Financial Intermediary Balance Sheet Management[*]

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February 2011

Summary. Conventional discussions of balance sheet management by non-financial firms take the set of positive net present value (NPV) projects as given, which in turns determines the size of the assets of the firm. The focus is on the funding of such assets between debt and equity. In contrast, the balance sheet management of financial intermediaries reveal that it is equity that behaves like the pre-determined variable, and the asset size of the bank or financial intermediary is determined by the degree of leverage that is permitted by market conditions. The relative "stickiness" of equity reveals possible non-pecuniary benefits to bank owners so that they are reluctant to raise new equity, even during boom periods when equity raising is associated with less stigma, and hence smaller discounts. We explore the empirical evidence both for market-based financial intermediaries such as the Wall Street investment banks, as well as the commercial bank subsidiaries of the large US bank holding companies. We further explore the aggregate consequences of such behavior by the banking sector for the propagation of the financial cycle and securitization.

Keywords. Capital, Debt, Leverage, Procyclicality, Securitization

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Summary points

1. Textbook discussions of balance sheet management by non-financial firms take the set of positive net present value (NPV) projects as given, which in turns determines the size of the assets of the firm. The focus is on the funding of such assets between debt and equity, where the relative mix is determined by the tradeoff between the tax advantages of debt and the potential for costs of financial distress when debt is too high.

2. In contrast, the balance sheet management of financial intermediaries reveal that it is equity that behaves like the pre-determined variable, and the asset size of the bank or financial intermediary is determined by the degree of leverage that is permitted by market conditions. Leverage of financial intermediaries is procyclical, where the procyclicality comes from expansions of the balance sheet during booms when intermediaries take on new assets, make new loans and purchase securities funded with new debt issuance.

3. Equity is "sticky" in the sense that even during the booms, banks do not fund their expanding balance sheet by raising new equity. The relative stickiness of equity reveals possible non-pecuniary benefits to bank owners so that they are reluctant to raise new equity, lest the new equity dilutes the inside owners' non-pecuniary benefits.

4. We explore the empirical evidence both for market-based financial intermediaries such as the Wall Street investment banks, as well as the commercial bank subsidiaries of the large US bank holding companies. We find that the procyclical leverage of commercial banks results in scatter charts of change in assets and leverage that are similar in shape to those for securities firms.

5. We further explore the aggregate consequences of such behavior by the banking sector for the propagation of the financial cycle and securitization. The fluctuations in intermediary balance sheets are closely associated with funding conditions and the perceived liquidity of financial markets.

Introduction

Banks and other financial intermediaries play the important role of channeling funding from savers to borrowers. In that respect, the balance sheet management of financial intermediaries have a far-reaching impact on the wider economy. The recent financial crisis has highlighted how much is at stake in the proper functioning of the intermediary sector, and hence how important it is to understand the motivation, mechanics, and the consequences of financial intermediary balance sheet management.

In a world where the Modigliani and Miller (1958) (MM) theorems hold, we can separate the decision on the size of the balance sheet (selection of the projects to take on) from the financing of the projects (composition of liabilities in terms of debt and equity).

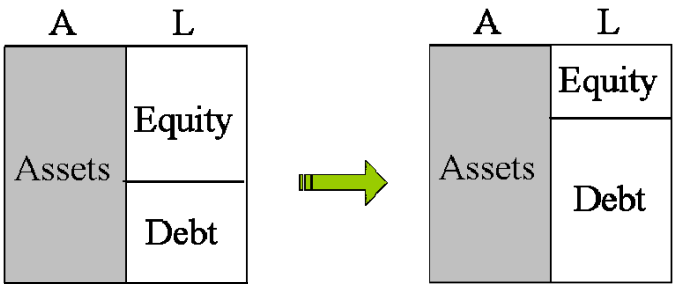
In popular textbook discussions of corporate financing decisions (see, for instance, Brealey, Myers and Allen (2009)), the set of positive net present value (NPV) projects is taken as being exogenously given. Thus, in such discussions, the size of the balance sheet is fixed and determined exogenously. The remaining focus is on the liabilities side of the balance sheet, in determining the relative mix of equity and debt. Textbook discussions deal with the tradeoffs involved when employing debt and equity. When capital markets are perfect and the conditions of the Modigliani and Miller (MM) theorems hold, then the mix of debt and equity is irrelevant to the value of the firm, and the capital structure of the firm is indeterminate.

Even when the conditions for the MM theorems do not hold, the textbook discussion starts with the assets of the firm as given, in order to focus on the financing decision alone. Miller (1977) raised the importance of taxes in influencing the corporate financing choice by making debt financing more attractive when debt interest payments are tax deductible. However, when there are costs associated with bankruptcy or financial distress more generally, then there is a tradeoff between debt and equity financing. The optimal capital structure is then determined by the optimal level of debt that strikes the best balance between high debt levels (with tax advantages) and low debt levels (which minimizes costs associated with bankruptcy).

In a static context, the choice can be depicted as in Figure 1 below. The assets of the firm are fixed, given exogenously by the set of projects that have positive net present value (NPV). The fixed nature of the assets of the firm is indicated by the grey shaded asset side of the balance

sheet. Having fixed the asset side of the balance sheet, the discussion turns on how those assets are financed – i.e. on the determination of the liabilities side of the balance sheet.

Figure 1. Choice of Mix of Debt and Equity Financing



On the left hand panel of Figure 1 is a balance sheet where the assets are financed predominantly by equity. The arrow indicates a shift in the funding mix where equity is replaced by debt. One way this could be accomplished is through the repurchase of equity by issuing debt. The leverage of the firm is defined as the ratio of assets to equity. Hence, the shift depicted in Figure 1 leads to an increase in the leverage of the firm, but without any change in the size of balance sheet as a whole.

Figure 2. Asset Growth and Leverage Growth

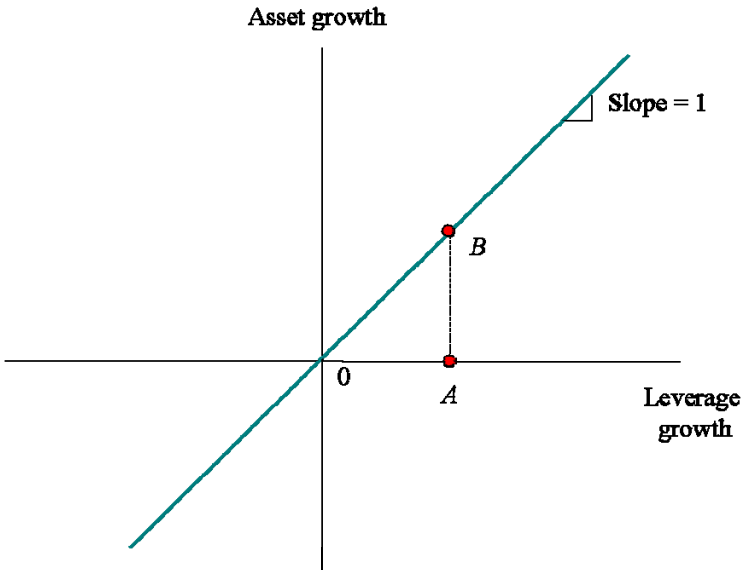


Figure 2 gives a useful diagrammatic device for visualizing changes in firm balance sheets. The horizontal axis gives the change in leverage of the firm, while the vertical axis gives the change in the assets of the firm itself. The changes in assets and leverage are measured in percentage terms. Point *A* in Figure 2 illustrates the increase in leverage given in Figure 1, where leverage increases through a shift in the composition of equity and debt, without a change in the asset size of the firm itself.

Even in a dynamic setting, if the assets of the firm evolves exogenously, the focus remains on the liabilities side of the balance sheet, and how the funding mix is determined between debt and equity. Leland (1994) presents a fully-fledged dynamic model where the assets of the firm evolves exogenously according to a diffusion process, and solves for the optimal financing between debt and equity given the trade-off between taxes and costs of financial distress.

By assuming that assets evolve exogenously, Leland's paper follows in the footsteps of Merton's (1974) celebrated examination of the pricing of corporate debt, using the insight that the payoff to holding debt is identical to holding a portfolio consisting of cash equal to the face value of the debt plus a short position in a put option on the assets of the firm, where the strike price is given by the face value of the debt.

Leland (1994) examines the initial once-and-for-all corporate financing decision where debt and equity choices are made at the beginning. This feature is shared with the original Merton (1974) model. However, to the extent that the asset value of the firm evolves dynamically, so does the leverage of the firm. Nevertheless, the change in the leverage of the firm is a consequence of the exogenous shift in the asset value of the firm.

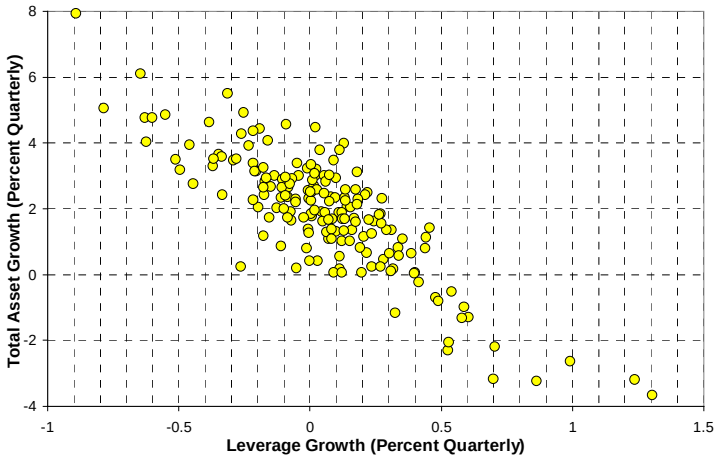
Relationship Between Leverage and Balance Sheet Size

When financing choices are made initially in a once-and-for-all way, then leverage changes result from the passive pricing effects of debt and equity. Consider a simple example of such shifts in leverage from a household balance sheet where the household has bought a house financed with a mortgage.

