Federal Reserve Bank of New York
Staff Reports

The Changing Nature of Financial Intermediation and the Financial Crisis of 2007-09

Tobias Adrian
Hyun Song Shin

Staff Report no. 439
March 2010
Revised April 2010

The Changing Nature of Financial Intermediation and the Financial Crisis of 2007-09

Tobias Adrian and Hyun Song Shin

Federal Reserve Bank of New York Staff Reports, no. 439
March 2010; revised April 2010
JEL classification: E02, E58, G10, G18

Abstract

The financial crisis of 2007-09 highlighted the changing role of financial institutions and the growing importance of the "shadow banking system," which grew out of the securitization of assets and the integration of banking with capital market developments. This trend was most pronounced in the United States, but it also had a profound influence on the global financial system as a whole. In a market-based financial system, banking and capital market developments are inseparable, and funding conditions are tied closely to fluctuations in the leverage of market-based financial intermediaries. Balance-sheet growth of market-based financial intermediaries provides a window on liquidity by indicating the availability of credit, while contractions of balance sheets have tended to precede the onset of financial crises. We describe the changing nature of financial intermediation in the market-based financial system, chart the course of the recent financial crisis, and outline the policy responses that have been implemented by the Federal Reserve and other central banks.

Key words: financial crisis, financial intermediation, intermediation chains, procyclicality, liquidity facilities, monetary polic

---

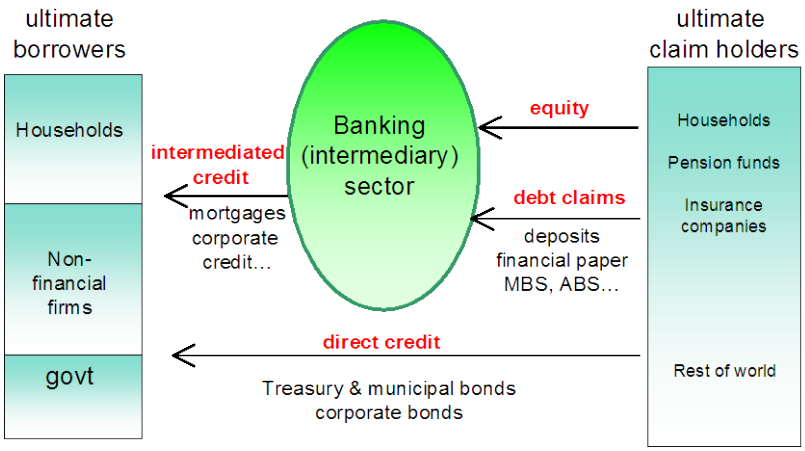
Adrian: Federal Reserve Bank of New York (e-mail: tobias.adrian@ny.frb.org). Shin: Princeton University (e-mail: hsshin@princeton.edu). This paper was prepared for the *Annual Review of Economics*.

INTRODUCTION

The financial system channels savings from investors to those who need funding—i.e., from ultimate lenders to ultimate borrowers. The ultimate lenders are households and institutions such as pension fund, mutual fund, and life insurance companies that invest on behalf of households. Some credit will be provided directly from the lender to the borrower, as is the case with Treasury securities, municipal bonds, and corporate bonds. However, the bulk of the credit financing in the economy is intermediated through the banking system, interpreted broadly. Understanding the workings of financial intermediation and the way in which the banking system has evolved over the past several decades is crucial for understanding the global financial crisis that erupted in 2007 and for formulating policy—both short-term crisis management policies as well as long-term policies for building a more resilient financial system.

Figure 1 is a stylized depiction of the financial system that channels funds from ultimate lenders to ultimate borrowers. For the household sector, borrowing is almost always intermediated through the banking system, broadly defined. At the end of 2008, U.S. household-sector mortgage liabilities amounted to approximately $10.6 trillion, and consumer debt accounts amounted to another $2.5 trillion.

Figure 1. Stylized Financial System



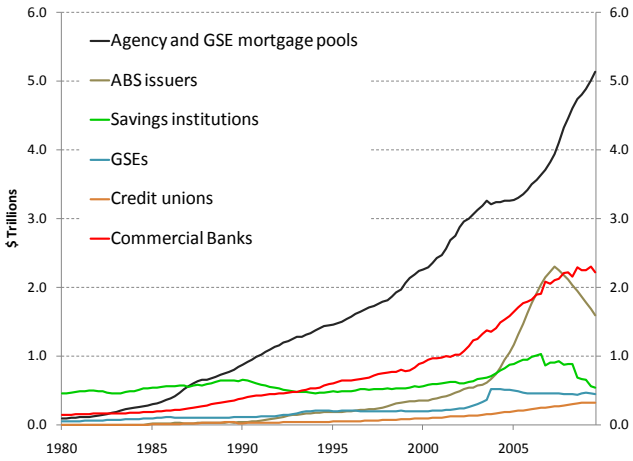
In the traditional model of financial intermediation, a bank takes in retail deposits from household savers and lends out the proceeds to borrowers such as firms or other households. **Figure 2** (see color insert) depicts the archetypal intermediation function performed by a bank; in this case, the bank channels household deposits to younger households who need to borrow to

buy a house. Indeed, until recently, the financial intermediation depicted in **Figure 2** was the norm, and the bulk of home mortgage lending in the United States was conducted in this way.

Figure 2. Short Intermediation Chain

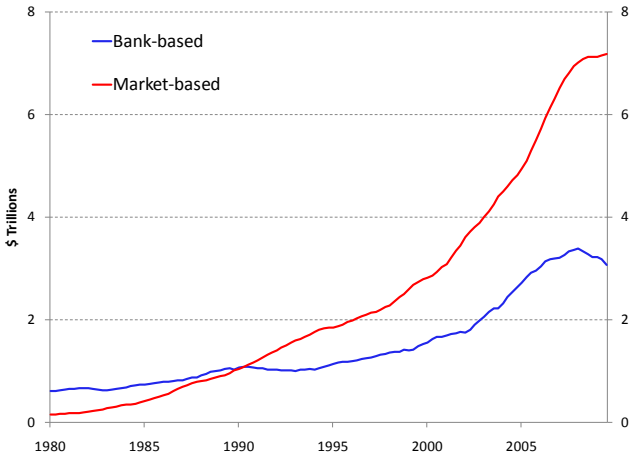
However, the U.S. financial system underwent a far-reaching transformation in the 1980s with the takeoff of securitization in the residential mortgage market. **Figure 3** charts the total dollar value of residential mortgage assets held by different classes of financial institutions in the United States, as taken from the Federal Reserve's Flow of Funds accounts.

Figure 3. Total Holdings of US Home Mortgages by Type of Financial Institution (Source: US Flow of Funds, Federal Reserve, 1980-2009)



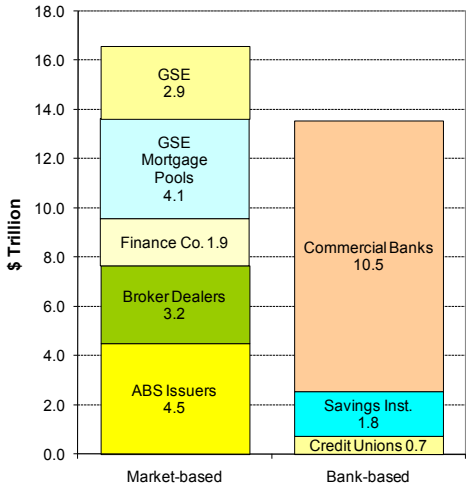
Until the early 1980s, banks and savings institutions (such as the regional savings and loans) were the dominant holders of home mortgages. However, with the emergence of securitization, banks sold their mortgage assets to institutions that financed these purchases by issuing mortgage-backed securities (MBSs). In particular, the GSE (government-sponsored enterprise) mortgage pools became the dominant holders of residential mortgage assets. In **Figure 4** (see color insert), bank-based holdings comprise the holdings of commercial banks, savings institutions, and credit unions. Market-based holdings are the remainder—i.e., the GSE mortgage pools, private-label mortgage pools, and the GSE holdings themselves. Market-based holdings now constitute two-thirds of the $11 trillion total of home mortgages.

Figure 4. Market Based and Bank Based Holding of Home Mortgages (Source: US Flow of Funds, Federal Reserve, 1980-2009)



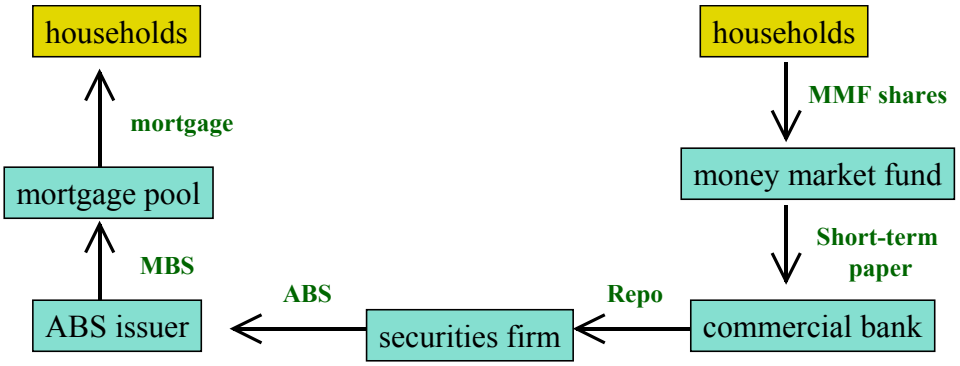
Although residential mortgages have been the most important element in the evolution of securitization, the growing importance of market-based financial intermediaries is a more general phenomenon that extends to other forms of lending—including consumer loans such as those for credit card and automobile purchases, as well as commercial real estate or corporate loans. The growing weight of the financial intermediaries that operate in the capital markets can be seen in **Figure 5**, which compares total assets held by banks with the assets of securitization pools and those held by institutions that fund themselves mainly by issuing securities. By the end of the second quarter of 2007 (just before the crisis began), the assets of this latter group (i.e., total market-based assets) were larger than the total assets on banks' balance sheets.

