

Federal Reserve Bank of New York  
Staff Reports

Financial Intermediaries, Financial Stability, and Monetary Policy

Tobias Adrian  
Hyun Song Shin

Staff Report no. 346  
September 2008

This paper presents preliminary findings and is being distributed to economists and other interested readers solely to stimulate discussion and elicit comments. The views expressed in the paper are those of the authors and are not necessarily reflective of views at the Federal Reserve Bank of New York or the Federal Reserve System. Any errors or omissions are the responsibility of the authors.

## **Financial Intermediaries, Financial Stability, and Monetary Policy**

Tobias Adrian and Hyun Song Shin

*Federal Reserve Bank of New York Staff Reports*, no. 346

September 2008

JEL classification: E50, G20

### **Abstract**

In a market-based financial system, banking and capital market developments are inseparable. We document evidence that balance sheets of market-based financial intermediaries provide a window on the transmission of monetary policy through capital market conditions. Short-term interest rates are determinants of the cost of leverage and are found to be important in influencing the size of financial intermediary balance sheets. However, except for periods of crises, higher balance-sheet growth tends to be followed by lower interest rates, and slower balance-sheet growth is followed by higher interest rates. This suggests that consideration might be given to a monetary policy that anticipates the potential disorderly unwinding of leverage. In this sense, monetary policy and financial stability policies are closely linked.

Key words: monetary policy, financial stability, financial intermediation, security brokers and dealers, commercial banks

---

Adrian: Federal Reserve Bank of New York (e-mail: [tobias.adrian@ny.frb.org](mailto:tobias.adrian@ny.frb.org)). Shin: Princeton University (e-mail: [hsshin@princeton.edu](mailto:hsshin@princeton.edu)). This paper was presented at the Federal Reserve Bank of Kansas City Symposium at Jackson Hole, Wyoming, August 21-23, 2008. The authors thank the discussant, John Lipsky, and other participants for their comments at the conference. They also thank Adam Ashcraft, Alan Blinder, Markus Brunnermeier, Terrence Checki, William Dudley, Michael Fleming, Mark Gertler, Charles Goodhart, Jan Hatzius, Charles Himmelberg, Bengt Holmström, Anil Kashyap, Nobuhiro Kiyotaki, Meg McConnell, Jamie McAndrews, Don Morgan, Simon Potter, Jeremy Stein, Joseph Tracy, and Michael Woodford for their comments on earlier drafts, as well as Jiang Wang for earlier discussions. The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

## 1. Introduction

Financial intermediaries have been at the center of the credit market disruptions that began in August 2007. They have borne a large share of the credit losses from securitized subprime mortgages, even though securitization was intended to parcel out and disperse credit risk to investors who were better able to absorb losses.<sup>1</sup> The capacity to lend has suffered as intermediaries have attempted to curtail their exposure to a level that can be more comfortably supported by their capital. The credit crisis has dampened real activity in sectors such as housing, and has the potential to induce further declines. The events of the last twelve months have posed challenges for monetary policy and have given renewed impetus to think about the interconnection between financial stability and monetary policy.

The current credit crisis has the distinction of being the first post-securitization crisis in which the banking and capital market developments have been closely linked. Historically, banks have always reacted to changes in the external environment, expanding lending when the economic environment is benign. However, the increased importance of intermediaries that mark balance sheets to market both sharpens and synchronizes the responses, giving more impetus to the feedback effects on the real economy. The potential for adverse real effects are especially strong when banks respond to credit losses or the onset of more turbulent conditions by cutting their exposures, reducing lending, and charging higher risk premiums. Prudent risk management dictates such actions, and the script is well rehearsed.<sup>2</sup>

One notable finding from our empirical analysis is that there are important distinctions between different categories of financial intermediaries. Fluctuations in the balance sheet size of security broker-dealers – the financial sector that includes the major investment banks – appear to signal shifts in future real activity better than the larger commercial banking sector. In fact, the evolution of broker-dealer assets has a time signature that is markedly different from those of commercial banks. We find that the growth in broker-dealer balance sheets helps to explain future real activity, especially for components of GDP that are sensitive to the supply of credit. Our results point to key differences between banking as traditionally conceived and the market-based banking system that has become increasingly influential in charting the course of economic events.

Broker-dealers have traditionally played market-making and underwriting roles in securities markets. However, their importance in the supply of credit has increased dramatically in recent years with the growth of securitization and the changing nature of the financial system toward one based on the capital market, rather than one based on the traditional role of the bank as intermediating between depositors and borrowers.

---

<sup>1</sup> See Greenlaw, et al. (2008). See BIS (2008 chapter 6), IMF (2008a), and Brunnermeier (2008) for an overview of recent events.

<sup>2</sup> Kashyap, Rajan and Stein (2008) describe the incentives operating within the institution. See also Rajan (2005).

Although total assets of the broker-dealer sector is smaller than total asset of the commercial banking sector, our results suggest that broker-dealers provide a better barometer of the funding conditions in the economy, capturing overall capital market conditions. Perhaps the most important development in this regard has been the changing nature of housing finance in the US. As we will see shortly, the stock of home mortgages in the US is now dominated by the holdings in market-based institutions, rather than traditional bank balance sheets. Broker-dealer balance sheets provide a timely window on this world. On a similar theme, we find that market equity (of both the broker-dealer sector and the commercial banking sector) do a better job of signaling future real activity than total assets themselves.

Having established the importance of financial intermediary balance sheets in signaling future real activity, we go on to examine the determinants of balance sheet growth. We find that the level of the Fed funds target is key. The Fed funds target determines other relevant short term interest rates, such as repo rates and interbank lending rates through arbitrage in the money market. As such, we may expect the Fed funds rate to be pivotal in setting short-term interest rates more generally. We find that low short-term rates are conducive to expanding balance sheets. In addition, a steeper yield curve, larger credit spreads, and lower measures of financial market volatility are conducive to expanding balance sheets. In particular, an inverted yield curve is a harbinger of a slowdown in balance sheet growth, shedding light on the empirical feature that an inverted yield curve forecasts recessions.

These findings reflect the economics of financial intermediation, since the business of banking is to borrow short and lend long. For an off-balance sheet vehicle such as a conduit or SIV (structured investment vehicle) that finances holdings of mortgage assets by issuing commercial paper, a difference of a quarter or half percent in the funding cost may make all the difference between a profitable venture and a loss-making one. This is because the conduit or SIV, like most financial intermediaries, is simultaneously both a creditor and a debtor – it borrows in order to lend.

Although our results are in line with the economics of financial intermediation, they run counter to some key tenets of current central bank thinking which has emphasized primarily the importance of managing *expectations* of future short rates, rather than the current level of the target rate *per se*. In contrast, our results suggest that the target rate itself matters for the real economy through its role in the supply of credit and funding conditions in the capital market. As such, the target rate may have a role in the transmission of monetary policy in its own right, independent of changes in long rates.

When we examine how monetary policy has been conducted in practice in the US, we find that the Fed funds target rate tends to be reduced following expansions of balance sheets, and tends to be raised following slowdowns in balance sheet growth. But there is one important proviso. In periods of crisis, the Fed funds target has been cut sharply to cushion the economy from the fallout from the crisis.

Our findings hold implications for the financial stability role of monetary policy. To the extent that the *financial system as a whole* holds long-term, illiquid assets financed by short-term liabilities, any tensions resulting from a sharp, synchronized contraction of balance sheets will show up somewhere in the system. Even if some institutions can adjust down their balance sheets flexibly in response to the greater stress, not everyone can. This is because the system as a whole has a maturity mismatch. While lender of last resort tools may mitigate the severity of the contraction in balance sheets, they cannot prevent the contraction altogether. Something has to give. There will be pinch points in the system that will be exposed by the de-leveraging. The pinch points will be those institutions that are highly leveraged and who hold long-term illiquid assets financed with short-term debt supplied by lenders who reduce their exposure in response to deteriorating financial conditions. When the short-term funding runs away, the pinch point financial institutions will face a liquidity crisis. Arguably, this is exactly what happened to Bear Stearns in the US and Northern Rock in the UK, as well as a host of conduits and SIVs that have been left stranded by the ebbing tide of funding in the current credit crisis.

In this way, the expansions and contractions of balance sheets have both a monetary policy dimension in terms of regulating aggregate demand, but also a financial stability dimension. Therefore, contrary to the commonly encountered view that monetary policy and policies toward financial stability should be conducted separately, the perspective provided by our study suggests that they are closely related. They are, in fact, two sides of the same coin. The common coin is the marked-to-market balance sheet dynamics of financial intermediaries.

Although there has been a long-running debate on how far monetary policy should take account of financial stability goals, the debate has primarily focused on either 1) commercial banks, or 2) asset prices. The debate has not focused as much on the institutions that are at the heart of the market based financial system, such as security broker-dealers. In relation to asset prices, the question has been whether central banks should react to asset price bubbles.<sup>3</sup> The case against reacting to asset price bubbles is a familiar one, and rests on the following arguments.

- Identifying a bubble is difficult.

---

<sup>3</sup> Arguments in favor of “leaning against the wind” of financial developments have been given by Blanchard (2000), Bordo and Jeanne (2002), Borio and Lowe (2002), Borio and White (2003), Cecchetti, Genberg, Lipsky and Wadhvani (2000), Cecchetti, Genberg and Wadhvani (2002), Crockett (2003) and Dudley (2006), Goodhart (2000) among others. The argument against is given in Bean (2003), Bernanke and Gertler (1999, 2001), Bernanke (2002), Greenspan (2002), Gertler (2003), Kohn (2005), Mishkin (2008) and Stark (2008).

- Even if there were a bubble, monetary policy is not the right policy tool in addressing the problem. An asset price bubble will not respond to small changes in interest rates. Only a drastic increase in interest rates will prick the bubble.
- However, such a drastic increase in interest rates will cause more harm than good to the economy in terms of future output and output volatility.

The claim that an asset price bubble will not respond to a small change in interest rates has mostly been argued in the context of the stock market, where the proposition is indeed plausible. However, the stock market is not the best context in which to discuss the financial stability role of monetary policy, as stocks are held mostly by unlevered investors. Much more central is the credit market, especially when backed by residential or commercial real estate. As argued already, a difference of a quarter or half percentage in the funding cost may make all the difference between a profitable venture and a loss-making one for leveraged financial intermediaries.

We believe that focusing on the conduct of financial intermediaries is a better way to think about financial stability since it helps us to ask the right questions. Concretely, consider the following pair of questions.

Question 1. Do you know for sure there is a bubble in real estate prices?

Question 2. Could the current benign funding conditions reverse abruptly with adverse consequences for the economy?

One can answer “yes” to the second question even if one answers “no” to the first. This is because we know more about the script followed by financial intermediaries and how they react to changes in the economic environment than we do about what the “fundamental” value of a house is, and whether the current market price exceeds that value.