Suppose that the house is the only asset owned by the household. Then, as the house price fluctuates, so will the leverage of the household. Since the equity of the household changes much more sensitively in percentage terms than the asset value changes themselves, the leverage

of the household moves in the opposite way from the change in the household's asset value.

Figure 3. Relationship between Asset Growth and Leverage Growth for US Household Sector (Source: Adrian and Shin (2010))

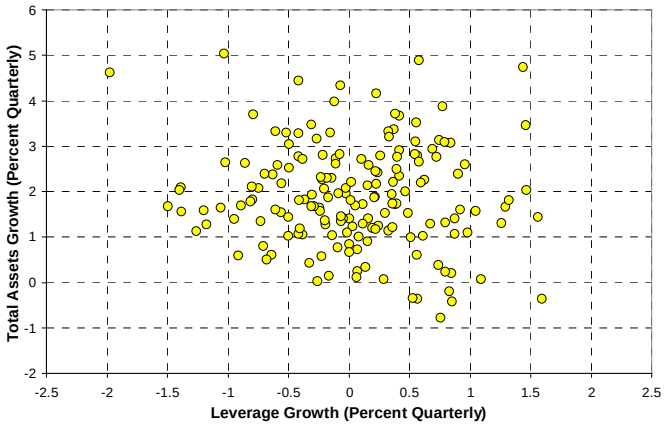


When the house price increases by 1%, the equity of the household will increase by approximately[1] 10% if the household is leveraged 10 to 1. Hence, leverage will fall when assets increase. Asset growth and leverage growth will thus be negatively related. Figure 3 shows the relationship between asset growth and leverage growth for the aggregate US household sector, taken from Adrian and Shin (2010). There is a clear negative relationship between the two, suggesting that leverage adjusts in a passive way for households.

For non-financial corporations, the relationship between asset growth and leverage growth is less clearly negative, as shown in Figure 4. The cluster of dots shows a less clearly negative relationship between asset growth and leverage growth, suggesting more active management of balance sheets. Nevertheless, a fitted regression line can still be shown to be negative, suggesting that for non-financial corporates, the predominant influence on the adjustment of leverage is through the passive impact of changes in asset values.

[1] The change in equity is only approximate, since the value of the debt is also shifting with asset value changes, in line with Merton's (1974) intuition that debt incorporates a short position in a put option. However, as long as the put option is far out-of-the-money, debt values will be relatively insensitive to shifts in assets, and equity values bear the burden of adjustment.

Figure 4. Relationship between Asset Growth and Leverage Growth for US Non-financial corporate sector (Source: Adrian and Shin (2010))



For financial firms, and in particular for banks and other financial intermediaries, there is evidence of much more active management of balance sheets, as compared to households and non-financial firms. In order to develop the point more clearly, it is useful to have some preliminary discussion on a framework for assessing active management of balance sheets.

First, consider the two axes in Figure 2. The vertical axis shows asset growth, which we can write as the change in the log assets of the firm from date t to date t+1. That is

$$\text{Asset growth} = \log A(t+1) - \log A(t)$$

Accordingly, leverage growth (the horizontal axis measure) can be defined as the change in log assets minus the change in log equity. In other words,

$$\text{Leverage growth} = \log A(t+1) - \log A(t) - (\log E(t+1) - \log E(t))$$

Then, the 45-degree line in Figure 2 represents the set of points where

$$\log E(t+1) - \log E(t) = 0$$

In other words, the 45-degree line represents the points where equity is unchanged. In Figure 2, point *B* corresponds to the change in the balance sheet where equity is unchanged, but only leverage increases so that the new leverage is the same as in point *A*.

Figure 5. Increased Leverage through Expansion in Balance Sheet Size

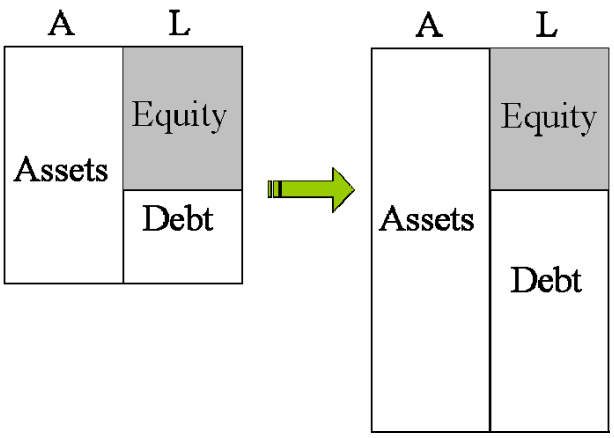
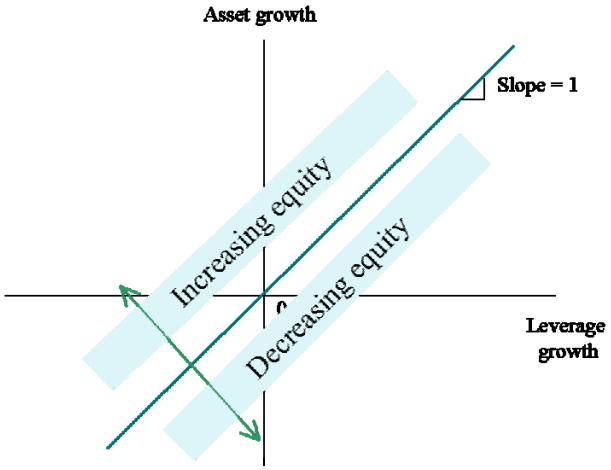


Figure 5 depicts the change in the firm's balance sheet that corresponds to point *B* in Figure 2. In Figure 5, it is equity that is shaded in grey so as to indicate that equity remains constant as the balance sheet increases in size. The firm takes on new assets funded by new issuance of debt and increases the total size of its balance sheet at the same rate as it increases its leverage.

Figure 6. Regions of Increasing and Decreasing Equity



The diagrammatical device for depicting shifts in the balance sheet can also yield information on whether equity is increasing or decreasing. In Figure 6, the points above the 45-degree line indicate the balance sheet shifts where asset growth is larger than leverage growth. That is, the set of points where we have:

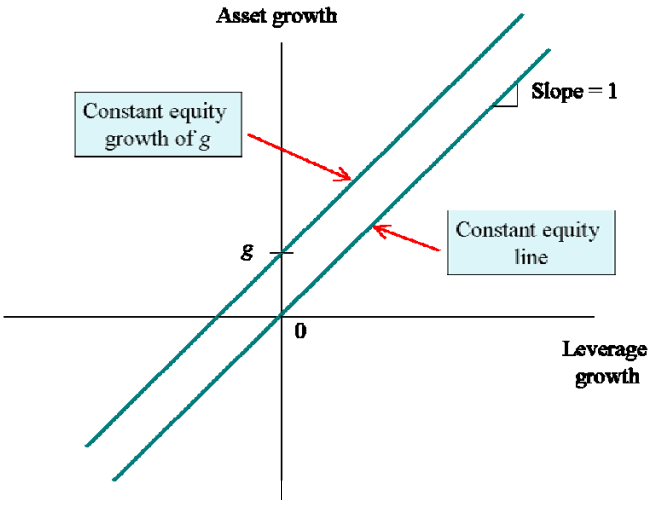
$$\log A(t+1) - \log A(t) > \log A(t+1) - \log A(t) - (\log E(t+1) - \log E(t))$$

or equivalently,

$$\log E(t+1) - \log E(t) > 0$$

In other words, the set of points above the 45-degree line indicate shifts in the balance sheet where equity is increasing, while the set of points below the 45-degree line indicate shifts where equity is decreasing. Indeed, any straight line with slope 1 and with intercept g indicates the set of points where equity is increasing at the rate g.