Figure 5. Total Assets at 2007Q2 (Source: US Flow of Funds, Federal Reserve)



As the financial system has changed, so has the mode of financial intermediation. A characteristic feature of financial intermediation that operates through the capital market is the long chain of financial intermediaries involved in channeling funds from the ultimate creditors to the ultimate borrowers. **Figure 6** illustrates one possible chain of lending relationships in a market-based financial system, whereby credit flows from the ultimate creditors (household savers) to the ultimate debtors (households who obtain a mortgage to buy a house).

Figure 6. Long Intermediation Chain



In this illustration, mortgages are originated by financial institutions such as banks that sell individual mortgages into a mortgage pool such as a conduit. The mortgage pool is a passive firm (sometimes called a warehouse) whose only role is to hold mortgage assets. The mortgage is then packaged into another pool of mortgages to form MBSs, which are liabilities issued against the mortgage assets. The MBSs might then be owned by an asset-backed security (ABS) issuer who pools and tranches them into another layer of claims, such as collateralized debt obligations. A securities firm (e.g., a Wall Street investment bank) might hold collateralized debt obligations on its own books for their yield but will finance such assets by collateralized borrowing through repurchase agreements (i.e., repos) with a larger commercial bank. In turn, the commercial bank would fund its lending to the securities firm by issuing short-term liabilities, such as financial commercial paper. Money market mutual funds would be natural buyers of such short-term paper, and, ultimately, the money market fund would complete the circle as household savers would own shares of these funds.

Figure 6 illustrates that those institutions involved in the intermediation chain were precisely those that were at the sharp end of the financial crisis that erupted in 2007. As subprime

mortgages cropped up in this chain and disrupted its smooth functioning, we witnessed both the near-failures of Bear Stearns and Merrill Lynch, as well as the failure of Lehman Brothers. This realization pushes us to dig deeper into the role of such market-based financial intermediaries in the modern financial system.

The answers are revealing. In a market-based financial system, banking and capital market developments are inseparable, and fluctuations in financial conditions have a far-reaching impact on the workings of the real economy. We see in the discussion that follows precisely how capital market conditions influence financial intermediation.

MARKET-BASED FINANCIAL INTERMEDIARIES

The increased importance of the market-based banking system has been mirrored by the growth (and subsequent collapse) of the broker-dealer sector of the economy, the sector that includes the securities firms. Broker-dealers are at the heart of the market-based financial system, as they make markets for tradable assets, they originate new securities, and they produce derivatives. Broker-dealers thus mirror the overall evolution of the market-based financial system.

Although broker-dealers have traditionally played market-making and underwriting roles in securities markets, their importance in the supply of credit has increased in step with securitization. Thus, although the size of total broker-dealer assets is small in comparison to the commercial banking sector (at its peak, it was approximately only one-third of the commercial bank sector), broker-dealers became a better barometer for overall funding conditions in a market-based financial system.

The astonishing growth of the securities sector can be seen in **Figure 7**, which charts the growth of four sectors in the United States: the household sector, the nonfinancial corporate sector, the commercial banking sector, and the security broker-dealer sector. All series have been normalized to 1 for March 1954. Whereas the first three sectors had grown roughly 80-fold since 1954, the securities sector had grown roughly 800-fold before collapsing in the crisis.

Figure 7: Growth of Assets of Four Sectors in the United States (March 1954 = 1)
(Source: US Flow of Funds, Federal Reserve, 1980-2009)

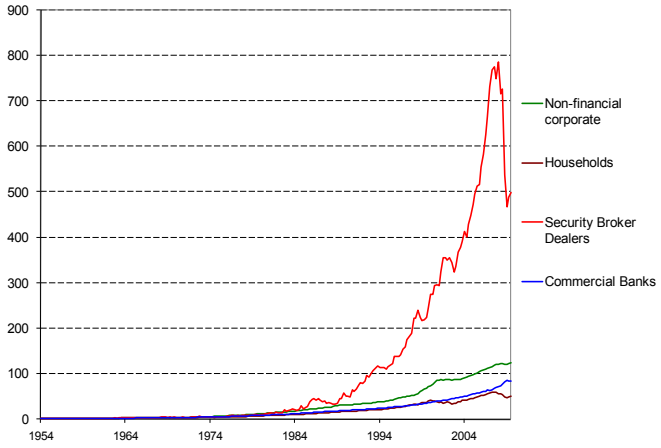
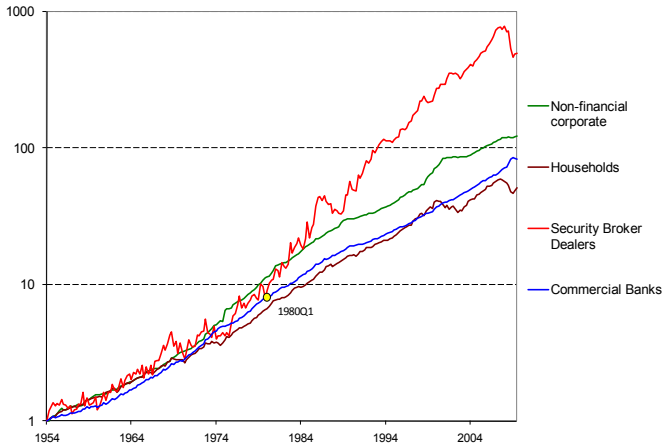


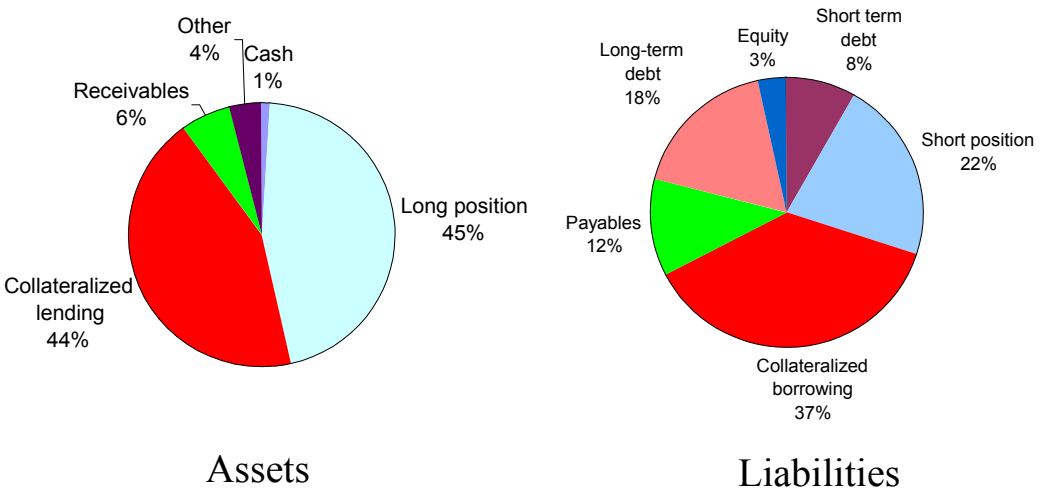
Figure 8 contains the same series depicted in **Figure 7**, but with the vertical axis expressed in log scale. We see from **Figure 8** that the rapid increase in the securities sector began around 1980, coincident with the takeoff in the securitization of residential mortgages.

Figure 8: Growth of Assets of Four Sectors in the United States (March 1954 = 1)
(Log scale) (Source: Federal Reserve, Flow of Funds, 1954-2009)



At the margin, all financial intermediaries (including commercial banks) have to borrow in capital markets, as deposits are insufficient to meet funding needs. The large balance sheets of commercial banks, however, mask the effects operating at the margin. In contrast, securities firms have balance sheets that are much more sensitive to the effects operating in the financial markets. As an illustration, **Figure 9** summarizes the balance sheet of Lehman Brothers at the end of the 2007 financial year, when total assets were $691 billion.

Figure 9. Balance Sheet Composition of Lehman Brothers, End 2007



The two largest classes of assets were (*a*) long positions in trading assets and other financial inventories and (*b*) collateralized lending. The collateralized lending reflected Lehman's role as a prime broker to hedge funds and consisted of reverse repos in addition to other types of collateralized lending. Much of this collateralized lending was short term, often overnight. The other feature of the asset side of the balance sheet is how small the cash holdings were; out of a total balance-sheet size of $691 billion, cash holdings amounted to only $7.29 billion.

Much of the liabilities of Lehman Brothers was of a short-term nature. The largest component was collateralized borrowing, including repos. Short positions (financial instruments and other inventory positions sold but not yet purchased) were the next largest component. Long-term debt was only 18% of total liabilities. One notable item is the payables category, which was 12% of the total balance-sheet size. Payables included the cash deposits of Lehman's customers, especially its hedge-fund clientele. It is for this reason that payables are much larger than receivables, which were only 6%, on the asset side of the balance sheet. Hedge-fund customers' deposits are subject to withdrawal on demand and proved to be an important source of funding instability.

In this way, broker-dealers have balance sheets that are short term and, thus, highly attuned to fluctuations in market conditions. The ultimate supply of securitized credit to the real economy is often channeled through broker-dealer balance sheets. As such, they serve as a barometer of overall funding conditions in a market-based financial system.

