

CHAPTER 5

LIQUIDITY PRODUCTION IN 21ST CENTURY BANKING

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ABSTRACT

I consider banks' role in provide funding liquidity (the ability to raise cash on demand) and market liquidity (the ability to trade assets at low cost), and how these roles have evolved. Traditional banks made illiquid loans funded with liquid deposits, thus producing funding liquidity on the liability side of the balance sheet. Deposits are less important in 21st century banks, but funding liquidity from lines of credit and loan commitments has become more important. Banks also provide market liquidity as broker-dealers and traders in securities and derivatives markets, in loan syndication and sales, and in loan securitization. Many institutions besides banks provide market liquidity in similar ways, but banks dominate in producing funding liquidity because of their comparative advantage in managing funding liquidity risk. This advantage, which came to the fore during the Fall of 2008, stems from the structure of bank balance sheets as well as their access to government-guaranteed deposits and central-bank liquidity.

Keywords: Liquidity; securitization; loan syndication

1. INTRODUCTION

Commercial banks produce credit and they provide liquidity. Credit involves channeling resources from entities with excess funds (savers) to entities with a scarcity of funds (investors). Many institutions produce credit. Banks collect savings from depositors and lend the funds to firms and households; finance companies collect funds in the commercial paper market and lend (or lease) the funds to various investors; insurance companies collect premiums and purchase stocks, bonds, commercial paper and other securities.

Defining liquidity is more difficult. Brunneimeier and Pederson (2007) contrast ‘funding liquidity’ with ‘market liquidity’. Funding liquidity involves raising cash on short notice. Brunneimeier and Pederson model trading in securities markets, so for them funding liquidity describes traders’ ability to raise cash with securities as collateral (i.e. margin requirements). But the concept is quite general. When a depositor withdraws cash or a firm borrows from a credit line, for example, the issuing bank has supplied funding liquidity to the customer. Market liquidity, in contrast, describes the cost of selling assets. Market liquidity is high when prices net of all transactions costs approximate fundamentals (present values). Real estate brokers produce market liquidity for houses. Broker-dealers (i.e. investment banks) produce market liquidity for stocks, bonds and derivatives, both as underwriters in primary markets and as market makers and traders in secondary markets.

Banks provide both funding liquidity and market liquidity. Traditional intermediation – making illiquid loans funded with liquid deposits – involves production of funding liquidity. Like investment banks, commercial banks also provide market liquidity in their role as market

makers in derivatives markets. Banks also create market liquidity in loans. For example, in securitization banks transform pools of illiquid loans, such as mortgages or credit card receivables, into liquid securities. Securitization only flourishes in the presence of a deep securities market. Banks' function in securitization is similar to the function played by investment bankers when they underwrite debt and equity for non-financial companies.

In this paper I consider how banks provide funding liquidity and market liquidity, and describe how these roles have evolved. With provision of both sorts of liquidity, banks face unique risks and risk-management challenges. I discuss how banks meet those challenges. I argue that banks have a special advantage in managing *funding* liquidity risk but not *market* liquidity risk. Hence, many institutions provide market liquidity, while banks dominate in producing funding liquidity. Their comparative advantage stems from the structure of bank balance sheets as well as their access to government guarantees and central bank liquidity. This advantage became especially clear during the 2007-08 financial crisis, discussed in Section 4 below, when the large stand-alone investment banks all either failed, were purchased or converted to bank holding companies.

In the end, I argue that liquidity production has always been, and continues to be, the core function of banking, but its form has changed in response to development of financial technology and deepening of securities markets. Traditional banks issued liquid deposits to finance illiquid loans. In this 'old-school' model, most bank liquidity production came in the form of issuing transactions deposits and supporting the payments system. Modern banks continue to run the payments system, but the rise of electronic mechanisms has made this function more efficient and reduced the float available to finance lending. At the same time, securities markets have expanded and deepened. Thus, much of the liquidity production supported by the banking

system now occurs (in the US) or likely will occur (in developing economies) in support of the capital markets. For example, in the form of off-balance sheet commitments to lend (e.g. lines of credit), credit guarantees (e.g. letters of credit), securitization (and the associated implicit support from originating banks), and syndicated lending. These modern roles have changed because financial innovations now allow funding to be separated from the information production and financial contracting necessary for credit production.¹

2. FUNDING LIQUIDITY

2.1 Liquidity Production from Deposits

Banks have traditionally provided funding liquidity to customers by issuing transactions deposits that act as a close substitute for currency. Transactions deposits allow account holders to take cash on demand from the bank. The float from this business - the average balance depositors hold in their accounts - can be invested by the bank in loans to businesses and households. Because banks tend to invest in illiquid loans, this business model has been called ‘asset transformation’ - banks *transform* illiquid and hence high-yield assets (loans) into liquid and thus low-yield assets (deposits). The yield spread creates positive carry for the bank. Loans are illiquid because banks lend to small and medium-sized businesses without access to broad securities market. To do such lending, banks collect private information on credit risk and future

¹ This paper will not survey the literature on liquidity and banking. The literature is a vast, with many hundreds of papers focusing on bank runs, contagion and financial crises. These papers span finance, industrial organization and macroeconomics. It is simply too much to review here. I will briefly discuss some classic treatments of these topics, but will focus most of the discussion on the current state of liquidity production and liquidity risk that we see emerging as banks change to keep pace with the development of capital markets.

growth opportunities and monitor borrowers over the life of the loan.

The early theory emphasized how information and monitoring solve financial contracting problems in bank lending (e.g., Leland & Pyle, 1977). As the intermediary, the bank pools funds from many small and uninformed depositors and lends on their behalf. Given the relatively limited information of these investors, banks tend to be financed with debt (Townsend, 1979). Because banks monitor loans on behalf of depositors, Diamond (1984) argues that they will be large and diversified. This structure minimizes the cost of delegating the monitoring role from the principal depositor to the agent banker. Safety and soundness improves the banker's incentives. So, theory suggests that loans are illiquid because the originating bank has superior information to any potential buyer, and that banks are large, well-diversified, and financed mainly with debt.

In contrast to loans, deposits are low in risk and high in liquidity. Bank deposits possess the three attributes theorists ascribe to money, namely they act as a store of value, they are denominated in the economy's unit of account (e.g. dollars for the U.S.), and they can be used as a medium of exchange. In order for deposits to act as an effective store of value, banks must minimize the risk to depositors that their claims will not be honored at face value; hence low risk and high liquidity go hand in hand.

Banks also spend substantial resources to enhance customers' ability to use deposits as a medium of exchange. For example, demand depositors use checks as a medium of exchange. In recent years, electronic payments technologies offer a cheaper alternative to cash or checks in both large and small transactions. Customers can use debit cards to transfer funds electronically from the buyer's deposit account to the seller's without losing interest before making the payment. Credit card transactions work similarly, although the buyer maintains more flexibility

by having the option to borrow funds from the issuing bank.

2.2 Liquidity Production from Loans

Banks also produce funding liquidity by issuing lines of credit (sometimes known as ‘revolvers’ or ‘loan commitments’), which allow customers to receive cash by drawing down the line, much as a demand deposit allows customers to take cash at any time. The difference between a demand deposit versus a line of credit - such as a credit card account – is that the line is not pre-funded. Instead, the customer borrows from the bank when they take cash, typically at a pre-arranged rate of interest. Households use unsecured lines in the form of credit card accounts and secured lines in the form of home-equity lines. Businesses typically also receive liquidity from banks in the form of credit lines.

The appeal of lines of credit has been studied theoretically from the stand point of businesses. For example, credit lines mitigate the risk of credit rationing for businesses during downturns (Berger & Udell, 1992; Morgan, 1998), and they insure firms against shocks to demand for capital (Holmstrom & Tirole, 1997). Firms can also use cash, but Sufi (2007) shows that firms with high cash flow use bank lines as a cheaper source of liquidity. Firms with low cash flow are unable to access bank liquidity on good terms and as a result hold cash instead. Sufi also finds that firms without bank lines adjust their buffer cash to changes in cash flow, while firms with access to bank lines do not. Together these results suggest that bank lines mitigate liquidity constraints on firms by providing them access to capital when investment opportunities improve (Almeida, Campello and Weisbach, 2004).

What explains the traditional model of banking?

Why combine liquid deposits with illiquid loans and credit lines? There have been many attempts to understand this traditional structure of banks. Some explanations suggest a causal chain running from liquid deposit to illiquid lending; some emphasize a chain of logic running from illiquid loans to liquid deposits; a third set emphasize a true synergy in which the causality goes in both directions.

Liquid Deposits → Illiquid Loans

One simple explanation for bank balance sheets stems from government deposit insurance. With insurance, deposits are safe, regardless of the bank's investment and financing decisions. Claims against banks are thus a close substitute for claims against the government and are an equally good store of value. Banks can invest in safe and liquid assets - they can be structured as narrow banks - or they can invest in higher yielding risky assets like loans. That decision does not matter to a fully insured depositor. With limited liability, bank shareholders receive the upside but have limited downside and benefit from risky, high-yield assets. Thus, the 'moral hazard' from deposit insurance encourages banks to invest in risky assets like loans and may play some role in explaining bank structure. Explicit deposit insurance schemes have become common worldwide. As of 1999, for example, 99 countries had created such programs (Kane and Demirguc-Kunt, 2002).

Kane and Demirguc-Kunt also show that deposit insurance was absent in most countries before the 1960s. Implicit insurance can also induce risk-shifting behavior, but history suggests that the structure of banking pre-dates active involvement by governments. Much theory attempts to explain the economics of combining illiquid loans with liquid deposits *absent*

government guarantees. Fama (1985) argues that banks have a comparative advantage in information production flowing from their role managing the payments system. Imagine a bank providing payments services to a small business. Each day the small business makes and receives payments, both in the form of checks as well as currency. These payment flows reflect the current state of business, and if the small firm uses one bank, this bank has the opportunity to know before others if the firm is having problems. Such private information could explain why the bank can lend on better terms than other competing intermediaries.