Figure 7. Set of Points with Constant Equity Growth

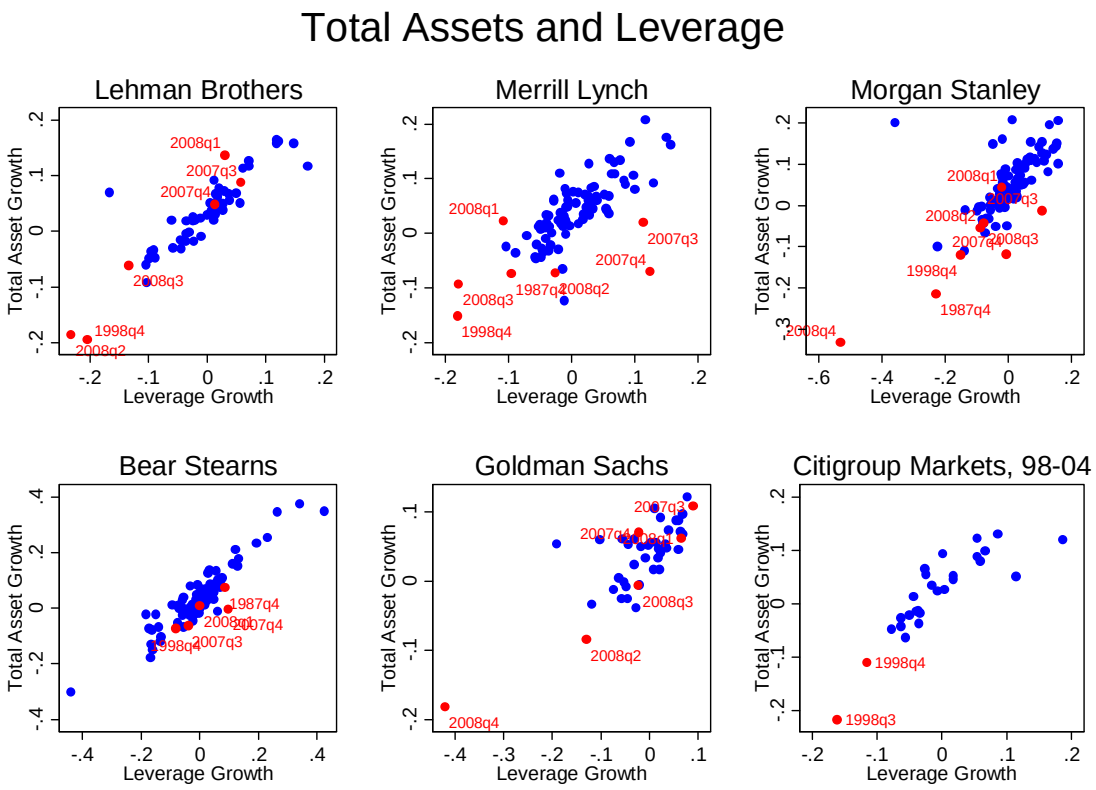


The distinguishing feature of banking sector assets is that they fluctuate over the financial cycle. Credit increases rapidly during the boom but increases less rapidly (or even decreases) during the downturn. Some of the variation in the size of banking assets could be accounted for by the fluctuations in the size of the pool of positive NPV projects, but some part of the fluctuations in banking sector assets may be due to shifts in the banks' willingness to take on risky positions over the cycle.

Figure 8, which is a chart taken from Adrian and Shin (2010) updated with data up to the end of 2008, shows the scatter chart the quarterly change in assets against the quarterly change in leverage of the (then) five stand-alone US investment banks plus Citigroup Global Markets (1998Q1 - 2004Q4) which reported independently of its parent until 2004. The (then) five stand-

alone US investment banks are Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch and Morgan Stanley.

Figure 8. US Investment Banks' Leverage and Total Assets
(Source SEC; Adrian and Shin (2010), updated)

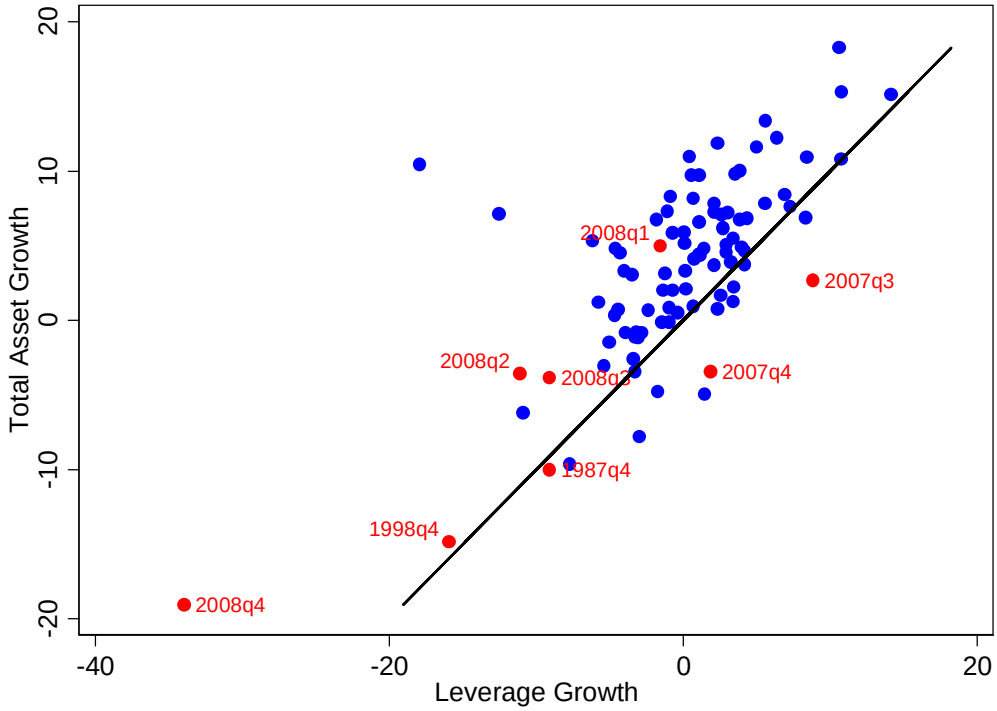


In Figure 8, we see that the slope of the scatter charts is close to 1, implying that we can describe equity as increasing at a constant rate on average. Thus, unlike the textbook discussion of the Modigliani-Miller theorem, or in the framework of Merton (1974) or Leland (1994), it is equity that seems to play the role of the pre-determined variable and total assets (the size of the balance sheet) is the endogenous choice variable that is determined by the willingness of banks to take on risky exposure given the realized value of equity.

In Figure 8, we see that in all cases, leverage is large when total assets are large – i.e., leverage is pro-cyclical. Figure 9 shows the scatter chart of the weighted average of the quarterly change in assets against the quarterly change in leverage of five investment banks. We can confirm from these figures the striking feature that leverage is pro-cyclical 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 compared to households or non-financial firms, whose leverage rises when balance sheets *contract*

Figure 9. Leverage Growth and Asset Growth of US Investment Banks (Source SEC; Adrian and Shin (2007), updated)



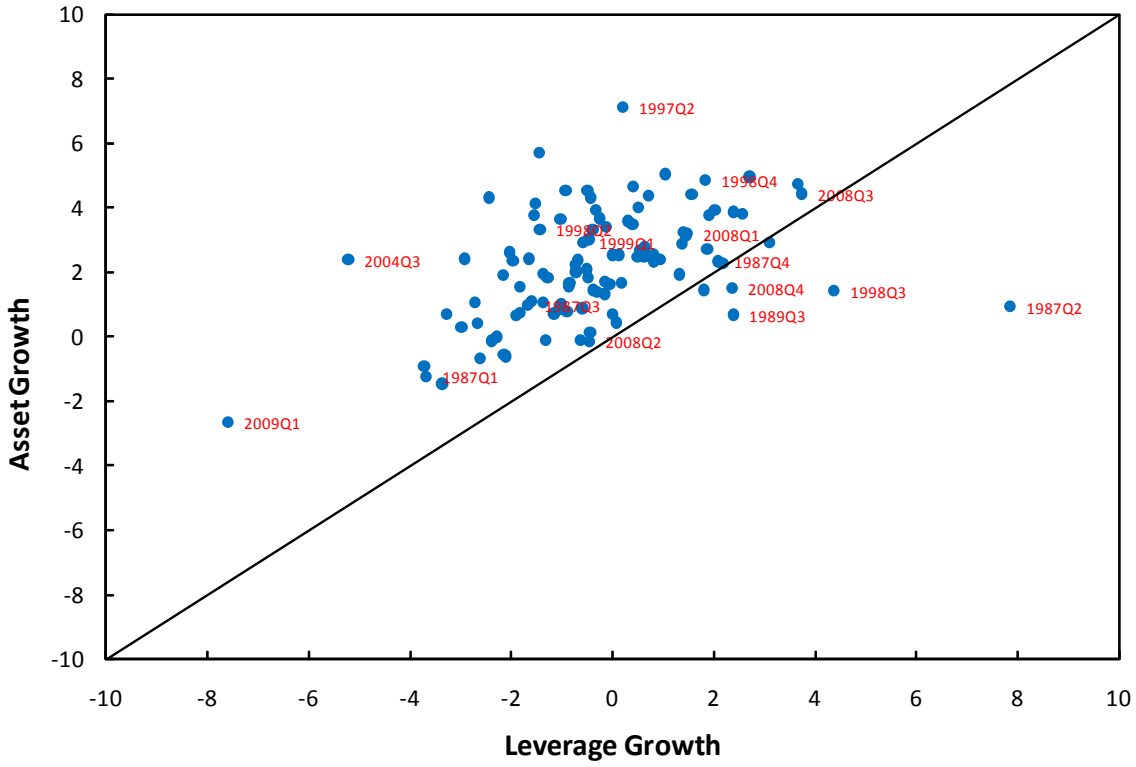
Pro-cyclical leverage offers a window on financial system liquidity. As reviewed above, the horizontal axis of Figure 9 measures the (quarterly) growth in leverage, as measured by the change in log assets minus the change in log equity. The vertical axis measures the change in log assets. We see that the realizations in the scatter plot in Figure 9 are clustered around a straight line with 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 being determined by the allowable leverage in operation at that date.

