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Liquidity, Monetary Policy, and Financial Cycles

Tobias Adrian and Hyun Song Shin

A close look at how financial intermediaries manage their balance sheets suggests that these institutions raise their leverage during asset price booms and lower it during downturns—pro-cyclical actions that tend to exaggerate the fluctuations of the financial cycle. The authors of this study argue that the growth rate of aggregate balance sheets may be the most fitting measure of liquidity in a market-based financial system. Moreover, the authors show a strong correlation between balance sheet growth and the easing and tightening of monetary policy.

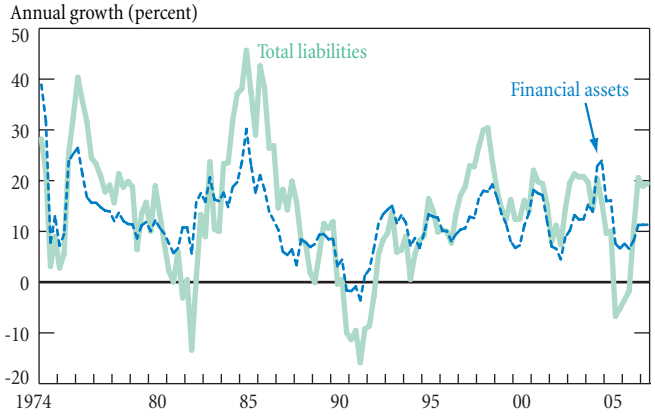
In recent years, financial commentators have linked stock market bubbles and housing price booms to excess liquidity in the financial system and an expansive monetary policy. However, in making these connections, the commentators often rely heavily on metaphors: "Holding interest rates too low for too long creates excess liquidity, which is now more likely to spill into the prices of homes, shares, or other assets." Or "the flood of global liquidity . . . has inflated a series of asset-price bubbles."[1] While figurative statements of this kind may be rhetorically effective, they tend to be quite imprecise, providing little insight into the economic mechanisms underlying the linkages they describe.

In this edition of *Current Issues*, we seek to clarify the economic relationships that exist between financial market liquidity, monetary policy, and credit cycles. Our approach is to examine how financial intermediaries react to the changes in their balance sheets that result either from market price fluctuations or from the decisions of others to increase or curtail lending and borrowing. We focus in particular on how banks adjust their leverage—defined here as the ratio of total assets to equity (net worth)—in response to a rise or fall in the value of their balance sheet assets.

Our empirical evidence suggests that banks are very aware of changes in asset value and the attendant effects on their overall leverage, and that they manage their leverage actively. More specifically, we find that institutions increase their leverage during booms and reduce it during downturns. Thus, contrary to common assumptions, financial institution leverage is *pro-cyclical*; the expansion and contraction of balance sheets amplifies, rather than counteracts, the credit cycle. A closer look at the fluctuations in balance sheets reveals that the chief tool used by institutions to adjust their leverage is collateralized borrowing and lending—in particular, repurchase agreements (repos) and reverse repurchase agreements (reverse repos), transactions in which the borrower of funds provides securities as collateral.

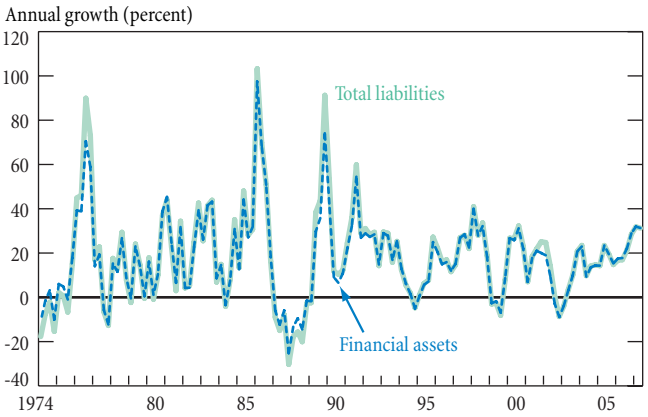
In line with our focus on balance sheet management, we present a new definition of liquidity as the growth rate of financial intermediaries' balance sheets. We then document

Chart 1
Asset and Liability Growth of U.S. Bank Holding Companies



Source: Board of Governors of the Federal Reserve System, *Flow of Funds Accounts*.

