as a sign of success, because it signals that there is no longer a desperate demand for Treasury securities.

Like the Term Auction Facility, the securities lending program changes the composition of the Fed's asset holdings without affecting their size. While this goal is not explicit, the Fed is essentially selling Treasury holdings and buying residential mortgage-backed securities. Like other changes in asset composition, this one is directed at reducing the relative price of various securities. The Term Auction Facility was aimed at the gap between term and overnight interbank lending rates; the Term Securities Lending Facility is directed toward the premium paid to hold U.S. Treasury securities relative to mortgage-backed securities. Fleming, Hrung, Keane, and McAndrews (forthcoming) estimate, and Figure 3 confirms, that the Term Securities Lending Facility was extremely effective in raising the Treasury repo rate back to levels close to the federal funds rate immediately upon implementation.

Bear Stearns

On March 13, 2008, it became apparent that the investment bank Bear Stearns was on the verge of shutting down. A letter one week later, from Securities and Exchange Commission Chairman Christopher Cox (2008) to Dr. Nout Wellink, Chairman of the Basel Committee on Banking Supervision, reports that Bear Stearns's "liquidity pool"—assets such as Treasury securities that can be quickly converted to cash—had dropped from $18 billion to $2 billion from Monday to Thursday. The firm was unable to obtain short-term loans to continue conducting business. As Cox's letter emphasizes, in mid-May the firm continued to remain solvent. Public disclosures in "10-Q filings" confirm this: two weeks earlier, at end of February 2008, Bear Stearns had had roughly $12 billion in capital to support just under $400 billion in assets (Bear Sterns, 2008).

The sudden bankruptcy of Bear Stearns would almost surely have been catastrophic. Again, public documents tell us that on February 29, 2008, the firm had $14.2 trillion of notional value in derivative contracts—futures, options, and swaps—outstanding with thousands of counterparties. Clearly, the firm was a part of a complex interconnected network of financial arrangements. If Bear Stearns

had failed, it would then need to sell its assets into a market that lacked the liquidity to handle it, so prices for those securities could collapse in a way that would affect the entire financial system.

Since Bear Stearns was not a commercial bank, it had no way to use its collateral to obtain liquidity from the Federal Reserve. While Fed officials did not care about Bear Stearns itself, their concern for system-wide financial stability led them to invoke Article 13(3) of the Federal Reserve Act, which gives the Board of Governors the power to authorize Federal Reserve banks to make loans to any individual, partnership, or corporation provided that the borrower is unable to obtain credit from a banking institution.

On March 14, 2008, the Federal Reserve Bank of New York made a loan directly to Bear Stearns. Data released on March 20, 2008, combined with press reports that the loan was repaid on March 17, imply that Bear borrowed approximately $12.9 billion.

By any measure, this action was extraordinary. Not since the 1930s had the Fed actually made a loan based on Article 13(3). Then, over the next weekend, central bank officials brokered a deal in which JPMorgan Chase purchased Bear Stearns for a total of approximately $3 billion. Included in the deal is a loan from the Federal Reserve Bank of New York.

The Fed's participation in the deal is described in congressional testimony by Federal Reserve Bank of New York President Timothy Geithner (2008, Annex III). The basics are as follows: The Federal Reserve Bank of New York made a $29 billion 10-year loan at the primary lending (discount) rate to a newly formed limited liability company created to hold $30 billion worth of mortgage-backed securities previously owned by Bear Stearns. JPMorgan Chase put in $1 billion and assumed the first loss. Unlike standard discount lending, where the Fed has recourse to go after the entire borrowing bank's assets if the pledged collateral is insufficient to cover the loan, here there is no recourse. This means that if the value of the assets placed in this new company turn out to be less than $29 billion, the Federal Reserve would suffer a loss.

But the credit risk associated with this extraordinary loan clearly belongs to the U.S. Treasury. A March 17, 2008, letter from Secretary of the Treasury Henry Paulson to Geithner reads, in part, "that if any loss arises out of the special facility . . . the loss will be treated by the FRBNY as an expense that may reduce the net earnings transferred by the FRBNY to the Treasury general fund." The standard practice is that Federal Reserve System revenue—including interest on its securities portfolio, net of operating expense—is turned over to the U.S. Treasury. Thus, any losses arising from the credit facility created to support the J.P. Morgan Chase purchase of Bear Stearns will reduce the amount of that transfer rather than the level of the Fed's capital.