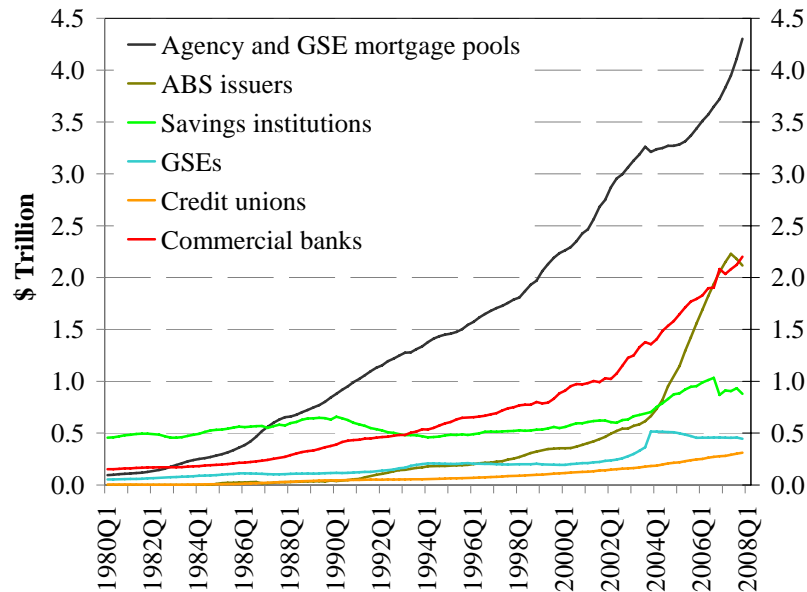
In any case, for a policy maker, it is the second question which is more immediately relevant. Even if a policy maker were convinced that the higher price of housing is fully justified by long-run secular trends in population, household size, rising living standards, and so on, policy intervention would be justified if the policy maker also believed that, if left unchecked, the virtuous circle of benign funding conditions and higher housing prices will go too far, and reverse abruptly with adverse consequences for the economy.

The outline of our paper is as follows. We begin with background descriptions of financial intermediation in a market-based banking system. We then present our empirical results on the real impact of broker-dealer balance sheet changes, the determinants of balance sheet changes, and how US monetary policy has reacted to balance sheet changes. We conclude with some implications of our findings for the conduct of monetary policy.

## 2. Financial Intermediaries in a Market-Based Financial System

Behind the development of the market-based banking system is the growth of mortgage backed securities as an asset class. Figure 1 plots the total holding of home mortgages in the US by types of financial institution, drawn from the Flow of Funds accounts for the US.

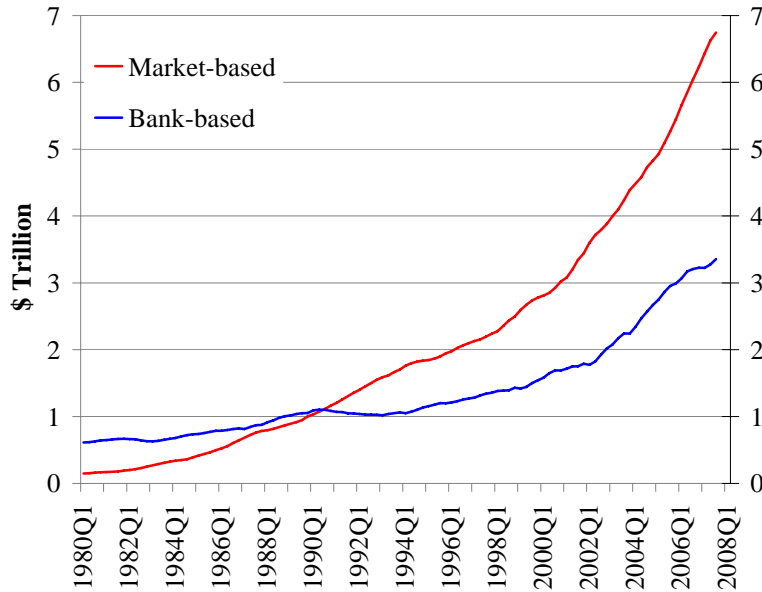
**Figure 1. Total Holdings of US Home Mortgages by Type of Financial Institution (Source: US Flow of Funds, Federal Reserve)**



As recently as the early 1980s, traditional banks were the dominant holders of home mortgages, but bank-based holdings have been quickly overtaken by market-based holders of mortgages. In Figure 2, bank-based holdings are defined as the sum of the holdings of the commercial banks, the savings institutions and credit unions. The market-based holdings are the remainder – the GSE mortgage pools, private label mortgage pools and the GSE holdings themselves. Market-based holdings overtook the bank-based holdings in 1990, and now constitute two thirds of the 11 trillion dollar total stock of home mortgages.

The increased importance of the market-based banking system has been mirrored by the growth of the broker-dealer sector of the economy. Broker-dealers have traditionally played market-making and underwriting roles in securities markets. However, their importance in the supply of credit has increased in step with securitization. Thus, although the size of total broker-dealer assets is small by comparison to the commercial banking sector (it is around one third of the commercial bank sector) it has seen rapid growth in recent decades and is arguably a better barometer of overall funding conditions in a market-based financial system.

**Figure 2. Market Based and Bank Based Holding of Home Mortgages**  
 (Source: US Flow of Funds, Federal Reserve)

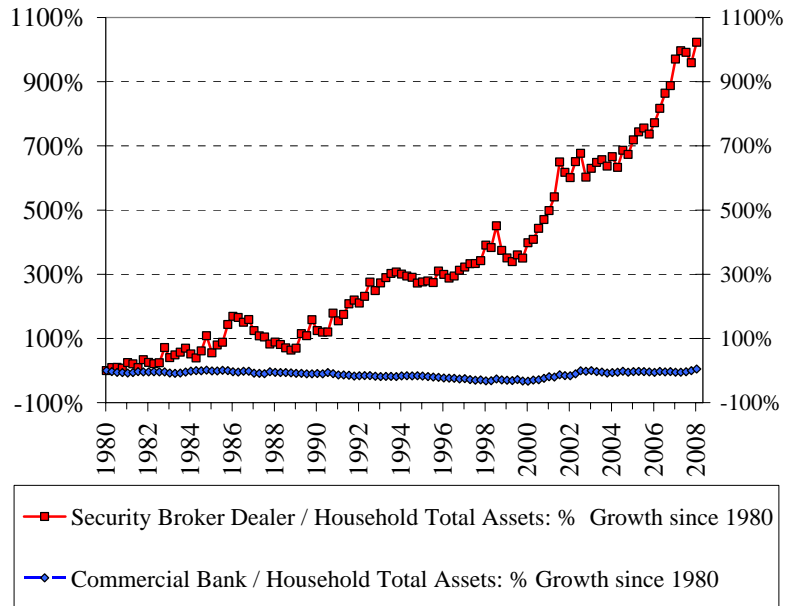


In a market-based financial system, broker-dealer assets may be a better signal of the *marginal* availability of credit as compared to commercial bank assets. At the margin, all financial intermediaries (including commercial banks or GSEs) have to borrow in capital markets through short term borrowing such as commercial paper or repurchase agreements. But for a commercial bank, its large balance sheet masks the effects operating at the margin. Also, commercial banks provide relationship-based lending through credit lines. Broker-dealers, in contrast, give a much purer signal of marginal funding conditions, as their balance sheet consists almost exclusively of short-term market borrowing and are not bound as much by relationship-based lending.

The growth of the broker-dealer sector has been striking since the 1980s. Figure 3 charts the increase in the size of the broker-dealer sector in the US relative to the commercial banking sector. Both series are normalized by the size of total household assets. We see that commercial bank total assets have roughly kept pace with total household assets, as evidenced by the flat curve for the series for the ratio of commercial bank assets to household assets. However, the relative size of the broker-dealer sector is more than ten times what it was at the beginning of 1980.



**Figure 3. Growth in Broker-Dealer and Commercial Bank Assets relative to Household Assets (1980Q1 as base)**  
 (Source: US Flow of Funds, Federal Reserve)



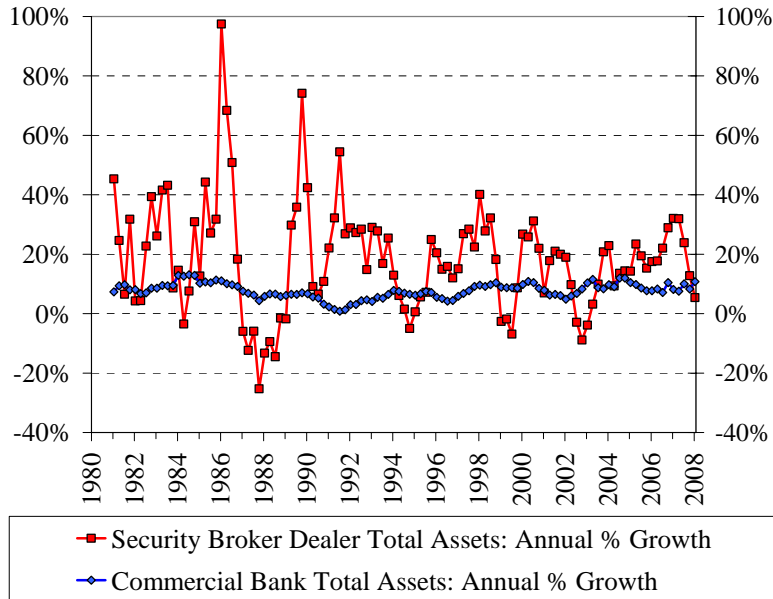
Besides growing much more rapidly than commercial bank assets, broker-dealer assets have been more volatile. Figure 4 plots the (annual) growth rates of broker-dealer assets together with the growth rates of commercial bank total assets for the US. We see that broker-dealer assets vary much more sensitively over time, as compared to commercial bank assets.

Not only is broker-dealer asset growth more volatile relative to commercial banks, the two series move in quite different ways. Figure 5 is a version of Figure 4 where the commercial bank series has been rescaled according to the right hand vertical axis. We see that the peaks and troughs of the two series differ markedly. The chart shows that traditional banking and the new market-based financial system move to a very different beat.<sup>4</sup>

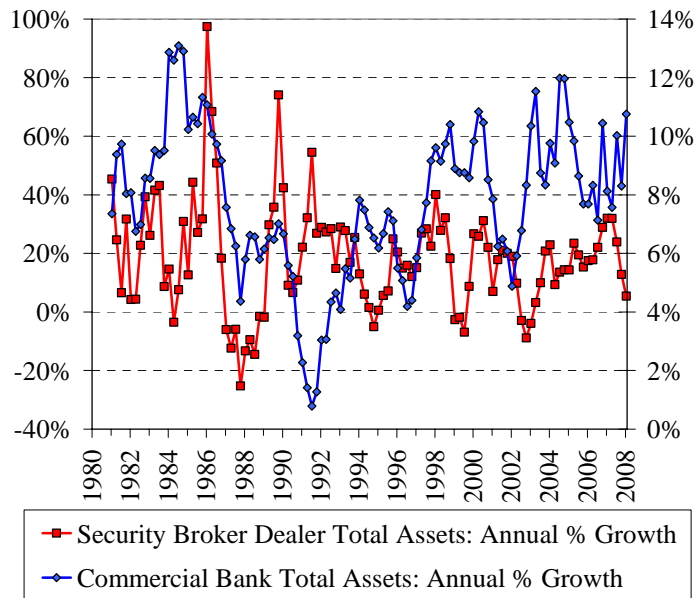
---

<sup>4</sup> A forthcoming IMF study (IMF (2008b)) shows how international differences in the incidence of market-based financial intermediaries results in markedly different relationships between asset growth and leverage growth.