Some evidence suggests that banks do have an information advantage stemming from deposits. Small firms concentrate their borrowing with a single financial service firm, and these firms usually borrow from commercial banks. More than 80 percent of borrowing from financial institutions comes from commercial banks, and most borrowing comes from lenders where firms have a deposit account (Petersen and Rajan, 1994). In two bank case studies, Mester, Nakamura and Renault (2006) and Norden and Weber (2007) find that changes in checking account balances help banks monitor small businesses. Similarly, Udell (2004) finds that finance companies that lend with account receivable as collateral sometimes require borrowers to set up a special checking account to take payment on the receivables, thus potentially providing the finance company with the same information flows available to banks.

Loan pricing and credit availability, however, *do not* seem lower for those borrowing from the bank that holds their checking account. Cole (1998), for example, finds no link between the presence of a checking account and the probability that a firm will be granted credit from a bank. Cole, Goldberg and White (2004) find that for small firms applying to borrow from small banks, the likelihood of approval increases with the presence of a deposit relationship but no such result is evident when small firms borrow from large banks. Petersen and Rajan (1994)

find no relationship between borrower deposits and the interest rate charged (holding constant the length of the bank-borrower relationship). Berger, Miller, Petersen, Rajan and Stein (2005) find no link between the presence of a checking account and the fraction of trade credit paid late, a measure of credit availability to the firm.

Beyond information, transaction deposits may be supplied inelastically with respect to market interest rates, thereby allowing banks to insure borrowers against credit shocks. Berlin and Mester (1999) present a model in which bank core deposits allow them to insure borrowers against credit shocks, whereas an intermediary funded with, say, commercial paper, would not be able to offer this insurance. Borrowers value this contract either because they are risk averse or because they face costly financial distress. Thus, the deposit franchise may give banks an advantage in lending that is unrelated to information. As evidence, Berlin and Mester show that interest rates on bank loans are less sensitive to economy-wide credit shocks (e.g. corporate bond spreads, changes in unemployment, etc) when the originating bank holds more core deposits (defined as deposits under \$100,000).

Myers and Rajan (1998) argue that because banks are funded with very liquid debt and have such high leverage, they need to some hold illiquid assets to mitigate the risk of expropriation or fraud. It is simply too easy for banker to “steal” when assets are highly liquid. In a sense, their model argues against the “narrow bank” in which deposits are backed 100 percent by low-risk and highly liquid government securities. Too much liquidity on the asset side is dangerous because it becomes too easy for funds to be expropriated quickly. Although not an empirical article, Myers and Rajan argue that the historical development of commercial banking supports their model. Banks historically emerged as payments-providers only; the bank began as a ‘money-changer’. These money changers held high levels of reserves, and the main

risk perceived at the time had to do with fraud rather than bank runs. Myers and Rajan argue that the money-changers enhanced their reputation for honesty by engaging in lending in the local community, hence the origin of asset transformation.

Illiquid Loans → Liquid Deposits

Several recent theories argue that the structure of bank lending shapes the nature of their liability structure. These arguments reverse the causal chain but lead to the same main implication, which is that illiquid loans go together with liquid deposits. For example, Calomiris and Kahn (1991) and Diamond and Rajan (2001) argue that demandable-deposits, by making the bank vulnerable to a destructive run, improve incentives for monitoring loans. Similarly, Flannery (1994) argues that very short term maturity of deposits improves bank incentives; for example, asset substitution problems are contained by short debt maturity. Moreover, Calomiris and Kahn emphasize that the “sequential service constraint”, whereby deposits are paid on a first-come, first-served basis, strengthens monitoring incentives for informed depositors. Thus, the nature of the bank loan portfolio shapes the structure of its deposits.

Illiquid Loans ← → Liquid Deposits

Diamond and Dybvig (1983) argue that the liquid deposit account offered through a financial intermediary fosters households insurance against liquidity risk and fosters consumption smoothing. In their model, a bank is a mechanism to allow investors to finance illiquid but high return projects while insuring against unpredictable early-period consumption demands through pooling. The cost of this arrangement is the possibility of a bank run. While this model does not suggest a true synergy between lending and deposits, it does begin to consider links between the two sides of the banking business.

Recent studies suggest that by combining exposure to liquidity risk in both deposit-taking

and lending yields a risk-reducing synergy. Kashyap, Rajan and Stein (2002) argue that as long as liquidity demands from depositors and borrowers off lines of credit are not too correlated, an intermediary reduces its cash buffer by serving both customers. Holding cash raises costs for both agency and tax reasons. Thus, their model yields a diversification synergy between transactions deposits and unused loan commitments. Gatev, Schuermann and Strahan (2007) show that bank stock-return volatility increases with both transactions deposits and unused loan commitments, but that volatility declines when banks are exposed to liquidity on both sides of the balance sheet. Thus, there seems to be a hedge associated with combining these two activities.

Gatev and Strahan (2006) suggest a stronger hypothesis than Kashyap et al, arguing that liquidity demands may be negatively correlated during episodes of ‘flight to quality’. Funds tend to flow into bank transactions deposits during such episodes. At the same time, demands from borrowers for liquidity from credit lines also increase then because of lack of liquidity in commercial paper and bond markets. Why do banks enjoy funding inflows when liquidity dries up? First, the banking system has explicit guarantees of its liabilities. Second, banks have access to emergency liquidity from the central bank. Third, large banks such as Continental Illinois have been supported in the face of financial distress (O’Hara and Shaw, 1990). Thus, funding inflows occur because banks are rationally viewed as a safe haven for funds. Consistent with this notion, Pennacchi (2006) finds that during the years before federal deposit insurance, bank funding supply did *not* increase when spreads tightened.

2.3 Sources of Funding Liquidity Risk

By its very nature, providing funding liquidity makes (non-narrow) banks unstable because they are in the position of promising to disgorge cash on demand. Diamond and Dybvig (1983) present the classic treatment of liquidity risk from traditional asset transformation. Under normal circumstances the bank can meet random liquidity demands from depositors, but the structure is vulnerable to a run based on depositors' expectation that *other* depositors will run. In other words, runs can occur with no basis in fundamentals. Forced early liquidation lowers value and so runs are costly. This bank-run scenario presents the classic rationale for government provision of deposit insurance and back-up liquidity from central banks because these safety nets eliminate the incentive to run based on depositor expectations that others may run. The safety net, however, creates a host of other incentive and implementation problems (see Chapters 26 & 27 in this volume).

The empirical evidence suggests that expectations-based runs are the exception rather than the rule. Gorton (1988) studies seven banking panics in the United States prior to the creation of the Federal Reserve and finds that in all seven cases rational concerns about solvency motivated depositors. Under such circumstances, runs may cripple even healthy banks if depositors can not distinguish solvent from insolvent banks. Gorton also finds, however, that the economic shocks preceding the banking panics during the Depression were not sufficiently large to justify the scale of the subsequent runs. Thus, changes in depositor expectations may have exacerbated the severity of bank runs above what one might normally expect. Calomiris and Mason (1997) study a specific run on Chicago banks in 1932 and also find no evidence that

solvent banks failed because of runs.

More recently, McCandless, Gabrielli and Rouillet (2003) study runs faced by banks in Argentina in 2001 and, consistent with the studies of the U.S., find that solvency concerns were at the root of the runs. Puri and Iyer (2007) used detailed depositor-level data from a single Indian bank that experienced a run triggered by the insolvency of a large cooperative bank invested heavily in securities-based lending. Sharp declines in stock prices in 2001 led to the panic, but the individual bank studied appears to have been solvent. The study finds that depositors with a longer history with the distressed bank, depositors that also borrow from the bank, and depositors from the majority ethnic groups were less likely to run than other account holders. Relationships between banks and depositors seem to mitigate liquidity risk.

Loss of funding from runs can spill over and constrain bank production of credit. Bernanke (1983) argued, for example, that bank failures reduced credit supply and worsened the U.S. depression during the 1930s. Many subsequent studies have tested how bank insolvency or monetary policy changes affect credit, but several recent studies have found that pure liquidity shocks can also alter credit. Khwaja and Mian (2005) study bank lending following runs on dollar-denominated deposits that occurred in the wake of Pakistan's unexpected nuclear test in 1998. They exploit variation in the magnitude of the liquidity shock across banks (from different levels of dollar deposits), and show that borrowers substituted away from banks experiencing greater runs and toward banks experiencing smaller runs (or no runs). Paravisini (2007) exploits the opposite kind of shock – an injection of liquidity by the Argentine government - and finds that profitable lending expanded following the liquidity infusion.

Banking panics and failures dropped to near zero in U.S. banks from the creation of the FDIC in 1934 until the late 1970s. This stability ended in the 1980s, but most of the failures

have been from investments in high-risk loans (e.g. Continental Illinois in business lending; Bank of New England in high-risk commercial real estate), or in the case of savings institutions in taking on interest rate risk. In some cases banks faced funding outflows, but for the most part instability had little to do with liquidity risk from depositors. For example, large, uninsured depositors began removing funds from Continental Illinois in response to large credit losses on business lending. In 2007, depositors ran from the UK bank Northern Rock and the US bank Countrywide, as did depositors and other short-term creditors at Bear Stearns and other financial institutions in 2008. These runs were again based fundamentally on rational concerns about solvency stemming from losses on securities backed by troubled sub-prime mortgages (see Section 4 below).