The subsidy implicit in the loan to Bear Stearns is clearly a fiscal, not a monetary, operation. The Federal Reserve is effectively acting as the fiscal agent for the Treasury. As an aside, note that actions in which the fiscal authority dictates how the central bank holds its assets can run the risk of compromising central bank independence if they become a regular occurrence.

There has been substantial criticism of the Bear Stearns action. Reinhart (2008) calls it a "bailout" and believes that it has dealt a fatal blow to the Fed's ability to act as an honest broker in encouraging private-sector solutions to problems posed by failing institutions, as it did in 1998 when confronting the failure of Long Term Capital Management (Lowenstein, 2001). At first glance, this accusation of a bailout may seem peculiar, because Bear Stearns's shareholders and employees took huge losses, and the price paid by JPMorgan Chase may well be below Bear Stearns's net worth. Nevertheless, there is a good argument that the holders of Bear Stearns's bonds and other liabilities were in fact bailed out. A disorderly collapse of the firm could very well have left this group repaid with even less. As a result, lenders may now feel safe in making loans to other investment banks, encouraging the borrowers to take more risk than they should.

As for the Fed's ability to marshal the private sector into cooperating when circumstances demand, we will have to wait and see. What we can say is that the decision to extend the Fed's lending facility to investment banks is likely to lead to increased regulation and supervision of entities in this business.

Primary Dealer Credit Facility

The evening of March 16, 2008, the Federal Reserve used its Article 13(3) powers for a second time in three days to create the Primary Dealer Credit Facility. The 19 primary dealers authorized to participate in daily open market operations and the Treasury auctions are not banks. They are investment banks and brokers. None of them have access to either traditional discount loans or the Term Auction Fund. Starting in mid-March they could borrow from the Federal Reserve. Like discount loans made to commercial banks, the Primary Dealer Credit Facility allows borrowers to pledge a relatively broad set of collateral including "investment-grade corporate securities, municipal securities, mortgage-backed securities and asset-backed securities for which a price is available" (see ⟨http://www.ny.frb.org/newsevents/news/markets/2008/rp080316.html⟩).

The Primary Dealer Credit Facility was immediately popular. For the first three weeks of its existence, borrowing averaged over $30 billion per day, before gradually declining to around $10 billion by the end of May 2008.

Lending directly to primary dealers serves two objectives: First, it ensures short-term funding for investment banks. The experience with Bear Stearns, which sustained a sudden loss of short-term funding but looks to have remained solvent, made Fed officials realize that lender-of-last resort operations needed to be extended beyond commercial banks (although the full implications of this have yet to be worked out). Second, the Primary Dealer Credit Facility seeks to reduce interest-rate spreads between the asset-backed securities that can be used for collateral in these loans and U.S. Treasury securities, thereby improving the ability of investors to buy and sell asset-backed securities in financial markets. Since primary dealers can now take a relatively broad set of bonds to the Fed and obtain immediate cash, these securities should be more readily acceptable as collateral in private borrowing arrangements. If this works, all the Fed should have to do is announce the program; it should not have to make many, if any, loans.

Looking back at Figure 2, notice that the gap between the interest rate on government agency and U.S. Treasury securities fell immediately on March 17, 2008, with the creation of the Primary Dealer Credit Facility and continued to decline, although much more modestly, as the Term Securities Lending Facility began operation. By the end of May 2008, the spread on government agency debt (normally 15 to 25 basis points above the Treasury rate) was still 50 basis points—not great, but better than the spread of 90 basis points in mid-March. There are several reasons the spread could have fallen at this time. It also could have been because of the reduction in Fannie Mae's and Freddie Mac's capital requirements announced on March 19 or Goldman Sachs' and Lehman Brothers' release of their quarterly earnings on March 18, 2008. But the new Federal Reserve programs probably played a role, too.

The Evolution of the Federal Reserve's Balance Sheet

To understand the comprehensive impact of all of these changes in Fed operations, we return to the balance sheet. Table 3 shows the evolution of Fed assets over the nine months from July 2007 to May 2008; and the changes are enormous.[6] Because the liabilities of the Federal Reserve have not changed in any material way, they are omitted from this table.