Although we have focused on the balance sheet adjustment of the market-based financial intermediaries, a similar picture emerges for commercial banks, which take up a much larger portion of the financial intermediary sector.

In Figure 10, we plot the asset and leverage changes of commercial banks from the FDIC's call reports. The total assets and total equity from this data is based on the balance sheet of the commercial bank subsidiary of larger bank holding companies. We first generate asset growth

and equity growth for each bank, for the period 1984Q1 to 2010Q1. We then aggregate asset growth and equity growth each quarter by value weighting with the previous quarters outstanding assets and equity. We then compute leverage growth for this aggregated series by taking the difference between log asset growth and log equity growth. Hence, growth rates are computed as log differences, and expressed in percent quarterly.

Figure 10. Leverage Growth and Asset Growth for US Commercial Banks (Source: FDIC Call Reports)



The chart shows that the commercial bank subsidiaries exhibit the procyclical leverage behavior similar to the investment banks studied above. However, there are some notable differences when inspecting the plot in more detail. First of all, the quarters that correspond to episodes of sharp deleveraging in the investment banking sector typically are not quarters where the commercial banking sector is unwinding. In particular, 2008Q3, 2008Q4, 1998Q3, and 1987Q4 are quarters where commercial banks increase leverage. The difference in the timing of balance changes is revealing in the respective role of commercial banks and market-based intermediaries. Commercial banks play a buffering role during downturns in the financial cycle, standing ready to provide financing when the financial market itself may be drying up. Commercial banks may offer lines of credit to their customers, who then turn to such credit lines when the financial

market is displaying signs of distress. Prior to the recent financial crisis, the previous instance of the divergent behavior of commercial banks and the market-based intermediaries was during the LTCM crisis of 1998, when bank credit substituted for the decline in market-based borrowing.

"Stickiness" of Equity

The important point to take away from Figure 10 is that commercial banks share with the investment banks the feature that leverage growth and asset growth are positively related, and that the scatter chart is aligned along the 45-degree line, indicating that equity is again the pre-determined variable that determines the other items on the balance sheet. In this respect, the empirical evidence on the balance sheet adjustment of banks has some interesting contrasts when compared to the textbook discussion of corporate finance and how balance sheets are determined.

First, the textbook discussions assume that the assets of the firm are given exogenously, and given by the set of positive NPV projects. Empirically, we see that the investment banks' assets vary widely over the cycle, often changing by more than 10% from one quarter to the next. If the textbook discussion is correct, then we must believe that the set of positive NPV value projects is also varying quite widely over the cycle.

Second, even if we entertain the possibility that the positive NPV projects vary so widely over the cycle, it is a challenge for the textbook discussion as to why equity is so "sticky" in the sense that equity is the pre-determined variable that increases at a constant rate on average, irrespective of the size of the balance sheet. If the textbook tradeoff theory of the capital structure were true, then we would expect to see the equity-debt mix to remain roughly stable, as long as the tax advantage and bankruptcy costs remain roughly constant. Instead, we see that equity is best characterized as growing at a constant rate, and all the adjustment in leverage comes from the shift in the size of total assets.

The fact that equity is "sticky" has some candidate explanations. During severe downturns when there are doubts about the solvency of the bank, the adverse selection problem associated with debt overhang will mean that any new equity will have go to repaying the existing debt holders rather than creating a stake on the assets for the new equity investors. Thus, during downturns, we would expect that equity is sticky and most of the adjustment is taken on by shrinking of

assets – that is, through the deleveraging of the banking sector. Hanson, Kashyap and Stein (2010) note that deleveraging of the intermediary sector will be associated with the contraction of credit to the economy, so that raising new equity should be given priority. However, if debt overhang is severe, then new equity issuance will be hampered and public injections of equity may be necessary.

Debt overhang during downturns is well understood, but what is more striking in Figure 9 is that equity seems to remain sticky even when assets are expanding during an upturn. When the financial intermediary is experiencing rapid asset growth, we would presume that the bank is well capitalized and that debt overhang is not an issue. However, the equity is still increasing at a constant rate on average, suggesting that equity remains "sticky" even during an upturn.

Adverse selection may still be important in such cases, too, as suggested by Myers and Majluf (1984), who present a framework with adverse selection where outside investors are less capable of assessing the true financial health of a firm than the managers themselves. Myers and Majluf (1984) argue that in such instances, any new equity raised by the existing owners will face a lemons problem and will suffer a discount relative to the true value of the claim. Thus, any new issuance will be associated with a dilution of the value of the stakes of the existing owners. Foreseeing this, the existing owners with control will be reluctant to raise new equity. Only those firms who are willing to accept the discount (and hence whose value is truly sub-par) will be issuing equity.

As well as the explanation for sticky equity by appeal to dilution arising from adverse selection, there may be other factors at work. Jensen and Meckling (1976) draw the distinction between the benefits enjoyed by equity holders who are "insiders" from those that are outsiders. The distinction is closely related to the issue of control and the benefits that arise from control. The benefits that accrue to insiders may be non-pecuniary, but they confer benefits to the insiders which may be diluted if new equity is issued and new stakeholders must share in the benefits. With respect to the decisions of an insider equity holder, Jensen and Meckling (1976) suggest that

> "decisions will involve not only the benefits he derives from pecuniary returns but also the utility generated by various non-pecuniary aspects of his entrepreneurial activities such as the physical appointment of the office, the attractiveness of the secretarial staff, the level of employee

> discipline, the kind and amount of charitable contributions, personal relations ("love", "respect" etc.) with employees, a larger than optimal computer to play with, purchase of production inputs from friends, etc." [Jensen and Meckling (1976, p. 312)]

Although Jensen and Meckling's (1976) discussion had mainly non-financial firms in mind, the non-pecuniary benefits may be even larger for financial firms and banks, in particular. The prestige and social status associated with financial firms may be even greater during boom periods when the perceived successes of such firms impart special status to the insiders of such firms. In emerging economies where the political economy factors are important, bank insiders with powerful political connections will derive additional benefits arising from such power that will be held closely within the group of insiders who control the bank. Even for advanced economies where the political economy factors arguably play a less important role, banks and other financial intermediaries may wield considerable influence through campaign contributions and other means to influence public discourse. Johnson and Kwak (2010) present a somewhat cynical perspective on the influence wielded by major banks in the United States in the aftermath of the recent financial crisis. Even if we do not accept such a cynical take, it would be reasonable to acknowledge the scope for non-pecuniary benefits that accrue to those with control of banks and other financial intermediaries, and hence the reluctance of insiders to dilute their controlling stake by financing the expansion of lending through the raising of new equity.

The stickiness of bank equity raises the possibility that there may be a divergence between the privately optimal level of bank capital and the socially optimal level. Admati, Demarzo, Hellwig and Pfleiderer (2010) make the case that standard arguments put forward by the banking industry against higher required capital for banks rest on weak foundations. In particular, they take issue with the claim that bank equity is an expensive form of funding relative to debt if the objective is to find the socially optimal capital structure for banks rather than the privately optimal one. Miles, Yang and Marcheggiano (2011) also argue that the socially optimal level of bank capital may be considerably higher than the conventional levels that have figured in regulatory levels up to now.

The stickiness of equity and the possible divergence between the privately optimal level of bank capital relative to the social optimum raises issues concerning the restrictions on depletion of bank capital through dividends. Rosengren (2010) has estimated that approximately $80 billion

of bank capital could have been retained in the 19 banks that underwent the U.S. stress tests (SCAP), had dividend payments been suspended promptly at the beginning of the financial crisis in the summer of 2007.[2] The sum paid out in dividends ($80 billion) is roughly half of the public capital injection into the SCAP banks through the U.S. government's Capital Purchase Program (CPP).

Balance Sheet Capacity

There is an additional perspective on the fluctuations in leverage drawing on the role of collateral in a collateralized borrowing arrangement. In particular, we can understand the fluctuations in leverage in terms of the implicit maximum leverage permitted by creditors in collateralized borrowing transactions such as repurchase agreements (repos). In a repo, the borrower sells a security today for a price 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 dollars for every 100 dollars worth of securities pledged; i.e., to hold 100 dollars worth of securities, the borrower must come up with 2 dollars of equity. Thus, if the repo haircut is 2%, the maximum permissible leverage (ratio of assets to equity) is 50.

Consider an example where the borrower leverages up to the maximum permitted level, consistent with maximizing the return on equity. The borrower then has 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 permitted leverage halves from 50 to 25. Either the borrower must double its equity, 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. Geanakoplos (2010) provides a general equilibrium framework where the haircut associated with collateralized borrowing arrangements can be determined endogenously.

[2] See also Acharya et al. (2010) for a detailed breakdown of dividend payouts and capital raising by U.S. and European banks during the crisis years

There is also a useful perspective on the fluctuations in leverage that comes from the risk management policies of financial intermediaries, as suggested by Adrian and Shin (2010). Suppose that banks aim to keep enough equity capital to meet its overall Value-at-Risk (VaR). If we denote by V the value at risk per dollar of assets, and A is total assets, then equity capital E must satisfy $E = V \times A$, implying that leverage L satisfies

$$L = A/E = 1/V$$

If Value-at-Risk is low in expansions and high in contractions, leverage is high in expansions and low in contractions – leverage is procyclical. Total assets are determined once the leverage of the firm is applied to the given equity.