**Figure 4. Growth Rates of Broker-Dealer and Commercial Bank Total Assets (Source: US Flow of Funds, Federal Reserve)**



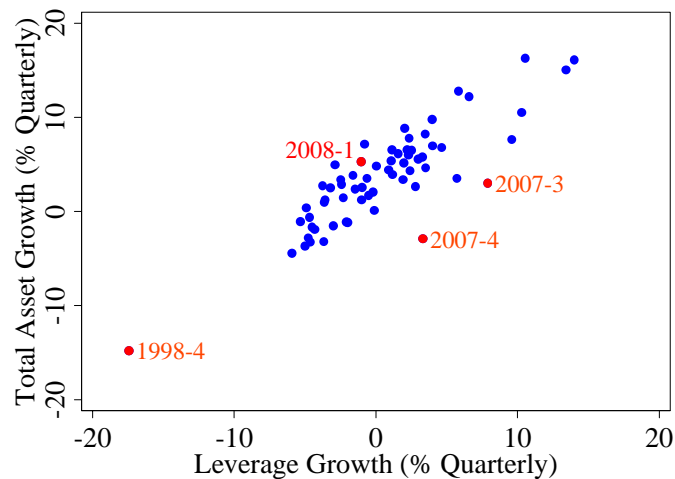
**Figure 5. Rescaled Growth Rates of Broker-Dealer and Commercial Bank Total Assets (Source: US Flow of Funds, Federal Reserve)**



The balance sheet dynamics of financial intermediaries that mark their balance sheets to market have some distinctive features. Figure 6 below is taken from Adrian and Shin (2007) and shows the scatter chart of the weighted average of the quarterly change in assets against the quarterly change in leverage of the (then) five stand-alone US investment banks – Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch and Morgan Stanley.

The first striking feature is that leverage is procyclical in the sense that leverage is high when balance sheets are large, while leverage is low when balance sheets are small. This is exactly the opposite finding compared to households, whose leverage is high when balance sheets are *small*. For instance, if a household owns a house that is financed by a mortgage, leverage falls when the house price increases, since the equity of the household is increasing at a much faster rate than assets. For investment banks, however, the relationship is reversed. It is as if the householder responded to an increase in house prices by increasing the mortgage loan to value so that leverage increases in spite of the increased value of his house.

**Figure 6. Leverage Growth and Asset Growth of US Investment Banks (Source SEC; Adrian and Shin (2007))**



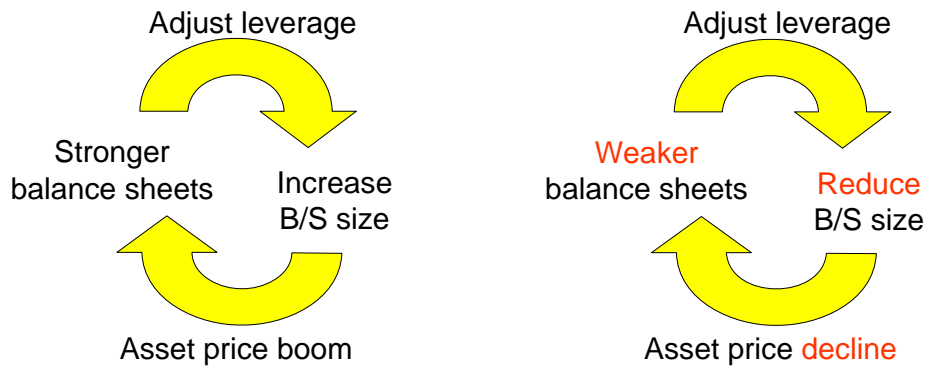
A procyclical leverage ratio offers a window on the notion of financial system liquidity. When leverage is procyclical, the demand and supply response to asset price changes can amplify shocks. To see this, consider an increase in the price of assets held widely by leveraged market players and intermediaries. The increase in the price of assets strengthens the players' balance sheets, since the net worth of levered players increases as a proportion of their total assets.

When balance sheets become stronger, leverage falls. To the extent that the intermediary wants to avoid holding too much equity (for instance, because return on equity is too low), it will attempt to restore leverage. One way it can do so is by borrowing more, and using the proceeds to buy more of the assets they already hold. Indeed, as we see below, the evidence points to broker-dealers adjusting leverage by adjusting the size of their balance sheets, leaving equity intact.<sup>5</sup>

---

<sup>5</sup> Commercial and investment banks offset some of the mortgage related losses since the summer of 2007 via equity issuance. In addition, expansionary monetary policy offset some of need to unwind assets. The two red dots corresponding to 2007Q3 and 2007Q4 are below the 45-degree line, showing that not all losses were offset by new equity

If greater demand for the asset puts upward pressure on its price, then there is the potential for a feedback effect in which stronger balance sheets feed greater demand for the asset, which in turn raises the asset's price and lead to stronger balance sheets. Having come full circle, the feedback process goes through another turn. The circular figure on the left illustrates the feedback during a boom. Note the critical role played by procyclical leverage.<sup>6</sup>



The mechanism works in reverse in downturns. Consider a fall in the price of an asset held widely by hedge funds and banks. Then, the net worth of such an institution falls faster than the rate at which asset falls in value, eroding its equity cushion. One way that the bank can restore its equity cushion is to sell some of its assets, and use the proceeds to pay down its debt. The circular chart above on the right illustrates the feedback during a bust. Note the importance of marking to market. By synchronizing the actions of market participants, the feedback effects are amplified.<sup>7</sup>

There is a more subtle feature of Figure 6 which tells us much about the financing decisions of financial intermediaries. Recall that the horizontal axis measures the (quarterly) change 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 where equity is unchanged. Above the 45-degree line equity is increasing, while below the 45-degree line, equity is decreasing. Any straight line with slope equal to 1 indicates constant growth of equity, with the intercept giving the growth rate of equity.

---

issuance. The determinants of equity issuance versus asset sales are further discussed in Adrian and Shin (2008b).

<sup>6</sup> Gromb and Vayanos (2002) and Brunnermeier and Pedersen (2007) provide models of how balance sheet constraints interact with market developments. See also Kyle and Xiong (2001) and Morris and Shin (2004) for models of liquidity crises. The feedback effects will be larger when market liquidity effects reinforce the balance sheet constraints (Brunnermeier and Pedersen (2007)).

<sup>7</sup> See Shin (2005) and Plantin, Sapra and Shin (2008a, 2008b).

The feature to note from Figure 6 is that the slope of the scatter chart is close to 1, implying that equity is increasing at a constant rate on average. Thus, equity seems to play the role of the forcing variable, and all the adjustment in leverage takes place through expansions and contractions of the balance sheet.

There is a useful perspective on this feature that comes from the risk management policies of financial intermediaries. 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.<sup>8</sup>

One further way we can understand the fluctuations in funding conditions is to look at the implicit maximum leverage that is permitted in collateralized borrowing transactions such as repurchase agreements (repos). The discussion of repurchase agreements is instructive in thinking about leverage and funding more generally, since repos are the primary source of funding for market-based banking institutions.

In a repurchase agreement, 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, and fluctuates together with funding conditions in the market.

The fluctuations in the haircut largely determine the degree of funding available to a leveraged institution. The reason is that the haircut determines the maximum permissible leverage achieved by the borrower. If the haircut is 2%, the borrower can borrow 98 dollars for 100 dollars worth of securities pledged. Then, 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.

Suppose that the borrower leverages up the maximum permitted level. Such an action would be consistent with the objective of maximizing the return on equity, since leverage magnifies return on equity. The borrower thus has a highly leveraged balance sheet with leverage of 50. If at this time, a shock to the financial system raises the market haircut, then the borrower faces a predicament. Suppose that the haircut rises to 4%. Then, the permitted leverage halves to 25, from 50. The borrower then faces a hard choice. Either

---

<sup>8</sup> Adrian and Shin (2008b) show how such behavior can be given theoretical rationale in terms of a contracting model between banks and their creditors.

it must raise new equity so that its equity doubles from its previous level, or it must sell half its assets, or some combination of both.

Note that the increase in haircuts will do most harm when starting from very low levels. A percentage point increase from 1% to 2% will mean leverage has to fall from 100 to 50. But a percentage point increase from 20% to 21% will have only a marginal effect on the initial leverage of 5. In this sense, the “chasing of yield” at the peak of the financial cycle is especially precarious, since the unwinding of leverage will be that much more potent.

Times of financial stress are associated with sharply higher haircuts, necessitating substantial reductions in leverage through asset disposals or raising of new equity. Raising new equity or cutting assets entail adjustments for the borrower. Raising new equity is notoriously difficult in distressed market conditions. But selling assets in a depressed market is not much better.<sup>9</sup> The evidence from the scatter chart above is that borrowers tend to adjust leverage primarily through adjustments in the size of the balance sheet, leaving equity unchanged, rather than through changes in equity directly.

For an investment bank, whose assets tend to be short term and liquid (such as short-term collateralized lending), it can adjust its balance sheet size flexibly by reducing lending and not rolling over debt. However, when the financial system as a whole holds long-term, illiquid assets financed by short-term liabilities, any tensions resulting from a sharp, synchronized contraction of balance sheets will show up somewhere in the system. Even if some institutions can adjust down their balance sheets flexibly, there will be pinch points in the system that will be exposed by the de-leveraging. We return to this issue below.

### **3. Macroeconomic Consequences**

In models of monetary economics that are commonly used at central banks, the role of financial intermediaries is largely incidental; banks and broker-dealers are passive players that the central bank uses to implement monetary policy. In contrast, our argument thus far suggests that they deserve independent study because of their impact on financial conditions and hence on real economic outcomes. In this section, we examine whether financial intermediaries’ impact on financial conditions feed through to affect real economic outcomes – in particular, on components of GDP. We find that it does, especially on those components of GDP that are sensitive to credit supply, such as housing investment and durable goods consumption.

---

<sup>9</sup> The “margin spiral” described by Brunnermeier and Pedersen (2007) models this type of phenomenon. See also He and Krishnamurthy (2007) for the asset pricing consequences of constrained intermediary capital.

In the language of “frictions”, our empirical findings are consistent with a set of principal-agent frictions that operate at the level of the financial intermediaries themselves. These frictions result in constraints on balance sheet choice that bind harder or more loosely depending on the prevailing market conditions. The fluctuations in haircuts and regulatory capital ratios that are critical in determining the leverage of financial intermediaries can be seen as being driven by the fluctuations in how hard these constraints bind. When balance sheet constraints bind harder, credit supply is reduced.

Broker-dealer balance sheets hold potentially more information on underlying financial conditions, as they are a signal of the *marginal* availability of credit. At the margin, all financial intermediaries (including commercial banks or GSEs) have to borrow in markets (for instance via commercial paper or repos). For a commercial bank, even though only a small fraction of its total balance sheet is market based, at the margin it has to tap the capital markets. But for commercial banks, their large balance sheets mask the effects operating at the margin. Broker-dealers, in contrast, give a purer signal of marginal funding conditions, as their liabilities are short term, and their balance sheets are close to being fully marked to market.

In addition, broker-dealers originate and make markets for securitized products, whose availability determines the credit supply for consumers and non-financial firms (e.g. for mortgages, car loans, student loans, etc.). So broker-dealers are important variables for two reasons. First, they are the marginal suppliers of credit. Second, their balance sheets reflect the financing constraints of the market-based financial system.

To the extent that balance sheet dynamics affect the supply of credit, they have the potential to affect real economic variables. To demonstrate that there are indeed real effects of the balance sheet behavior of intermediaries, we estimate macroeconomic forecasting regressions.

In Table 1, we report the results of regressions of the annual growth rate of GDP components on lagged macroeconomic and financial variables. In addition, we add the lagged growth rate of total assets and market equity of security broker-dealers on the right hand side.<sup>10</sup> By adding lags of additional financial variables on the right hand side (equity market return, equity market volatility, term spread, credit spread), we offset balance sheet movements that are purely due to a price effect. By adding the lagged macroeconomic variables on the right hand side, we control for balance sheet movements due to past macroeconomic conditions. In Table 1 (and all subsequent tables), \* denotes statistical significance at the 10%, \*\* significance at the 5% level, and \*\*\* at the 1% level. All our empirical analysis is using quarterly data from 1986Q1 to 2008Q1. Variable definitions are given in the appendix.

---

<sup>10</sup> We use total asset growth of security broker-dealers as indicator of financial sector balance sheet growth. Deflating the asset growth by the core PCE inflation or household total asset growth does not change the results in this or later tables qualitatively.

