FED Liquidity Policy during the Financial Crisis: Playing For Time

by

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Introduction

This paper focuses on how the Federal Reserve (Fed) responded to the early stage of the international financial crisis, from 2007 through 2008, which it characterized as a short-term liquidity problem, despite growing evidence of potential insolvencies among some of the largest banks and investment banks [1]. The Fed provided large amounts of liquidity to both domestic and international institutions when credit risk spreads suddenly widened in September of 2007 and still more liquidity when these spreads virtually exploded in September of 2008 in the wake of the collapse of Fannie Mae and Freddie Mac and the bankruptcy of Lehman Brothers [2]. We argue that signs of increasing financial fragility and potential insolvencies appeared much earlier than fall of 2007. If these had been recognized and acted upon by the regulatory authorities, then it is possible that the most serious financial crisis since the Great Depression might have been substantially mitigated. While it is inherently difficult to disentangle issues of illiquidity from insolvency, the failure to recognize and address the insolvency problems in several major institutions delayed necessary adjustments and undermined confidence in the financial system.

The classical role of the Lender of Last Resort (LLR) is often summarized by a simple set of rules [3]. The LLR should: (1) lend freely, (2) against good collateral, (3) to solvent institutions, (4) at a penalty rate. If the LLR follows these rules strictly, the economy benefits from a virtuous circle. So long as the LLR lends only to solvent institutions, its willingness to lend freely to a particular institution signals that the institution is sound. This will restore market confidence in the

institution and enable it to regain access to its creditors and counterparties without borrowing significant amounts from the LLR

In what follows we briefly describe the events that led up to the crisis, and concentrate on the policies initiated by the Fed to deal with the crisis and minimize systemic contagion.

Causes of the Crisis

In the US Shadow Financial Regulatory Committee's chapter for the book *The World in Crisis*, (2011), the authors noted that "The 2007-2009 financial crisis . . . had its origins in US housing policies, the subprime mortgage market in particular, and the end of the real estate bubble in the US." While the collapse of the housing bubble triggered the crisis, the fragility of the financial system amplified the scope and magnitude of what otherwise might have been a collapse in a relatively small sector of US financial markets. Indeed, the causes reached far beyond housing to include excessively accommodative monetary policy, international capital inflows that kept the risk-free interest rate too low and contributed to the housing bubble, structural defects in the primary dealer system and related tri-party repo market, inadequate risk measurement and monitoring by both institutions and regulators, and relaxed prudential standards. These factors were both domestic and international in scope and origin. They were compounded by U.S. government policies to subsidize homeownership that encouraged over-investment in housing, and contributed to a housing bubble that ultimately collapsed.

These policies and the "Great Moderation," the generally benign macroeconomic environment characterized by exceptionally low volatility, led borrowers, lenders, and investors to increase leverage and take riskier positions without necessarily perceiving that they were exposing themselves to a greater risk of insolvency. Borrowers took out mortgages that they could afford only in good times; lenders made loans that fell below traditional underwriting standards; and investors bought what were (and were disclosed to be) illiquid, complex securities in enormous

amounts assuming that secondary markets would continue to be highly liquid. The resulting housing bubble first burst in the subprime sector, and then spread to mortgage-backed securities, other asset-backed commercial paper (ABCP), and interbank markets, ultimately damaging the real economy.

No one of these factors was likely to have been sufficient alone to cause the financial crisis, but together they formed what is often characterized as a "perfect storm" that destroyed several key financial markets, de-capitalized several important financial institutions and helped cause the ensuing recession (see the Financial Crisis Inquiry Commission's (2011) final report). Among these factors were a number of events outside the U.S. -- fiscal shocks, current account surpluses and financial market developments -- that had important impacts on U.S. financial markets, and arguably played a role in the financial crisis.

The Accumulation of US Dollars Abroad and the Demand for High Quality Safe-Haven Assets

Over most of the period of the Great Moderation, the U.S. was running persistent fiscal deficits, as entitlement spending expanded without the provision of adequate funding.[1,2] Simply put, the growth in government spending outstripped tax collections.

Three key international developments contributed to the accumulation of dollars abroad. This accumulation helped fuel demand for U.S. Treasury debt, as U.S. fiscal deficits increased

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[1] For discussions on the fiscal deficit, see Auerbach, Alan J., "The U.S. Fiscal Problem; Where We Are, How We Got Here, and Where We're Going," National Bureau of Economic Research, Vol. 9 (January 1994), available at http://www.nber.org/chapters/c11009.pdf ("Auerbach (1994)"); Auerbach, Alan J., "Formation of Fiscal Policy: The Experience of the Past Twenty-Five Years," Economic Policy Review, Vol. 6, No. 1 (April 2000) ("Auerbach (2000)"); Auerbach, Alan J., "Quantifying the Current U.S. Fiscal Imbalance," Working Paper 6119, National Bureau of Economic Research (August 1997), available at http://www.nber.org/papers/w6119.pdf?new_window=1; and Reinhart, Carmen M., and Kenneth S. Rogoff, "This Time is Different: A Panoramic View of Eight Centuries of Financial Crises," NBER Working Paper No. 13882 (April 16, 2008) ("Reinhart and Rogoff (2008)"), available at http://www.nber.org/papers/w13882.pdf .

[2] For a brief period during the Clinton administration, the U.S. ran a surplus, and the national debt was cut to the point that the Federal Reserve even became concerned about the availability of sufficient Treasury securities to conduct day-to-day open market operations.

the supply. Foreign demand for Treasury debt was so strong that it helped keep both U.S. and foreign interest rates lower than they otherwise would have been. (See Figure 1.)

[Insert Figure 1 here]

First, the rise of oil prices, led by OPEC countries, meant that many oil exporters (including Russia) began to accumulate significant amounts of dollar claims in excess of their expenditures. Oil exports were denominated in dollars (as were many of the goods and services these countries purchased) and so it was natural for oil producers to allocate a substantial amount of their reserves to dollar-denominated U.S. Treasury debt.

Second, beginning in the 1990s, China emerged as a major exporter of consumer goods, with exports greatly exceeding China's purchases from the rest of the world. The resulting large current account surpluses led to rapidly growing accumulations of claims on the rest of the world that were allocated mainly to dollar-denominated assets.[3] China is now the largest external holder of U.S. Treasury debt. Indeed, only the holdings of the Federal Reserve exceed those of China (see Figures 1 and 2).

[Insert Figure 2 here]

Third, Japanese monetary policy also contributed to the demand for dollar liquidity and enabled the U.S. to fund its fiscal deficit (and current account deficit) on favorable terms. Japan was mired in a protracted slowdown, which led to severe deflationary pressures. Auerback (2006) argued that during this time Japan experienced a deleveraging, which, when combined

[3] For a discussion of China's exchange-rate policies and global imbalances, see, for example, "Report to Congress on International Economic and Exchange Rate Policies," U.S. Treasury Department (June 2007), available at http://www.treasury.gov/resource-center/international/exchange-rate-policies/Documents/2007_FXReport.pdf. See also, Bernanke, Ben S., "The Global Saving Glut and the U.S. Current Account Deficit," The Federal Reserve Board, March 10, 2005, available at http://www.federalreserve.gov/boarddocs/speeches/2005/200503102/ ("Bernanke (2005)") and Bernanke, Ben S., "Global Imbalances: Recent Developments and Prospects," Speech delivered at the Bundesbank Lecture, Berlin, Germany, September 11, 2007, available at http://www.federalreserve.gov/newsevents/speech/bernanke20070911a.htm ("Bernanke (2007)"). Because the markets for U.S. Treasury debt are by the far the broadest, deepest and most resilient in the world, foreign entities that manage large international portfolios will almost inevitably make a significant allocation to U.S. treasury securities to facilitate large transactions. Relative to the alternatives, U.S. Treasury debt is usually regarded as the safest, most reliable source of liquidity (Herring, 2012).

with the Bank of Japan's extremely expansionary monetary policy, flooded the market with cheap funds which could be borrowed at near-zero interest rates.[4] Arbitragers quickly perceived an opportunity to borrow yen and purchase higher yielding dollar assets, including U.S. Treasuries, in what became known as the yen "carry trade." This return was perceived to be nearly risk free so long as the yen was not expected to appreciate against the dollar by more than the interest differential. While the size of the yen carry trade was difficult to measure, estimates range from $400 billion to $1 trillion.[5]

Foreign central banks accumulated large stocks of US government debt as part of their foreign exchange reserves. Moreover, sovereign wealth funds invested substantial amounts in U.S. Treasury and agency securities, which were viewed as safe and liquid.

In essence, these three factors allowed the U.S. Treasury to finance its debt internationally at low rates. If the same volume of debt were to have been financed through domestic savings alone, the required interest rates would have risen sharply. The Fed would have had to buy Treasuries in the market to keep its target policy rate at the desired level. This, of course, would have increased the monetary base and the risk of inflation [6],

The Changing Nature of Real Estate Lending, the Asset-Backed Commercial Paper Market and Its Role in the Crisis

[4] See Auerback, Marshall, "The BOJ Talks The Talk (But Will It Walk The Walk?)," Working Paper 109, Japan Policy Research Institute (April 2006) ("Auerback (2006)").

[5] See Cecchetti, Stephen G., Ingo Fender, and Patrick McGuire, "Toward a Global Risk Map," Working Paper No. 309, Bank for International Settlements, (May 2010) ("Cecchetti, Fender, and McGuire (2010)"); Fackler, Martin, "In Japan, a Robust Yen Undermines the Markets," *New York Times*, October 27, 2008, available at http://www.nytimes.com/2008/10/28/business/worldbusiness/28yen.html; and "What keeps bankers awake at night?" *The Economist*, February 1, 2007, available at http://www.economist.com/node/8633485?story_id=8633485.

[6] The combination of external demands for U.S. debt from three disparate sources contributed to keeping inflation and interest rates lower than they might otherwise have been and helps to explain Greenspan's "conundrum." Indeed, this downward pressure on rates occurred despite the efforts of the FOMC to raise rates in 2004.

A considerable amount of the interbank funding was related to the growth of the "originate to distribute" model for mortgages—both prime and sub-prime [4]. Figure 3 shows the rapid growth in the issuance of residential (and commercial) mortgage-backed securities. Note that issuance accelerated during the latter half of 2006 and the first half of 2007, after housing prices had peaked in 2006 and had begun to fall precipitously. While much attention has been paid to the role that commercial banks played in the issuance of subprime related securities, Figure 4 shows that foreign institutions, based in both the UK and Continental Europe each issued a more significant share of residential mortgage backed securities in 2006 that U.S commercial banks. But, U.S. investment banks accounted for the dominant share.

[Insert Figures 3 and 4 here]

Not only did the issuance of residential mortgage-backed securities (RMBS) accelerate, but also the market for these instruments became more opaque because these securities were increasingly repackaged and tranched in Collateralized Debt Obligations (CDOs). Figure 5 shows that the issuance of CDOs during the first half of 2007 [5] exceeded the total issuance of CDOs during the entire previous year, which had set a record.

[Insert Figure 5 here]

By 2007, issuance of RMBs and CDOs had become a dominant source of revenue for many primary dealers, which included most of the largest banks and investment banks in the United States and Europe. Figure 6 shows the growth in revenue for these banks [6]. The Bank of England (2007, p. 37-38) observed that both trading profits and fees and commissions were important drivers of growth, which was " . . . supported by the growth in structured credit markets." The [institutions] have not only generated revenues through their origination and distribution

activities, but demand for structured credit products has also allowed them to earn fees through the traditional investment banking activity of underwriting new debt issues."

[Insert Figure 6, here]

Of course, the issuance of large volumes of MBS could not have been sustained without robust demand for such securities. Sovereign wealth funds had already begun to accumulate the debt of Freddie Mac and Fannie Mae, which was widely perceived to benefit from an implicit US government guarantee. However, demand for high quality assets was also supported by the accumulation of dollars held in large institutional cash pools both in the U.S and abroad. These Cash pools, the short-term cash balances of global non-financial corporations and institutional investors, are large and centrally managed. The demand from these cash pools for safe alternatives to insured deposits far exceeded the supply of government guaranteed instruments and so private sector alternatives emerged to fill the gap. According to Pozsar, estimated demand exceeded available supply by some $1.5 trillion.

The Unfolding of the Financial Crisis

While the real estate bubble, the surge in lending to the subprime sector, and securitization of low-quality mortgages surely ignited the crisis, they cannot explain the damage to the financial system and the real economy. Subprime mortgages were a relatively small proportion of aggregate financial assets and if the claims on the subprime sector had been held in well-diversified portfolios, the collapse in the value of subprime mortgages (which was less than a standard-deviation fall in the value of the S&P 500) would have resulted in losses that could have been easily absorbed without significant spillover effects on other financial markets and key financial institutions. However, the activity was heavily concentrated in some of the largest financial institutions, many of them foreign institutions [7]. Moreover, many of the significant players were designated as "primary dealers" in government securities. These institutions held highly leveraged positions

funded with very short-term wholesale market liabilities that were subject to substantial rollover risk. Our focus will be on these institutions and the markets on which they relied for short-term funding.

The US Shadow Committee (2012) divided the financial crisis and responses to it into three distinct phases: (1) a Liquidity Phase from mid-summer 2007 to adoption of the Troubled Asset Relief Program (TARP) in October 2008; (2) a Solvency Phase that extended from introduction of TARP; (3) a Recovery Phase that began in January 2009 and continues. Our focus is the Liquidity and Solvency Phases, during which the Fed perceived that markets had frozen and several institutions could no longer fund themselves in the short-term money markets. The Fed's response was to liberalize existing lending facilities and to introduce a number of new liquidity facilities to augment funding for large institutions that experienced difficulty in financing their balance sheets.

Liquidity vs. Solvency?