The above discussion suggests that there is a well-defined notion of balance sheet capacity for financial intermediaries that depends on (i) the size of its capital base (its equity) and (ii) the amount of lending that can be supported by each unit of capital. Total assets are then determined by the multiplication of the two.

Balance sheet capacity increases during a boom, since the greater profitability of the banks adds to the capital base. In addition, measured risks are low during a boom, implying that the banks' willingness to lend for each unit of capital is also high.

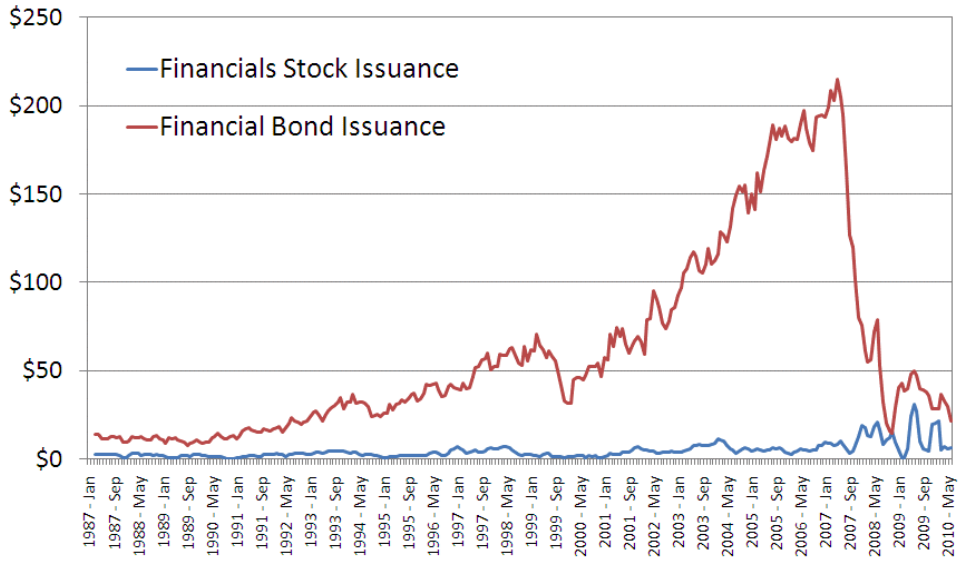
A high balance sheet capacity translates into a higher supply of credit. The greater supply of credit by the banking sector means that the size of the banking sector becomes large relative to the total credit system. An increased supply of loans may also imply a narrowing of risk spreads and/or the lowering of lending standards (see Adrian and Shin (2010) and Shin (2010) for a more formal development of the argument).

When booms turns to bust, the balance sheet capacity of the banking sector shrinks for two reasons. First, loan losses lower bank capital, while the greater measured risks lower the lending that is available for each unit of capital. When the downturn is severe, the lower balance sheet capacity may result in a credit crunch. Central bank intervention in the financial market such as the direct purchase of risky assets is one way to make up for the shortfall in private sector balance sheet capacity.

New Issuance of Debt

Given the highly procyclical nature of the banking sector balance sheet, we should expect increases in the debt-like liabilities of the banks to be the primary channel for the adjustment of balance sheets.

Figure 11. New Issuance of Debt and Equity for Financial Firms (Source: Federal Reserve Board and Securities Data Company)



Some insight into the balance sheet changes can be gained by examining new debt issuance by the financial sector. Figure 11 gives the time series for new issuance of stock and bonds for financial firms. The data is compiled by the Federal Reserve Board based on the Securities Data Company, and is available at a monthly frequency. We plot the average issuance within each quarter starting in 1987. We plot both the issuance of stocks and of bonds of the financial sector.

In Figure 11, we note that there is a striking increase in new debt issuance relative to the issuance of equity in the period preceding the financial crisis. What is particularly noteworthy about Figure 11 is that equity issuance stayed low, while debt issuance was increasing rapidly between 2001 and 2007. Thus “leverage at issuance” kept rising.

One might raise the concern that the sharp increase of financial sector debt issuance could be an artifact of the shortening of debt maturity. Figure 12 shows that this was not the case during between 2001 and 2007. In particular, the maturity structure of issuance broken down into 1 - 5 year, 6 -10 year, and >10 year buckets did not change drastically during the years of the housing

boom. Measured in terms of ratings, the rapid issuance of financial sector debt also did not coincide with a deterioration of credit quality at issuance. The share of AAA and AA debt increased relative to the issuance of A or lower rated financial sector debt, although with the benefit of hindsight, the high ratings did not guarantee credit quality.

Figure 12.

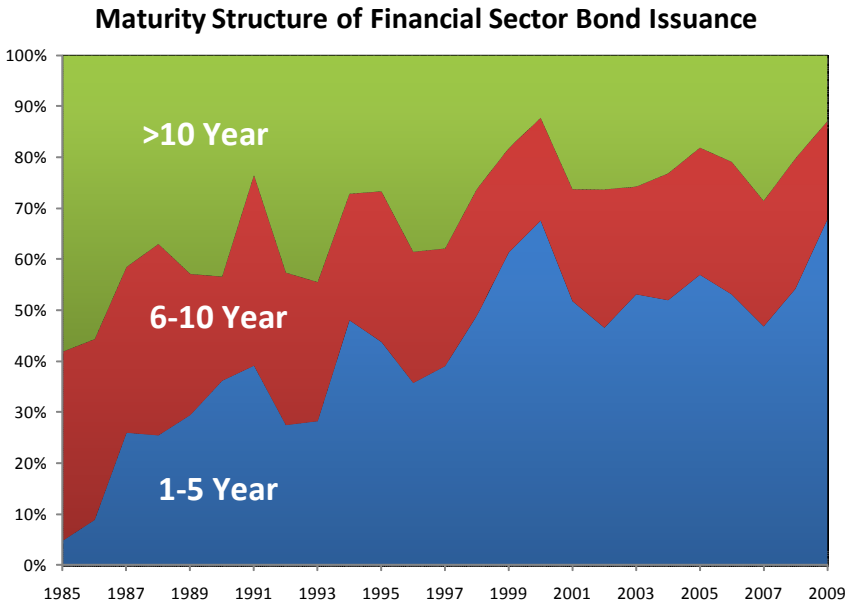


Figure 13.

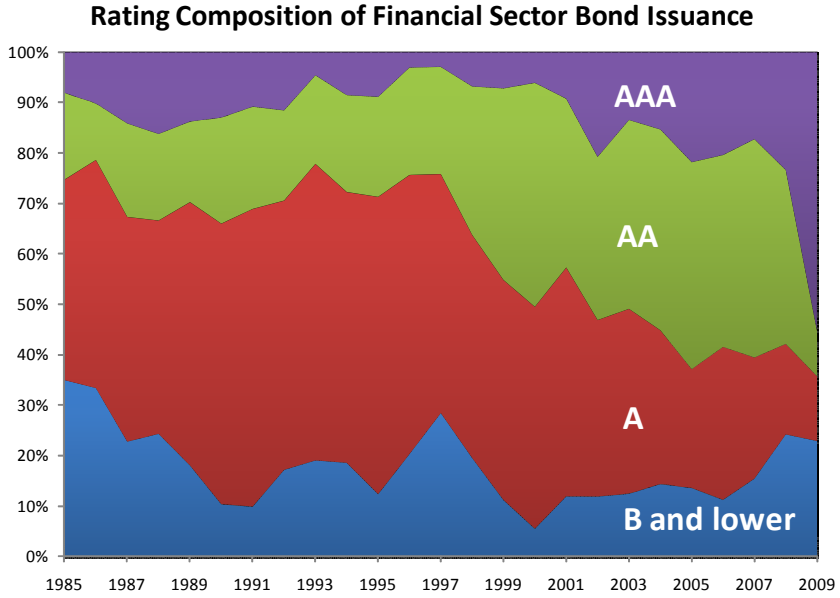
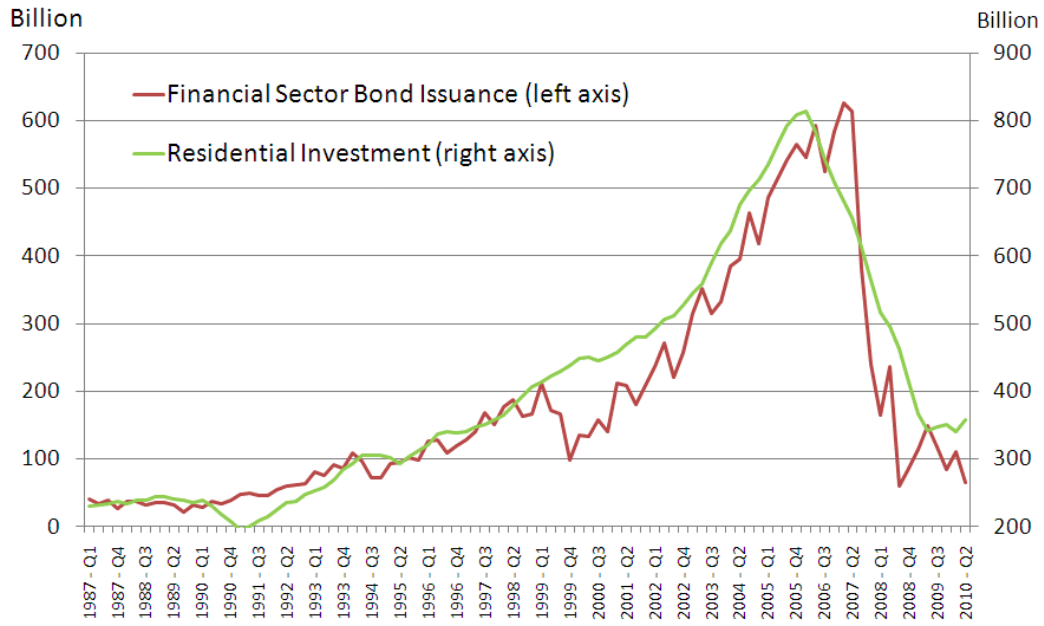


Figure 14. Financial Sector Bond Issuance and Residential Investment



One series that closely tracks the new issuance of debt is the series for residential investment, given in the Figure 14. This evidence suggests the hypothesis that the expansion and contraction of the housing market and the financial sector debt are feedking off each other.