Chart 2
Asset and Liability Growth of U.S. Security Brokers and Dealers



Source: Board of Governors of the Federal Reserve System, *Flow of Funds Accounts*.

how monetary policy affects overall liquidity conditions. When monetary policy is "loose" relative to macroeconomic fundamentals, financial institutions expand their balance sheets through collateralized borrowing; as a consequence, the supply of liquidity increases. Conversely, when monetary policy is "tight," institutions shrink their balance sheets, reducing the stock of repos and the overall supply of liquidity.

Our findings suggest a need to rehabilitate balance sheet quantities as a relevant measure in the conduct of monetary policy, but with one twist. Rather than reaffirming the conventional monetarist identification of the money stock as an indicator of liquidity, our analysis assigns this role to the stock of collateralized borrowing.

Assets, Liabilities, and the Leverage of Financial Institutions

To understand how banks manage their leverage, we look first at aggregate data on the assets and liabilities of U.S. bank holding companies, drawn from the Federal Reserve's *Flow of Funds Accounts* (Chart 1). As the chart shows, liabilities are more volatile than assets: during booms, banks increase their liabilities more than they increase their assets; during downturns, banks reduce their liabilities more than they reduce their assets. Thus, the overall book leverage of bank holding companies—the value of the companies' total assets divided by the value of the companies' total equity (where equity is calculated as assets minus liabilities)—rises during booms and falls during downturns, establishing a pro-cyclical pattern.

For bank holding companies, a large proportion of assets are loans that are carried on the financial accounts at book value rather than being adjusted for the fluctuations in value that arise from changes in credit and liquidity risk over the cycle. During booms, the book value of loans will understate the market value of such loans, while during downturns in the financial cycle, the book value will overstate the loans' market value. Thus, Chart 1 is likely to exaggerate the fluctuations in leverage by failing to adjust the book value of loans to market values.

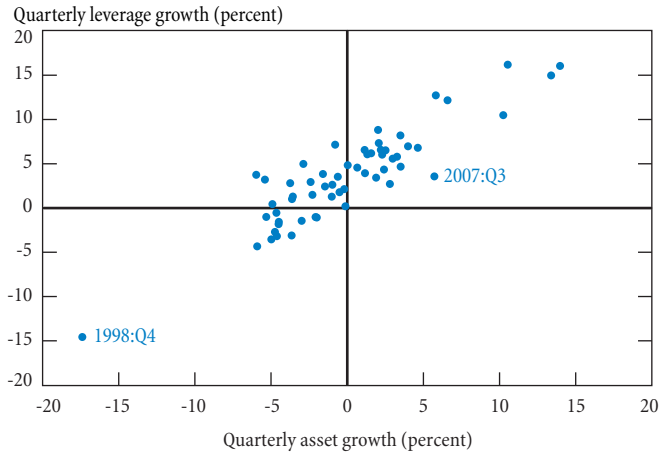
A different pattern is evident in Chart 2, which presents aggregate growth data on the assets and liabilities of security brokers and dealers (whose largest constituents are investment banks). For security brokers and dealers, assets consist largely of claims that are either marketable or very short-term in nature, such as collateralized loans. For this reason, the discrepancy between book values and market values is smaller than it is for bank holding companies.

The most striking feature of Chart 2 is that the changes in assets and liabilities appear to be very closely related. To be sure, the value of some items on the liabilities side of a security dealer's balance sheet—such as sales of borrowed securities to fund investments in other assets—might be expected to rise or fall in tandem with the value of the dealer's traded assets. However, a security dealer's liabilities consist largely of forms of short-term borrowing (for example, repurchase agreements and other types of collateralized financing) whose value would accurately reflect the current market value. Thus, the close co-movement of assets and liabilities serves as evidence of active management of leverage by the brokers and dealers themselves.