As with all such spreads, precisely how to separate the credit risk component from the liquidity risk component remains an ongoing challenge for research. If it were possible to make such inferences from the TED spread with a high degree of confidence, then it would be a useful guide to policymakers (and investors). If an increase in spreads were attributable to an increase in liquidity risk, then the appropriate policy response would aim to improve liquidity conditions, but if the increase is attributable to an increase in credit risk, then corrective policy should focus on bolstering solvency.

Unfortunately, it is not yet possible to distinguish these factors in real time and, indeed, the interdependence between liquidity and default risks is so complex that it may always present a challenge. For example, when concerns arise about the liquidity of a financial institution, solvency concerns are sure to follow, particularly if the institution is thinly capitalized. If an institution is obliged to sell assets quickly to meet its cash-flow obligations, it will incur losses that undermine its

solvency. But causation may run in the opposite direction. Concerns about an institution's liquidity often arise because of doubts about its solvency. When one adds to that the importance of changes in beliefs about an institution's access to government support, the two factors become almost inextricably intertwined. More importantly, liquidity crises do not last for months. As the duration of liquidity problems increases, it almost always signals growing concerns about solvency. If liquidity problems persist, policy-makers should shift their attention to the possibility of underlying solvency problems if they have not already done so.

Bank managers are sure to argue that their central problem is lack of access to liquidity. Similarly, bank supervisors and central banks tend to support this view, both because they often lack reliable information about an institution's solvency, and because they believe that providing generous liquidity support may forestall the necessity of taking difficult and politically painful choices about resolving an insolvent institution.

The liquidity phase

The precise onset of the Liquidity Phase is subject to debate. Those who focus on the emerging weaknesses in the housing market would select a date in 2006, after the housing bubble peaked and older vintages of subprime mortgages (that had readjusted from very low, teaser rates to a much higher floating rates) began to default at an unexpectedly high rate (see Figure 7). Others might identify the profit warning regarding losses on subprime debt issued by HSBC on February 7, 2007, the first such warning in its 142-year history (HSBC, 2007), and the illuminating transcript of the conference call with security analysts on February 8 that followed the profit warning (HSBC 2007). HSBC announced that it would need to set aside an additional $1.8 billion to cover unexpectedly higher default rates in its holdings of subprime loans at its US consumer finance subsidiary. This may have been the first clear sign of the implications of the decline in house prices for the financial sector.

[Insert Figure 7 here]

The first unambiguous signs of unease in the key interbank markets appeared in early June 2007, after Standard and Poor's and Moody's Investor Services downgraded over 100 bonds backed by second-line subprime mortgages. A week later Bear Stearns suspended redemptions from its High-Grade Structured Credit Strategies Fund and its Enhanced Leverage Fund because of difficulties in valuing various types of mortgage-backed securities. Bear Stearns liquidated these funds on July 31, 2007.

The stress in interbank markets became highly visible on August 9, 2007, after the announcement by BNP Paribas (Dealbook, 2007) that it had suspended redemptions from three of its funds – Parvest Dynamic ABS, BNP Paribas ABS Euribor and BNP Paribas ABS Eonia – because the collapse of liquidity in the U.S. subprime related ABS made it impossible for them to compute reliable net asset values. The bank stated, "The complete evaporation of liquidity in certain market segments of the U.S. securitisation market has made it impossible to value certain assets fairly regardless of their quality or credit rating." This prompted extraordinary actions by the European Central Bank, which on August 9, 2007 injected €95 billion overnight to improve liquidity. On August 17, 2007, the Fed approved a temporary 50-basis point reduction in the discount window borrowing rate, extended term financing, and noted that it would accept "a broad range of collateral."[7]

Precisely how the degree of distress should be measured is also open to some debate. The traditional measure has been the difference between the London Interbank Offer Rate (LIBOR) [8] and the Treasury Bill Rate (the TED spread [9]; see Figure 8 [10]). The TED spread (and other similar measures such as the LIBOR/OIS spread) attempt to capture "funding liquidity risk," the banks' difficulty in borrowing to meet its cash flow needs. However, "market liquidity risk" also

[7] Board of Governors of the Federal Reserve System, press release August 17,2007, http://www.federalreserve.gov/newsevents/press/monetary/20070817a.htm

matters. If a bank experiences difficulty in borrowing to meet its cash flow needs, it will need to sell assets; but if it is unable to sell assets without adversely affecting market prices, it may have to accept fire-sale prices. Unfortunately, transacting at fire-sale prices may trigger further sales if, for example, the firm is obliged to meet margin calls or is required to provide more security on collateralized borrowings. Moreover, the fall in prices will transmit the bank's funding problem to other financial institutions holding the same asset that has fallen in price.

[Insert Figure 8 here]

Both measures are broadly consistent with one another in terms of the signals that were sent about financial stress. The behavior of the TED spread is illustrative. For example, before the crisis, the typical TED spread averaged about 25 basis points through April 2007. It then jumped to an average of about 50 basis points in May. This doubling of spreads should have raised questions about the cause of increased anxieties within the interbank market. The TED spread increased sharply from about 50 basis points to 100 basis points on August 10, 2007 (just after the previously mentioned announcement by BNP Paribas), then to 130 basis points on August 15, 2007 before peaking at 237.5 basis points on August 20, 2007. On August 10 the Federal Reserve (2007) issued a press release indicating that it would provide liquidity through open-market operations to ensure that the funds market would trade near its target of 5.25 percent and that the discount window was open.

By September 2007, the broad outline of the unfolding crisis was clear even though the Fed continued to characterize it as a liquidity crisis. What was initially perceived as a disruption in a relatively minor sector of the debt market had spilled over to damage much of the rest of the financial system. The process began with a drop in demand and a sharp downward revaluation in the price of subprime-related debt, which was attributable to deterioration in the performance of underlying subprime mortgages. This led market participants to realize that (at best) credit ratings

indicated the probability of default, not the overall risk of asset price volatility. The virtual evaporation of liquidity in the secondary market for subprime-related debt meant that trading was infrequent (and possibly at fire-sale prices), and so it was very difficult to verify the market value of the outstanding debt. The sharp fall in the prices of these assets undermined confidence in the customary valuation models, which had relied heavily on credit ratings for tranches of particular issues. This undermined confidence in the ability to forecast losses and the correlation of losses in the underlying collateral. Valuations were further complicated by the complexity of asset structures that had previously had been virtually ignored by investors. This concern immediately spread to other complex securities and these market disruptions triggered several knock-on effects. The CDO and Collateralized Loan Markets virtually disappeared (See Figure 9).

[Insert Figure 9, here]

The fall in prices had an immediate impact on institutions heavily involved in securitization, which threatened to become self-reinforcing. Collateralized lenders reacted to the drop in prices by demanding larger haircuts to accept ABCP, when they would accept it at all. Demands for more collateral pressured borrowers to sell ABCP in illiquid markets in order to maintain their access to funds. This put additional downward pressure on prices, which led to additional demands for more collateral. Borrowers also tried to reduce the size of their balance sheets as funding costs became uneconomic.

These market responses intensified pressures on primary dealers and other participants in the market for subprime mortgages, who were unable to securitize existing warehouses of mortgages and were forced to seek other forms of funding. The rapid contraction of the ABCP market forced banks to honor backstop liquidity facilities or take securitized assets back onto their balances sheets. The emerging pressure on dealer balance sheets and income statements was apparent, even though accounting disclosures failed to reflect the extent of the damage or,

importantly, how the losses that had already occurred would be allocated across institutions. Institutions attempted to hoard liquidity to meet contingent commitments and protect against further disruptions. They attempted to reduce the size of their balance sheets and increase their borrowings in interbank markets. This put upward pressure on the cost of term funding. Institutions responded by shifting much of their borrowing to overnight funding markets, but this increased their exposure to the risk they would be unable to roll over their borrowing if they should suffer a loss of market confidence.

The Fed viewed this series of events as a liquidity crisis that required intervention by the central bank to increase bank liquidity. In the August 10, 2007 conference call of the Federal Open Market Committee, Fed Chairman Bernanke provided the rationale for this diagnosis of the problem and the Fed's remedy, emphasizing that the "goal is to provide liquidity support not to support asset prices per se in any way." He added that "[T]he price discovery process was inhibited by the illiquidity of the subprime-related assets that are not trading, and nobody knows what they're worth and so [t]here's a general freeze up. The market is not operating in a normal way. The idea of providing liquidity is essentially to give the market some ability to do the appropriate re-pricing it needs to do. So it's a question of market functioning, not a question of bailing anybody out" (Federal Open Market Committee, 2007, p.8).

The Fed hoped that if it provided more liquidity to banks they would be induced to buy subprime-related assets from other market participants trying to unload them. Even if the underlying diagnosis is accepted, this remedy seems dubious. It ignores the fact that many of the market participants attempting to unload their subprime-related debt were the same banks to which the Fed was providing liquidity. It is unlikely that more liquidity would induce them to shift their portfolio preferences in favor of holding more subprime-related debt (although it might have mitigated pressures to sell into illiquid markets).

More fundamentally, the inability of the market to find a market-clearing price may have had deeper explanations. Normally, when demand shifts downward the market price will fall until supply equals demand. Presumably investors would have been willing to pay some positive price for the distressed debt, and so the underlying problem must have been the unwillingness of holders of the debt to sell at that price. This would certainly make sense if holders of the debt believed the fall in prices were temporary and would be quickly reversed.

The economic fundamentals offered no support for this view, however. Delinquencies on subprime mortgages were rising and housing prices continued to fall. Moreover, structured credit facilities were designed so that losses experienced by the most junior tranches could not be recouped in subsequent recovery operations. Alternatively, holders of the distressed debt may have believed they could delay recognition of the loss (and the unpleasant consequences that might follow, such as increased regulatory capital requirements and heavier margin requirements, or larger haircuts imposed by counterparties) [11]. Moreover, some holders of the distressed debt may have believed recognition of losses could be postponed more or less indefinitely if the government could be induced to support the price of the debt. Indeed, the first draft of the Troubled Asset Relief Program (and the name of the proposed legislation itself) aimed to do just that [12].

It seems possible that market clearing was inhibited by the possibility of government support and accounting practices and regulations that permitted institutions to avoid marking their positions to market. This illustrates the difficulty in disentangling a credit shock from a liquidity shock. While the institutions experiencing an increased cost and limited access to funds surely perceived these events as a liquidity shock, the underlying cause was a credit shock that raised questions about the value of MBS and, by inference, concerns about the solvency of the thinly capitalized institutions that had played a leading role in these markets.

Although the Fed chose to frame the series of events as a liquidity crisis, the implications for the solvency of institutions heavily involved in the ABS markets were clear. First, these institutions experienced direct losses on their holdings of downgraded securities. Second, banks experienced losses from honoring their implicit (and often explicit) guarantees to back up off-balance sheet vehicles, whether by extensions of liquidity or purchases of securities that the vehicle could no longer finance in capital markets. Third, institutions actively engaged in underwriting securitized debt experienced losses from assets they were holding on their balance sheets in preparation for securitization. Fourth, the collapse of the ABS markets meant not only a loss of current revenue, but also quite possibly the loss of an important continuing source of revenue. Banks also faced a capital challenge. They needed to replace lost capital to meet regulatory requirements and regain market confidence, and they also experienced pressure to stockpile capital as a precaution against loss of access to funding. In addition, they needed to prepare for the possibility that they would be obliged to bring many of their off-balance sheet activities back onto the balance sheet. Credit Default Swap spreads indicated that anxieties focused on particular categories of institutions and specific institutions within these categories. As Figure 10 shows, US investment banks experienced the heaviest pressure.

[Insert Figure 10 here]

The Fed's Policy Responses

The Fed devised numerous ways of injecting liquidity into the system without subjecting borrowers to the "stigma" of being observed to receive funds from the Fed. These programs included expanded discount-window access; emergency lending facilities for both bank and non-bank primary dealers; and lending securities, both short and longer term, from the Fed's portfolio

to institutions needing better-quality collateral to pledge in overnight markets to obtain funding on more favorable terms. Calomiris et al (2011) discuss these programs in detail. Table 1 lists the principal Fed liquidity facilities during the crisis along with the maximum outstanding amount under each facility.

[Insert Table 1 here]

Five of the programs including, importantly, the programs available to non-depository primary dealers, were established under the emergency provisions of Section 13(3) of the Federal Reserve Act, which authorizes the Fed to lend to various entities in unusual and exigent circumstances [13]. Because of this, the Fed could not legally extend these programs beyond the period deemed "unusual and exigent" under the terms of the statute [14].

Discount-window lending (DW)

The Fed's first response to the crisis was to attempt to make discount-window borrowing more attractive. In a conference call on August 10, 2007 the Fed (2007) pledged to provide reserves as necessary through open-market operations to promote trading in federal funds at rates close to the Federal Open Market Committee's target rate of 5.25 percent. In addition, they committed to work against any remaining stigma[8] associated with borrowing at the discount window [15]. New York Fed President Geithner (Federal Open Market Committee, 2007, p. 8) emphasized that the Fed was sending a "signal that we're prepared to relax or to provide liquidity to help make sure markets come back in some more orderly functioning." The meeting ended with an observation that it might

[8] Ashcraft, Bech and Frame (2010) provide a compelling alternative explanation for the relatively limited borrowing from the primary credit discount window. US depository institutions had access to a lower cost government-sponsored liquidity backstop: The Federal Home Loan Bank System (FHLBS). Indeed, the FHLBS remained the largest lender to U.S. depository institutions until the fall of 2008.

be necessary to lower the discount rate to reduce the 100 basis point spread between the discount rate and the federal funds rate.

Just six days later, another special telephonic meeting of the Open Market Committee was convened to consider lowering the discount rate as well as liberalizing other features of the primary credit discount window lending. The Fed agreed to lower the spread between the primary credit rate [16] and the Federal Open Market Committee's discount rate to 50 basis points. Two important additional features accompanied this reduction in the cost of discount-window borrowing. Banks would be permitted to borrow for as long as 30 days renewable by the borrower, not just the traditional overnight borrowing. The Fed agreed to continue accepting a broad range of collateral (including mortgage-related debt) at the Fed's existing collateral margins even though haircuts in the tri-party repo market had increased substantially, particularly with regard to private MBS. The hope was that (Federal Open Market Committee, 2007, p.10) "[The] signal would help the banks come to the collective judgment [that it's] in everybody's interest to start financing these securities." This proved to be the first in a long series of reductions that brought the discount rate from 6.25 percent during the summer of 2007 to 0.50 percent by December 16, 2008.