The growth rate of security broker-dealer total assets has strongest significance for the growth rate of future housing investment and for durable good consumption (Table 1, columns (iv) and (ii), respectively). Our interpretation of this finding is that the mechanisms that determine the liquidity and leverage of broker-dealers affect the supply of credit, which in turn affect investment and consumption. The finding that dealer total assets significantly forecast durable but not total consumption, and that they forecast housing investment but not total investment, lends support to this interpretation, as durable consumption and housing investment could be seen as being particularly sensitive to the supply of credit. The market value of security broker-dealer equity also has predictive power for housing investment, but additionally forecasts total consumption, total investment, and GDP.

In Table 1, equity is market equity, rather than book equity. To the extent that shifts in market equity are good indicators of the shifts in the marked-to-market value of book equity, we can interpret the empirical finding that equity growth has real impact through the amplification mechanism illustrated in Figure 6, the scatter chart of leverage against assets. When balance sheets become strong, equity increases rapidly, eroding leverage. Financial intermediaries then attempt to expand their balance sheets to restore leverage. Since our data are quarterly, but balance sheets adjust quickly, the one quarter lagged assets may not fully capture this effect. However growth in market equity may be a good signal of growth of spare balance sheet capacity.

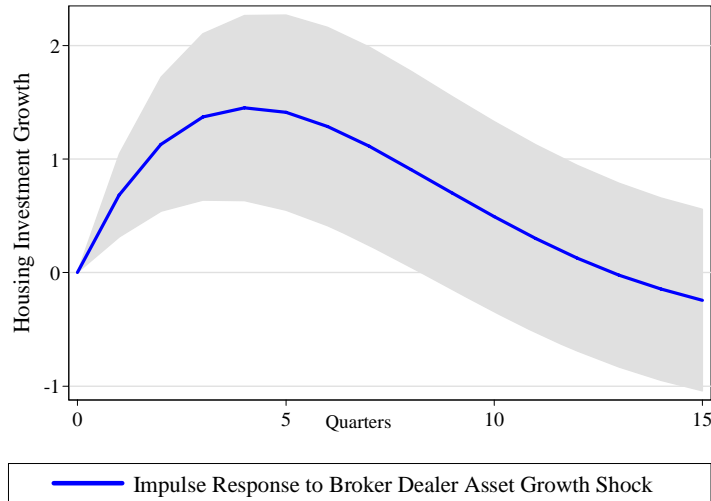
**Table 1:**  
**Broker-Dealer Assets are Significant for Future Macroeconomic Growth**

	(i)	(ii)	(iii)	(iv)	(v)
	<u>Consumption</u>	<u>Durable</u>	<u>Investment</u>	<u>Housing</u>	<u>GDP</u>
	(4Q growth)	Consumption	(4Q growth)	Investment	(4Q growth)
<u>Broker-Dealer Variables</u>					
Asset growth (1Q lag)	0.003	0.048 *	-0.007	0.062 **	0.005
Equity growth (1Q lag)	0.008 **	0.013	0.026 **	0.055 ***	0.006 *
<u>Macroeconomic conditions</u>					
Lag of left hand side variable	0.746 ***	0.468 ***	0.873 ***	0.829 ***	0.812 ***
PCE core inflation (1Q lag)	-0.199	-2.225 ***	0.247	0.344	-0.112
Fed Funds Target (1Q lag)	0.066	0.667	-0.342 ***	-0.253	0.003
<u>Financial Market Conditions</u>					
S&P500 Return (1Q lag)	0.008	-0.002	0.039	0.041	0.009
S&P500 implied volatility VIX (1Q lag)	0.018	0.075	0.126 **	0.183 *	0.026 *
10-year/3-month spread (1Q lag)	0.180 *	1.456 **	0.460	0.972	0.187 **
Baa/10-year spread (1Q lag)	-0.023	-0.182	-1.492 **	0.367	-0.183
<u>Constant</u>	0.252	1.111	1.114	-7.078	0.238



The forecasting power of dealer assets for housing investment is graphically illustrated in Figure 7. The impulse response function is computed from a first order vector autoregression that includes all variables of Table 1, Column (iv). The plot shows a response of housing investment to broker-dealer assets growth that is positive, large, and persistent.

**Figure 7. Impulse Response Function of Housing Investment Growth to a Broker-Dealer Asset Growth Shock (in units of standard deviations)**



We next ask whether commercial bank balance sheet variables have additional forecasting power for real economic growth. One way to do so is to first orthogonalize commercial bank total asset growth and equity growth with respect to the broker-dealer variables, and then add the commercial banks variables that is unexplained by the broker-dealer variables to the regressions. The results are presented in Table 2. We find that commercial bank equity does have some additional information for housing investment, but total commercial bank assets do not.

To further understand differences between the security broker-dealer and commercial bank balance sheet interactions with the macroeconomic aggregates, we run the same regressions as in Table 1, but with commercial bank variables instead of security-broker-dealer variables (see Table 3). We do find that commercial bank (market) equity is significant in explaining real economic activity, but commercial bank total assets are not. Our interpretation of these findings is that commercial bank balance sheets are less informative than broker-dealer balance sheets as they (largely) did not mark their balance sheets to market, over the time span in our regressions. However, market equity is a better gauge of underlying balance sheet constraints, and so better reflects the marginal increases in balance sheet capacity. So, whereas growth in total assets do not signal future changes in activity, growth in market equity does.

The finding that commercial bank assets do not predict future real growth is also consistent with Bernanke and Lown (1991) who use a cross sectional approach to show that credit losses in the late 80's and early 90's do not have a significant impact on real economic growth across states. See Kashyap and Stein (1994) for an overview of the debate on whether there was a "credit crunch" in the recession in the early 1990s.

In the same vein, Ashcraft (2006) finds small effects of variations in commercial bank loans on real activity when using accounting based loan data, but Ashcraft (2005) finds large and persistent effects of commercial bank closures on real output (using FDIC induced failures as instruments). Morgan and Lown (2006) show that the senior loan officer survey provides significant explanatory power for real activity – again a variable that is more likely to reflect underlying credit supply conditions, and is not based on accounting data.

**Table 2:**  
**Commercial Bank Assets do not have Additional Explanatory Power  
for Real Activity (except for Housing Investment)**

	(i)	(ii)	(iii)	(iv)	(v)
	<u>Consumption</u>	<u>Durable Consumption</u>	<u>Investment</u>	<u>Housing Investment</u>	<u>GDP</u>
<u>Broker-Dealer Variables</u>					
Asset growth (1Q lag)	0.002	0.050 *	-0.007	0.054 **	-0.001
Equity growth (1Q lag)	0.009 **	0.015	0.026 **	0.057 ***	0.007 *
<u>Commercial Bank Variables</u> (Orthogonalized with respect to Broker-Dealer Variables)					
Asset growth (1Q lag)	0.060	0.353	0.038	-0.045	0.027
Equity growth (1Q lag)	0.004	0.047	0.011	0.088 ***	0.005
<u>Macroeconomic conditions</u>					
Lag of left hand side variable (1Q lag)	0.688 ***	0.418 ***	0.866 ***	0.812 ***	0.770 ***
PCE core inflation (1Q lag)	-0.199	-2.114 ***	0.258	0.395	-0.022
Fed funds target (1Q lag)	0.092	0.716	-0.341 ***	-0.375	-0.038
<u>Financial Market Conditions</u>					
S&P500 return (1Q lag)	0.006	-0.011	0.037	0.031	0.011
S&P500 volatility VIX (1Q lag)	0.020	0.081	0.125 **	0.171 *	0.036 *
10-year/3-month (1Q lag)	0.232 *	1.636 **	0.452	0.542	0.167
Baa/10-year (1Q lag)	-0.088	-0.658	-1.576 **	0.388	-0.516 **
<u>Constant</u>	0.339	1.426	1.315	-5.618	0.944

**Table 3:  
Commercial Bank Equity has Explanatory Power  
... but Commercial Bank Assets do not**

	(i)	(ii)	(iii)	(iv)	(v)
	<u>Consumption</u>	<u>Durable Consumption</u>	<u>Investment</u>	<u>Housing Investment</u>	<u>GDP</u>
<u>Commercial Bank Variables</u>					
Asset growth (1Q lag)	0.063	0.329	0.055	0.024	0.039
Equity growth (1Q lag)	0.009 ***	0.048 **	0.022 **	0.007 ***	0.011 **
<u>Macroeconomic conditions</u>					
Lag of left hand side variable (1Q lag)	0.714 ***	0.412 ***	0.882 ***	0.792 ***	0.785 ***
PCE core inflation (1Q lag)	-0.200	-1.907 ***	0.201	-0.033	-0.113
Fed funds target (1Q lag)	0.084	0.642	-0.333	-0.042	0.004
<u>Financial Market Conditions</u>					
S&P500 return (1Q lag)	0.007	-0.021	0.043	0.012	0.008
S&P500 volatility VIX (1Q lag)	0.017	0.067	0.126 **	0.035 **	0.027 **
10-year/3-month (1Q lag)	0.211 ***	1.397 **	0.482	0.166	0.195
Baa/10-year (1Q lag)	-0.128	-0.232	-1.741	-0.536	-0.244 **
<u>Constant</u>	0.080	-0.779	1.239	0.815	0.165

The credit supply channel sketched so far differs from the financial amplification mechanisms of Bernanke and Gertler (1989), and Kiyotaki and Moore (1997, 2005). These papers focus on amplification due to financing frictions in the *borrowing* sector, while we focus on amplification due to financing frictions in the *lending* sector. Our approach raises the question of whether the failure of the Modigliani-Miller theorem may be more severe in the lending rather than the borrowing sector of the economy. The interaction of financial constraints in the lending and the borrowing sector is likely to give additional kick to financial frictions in the macro context that mutually reinforce each other. These interactions would be fertile ground for new research.

We should also reiterate the caveats that underpin the results in Table 2. Inference for macroeconomic aggregates is difficult as all variables are endogenous. In analyzing the data, we started with the prior that balance sheets of financial intermediaries should matter for real economic growth. This prior has guided our empirical strategy. Researchers who look at the data with a different prior will certainly be able to minimize the predictive power of the broker-dealer balance sheet variable. However, analyzing the data with the prior that financial intermediary frictions are unimportant has the potential cost of overlooking the friction. Further searching examinations of the data will help us uncover the extent to which financial variables matter. In addition, we have not analyzed

the importance of the balance sheets of other institutions of the market based financial system, such as the GSEs, hedge funds, etc.

We now present some additional evidence of the impact of broker-dealer assets from vector autoregressions that summarize the joint dynamics of macroeconomic variables, broker-dealer variables, and monetary policy. Figure 8 refers. The figure is deliberately constructed to resemble the impulse response functions of Bernanke and Gertler (1995). In this exercise, we make no structural assumptions and instead examine the embedded empirical relationships by conducting a VAR exercise in the spirit of Sims (1980). To illustrate the impact of adding financial institutions to the monetary policy transmission mechanism, we plot the impulse response functions of housing investment growth from two vector autoregressions. In the first VAR, only GDP growth, PCE inflation, the Federal funds target, and housing investment are included (in that order). The second VAR adds the security-broker-dealer variables to the macro variables, with the macro variables ordered before the financial institution variables. Each VAR is nonstructural, and includes four lags of all variables. By adding the financial institution variables after the baseline macroeconomic variables, we are being conservative, giving the financial institution variables the least possible chance to impact shocks to the Fed funds target on housing investment. Each VAR is estimated with four lags, from 1986Q1 – 2008Q1. The impulse response functions are plotted in Figure 8.