Bank exposure to funding liquidity risk also arises from issuance of lines of credit, which commit the bank to provide cash on demand. Much of the day-to-day variation in liquidity risk is managed by diversification across a large base of customers. Kashyap, Rajan and Stein (2002) argue that diversification benefits across broad classes of customers – specifically borrowers off lines of credit and demand depositors – can reduce risk and the need to hold cash. As evidence, they report that banks dominate the market for lines of credit and, among banks, those with high transactions deposits issue more credit lines. Gatev, Schuermann and Strahan (2007) show that stock-return volatility is lower at banks exposed to liquidity risk in both lines of credit and deposits, suggesting a powerful hedge associated with combining these two products.

Several studies explore why firms and households draw funds from credit lines. Aggarwal, Ambrose and Lin (2005) find that individuals draw more funds from home equity lines when their credit quality declines. Using data on Spanish firms, Jimenez, Lopez and Saurina (2007) find that usage rates on credit lines increase as firms near bankruptcy. These

studies suggest that *ex post* demand for liquidity increases as a borrower's credit quality deteriorates, but other studies suggest that bank *ex ante* supply of lines offsets this risk. Banks restrict access to lines for poor credit quality firms and households. For example, Gropp, Schulz and White (1997) show that total supply of credit to households is lower in states with large housing exemption, and that this reduction restricts access to low-income, high-default risk customers. Sufi (2007) finds that large public firms with low cash flow have less access to liquidity from bank lines and thus hold more balance-sheet cash. Similarly, Agarwal (2004) finds that riskier private firms have both less access to credit lines and lower utilization rates than safer firms, and Agarwal et al (2006) compare home equity lines with second mortgages (home equity loans) and finds greater default risk in the second category of 'spot loans'.

2.4 Managing Funding Liquidity Risk

Banks use several tools to manage funding liquidity exposures. First, they hold liquid assets – cash, securities, and loans that may be sold easily. Second, they have access to liquidity from other banks in the inter-bank market. Third, they have liquidity support from the Central Bank. And, fourth, they are funded with deposits that expand during periods of market uncertainty.²

Holding cash is a simple yet costly way to bear liquidity risk. Banks have no particular advantage in bearing risk this way. Cash is costly because it earns a low return, is tax inefficient, and may be easily diverted or misallocated (Jensen, 1986). Nevertheless, during the early part of

² Banks also face similar liquidity risk management problem in balancing high frequency payments during daylight hours. The Federal Reserve provides intraday credit to help grease the wheels of the payments system. The funding liquidity risk discussed here involves somewhat longer-lived risks of loss of funding sources beyond a single day.

the 20th century banks used cash to persuade depositors of their soundness. A.P. Giannini, the founder of what is now the Bank of America, famously withstood runs during the panic of 1906 by displaying gold reserves on the street front, and offering to convert deposits into gold to all comers. This show of strength calmed his depositors while many competing banks failed. Modern evidence also suggests that cash and liquid assets, as well as loans that can potentially be sold or securitized, act as a buffer for banks against funding shocks (e.g. Kashyap and Stein, 2000; Loutskina, 2005).

Banks second layer of support comes from borrowing and lending in the interbank market. While not a source of aggregate liquidity, interbank markets can recycle liquidity through the system. Typically large banks have greater access to inter-bank credit than small ones. Ashcraft, McAndrews and Skeie (2007) find that small U.S. banks hold larger cash buffers and excess reserves with the Federal Reserve than large banks, and that they supply funds to large banks in the Federal Funds market.

Even with such access, a key issue for large banks, and one that came into sharp focus during the 2007-08 crisis, is how well this market functions during periods of market stress. Allen and Gale (2000) show theoretically how interbank connections can lead to contagion of liquidity shortages from one part of the banking system to others. Furfine (2002) studies the Fed Funds market during the LTCM crisis and finds that LTCM-exposed banks continued to have access to borrowing during this period. During the summer of 2007, however, spreads in the LIBOR market increased to about 50 basis points above rates in the Fed Funds market as investors appeared to lose confidence in their ability to evaluate the risks of large European banks with potential exposure to losses in the U.S. sub-prime mortgages market (Kane, 2007). As we will see below, the interbank market dried up spectacularly following the failures of AIG

and Lehman Brothers in the Fall of 2008.

The third source of liquidity for banks is from the Central Bank, the ‘lender of last resort’. According to Bagehot (1873), central banks should lend to illiquid but solvent banks at a penalty rate. Some have argued that such targeted liquidity support may worsen moral hazard problems associated with bailouts. Instead, open market operations that expand the total supply of liquidity are preferable. Such broad expansions of liquidity can be recycled in the interbank lending market without (or with less) moral hazard (e.g. Goodfriend and King, 1988).

Coordination failures may occur in the interbank market, however, whereby banks hoard liquidity because of concern about counterparty solvency (e.g. Rochet and Vives, 2004). Such coordination failures worry policymakers, who often intervene to overcome them. Historical examples include the 1987 stock market crash, when commercial banks were encouraged to lend by the Federal Reserve to distressed investment banks; the reorganization of LTCM in 1998, where counterparties were discouraged from forcibly liquidating the hedge fund; the temporary freezing up in the wholesale payments system following 9/11/01, when Federal Reserve officials not only injected liquidity through open market operations and direct lending to banks, but also implored banks to resume making payments to restore the normal patterns of payment coordination (McAndrews and Potter, 2002); and, of course, the 2007-08 crisis, which we discuss in Section 4 below.

Combining exposure to funding liquidity on both the asset and liability sides of the balance sheet provides the fourth measure of liquidity stability for banks. First, as noted above Kashyap, Rajan and Stein (2002) argue that demands for funding liquidity by borrowers and depositors tends to be less than perfectly correlated, so combining the two products offers some diversification benefits. Moreover, Saldenber and Strahan (2000) study the LTCM crisis during

1998 and find that bank lending increased to satisfy a *systematic* increase in loan demand from firms that normally receive liquidity in the commercial paper market, but that this increase in liquidity demand from borrowers was offset by funding inflows by depositors. Gatev and Strahan (2006) study these flows across many market conditions and find that both bank loans and their holding of cash and securities increase when market liquidity dries up generally (as proxied by the commercial paper-T-bill spread).

2.5 Empirical Trends in Funding Liquidity

The importance of funding liquidity produced through deposits seems to be falling consistently over time, as shown graphically in Figure 1. The decline in the ratio of transactions deposits to GDP has occurred as banks have increasingly offered customers money-like services via electronic technologies. Similar trends are evident in plotting the ratio of M1, which also includes currency, to GDP. The secular decline in ‘money demand’ reflects better payments technologies that allow households to make payments without losing interest on their savings. For example, credit card payments’ share rose consistently since 1980. Debit card usage remained very small (around 2% or less) until the middle of the 1990s, and then rose sharply to about 20 percent of all payments by 2006.

[FIGURE 1 HERE]

Figure 1 also shows that the drop in transaction deposits has been more than offset by the growth in unused credit lines. All kinds of lines – lines to consumers (mainly home equity lines and credit cards) and business lines - have grown relative to GDP over the past 20 years, in contrast to the declining ratio of transaction deposits to GDP. Lines to households have grown

most dramatically, from about 10 percent of GDP in the early 1990s to more the 30 percent by 2006, more than offsetting the decline in transactions deposits to GDP. Moreover, the total amount of liquidity provision by the banking system as a whole has grown. Thus, while the composition of banks provision of funding liquidity has changed, it remains as important as ever (Berger and Bouwman, 2007).

3. MARKET LIQUIDITY

Many of the changes in banking over the past twenty years reflect moving from a model of ‘originate and hold’ to one of ‘originate-to-distribute.’ The first model involved creation of funding liquidity through asset transformation from loans to deposits. This traditional model has been reshaped by the growth of loan sales and securitization. In the modern approach, the bank creates *market* liquidity rather than *funding* liquidity; that is, the bank (or other intermediary) transforms a hard-to-sell asset like a loan into one that is easier to sell, like a bond or other security. This allows the originating bank to sell the asset to passive investors and re-cycle their capital to originate new loans, which can in turn be transformed and sold.

3.1 Securitization

Banks have increasingly used securitization to finance their lending by creating structures such as collateralized loan, mortgage and debt obligations (CDOs, CLOs, CMOs and, generically SIVs, or structured investment vehicles). These financing arrangements allow the originating bank to remove business loans, credit card loans and mortgages from the balance sheet.

Securitization involves pooling the cash flows from a number of similar assets and selling the pool to a separate legal entity known as a special purpose vehicle (SPV). The SPV purchases those cash flows from the proceeds of the sale of securities, such as bonds or commercial paper. The securities are sold to arm's-length investors like insurance companies and money market mutual funds. Rather than holding the asset on a balance sheet financed with liquid deposits (the traditional model of asset transformation), securitization transforms the asset itself from an illiquid one (pools of loans) into a liquid securities issued by the SPV (bonds and commercial paper).

The pooling process results in a diversified portfolio of cash flows, which are used to support payments on debt securities issued by the SPV. Creating the separate SPV isolates the cash-flow generating assets and/or collateral so that securities issued by the SPV are not a general claim against the issuer, just against those assets. Cash flows from the original pool of loans can be further stripped and repackaged based on various characteristics (e.g., the prepayment behavior or payment priority) to enhance their liquidity. Often, the cash flows come with some additional implicit or explicit guarantees from the originating financial institution. For example, the originator may retain the residual or equity tranche in the SPV, thus retaining most of the credit risk. Originating banks also will often issue backup liquidity when SPV funding comes from short-term sources such as commercial paper. The backup liquidity may be necessary if the SPV has trouble rolling over the commercial paper, as occurred during the Summer of 2007 (see Section 4 below). In cases like this, there is no clean separation between the bank's production of funding and market liquidity because without the backup liquidity (i.e. the funding liquidity), the securitization would probably not be possible.