Despite the Fed's efforts to make discount-window borrowing more attractive, very little lending was done during the fall of 2007. Figure 11 shows that during 2007 lending volumes peaked at $2.9 billion on September 12, 2007, and then tapered off significantly until they began to expand during March 2008, in the wake of the collapse of Bear Stearns.

[Insert Figure 8 here]

The Term Auction Facility (TAF)

The Fed introduced TAF in December 2007. The design was motivated by the Fed's frustration that its efforts to promote use of the discount window had yielded only minimal

participation (Cecchetti, 2009). The Fed believed that the stigma associated with discount-window borrowing was inhibiting prospective borrowers from making use of liberalized access to the discount-window facility directly.

Wu (2011) and Armantier et al (2008) examine the effectiveness of the TAF. The TAF auctions ranged from $20 to 50 billion per auction. The first 10 auctions were over-subscribed and all were above the applicable stop-out rate. For five of the first 10 auctions, successful bidders were able to borrow from the TAF at rates that were anywhere from 8 to 42 basis points below rates at which they could have borrowed at the discount window. Thus, for several of the auctions, the TAF provided a subsidy over traditional discount-window borrowing to the successful bidders. Wu (2011) suggests that the introduction of the TAF reduced LIBOR-OIS spreads by 31 basis points, and the three-month LIBOR-OIS spread by about 44 basis points, in the first and into the second quarter of 2008 [17]. He finds no effect on counterparty-risk premiums.

Central Bank Liquidity Swaps Program (CBLS)

The TAF was part of a two-pronged effort announced on December 17, 2007. The Central Bank Liquidity Swaps program was introduced to reduce liquidity pressures on major financial institutions operating in US and European money markets. While TAF provided liquidity to US institutions and the US affiliates of foreign depository institutions, CBLS attempted to alleviate dollar-liquidity problems abroad, using foreign central banks as the intermediary. The need for liquidity was forcing institutions based abroad to liquidate dollar-denominated assets. The swap program permitted foreign central banks to draw on predetermined swap lines as needed in order to provide short-term dollar funding to depository institutions in local money markets, mainly in the European Monetary Union, Sweden, Switzerland and the United Kingdom [18]. The program was subsequently widened on at least two occasions, first by upping the size of the lines and then

by removing the size caps. The largest amounts extended during any one week under that program were about $642 billion.

The Fed hoped that by increasing the availability of dollars in foreign markets, financial market stability in the US would be enhanced. To evaluate the effectiveness of the swap program, Fleming and Klagge (2010), examined LIBOR spreads, the comparative cost of borrowing dollars directly from the foreign central bank versus the cost of borrowing in euros, for example, and then buying dollars in the foreign exchange market, and finally, the auction rates for dollars from foreign central banks. Before the crisis, spreads were close to zero; they rose to over 300 basis points in the late fall of 2008 and finally settled in a range of from 2 to 25 basis points by year-end 2008 and thereafter. The relative cost of borrowing in the euro market and purchasing dollars tended to follow the path of the LIBOR spreads, but the cost appears to have risen much more.

Finally, their analysis of the stop-out rates on overnight auctions again followed the pattern of LIBOR spreads more generally and gradually fell to zero, which is consistent with the conclusion that the policy was effective in relieving pressures in the overnight markets. Goldberg et al (2010), who review both the spread studies and event studies of the announcement effects of the swap program, reach similar conclusions about the likely beneficial effects. However, they are careful to point out that because of the close relationship between the TAF and swap program, isolating the impact of the swap program is suggestive at best.

In one of the few studies of the swap program conducted outside the Federal Reserve System, Aizenman and Pasricha (2011) examined the exchange-rate impacts of the swap programs, and found significant short-run positive impacts on the exchange rates for certain emerging markets (those to which US banks had the greatest exposures), but less of an impact on other emerging markets. However, those impacts also appeared to be relatively short lived and may have subsequently been reversed.

Single-Tranche Open Market Operations (ST OMO)

Secured lending markets began to show signs of strain early in 2008. Primary dealers rely heavily on this market to fund their positions. As lenders became concerned about the possibility of a decline in the value of collateral, and the credit risk of their counterparties, they responded by demanding larger haircuts and greater compensation for lending against riskier collateral; and by halting lending against certain types of collateral. To ease liquidity pressure on primary dealers, the Fed announced on March 7, 2008 that it would initiate a series of single-tranche open market operations (ST OMOs) directed toward primary dealers. Fleming (2012) offers additional details. Primary dealers could bid to borrow funds through repos for a term of 28 days while providing any collateral that would be eligible in conventional open market operations. Like TAF, this program was designed to provide term funding via an auction format, but it was directed at non-depository primary dealers. These single-tranche open-market operations were structured as an extension of the Fed's regular open-market operations and were thus intended to allocate an amount of funds equal to the full quantity of offered collateral at a market-determined interest rate. The program was relatively small in size, peaking at $80 billion, and was overshadowed by later programs to provide liquidity assistance to non-depository primary dealers, most notably the PDCF introduced nine days later on March 16, 2007. (See the PDCF section below.)

Term Securities Lending Facility (TSLF)

To further enhance the access of primary dealers to liquidity, the Fed created the Term Securities Lending Program (TSLF) on March 11, 2008. This program broadened the Fed's securities lending program to include all of the primary dealers, not just the depository institutions. It permitted the primary dealers to borrow securities overnight from the System Open Market Account (SOMA) for as long as 28 consecutive days. The dealers could in turn repo these higher-

quality, borrowed securities, using them as collateral in the market for overnight funds. This enabled them to avoid liquidating securities at fire-sale prices.

The Fed employed an auction process to allocate securities among bidders. Each morning the securities were taken back into the Fed's portfolio so that the program was off balance sheet. This enabled the Fed to enhance the liquidity of primary dealers without reporting an increase in bank reserves on its own books. Thus the effect of the TSLF was to reallocate bank reserves away from smaller banks or other holders of Fed funds to the primary dealers. While the intent was to make funds available to dealer banks, it is not obvious that the TSLF increased the availability of credit more generally, especially since smaller banks and other holders of Fed funds might have used them to support lending and asset acquisition,

Fleming et al (2009) examined the TSLF and emphasized the difficulty in assessing the effectiveness of the program [19]. Indirect evidence, however, suggests that the program did supply liquidity to institutions experiencing stress, but that demand quickly tailed off. The first four auctions between March 2008 and April 17, 2008 were fully subscribed at stop-out rates above the minimum. But the next six auctions (which cover the period of April 24-May 29) were not fully subscribed and the amounts bid declined; all stopped out at the minimum. This suggested that liquidity conditions had improved. In addition, spreads narrowed in several key markets, such as the agency MBS repo and Treasury repo markets. Similarly, using event-study methodology, Campbell et al (2011) find evidence that the TSLF helped to lower spreads for some classes of asset-backed securities, namely, in the highly rated auto-loan -backed securities and commercial mortgage-backed securities markets, but had only small effects on the pricing of individual securities. The key question not addressed by this research, however, is whether the improvement in liquidity translated into increased credit availability, thus improving the functioning of the credit channel.

Primary Dealer Credit Facility (PDCF)

The rapidity of the collapse of Bear Stearns on March 13, 2007 made clear that Single Tranche Open Market Operations and the TSLF were not sufficiently flexible to meet the emergency liquidity needs of non-depository primary dealer banks. On the day that JPMorgan Chase agreed to take over Bear Stearns (with a $29 billion subsidy), the Fed announced the creation of the PDCF. The new facility enabled the Fed to make overnight loans to primary dealers at the discount window's primary credit rate. In effect, this was an extension of the privilege of discount-window borrowing to non-depository primary dealers at the primary credit rate. The Fed relied on the "unusual and exigent" circumstances clause of the Federal Reserve Act to extend this privilege to non-depository institutions.

The PDCF was more flexible than the Single Purpose Open Market Operations or auction facilities because it was available to non-depository primary dealers at any time and allowed them to borrow against a wider range of eligible collateral. Later the Fed announced liquidity support for certain securities subsidiaries of Goldman Sachs, Morgan Stanley, and Merrill Lynch; and for the London-based broker-dealer of Citigroup under terms parallel to the PDCF (Fleming, 2011, p.7).

Cecchetti (2009) indicates that one of the purposes of the PDCF was to reduce the spreads between the rates on asset-backed securities that served as collateral for interbank borrowing, and the rates on Treasury securities that were regarded as higher-quality collateral in the interbank and repo markets. During the first three weeks of the PDCF outstanding borrowing averaged $30 billion per day.

Two important features of the PDCF are worthy of note. First, although the PDCF was initially billed as a way of providing liquidity to all primary dealers, Figure 12 shows that the two institutions were the main beneficiaries of the facility from its inception in March 2007 through June of that year: Barclays and Bear Stearns. After the collapse of Lehman Brothers in September

2008, use of the facility expanded greatly, but even then there were only four major beneficiaries: Morgan Stanley, Goldman Sachs, Citigroup and Bank of America. Since none of these institutions was in robust financial condition when it accessed the PDCF, the program had the effect of having provided life support for institutions with questionable economic capital, rather than providing broad liquidity support to the market. Second, while the bulk of the funding support went mainly to four large US institutions, eight of the 17 primary dealers listed in Figure 9 as borrowers were foreign institutions, mainly from Europe and Japan.

[Insert Figure 12 here]

The market effects of the program are hard to identify specifically. Cecchetti (2009) provides some evidence that the 90 basis point spread between US agency securities and US treasuries fell the day after the program was announced, and declined modestly thereafter to about 50 basis points [20]. But no statistical tests were performed so the spread effect is at best an indirect index of program effectiveness.

Assessing the Effects of Liquidity Facilities

Teasing out the individual effects of the TSLF, TAF and CBLS programs presents a challenge because several other policy changes were made both in the US and abroad at more or less the same time, and the impacts of earlier liquidity programs continued. At root this is an identification problem, a fundamental issue for most empirical research in finance and economics. Aside from examining program usage, studies have focused on the behavior of spreads in various markets that would have been most likely to benefit from the liquidity programs. Those studies have tended to produce more mixed results.

Kwan (2009) notes that LIBOR-OIS spreads narrowed somewhat and that in regressions, variations in perceived credit risk explained only 44 percent of the variation following the introduction of the liquidity programs in 2007. He hypothesizes that variations in liquidity premiums might also be important, and indirectly may account for the reduction in spreads. However, work by Taylor and Williams (2008) fails to find a significant liquidity effect. This contrasts with McAndrews et al (2008), who estimate that the TAF reduces the LIBOR-OIS spread by some 50 basis points. Cecchetti (2009) notes that the TED spread declined in early December 2007, which corresponded with the introduction of the TAF. However, he also concludes that as the crisis went on, the TAF had a limited impact upon spreads. In a more detailed study, Christensen et al (2009) examine the impact of the TAF on three-month TED spreads. Their model attempts to control for variations in Treasury rates and credit-risk premiums, and when they do, they conclude that spreads after the introduction of the TAF were lower than they would have been had the program not been introduced [21].

Market Liquidity: The Commercial Paper Funding Facility (CPF)

Although the asset-backed commercial-paper market peaked in the first week of August 2007, the financial commercial-paper segment remained buoyant until a year later in September 2008, after the bankruptcy of Lehman Brothers and rescue of AIG. Remarkably, the volume of commercial paper issued by non-financial firms did not peak until even later, in January of 2009. It should be noted, however, that in 2007 the commercial-paper market as a whole did not suffer from liquidity problems. Liquidity problems centered on the RMBS market, albeit the largest segment of the commercial-paper market at that time (Calomiris et al, 2011, Figure 3).

On October 7, 2008 the Fed addressed the collapse of liquidity in the financial commercial-paper market by establishing a new facility under the "unusual and exigent" circumstances clause. The CPFF was designed to provide temporary liquidity in the form of support to commercial paper

issuers and to facilitate the issuance of longer-term commercial paper, which had virtually disappeared. The CPFF operated through a special-purpose vehicle that purchased highly-rated paper from qualified issuers. This effectively gave discount-window access to issuers of commercial paper who were not otherwise eligible for discount-window loans. It was designed as a backstop facility, but because it provided funds directly, it augmented demand for paper that might otherwise have come from money-market mutual funds, which were themselves experiencing liquidity problems due to increasing redemptions by shareholders. The CPFF supplemented the supply of funds to the asset-backed commercial-paper market while also bolstering the money-market mutual funds, which normally purchased commercial paper. The pricing was structured to be attractive when spreads widened, but would not be cost effective when spreads returned to average levels.

The CPFF program enabled both foreign and domestic issuers to obtain short-term funding for their commercial paper. Foreign sponsors, and by inference foreign issuers, were significant beneficiaries of CPFF program. About 125 different issuers received more than $730 billion in financing, with more than half going to issuers in 16 foreign countries (this credit was not outstanding at any one time). This included financing provided to issuers in China, Japan, Korea, and Germany. Approximately 57% of the sponsoring institutions and entities were European including entities from Scandinavia, UK, France and Germany, in particular.

It is not clear whether the foreign entities that received credit under the CPFF had been significant issuers in the US commercial-paper market, but the Fed published criteria for access to the facility indicating that those receiving credit should have issued paper in the US during at least one period of three consecutive months from January 1 through August 31, 2007.[9] Moreover, it is hard to justify the systemic importance to the US of many of the recipients. Most of the foreign

[9] http://www.newyorkfed.org/markets/cpff_faq.html

sponsors were banks and some were of questionable credit quality including Dexia, Fortis, RBS and UBS. There were also some puzzling borrowers including Toyota and the Republic of Korea.