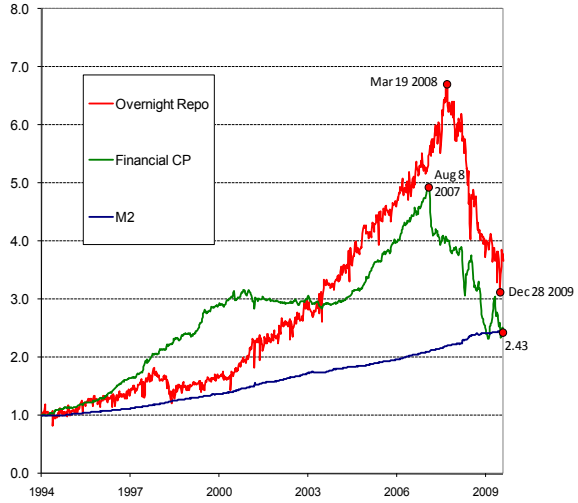
The growing importance of securities firms as a mirror of overall capital market conditions can be seen from the aggregate balance-sheet quantities in the economy (see Adrian and Shin (2009b). **Figure 10** compares the stock of repos of U.S. primary dealers[1] plus the stock of financial commercial paper expressed as a proportion of the M2 money stock. M2 includes the bulk of retail deposits and holdings in money market mutual funds and, thus, is a good proxy for the total stock of liquid claims held by ultimate creditors against the financial intermediary sector as a whole. As recently as the early 1990s, repos and financial commercial paper were only one-quarter the size of M2. However, their combined total rose rapidly and reached over 80% of M2 by August 2007, only to collapse with the onset of the financial crisis.

Figure 10. Repos and Financial CP as Proportion of M2
(Source: US Flow of Funds, Federal Reserve, 1990W1-2010W5)

The ultra-short nature of financial intermediaries' obligations to each other can be better seen by plotting the component of the overall repo series consisting only of overnight repos. **Figure 11** plots the size of the overnight repo stock, financial commercial paper, and M2, all normalized to equal 1 on July 6th, 1994 (the data on overnight repos are not available before that date). The stock of M2 has grown by a factor of over 2.4 since 1994, but the stock of overnight repos had grown almost sevenfold up to March 2008. Brunnermeier (2009) has noted that the use of overnight repos became so prevalent that, at its peak, the Wall Street investment banks were rolling over one-quarter of their balance sheets every night.

Figure 11. Overnight Repos and M2

(Source: Federal Reserve, 1994W1-2010W5)



LIQUIDITY AND LEVERAGE

Much more important than the sheer size of the securities sector, however, is the behavior of the market-based intermediaries themselves and how they react to shifts in market conditions. We can pose the question in terms of how market-based intermediaries manage their balance sheets and, in particular, how leverage and balance-sheet size are related.

Leverage is the ratio of total assets to equity. For households, leverage is inversely related to total assets. For example, when households buy a house with a mortgage, their net worth increases at a faster rate than total assets as housing prices rise, leading to a fall in leverage.

The negative relationship between total household assets and leverage is clearly borne out in the aggregate data. **Figure 12** plots the quarterly changes in total assets versus the quarterly changes in leverage as given in the Flow of Funds accounts for the United States, as taken from Adrian & Shin (2007). The scatter chart shows a strongly negative relationship, as suggested by a passive behavior toward asset price changes.

Figure 12. Household Sector Leverage and Total Assets
(Source: U.S. Flow of Funds, Federal Reserve, 1963-2007)

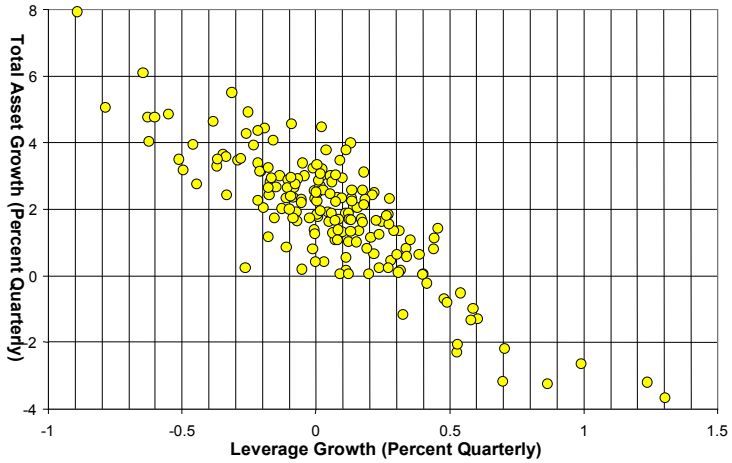


Figure 13 (see color insert) is a similar scatter chart of the change in leverage and change in total assets for nonfinancial, nonfarm corporations drawn from the U.S. Flow of Funds. The scatter chart shows a much weaker negative pattern, suggesting that companies react only somewhat to changes in asset prices by shifting their stance on leverage.

Figure 13. Non-financial corporate sector leverage and total assets
(Source: U.S. Flow of Funds, Federal Reserve, 1963-2007)

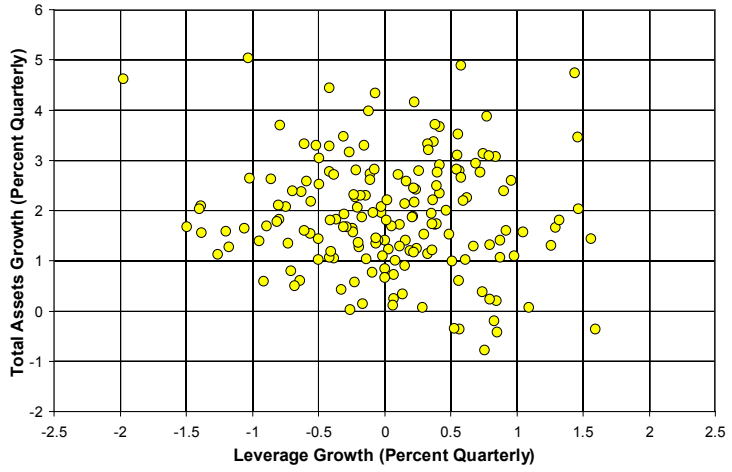


Figure 14 is the corresponding scatter chart for U.S. security dealers and brokers. The alignment of the observations is now the reverse of that for households. There is a strongly positive relationship between changes in total assets and changes in leverage. In this sense, leverage is procyclical.

Figure 14. Broker Dealer Sector Leverage and Total Assets
(Source: U.S. Flow of Funds, Federal Reserve, 1963-2007)

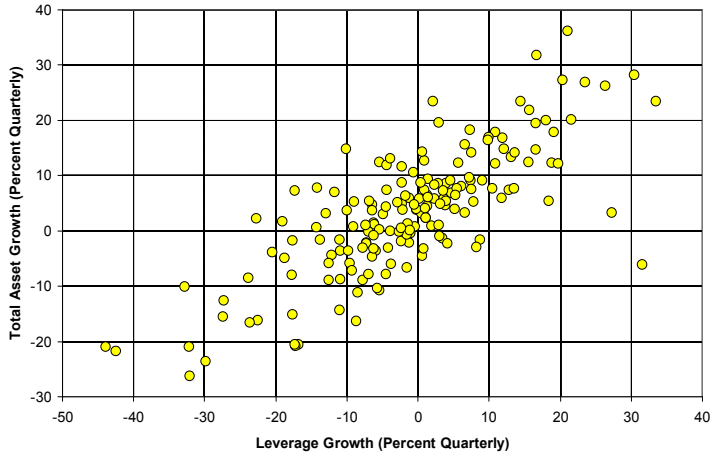
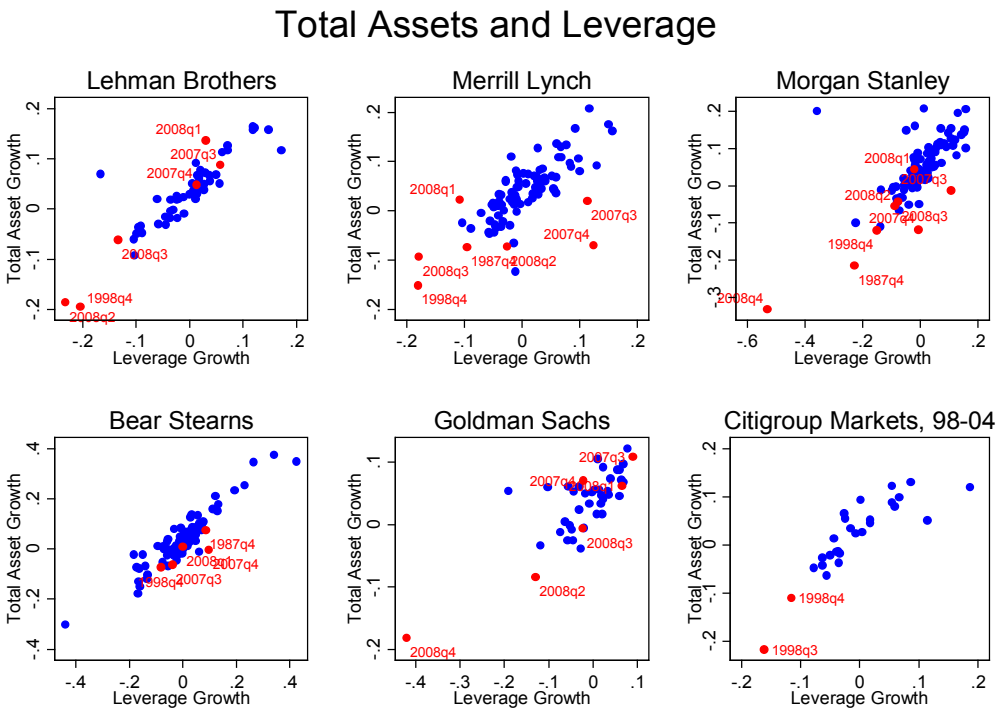