Securitization is attractive to banks (as well as to non-financial firms) because it lowers

the total cost of financing loans. One benefit of securitization is that it avoids bankruptcy costs. In contrast to normal debt finance, owners of the SPV-issued debt have *no claim* against the originator's other assets if the originator files for bankruptcy (Ayotte and Gaon, 2006). Moreover, the SPV itself can not go bankrupt, although defaults on the underlying loans can create losses for bondholders. This is accomplished contractually by forcing early amortization of the bonds issued by the SPV if cash flows from the underlying assets are lower than expected. With no possibility of default on the bonds, no claim against the originator when cash flows are low, and no decisions to be made by the SPV itself, the bonds sold by the SPV have side stepped both the agency costs of financial distress as well as direct and indirect costs of bankruptcy (Gorton and Souleles, 2006).

While early amortization avoids financial distress cost, it does impose losses on bondholders. Thus, buyers of bonds created through securitization face a potential lemons problem because originators have better information and may be tempted to securitize their low-quality loans (Akerlof, 1970). If the lemons problem were not solved in some manner, securitization would fail to lower the costs of finance. Demarzo (2005) shows how pooling and tranching can reduce the lemons problem by allowing the SPV to fund most of the purchase of the original assets with very safe bonds issued by the SPV. In a typical structure, the SPV will issue senior notes with a high rating (say AA), a mezzanine tranche with a lower rating (say BB), and an equity tranche that is unrated. Both the senior and mezzanine tranches are liquid and held by various sorts of institutional investors; only a small piece of the financing – the equity tranche – remains illiquid. The equity tranche bears all of the losses (unless losses fully deplete this tranche), and is typically held by the originator (Franke and Krahen, 2004) or the master or special servicer (Sanders, 2004). Thus, most of the credit risk is concentrated in the equity

tranche; because the originator holds this tranche, their incentive to place lemons in the pool is reduced. Moreover, the originator typically continues to collect payments and pass these payments to the SPV. Again, holding the first loss also improve incentives to monitor the assets to minimize losses on this riskiest tranche.

To reduce the risk of early amortization further, there have been a number of documented instances in which originating financial institutions voluntarily enhanced the cash flows to the SPV (and thus reduced losses to security holders) to preserve their reputation in the market (e.g. Calomiris and Mason, 2002 and Higgins and Mason, 2004). In 2007, several large banks repurchased billion in assets that had been securitized in SIVs. Gorton and Souleles (2006) show that the pricing of bonds issued by the SPV reflect not only the quality of assets in the pool but also the rating of the issuer, suggesting that investors value implicit support for unexpectedly low cash flows.

Securitization also enhances liquidity by creating classes of assets with risk characteristics suitable to different clienteles. For example, insurance companies may be the natural clientele for the most senior tranches, while hedge funds with either a strong appetite for risk or superior credit-risk management models may be the natural clientele for the subordinated tranches. Mortgage securitizations are often tranced according to prepayment risk. Again, this kind of structure allows specialists in pre-payment risk to earn returns on their expertise by concentrating that risk in one class of securities.

Securitization of mortgages has grown most dramatically in the United States, in large part because of subsidies from Government-Sponsored Enterprises (GSEs) - The Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac). Fannie Mae was created by the U.S. Congress in 1934 to promote access to

mortgage credit for low and moderate-income household. During its first three decades, Fannie Mae was operated as a government agency that purchased mainly mortgages insured by the Federal Housing Authority (FHA). In 1968, Fannie Mae became a public corporation; its role in purchasing FHA mortgages (as well as mortgages insured by the Veteran's Administration) was taken over by a new government agency, the Government National Mortgage Association (GNMA). Freddie Mac was chartered by Congress in 1970 to provide stability and liquidity to the market for residential mortgages, focusing mainly on mortgages originated by savings institutions. Freddie Mac was privatized in 1986.

By the 1990s, both Fannie Mae and Freddie Mac were heavy buyers of mortgages from all types of lenders, with the aim of holding some of those loans and securitizing the rest. Together they have played the dominant role in fostering the development of the secondary market. As shown by Frame and White (2005), the GSEs combined market share has grown rapidly since the early 1980s. In 1990 about 25% of the \$2.9 trillion in outstanding mortgages were either purchased and held or purchased and securitized by the two major GSEs. By 2003, this market share had increased to 47%.³ GSE access to implicit government support allows them to borrow at rates below those available to private banks. Passmore, Sherlund and Burgess (2005) argue that most (but not all) of the benefits of GSE subsidized borrowing benefits their shareholders rather than mortgage borrowers. To take advantage this subsidy, during the 1990s the GSEs increasingly opted to hold, rather than securitize, many of the mortgages that they buy. During the expansion of credit to sub-prime borrowers, the GSEs also encouraged securitization by buying mortgage-backed securities in the secondary market.

³ GNMA provides a very important source of mortgage finance to low-income borrowers, holding or securitizing about 10% of all mortgages outstanding.

Despite the policy concerns, the GSEs do enhance mortgage liquidity either by buying and holding mortgages or by securitizing them. The GSEs operate under a special charter, however, limiting the size of mortgages that they may purchase or securitize. Today, the GSEs may only purchase ‘non-jumbo’ mortgages, defined in 2006 as those below \$417,000 for loans secured by single-family homes. The loan limit, first set at \$93,750 in 1980, increases each year by the percentage change in the national average of one-family housing prices, based on a survey of major lenders by the Federal Housing Finance Board. Loutskina and Strahan (2007) show that bank supply of mortgages to the jumbo market are constrained by their liquidity and cost of funds, whereas there are no such supply constraints to the non-jumbo market because banks have the low-cost option of selling those mortgages to the GSEs.

3.2 Loan sales and syndication

Banks also create market liquidity in loan syndication and in secondary market trading of loans. Gorton and Pennacchi (1995) describe how adverse selection and moral hazard dampen the liquidity of loans. They argue that loan sales took off in 1980s because banks learned to sell only a portion of loans and began to offer implicit guarantees to buyers (e.g. promises to buy back troubled loans).⁴ As a result, loan sales grew from \$27 billion in 1983 to \$291 billion by 1989. Loan syndication, which grew dramatically during the 1990s, works much the same as loan sales. In these structures financial institutions lend as a group at the outset, with one bank taking the lead in contracting with the borrower.

⁴ Such guarantees undermined the spirit of bank capital requirements and have been a concern to bank supervisors.

Loan sales and syndication differ from securitization mainly in the scale of loans considered. Loan sales involve large loans while securitization achieves sufficient scale by pooling of many small loans. But the fundamental contracting problems - asymmetric information and moral hazard - are basically the same. In loan syndication, a lead bank has the primary responsibility for negotiation with the borrower, writing contracts, pricing the loan, and setting the non-price terms (e.g. covenants). The lead bank also manages the relationship over time. The lead bank will often guarantee a commitment amount to the borrower, and then sell pieces of the loan to participant banks. The participant banks thus help fund the loan but are less involved in the relationship on a day-to-day basis. Lead banks thus typically have better information than participants, so there is a potential lemons problem similar to the one described earlier about securitization.

As with securitization, the contracting problem in loan sales and syndication is solved in part through incentives and in part through the lead-bank's reputation. Lead banks generally retain the largest share of syndicated loans, which helps mitigate the information problem faced by less-informed participants. Both the lead-bank's share and the concentration of the syndicate increase with borrower opacity (Dennis & Mullineaux, 2000; Lee & Mullineaux, 2004; Jones, Lang and Nigro, 2005; and Sufi, 2007). Moreover, Ivashina (2006) shows that the incentive problems built into a syndicate are priced into the yield.

Syndication itself is a kind of liquidity production on the part of the lead bank, similar conceptually to bond underwriter. Since 1995, many cases of loan syndications have also received ratings from Moody's and Standard & Poor's, just as bonds do. In contrast to bonds underwritten by investment banks, however, lead banks are more actively involved in

maintaining a relationship with the borrower after syndication. And, as we have seen, the lead bank invariably retains a stake in the loan, again in contrast to the case of bond underwriting.

In recent years, participation in syndicated loans has become increasingly liquid as secondary market trading has flourished. Güner (2006) finds that yields on loans issued by banks that actively sell loans tend to be lower than other loans, consistent with the idea that liquidity reduces the yield required to compensate lenders. Wittenberg-Moerman (2006) finds that bid-ask spreads are higher when borrowers are more opaque (e.g. unrated, private firms v. rated, public firms), consistent with private information reducing liquidity. She also finds, however, that loans originated by lead arrangers with greater market share trade at lower spreads. This result echoes studies of securitization, providing further evidence that banks enhance liquidity not only with explicit contracting and credit guarantees but also with their reputation (e.g. through implicit guarantees or recourse).

Much of the secondary market trading occurs as a means for non-bank investors to enter the syndicated lending market. Term loans trade much more than credit lines because non-bank institutional investors do not want the funding risk. Drucker and Puri (2005) study the emergence of secondary market trading volume in syndicated loans, which has grown from nearly nothing in 1990 to about \$180 billion in 2006. They find that loans with more restrictive covenants are more likely to trade because covenants provide assurances to buyers that they will have sufficiently strong control rights to protect their investment. In this case, control rights seem to act as an alternative to information in enhancing liquidity. Their results are surprising because most public debt, which continues to trade more than bank loans, comes with much looser covenants than what is seen in the typical syndicated loan. Overall, however, this paper suggests that information asymmetry between bank lenders and potential buyers continue to

dampen liquidity. For example, in their sample 88% of sold loans are rated, compared to just 39% for loans that have no secondary market liquidity.

So, banks provide market liquidity when they repackage loans via securitization, when they trade loans, and when they act as lead arrangers in loan syndication. In all three cases the asymmetric information creates a barrier to liquidity. To overcome this barrier, banks expose themselves to risk - in the case of loan securitization by taking the first losses and in the syndicated lending context by holding the largest share of the loan. In many cases originating banks also provide implicit guarantees. Reputation in the market mitigates shirking incentives, and helps explain why large, well capitalized banks tend to dominate as lead arrangers (Gatev and Strahan, 2007).