The criteria used to allocate funding remain murky. In the case of U.S. participants included not only banks, but also major U.S. companies with recipients as diverse as AIG, Caterpillar, Ford, Chrysler, GE, Genworth, GMAC, Georgia Transmission Corp., Members United Corporate Credit Union, PACCAR, Wisconsin Corporate Credit Union, Verizon and even Harley Davidson. Given the current law suit by creditors of AIG against the government for undue taking of funds, it is worth noting that large benefit that AIG reaped by issuing paper through the CPFF at very favorable, rates that constituted a subsidy from the U.S. taxpayer to creditors and shareholders of AIG.

Both the asset-backed and financial segments of the commercial-paper market continued to trend down over the life of the CPFF. Subsequently, the non-financial segment began to pick up, but only after the CPFF program had been terminated.

The CPFF proved to be both large in absolute and relative terms, accounting for over $175 billion of the commercial paper issued at the end of October 2008. The usage peaked in January 2009 at $350 billion and accounted for 20 percent of the outstanding volume (Adrian et al, 2011). Federal Reserve economists suggest that CPFF was successful in stabilizing the market in two respects. First, although the outstanding volume of commercial paper declined, the Fed's purchases offset the decline in demand. At its peak, the facility contained about 20% of the volume of outstanding commercial paper, thereby cushioning what would have been a precipitous decline in volume. To be sure, total outstanding volume did decline but the pace and trajectory was much more gradual than it would have otherwise been. As the pricing of the CPFF became less favorable, purchases of non-CPFF paper declined slightly from about $130 to $125 billion from the middle of 2009 through the end of 2010. Second, in contrast, the impact on spreads is unmistakable. Adrian et al (2011) note that spreads in the market eligible for CPFF funding declined from 256 to 86 basis

points from the inception of the program until year-end 2009, as the markets revived. In comparison, spreads in the A2/P2 market, which were not eligible for CPFF funding, actually increased from 483 to 503 basis points over the same period.

Which Institutions Received the Largest Amount of Liquidity Assistance?

This question could not be answered until Bloomberg won a suit against the Fed under the Freedom of Information Act, and a team of reporters sifted through the massive amount of data released by court order. Figure 13 shows total peak and average borrowing amount over the period from August 2007 through December 2009 under seven Fed programs: DW, TAF, ST OMO, TSLF, PDCF, AMLF, and the CPFF [22]. Institutions that had primary-dealer status are identified by an asterisk. Note that all 12 of the institutions that drew the peak amounts from the Fed's liquidity programs had primary dealer status. Nine of the 12 also had the largest average daily balance outstanding from August 2007 through December 2009. Five of the 12 were headquartered abroad. These totals reflect the Fed's direct (collateralized) exposure to these banks, but do not include whatever amounts these institutions may also have received indirectly through the Central Bank Liquidity Swap Lines. The important difference between the two channels is that under the CBLS, the Fed's credit exposure is to the counterparty foreign central bank, which is usually considered the highest-quality exposure within any country. The foreign central bank, not the Fed, then assumes the credit risk in loaning the funds to local borrowers.

[Insert Figure 13 here]

It is also instructive to examine how much these institutions borrowed under each of the Fed's liquidity programs. Figure 14 disaggregates the total amount borrowed by each of these institutions by each of the seven Fed special liquidity facilities: DW, TAF, ST OMO, TSLF, PDCF,

AMLF, and CPFF. Overall DW borrowing was relatively unimportant except in the case of Wachovia, which was forced to merge with Wells Fargo, and Dexia and Hypo Real Estate Holding, two European financial institutions that failed during the crisis. These data raise doubts about whether the Fed was restricting its primary credit lending to solvent institutions. In any event, these discount window loans certainly did not dispel the presumption that borrowing from the Fed through the primary credit window signals impending insolvency, which might have been the best hope of eliminating the "stigma" that concerned the Fed so greatly during the crisis. The TAF was very important to Bank of America and Wells Fargo; and less so for Citigroup, Royal Bank of Scotland, Deutsche Bank, and Dresdner Kleinwort Securities. For the other banks TAF borrowings were relatively inconsequential.

[Insert Figure 14 here]

Single Tranche Open Market Operations accounted for half or more of the outstanding credit at Credit Suisse, Goldman Sachs, BNP Paribas, Countrywide, and Cantor Fitzgerald. Morgan Stanley, Royal Bank of Scotland, UBS, Deutsche Bank, and Barclays also benefited from the ST OMO, but for a much smaller proportion of their outstanding borrowings from the Fed. Apart from these 10 institutions, the ST OMO had negligible impact.

The TSLF accounted for a third or more of the borrowing at Morgan Stanley, Citigroup, Royal Bank of Scotland, Goldman Sachs, Deutsche Bank, Barclays, and BNP Paribas. It was much less important to Bank of America, UBS, JPMorgan Chase, Merrill Lynch, Credit Suisse, and Countrywide. For the other banks, the TSLF was irrelevant. The impact of the AMLF was even more concentrated. It was hugely important for State Street and JPMorgan Chase, but not for any of the other institutions.

Insert Figure 11, AVERAGE BORROWING (APRIL 2007-DECEMBER 2009) DISAGGREGATED BY FACILITY, here.

The CPFF produced substantial benefits for UBS, Citigroup, Dexia and Fortis, which all experienced serious financial stress and had questionable solvency. Barclays also benefited while the CPFF accounted for the majority of the borrowing by HSBC, although the overall amount of its borrowing was trivial. The program did not matter for the other institutions.

Special Benefits for Special Institutions

Overall, it is remarkable that the benefits of each of these programs were so narrowly focused. In most cases it appears that the programs were tailored for the needs of a handful of institutions. None of the programs had the wide impact that one might expect to observe if they had been designed to address the liquidity needs of the broader market. In several cases, it appears that the Fed may have been engaged in disguised bailout lending since the institutions that drew heavily from these programs had dubious economic capital. In fact, half of these institutions (listed in Figure 14) failed during the crisis, required a government-assisted merger, or received substantial government subsidies (in addition to access to these liquidity programs) [23].

The prominence of primary dealers on this list—all twenty of the primary dealers in 2007 appear—raises questions about why they appear to have received special treatment. Primary dealers are banks or securities firms that have received authorization to trade directly with the Fed. They must make bids or offers when the Fed conducts open-market operations, provide information to the Fed's open-market trading desk, and participate actively in auctions of US Treasury securities [24].

The Fed has been conscious of the special status and of the potential implicit subsidy that the primary dealer designation might convey; it decided in 1993 to stop surveillance over the primary dealers and, instead, to focus solely on the quality of the collateral they pledged. The hope was that this would blunt any perception that these institutions had a privileged position. Yet it did not dispel the belief that such institutions had a special status—at least in part because the Fed

does require institutions to meet demanding criteria before being designated as primary dealers. Several central banks, governments and some institutional investors continue to insist on transacting only with primary dealers and, of course, primary dealers benefit from spreads earned in intermediation. Thus, abandoning Fed oversight of primary dealers may have inadvertently exacerbated the problem. It did not eliminate the perception that primary dealers had a special status, yet it surrendered one potentially important constraint over moral hazard— regulatory oversight.

The fact that so many of the designated primary dealers required and received special liquidity assistance during the crisis certainly reinforces the presumption that these institutions may be too important to fail—Lehman Brothers notwithstanding. And it raises the question of whether the special category of firms is still essential to the functioning of debt markets in the United States. Improvements in information and communications technology since the primary dealer system was established surely reduce the need for the Fed to have a "special relationship" with a handful of institutions. Moreover, it seems likely that more bidders for new issues of government securities would result in more favorable prices for the Treasury. The European Central Bank, for example, is able to conduct transactions with literally hundreds of counterparties without obvious difficulty.

Policy Concerns Shift From Illiquidity to Insolvency

After the horrifying series of events during the fall of 2008—the placement of Fannie Mae and Freddie Mac in conservatorship, the bankruptcy of Lehman Brothers, the bailout of AIG, the run on institutional money market funds, and the seizing up of much of the commercial paper market—the Fed was obliged to recognize that improvising yet another special liquidity program would not

quell the crisis. The Fed and the Treasury confronted the possibility that the fundamental issue was uncertainty about the solvency of many of the largest financial institutions. They appealed to Congress for $700 billion to fund the Troubled Asset Relieve Program (TARP). The aim was stabilize the financial system by buying troubled assets. After an initial false start, Congress passed the Emergency Economic Stabilization Act of 2008 on October 3, 2009, which authorized the funding of a program to purchase troubled assets in the hope of stabilizing the financial system. Although TARP appeared to be yet another attempt to provide liquidity to the financial system by purchasing "troubled assets" from the institutions which held them, the Treasury changed course within a few days and used the funds to inject capital into the nation's largest financial institutions (and others on an as-needed basis) through a Capital Purchase Program.

This was a turning point in the crisis. Officials no longer characterized the crisis as a liquidity problem affecting specific markets and a few unlucky institutions that were exposed to these markets. The Treasury was focused on recapitalizing weak financial institutions. The Fed shifted from channeling liquidity to the major primary dealers (while offsetting those efforts with sales of assets from its portfolio) to one of unprecedented monetary expansion.

Once the TARP program was launched, the banking agencies attempted to restore confidence by requiring that the largest banks pass a Supervised Capital Assessment Program. They compelled the nineteen largest banks to demonstrate that they could maintain adequate capital under the most severe of three regulator-specified stress scenarios during the first quarter of 2009. Ten of the 19 largest banks failed the test and were estimated to have a capital gap ranging from $0.6 billion to $33.9 billion. They were obligated to fill in the shortfall by drawing on the Capital Purchase Program.[10] This recapitalization succeeded in restoring public confidence in the large financial institutions. ln fact, the losses at those institutions were large enough to raise questions

[10] http://www.newyorkfed.org/research/staff_reports/sr460.pdf

about their solvency. From 2007:III to 2009:II, losses in the banking system exceeded $1.6 trillion, with the nineteen largest institutions accounting for more than two thirds of the total.

Why Did the Regulatory Authorities Delay Recognition of the Solvency Problem for So Long?

When so many of the primary dealers experienced financial stress, why did authorities focus mainly on the liquidity symptoms rather than examining the underlying problem of impending insolvencies? It seems clear (albeit with the benefit of hindsight) that the financial disruptions arising in mid-2007 differed from traditional, temporary liquidity crises. They were rooted in three fundamental problems that required a different solution.

First was the reliance of several large institutions on a business model that required the funding of longer-term assets with overnight liabilities. Although maturity mismatches have been a recurrent problem in financial history, this mismatch was different from earlier examples, such as the Savings and Loan (S&L) crisis in which assets with maturities of 20 to 30 years were funded with liabilities of one to two-year duration. In the recent crisis, many institutions were simply warehousing longer-term assets for a short interval before they could be securitized and placed with investors who preferred to hold longer-term assets. The mismatch seemed temporary and, indeed, had been so as long as the securitization process could be completed as expected. When the secondary market dried up, however, institutions found that it was impossible to place new securitizations. The warehousing operations, which most of these institutions expected to be very short-term commitments, needed to be financed for a much longer period. This proved a challenge because many mortgage-related securitizations were no longer acceptable for collateralized loans (or could be pledged only at haircuts that were uneconomic). The potential threat to the solvency of these institutions made it increasingly difficult to renew overnight loans at usual rates. Indeed, the

experience suggests that highly leveraged short term-duration mismatches can become very risky positions. The authorities clearly perceived part of the problem and focused on trying to restore liquidity to the secondary market for mortgage-related debt, but given the deterioration in the underlying fundamentals of the housing market, this was impossible without allocating the losses that had already been incurred.

Second, the authorities appear to have underestimated the leverage that some of the largest institutions had achieved. This is highly surprising because in 1998 the Basel Committee had agreed to reduce the minimum required amount of equity to be held against risk-weighted assets from roughly four percent to two percent. In effect the bank regulators were permitting banks to take on leverage ratios of 50:1. Even this understates the magnitude of the policy blunder, because risk-weighted assets tend to be roughly 50 percent of total assets and so the permissible leverage ratio increased implicitly to 100:1 [25]. Interestingly, AIG facilitated regulatory arbitrage with its Regulatory Capital swaps program that shifted credit risk, according to then-current capital adequacy guidelines, from banks to AIG thereby, reducing their regulatory capital requirements (Carney, 2009; also Nocera, 2009). Certainly, many financial institutions did not take full advantage of the opportunity to increase leverage, but the authorities were simply tracking the wrong capital concept. The new definition of Tier 1 capital provided only half the margin of safety required under the original definition, yet there is no indication that the authorities realized they had authorized a massive expansion of leverage [26].

Minimum capital ratios based on risk-weighted assets suffered from yet another major defect. The risk-weighted assets were lower than they should have been because the regulators relied heavily on self-reporting and politically motivated risk weights that understated the risks of mortgages, interbank lending, and sovereign debt; and failed to properly consider the interest rate and funding risks inherent in the business models being employed by several major banks [27].

Moreover the regulatory ratios fail to reflect market values, which means that regulatory capital is likely to be substantially overstated when market values of assets fall.

The problem of excessive leverage was mitigated to some extent in the United States because the banking regulators maintained a minimum capital-to-asset ratio [28]. But the regulatory measure of leverage was subject to another major flaw: the denominator, total on balance-sheet assets, hugely underestimated the actual scale of banks' risk taking. The measure neglected off-balance sheet positions and off-balance sheet vehicles that might need to be taken onto the balance sheet in times of stress. Moreover, regulators failed to take account of the leverage inherent in collateralized borrowing, which had become a major source of funds for many of the financial institutions most active in capital markets. Given the possibility of rehypothecating collateral, it was possible to leverage borrowing several times on the basis of the same underlying collateral.

Heightened leverage exacerbated the risk in maturity mismatches and the damage inflicted by any other shock. This feature also served to differentiate the current crisis from the earlier problems with S&Ls. Leverage taken on by some of the largest financial institutions was an order of magnitude greater than that of the earlier S&Ls.