While the balance sheet data from the *Flow of Funds Accounts* are broadly suggestive, they yoke together very

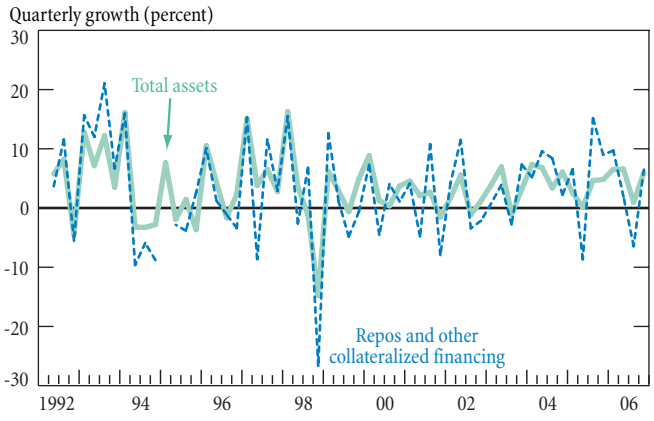
[1] "Still Gushing Forth," *The Economist*, February 3, 2005; for another example, see "Bubbles Caused by Cheap Cash Menace World Economy," Reuters, July 24, 2006.

Chart 3
Total Asset Growth and Leverage Growth of U.S. Investment Banks



Sources: Authors' calculations; Securities and Exchange Commission, EDGAR database.

Chart 4
Total Asset Growth and Repo Growth of U.S. Investment Banks



Sources: Authors' calculations; Securities and Exchange Commission, EDGAR database.

different financial institutions in the security broker and dealer category. To gain a more detailed understanding of financial institution behavior, we construct balance sheet data from the regulatory filings of five large U.S. investment banks.[2] The five banks are typical "stand-alone" investment banks, not owned by a large commercial banking group.

Using the balance sheet data, we can plot the quarterly change in leverage for our sample of U.S. investment banks against the quarterly change in the banks' total assets (Chart 3). Given that leverage is defined as the ratio of total assets to shareholder equity, we would expect to see a negative relationship between changes in total assets and changes in leverage: That is, a rise in the value of total assets would boost equity as a proportion of total assets, leading to a decline in leverage. (By the same logic, a homeowner whose house jumped in price would be expected to experience a rise in equity and a consequent fall in leverage.) Contrary to expectations, however, Chart 3 shows a strongly positive relationship between leverage and total assets. The implication is that the investment banks are actively responding to a rise in asset value (and the consequent decline in leverage) by expanding their balance sheets.

The tool that the investment banks use to expand their balance sheets is collateralized borrowing—in particular, repurchase agreements. In these short-term borrowing transactions, the borrower of funds provides securities to the lender as collateral and agrees to repurchase the securities at a higher price on a future date. Chart 4 plots the quarterly changes in the banks' assets against the quarterly changes in repos. The two series move closely together,[3] suggesting that the banks respond to a rise in assets by taking on more liability in the form of repurchase agreements.

In sum, our evidence implies that investment bank leverage is pro-cyclical: During booms, banks increase their liabilities by more than their assets have risen, thus raising their leverage. During troughs, they reduce their liabilities more sharply than their assets have declined, thus lowering their leverage. Although the term "pro-cyclical leverage" is not one that the banks themselves would use in describing their actions, it does capture the basic nature of their practice.

What guides the actions of the investment banks? Essentially, the banks' models of risk and economic capital dictate active management of their overall value at risk (VaR)—the risk of loss on banks' asset portfolios—through adjustments of their balance sheets. In particular, banks will adjust assets and liabilities to ensure that their total equity is proportional to the total value at risk of their assets.