3.3 Sources of Market Liquidity Risk

Market liquidity risk occurs if banks lose the ability to sell or securitize loans at fair prices. Under such circumstances, market liquidity risk feeds back to funding liquidity if the bank must raise funds on short notice in order to hold those assets on their balance sheet, or if a bank must re-purchase assets sold in a securitization due to funding disruptions in the capital markets (see below).

Producing market liquidity requires banks to bear enough risk to maintain incentives to deal responsibly with the borrower in setting prices and enforcing covenants. Loan syndication also exposes lead banks to ‘underwriter risk’, similar to the risk born by securities underwriters offering firm commitments to debt and equity issuers. In the case of syndicated lending, if demand from participant banks is lower than expected, the lead arranger must either fund more

of the loan than anticipated or the deal may fail to close.⁵ Both outcomes are costly for the lead bank. The first option would require the bank to have additional debt and equity capital; the second would be harmful to the lead bank's reputation.

Securitization also often comes with not only credit guarantees of various kinds but also liquidity support. For example, asset-backed commercial paper structures usually come with a liquidity backstop facility issued by the bank that set up the securitization. These facilities expose banks to funding liquidity risk as described above, but the facilities are necessary to create the securitization in the first place. Many of these kinds of structures could not re-finance their commercial paper market during the credit crunch of 2007 and required banks to replace that financing to avoid default. In such cases, there is no bright line between market liquidity and funding liquidity.

3.4 Empirical Trends in Market Liquidity

Figure 2 illustrates the growing quantitative importance of loan securitization for different types of loans over time. In 1976, there was no securitization of commercial mortgages, business loans (commercial and industrial, or C&I, loans) or consumer loans. By the end of 2007, 28% of commercial mortgages and 27% consumer loans had been securitized. But the really explosive growth has occurred in the market for home mortgages: by the end of 2007 the total amount of securitized home mortgages had grown to almost 60% of the market.

⁵ While most loan syndicates are arranged under a firm commitment between the bank and the borrower (opposed to 'best efforts' where borrowers bear all of the risk of the issue failing), some syndicated loans have been arranged under market-flex contracts whereby the pricing of a loan may not be guaranteed by the lead bank (Standard & Poor's, 2006). These kinds of arrangements shift some of the underwriting risk from the lead arranger(s) to the issuer.

[FIGURE 2 HERE]

[TABLE 1 HERE]

Unlike the United States, securitization has not been spurred elsewhere by government enterprises – there are no institutions analogous to the GSEs in Europe. Nevertheless, securitization has taken root there as private banks have begun to tap into markets to fund various kinds of loans. Table 1 reports the rate of securitization issuance for new loans between 2000 and 2006, and by collateral type in 2005. The figures show rapid growth overall. For example, between 2000 and 2006 securitization origination rates soared by more than 35% per year in Europe; in contrast, based on growth in outstandings, securitization in the U.S. rose by only about 9% per year over the same period. Securitization of residential mortgage-backed securities grew fastest in Europe, by almost 70% between 2005 and 2006. Moreover, as in the U.S., securitization of loans backed by real estate – both residential and commercial - seem to be taking the lead, comprising about 56% of total securitization in 2005 (compared with about 80% share for real estate loans in the U.S.). Presumably real estate backed loans are relatively transparent and thus amenable to purchase by a diffuse class of investors, in contrast to more opaque assets such as loans to businesses.

4. The Financial Crisis of 2007-2008

The Financial Crisis of 2007-08 is the biggest shock to the banking and financial system since the 1930s and offers the greatest challenge to our understanding of liquidity production and liquidity-risk management, both for private institutions and for regulators and central banks. In broad terms, the financial system experienced runs from various sources, including depositors,

customers, counterparties, and short-term creditors. This liquidity crisis mirrors what has happened in the past in that the runs were based on concerns over solvency rather than representing runs based solely on expectations that others might run. The crisis, ongoing at this writing, has led to a severe contraction in bank loan originations. Figure 3 illustrates the time series of new lending to large businesses from Loan Pricing Corporation's *Dealscan* database from 2000 to the third quarter of 2008. During the 2001-02, both lines of credit and term loans declined, as would be expected during a mild recession; but, this earlier decline pales relative to the steep drop in new lending beginning in the middle of 2007. As of this writing, one can not say how deeply the crisis will reduce consumption and investment, or how profoundly the downturn will change the management of risk and the regulation of financial institutions going forward. Nevertheless, after describing very briefly what happened, I will discuss the early lessons for liquidity production and risk management, focusing mainly on the U.S. financial system.

4.1 What caused the Crisis?

The roots of the crisis lie in the overvaluation in housing prices and the subsequent crash in those prices beginning around 2007. The popping of this real estate bubble created large losses to lenders. Kindelberger (2000) describes past episodes of asset pricing bubbles, going back several hundred years. He finds that such bubbles tend to be preceded by loose monetary policy and an over-expansion of credit. The current episode supports his understanding of the historical record. Sufi and Mian (2008) show that markets where credit expanded most experienced both the greatest house-price appreciation and the worst subsequent crashes.

Demyanyk and Ven Hemert (2008) provide evidence that underwriting standards eased with each lending cohort from 2000 through 2006, coinciding with the run-up in prices.

Most analysts have blamed the move from the traditional ‘buy and hold’ to the new ‘originate-to-distribute’ model of lending for the credit expansion, and a few recent studies have offered rigorous evidence consistent with this notion. For example, Keys et al (2008) show that mortgages expected to be securitized had greater ex-post default rates than otherwise similar mortgages retained by lenders; Purnanadam (2008) shows that banks with large pipelines of mortgages that were intended to be sold faced losses when liquidity dried up in the mortgage-backed securities market in 2007. Loutskina and Strahan (2008) argue that because banks moved en masse toward a diversified lending model – a model facilitated by securitization - investments in private information about local credit markets declined, thus setting the stage for over-expansion of credit.

4.2 An abbreviated chronology of key events

While concern about sub-prime mortgages began somewhat earlier, the crisis really took hold in the summer of 2007. In June and July, two Bear Stearns hedge funds required assistance, and Countrywide, one of the largest sub-prime originators, announced unexpectedly large losses. In August 2007, the asset-backed securities market dried up when several issuers failed to provide liquidity to support funding of securitized assets financed with short-term commercial paper (Brunnermeier, 2008). Banks had been moving pools of loans off balance sheet and into so-called structured investment vehicles (SIVs) financed with short-term commercial paper. This market peaked in 2007 with about \$1.2 trillion outstanding, and then declined by about 50%

in just six months (Figure 4). The funding liquidity risk of these structures, which replaced the old on-balance sheet model of asset transformation, *did not* leave the banking system because issuers provided liquidity backstops to insure against re-financing risk in the asset-backed commercial paper. The market's faith in these backstop facilities wavered when an SIV issued by IKB, a small German bank, was unable to re-finance its short-term commercial paper, and IKB could not meet its obligation to re-finance the SIV through its line of credit. The asset-backed securitization market collapsed, leading to balance sheet stress for large issuers such as HSBC and Citigroup, who had to take large pools of these assets back onto their balance sheets.

In response to the decline in asset values and an increase in concerns about bank solvency, the interbank market began to lose liquidity. The cost of borrowing at maturities beyond overnight rose especially sharply. In August of 2007, the spread between the three-month bank CDs and the US Treasuries tripled, from about 50 to 150 basis points (Figure 5).⁶ Spreads fell back to a lower yet still elevated level in the Fall, and then spiked to more than 200 basis points in December of 2007. In reaction to this illiquidity, the Federal Reserve created the Term Auction Facility (TAF) to sell a fixed quantity of three-month credit (and later longer term) in a competitive auction. These auctions reduced borrowing costs temporarily, with spreads falling below 100 basis points by February 2008 (McAndrews, Sarkar and Wang, 2008).

Then, in March 2008, concern about the value of Bear Stearns' large portfolio of sub-prime mortgage-backed securities led to a run by many of their counterparties, short-term creditors and large customers (e.g. hedge funds), again stressing the interbank market. Spreads jumped above 150 basis points (Figure 5). The Federal Reserve stepped in, brokering a rescue of Bear Stearns by JP Morgan, and guaranteeing most of the losses on Bear's troubled portfolio of

⁶ Similar patterns are evident using other bank borrowing rates such as the LIBOR at various maturities.

sub-prime assets. The Federal Reserve then launched the Term Securities Lending Facility and the Primary Dealer Credit Facility, essentially opening up its discount window to the remaining large Wall Street investment banks. With these three creative new lending facilities, the Federal Reserve began playing its role as lender of last resort on a massive scale, stepping in to supply the liquidity that had ceased to flow in the interbank credit markets.

Conditions improved following the bailout of Bear Stearns. The cost of funds to banks fell, as did spreads over Treasuries (Figure 5). In the summer of 2008, however, mortgage foreclosures continued to rise, leading to further downgrades of mortgage-backed securities by the credit rating agencies and accelerating losses to holders of those securities. In July, Congress passed stop-gap legislation, formalizing its previously implicit guarantee of debt issued by Fannie Mae and Freddie Mac. Despite the debt guarantee, the razor-thin capital ratios of these two government-sponsored enterprises (GSEs) were overwhelmed by credit losses, forcing the Treasury to take both into conservatorship by early September. Similar losses accrued to others with exposure to real-estate, leading to the failures of AIG and Lehman Brothers.