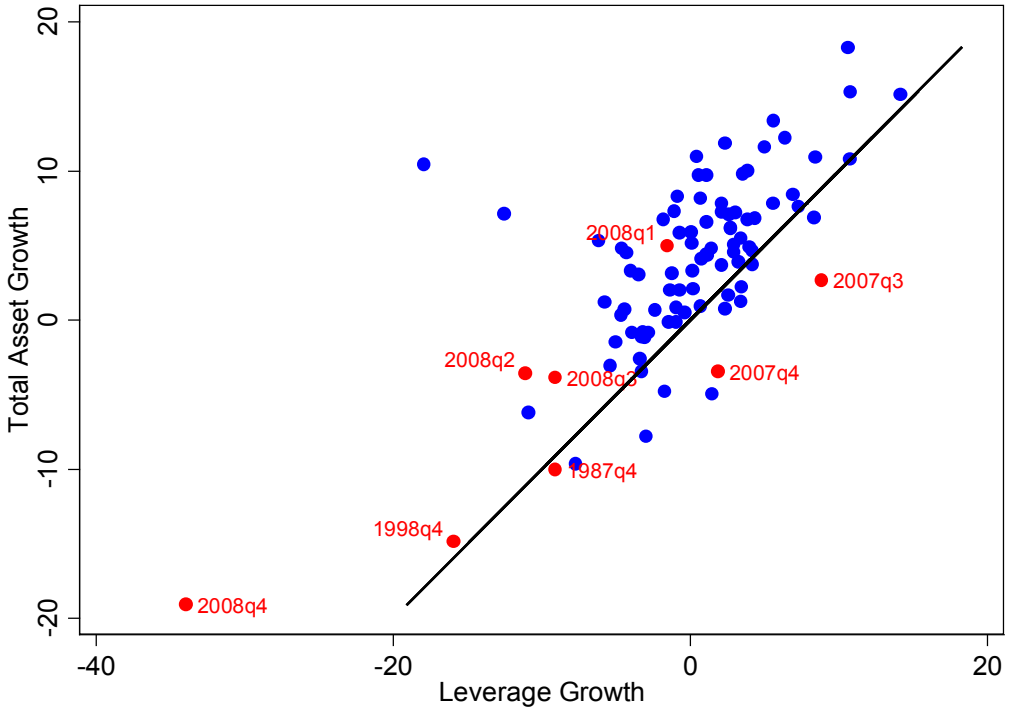
Figure 15. US Investment Banks' Leverage and Total Assets
(Source SEC; Adrian and Shin (2007), updated)



The procyclical nature of leverage is evident for individual firms, too, as seen in **Figure 15**, which gives the scatter plots for quarterly growth in leverage and total assets of what were, at the time, the five stand-alone U.S. investment banks (Bear Stearns, Goldman Sachs, Lehman

Brothers, Merrill Lynch, and Morgan Stanley) together with Citigroup Global Markets (1998Q1–2004Q4). In all cases, leverage is large when total assets are large—i.e., leverage is procyclical. **Figure 16** shows the scatter chart of the weighted average of the quarterly change in assets against the quarterly change in leverage of the five investment banks.

Figure 16. Leverage Growth and Asset Growth of US Investment Banks
(Source SEC; Adrian and Shin (2007), updated)



We can confirm from these figures the striking feature that leverage is procyclical in the sense that leverage grows when balance sheets are growing and then contracts when balance sheets are contracting. This is exactly the opposite finding for households, whose leverage rises when balance sheets contract.

Procyclical leverage offers a window into financial system liquidity. The horizontal axis of **Figure 16** measures the (quarterly) growth in leverage, as measured by the change in log assets minus the change in log equity. The vertical axis measures the change in log assets. Hence, the 45-degree line indicates the set of points at which (log) equity is unchanged. In other words, the 45-degree line indicates the set of points at which equity is unchanged from one period to the next.

Above the 45-degree line, equity is increasing while equity is decreasing below it. The distance from the 45-degree line indicates the growth of equity from one period to the next. Thus, any straight line parallel to the 45-degree line indicates the set of points at which the growth of equity is equal. In other words, any straight line with a slope equal to 1 indicates constant growth of equity, with the intercept giving the growth rate of equity. We see that the realizations in the scatter plot in **Figure 16** are clustered around a straight line with a slope roughly equal to 1, suggesting that a useful first approximation of the data is that equity is increasing at a constant rate on average, with total assets determined by the allowable leverage ruling at that date.

In this way, equity appears to play the role of the forcing variable, and the adjustment in leverage primarily takes place through expansions and contractions of the balance sheet rather than through the raising or paying out of equity. We can understand the fluctuations in leverage in terms of the implicit maximum leverage permitted by creditors in collateralized borrowing transactions such as repos. In a repo, the borrower sells a security today for below the current market price on the understanding that it will buy it back in the future at a pre-agreed price. The difference between the current market price of the security and the price at which it is sold is called the haircut in the repo. The fluctuations in the haircut largely determine the degree of funding available to a leveraged institution, as the haircut determines the maximum permissible leverage achieved by the borrower. For example, if the haircut is 2%, the borrower can borrow $98 for every $100 worth of securities pledged; i.e., to hold $100 worth of securities, the borrower must come up with $2 of equity. Thus, if the repo haircut is 2%, the maximum permissible leverage (ratio of assets to equity) is 50.

Consider an example in which the borrower leverages up to the maximum permitted level, consistent with maximizing the return on equity. The borrower then has a leverage of 50. If a shock raises the haircut, then the borrower must either sell assets or raise equity. Suppose that the haircut rises to 4%. Then the permitted leverage halves from 50 to 25. The borrower must either double its equity or sell half its assets, or do some combination of both. Times of financial stress are associated with sharply higher haircuts, necessitating substantial reductions in leverage through asset disposals or raising of new equity.

Table 1 shows the repo haircuts on credit collateral, as reported by the Depository Trust and Clearing Corporation, together with the option-adjusted credit spreads of the credit collateral, as taken from Bloomberg. The credit spread is a proxy for the expected return of a

long position in the particular security and a short position in the Treasury security of matching duration. The haircuts and spreads are reported for three dates: May 2007 (prior to the crisis), May 2008 (in the midst of the crisis), and May 2009. Both haircuts and spreads rose substantially during the crisis. One way to visualize the effect is through shifts in the haircut curve, as plotted in **Figure 17** (see color insert, from Adrian and Shin (2009c)). The curve plots option-adjusted credit spreads against the percent haircut for the credit securities of different ratings in **Table 1**.

Table 1 Yield spreads and repo haircuts (basis points)

		Haircuts			**Spreads**		
		May 07	**May 08**	**May 09**	**May 07**	**May 08**	**May 09**
Corporate debt	A	5	10	20	86	235	364
Corporate debt	Baa	5	20	30	115	278	508
Asset-backed security	Aaa	10	25	35	73	327	350
Corporate debt	Ba	25	30	40	177	433	833
Corporate debt	B	25	40	50	239	618	996
Corporate debt	Caa	25	100	100	396	932	1573

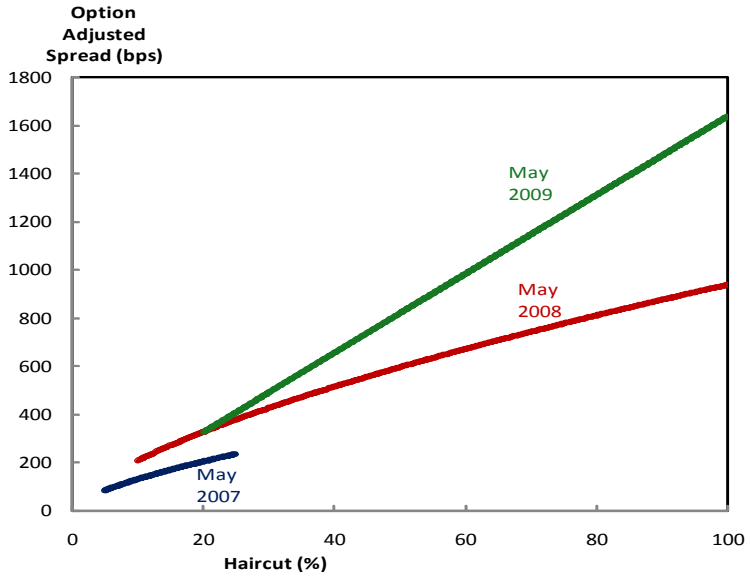
Data taken from Depository Trust and Clearing Corporation and Bloomberg.

The haircut curve has three important dimensions: level, slope, and length. As the crisis unwound, the curve shifted up (i.e., spreads increased for any given haircut), became steeper (i.e., each additional unit of haircut demanded a higher compensation in terms of credit spread), and became longer and shifted to the right (i.e., the haircuts on the most liquid and least liquid securities both increased). Such shifts in level, slope, and length can be compared with the traditional level, slope, and curvature shifts of the Treasury yield curve. The major advantage of plotting the haircut curve is that it clearly shows the impact of the crisis: Haircut increases are both causes and consequences of financial crises. Gorton & Metrick (2009) present time-series evidence of how haircuts have evolved over the course of the financial crisis.

The reason that the curve shifts in **Figure 17** is that the return-liquidity trade-off is changing as the crisis progresses. As haircuts increased, institutions were forced to unwind securities, resulting in declining asset prices and correspondingly widening yield spreads. So for a given haircut (i.e., for a given maximum permitted leverage), equilibrium compensation

increased as balance-sheet capacity in the system as a whole declined. Furthermore, the increasing steepness of the haircut curve implies that this equilibrium pricing effect became more pronounced for more illiquid securities.

Figure 17. The Haircut Curve



Source: DTCC, Bloomberg.

Very high values of the haircut—reaching 100% in extreme cases—are difficult to explain in terms of standard models of adverse selection. Indeed, coming up with rigorous theoretical models that can explain such episodes is one of the urgent tasks made necessary by the crisis. However, a useful approach would be to consider the fluctuations in the balance-sheet capacity of financial intermediaries who find that their ability to lend is impaired by lack of capital and the inability to borrow against yet another set of intermediaries. Adrian & Shin (2008) present a theory of haircuts based on the economic incentives of financial intermediaries.

The fluctuations in leverage resulting from shifts in funding conditions are closely associated with periods of financial booms and busts. **Figure 18** plots the leverage of U.S. primary dealers—the set of banks that has a daily trading relationship with the Federal Reserve. They consist of U.S. investment banks and U.S. bank holding companies with large broker subsidiaries (such as Citigroup and JP Morgan Chase), as well as of security broker-dealers that are owned by foreign banks.