Thus, for a given amount of equity, a lower value at risk allows banks to expand their balance sheets: Leverage is inversely related to value at risk. Since measured risk is countercyclical—low during booms and high during busts—the banks' efforts to control risk will lead to pro-cyclical leverage.

From the point of view of each financial intermediary, decision rules that result in pro-cyclical leverage are readily understandable. However, in the aggregate, such behavior

[2]Our data source is the Securities and Exchange Commission's EDGAR database, available at <http://www.sec.gov/edgar.shtml>.

[3]It is apparent, however, that repo growth is more volatile than the growth of total assets.

Figure 1
Leverage Management during an Asset Price Boom

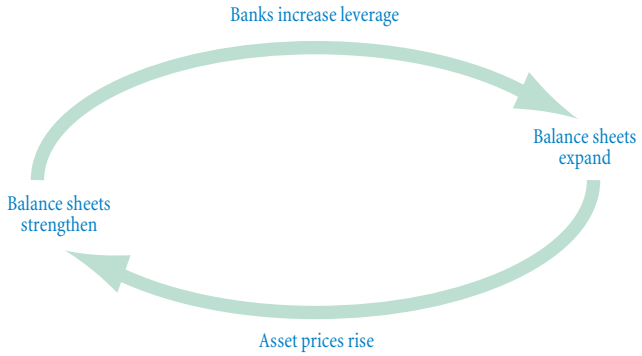
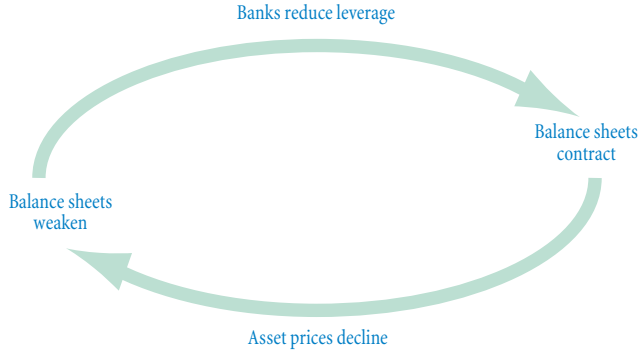


Figure 2
Leverage Management during an Asset Price Decline



has consequences for the financial system as a whole that are not taken into consideration by an individual institution. In the next section, we explore these consequences by examining the economic mechanism that is set in motion by the balance sheet adjustments of financial institutions.[4]

Consequences of Pro-cyclical Leverage

Pro-cyclical leverage offers a window on the notion of financial system liquidity. To understand how the decisions of investment banks to pursue pro-cyclical leverage affect their own balance sheets and ultimately the financial system as a whole, we look more closely at the chain of events that follows a rise in asset prices during a boom or, alternatively, a decline in asset prices during a downturn. What is evident in these sequences is that pro-cyclical leverage reverses the normal demand and supply responses to asset price changes.

Consider first a "boom" scenario in which the assets held widely by market players and intermediaries with pro-cyclical leverage increase in price. As noted earlier, this price increase will boost the equity or net worth of these institutions as a proportion of their total assets, strengthening their overall balance sheets. When balance sheets become stronger, leverage falls. Because the institutions have pro-cyclical leverage, they must respond to the erosion of leverage by raising leverage upward.

How can they restore leverage? One way is to borrow more, then use the proceeds to buy more of the assets they already hold. Such a reaction—buying more, rather than less, of an asset when its price is rising—clearly reverses the normal demand response.

If, moreover, increased demand for the asset tends to put upward pressure on its price, there is the potential for a feedback effect: the stronger balance sheets lead to greater demand for the asset, and this outcome in turn raises the asset's price and further strengthens the balance sheets. Having come full circle, the feedback process goes through another turn (Figure 1).

During downturns, the mechanism works in reverse. Consider a scenario in which asset prices decline. Then, the net worth of institutions will fall faster than the rate at which their assets decrease in value. As the institutions' balance sheets weaken, their leverage will increase. Since these institutions are targeting pro-cyclical leverage, however, they must attempt to reduce leverage in some way—in some cases, quite drastically.