In Figure 14, we have plotted the new bond issuance superimposed on the flow of residential investment. In order to compare the magnitude of the series, we have taken the sum of debt issuance within each quarter (so the issuance is three times the one of the previous chart). We do that because investment is a quarterly series that is cumulative for each quarter.

Shleifer and Vishny (2009, 2010a, 2010b) discuss the spillover effects with the balance sheet adjustment of financial intermediaries, both “on the way up” during financial booms and on the “way down” during downturns. In particular, they emphasize the effect of firesales of bank assets that were built up during the boom and financed with new debt issuance, but which are shed during the deleveraging episode. Since the natural holders of bank assets are other banks, the firesale associated with deleveraging episodes are associated with deeper and more disruptive adjustments than would otherwise would be the case.

Aggregate Implications

As new debt is issued, there will also be implications for the composition of debt funding. The core funding available to the banking sector is retail deposits of household savers. However, retail deposits grow in line with the aggregate wealth of the household sector. In a lending boom when credit is growing very rapidly, the pool of retail deposits is not sufficient to fund the increase in bank credit. Other sources of funding are tapped to fund rapidly increasing bank lending. The state of the financial cycle is thus reflected in the composition of bank liabilities.

Figure 15. Northern Rock's Liabilities (1998 – 2007)

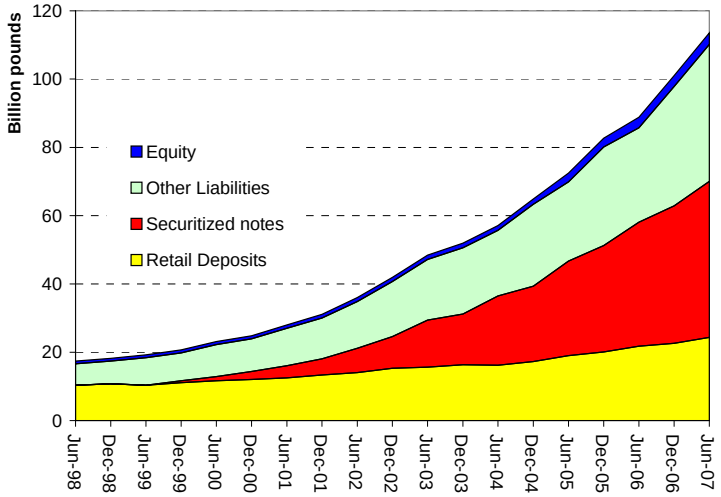
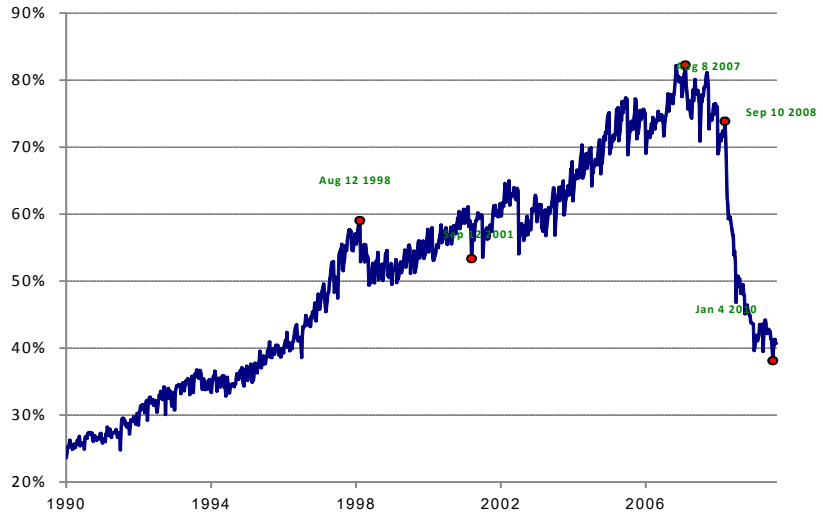


Figure 15 shows the composition of the liabilities of Northern Rock, the UK bank whose failure in 2007 heralded the global financial crisis. In the nine years from 1998 to 2007, Northern Rock's lending increased 6.5 times. This increase in lending far outstripped the funds raised through retail deposits (in yellow), with the rest of the funding gap being made up with wholesale funding (in red and light blue).

Northern Rock's case illustrates the general lesson that during a credit boom, the rapid increase in bank lending outstrips the core deposit funding available to a bank. As the boom progresses, the bank resorts to alternative, non-core liabilities to finance its lending. Therefore, the proportion of non-core liabilities of banks serves as a useful indicator of the stage of the financial cycle and the degree of vulnerability of the banking system to a downturn of the financial cycle.

The role of non-core liabilities in signaling the stage of the financial cycle can also be seen at the aggregate level. Figure 16 plots data from the United States and charts the stock of repurchase agreements (repos) of US primary dealers[3] plus the stock of financial commercial paper expressed as a proportion of the M2 money stock.

Figure 16. Repos and Financial CP as Proportion of M2
(Source: US Federal Reserve)[4]



M2 consists of retail deposits and holdings in money market funds, and thus can be regarded as retail depositors' claim on the broader banking system. As recently as 1990, repos and financial CP were only a quarter of the size of M2. However, the ratio rose rapidly and reached over 80% by August 2007, only to collapse with the onset of the financial crisis.

Financial System Risk

Consider a domestic financial system consisting of ultimate borrowers (domestic firms and households) and ultimate creditors (domestic households). The domestic banking sector channels funds from ultimate creditors to ultimate borrowers. There is also a foreign creditor sector who stands ready to supply funds to the domestic banking sector.

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[3] US primary dealers are US banks and securities firms that have a daily trading relationship with the Federal Reserve, and which are permitted to bid at the auctions of US Treasury securities.
[4] See Adrian and Shin (2010) "The Changing Nature of Financial Intermediation and the Financial Crisis of 2007-09" http://www.princeton.edu/~hsshin/www/ar2010.pdf

Suppose there are *n* banks in the domestic banking system. The term "bank" should be interpreted widely, to include securities firms and other intermediaries. We denote the banks by an index that takes values in the set {1, 2, …, *n*}.

The domestic household creditor sector is given the index *n* +1. The foreign creditor sector is given the index *n* +2.

Bank *i* has two types of assets. First, there are loans to end-users such as corporates or households. Denote the loans by bank *i* to such end users as y_i. Next, there are the claims against other financial institutions. Call these the "interbank" assets, although the term covers all claims on other intermediaries. The total interbank assets held by bank *i* are

$$\sum_{j=1}^{n} x_j \pi_{ji}$$

where x_j is the total debt of bank *j* and π_{ji} is the share of bank *j*'s debt held by bank *i*.

Note that $\pi_{i,n+1}$ is the proportion of the bank's liabilities held by the domestic creditor sector (e.g. in the form of deposits), while $\pi_{i,n+2}$ is the proportion of the bank's liabilities held by foreign creditors (e.g. in the form of short-term foreign currency-denominated debt)

Since "banks" *n*+1 and n+2 are not leveraged, we have $x_{n+1} = x_{n+2} = 0$. The balance sheet identity of bank *i* is given by

$$y_i + \sum_{j=1}^{n} x_j \pi_{ji} = e_i + x_i$$

The left-hand side is the total assets of the bank. The right-hand side is the sum of equity and debt. Letting $x = \begin{bmatrix} x_1 & \cdots & x_n \end{bmatrix}$ and $y = \begin{bmatrix} y_1 & \cdots & y_n \end{bmatrix}$, we can write in vector notation the balance sheet identities of all banks as

$$y + x\Pi = e + x$$

where Π is the matrix whose (i, j)th entry is π_{ij}. Solving for *y*,

$$y = e + x(I - \Pi)$$

Define leverage as the ratio of total assets to equity, given by

$$\frac{a_i}{e_i} = \lambda_i$$

Then defining Λ as the diagonal matrix with λ_i along the diagonal,

$$y = e + e(\Lambda - I)(I - \Pi)$$

where Π is the matrix of interbank liabilities. By post-multiplying the above equation by the unit vector

$$u = \begin{bmatrix} 1 \\ \vdots \\ 1 \end{bmatrix}$$

We can sum up the rows of the vector equation above, and we have the following balance sheet identity.

$$\sum_i y_i = \sum_i e_i + \sum_i e_i z_i (\lambda_i - 1)$$

where is given by the *i* th row of $(I - \Pi)u$. Here, z_i has the interpretation of the proportion of the bank's liabilities that come from outside the banking sector – i.e. the proportion of funding that comes either from the ultimate domestic creditors (e.g. deposits) or the foreign sector (e.g. foreign-currency denominated banking sector liabilities).