Figure 18. Mean Leverage of Primary Dealers
(June 86 to September 09. Source: SEC 10-K and 10-Q filings)

The plot has two main features. First, leverage has increased sharply since 2001. Second, each of the peaks in leverage is associated with the onset of a financial crisis (the peaks are 1987Q2, 1998Q3, and 2008Q1). Financial crises tend to be preceded by marked increases in leverage and are subsequently followed by sharp deleveraging.

The increase in total primary dealer leverage between 2001 and 2007 masks an intriguing pattern when comparing primary dealers in the United States with those owned by foreign holding companies (**Figures 19** and **20**). Whereas domestic dealers have experienced a slowly moving downward trend in leverage since 1986, foreign dealers have experienced a long-term upward trend in leverage. The decline in leverage of U.S. dealers results from the bank holding companies in the sample—a sample consisting only of investment banks shows no such declining trend in leverage (see Adrian & Shin 2007).

The fluctuations of credit in the context of secured lending expose the fallacy of the lump of liquidity in the financial system. The language of liquidity suggests a stock of available funding in the financial system, which is redistributed as needed. However, when liquidity dries up, it disappears altogether rather than being reallocated elsewhere. When haircuts rise, all balance sheets shrink in unison, resulting in a generalized decline in the willingness to lend. In this sense, liquidity should be understood in terms of the growth of balance sheets (i.e., as a flow), rather than as a stock. Liquidity in this sense is a sign of the balance-sheet constraint being relaxed. Therefore, liquidity indicates the relaxation of a constraint on the firm's leverage, so that

the firm is able to take on more exposure (see Adrian & Shin 2009a for a formal development of this idea).

Figure 19. Domestic Dealer Leverage

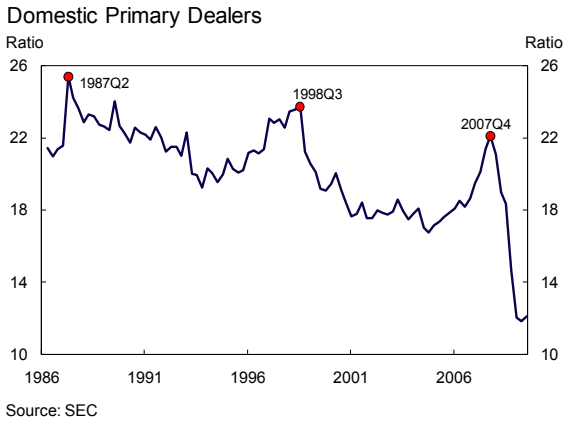
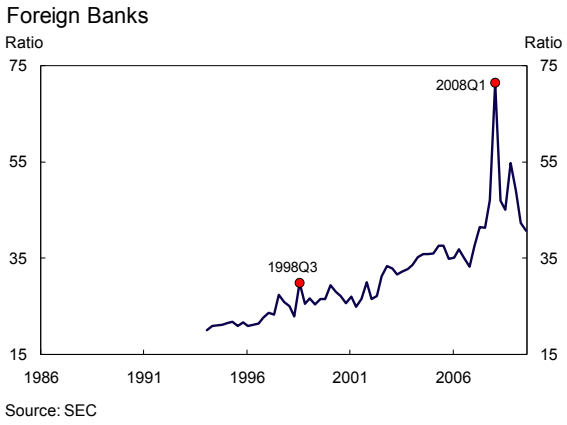
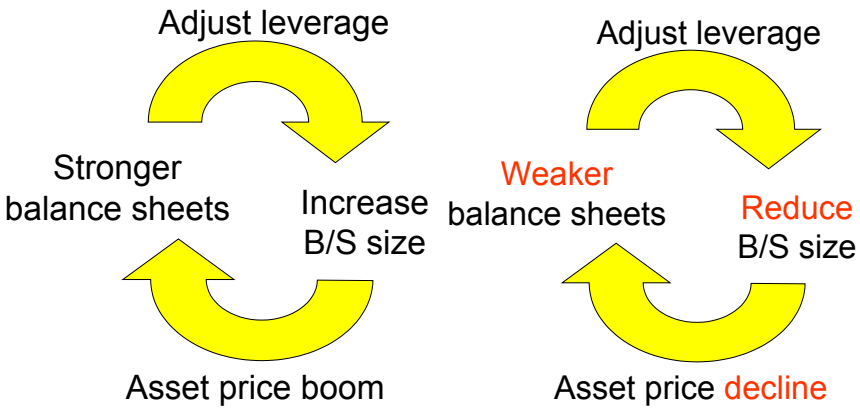


Figure 20. Foreign Dealer Leverage



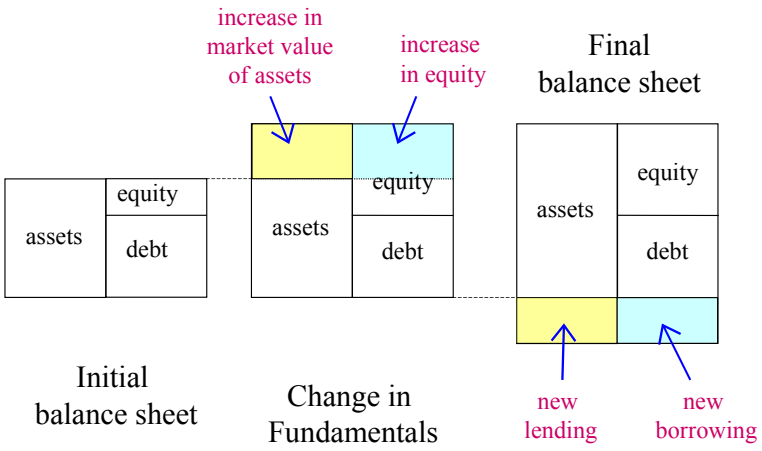
In a financial system in which balance sheets are continuously marked to market, changes in asset prices show up immediately on them and have an instant impact on the net worth of all constituents of the financial system. The net worth of financial intermediaries is especially sensitive to fluctuations in asset prices given the highly leveraged nature of such intermediaries' balance sheets. Far from being passive, the evidence points to financial intermediaries adjusting their balance sheets actively and doing so in such a way that leverage is high during booms and low during busts. That is, leverage is procyclical.

Procyclical leverage can be seen as a consequence of the active management of balance sheets by financial intermediaries who respond to changes in prices and measured risk. Geanakoplos (1997, 2010) has developed general equilibrium examples of balance-sheet fluctuations, but the arguments can be illustrated more simply if we follow the consequences of risk management by banks and other intermediaries.



For financial intermediaries, models of risk and economic capital dictate active management of their overall value at risk through adjustments of their balance sheets. The process is illustrated in **Figure 21**, which breaks down the steps in the balance-sheet expansion. Adrian & Shin (2009b) and Shin (2010) spell out formal models that correspond to the sequence depicted in **Figure 21**.

Figure 21. Balance Sheet Adjustment



The initial balance sheet is illustrated on the left. The middle balance sheet shows the effect of an increase in balance-sheet size that comes from an improvement in economic fundamentals. There is an increase in the market value of equity, even as the measured risks decline, and there is excess capacity in the bank's balance sheet following these changes. The excess balance-sheet capacity is utilized by taking on more debt in order to expand the size of the balance sheet and to lend more. Of course, the brief description above does not tie down the extent of the balance-sheet expansion (which is key for the empirical investigation). Thus, the above argument should be seen as a qualitative sketch.

For a bank, expanding its balance sheet means purchasing more securities or increasing its lending. But expanding assets means finding new borrowers. Someone has to be on the receiving end of new loans. When all the good borrowers already have a mortgage, the bank has to lower its lending standards in order to capture new borrowers. The new borrowers are those who were previously shut out of the credit market but who suddenly find themselves showered with credit. The ballooning of subprime mortgage lending can be seen through this lens. The pressure on the banks' managers to expand lending reveals an important feature of financial constraints. They bind in boom times as well as during crises. Although the constraint operates

through channels that appear more benign in boom times (such as the pursuit of shareholder value by raising return on equity), it is a constraint nonetheless.

Table 2 Total exposure to losses from subprime mortgages

	Total reported subprime exposure (billions of U.S. dollars)	**Percent of reported exposure**
Investment banks	75	5%
Commercial banks	418	31%
GSEs (government-sponsored enterprises)	112	8%
Hedge funds	291	21%
Insurance companies	319	23%
Finance companies	95	7%
Mutual and pension funds	57	4%
Leveraged sector	896	66%
Unleveraged sector	472	34%
Total	1368	100%

Table taken from Greenlaw et al. 2008.

In this way, the subprime crisis can be seen through the lens of the increased supply of loans—or equivalently, in the imperative to find new assets to fill the expanding balance sheets. This explains two features of the subprime crisis—first, why apparently sophisticated financial intermediaries continued to lend to borrowers of dubious creditworthiness and, second, why such sophisticated financial intermediaries held the bad loans on their own balance sheets, rather than passing them on to other, unsuspecting investors. Both facts are explained by the imperative to use up slack in balance-sheet capacity during an upturn in the credit cycle.