How do these institutions reduce leverage? One way is to sell some assets, then use the proceeds to pay down debt. Thus, a fall in the price of the asset can lead to an increase in the supply of the asset, overturning the normal supply response to a drop in asset price.

If we further hypothesize that greater supply of the asset tends to put downward pressure on its price, then there is again the potential for a feedback effect. Weaker balance sheets lead to greater sales of the asset, and this outcome in turn depresses the asset's price and leads to even weaker balance sheets. But weaker balance sheets will kick off another cycle of selling and price declines (Figure 2).

Of course, the perverse nature of the demand and supply responses applies solely to leveraged institutions. Non-leveraged institutions—such as households, pension funds, and insurance companies—can be expected to moderate the amplification mechanism created by the balance sheet dynamics. How fully they can offset this mechanism remains unclear, however.

[4]Further evidence that financial institution behavior has consequences for overall financial conditions can be found in Adrian and Shin (2007). This earlier paper demonstrates that changes in collateralized borrowing by the major banks can forecast shifts in risk appetite as captured in the VIX index, a widely followed summary measure of the aversion to risk priced into the options on the S&P 500 stock index. When balance sheets expand, the VIX index tends to decline over the next week. When balance sheets contract, the VIX index tends to rise. In this sense, the fluctuations of balance sheets through collateralized borrowing can predict shifts in risk appetite.

A New Definition of Liquidity

Our discussion of financial institution behavior suggests a natural definition of liquidity as the *rate of growth of aggregate balance sheets*. In more concrete terms, we can define liquidity as the rate of growth of repos, since repos and other forms of collateralized borrowing are the tool that financial institutions use to adjust their balance sheets.

When financial intermediaries' balance sheets are generally strong, their leverage is low. They hold surplus capital, and will attempt to find ways in which they can employ it. In an analogy with manufacturing firms, the financial system could be said to have "surplus capacity." For such surplus capacity to be utilized, the intermediaries must expand their balance sheets. On the liabilities side, they take on more short-term debt. On the asset side, they search for potential borrowers to lend to. Aggregate liquidity, we suggest, is intimately tied to how hard the financial intermediaries search for borrowers. In the case of the subprime mortgage market in the United States, we have seen that when balance sheets are expanding fast enough, even borrowers who do not have the means to repay are granted credit—so intense is the urge to employ surplus capital. In this way, the conditions are set for the subsequent downturn in the credit cycle.

The Role of Money

In what sense is our notion of aggregate liquidity related to the traditional notion of liquidity as the money stock? In a hypothetical world where deposit-taking banks are the only financial intermediaries and where their liabilities (deposits) can be identified with a broad definition of "money," the money stock would be a good indicator of the aggregate size of the balance sheets of leveraged institutions. To this extent, the growth of the money stock would play a useful role in signaling changes in the size of the aggregate balance sheet of the leveraged sector.

However, it is clear that we cannot readily identify money with the aggregate size of the liabilities of leveraged institutions. First, many of the leveraged institutions—investment banks, hedge funds, off-balance-sheet vehicles and others—do not conform to the textbook ideal of the deposit-funded bank. Hence, their liabilities are not counted as money. Second, even for banks that are mainly deposit-funded, not all liabilities qualify as money. The banks also raise funding from financial markets to supplement their deposit funding.

Just as the money stock is a poor measure of aggregate liquidity, so excessive growth of the money stock is a flawed measure of excess liquidity. To be sure, if the financial system were dominated by deposit-taking banks, so that the aggregate liabilities of the financial system as a whole were well captured by the stock of deposits, then excess liquidity would correspond to excessive growth of the money stock. Deposits fall under conventional broad notions of money. However, the ideal of a financial system dominated by deposit-funded banks may never have existed in its purest form, and it is becoming less relevant over time. Certainly, empirical evidence from the United States since the 1980s detects very little role for the money stock in explaining macroeconomic fluctuations (see, for example, Friedman [1988]).