**Figure 8: Response of Housing Investment to Fed Funds Shock (in units of standard deviations). Comparison of Nonstructural Models with and without Broker-Dealer Variables**

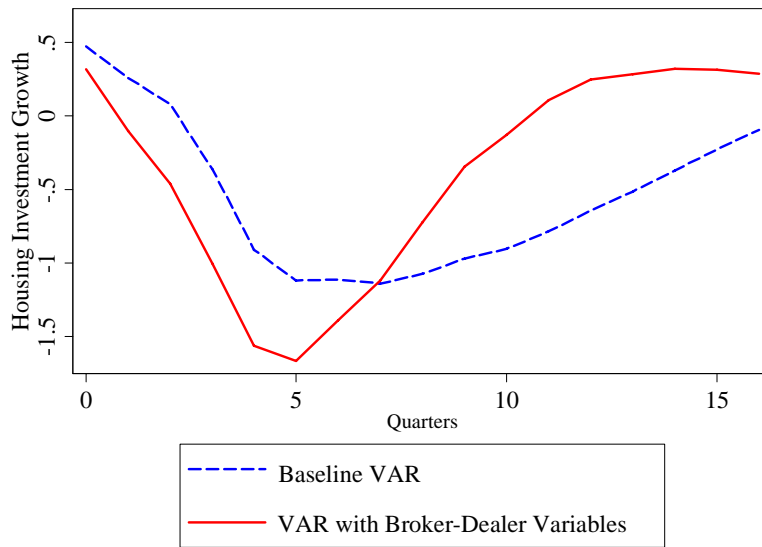


Figure 8 shows that the dynamics of housing investment in response to monetary policy shocks differs in the two VAR specifications. The drop in housing investment in response to a Fed funds target increase is both quicker and larger in the VAR with the broker-dealer variables, compared to the baseline model. However, the recovery is also quicker. The two response functions of Figure 8 again illustrate that balance sheet variables of financial institutions have quantitatively important effects on macroeconomic dynamics. We interpret Figure 8 as showing that the market based financial system has a noticeable impact on the monetary policy transmission mechanism.

#### 4. Determination of Broker-Dealer Balance Sheets

Having established that broker-dealer balance sheets matter for real activity, we investigate what determines the growth of broker-dealer balance sheets.<sup>11</sup> Broker-dealers fund themselves with short term debt (primarily repurchase agreements and other forms of collateralized borrowing). Part of this funding is directly passed on to other leveraged institutions such as hedge funds in the form of reverse repos.<sup>12</sup> Another part is invested in longer term, less liquid securities. The cost of borrowing is therefore tightly linked to short term interest rates in general, and the Federal funds target rate in particular. Broker-dealers hold longer term assets, so that proxies for expected returns of broker-dealers are spreads – either credit spreads, or term spreads. Leverage is constrained by risk; in more volatile markets, leverage is more risky and credit supply can be expected to be more constrained.

Increases in the Fed funds target rate are generally associated with a slower growth rate of broker-dealer assets. The first four columns of Table 4 show that this finding holds contemporaneously (column i and ii), it holds with a lag (column iii), and it holds in a forward looking sense (column iv). Put differently, expectations of increases in the Fed funds target are associated with declines in dealer assets, as are contemporaneous changes. Interestingly, we do not find that commercial bank total asset growth is significantly explained by changes in the Federal funds target. This finding is again consistent with two explanations. Either commercial bank balance sheets do not reflect the current positions of assets and liabilities properly, as their balance sheets have historically not been marked to market, or commercial banks do not manage their balance sheet as actively.

In all of the regressions of Table 4, we add GDP growth and PCE core inflation on the right hand side. Interestingly, neither growth nor inflation are significant determinants of broker-dealer total asset growth. It appears that the level of the Fed funds target is sufficient in capturing all of the macroeconomic information that is relevant for broker-dealers. We again find that commercial banks differ sharply in this respect; while their asset growth is not significantly determined by the Fed funds target, it is significantly positively correlated with GDP growth and negatively with core PCE inflation.

Financial market volatility, as measured by the VIX index of implied volatility, relates negatively to security broker-dealer asset growth, as higher volatility is associated with higher margins and tighter capital constraints, both inducing tighter constraints on dealer leverage. Credit spreads are positively related to dealer asset growth, as they proxy the profitability of a holding risky, illiquid, longer maturity assets.

---

<sup>11</sup> Adrian and Shin (2008b) present microeconomic foundations for the variables that constrain the size and leverage of market based financial intermediaries.

<sup>12</sup> Adrian and Fleming (2005) analyze net collateralized financing as an indicator of primary dealer leverage, while Adrian and Shin (2007) focus on gross collateralized financing as an indicator of overall financial system leverage.

**Table 4:**  
**Increases in the Federal Funds Target (and the Expectation of the Future Target)**  
**Tend to Reduce Broker-Dealer Balance Sheets**

	(i)		(ii)		(iii)		(iv)		(v)
	<u>Asset</u>		<u>Asset</u>		<u>Asset</u>		<u>Asset</u>		<u>Asset</u>
	<u>Growth</u>		<u>Growth</u>		<u>Growth</u>		<u>Growth</u>		<u>Growth</u>
	Broker-		Broker-		Broker-		Broker-		Commercial
	Dealers		Dealers		Dealers		Dealers		Banks
<u>Fed Funds</u>									
Target (1Q change)	-15.87	***							0.071
Target (4Q change)			-4.87	***					
Target (lag, 1Q change)					-11.65	***			
1-year Eurodollar future (spread to Fed Funds)							-15.42	***	
<u>Macroeconomic Conditions</u>									
Real GDP Growth (1Q lag)	0.553		0.833		-0.740		0.679		0.516 ***
PCE Core Inflation (1Q lag)	-1.060		-1.065		0.284		-0.789		-0.966 ***
<u>Financial Market Variables</u>									
S&P500 Return (1Q lag)	-0.013		0.118		0.159		0.151		0.013
S&P500 Volatility VIX (1Q lag)	-1.125	***	-1.220	***	-0.941	***	-1.178	***	0.040
10-year/3-month (1Q lag)	-5.697		-3.027		2.503		-2.242		-0.426
Baa/10-year (1Q lag)	4.871	**	18.131	***	14.781		23.398	***	0.216
<u>Constant</u>	36.787	***	37.538	***	40.102	***	36.550	***	7.112 ***

Broker-dealers trade actively, so it would be desirable to study their balance sheet behavior at higher frequencies. Fortunately, the Federal Reserve Bank of New York collects financing data of the so called Primary Dealers at a weekly frequency. Adrian and Shin (2007) document that dealer total asset growth is tightly linked to dealer repo growth, as expansions and contractions of broker-dealer total assets are primarily financed by expansions and contractions in repos. In Table 5, we explain Primary Dealer repo borrowing by the same variables as in Table 4 (except for GDP and inflation which we had seen were insignificant anyway, and which are not available at a weekly frequency). We use 13-week changes and lags in the regression, in order to pick up correlations that occur at the same frequency as the quarterly data. We again find the negative comovement of dealer balance sheets with changes in the Fed funds target, and we additionally uncover a positive relation between dealer repos and the term spread.

**Table 5:  
Primary Dealer Repo Growth Expands when the Term Spread is Large**

	<u>Repo Growth</u>
	Primary Dealers
Fed Funds (13 week change)	-0.037 **
Fed Funds (13 week lag)	0.037 ***
S&P500 Return (13 week)	0.000 *
S&P500 (13 week lag)	0.000 ***
VIX (13 week change)	-0.001
VIX (13 week lag)	-0.007 ***
10-year / 3-month Treasury spread (13 week change)	0.049 **
10-year / 3-month Treasury spread (13 week lag)	0.087 ***
Baa / 10-year credit spread (13 week change)	0.150 ***
Baa / 10-year credit spread (13 week lag)	0.017
Repo Growth (13 week lag)	-0.242 ***
Constant	-0.163

## 5. Monetary Policy and Balance Sheets

We have seen in the previous two sections that dealer asset growth and market equity of broker-dealers and commercial banks explain future real growth of macroeconomic aggregates such as durable consumption and housing investment. In addition, we have seen that changes in the Federal funds target rate, and expectations of the future path of policy, are important determinants in broker-dealer total asset growth. Changes to the Federal funds target are further primarily determined by real growth and inflation (see Taylor (1993)). So how does monetary policy interact with the waxing and waning of financial intermediary balance sheets?

In financial crises, the tight connection between balance sheets and monetary policy certainly becomes apparent. In the fall of 1987 and again in the fall of 1998, the Fed funds target was cut in order to insulate the real economy from financial sector distress. While this interaction between monetary policy and financial sector distress is apparent in crises, what is the relationship between the two in normal times?

We find that higher balance sheet growth of broker assets is associated with a *lower* Fed funds target (see Table 6, column ii), except in crisis, when the sign reverses (see column iii). We also find that increases in dealer balance sheets tend to precede a lower Fed funds target in the next quarter.

**Table 6:  
Monetary Policy is Pro-Cyclical Relative to Broker-Dealer Asset Growth  
... Except in Crises**

	(i)		(ii)		(iii)		(iv)	
	<u>Fed Funds</u>		<u>Fed Funds</u>		<u>Fed Funds</u>		<u>Fed Funds</u>	
	<u>Target</u>		<u>Target</u>		<u>Target</u>		<u>Target</u>	
	(change)		(change)		(change)		(change)	
<u>Macroeconomic Conditions</u>								
Fed funds target (1Q lag)	-0.090	***	-0.070	***	-0.070	**	-0.073	***
Real GDP growth	0.240	***	0.220	***	0.230	***	0.229	***
PCE core inflation	0.130	**	0.110	*	0.140	**	0.123	**
<u>Broker-Dealer Balance Sheets</u>								
Asset growth			-0.007	**	-0.009	***		
Asset growth * crisis dummy					0.038	**		
Asset growth (1Q lag)							-0.008	**
<u>Constant</u>	-0.698	***	-0.567	***	-0.587	***	-0.573	***

One explanation for these findings may be the slow adjustment of the Fed funds rate, and the market's anticipation of such slow adjustment. Once the interest rate cycle turns, banks expect more moves in the same direction in the future. Anticipating such future moves, banks expand balance sheets following initial cuts in the Fed funds rate. Then, the anticipated future cuts materialize. In the time series, the realized subsequent cuts trail the balance sheet expansions.

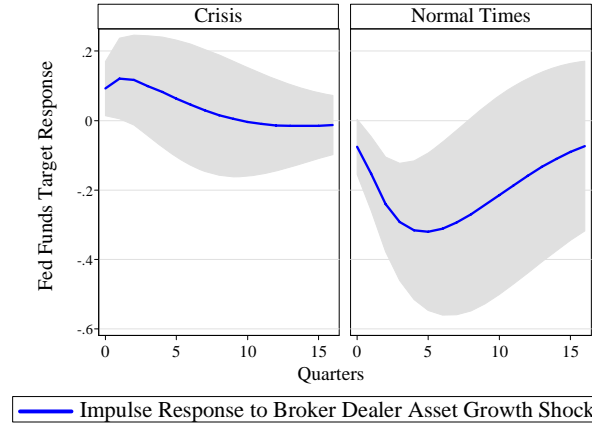
In Figure 9, we plot the impulse response function of the Fed funds target rate to a one standard deviation shock to the growth rate of security broker-dealer assets. We include the Fed funds target, real GDP growth, PCE core inflation, broker-dealer asset growth, and the interaction of broker-dealer asset growth with the crisis dummy in the VAR.<sup>13</sup> The left hand panel draws the impulse response in crisis periods; the right hand side draws it in normal times. Note that Figure 9 is drawn as the impulse responses of the Fed funds target to a positive broker-dealer asset growth shock. The left hand panel is familiar from the 1987 crash and the 1998 crisis; the Fed funds target was cut aggressively in response to financial sector distress. The right hand panel of the impulse

<sup>13</sup> Note that column (iii) of Table 6 does not correspond directly to the VAR, as all variables enter contemporaneously in that Table, while all variables enter as lags in the VAR.



response function is less familiar: it shows the procyclicality of Fed funds policy relative to dealer balance sheet growth.<sup>14</sup>

**Figure 9: Impulse Response of the Fed Funds Target to a (positive) Shock to Security Broker-Dealer Asset Growth in Crisis and in Normal Times**



As we outlined in section 2, when the relation between financial markets and monetary policy is discussed, the conclusion is often drawn that policy should only incorporate financial market variables insofar as they help to predict future macroeconomic variables such as future output and future inflation. It could be that broker-dealer asset growth is only significant in the policy rule because it reflects movements in asset prices that are helpful in predicting future macroeconomic variables.