Third was the problem of complexity—with regard to both organizational structures and financial instruments. The complexity of legal structures adopted by many large banks, involving literally a thousand or more subsidiaries, made it difficult for regulators (and, often management) to properly understand an institution's exposure to risks. This may also have discouraged the regulatory authorities from dealing with issues of insolvency, since the complexity of some legal structures that crossed multiple national borders and an even greater number of regulatory jurisdictions defied an orderly resolution. Complexity of legal structures may also have made it difficult for regulators and market participants to understand the fragility of secondary markets in which mortgage-backed securities were traded. For example, regulators regarded the special-

purpose vehicles established by banks to conduct securitizations as bankruptcy remote and so the required capital for such activities was much lower than if the loans had remained on a bank's balance sheet. This disparity invited regulatory arbitrage by the sponsoring financial institutions.

Complexity of new financial instruments also inhibited regulatory scrutiny and market discipline. Many of the assets that originated in the securitization process were difficult to value. Moreover, it was difficult to anticipate how losses would be allocated if the securities should default. This was particularly a problem in private-label securitizations because many market participants and the regulatory authorities relied primarily on the risk ratings provided by the independent ratings organizations, rather their own independent analysis.

None of these problems—vulnerability to funding, interest-rate risk in the business model underlying the securitization of mortgages, and excessive leverage and complexity in instruments and institutions—could be addressed by the provision of liquidity support. Indeed, the provision of liquidity may have delayed the necessary restructuring process and the allocation of losses already incurred.

Concluding Comments

To date, a certain amount of progress has been made to rectify some of the problems noted above. Accounting standards have been refined, but primary reliance upon book values rather than market prices remains a problem. Regulatory reliance upon ratings issued by the ratings organizations has been written out of banking regulations. Capital requirements have been strengthened and augmented by regular stress tests designed to determine whether an institution can maintain adequate capital in the event regulator-specified macro-shocks. These stress tests should be augmented with an emphasis on shocks likely to affect particular institutions. The Shadow Committee has expressed reservations about the continued reliance upon risk-based capital standards that employ arbitrary weights, and has urged greater emphasis on a simple leverage

requirement that would be more transparent and less subject to manipulation (Shadow Financial Regulatory Committee, 2012).

In addition, the Federal Reserve is in the process of imposing heavier capital requirements on institutions with assets greater than $50 billion—a welcome change from the pre-crisis trend of applying differentially lighter capital requirements on the largest institutions. With the FDIC, the Fed is requiring that large institutions submit "living wills" that will describe how they could be resolved under bankruptcy. The two agencies are also developing procedures that would trigger remediation of financially troubled institutions, including federal intervention to facilitate an orderly resolution when necessary (Shadow Financial Regulatory Committee, 2012b). At the same time the Shadow Committee has expressed concerns about the proposed book value measure of capital to trigger the process.

The process would also apply to institutions that the Financial Stability Oversight Council (FSOC) designates as "systemically important." Relative to the regulatory framework before the crisis, this is substantial progress. But challenges still remain with regard to the cross-border issues and the possibilities for opaque risk transfers that arise when complex institutions operate in a global financial marketplace. Despite the implementation of the living-will requirement, organizational complexity remains, differential rules and regulations apply, and uncertainty remains about whether and how a large complex financial institution can be resolved in an orderly fashion.

Although changes in regulations and supervisory policies have been made, questions remain about whether the resilience of the financial system will be significantly strengthened by more and higher-quality capital. Will strengthening the leverage ratio provide better shock absorbers? Will the Comprehensive Capital Analysis and Review process, designed to evaluate the capital adequacy of institutions under a severe regulatory-specified stress test, give the regulatory

authorities a better sense of emerging problems? Will the overall impact of stronger capital requirements mainly shift risky activities to the shadow banking sector?

Will the new liquidity requirements be effective? Would they have prevented the kind of liquidity crisis that the Fed perceived in 2007? Does the numerator in the Liquidity Coverage Ratio reflect the kind of liquidity that would have been helpful in 2007? Does the denominator in the Liquidity Coverage Ratio reflect the degree of stress experienced by financial institutions in 2007?

Would an earlier focus on solvency issues during the crisis have avoided the massive dislocations and interruption in flows of credit to sound borrowers? Would earlier attention to the solvency problems have restored confidence in the financial system earlier? Clearly the barrage of liquidity programs did not restore confidence. Only full disclosure of stress tests and capital infusions achieved this objective.

With regard to the Bagehot (1873)/Thornton (1802) rules, how do the liquidity programs measure up? Without doubt the Fed lent freely. It did, however, accept some rather dubious collateral at haircuts that were substantially below those determined in the market. Nonetheless, it appears not to have suffered losses as a result. The rate on most Fed facilities was not much of a penalty. It was usually set only slightly above the primary credit discount-window rate. But in most cases it did provide an incentive for institutions to repay as quickly as possible. From the list of the largest recipients of Fed liquidity support during the crisis, it is apparent that the Fed placed little emphasis on solvency. Perhaps, the lack of efficient resolution tools biased the Fed's decision in favor of the generous provision of liquidity. This provision of liquidity to financial institutions with questionable solvency will not diminish the "stigma" associated with discount-window borrowing from the Fed. But was it costly to the financial system as well?

It is not possible to specify a convincing counterfactual scenario, but it seems possible that delays in addressing the solvency problem may have exacerbated the crisis. Generous provision of liquidity certainly permitted institutions with little or no economic capital to continue operation

longer than would otherwise have been possible. This perpetuated a misallocation of financial resources, led some institutions to defer needed recapitalizations and restructurings, and contributed to the perception that some institutions were too big to fail. Moreover, the delay in recognition of losses already incurred undermined confidence in the financial system and exacerbated the deterioration in interbank markets.

The major unknown, however, is whether the resolution tools available to the authorities during the crisis were adequate to address the insolvency issues before the crisis in a relatively small sector of debt markets spilled over. This highlights the importance of completing a set of procedures that will give the regulators and market participants confidence that an orderly resolution can be achieved for large, complex, international financial institutions. The August 2014 rejection by the Federal Reserve and FDIC of the living wills submitted by 11 of the major institutions, after three rounds of the submissions required by the Dodd-Frank Act, highlights the practical difficulties in unscrambling highly integrated, complex institutions when their operational structures are not aligned with their legal structures.

Endnotes

1. The scope of this analysis is limited to US dollar-denominated markets and the actions of the Federal Reserve. Of course, the financial crisis was truly international in scope and foreign central banks adopted many of the same policies implemented by the Federal Reserve. For a comparative analysis of these policies across countries see IMF (2009, Chapter 3).

2. Note that we do not address the Quantitative Easing Programs or other policies implemented by the Fed to counter the recession.

3. The role of the LLR has been clearly recognized and analyzed since the days of Henry Thornton (1802) and Walter Bagehot (1873). For a summary and interpretation of these rules see Humphrey (1989); for a contrasting view, see Goodhart (1999).

4. Huertas (2011) notes that for some banks a more accurate description of the business model would be "acquire to arbitrage." In effect, these banks substituted holdings of securitized debt in the trading books for mortgage loans in their banking book in order to take advantage of the lighter regulatory capital charge against trading book assets.

5. Issuance during the second half of 2007 was virtually nil. The primary market simply disappeared when the secondary market evaporated.

6. The Bank of England measure is for Large Complex Financial Institutions (LCFIs); which in October 2007 included ABN AMRO, Bank of America, Barclays, BNP Paribas, Citi, Credit Suisse, Deutsche Bank, Goldman, HSBC, JPMorgan Chase, Lehman, Merrill, Morgan Stanley, RBS, Société Générale, and UBS.

7. The large role played by European institutions helps to explain in part how problems in US markets were transmitted to Europe so rapidly. Indeed, some of the first institutions that received substantial government subsidies were some German Landesbanks and Northern Rock in the UK.

8. LIBOR is not an actual market rate. Rather, it is the result of a survey of 20 (formerly 15) banks, conducted by the British Bankers Association. Each bank is asked the question: "At what rate could you borrow funds, were you to do so by asking of and then accepting interbank offers in a reasonable market size, just prior to 11:00 GMT." With 20 bank responses, the top five and the bottom five are dropped and the remaining 10 are averaged.

9. But LIBOR is an indicator, not a market rate at which actual transactions take place, and LIBOR deposits are not traded in secondary markets. Moreover, interbank deposits cannot be used as collateral. In contrast, Treasury bill (T-Bill) rates are actual market rates; indeed, Treasury bills are traded in arguably the most liquid secondary market in the world and they are preferred as collateral in any secured lending. These differences imply that one should be cautious about making inferences from movements in the TED spread. Critics of this measure emphasize that the T-Bill rate may be subject to a variety of influences that have no implication about the fragility of the banking system.

10. Although in principle a credit default swap contract could be entered into with the issuer's LIBOR rate as the reference rate, in practice the transaction's costs would be prohibitive, and so there is no practical way to insure against the default of an interbank deposit.

11. Some issuers were reportedly subject to contractual provisions that strongly discourage selling at lower prices that might have cleared the market, such as clauses stipulating that if the spread increases beyond some agreed amount the conduit facility would need to be liquidated (Federal Reserve 2007).

12. Originally the TARP was intended to enable the government to purchase troubled assets from banks and hold them until favorable market conditions returned. This reluctance to recognize losses that had already been incurred meant that doubts about the solvency of major institutions that were central to the functioning of the international financial system would remain and lead to increasing financial fragility. Moreover, information regarding losses due to securitized assets was sporadic and often incomplete, undermining confidence in the reliability of banks' disclosures.

13. See Brave and Genay (2011) for a description of these programs.

14. The prospect that these programs would terminate undoubtedly influenced the decisions of Goldman Sachs and Morgan Stanley to give up their decades-old efforts to resist Fed supervision and apply to become bank holding companies during the fall of 2008. As bank holding companies, they would have access to the full range of liquidity programs established for depository institutions.

15. The stigma in discount-window borrowing is inconsistent with the Thornton/Bagehot view that discount-window lending by the central bank should be a positive signal to restore confidence. The reason is that the Fed (and other central banks) have repeatedly used discount-window lending to prop up a failing bank until appropriate arrangements could be made for its resolution. Removing the stigma continued to be one of the Fed's major concerns throughout the crisis. This view did not go unchallenged. Richmond Fed President Lacker, for example, expressed skepticism that discount-window lending presented much of a stigma, noting that "[B]anks in New York were borrowing money to lend to banks in the Fifth District when the Fed funds rate spikes above the discount rate. That suggests that the price for overcoming stigmas might be relatively low." (Federal Open Market Committee, 2007, p.24).

16. Armantier et al (2011) argue that TAF transactions provide evidence of a significant discount-window stigma. Banks were willing to pay an average premium of 37 basis points at the height of the crisis to borrow from the TAF rather than the discount window. Moreover, they found that banks using the discount window tended to face a rise in borrowing costs and a decrease in stock prices relative to banks that did not use the discount window.

17. Wu's result differs from that of Taylor and Williams (2008) who use a similar methodology but differ in how the spread effect is measured.

18. Swaps were arranged with the Reserve Bank of Australia, the Banco Central do Brasil, the Bank of Canada, Danmarks Nationalbank, the Bank of England, the European Central Bank, the Bank of Japan, the Bank of Korea, the Banco de Mexico, the Reserve Bank of New Zealand, Norges Bank, the Monetary Authority of Singapore, Sveriges Riksbank, and the Swiss National Bank. Those arrangements terminated on February 1, 2010, but some were re-established temporarily in May 2010.

19. Specifically, the difficulties they cite are the "broad objectives of the program, the scarcity of detailed financing data, and the wide variety of factors influencing financing markets, including the existence of other liquidity facilities" (Fleming et al, 2009, p.7).

20. Cecchetti (2009) goes on to note other possible explanations for the decline in the spread.

21. Importantly, the authors cannot parse out how much of the reduction in actual relative to predicted spreads may have been due to other concurrent programs that had been put in place.

22. The totals do not include subsidies to Bear Stearns, Citi, Bank of America or AIG.

23. This does not take into account the TARP program that required all of the largest US banks to accept an infusion of government equity capital.

24. The relationship between the Fed and the primary dealers is governed by the Primary Dealers Act of 1988 and the Fed's operating policy, "Administration of Relationships with Primary Dealers."

25. This point was made eloquently by Paul Tucker, former Deputy Governor of the Bank of England, in a speech at Yale University on August 1, 2014.

26. Of course, Tier 2 capital was never relevant as going-concern capital and provided no real constraint on institutions taking greater leverage.

27. Banks outside the United States and US investment banks may have also understated their risks by crafting internal models that could be used for regulatory purposes. The United States had delayed adoption of Basel II and after the crisis erupted it became irrelevant.

28. This constraint did not apply, however, to investment banks. Moreover, the Fed actively sought to eliminate the leverage ratio.

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Figure 1.