The depth of the crisis dramatically expanded when markets were shocked by the AIG/Lehman collapses in mid September. Lehman was allowed to go bankrupt and, as a result, a large and reputedly conservative money market fund - the Primary Reserve Fund - 'broke the buck', meaning that its investors lost principal. This fund had built a reputation for safe investment; hence its exposure to Lehman scared investors, leading to a run on mutual funds broadly.⁷ Within a few days more than \$200 billion had flowed out of these funds (Krishnamurthy, 2008). The US Treasury stopped the run by extending government insurance

⁷ The *Wall Street Journal* reported that the head of the Primary Reserve Fund had criticized competing money market fund managers for holding assets with credit risk. "Commercial paper is anathema to the concept of the money fund," Mr. Bent told Reuters in 2001 (Wall Street Journal, December 8, 2008).

over money market mutual fund accounts on a temporary basis. Nevertheless, the panic soon spread globally, leading to expansion of insurance on deposits and interbank funds, first in Europe and then very quickly in the United States. Public capital was also injected into all of the large banks in an attempt to allay fears about solvency.

4.3 Demand and Supply of Funding Liquidity

The demise of AIG and Lehman massively increased the demand for funding liquidity across the whole financial system. US Banks' cash holding rose dramatically (Figure 6). Until the Fall of 2008, banks held a very stable level of about \$300 billion in cash going back at least five years. Starting in September, however, banks begin to hoard cash, with the level rising sharply, peaking at about \$850 billion in the middle of November, 2008. Why the increase? As noted earlier concerns about the solvency of financial institutions had damped the supply of credit in the interbank market. The absence of interbank credit thus increased banks' precautionary motive to hold cash as a liquidity buffer.

Non-financial firms also lost access to short-term funds as the commercial paper market dried up (Figure 7). Commercial paper had typically been held by money market mutual funds, but their appetite for such assets collapsed in the wake of the Lehman failure; instead, these funds began to fill up their balance sheets with Treasuries. Demand for liquidity from banks by non-financials also increased as issuers drew funds from pre-arranged backup lines to re-finance their commercial paper as it came due, thereby feeding back into banks' demand for cash. This spike in liquidity demands on the banking system can be seen clearly in Figure 7, where the drop in outstanding commercial paper coincides exactly with an increase in business loans on bank

balance sheets. Thus, loans increased in response to draw downs on credit lines; banks responded rationally by hoarding cash (Figure 6) and by ceasing to make new loans (Figure 3). The increase in loans on bank balance sheets, however, turned around, as did commercial paper outstanding, in the last week of October because the Federal Reserve began to purchase commercial paper, both directly from issuers and indirectly from mutual funds and other investors. Notice that the turning points in Figure 7 for commercial paper outstanding and bank loans corresponds *exactly* (week ending on October 29).

Funding liquidity demanded by non-financial firms increased not only to substitute for the absence of market liquidity, but also to meet increased *precautionary* demands for cash. Many non-financial firms drew funds from existing lines of credit simply due to fears about disturbances in the credit markets. Ivashina and Scharfstein (2008) present a table summarizing eighteen instances in which large firms drew funds not to meet direct needs for cash but in reaction to concern about debt-market access. To take one example, American Electric Power (AEP) drew down \$3 billion from an existing credit line issued by JP Morgan and Barclays. According to their SEC Filing, “AEP took this proactive step to increase its cash position while there are disruptions in the debt markets. The borrowing provides AEP flexibility and will act as a bridge until the capital markets improve.” Given cash demands on banks from existing customers, and given the increased cost of borrowing to banks, it’s no surprise that new lending has fallen off a cliff (recall Figure 3).

How did banks meet the drastic increase in demands for funding liquidity? Figure 8 reports the three main sources of funds flowing into US banks. First, deposits flowed in, with the total stock of transactions deposits rising by about \$200 billion between the middle of September and the middle of November. The deposit inflows, it should be noted, were *not* evenly

distributed across banks. For example, Bank of America and JP Morgan experience large inflows, while others, such as Washington Mutual and Wachovia, faced sufficient outflows to force their closure by the Federal Deposit Insurance Corporation. Second, lending from the Federal Reserve to banks and other financial institutions increased from nearly zero to almost \$900 billion. This flood of liquidity, as noted above, did not spur additional lending but merely acted to swell banks' buffer stock of cash and allow them to meet demands from existing credit lines. Third, starting in the middle of October, US banks raised almost \$500 billion from their foreign affiliates and branches. These foreign flows reversed the liquidity outflows from US banks' foreign operations that began in the middle of 2007, when the magnitude of the crisis was first recognized. What changed were perceptions of the impact of the crisis globally. In the middle of October, the contagion into Europe and Asia began, leading to government expansion of guarantees of both deposits and interbank loans, first in Ireland, Germany and the UK and then very quickly matched by the US. The flow of funds into foreign arms of US banks suggests that investors have greater faith in US guarantees than those of other governments. The appreciation of the dollar and the declining yields on Treasuries, despite a massive increase in supply, are both consistent with this interpretation.

4.4 Lessons from the 2007-08 Financial Crisis

What are the lessons of the crisis of 2008 for liquidity risk management?⁸ First, the crisis supports the broad thesis of this paper, which is that banks have special advantage in managing funding liquidity risk. As we have seen, access to deposits and central bank liquidity were both

⁸ There are certainly lessons beyond liquidity, such as flaws in the originate-to-distribute model of lending.

critically important factors allowing banks to support liquidity guarantees to the non-financial sector. Depositories that did fail – Countrywide, IndyMac, Washington Mutual and Wachovia - faced runs having to do with rational concerns about their *solvency*; these institutions were all heavily exposed to sub-prime mortgages. Moreover, the five large stand-alone investment banks - Bear Stearns, Merrill Lynch, Lehman Brothers, Goldman Sachs and Morgan Stanley - have either failed, been purchased by a large bank holding company, or registered themselves as bank holding companies. These investment banks had relied on wholesale short-term credit markets, which proved to be the most sensitive to the crisis. Anecdotal evidence suggests that these institutions intend to raise deposits as a more stable source of funds. For example, according to press accounts Goldman Sachs will develop an internet bank to raise deposits, expand its existing Utah-based bank, and re-brand its trust business into a full-service bank with its name changed from Goldman Sachs Trust co. to Goldman Sachs Bank USA (American Banker, December 4, 2008).

Second, we have learned that the interbank market, which efficiently circulates liquidity during normal times, can fail spectacularly. Liquidity outside of the overnight market dried up during the crisis, raising the price of credit not just to banks but also to non-financial borrowers whose loan rates are typically tied to interbank rates (e.g. three-month LIBOR). As we have seen, bank willingness to extend new credit also dried up. The failure of the interbank market stemmed from uncertainty about the solvency of counter-parties in an environment of asymmetric information. Growth of credit derivatives almost surely worsened the asymmetric information problem by lowering the cost of trading risks. Credible estimates of the aggregate hole in bank balance sheets are on the order of \$500 billion to \$1 trillion; losses of this magnitude could clearly bankrupt many institutions. Moreover, because it was very hard for

outsiders to evaluate *how* these losses were distributed across firms, the rational response was to ration credit to everyone. This asymmetry of information can explain why the interbank market failed to re-circulate the liquidity supplied by the Federal Reserve. In fact, banks' cost of borrowing did not begin to decline until the Treasury attempted to reduce concerns about solvency by injecting public funds into banks, raising limits of deposit insurance, and guaranteeing interbank credit (recall Figure 5).

Third, much of the funding liquidity risk stemmed from short-term wholesale credit markets and from off-balance sheet commitments, rather than from deposits. To the extent that depositors ran, they ran away from insolvent banks and toward solvent ones. In aggregate, depositors added liquidity to the banking system. The liquidity stresses on the banking system came from increased take downs on existing lines of credit; these take downs increased systematically in response to the lack of liquidity in the debt markets. Some of the demand occurred mechanically because commercial paper issuers could not re-finance, and other demands stemmed from non-financial firms' precautionary motive to build up a war chest of cash. Ironically, runs from depositors had been the concern that motivated building the safety net for the banking system back in the 1930s. But it is runs *to* the banking system and *away* from the markets that generates systematic funding liquidity risk for banks today.

5. CONCLUSIONS

Banks provide both funding liquidity and market liquidity in various ways. Some of these liquidity-producing activities are unique to banking (or are dominated by banks), such as holding deposits and issuing lines of credit. Others are similar to liquidity provision by non-bank

intermediaries like investment banks. For example, both securitization and loan syndication share features in common with bond underwriting. The differences are related to the greater information asymmetry and incentive problems – in the case of bond and equity underwriting, investment banks sell all of an issuance to arm’s length investors; in securitization and syndication, only a portion of the funding comes at arm’s length. Moreover, both commercial as well as investment banks and unregulated finance companies are active securitizers. Both investment banks and large commercial banks also make markets in over-the-counter derivatives such as interest rate swaps and foreign exchange, which enhance market liquidity of those assets. In general, *market* liquidity production is something that is not unique to banking.

What *is* different about commercial banks, what distinguishes them from other intermediaries, are products like checkable deposits and loan commitments. These products supply *funding* liquidity to customers; they offer cash on demand. Banks ‘special role’ lies mainly in providing this funding liquidity, but their day-to-day business has increasingly involved provision of market liquidity as a consequence of the growth and deepening of securities markets. This changing role can be seen in the evolution of syndicated lending, where banks typically continue to dominate in the market for credit lines, in both the primary and secondary markets (Gatev and Strahan, 2008). In contrast, non-bank institutional investors play an important role in term lending in the syndicated market.

Looking ahead, banks will likely continue to provide liquidity in both dimensions. The Financial Crisis of 2007-08 seems to have strengthened bank dominance at the expense of the large stand-alone investment banking model. Until the crisis, the traditional asset transformation role of banks – holding loans financed with liquid deposits – was waning. The growth of securitization seemed to offer a cheaper way to finance loans, although banks continued to

provide the funding liquidity support through back-up lines of credit. But this originate-to-distribute model went too far, facilitating the lax underwriting standard that fueled the credit bubble at the heart of the ongoing crisis. Looking ahead it seems plausible that the traditional model of bank lending and asset transformation may become increasingly attractive.