Column (i) of Table 7 shows that the significance of security broker-dealer asset growth is unaffected when additional asset price controls are included in the regression. In Column (ii) of Table 7, we first regress security broker-dealer asset growth on four lags of PCE core inflation and GDP growth, and then add the predicted value from that regression to the right hand side of the policy rule regression. We see that both security broker-dealer assets and the value of security broker-dealer assets that is explained by past macroeconomic variables are both significant, so the security broker-dealer variable is not significant simply because it correlates with past macroeconomic variables.

In column (iii), we do the reverse; we first regress GDP growth and PCE core inflation on four lags of security broker-dealer growth, and add the predicted value of those regressions to the right hand side. This captures the degree to which asset growth is forecasting future macroeconomic activity. We again find that the asset growth variable becomes more significant and larger in magnitude, and the predicted values from the first stage regression are not significant. Finally, in the last column of Table 7, we show that commercial bank total asset growth is not significant in the policy rule regression. This

<sup>14</sup> By aggressively cutting the target during times of financial intermediary distress, the Federal Reserve provides liquidity to the economy, which can be rationalized within the context of the Holmström and Tirole (1998) model.

again suggests that the transmission mechanism of monetary policy should take the liquidity and leverage of market based financial intermediaries explicitly into account.

**Table 7:**  
**Pro-Cyclical Monetary Policy is Robust to Asset Price Controls and Controls for Future and past Macroeconomic Variables**

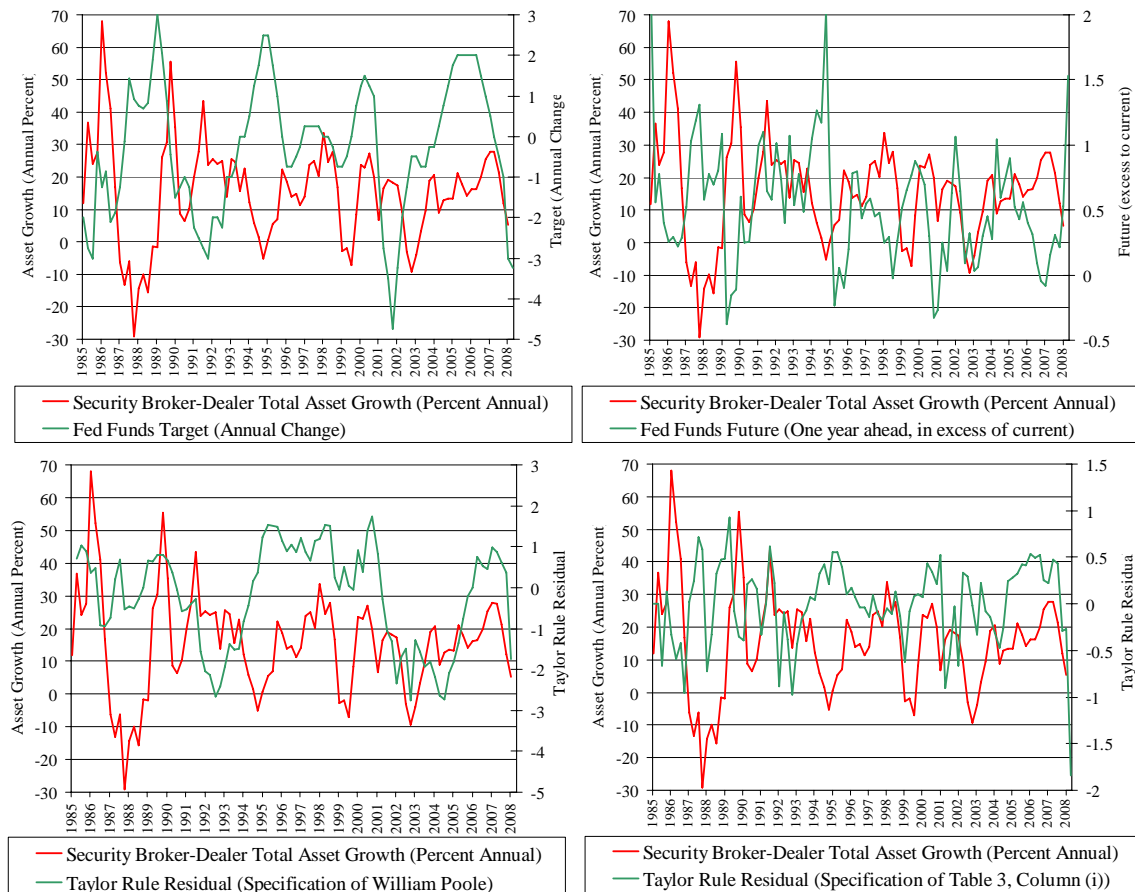
	(i) <u>Fed Funds</u> <u>Target (change)</u>	(ii) <u>Fed Funds</u> <u>Target (change)</u>	(iii) <u>Fed Funds</u> <u>Target (change)</u>	(iv) <u>Fed Funds</u> <u>Target (change)</u>
<u>Macro Variables</u>				
Fed funds target (lag)	-0.135 **	-0.116 **	-0.146 **	-0.084 ***
Real GDP growth (4Q)	0.215 ***	0.189 ***	0.192 ***	0.233 ***
PCE core inflation (4Q)	0.200 **	0.141	0.187 **	0.169 **
GDP forecasted by four lags of broker asset growth (lag)			0.191	
PCE forecasted by four lags of broker asset growth (lag)			-0.239	
<u>Balance Sheet Variables</u>				
BD asset growth				
BD asset growth (lag)	-0.012 ***	-0.009 **	-0.014 ***	
BD asset growth (explained by four lags of GDP & PCE)		-0.014 *		
CB asset growth (lag)				0.029
<u>Financial Markets</u>				
S&P500 return	0.009	-0.014	0.011 *	
S&P500 volatility VIX	-0.021	0.01	-0.017	
10-year / 3-month (lag)	-0.114 *	-0.021 *	-0.113	
Baa / 10-year (lag)	-0.079	-0.087	-0.176	
<u>Constant</u>	0.380	-0.096	0.677	-0.966 ***

We do not interpret the results of Tables 6 and 7 as saying that the balance sheets of broker-dealers are the only relevant measure of financial intermediary liquidity and leverage. There are other leveraged institutions (such as GSEs, hedge funds, to name but a view) whose potential to affect the economy have not been examined here. Our focus on broker-dealers is motivated by the hypothesis that they provide a useful window on the market-based financial system.

We do not advocate any particular monetary policy rule that targets balance sheet growth. Considerations of Goodhart’s Law and the Lucas critique will be relevant here as for any simplistic macro policy rule. This point is especially relevant given our observation earlier that the association between balance sheet dynamics and Fed funds dynamics may be due to banks’ anticipation of future Fed funds changes.

One way we can visualize the policy response in setting the Fed funds rate to growth in the broker-dealer balance sheet is to compute the residual relative to a benchmark Taylor rule, and then plot the residual of the Taylor rule together with the series for the growth in broker-dealer assets. Such plots give an alternative representation of the regression results in Table 7. Figure 10 provides a panel of such plots. The bottom left panel plots the Taylor rule residuals from Table 3, column (i), which best fits the observed Fed funds target. The bottom right panel gives the residual from William Poole’s rule, as sketched in Poole (2005). We see the negative correlation between Taylor rule residuals and balance sheet growth clearly in the data.<sup>15</sup>

**Figure 10: Broker-Dealer Asset Growth and Fed Funds Target, Fed Funds Futures, and two Measures of Taylor Rule Residuals**



<sup>15</sup> Also see also Adrian and Shin (2008a).

## 7. Implications for Monetary Policy

In conventional monetary theory, the primary friction is the price stickiness of goods and services.<sup>16</sup> Financial intermediaries do not play a role in these models other than as a passive player that the central bank uses to implement policy. Our findings suggest the need to give these players an independent role. Quantity variables seem to matter – especially components of financial intermediary balance sheets. Using the language of “frictions”, our results suggest a second friction, in addition to sticky prices. This second friction originates in the agency relationships embedded in the organization of market based financial intermediaries, which are manifested in the way that financial intermediaries manage their balance sheets.<sup>17</sup> This is a friction in the supply of credit.

We are certainly not the first to study frictions in the supply of credit. There has been an extensive discussion of financial frictions within monetary economics (see, for example, the overview by Bernanke and Gertler (1995)). However, it would be fair to say that financial frictions have received less emphasis in the last few years. One reason for the lack of emphasis may be that the earlier literature that focused on commercial bank balance sheets or borrowers’ balance sheets did not produce conclusive empirical results.

We conclude from our own study that the time is now ripe to redress the balance and bring financial institutions back into the heart of monetary economics. When we examine an appropriate balance sheet measure that reflect the underlying funding conditions in capital markets, we stand a better chance of capturing the transmission mechanism through credit supply more fully. In our view, the appropriate balance sheet quantities are those that are marked to market, and hence reflect current market conditions. In this regard, we have seen that broker-dealer assets are more informative than commercial bank assets, and market equity of either commercial banks or broker-dealers do a better job of explaining future activity than (book) asset values. As commercial banks begin to mark more items of their balance sheets to market, commercial bank balance sheet variables are likely to become more important variables for studying the transmission mechanism.

Fluctuations in the supply of credit arise from how much slack there is in balance sheets. The cost of leverage of market-based intermediaries is determined by two main variables – risk, and short term interest rates. The expected profitability of intermediaries is proxied by carry spreads such as the term spread and various credit spreads. Variations in the policy target determine short term interest rates, and have a direct impact on the profitability of intermediaries. When monetary policy is tightened at the end of an economic expansion, the slope of the yield curve becomes shallower and sometimes inverts. Intermediaries have to reduce the supply of credit when faced with a shallow

---

<sup>16</sup> See, for example, Woodford (2003).

<sup>17</sup> These frictions are described in Rajan (2005) and Kashyap, Rajan and Stein (2008).

yield curve.<sup>18</sup> Deleveraging is particularly rapid when measured risks also increase. We have already argued that even small increases in repo haircuts can induce drastic reductions in leverage. As the economy slows, financial constraints may bind harder and prices fall more than in the absence of constraints.

To the extent that financial intermediaries play a role in monetary policy transmission through credit supply, short term interest rates matter directly for monetary policy. This perspective on the importance of the short rate as a price variable is in contrast to current monetary thinking, where short term rates matter only to the extent that they determine long term interest rates, which are seen as being risk-adjusted expectations of future short rates. Alan Blinder (1998, p.70) in his book on central banking puts it in the following terms:

"central banks generally control only the overnight interest rate, an interest rate that is relevant to virtually no economically interesting transactions. Monetary policy has important macroeconomic effects only to the extent that it moves financial market prices that really matter - like long-term interest rates, stock market values and exchange rates."