Before the crisis, the Fed held nearly $800 billion in securities outright. By the end of May 2008, that had fallen to almost $500 billion, of which roughly one-fifth was committed to the Term Securities Lending Facility. Repurchase agreements used to be around $30 billion; by spring 2008, they exceeded $100 billion. Prior to December 2007, loans were inconsequential. Nine months into the crisis, the Fed was lending over $170 billion through a variety of mechanisms. Interestingly, from the beginning of April, with the discount rate penalty cut to 25 basis points above the federal funds rate target, discount borrowing skyrocketed, reaching $19 billion by the end of May 2008. All the while, the size of the Federal Reserve balance sheet hardly changed, rising at the end of the year to accommodate seasonal demand for currency, but then falling back. Everything Federal Reserve policymakers had done was aimed at changing the composition of assets they held, not the size of their balance sheet.

Conclusion

On August 9, 2007, the global financial system started to crack. Financial institutions everywhere were forced to confront the reality that their substantial holdings of mortgage-backed securities were worth less than they thought and had

[6] Aid to commercial banks does not end with the changes in Federal Reserve practice. The little-known Federal Home Loan Banks have been another source of funding. During second half of 2007, these government-sponsored enterprises provided commercial banks with roughly $230 billion in loans. These loans are for longer terms than the discount window, are cheaper than discount loans even at a penalty spread of 25 basis points, and allowed for a broad range of mortgage-based collateral.

Table 3
Federal Reserve Assets on Various Dates
(in billions of dollars)

	July 4, 2007	*Jan 2, 2008*	*Mar 19, 2008*	*May 28, 2008*
Securities				
Held outright				
Uncommitted	$790.6	$740.6	$660.5	$384.8
Committed to TSLF				$106.3
Repurchase agreements	$30.3	$56.3	$62.0	$115.0
Loans				
Primary credit	$0.19	$4.9	$0.12	$19.0
Term auction credit		$40.0	$80.0	$150.0
Primary dealer credit			$28.8	$10.1
Foreign exchange reserves	$20.8	$27.3	$27.3	$25.2
Foreign exchange swaps		$24.0		$62.0
Gold	$11.0	$11.0	$11.0	$11.0
Other assets	$27.5	$21.6	$21.0	$22.4
Total assets	**$880.4**	**$925.7**	**$890.7**	**$905.8**

Source: Board of Governors of the Federal Reserve System, Release H.4.1, various dates.
Note: "TSLF" is Term Securities Lending Facility.

become very difficult to value. Banks' uncertainty about both their own level of capital and their ability to borrow made them unwilling to lend. Some financial intermediaries began to have trouble finding the short-term financing that was essential for them to carry on their daily business.

Central bank policymakers worked to respond appropriately. Traditional interest rate instruments proved to be ineffective, so Fed officials innovated in a number of ways. By lending both cash and securities based on collateral of questionable value, the Fed tried to bring order back to financial markets. The amounts involved are massive. By the end of May 2008, the Fed had committed nearly two-thirds of its $900 billion balance sheet to these new programs: $150 billion to the Term Auction Facility; $100 billion (of the $115 billion total) to 28-day repo of mortgage-backed securities; a maximum of $200 billion to the Term Securities Lending Facility (of which $106.3 billion were outstanding); $62 billion to foreign exchange swaps; $29 billion to a loan to support the sale of Bear Stearns (to be made at the end of June 2008); and a potentially unlimited amount to the Primary Dealer Credit Facility.

Was it prudent for the Federal Reserve to refashion its policy tools in this way? The amount committed by the Federal Reserve has been so large that it is natural to wonder what would happen if the Fed were to run out of capacity to engage in transactions that change asset composition without changing the federal funds rate target. Does the size of the Fed's balance sheet pose a constraint on the amount of lending it can do? Ip (2008) reports that Fed officials were concerned about this possibility and have examined several mechanisms to increase lending capacity should the Fed need it. The simplest approach is to have the Treasury increase the size of its deposit account, with the Fed then using the proceeds as they see fit.

There is also the possibility that, even without further legislation, the Federal Reserve could issue its own debt.

The financial crisis of 2007–2008 raises a number of substantial and difficult questions: What should policymakers do when prices of leveraged assets boom? How should central banks respond to declines in the price of risky assets and the associated increase in risk premia? Should monetary policymakers react to illiquidity in the market for specific assets, and if so, how? When a highly leveraged and complex financial institution experiences losses, what is the central bank's responsibility? Should a central bank take on credit risk in its lending operations, or should this function belong to the U.S. Treasury? Perhaps with experience and research, the answers to these questions will become clear. Once the crisis is safely past, we might want to reassess the role of the central bank. But in the financial crisis of 2007–2008, the Federal Reserve was the only official body that could act quickly and powerfully enough to make a difference. Given the very real and immediate dangers posed by the financial crisis that began in August 2007, it is difficult to fault the Federal Reserve for its creative and aggressive responses.