Figure 1: Bank Liquidity Production to GDP

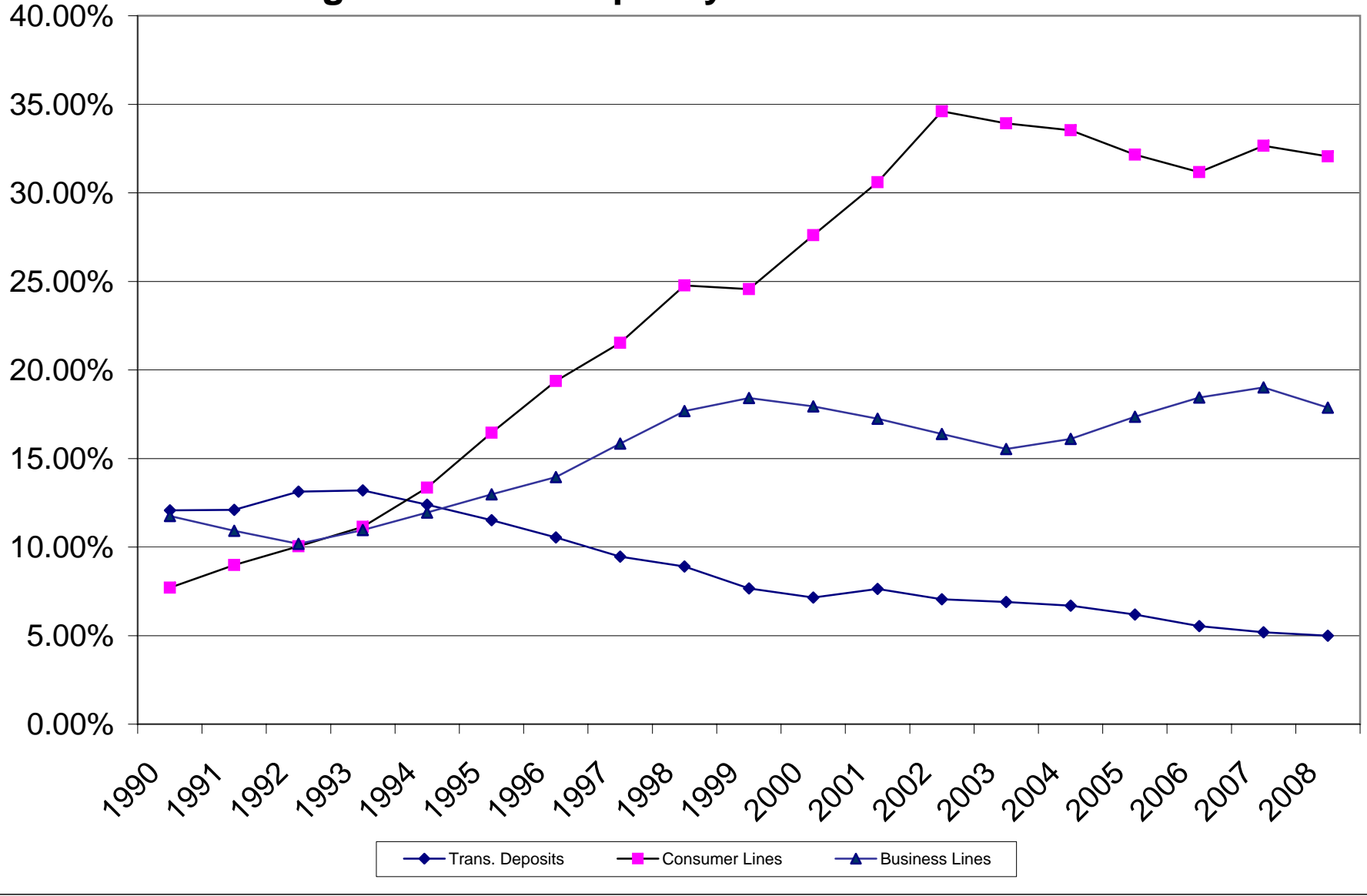
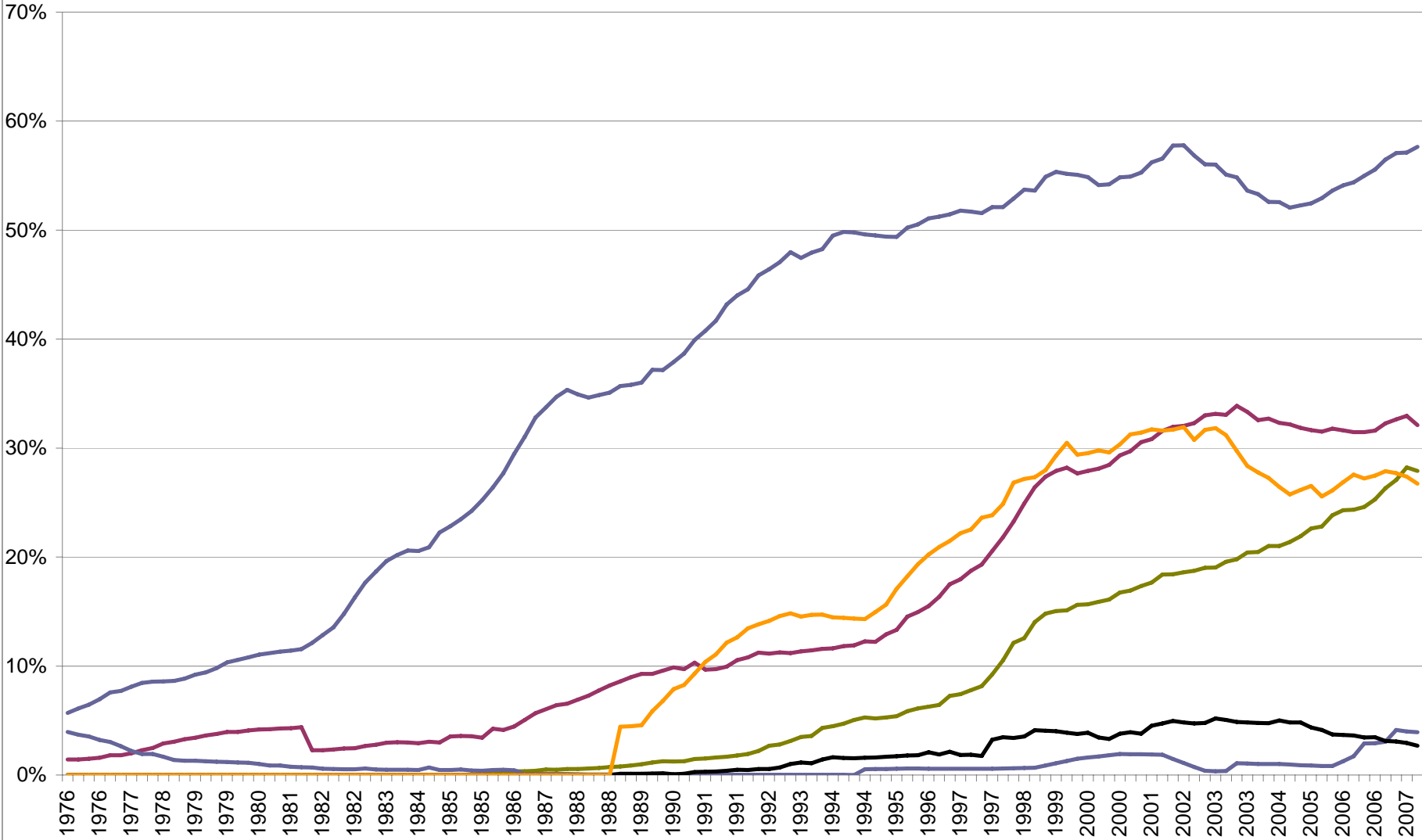


Figure 2: Share of Securitized Loans in the US Economy



- Home Mortgages
- Commercial Mortgages
- Commercial and Industrial Loans
- Multifamily Home Mortgages
- Farm Loans
- Consumer Credit