If the financial system is instead organized around the capital market, then conventional measures of money represent only a small proportion of the aggregate size of the leveraged sector. Nor is the quantity of deposits the most volatile component of the total aggregate liabilities of the financial system. In such a world, money is less useful as a measure of liquidity. The rapid move toward a market-based financial system in recent years has accelerated the trend toward greater reliance on nontraditional, non-deposit-based funding and toward greater use of the interbank market, the market for commercial paper, and asset-backed securities.

Liquidity and Monetary Policy

The concept of liquidity we proposed earlier—the growth rate of aggregate balance sheets or, more precisely, the growth rate of outstanding repurchase agreements—is a far better measure for a modern, market-based financial system than is the money stock. In this section, we focus on the question whether our preferred notion of liquidity has any bearing on monetary policy, and in particular whether the growth of repos is linked in a direct way with the easing or tightening of monetary policy.

Our empirical tests of this relationship suggest that the answer to this question is a resounding "yes." We find that repo growth is closely correlated with the ease or restrictiveness of monetary policy as measured by the Taylor rule (see the box). The Taylor rule specifies how a central bank should alter its targeted short-term interest rate (the federal funds rate in the United States) in response to evolving macroeconomic fundamentals—specifically, the divergence of current output from potential output and of current inflation from the desired rate of inflation. We show that when monetary policy is loose in the sense that the federal funds rate is lower than the rate implied by the Taylor rule, there is rapid growth in repos and financial market liquidity is high. Conversely, when monetary policy is tight in the sense that the fed funds rate is higher than the rate implied by the Taylor rule, repo growth is much lower, even negative at times, and financial market liquidity is low.[5]

[5]For a discussion of these relationships from a policymaker's perspective, see Tucker (2007).

The Link between Monetary Policy and the Growth of Repos

To test the relationship between monetary policy and the growth of repurchase agreements, we estimate the following Taylor rule:

$$\textit{Federal funds target} = 1.3 + 0.8 \times \textit{output gap} + 1.3 \times \textit{inflation rate} + \textit{Taylor rule residual.}$$

We calculate the output gap as the percentage difference between real (inflation-adjusted) GDP and real potential GDP, and the inflation rate as the annual percentage growth of the core consumer price index (core CPI). Summary statistics for these variables, as well as the Taylor rule residual from the equation, are given in Table A1. All coefficients in the equation are statistically significant at the 1 percent level.

Following Taylor (1993), we can interpret the predicted value from the equation as "rule-based" monetary policy, and the Taylor rule residual as "discretionary" monetary policy. A positive residual indicates tight monetary policy relative to the rule, while a negative residual indicates relatively loose policy. The R^2 of the equation is 75 percent, indicating that three quarters of the variation in monetary policy is attributable to the Taylor rule, while one quarter of the variation is discretionary.

As a measure of aggregate growth of repurchase agreement liabilities, we use the comprehensive figures for the so-called primary dealers that have a trading relationship with the Federal Reserve Bank of New York (see Adrian and Fleming [2005] and Kambhu [2006] for earlier analysis of the primary dealer repo data). One advantage of these data is that they include the marked-to-market repo financing of investment banks, commercial banks with large investment banking operations, and nonbank security brokers and dealers. The primary dealer data can thus be interpreted as an aggregate measure of the financial system's repo financing. Our key results relating repo growth to the stance of monetary policy are contained in Table A2.

When the residuals of the Taylor rule regression are negative (that is, when the federal funds rate is lower than that predicted by the Taylor rule), repo growth is higher than average. Conversely, when the residuals of the Taylor rule regression are positive (that is, when the fed funds rate is higher than that predicted by the Taylor rule), repo growth is lower than average, sometimes even becoming negative.