Therefore, we can re-write the aggregate balance sheet identity in the following way.

Total Credit = Total Equity of Banking Sector
+ Liabilities to Non-bank Domestic Creditors
+ Liabilities to Foreign Creditors

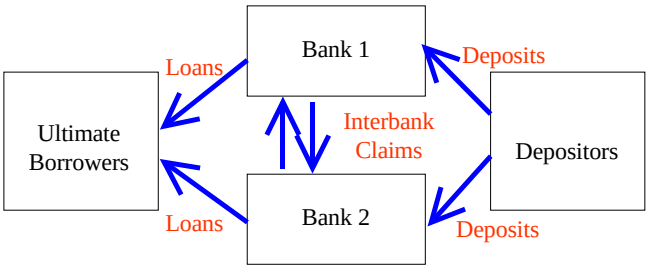
The accounting framework outlined above helps us to understand the connection between (i) the procyclicality of the banking system, (ii) systemic risk spillovers, and (iii) the stock of non-core liabilities of the banking system. Let us define the core liabilities of a bank as its liabilities to the non-bank domestic creditors (such as through deposits). Then, the non-core liabilities of a bank is either (i) a liability to another bank, or (ii) a liability to a foreign creditor.

In a boom when credit is growing very rapidly, the growth of bank balance sheets outstrips the growth in the pool of retail deposits. As a result, the growth of bank lending results in greater lending and borrowing between the intermediaries themselves, or results in the sucking in of foreign debt.

Interconnectedness and Systemic Risk

Rapid asset growth and greater reliance on non-core liabilities are closely related to systemic risk and interconnectedness between banks. In a boom when credit is growing rapidly, the growth of bank balance sheets outstrips available core funding, and asset growth is mirrored in the greater cross-exposure across banks. Consider a stylized banking system in Figure 17 with two banks – Bank 1 and Bank 2. Both banks draw on retail deposits to lend to ultimate borrowers. They also hold claims against each other.

Figure 17. Stylized Financial System



Imagine a boom where the assets of both banks double in size, but the pool of retail deposits stays fixed. Then, the proportion of banking sector liabilities in the form of retail deposits must fall, and there must be increased cross-claims across banks. In this sense, the growth in bank assets and increased interconnectedness are two sides of the same coin.

The relationship between banking sector assets and increased cross-exposures across banks holds more generally as an accounting identity. Define the *core liabilities* of a bank as its liabilities to claimholders who are not financial intermediaries themselves. Retail deposits would be the best example of core liabilities. Covered bonds held by a pension fund would also count as a core liability. However, any liability of an intermediary held by another intermediary would be a *non-core liability*. Under this definition, we have the following accounting identity[5] for the total core liabilities of the banking sector:

$$\text{Total Core Liabilities} = \sum_{i=1}^{n} e_i z_i (\lambda_i - 1)$$

where e_i is the equity of bank i, λ_i is the leverage of bank i, z_i is the ratio of bank i's core liabilities to its total liabilities, and n is the number of banks in the banking system. Since total core liabilities (retail deposits) are slow-moving, a rapid increase in total bank assets (equity times leverage) must result in lower z_i values, implying a greater reliance on non-core funding.

In this way, there are close conceptual links between procyclicality, interconnectedness and the stock of non-core liabilities of the banking system. In a boom, we have the conjunction of three features:

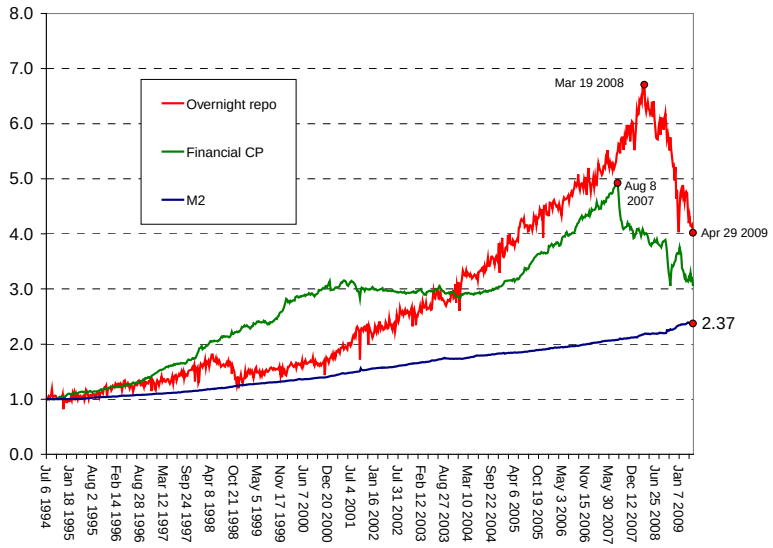
- Total lending increases rapidly
- Non-core (including foreign currency) liabilities increase as a proportion of total liabilities
- Systemic risk increases through greater cross-holdings between intermediaries

[5] See Shin (2010) *Risk and Liquidity*, Clarendon Lectures in Finance, Oxford University Press, Chapter 9.

In this respect, systemic risk is procyclical and excessive asset growth lies at the heart of the increase in bank interconnectedness. Therefore, addressing excessive asset growth in booms will go a long way toward mitigating systemic risks and the cross-exposure across banks.

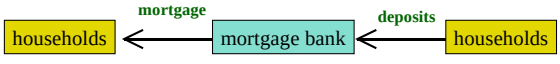
The growth in non-core liabilities is accompanied by the shortening of maturity of the liabilities. Figure 18 plots three series for the US: the size of the *overnight* repo stock, the total stock of financial commercial paper and M2, all normalized to equal 1 on July 6th, 1994. In Figure 18 we see that M2 grows by a factor of 2.4, but overnight repos grow seven-fold before collapsing with the onset of the crisis in 2008.

Figure 18. Overnight Repos and M2 (weekly data)
(Normalized to 1 on July 6th 1994. Source: Federal Reserve)



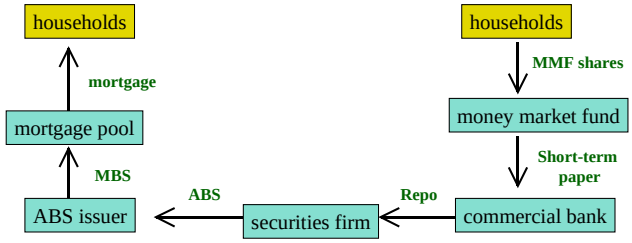
The prevalence of short-maturity liabilities is a consequence of longer intermediation chains and the need to maintain a lending spread for each link in the chain. Figure 19 depicts a traditional deposit-taking bank that collects deposits and holds mortgages. All banking liabilities are core liabilities in such a system.

Figure 19: Short Intermediation Chain



However, lengthening intermediation chains increases cross exposures across intermediaries. In Figure 20, mortgage assets are held in a mortgage pool, but mortgage-backed securities are owned by an asset-backed security (ABS) issuer who pools and tranches the MBSs into another layer of claims, such as collateralized debt obligations (CDOs). Then, a securities firm might hold CDOs and finances them by pledging them as collateral to a commercial bank through repurchase agreements (repos). The commercial bank in turn funds its lending to the securities firm by issuing short term liabilities such as financial commercial paper. Money market mutual funds complete the circle, and household savers own shares to these funds.

Figure 20: Long Intermediation Chain



The illustration in Figure 20 is a simple example of potentially much more complex and intertwined relationships. At each stage of the intermediation chain, the funding interest rate must be lower than the asset interest rate. As the intermediation chain becomes longer, more short-term funding must be used to support the chain, as short-term funding tends to be the cheapest. In this way, the prevalence of short-term debt is a natural consequence of the increased weight of non-core liabilities in the intermediary sector.

What is noticeable from the institutions involved in Figure 9 is that they were precisely those institutions that were at the sharp end of the recent financial crisis. Subprime mortgages cropped up in this chain, and the failure of Bear Stearns and Lehman Brothers owed to problems in the smooth function of this chain.

Understanding the role of non-core funding in the financial cycle gives some insights into the role of securitization. Securitization can be seen as a way for intermediaries to tap non-deposit funding by creating securities that can be pledged as collateral. The demand for collateral assets is therefore a demand for leverage. In this respect, subprime lending in the US can be seen as a

reflection of the wider principle that the growth of non-core funding is a sign of excessive asset growth in a lending boom.