Current models in monetary economics emphasize the importance of managing market expectations. By charting a path for future short rates and communicating this path clearly to the market, the central bank can influence long rates and thereby influence mortgage rates, corporate lending rates and other prices that affect consumption and investment. The "expectations channel" has become an important consideration for monetary policy, especially among those that practice inflation targeting.<sup>19</sup> Our approach entails quite different policy implications on some key issues. We mention three in particular.

One has to do with forward-looking guidance on future policy rates or the publication of the central bank's own projections of its policy rate. Such communication not only has implications for market participants' expectations of the future path of short rates, but also for the uncertainty around that path. If central bank communication compresses the uncertainty around the path of future short rates, the risk of taking on long-lived assets financed by short-term debt is compressed. If the compression increases the potential for a disorderly unwinding later in the expansion phase of the cycle, then such compression of volatility may not be desirable for stabilization of real activity. In this sense, there is the possibility that forward-looking communication can be counterproductive.<sup>20</sup>

---

<sup>18</sup> Adrian and Estrella (2008) explore further the signal value of the term spread for future macroeconomic outcomes in conjunction with monetary policy tightening cycles.

<sup>19</sup> The expectations channel is explained in Blinder (1998), Bernanke (2004), Svensson (2004) and Woodford (2005).

<sup>20</sup> Considerations of international monetary coordination reinforce this point. Hattori and Shin (2008) exhibit evidence that some of the expansions of intermediary balance sheets

Secondly, there is a case for rehabilitating some role for balance sheet quantities for the conduct of monetary policy. Ironically, our call comes even as monetary aggregates have fallen from favor in the conduct of monetary policy (see Friedman (1988)). The instability of money demand functions that makes the practical use of monetary aggregates challenging is closely related to the emergence of the market-based financial system. As a result of those structural changes, not all balance sheet quantities will be equally useful. The money stock is a measure of the liabilities of deposit-taking banks, and so may have been useful before the advent of the market-based financial system. However, the money stock will be of less use in a financial system such as that in the US. More useful may be measures of collateralized borrowing, such as the weekly series on repos of primary dealers.

Finally, our results highlight the way that monetary policy and policies toward financial stability are linked. When the financial system as a whole holds long-term, illiquid assets financed by short-term liabilities, any tensions resulting from a sharp pullback in leverage will show up somewhere in the system. Even if some institutions can adjust down their balance sheets flexibly, there will be some who cannot. These pinch points will be those institutions that are highly leveraged, but who hold long-term illiquid assets financed with short-term debt. When the short-term funding runs away, they will face a liquidity crisis. The traditional lender of last resort tools (such as the discount window), as well as the recent liquidity provision innovations are tools that mitigate the severity of the tightening of balance sheet constraints. However, experience has shown time and again that the most potent tool in relieving *aggregate* financing constraints is a lower target rate. Past periods of financial stress such as the 1998 crisis was met by reduction in the target rate, aimed at insulating the real economy from financial sector shocks. In conducting monetary policy, the potential for financial sector distress should be explicitly taken into account in a forward looking manner.

In analyzing the interaction between financial stability and monetary policy in the time series of the last decades, it is important to keep in mind that the interaction of monetary policy and lender of last resort provision was successful in insulating the real economy from financial sector distress. So one can—in our view falsy—conclude that policies toward financial stability are more or less orthogonal to monetary policy analysis. To put it into Bayesian language, when analyzing the data (either via econometric or via structural approaches) with the prior that monetary policy and financial stability are orthogonal, one runs the risk of confirming that prior all too easily. The events of the past 12 months have clearly shown that now is the right time to reset the prior and to rethink the monetary policy transmission mechanism in a market based financial system.

The lesson for financial regulation is that the current risk-based capital requirements are powerless against the pull-back in lending that arises from a system-wide de-leveraging.

---

are financed through the yen carry trade, which rely on predictable discrepancies in short rates across currencies.

When there are spillover effects, actions that enhance the soundness of one institution may end up by undermining another. The prudent curtailing of exposures by the creditors of Bear Stearns will be a run from the point of view of Bear Stearns itself. Secondly, even very safe assets such as reverse repos may be systemically important in that withdrawal of funding creates spillover effects on others.<sup>21</sup>

As well as the implications for prudential regulation, balance sheet dynamics imply a role for monetary policy in ensuring financial stability. The waxing and waning of balance sheets have both a monetary policy dimension in terms of regulating aggregate demand, but it has the crucial dimension of ensuring the stability of the financial system. Contrary to the common view that monetary policy and policies toward financial stability should be seen separately, they are inseparable. At the very least, there is a strong case for better coordination of monetary policy and policies toward financial stability.

## **8. Concluding Remarks**

Financial intermediaries lie at the heart of both monetary policy transmission as well as policies toward financial stability. The key thread to our discussion has been that 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.

The current credit crisis has the distinction of being the first post-securitization crisis, where the market-based banking system has come into its own, and has exerted a profound influence in the playing out of events in the financial markets and the wider economy over the last twelve months.

We have shown that financial intermediary balance sheet management matters for the real economy, as well as for the soundness of the financial system. There are also important lessons for the conduct of monetary policy – some of them at variance with the current mainstream views on how monetary policy should be conducted. Due to their interaction with the leverage constraints of financial intermediaries, short rates are important prices in their own right, and a smaller term premium is associated with contractions in the supply of credit.

Our discussion suggests that tracking measures of financial market liquidity derived from the balance sheets of intermediaries has some information value in the conduct of monetary policy. The security broker-dealer assets are a key variable, but certainly not the only balance sheet variable that has the potential to be systemically important. Many other intermediaries use high degrees of leverage, and have the potential for disorderly deleveraging. In addition, the economics of commercial banking is becoming more

---

<sup>21</sup> Morris and Shin (2008) examine issues for financial regulation in a system context. Shin (2008) is a case study of Northern Rock from a system perspective.

similar to the economics of broker-dealers as their balance sheets are marked to market to a greater degree. An important lesson of our study is that asset prices alone, are likely not to be sufficient to summarize the conditions of intermediaries. As a result, balance sheet dynamics are informative both on key components of GDP as well as the resilience of the financial system. Monetary policy and policies toward financial stability are therefore two sides of the same coin.



## References

- Adrian, Tobias and Arturo Estrella (2008) “Monetary Tightening Cycles and the Predictability of Economic Activity,” *Economics Letters* 99, 260 – 264.
- Adrian, Tobias and Michael Fleming (2005) “What Financing Data Reveal about Dealer Leverage,” *Federal Reserve Bank of New York Current Issues in Economics and Finance*, Volume 11 (3).
- Adrian, Tobias and Hyun Song Shin (2007) “Liquidity and Leverage,” working paper, Federal Reserve Bank of New York and Princeton University. Available as *Federal Reserve Bank of New York Staff Reports* 328. Previous version “Liquidity and Financial Cycles,” presented at the Sixth BIS Annual Conference on Financial System and Macroeconomic Resilience, 18-19 June 2007, *BIS Working Paper* No. 256.
- Adrian, Tobias and Hyun Song Shin (2008a) “Liquidity, Monetary Policy, and Financial Cycles,” *Federal Reserve Bank of New York Current Issues in Economics and Finance*, Volume 14 (1).
- Adrian, Tobias and Hyun Song Shin (2008b) “Financial Intermediary Leverage and Value at Risk,” working paper, Federal Reserve Bank of New York and Princeton University. *Federal Reserve Bank of New York Staff Reports*, 338.
- Ashcraft, Adam (2005) “Are Banks Really Special? New Evidence from the FDIC-Induced Failure of Healthy Banks,” *American Economic Review* 95, pp. 1712-1730.
- Ashcraft, Adam (2006) “New Evidence on the Lending Channel,” *Journal of Money, Credit, and Banking* 38, pp. 751-776.
- Bank for International Settlements (2008) *78th Annual Report*, Basel, Switzerland.
- Bean, Charles (2003) “Asset Prices, Financial Imbalances and Monetary Policy: Are Inflation Targets Enough?” in *Asset Prices and Monetary Policy*, eds. Anthony Richards and Tim Robinson, Reserve Bank of Australia, pp.48-76.
- Bernanke, Ben (2002) “Asset-Price “Bubbles” and Monetary Policy,” remarks at New York Chapter of the National Association for Business Economics, October 15, 2002. <http://www.federalreserve.gov/boarddocs/speeches/2002/20021015/default.htm>
- Bernanke, Ben (2004) “The Logic of Monetary Policy,” remarks before the National Economists Club, December 2, 2004. [www.federalreserve.gov/boarddocs/speeches/2004/20041202/default.htm](http://www.federalreserve.gov/boarddocs/speeches/2004/20041202/default.htm)
- Bernanke, Ben and Mark Gertler (1989) “Agency Costs, Net Worth, and Business Fluctuations,” *American Economic Review* 79, pp. 14 - 31.

Bernanke, Ben and Mark Gertler (1995) “Inside the Black Box: The Credit Channel of Monetary Policy Transmission,” *Journal of Economic Perspectives* 9, pp. 27-48.

Bernanke, Ben and Mark Gertler (1999) “Monetary Policy and Asset Volatility,” *Federal Reserve Bank of Kansas City Economic Review* 84, pp. 17-52.

Bernanke, Ben and Mark Gertler (2001) “Should Central Banks Respond to Movements in Asset Prices?” *American Economic Review* 91, pp. 253-257.

Bernanke, Ben and Cara Lown (1991) “The Credit Crunch,” *Brookings Papers on Economic Activity* 2, pp. 205-247.

Blanchard, Olivier (2000) “Bubbles, Liquidity Traps, and Monetary Policy,” in: *Japan’s Financial Crisis and its Parallels to the US Experience*, edited by Ryoichi Mikitani and Adam Posen, Institute for International Economics Special Report 13.

Blinder, Alan (1998) *Central Banking in Theory and Practice*, MIT Press, Cambridge.

Bordo, Michael and Olivier Jeanne (2002) “Monetary Policy and Asset Prices: Does Benign Neglect Make Sense?” *International Finance* 5, pp.139-164.

Borio, Claudio and Philip Lowe (2002) “Asset Prices, Financial and Monetary Stability: Exploring the Nexus,” *Bank for International Settlements Working Paper* 114.

Borio, Claudio and William White (2003) “Whither Monetary and Financial Stability? The Implications of Evolving Policy Regimes,” *Proceedings of the Federal Reserve Bank of Kansas City Symposium at Jackson Hole 2003*.  
<http://www.kc.frb.org/publicat/sympos/2003/sym03prg.htm>

Brunnermeier, Markus (2008) “De-Ciphering the Credit Crisis of 2007,” forthcoming, *Journal of Economic Perspectives*.

Brunnermeier, Markus and Lasse Pedersen (2007) “Market Liquidity and Funding Liquidity,” forthcoming *Review of Financial Studies*.

Cecchetti, Stephen, Hans Genberg, John Lipsky and Sushil Wadhvani (2000) “Asset Prices and Central Bank Policy,” *Geneva Reports on the World Economy* 2, International Centre for Monetary and Banking Studies and Centre for Economic Policy Research.

Cecchetti, Stephen, Hans Genberg and Sushil Wadhvani (2002) “Asset Prices in a Flexible Inflation Targeting Framework,” in *Asset Price Bubbles: The Implications for Monetary, Regulatory and International Policies*, eds. William Hunter, George Kaufman and Michael Pomerleano, MIT Press, pp. 427-444.

Crockett, Andrew (2003) “International Standard Setting in Financial Supervision,”

*Institute of Economic Affairs Lecture*, Cass Business School, London, 5 February.

Dudley, William (2006) Panel discussion, NBER conference on Monetary Policy and Asset Prices, May 5-6, 2006.