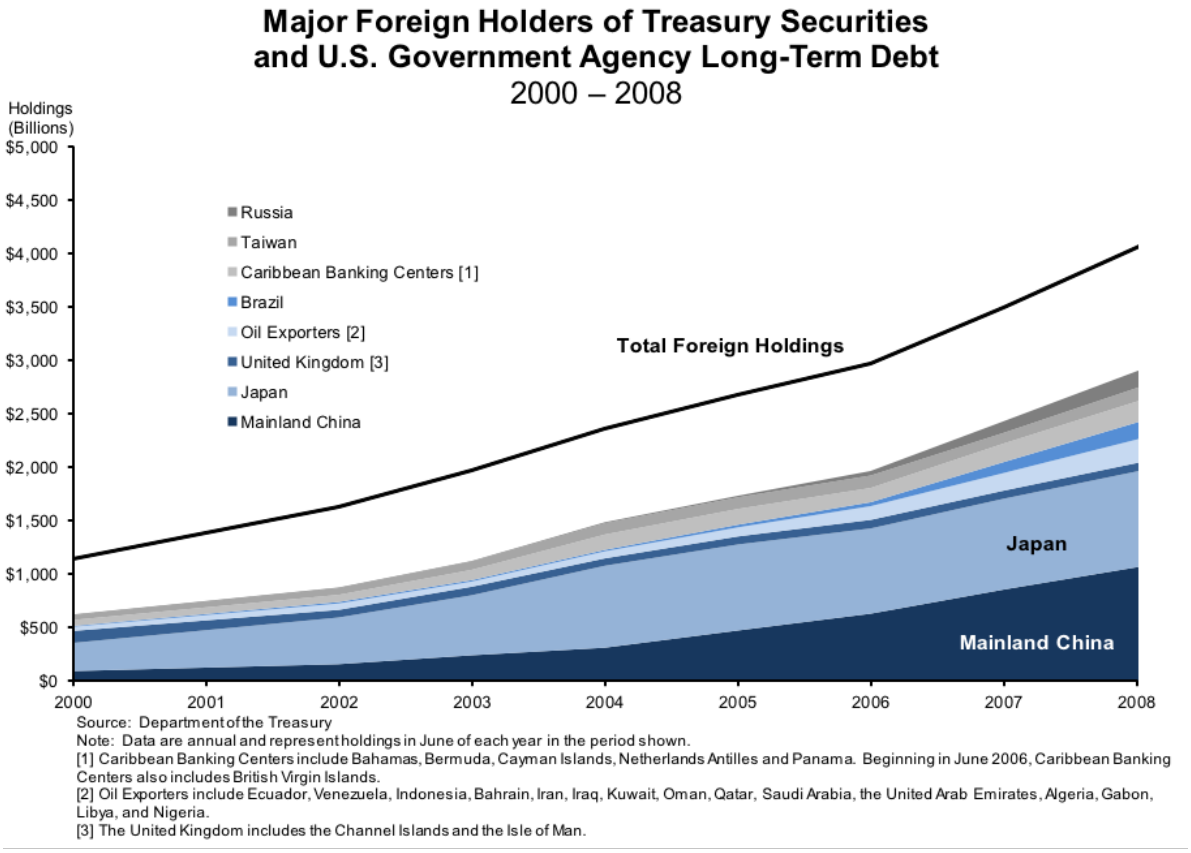

Major Foreign Holders of Treasury Securities
and U.S. Government Agency Long-Term Debt
2000 – 2008
Holdings
(Billions)
$5,000
$4,500
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
Russia
Taiwan
Caribbean Banking Centers [1]
Brazil
Oil Exporters [2]
United Kingdom [3]
Japan
Mainland China
Total Foreign Holdings
Japan
Mainland China
2000
2001
2002
2003
2004
2005
2006
2007
2008
Source: Department of the Treasury
Note: Data are annual and represent holdings in June of each year in the period shown.
[1] Caribbean Banking Centers include Bahamas, Bermuda, Cayman Islands, Netherlands Antilles and Panama. Beginning in June 2006, Caribbean Banking Centers also includes British Virgin Islands.
[2] Oil Exporters include Ecuador, Venezuela, Indonesia, Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates, Algeria, Gabon, Libya, and Nigeria.
[3] The United Kingdom includes the Channel Islands and the Isle of Man.

Figure 2.

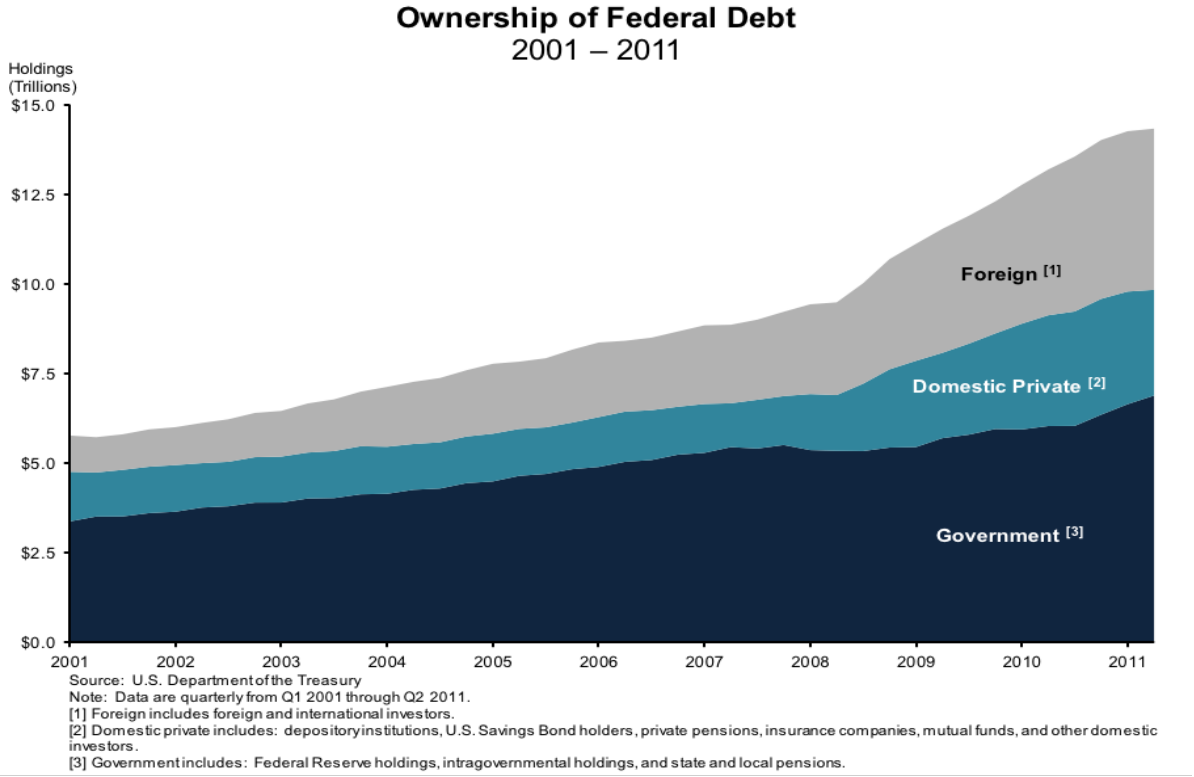
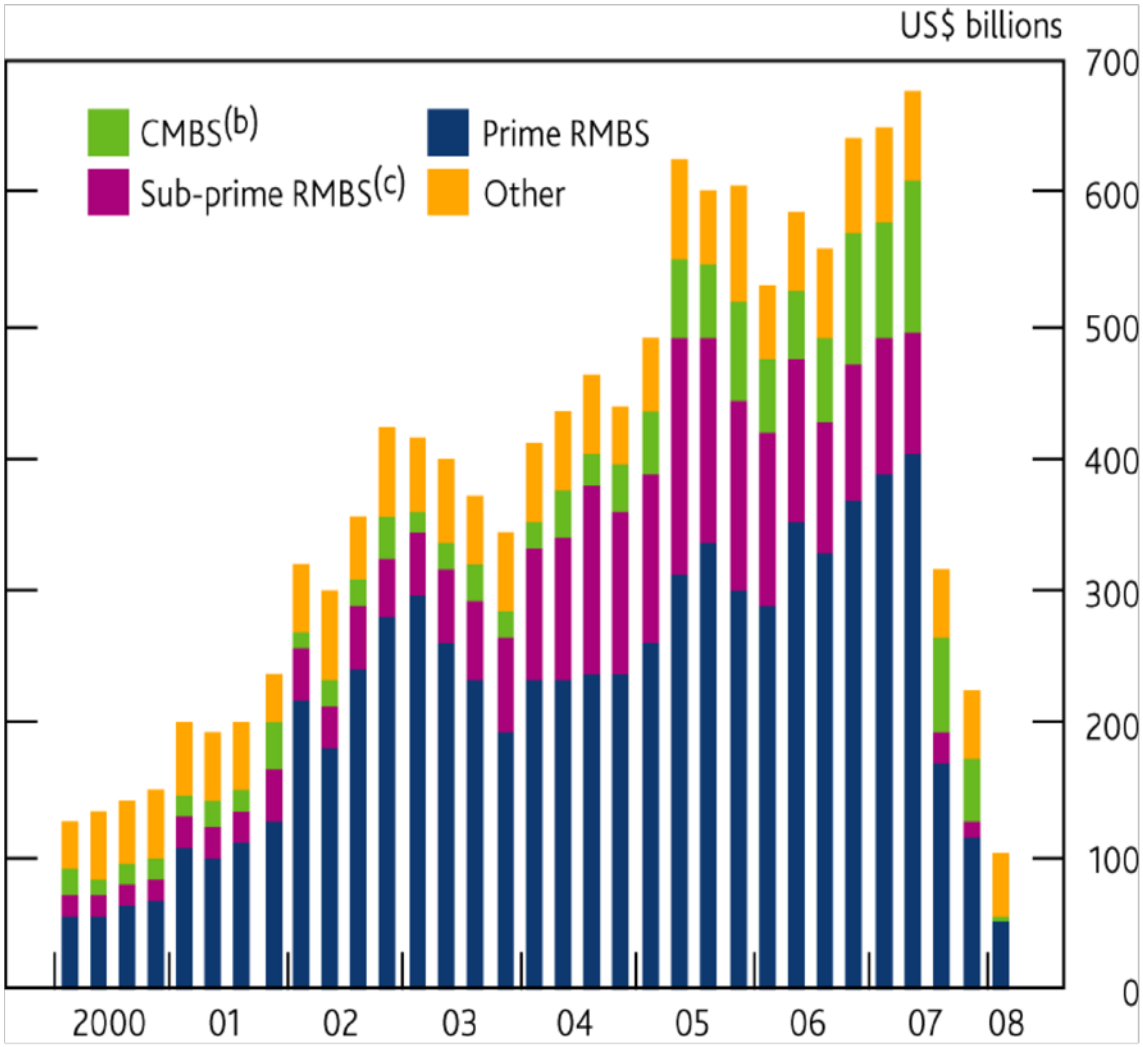


Figure 3. Growth in issuance of mortgage-backed securities



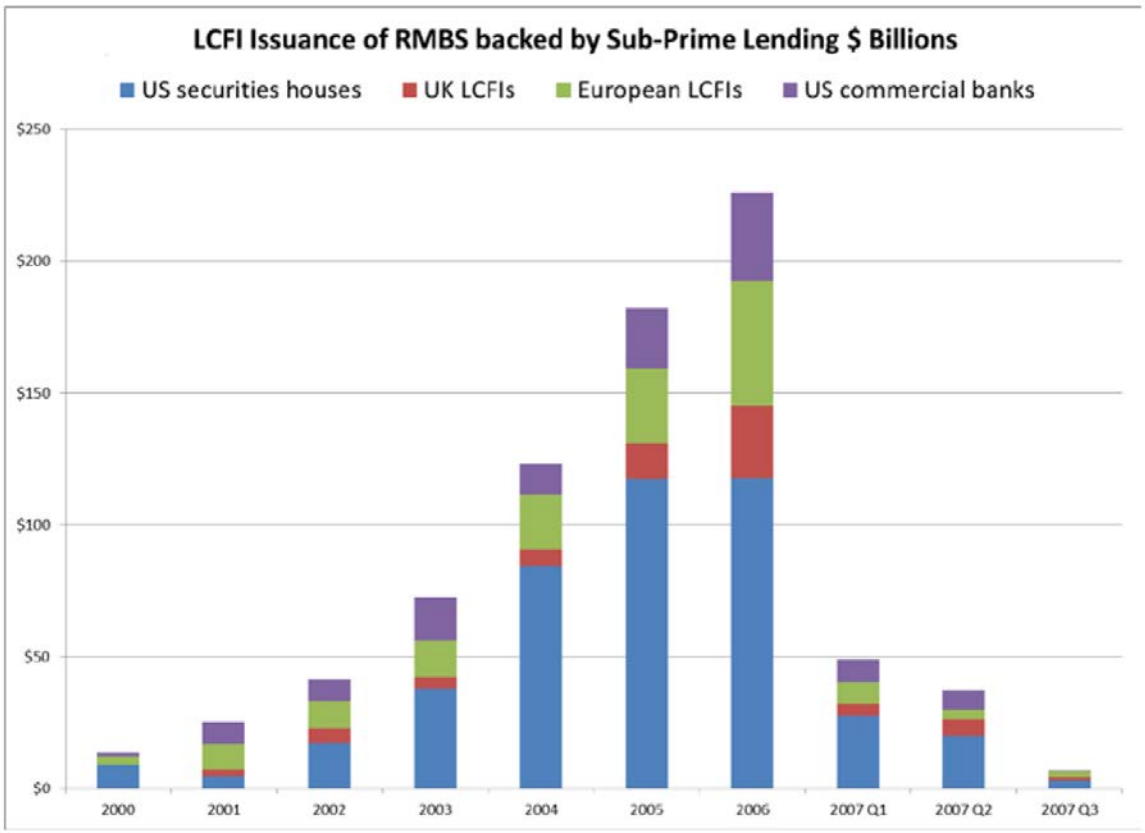
(a) Quarterly issuance. 'Other' includes auto, credit card and student loan ABS.

(b) Commercial mortgage-backed securities.

(c) Residential mortgage-backed securities.