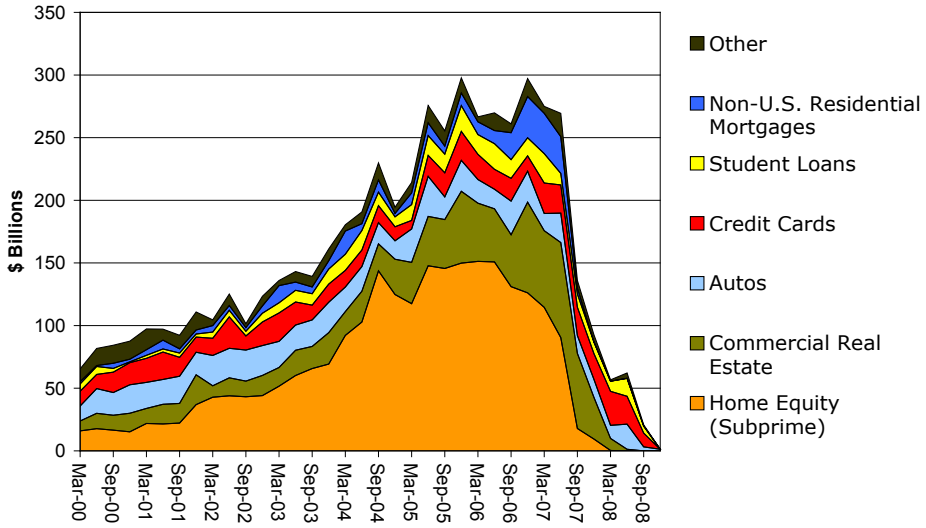
Table 2 shows that, of the approximately $1.4 trillion total exposure to subprime mortgages, approximately two-thirds of the potential losses were borne by leveraged financial institutions such as commercial banks, securities firms, and hedge funds. Thus, although securitization was meant to transfer credit risk to those who were better able to bear it, the

balance-sheet management of financial intermediaries appears to have achieved the opposite outcome—of concentrating risks in the financial intermediary sector itself.

CREDIT CRUNCH

The onset of the financial crisis in 2007 can be seen as the reversal of the boom scenario pictured in **Table 2,** in which benign capital market conditions were reflected in increased lending. When the tide began to turn in the summer of 2007, all the forces that combined to perpetuate the boom scenario turned to amplify the bust. Greenlaw et al. (2008) present an early attempt to quantify the balance-sheet contractions arising from subprime losses.

Figure 22. New Issuance of Asset Backed Securities in Previous Three Months (Source: JP Morgan Chase and Adrian and Shin (2009))

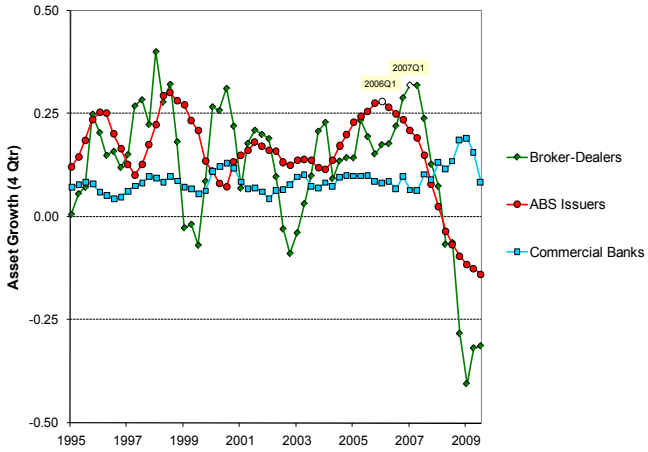


A dramatic picture of that reversal can be seen in **Figure 22**, which plots the flow of new credit from the issuance of new ABSs. Although the most dramatic fall is in the subprime mortgage category, the credit supply of all categories, ranging from auto loans and credit card loans to student loans, has collapsed.

However, the drying up of credit in the capital markets would have been missed if one paid attention only to bank-based lending. As seen in **Figure 23**, commercial bank lending has picked up pace since the start of the financial crisis, even as market-based providers of credit have contracted rapidly. Banks have traditionally played the role of a buffer for their borrowers

in the face of deteriorating market conditions (as during the 1998 crisis) and appear to have played a similar role in the 2007–2009 crisis.

Figure 23. Annual Growth Rates of Assets
(Source: US Flow of Funds, Federal Reserve)

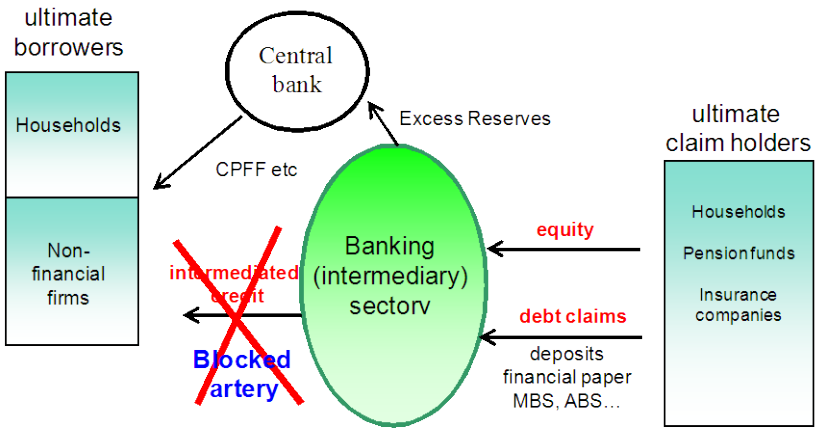


The credit crunch associated with the financial crisis is the collapse of balance-sheet capacity, especially for those financial intermediaries that operate in the capital markets. In an era in which loans are packaged into securities and balance sheets are continuously marked to market, the galvanizing role of market prices reaches into every nook and cranny of the financial system. In this way, the severity of the global financial crisis can be explained, in some part, by (*a*) financial developments that put marketable assets at the heart of the financial system and (*b*) the increased sophistication of financial institutions that held and traded the assets. To be sure, any substantial fall in house prices will cause solvency problems in the banking sector. However, the speed with which the crisis progressed, as well as the severity of the crisis, could be attributed at least in part to the feedback effects that magnified the distress. The role of mark-to-market accounting is one example of the debates that have received impetus from suspicions that such feedback effects contributed to the crisis.

POLICY RESPONSE

To the extent that the credit crunch resulted from a collapse of balance-sheet capacity in the financial intermediary sector, the Federal Reserve's policy response has been to counter the collapse through direct interventions to replace the lost balance-sheet capacity. **Figure 24** (see color insert) is an illustration.

Figure 24. Making Up the Lost Balance Sheet Capacity

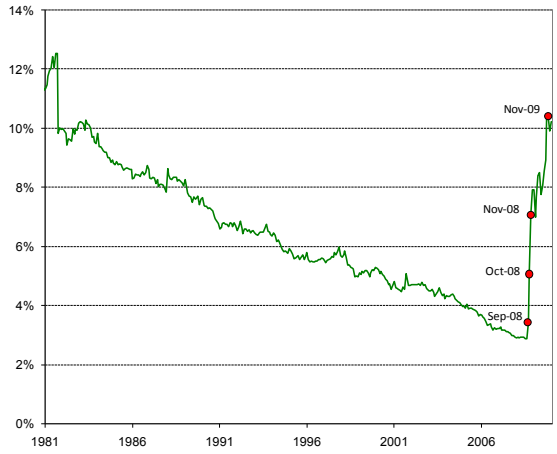


In **Figure 24**, the financial intermediation role normally played by the banking sector is impaired, because of the collapse of the ABS sector (shown in **Figure 22)**. The Federal Reserve's response was to make up for the lost balance-sheet capacity by interposing the Fed's balance sheet between the banking sector and the ultimate borrowers. The Fed took in deposits from the banking sector (through increased reserves) and then lent out the proceeds to the ultimate borrowers through the holding of securities (Treasuries, MBSs, and credit securities) and commercial paper, and through currency swap lines to foreign central banks. One indication of the increased Fed balance sheet can be seen in the sharp increase in cash holdings by U.S. commercial banks, as shown in **Figure 25** (see color insert). The increased cash holdings are reflected in an increase in the money supply—a liability of the Fed to the commercial banks.

In this way, central bank liquidity facilities have countered the shrinking of intermediary balance sheets and have become a key plank of policy, especially after short-term interest rates were pushed close to their zero bound. The management of the increased Federal Reserve balance sheet has been facilitated by the introduction of interest on reserves as of October 1, 2008, which effectively separates the management of balance-sheet size from the Federal Funds interest rate management (see Keister & McAndrews 2009 for a discussion of the "interest on reserves" regime on the Federal Reserve's balance-sheet management).

Figure 25. Cash as a Proportion of Total Assets of US Commercial Banks

(Source: H8 database, Federal Reserve)

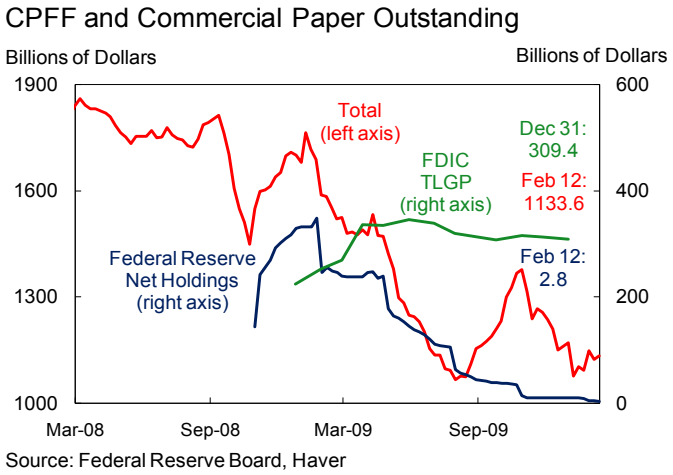


The Federal Reserve has also put in place various lender-of-last-resort programs under section 13(3) of the Federal Reserve Act to cushion the strains on balance sheets and thereby target the unusually wide spreads in a variety of credit markets. Liquidity facilities have been aimed at the repo market [the Term Securities Lending Facility (TSLF) and Primary Dealer Credit Facility (PDCF)], the commercial paper market [the Commercial Paper Funding Facility (CPFF) and Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF)], ABS markets [the Term Asset-Backed Loan Facility (TALF)], and the interbank market [the Term Auction Facility (TAF)].[2] In addition, the Federal Reserve has conducted outright purchases of Treasury and agency securities and has stabilized international borrowing imbalances via the foreign exchange futures markets (FX Swap lines). The common element in these liquidity facilities has been to alleviate the strains associated with the shrinking balance sheets of intermediaries. The narrowing of spreads is a byproduct of such actions. Whereas classic monetary policy targets a price (e.g., the Fed Funds rate), the liquidity facilities affect balance-sheet quantities.