[http://www.nber.org/books\\_in\\_progress/assetprices/dudley6-28-06.pdf](http://www.nber.org/books_in_progress/assetprices/dudley6-28-06.pdf)

Friedman, Benjamin (1988) “Monetary Policy Without Quantity Variables,” *American Economic Review* 78, 440-45.

Gertler, Mark (2003) “Commentary: Whither Monetary and Financial Stability? The Implications of Evolving Policy Regimes,” *Proceedings of the Federal Reserve Bank of Kansas City Symposium at Jackson Hole*, 2003.

<http://www.kc.frb.org/publicat/sympos/2003/sym03prg.htm>

Goodhart, Charles (2000) “Asset Prices and the Conduct of Monetary Policy,” working paper, London School of Economics.

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

Greenspan, Alan (2002) “Economic Volatility,” remarks at *Federal Reserve Bank of Kansas City symposium, Jackson Hole*, 2002.

<http://www.federalreserve.gov/boarddocs/speeches/2002/20020830/default.htm>

Gromb, Denis and Dimitri Vayanos (2002) “Equilibrium and Welfare in Markets with Financially Constrained Arbitrageurs,” *Journal of Financial Economics* 66, pp. 361-407.

Hattori, Masazumi and Hyun Song Shin (2008) “Yen Carry Trade and the Subprime Crisis,” working paper, Bank of Japan and Princeton University.

He, Zhiguo and Arvind Krishnamurthy (2007) “Intermediary Asset Pricing,” working paper, Northwestern University.

Holmström, Bengt, and Jean Tirole (1998) “Private and Public Supply of Liquidity,” *Journal of Political Economy* 106, pp. 1-40.

International Monetary Fund (2008a) *Global Financial Stability Report*, April, Washington DC.

International Monetary Fund (2008b) *World Economic Outlook*, forthcoming draft of chapter 4, October 2008 issue, Washington DC.

Kashyap, Anil and Jeremy Stein (1994) “Monetary Policy and Bank Lending,” in N. Gregory Mankiw (ed.) *Monetary Policy*, University of Chicago Press.

Kashyap, Anil, Raghuram Rajan and Jeremy Stein (2008) “Rethinking Capital Regulation” paper prepared for the Federal Reserve Bank of Kansas City Symposium at Jackson Hole, 2008.

Lown, Cara, and Don Morgan (2006) “The Credit Cycle and the Business Cycle: New Findings Using the Loan Officer Opinion Survey,” *Journal of Money, Credit, and Banking* 38, pp. 1575-1597.

Kiyotaki, Nobuhiro, and John Moore (1997) “Credit Cycles,” *Journal of Political Economy* 105, pp. 211-248.

Kiyotaki, Nobuhiro, and John Moore (2005) “Liquidity and Asset Prices,” *International Economic Review* 46, pp. 317-349.

Kohn, Donald (2005) “Commentary: Has Financial Development Made the World Riskier?” Proceedings of the Federal Reserve Bank of Kansas City Symposium at Jackson Hole, 2005. <http://www.kc.frb.org/publicat/sympos/2005/sym05prg.htm>

Kyle, Albert S. and Wei Xiong (2001) “Contagion as a Wealth Effect”, *Journal of Finance* 56, pp. 1401-1440.

Mishkin, Frederic (2008) “How Should We Respond to Asset Price Bubbles?” Speech at the Wharton Financial Institutions Center and Oliver Wyman Institute's Annual Financial Risk Roundtable, Philadelphia, May 15, 2008  
<http://www.federalreserve.gov/newsevents/speech/mishkin20080515a.htm>

Morris, Stephen and Hyun Song Shin (2004) “Liquidity Black Holes” Review of Finance, 8, 1-18

Morris, Stephen and Hyun Song Shin (2008) “Financial Regulation in a System Context,” working paper, Princeton University.

Plantin, Guillaume, Haresh Sapra and Hyun Song Shin (2008a) “Marking to Market: Panacea or Pandora’s Box?” *Journal of Accounting Research* 46, 435 – 460.

Plantin, Guillaume, Haresh Sapra and Hyun Song Shin (2008b) “Fair Value Accounting and Financial Stability,” forthcoming, *Financial Stability Review*, Banque de France.

Poole, William (2005) “The Fed's Monetary Policy Rule,” remarks at the Cato Institute, October 14, 2005. [http://www.stls.frb.org/news/speeches/2005/10\\_14\\_05.htm](http://www.stls.frb.org/news/speeches/2005/10_14_05.htm)

Rajan, Raghuram (2005) "Has Financial Development Made the World Riskier?" Proceedings of the Federal Reserve Bank of Kansas City Symposium at Jackson Hole, 2005. <http://www.kc.frb.org/publicat/sympos/2005/sym05prg.htm>

Shin, Hyun Song (2005) "Commentary: Has Financial Development Made the World Riskier?" Proceedings of the Federal Reserve Bank of Kansas City Symposium at Jackson Hole, 2005. <http://www.kc.frb.org/publicat/sympos/2005/sym05prg.htm>

Shin, Hyun Song (2008) "Reflections on Modern Bank Runs: A Case Study of Northern Rock," working paper, Princeton University.

Sims, Christopher (1980) "Macroeconomics and Reality," *Econometrica* 48, 1-48

Stark, Jürgen (2008) "Main Challenges for Monetary Policy in a Globalised World" speech at the conference "Monetary Policy in Sub Saharan Africa: Practice and Promise," Cape Town, 28 March 2008. <http://www.bis.org/review/r080331e.pdf>

Svensson, Lars (2004) "Challenges for Monetary Policy," paper for the Bellagio Group Meeting at the National Bank of Belgium, January 2004. [www.princeton.edu/~svensson](http://www.princeton.edu/~svensson)

Taylor, John (1993) "Discretion Versus Policy Rules in Practice," *Carnegie-Rochester Series on Public Policy* 39, pp. 195-214.

Woodford, Michael (2003) *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press.

Woodford, Michael (2005) "Central Bank Communication and Policy Effectiveness," *Proceedings of the Federal Reserve Bank of Kansas City Economic Symposium at Jackson Hole* 2005. <http://www.kc.frb.org/publicat/sympos/2005/sym05prg.htm>

## Appendix: Data Sources and Variable Definitions

**Figure 1:** US Flow of Funds, Board of Governors of the Federal Reserve. 1980Q1 – 2008Q1. Table L.218, home mortgage assets for various institutions.

**Figure 2:** Source data as in Figure 1. Bank based institutions: Commercial banking, Savings institutions, Credit unions. Market based institutions: Government-sponsored enterprises, Agency-and GSE-backed mortgage pools, Issuers of asset-backed securities

**Figures 3-5:** US Flow of Funds, Board of Governors of the Federal Reserve. 1980Q1 – 2008Q1. Security brokers and dealers, total financial assets, table L.129. Commercial Banks, Total Financial Assets, sum of tables L.110 and L.113. Households, total financial assets, table L.100.

**Figure 6:** 10-K and 10-Q filings of the US Securities and Exchange Commission for Bear Stearns (1997Q1-2008Q1), Goldman Sachs (1998Q4-2008Q1), Lehman Brothers (1994Q4-2008Q1), Merrill Lynch (1992Q1-2008Q1), and Morgan Stanley (1997Q2-2008Q1). Leverage is the ratio of total assets to total stockholders equity. Quarterly growth rates of total assets and leverage are aggregated by weighting by total assets of the previous quarter.

**Figure 7:** Impulse response function computed from a first order vector autoregression of security broker-dealer asset growth, security broker-dealer equity return, housing investment, PCE core inflation, Fed funds target, S&P500 return, S&P500 implied volatility VIX, 10-year/3-month spread, Baa/10-year spread. Variable definitions are given below.

**Figure 8:** Impulse response function computed from a first order vector autoregression of Fed funds target, GDP growth, PCE core inflation, security broker-dealer asset growth, security broker-dealer equity return, S&P500 return, S&P500 implied volatility VIX, 10-year/3-month spread, Baa/10-year spread. Variable definitions are given below.

**Figure 9:** In all four panels security broker-dealer growth, the Federal funds target, and the Federal funds future are as defined below. In the lower left hand panel, Taylor rule residuals are the residuals of a regression of Federal fund changes on the lagged Federal funds target rate, current GDP growth, and current core PCE growth. These residuals are the residuals of the regression reported in Column (i) of Table 3. The Taylor rule residuals of the lower left hand panel correspond to the Taylor rule described in Poole (2005):  $\text{Federal Funds} = 1.5 * (\text{lagged core PCE core inflation} - 1.5) + 0.5 * \text{Output Gap} + 2.3 + 1.5$ . The output gap is computed as the percent deviation of real GDP (Bureau of Economic Analysis) from potential real GDP (Congressional Budget Office).

**Figure 10:** The impulse response functions are computed from a vector autoregression (VAR) using a standard Cholesky decomposition. The baseline specification includes annual GDP growth, annual PCE inflation, the Fed funds target, and annual housing investment growth. The specification with financial asset prices adds the market return,

market volatility, the term spread, and the credit spread to the VAR (in that order, variable definitions given below). The VAR with security broker-dealers add annual broker-dealer total asset growth and broker-dealer annual equity growth to the macro variables (in that order).

**Tables 1-4, 6-7:** Variable definitions. All variables are quarterly from 1986Q1-2008Q1. GDP growth denotes the annual percentage growth rate of real gross domestic product in chained 2000 US dollars, reported by the Bureau of Economic Analysis. Total consumption, durable consumption, total investment, and housing investment are the respective annual percentage growth rates as reported by the Bureau of Economic Analysis. Core PCE inflation is the annual percentage growth rate of the chained price index of personal consumption expenditures less food and energy, reported by the Bureau of Economic Analysis. The Federal funds target is set by the Federal Open Market Committee and calculated as average over the quarter. The term spread is the difference between the 10-year Treasury constant maturity yield and the three month constant maturity yield from the Federal Reserve Board's H.15 data release. The credit spread is the difference between Moody's BAA yield and the 10-year constant maturity yield, both from the from the Federal Reserve Board's H.15 data release. The Federal funds future is from the one year Eurodollar rate published by the Financial Times. The S&P 500 return is the quarterly return reported by Standard and Poor's. The S&P 500 volatility index is the VIX since 1991, and the VXO from 1986-1990, as reported by the Chicago Board Options Exchange. Security Broker and Dealers equity growth is the annual equity return from the Center for Research in Security Prices, according to the Standard Industrial Classification codes. Commercial bank equity is the annual equity return from the Center for Research in Security Prices, according to the Standard Industrial Classification codes. Security broker-dealer total asset growth is the annual growth rate of total financial assets from table L.129 of the Federal Reserve Board's Flow of Funds. Commercial bank total asset growth is the annual percentage growth rate of the sum of total financial assets from tables L.110 and L.113 of the Federal Reserve Board's Flow of Funds. The crisis dummy equals 1 in 1987Q4, 1994Q4, and 1999Q1, and 0 otherwise.<sup>22</sup>

**Table 5:** The Primary Dealer Repo series is the memorandum item "Total Reverse Repurchase Agreements" of Table 4 "Financing by Primary US Government Securities Dealers" from the weekly release of the FR2004 date by the Federal Reserve Bank of New York. The other variables in Table 4 are the same as the ones used in Tables 1-4 and 6-7, at a weekly frequency.

---

<sup>22</sup> We use 1999Q1 instead of 1998Q4 as crisis quarter for the LTCM episode as the Flow of Funds data only show a negative growth in security-broker dealer assets in that quarter. In comparison, data from the SEC shows a decline already in 1998Q4 (see Figure 6). This difference is likely a data issue of the Flow of Funds relating to mergers and initial public offerings of some large broker-dealers.