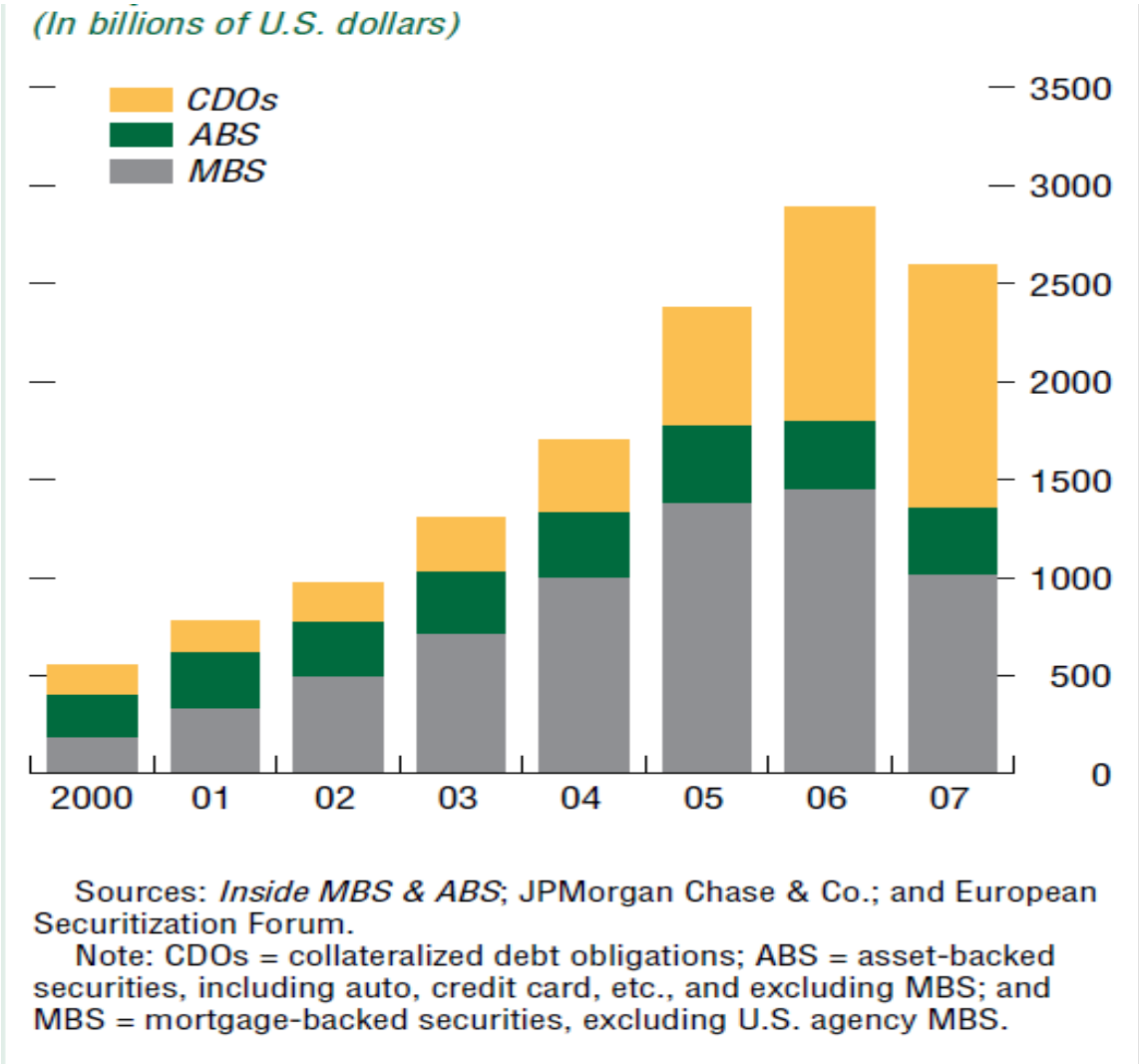
Source: Bank of England Financial Stability Report, May 1, 2008 and Dealogic.

Figure 4.



Source: Bank of England Financial Stability Report 2007

Figure 5. Acceleration in the issuance of CDOs by European and U.S. firms



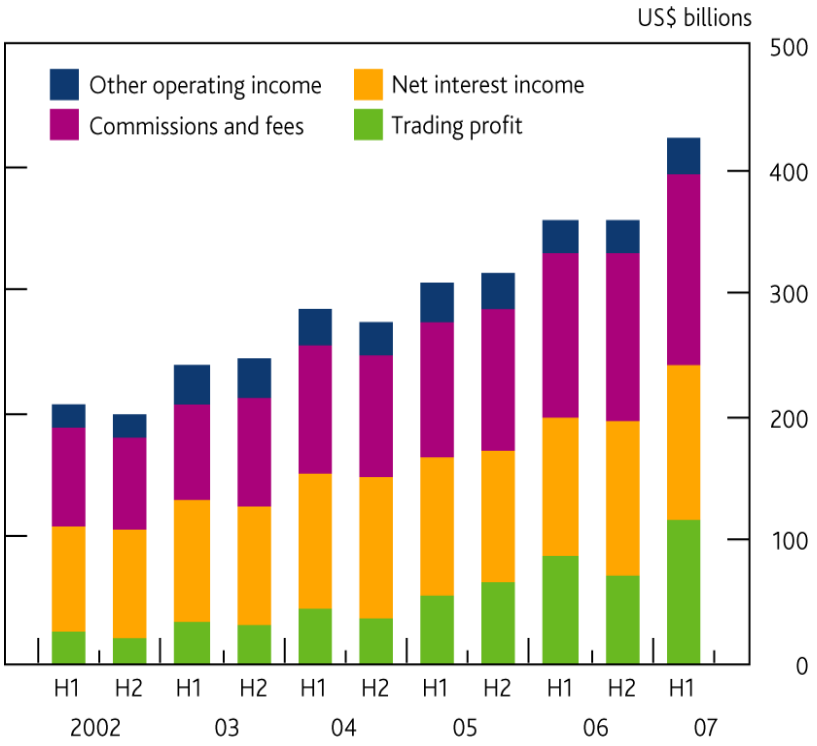
Sources: *Inside MBS & ABS*; JPMorgan Chase & Co.; and European Securitization Forum.

Note: CDOs = collateralized debt obligations; ABS = asset-backed securities, including auto, credit card, etc., and excluding MBS; and MBS = mortgage-backed securities, excluding U.S. agency MBS.

Note: Issuance during the second half of 2007 was virtually nil. The primary market had simply disappeared when the secondary market evaporated.

Source: IMF Global Financial Stability Report, p. 56.

Figure 6. Growing importance of trading profits, commissions and fees for large dealer banks



Sources: Bloomberg and Bank of England calculations, Bank of England Financial Stability Review, October 2007, p. 38.

Figure 7. Real housing prices, 1975–2008

Source: U.S. Office of Housing Enterprise Oversight.

Figure 8. The LIBOR/Treasury Bill spread

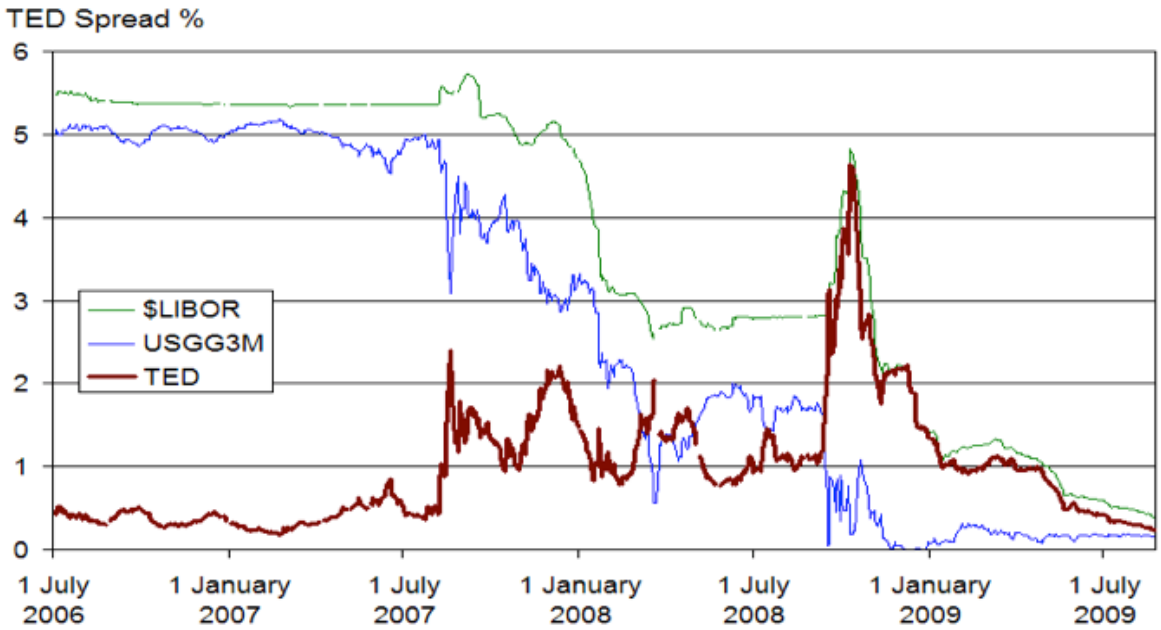
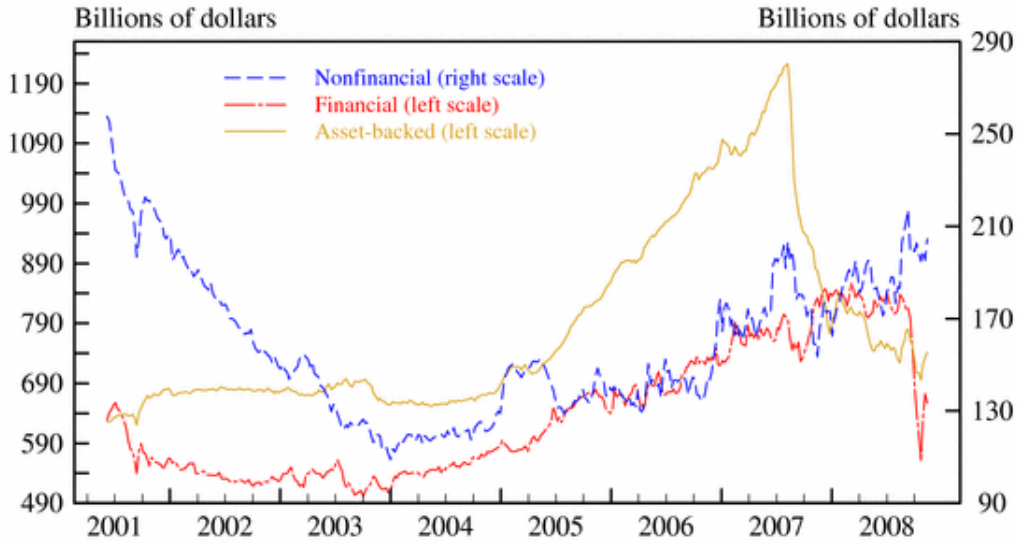
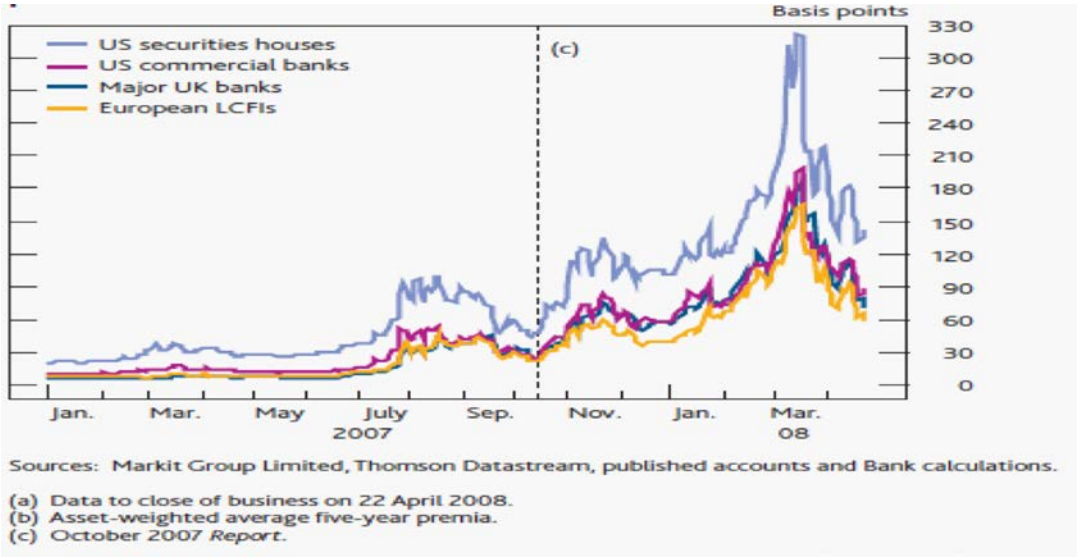


Figure 9. Weekly outstanding volume of asset-backed commercial paper



Source: Board of Governors of the Federal Reserve System as of Nov. 14, 2008 in Eisenbeis (2009).

Figure 10. The evolution of credit default swap spreads from January 2007 through May 2008



Source: Bank of England Financial Stability Report, April 2008, p.11.

Figure 11. Primary credit extension through the discount window, April 2007–April 2011.