One picture of the Fed's liquidity facilities can be seen in **Figure 26** (see color insert), which charts the total outstanding commercial paper as well as net Federal Reserve commercial paper holdings. Following the Lehman Brothers bankruptcy in September 2008, the outstanding amount of commercial paper began to fall precipitously, as shown by the sharp downward shift in the red line in **Figure 26**. With the creation of the CPFF in October 2008, the Fed's net holdings of commercial paper began to increase rapidly, as shown by the blue line in **Figure 26**. The Fed's holdings can be seen to replace, virtually dollar for dollar, the decline in the outstanding amount of commercial paper. In this respect, the Fed's balance sheet was being used

to directly replace the decline in balance-sheet capacity. The introduction of the Federal Deposit Insurance Corporation's Temporary Liquidity Guarantee Program in December 2008 led to a lengthening of debt issuance of financial intermediaries and a subsequent decline in both the CPFF usage and total outstanding commercial paper. Adrian et al. (2009c) give more detail about the functioning and the effects of the CPFF.

Figure 26. Commercial Paper Funding Facility (CPFF)



The TSLF was introduced just before the Bear Stearns crisis in March 2008. It is a temporary Federal Reserve Act 13(3) facility that allows the substitution of relatively illiquid collateral for liquid Treasury collateral via the triparty repo market. The TSLF addresses shortages of liquid relative to illiquid collateral. Whereas schedule 1 TSLF is restricted to a relatively narrow class of securities, schedule 2 includes investment-grade MBS, ABS, municipal, and corporate securities. By swapping relatively illiquid securities held by market participants with Treasuries held by the Fed, the borrowing capacity of financial intermediaries increases as securities with large haircuts (such as MBSs and ABSs) are replaced by securities with smaller haircuts (Treasuries). **Figure 27** (see color insert) shows that TSLF usage increased dramatically around the near-failure of Bear Stearns in March 2008 and the Lehman crisis in September 2008 but has since declined to zero. The recent decline of TSLF usage, in turn, indicates that the demand and supply imbalance of liquid versus illiquid collateral has abated, which might partially result from the increased availability of Treasury collateral. Fleming et al. (2009) give a more detailed introduction into the functioning of the TSLF.

Figure 27. Term Securities Lending Facility (TSLF)

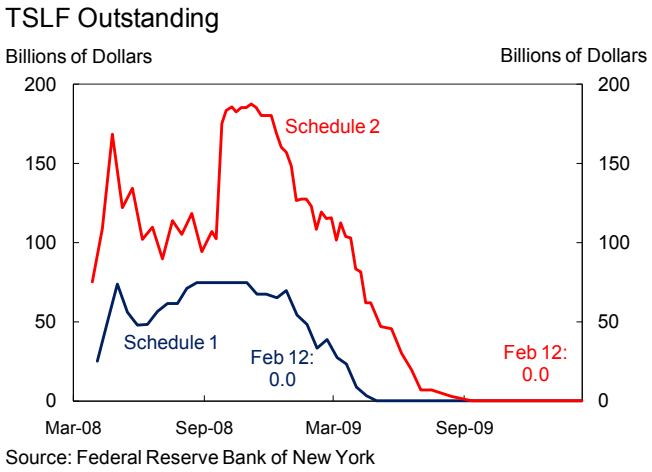
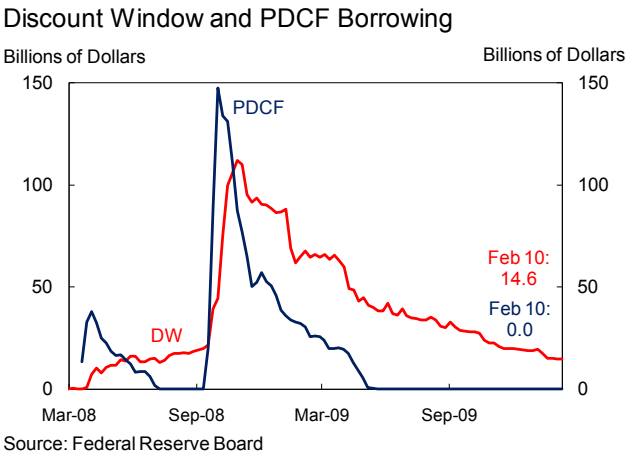


Figure 28 (see color insert) shows the total outstanding amounts of discount-window borrowing by commercial banks and the PDCF borrowing by primary dealers. As with the earlier figures, the Lehman Brothers bankruptcy marks a watershed for which the use of the Fed's facility peaks; a slow decline in the use of the facility followed as financial conditions began to improve in the spring of 2009. The PDCF is described by Adrian et al. (2009a).

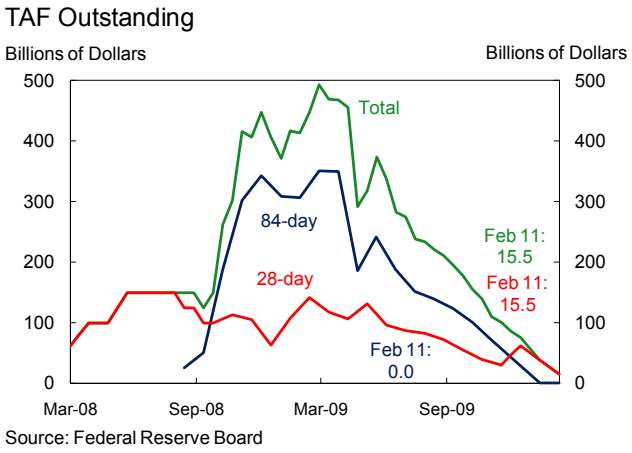
Figure 28. Discount Window and Primary Dealer Credit Facility



In September 2007, the Federal Reserve created the TAF, which allows commercial banks to borrow term at the discount window via an auction. The auction mechanism overcomes the problem of discount-window borrowing typically introducing a stigma effect. TAF was initially created in response to the collapse of the asset-backed commercial paper market in 2007, when commercial banks were forced to move onto their balance sheets the assets of conduits and

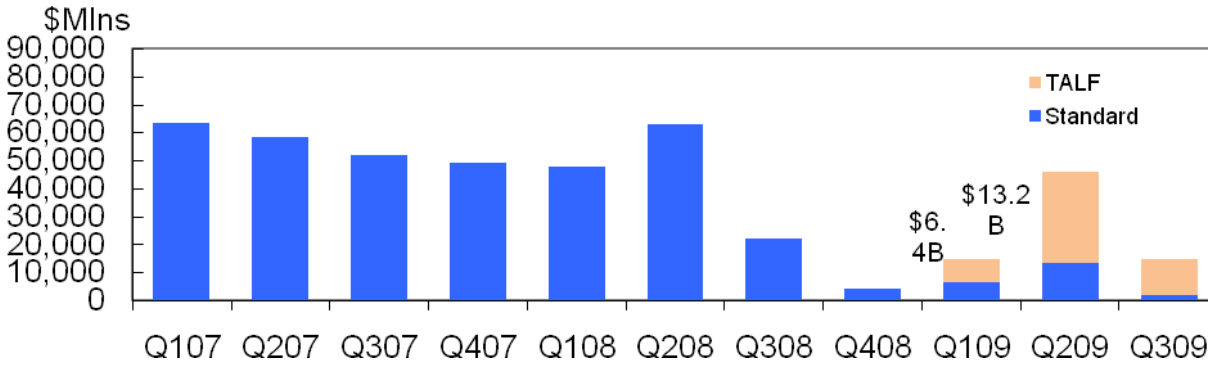
structured investment vehicles that they sponsored. This moved the funding needs from the asset-backed commercial paper market to the unsecured interbank borrowing market, leading to a sharp increase in the Libor-OIS spread. An introduction to the TAF is provided by Armantier et al. (2008). Usage of the TAF is provided in **Figure 29**.

Figure 29. Term Auction Facility



In November 2008, the Federal Reserve announced the creation of the Term Asset-Backed Securities Loan Facility (TALF), designed specifically to revitalize the ABS market. TALF is a facility whereby the Federal Reserve provides secured loans to new AAA-rated ABSs at a low haircut to private-sector investors. **Figure 30** (see color insert) shows the effect on new issuance of ABSs before and after the introduction of TALF. The light-colored bars on the right show that much of the issuance of ABSs is due to TALF, and that TALF-backed issuance dwarfs the issuance of standard issues. The bypass operation shown in **Figure 24** is very much apposite.

Figure 30. ABS issuance (Source: JP Morgan)



The expansion of the Federal Reserve's balance sheet in response to the financial crisis of 2007–2009 has refocused the monetary policy debate on the role of quantities in the monetary policy transmission mechanism. The financial crisis forcefully demonstrated that the collapse of the financial sector's balance-sheet capacity can have powerful adverse affects on the real economy. A good indicator for this causality is the sharp deterioration in real economic activity following the bankruptcy of Lehman Brothers on September 15, 2008. Additional evidence for this argument is provided by a sharp revision of real economic forecasts immediately following the Lehman crisis.

It may be argued that the crisis management efforts of a central bank are driven by special considerations that are not operative under so-called normal conditions. The counterargument is that the crisis did not erupt out of the blue but was instead the culmination of a long process of accumulated vulnerabilities that were left unchecked. The relevant question, then, is whether a rethinking of monetary transmission may have led to a better outcome.

REFOCUSING MONETARY POLICY

Monetary policy and lender-of-last-resort policies affect overall capital market conditions through the balance sheets of financial intermediaries. The variation of the Federal Funds target primarily moves around the slope of the yield curve, making the lend-long/borrow-short carry more or less profitable. Central bank liquidity facilities work through the equilibrium trade-off between credit spreads and haircuts. An increase of central bank lending against a particular asset class will tend to lower haircuts and spreads. As the financial crisis can be viewed as a shortage of financial intermediary balance-sheet capacity, lender-of-last-resort operations tend to offset the decline of that capacity. The Federal Reserve's balance-sheet expansion can thus be viewed as an emergency replacement for lost private-sector balance-sheet capacity.