Shadow Banking

Pozsar et al (2010) provide a detailed overview of the shadow banking system. Shadow banks are financial entities that conduct either all three or any one of the classic bank functions: A) credit transformation, B) maturity transformation, C) liquidity transformation, but without the liquidity and credit puts provided by the discount window and deposit insurance. Much of the interaction between financial intermediaries and financial markets is conducted by these "shadow banks." Pozsar et al (2010) provide a breakdown of a typical intermediation chain into seven steps:

1. Loan Origination: finance companies, industrial loan companies, and commercial banks
2. Loan Warehousing: single and multiseller conduits
3. ABS Issuance: RMBS, CMBS, ABS
4. ABS Warehousing: broker-dealer warehousing
5. ABS CDO and Synthetic CDO Issuance: primarily provides market for shorting
6. ABS Intermediation: SIVs, TOB, HF, foreign entities
7. Wholesale Funding: 2(a)-7 fund, enhanced cash fund, offshore money funds

In the first step of the intermediation chain, loans or mortgages are originated by institutions such as finance companies or commercial banks. These loans are then warehoused temporarily in conduits, which are bankruptcy remote special purpose vehicles with primary funding the ABCP market. Such conduits are typically not endowed with any equity, but instead are able to issue commercial paper due to credit lines provided by sponsoring commercial banks.

The third step of the shadow banking intermediation chain consists in the issuance of asset backed securities. ABS are pools of loans or mortgages that issue tranches of debt that are rated according to the seniority of cash flows to which each of the tranches corresponds. Different tranches of the ABS are then potentially re-securitized in CDOs. The resecuritization necessitates ABS warehousing by the broker dealers that engineer the CDOs. CDOs have the economic role of facilitating short selling of structured credit products. CDOs are tranches of ABS, particularly the mezzanine tranches. The sixth step in the shadow banking intermediation chain consists of

maturity transformation that is conducted by structured investment vehicles (SIVs) or credit hedge funds.

Finally, the seventh step consists of the funding by money market mutual funds that hold repo, commercial paper, and other short term debt of the maturity transformation vehicles. The entirety of the shadow banking system intermediates between the ultimate savers and ultimate borrowers much like a traditional commercial bank does.

The Role of Securitization

Even as the secondary market for existing securities has come back to life after the global financial crisis of 2007-9, new private issuance activity is barely a trickle compared to the years before the crisis. Some ask if securitization in some markets will ever return.

We can obtain some clues on the answer by studying the implications of discussion above, and considering the role played by the banking sector in the boom years. Securitization was meant to disperse risks associated with bank lending so that deep-pocketed investors who were better able to absorb losses would share in the risks. When the crisis dented this benign view of securitization, conventional wisdom swung to the opposite extreme and emphasized the chain of unscrupulous operators who passed on bad loans to the greater fool next in the chain. One could dub this the "hot potato" argument. The idea was attractively simple, and there was a convenient villain to blame, and so has figured in countless speeches given by central bankers and politicians on the causes of the subprime crisis.

But the new conventional wisdom is just as flawed as the old one. Remember that the bulk of the losses were borne by the banking sector. Roughly two third of the losses from subprime mortgages were borne by the banks themselves.[6] Of the remaining one third borne by non-banks, AIG accounts for a large chunk, and so relatively little of the losses from subprime fell on the unsophisticated final investors. In this way, rather than dispersing credit risk into the hands of final investors, securitization served to concentrate credit risk in the banking sector itself – a sector that is leveraged, and hence most vulnerable to credit losses.

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[6] Greenlaw, Hatzius, Kashyap and Shin (2008) "Leveraged Losses: Lessons from the Mortgage Market Meltdown" http://research.chicagogsb.edu/igm/events/docs/USMPF-final.pdf

In a traditional banking system that intermediates between savers and borrowers, the core funding available to the banking sector is retail deposits, which grow in line with the aggregate wealth of the household sector. However, during a credit boom, the rapid increase in bank lending outstrips the core deposit funding available to a bank. As the boom progresses, the bank resorts to alternative, non-deposit funding to finance its lending.

Securitization is a way for intermediaries to tap non-deposit funding by creating securities that can be pledged as collateral. Securitization opens up new sources of funding such as from domestic pension funds and mutual funds, as well as from foreign investors including foreign central banks who hold US GSE securities. The demand for collateral assets for securitization is therefore a demand for leverage. As balance sheets expand, new borrowers must be found. When all prime borrowers already have a mortgage, but still balance sheets need to expand, then banks have to lower their lending standards in order to create more collateral assets. Subprime is thus born.

One has to distinguish *selling a bad loan* down the chain and *issuing liabilities backed by bad loans*. By selling a bad loan, you get rid of the bad loan from your balance sheet. In this sense, the hot potato is passed down the chain to the greater fool next in the chain. However, issuing liabilities backed by bad loans does not get rid of the bad loan. The hot potato is sitting on your balance sheet or on the books of the special purpose vehicles that you are sponsoring. While investors who buy your securities will end up losing money, the intermediaries that have issued the securities are in danger of larger losses. Since the intermediaries are leveraged, they are in danger of having their equity wiped out, as many have found to their cost.

We can draw the following lesson for the role of securitization going forward. To the extent that the boom years were an aberration when securitization was being driven by the banks themselves in their search for leverage, the securitization activity that flourished most during that period is least likely to make a come-back.

Glossary

ABCP (Asset-Backed Commercial Paper): A form of commercial paper that is collateralized by other financial assets. ABCPs are typically short-term investments that mature between 90 and 180 days, and are generally issued by a bank or other financial institution.

ABS (Asset-Backed Security): A security whose value and income payments are derived from and collateralized by a specified pool of underlying assets, such as credit cards, auto loans, or mortgages.

BHC (Bank Holding Company): Any company that has control over one or more banks. All BHCs are required to register with the Board of Governors of the Federal Reserve System.

CDO (Collateralized Debt Obligation): A type of structured asset-backed security whose value and payments are derived from a portfolio of underlying fixed-income assets. CDOs are split into different risk classes, and their interest and principal payments are made in order of seniority.

Federal Reserve: The central banking system of the United States.

GSE (Government Sponsored Enterprise): A financial service corporation created by the United States Congress in order to enhance the flow of credit to targeted sectors of the economy, including agriculture, home finance, and education. GSEs primarily act as financial intermediaries to assist lenders and borrowers in these segments of the capital market, but are also involved in creating a secondary market in loans through guarantees, bonding, and securitization.

M2: A measure of money supply published by the Federal Reserve. M2 includes M1, which includes currency and checking deposits, in addition to transaction accounts that can be readily converted to M1 with little or no loss of principal. This includes, for example, savings accounts and money market accounts.

MBS (Mortgage Backed Security): An asset-backed security or debt obligation that represents a claim on the cash flows from mortgage loans, most commonly on residential property.

Primary Dealer: A bank or securities broker-dealer that may trade directly with the Federal

Reserve. Such firms are required to make bids or offers when the Fed conducts open market operations, provide information to the Fed's open market trading desk, and to participate actively in U.S. Treasury securities auctions.

Repo (Repurchase Agreement): A transaction in which the borrower sells a security to a lender while also agreeing to buy back the same security from the lender at a fixed price at some later date. A repo is equivalent to a cash transaction combined with a forward contract.

Security Broker-Dealer: A company or other organization that trades securities for its own account or on behalf of its customers.

VaR (Value at Risk): A widely used risk measure of the risk of loss on a specific portfolio of financial assets. For a given portfolio, probability, and time horizon, VaR is defined as a threshold value such that the probability that the mark-to-market loss on the portfolio over the given time horizon exceeds this value is the given probability level.

Sidebar: Basel III

The financial crisis of 2007-2009 gave rise to concerted international efforts under the G20 process to arrive at strengthened capital requirements for banks. The international efforts resulted in a new capital regime known as Basel III, which was agreed by the 27 member countries of the Basel Committee for Banking Supervision. The main elements of the new accord are a strengthening of required minimum regulatory capital of 7% of common equity relative to risk-weighted assets. The emphasis on common equity represents a strengthening of standards relative to the previous rules which allowed capital requirements to be met with capital instruments such as preferred equity that had attributes of debt as well as that of equity.

In addition, Basel III envisages the future introduction of a leverage ratio, which sets minimum capital requirements as a proportion of total assets – i.e. without risk weights, as well as liquidity rules that govern the holding of cash-like assets to deal with short-term funding problems in a crisis, and with rules that restrict the degree of maturity mismatch between assets and liabilities.

Basel III also has two "macroprudential" features that attempt to mitigate the procyclicality of the financial system. There is, first, a countercyclical capital charge of between 0% to 2.5% that may be imposed at the discretion of the national regulator if credit growth is judged to be outpacing GDP growth by a large margin. The additional capital requirement is intended to restrain excessive asset growth in booms. Second, there are provisions to impose additional measures against "too-big-to-fail" institutions that are systemically important. The group of systemically important financial institutions (SIFIs) may be subject to capital surcharges or other additional measures.

Future Research Topics

1. The aggregate effects of balance sheet behavior of financial institutions for the financial system and the determination of the risk premium.

2. The length of intermediation chains and the role of securitization on financial stability.

3. The corporate finance motivation for balance sheet adjustment by banks and other financial intermediaries, and the relationship to the non-pecuniary benefits to control of banks.

4. New issuance of the debt and the relationship between new issuance activity and the maturity structure of debt.

5. The relationship between new issuance of debt by banks and other financial intermediaries and the funding of housing investment.

Related resources

1. **Financial crisis timeline:**

   http://timeline.stlouisfed.org/

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

2. **Regulatory reform proposals:**

   http://www.squamlakeworkinggroup.org/

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

3. **Policy work streams:**

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

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

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