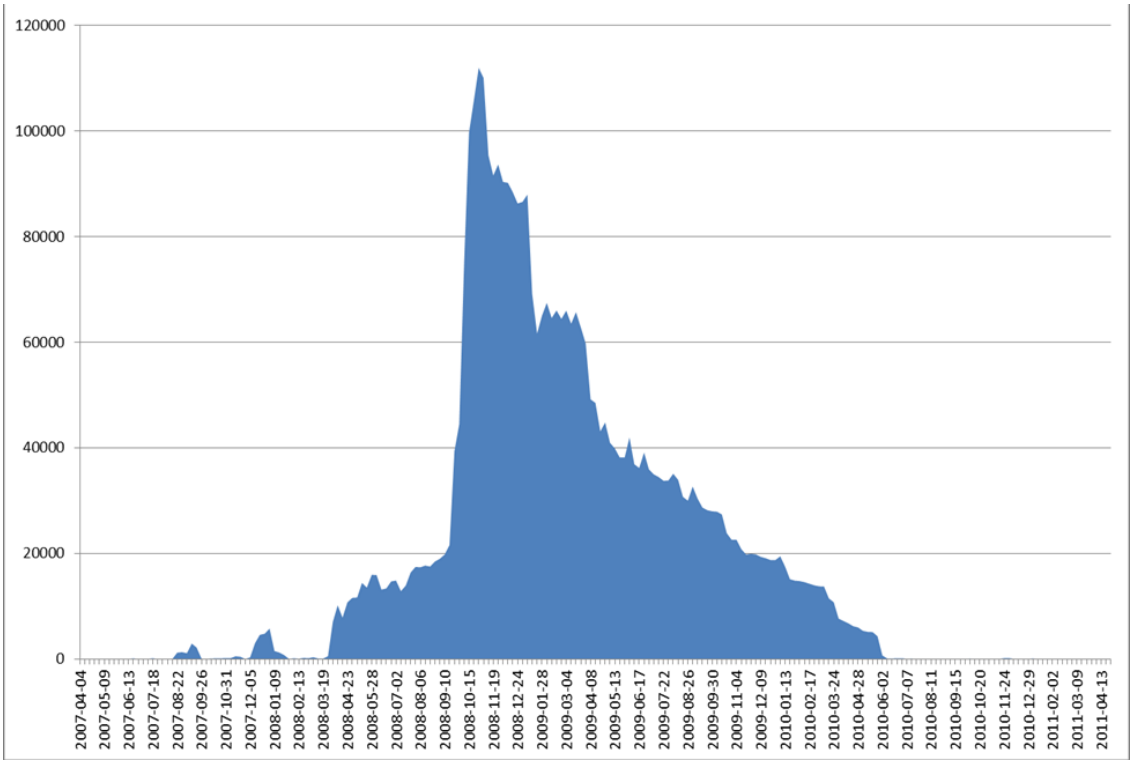


Figure 12. Lending under the primary dealer credit facility v TED spread

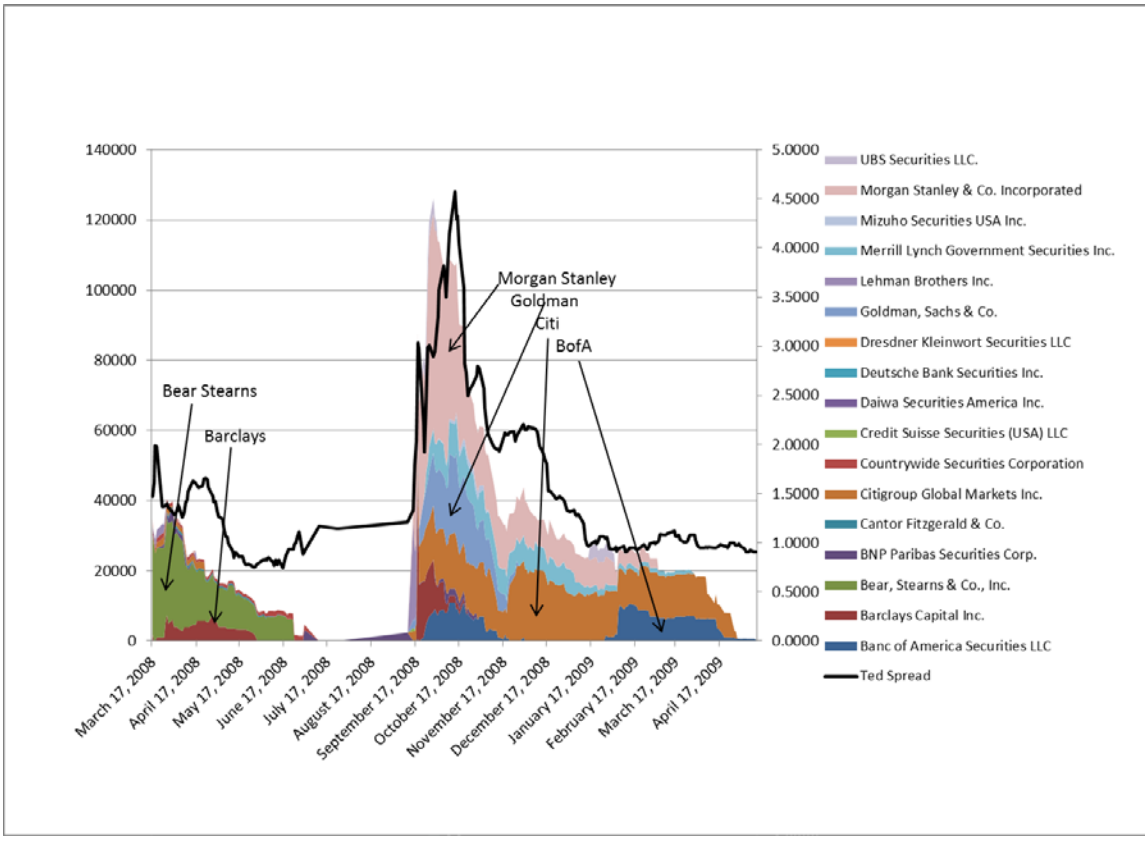
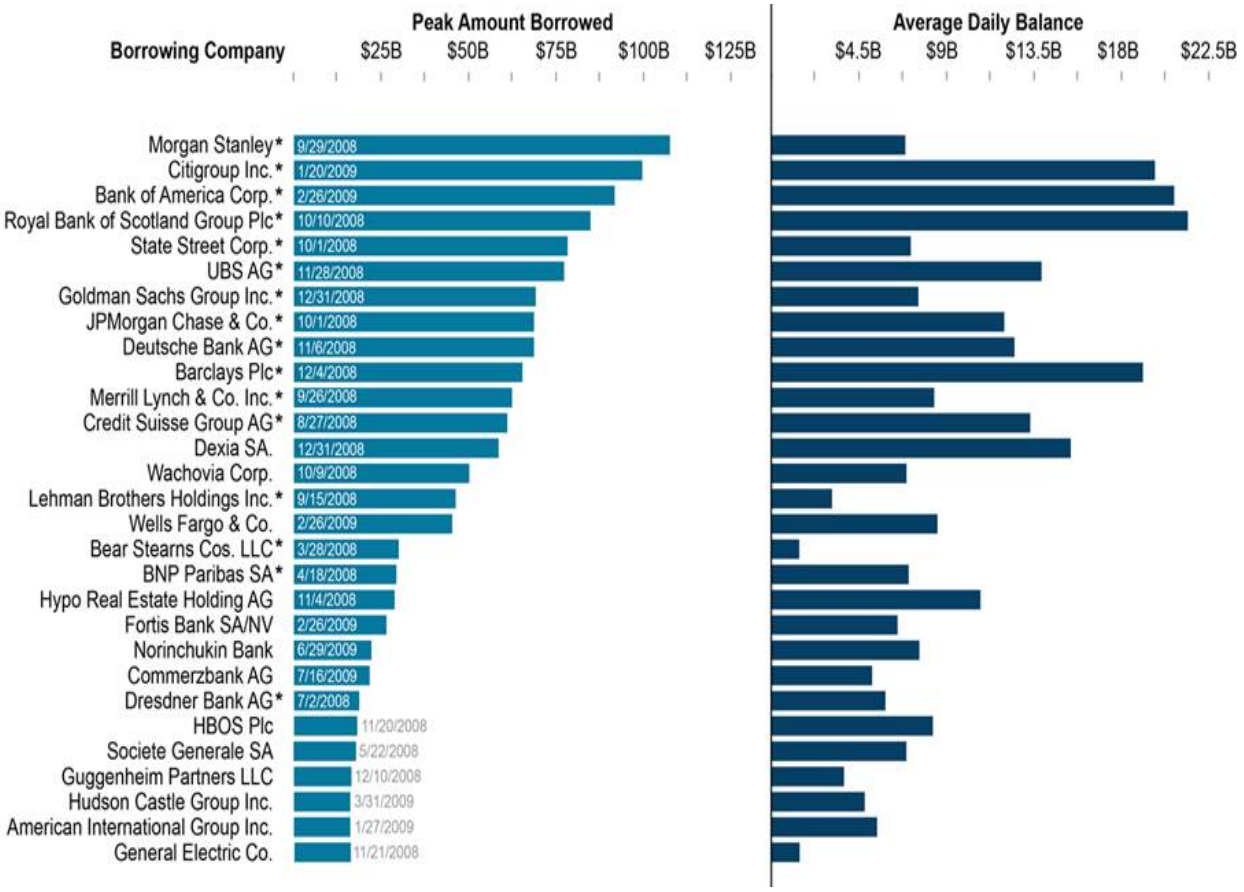
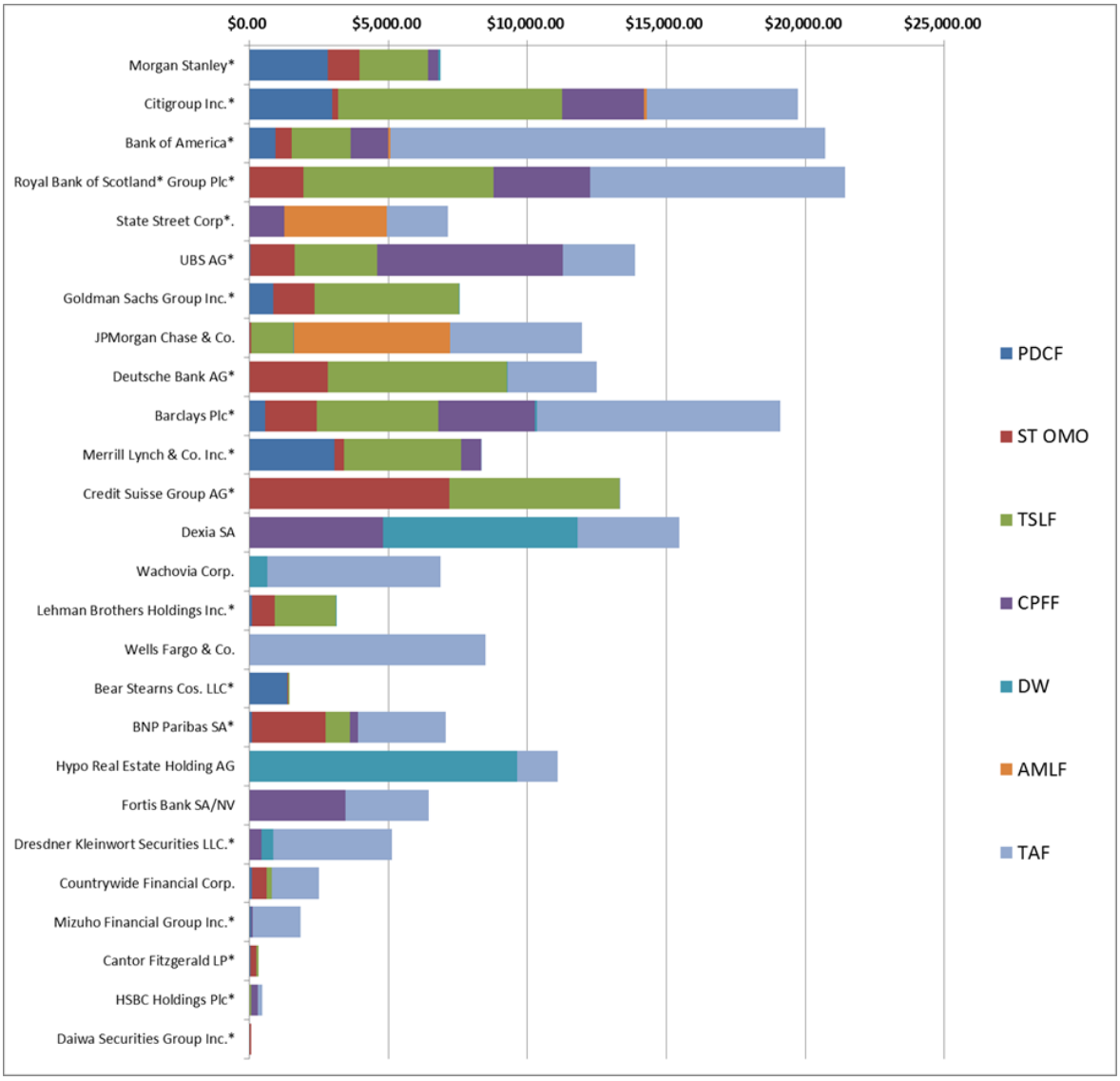


Figure 13. Total peak and average borrowings from Fed liquidity facilities from August 2007 through December 2009



Source: Bloomberg, December 23, 2011, available at www.bloomberg.com/news/print/2011-12-23/nce-secret-data-compiled-by-bloomberg-released-to-public.html

Figure 14. Average borrowing (April 2007–December 2009), disaggregated by facility



Source: Bloomberg, December 23, 2011, available at http://www.bloomberg.com/news/print/2011-12-23/fed-s-once-secret-data-compiled-by-bloomberg-released-to-public.html

Table 1. Federal Reserve liquidity facilities during the crisis

Federal Reserve Liquidity Facilities during the Crisis

	Facility	Date Announced	Eligible Borrowers	Maximum Amount Outstanding
DW	Discount window	Ongoing	Depository institutions	111
TAF	Term Auction Facility	December 12, 2007	Depository institutions	493
ST OMO	Single-tranche open market operations	March 7, 2008	Primary dealers	80
TSLF	Term Securities Lending Facility	March 11, 2008	Primary dealers	236
PDCF	Primary Dealer Credit Facility	March 16, 2008	Primary dealers	147
AMLF	Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility	September 18, 2008	Depository institutions	152
CPFF	Commercial Paper Funding Facility	October 7, 2008	Commercial paper issuers	351
	Programs for Central Banks and Non-Bank, Non-Primary Dealer Borrowers			
CBLS	Central bank liquidity swaps	December 12, 2007	Banks	583
	Money Market Investor Funding Facility	October 21, 2008	Money market investors	0
	Term Asset-Backed Securities Loan Facility	November 25, 2008	Asset-backed securities 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 to banks in their jurisdiction.

Source: Michael Fleming, 2012 "Federal reserve liquidity provision during the financial crisis of 2007-2009," Federal Reserve Bank of New York Report, No. 563, p. 24, July