Prior to 1980, the monetary policy literature primarily focused on the role of monetary aggregates in the supply of credit. However, with the emergence of the market-based financial system, the ratio of high-powered money to total credit (the money multiplier) became highly unstable. As a consequence, monetary aggregates faded from both the policy debate and the monetary policy literature.

However, there is a sense in which the focus on balance-sheet quantities is appropriate. The mechanisms that have amplified fluctuations in capital market conditions are the fluctuations in leverage and the associated changes in haircuts in collateralized credit markets.

Financial intermediaries lie at the heart of both monetary policy transmission and liquidity policies. The interaction of financial intermediaries' balance-sheet management with changes in asset prices and measured risks represents an important component in the transmission mechanism of monetary policy. Financial intermediaries' balance-sheet management matters both for the real economy and for the soundness of the financial system.

MACROPRUDENTIAL REGULATORY REFORM

The global financial crisis of 2007–2009 has given rise to a renewed impetus to reform the financial system. Whereas the current article's discussion of policy focuses primarily on ex post liquidity injections to financial intermediaries and markets that are outside of the traditional safety net, regulatory reforms aim at building a financial architecture that makes the system more stable from an ex ante point of view.

A major theme in regulatory reform efforts is macroprudential policy. Macroprudential policy is based on the insight that microprudential regulation might not give rise to the proper incentives from the perspective of the financial system as a whole. For example, deposit insurance and discount-window access address market failures that are primarily microeconomic (bank runs at depository institutions). Much of the existing banking regulation addresses the moral hazard that arises because of the tail risk insurance and liquidity provision via deposit insurance and discount-window access.

However, such microprudential regulation might not provide adequate incentives for the financial system as a whole. In particular, the rise of the shadow banking system can be seen as a response to the regulation of the core financial institutions, but the interconnection between those core institutions and the shadow banks effectively made the system as a whole more unstable. One way to reform the regulatory structure in line with macroprudential objectives is to make capital regulation directly proportional to each institution's contribution to the risk of the financial system as a whole. Adrian & Brunnermeier (2008), as well as Brunnermeier et al. (2009) and Acharya and Richardson (2009), offer regulatory reform proposals that focus on macroprudential policy.

SUMMARY POINTS

1. Securitization increased the fragility of the financial system by allowing banks and other intermediaries to leverage up by buying each other's securities.

2. A characteristic feature of financial intermediation that operates through the capital market is the long chain of financial intermediaries involved in channeling funds from the ultimate creditors to the ultimate borrowers.

3. In a market-based financial system, banking and capital market developments are inseparable, and fluctuations in financial conditions have a far-reaching impact on the workings of the real economy.

4. We can understand the fluctuations in leverage in terms of the implicit maximum leverage permitted by creditors in collateralized borrowing transactions, such as repos.

5. The fluctuations in leverage resulting from shifts in funding conditions are closely associated with periods of financial booms and busts.

6. For a bank, expanding its balance sheet means purchasing more securities or increasing its lending. But expanding assets means finding new borrowers. When all the good borrowers already have a mortgage, the bank has to lower its lending standards to capture new borrowers who were previously shut out of the credit market. The ballooning of subprime mortgage lending can be seen through this lens.

7. The credit crunch can be seen in the collapse of new ABS issuance.

8. To the extent that the credit crunch resulted from a collapse of balance-sheet capacity in the financial intermediary sector, the Federal Reserve's policy response has been to counter the collapse through direct interventions to replace the lost balance-sheet capacity.

FUTURE ISSUES

1. Financial stability and monetary policy should focus on tracking asset valuation distortions due to the excessive buildup of leverage and asset growth. Such financial stability monitoring should combine the use of quantitative asset pricing models, the collection of market intelligence, and the tracking of microeconomic distortions in the real economy.

2. The conduct of monetary policy should consider the effect of short-term interest rates on the leverage of financial institutions and should assess the risk-taking channel and credit channel of monetary policy quantitatively.

3. Quantitative easing via liquidity facilities and outright purchases are key tools central banks can use to counteract the implosion of private balance-sheet capacity during severe financial crises. The effectiveness and operation of such tools should be studied closely by central banks.

4. The relationship between the shadow banking system and the core commercial banking system was the nexus of the crisis. Understanding this nexus better, and monitoring the relationship between the commercial banking system and the shadow banking system, is key to avoiding future financial crises.

RELATED RESOURCES

Financial crisis timeline:

http://timeline.stlouisfed.org/

http://www.newyorkfed.org/research/global_economy/policyresponses.html

Federal Reserve overview of liquidity facilities:

http://www.newyorkfed.org/markets/funding_archive/

http://www.federalreserve.gov/monetarypolicy/bst.htm

Regulatory reform proposals:

http://www.squamlakeworkinggroup.org/

http://www.group30.org/pubs/pub_1460.htm

Policy work streams:

http://www.group30.org/pubs/pub_1460.htm

http://www.bis.org/stability.htm

LITERATURE CITED

Acharya V, Richardson M. 2009. *Restoring Financial Stability: How to Repair a Failed System*. New York: Wiley & Sons

Adrian T, Brunnermeier MK. 2008. CoVaR. *Fed. Reserve Bank NY Staff Rep. 348*. http://newyorkfed.org/research/staff_reports/sr348.html

Adrian T, Burke C, McAndrews J. 2009a. The Federal Reserve's Primary Dealer Credit Facility. *Fed. Reserve Bank NY Curr. Issues Econ. Finance* 15(4). http://www.ny.frb.org/research/current_issues/ci15-4.html

Adrian T, Marchioni D, Kimbrough K. 2009c. The Federal Reserve's Commercial Paper Funding Facility. *Fed. Reserve Bank NY Staff Rep. 423*. http://www.newyorkfed.org/research/staff_reports/sr423.html

Adrian T, Shin HS. 2007. Liquidity and leverage. *J. Financ. Intermediat*. In press*Fed. Reserve Bank NY Staff Rep. 328.* http://www.newyorkfed.org/research/staff_reports/sr328.html

Adrian T, Shin HS. 2008. Financial intermediary leverage and value at risk. *Fed. Reserve Bank NY Staff Rep. 338*. http://www.newyorkfed.org/research/staff_reports/sr338.html

Adrian T, Shin HS. 2009a. Financial intermediaries and monetary economics. In *Handbook of Monetary Economics, see also Fed. Reserve Bank NY Staff Rep.* 398. http://www.newyorkfed.org/research/staff_reports/sr398.html

Adrian T, Shin HS. 2009b. Money, liquidity and monetary policy. *Am. Econ. Rev. Pap. Proc.* 99(2):**.** See also *Fed. Reserve Bank NY Staff Rep. 360*. http://www.newyorkfed.org/research/staff_reports/sr360.html

Adrian T, Shin HS. 2009c. Prices and quantities in the monetary policy transmission mechanism. *Int. J. Central Bank.* 5:131–42. *Fed. Reserve Bank NY Staff Rep. 396*. http://www.ny.frb.org/research/staff_reports/sr396.html

Armantier O, Krieger S, McAndrews J. 2008. The Federal Reserve's Term Auction Facility. *Fed. Reserve Bank NY Curr. Issues Econ. Finance*. 14(5). http://www.ny.frb.org/research/current_issues/ci14-5.html

Ashcraft, A., A. Malz, and Z. Pozsar. 2010. The Federal Reserve's Term Asset-Backed Securities Loan Facility, unpublished working paper, Federal Reserve Bank of New York.

Brunnermeier M. 2009. De-ciphering the credit crisis of 2007. *J. Econ. Perspect.* 23(1):77–100

Brunnermeier M, Crockett A, Goodhart C, Persaud A, Shin HS. 2009. The fundamental principles of financial regulation. *Geneva Rep. World Econ. 11*. http://www.cepr.org/pubs/books/CEPR/booklist.asp?cvno=P197

Coffey N, Hrung W, Sarkar A. 2009. Capital constraints, counterparty risk and deviations from covered interest rate parity. *Fed. Reserve Bank NY Staff Rep. 393*. http://www.newyorkfed.org/research/staff_reports/sr393.html

Fleming MJ, Hrung WB, Keane FM. 2009. The Term Securities Lending Facility: origin, design, and effects. *Fed. Reserve Bank NY Curr. Issues Econ. Finance* 15(2). http://www.ny.frb.org/research/current_issues/ci15-2.html

Geanakoplos J. 1997. Promises, promises. In *The Economy as an Evolving Complex System II*, ed. WB Arthur, S Durlauf, D Lane, pp. 285–320. Reading, MA: Addison-Wesley

Geanakoplos J. 2010. The leverage cycle. In *NBER Macroeconomics Annual 2009*, ed. D Acemoglu, K Rogoff, M Woodford. Chicago: Univ. Chicago Press. In press

Gorton G. 2008. The subprime panic. *Proc. Fed. Reserve Bank Kansas City Symp. Jackson Hole*

Gorton G, Metrick A. 2009. *Haircuts*. Work. Pap., Yale School Manag., Yale Univ.

Greenlaw D, Hatzius J, Kashyap A, Shin HS. 2008. Leveraged losses: lessons from the mortgage market meltdown. *US Monet. Policy Forum Rep. 2*. http://research.chicagogsb.edu/igm/events/docs/USMPF-final.pdf

Keister T, McAndrews J. 2009. Why are banks holding so many excess reserves? *Fed. Reserve Bank NY Staff Rep. 380*. http://www.ny.frb.org/research/staff_reports/sr380.html

Shin HS. 2010. *Risk and Liquidity: Clarendon Lectures in Finance.* New York: Oxford Univ. Press. In press