■ *Among the vast number of people I spoke with in preparing this essay, I wish especially to thank David Archer, Peter Fisher, Michael Fleming, Jens Hilscher, Spence Hilton, Anil Kashyap, Jamie McAndrews, Kim Schoenholtz, Andrei Shleifer, Jeremy Stein, Timothy Taylor, and Paul Tucker for their insights and comments. An earlier version of this essay was presented as the Edgeworth Lecture at the 2008 Annual Meeting of the Irish Economic Association.*

References

Almantier, Olivier, Sandy Kreiger, and James McAndrews. Forthcoming. "The Term Auction Facility." *Current Issues in Economics and Finance*, Federal Reserve Bank of New York.

Artuç, Erhan, and Sevla Demirlap. 2007. "Discount Window Borrowing after 2003: The Explicit Reduction in Implicit Costs." Tüsiad-Koç University Economic Research Forum Working Paper 0708.

Bank of England. 2008. "Markets and Operations." *Quarterly Bulletin,* Q1, 28(1): 6–24.

Bear Stearns. 2008. "Form 10-Q for the Quarterly Period Ending February 29, 2008." April 8. Available at: http://www.bearstearns.com/sitewide/investor_relations/index.htm.

Cecchetti, Stephen G. 2008. *Money, Banking, and Financial Markets*, 2nd edition. New York, NY: McGraw Hill, Irwin.

Cox, Christopher. 2008. "Letter to Dr. Nout Wellink, Chairman of the Basel Committee on Banking Supervision. March 20. http://www.sec.gov/news/press/2008/2008-48.htm.

Fleming, Michael J., and Kenneth D. Garbade. 2007. "Dealer Behavior in the Specials Market for US Treasury Securities." *Journal of Financial Intermediation,* 16(2): 204–228.

Fleming, Michael J., Warren Hrung, Frank Keane, and James McAndrews. Forthcoming. "Repo Market Effects of the TSLF." Federal Reserve Bank of New York *Current Issues in Economics and Finance.*

Geithner, Timothy. 2008. "Testimony before the U.S. Senate Committee on Banking, Housing and Urban Affairs, Washington, D.C." April 3. http://www.ny.frb.org/newsevents/speeches/2008/gei080403.html.

Greenlaw, David, Jan Hatzius, Anil K Kashyap, and Hyun Song Shin. 2008. "Leveraged Losses: Lessons from the Mortgage Market Meltdown." U.S. Monetary Policy Forum Report No. 2, Rosenberg Institute, Brandeis International Business School and Initiative on Global Financial Markets, University of Chicago Graduate School of Business.

Federal Reserve System Study Group on Alternative Instruments for System Operations. 2002. *Alternative Instruments for Open Market and Discount Window Operations*. Federal Reserve System, December. Available at: http://www.newyorkfed.org/markets/openmarket.html.

Ip, Greg. 2008. "Fed Weighs Its Options in Easing Crunch." *Wall Street Journal*, April, 9, p. A3.

Lowenstein, Roger. *When Genius Failed*. New York: Random House, 2001.

McAndrews, James, Asani Sarkar, and Zhenyu Wang. Forthcoming. "The Effect of the Term Auction Facility on the London Inter-bank Offered Rate." *Current Issues in Economics and Finance*, Federal Reserve Bank of New York.

Paulson, Henry M., Jr. 2008. Letter from Henry M. Paulson Jr., Secretary of the U.S. Treasury, to Timothy F. Geithner, President of the Federal Reserve Bank of New York. March 17. Available at: http://finance.senate.gov/press/Bpress/2008press/prb040108a.pdf (last page of the file).

Reinhart, Vincent R. 2008. "Fallout from a Bailout." *Washington Post*, May 22, p. A25.

Tett, Gillian. 2008. "US Banks Quietly Borrow $50bn from Fed via New Credit Facility." *Financial Times*, February 19, pg. 1.

Taylor, John B., and John C. Williams. 2008. "A Black Swan in the Money Market." NBER Working Paper 13943.

Volcker, Paul A. 2002. "Monetary Policy Transmission: Past and Future Challenges." *Federal Reserve Bank of New York Economic Policy Review*, May, pp. 7–11.

U.S. Treasury. 2006. *The Uses and Counterfeiting of United States Currency Abroad, Part 3*. September. http://www.federalreserve.gov/boarddocs/rptcongress/counterfeit/counterfeit2006.pdf.