Interestingly, the behavior of repos is quite different from that of commercial paper. Although both repos and commercial paper are forms of short-term borrowing, the evidence suggests that financial intermediaries take on more of one when the other is less available. The coefficients on the liquidity regression using commercial paper growth instead of repo growth (reported in columns 3 and 4 of Table A2) show signs exactly opposite to those for repo growth. One possible explanation for the reverse in signs could be that financial intermediaries turn to commercial paper when repos are difficult to obtain (for example, during the hedge fund crisis of 1998). Conversely, when repos are increasing rapidly so that balance sheet capacity is low, there is less spare capacity for the issuance of commercial paper. The credit crisis of 2007 conforms to the latter scenario.

Table A1
Summary Statistics for Taylor Rule Regressions
1991:Q3 to 2007:Q1

	Mean	Standard Deviation	Minimum	Maximum
Primary dealer repo growth	14.32	11.03	-17.69	34.92
Outstanding financial commercial paper growth	10.07	10.38	-5.49	29.24
Federal funds target rate	4.07	1.67	1.00	6.50
Output gap	-0.72	1.60	-3.18	2.91
Core CPI inflation	2.56	0.65	1.15	4.60
Taylor rule residuals	0.00	0.95	-1.81	2.40

Sources: Board of Governors of the Federal Reserve System, H.15 statistical releases, for data on growth in outstanding commercial paper; Federal Reserve Bank of New York, for primary dealer statistics and the federal funds target rate; U.S. Congressional Budget Office, for the output gap; U.S. Department of Labor, for core CPI inflation; authors' calculations.

Notes: All growth rates are annual percentages. Primary dealer repo growth is the annual growth rate of the repurchase agreement liabilities of the Federal Reserve's primary dealers. The output gap is the percentage difference between current real GDP and potential real GDP. Taylor rule residuals are the residuals of an ordinary least squares regression of the federal funds target rate on core CPI inflation and the output gap.

Table A2
Taylor Rule Regressions
1991:Q3 to 2007:Q1

	Primary Dealer Repo Growth		Financial Commercial Paper Growth	
	(1)	(2)	(3)	(4)
Fed funds target	-2.29**		4.77***	
Taylor rule residuals		-4.68***		5.61***
Taylor rule fed funds prediction		-1.11		5.49***
Constant	23.64***	18.85***	-9.35***	-7.89***
R^2 (percent)	12	18	59	59

Source: Authors' calculations.

Note: This table reports regressions of primary dealer repo growth rates and outstanding commercial paper growth rates on the federal funds target rate and Taylor rule residuals.

** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Conclusion

Our look at how banks and other financial intermediaries manage their balance sheets reveals that these institutions increase their leverage during asset price booms and reduce it during busts. This pro-cyclical behavior is likely to exacerbate financial market fluctuations as institutions overturn the normal supply and demand responses by buying assets when the price rises and selling them when the price falls. These findings lead us to propose a new definition of financial market liquidity as the growth rate of aggregate balance sheets—or, more specifically, as the growth rate of repurchase agreements, the tool used by financial institutions to adjust their leverage.

Taking our analysis a step further, we show that the growth rate of repos is closely related to the degree of ease in monetary policy: when monetary policy is loose, the stock of repos grows rapidly and market liquidity is high; when monetary policy is tight, repo growth is slow and market liquidity declines markedly. One implication of the link between repo growth and monetary policy is that the short-term rate targeted by policymakers (the federal funds rate in the United States) may be a key price variable in its own right. This rate has been regarded mainly as a vehicle for signaling the central bank's intentions to the financial markets and thereby influencing the markets' expectations about the future course of central bank actions. In contrast to this orthodox view, our results suggest that the policy rate—through its effects on the cost of leverage—may be an important determinant of the expansion and contraction of balance sheets and the liquidity of the financial system. Certainly, the financial turmoil of 2007 has dramatically underscored the significance of financial intermediaries' balance sheets for market performance and hence for monetary policy. Financial system liquidity emerges as the crucial concept that ties balance sheet management, asset prices, and monetary policy together.

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