Figure 3: Business Loan Originations Collapse

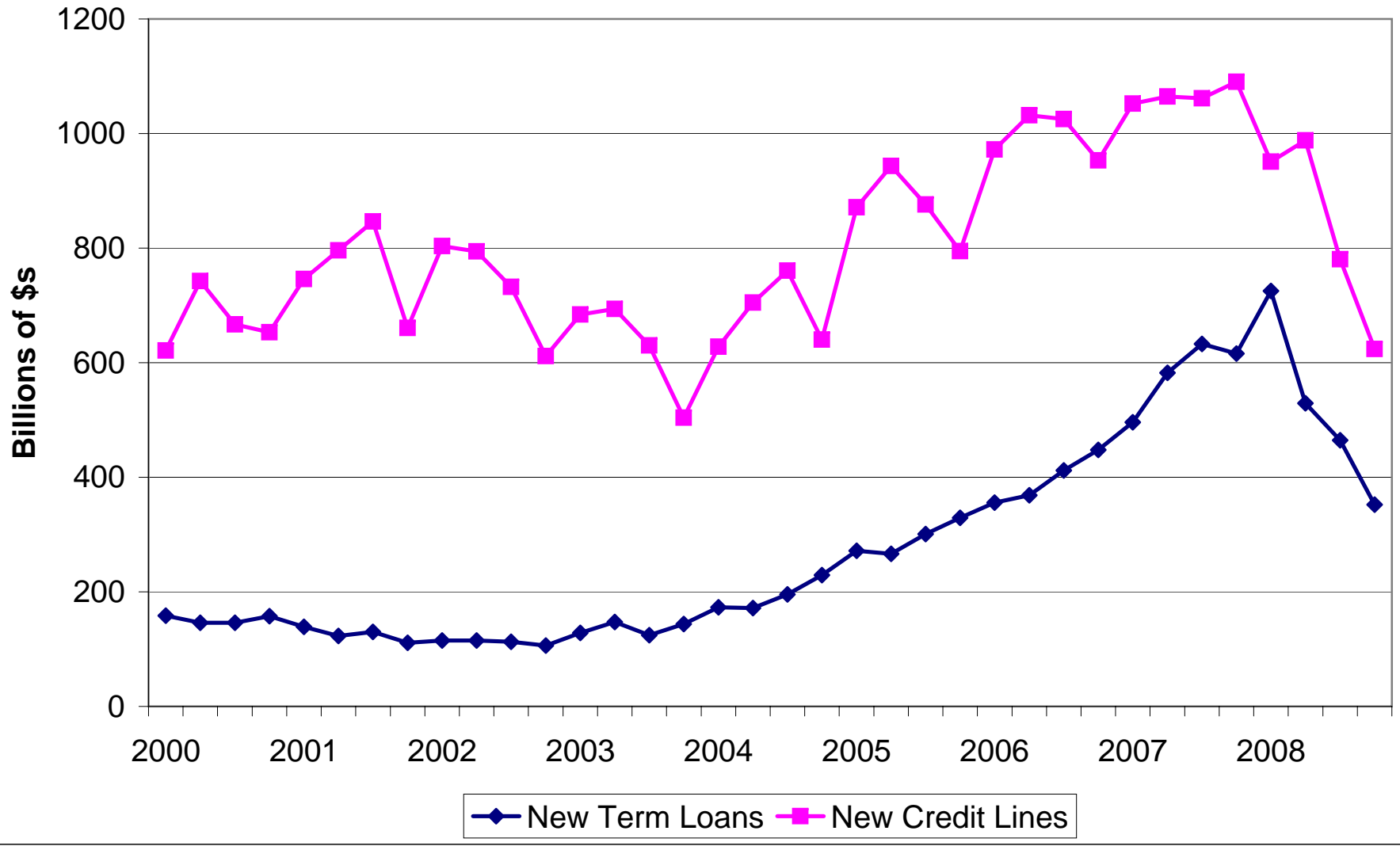


Figure 4: Asset-Backed Commercial Paper Dries up

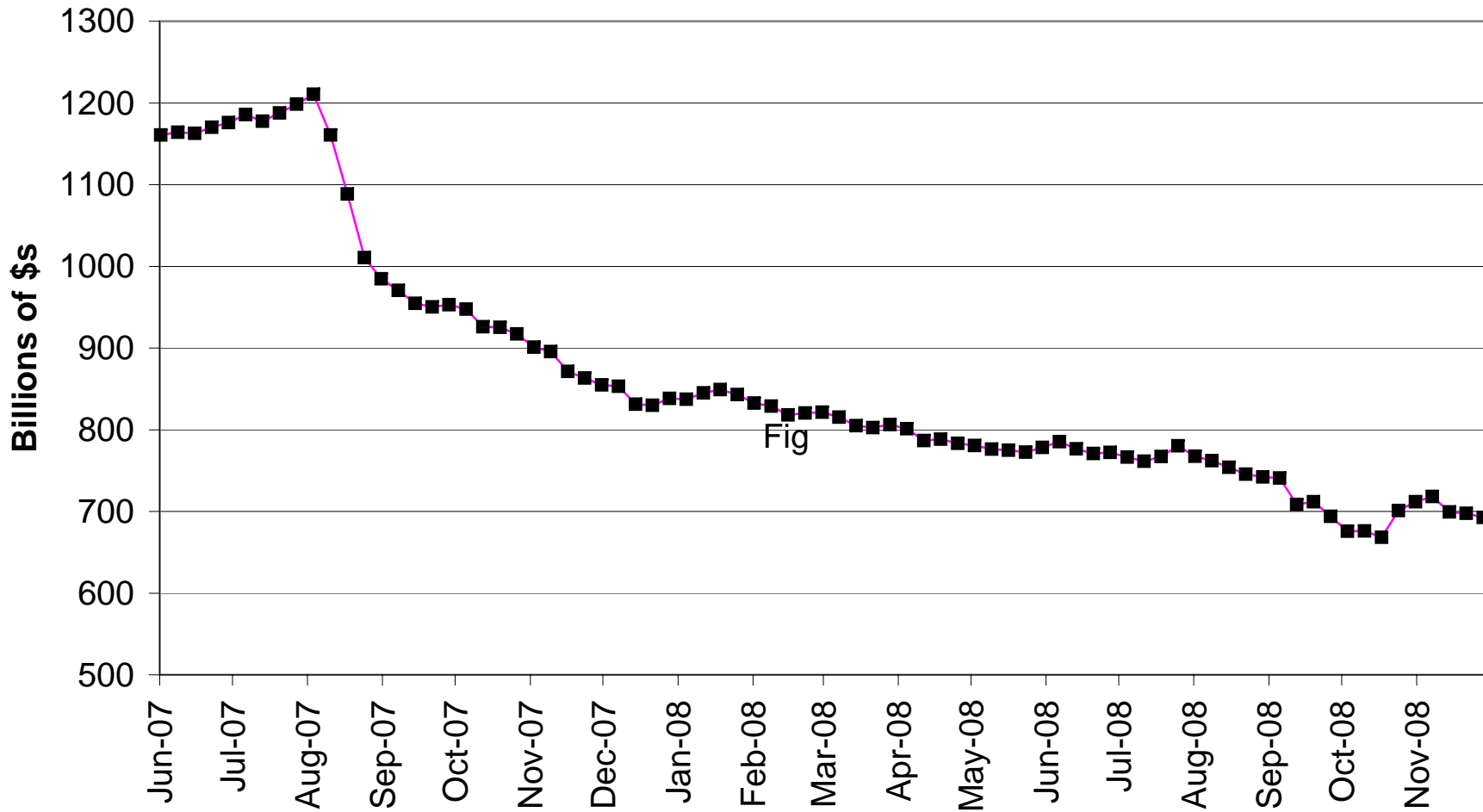
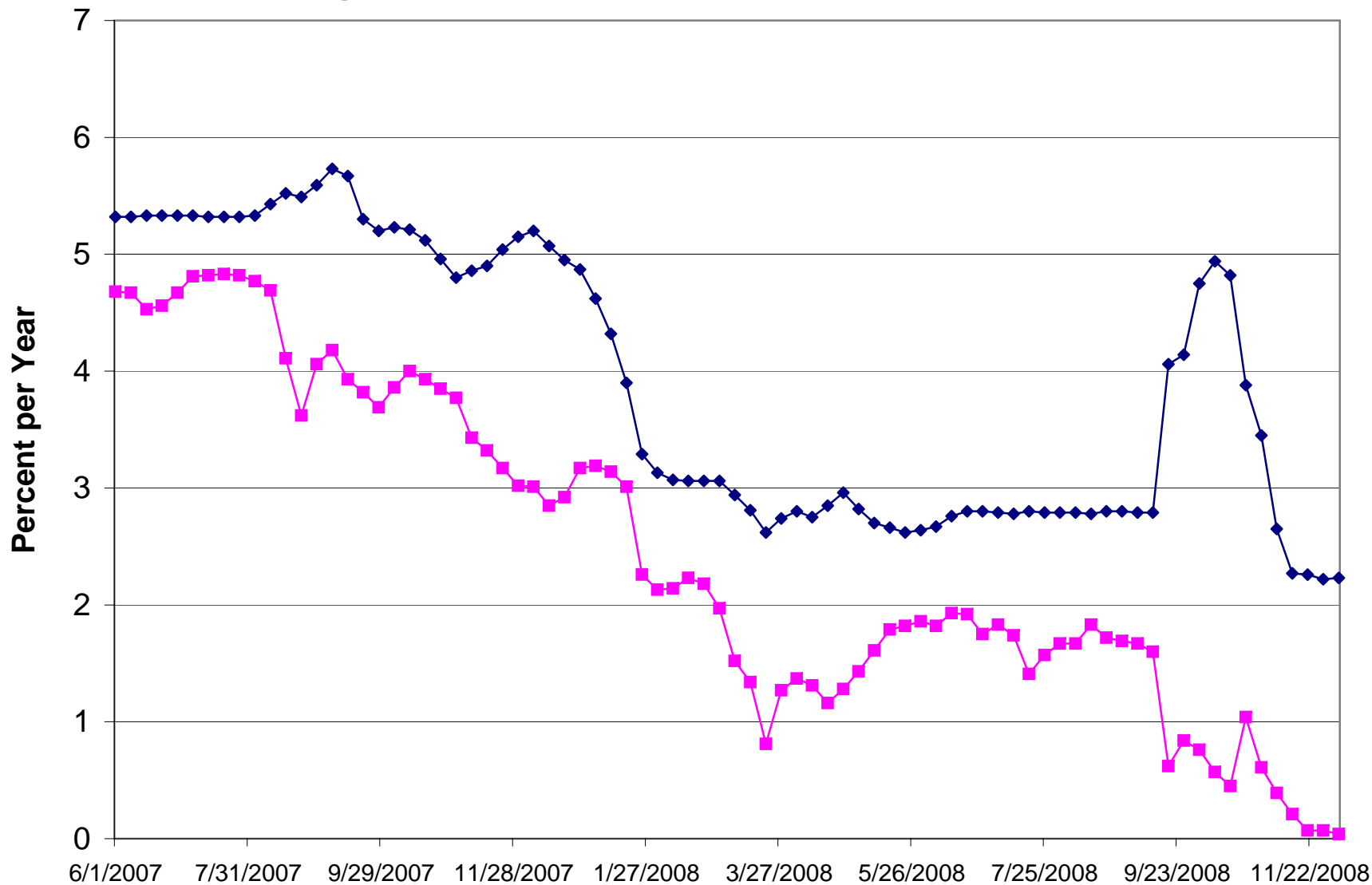
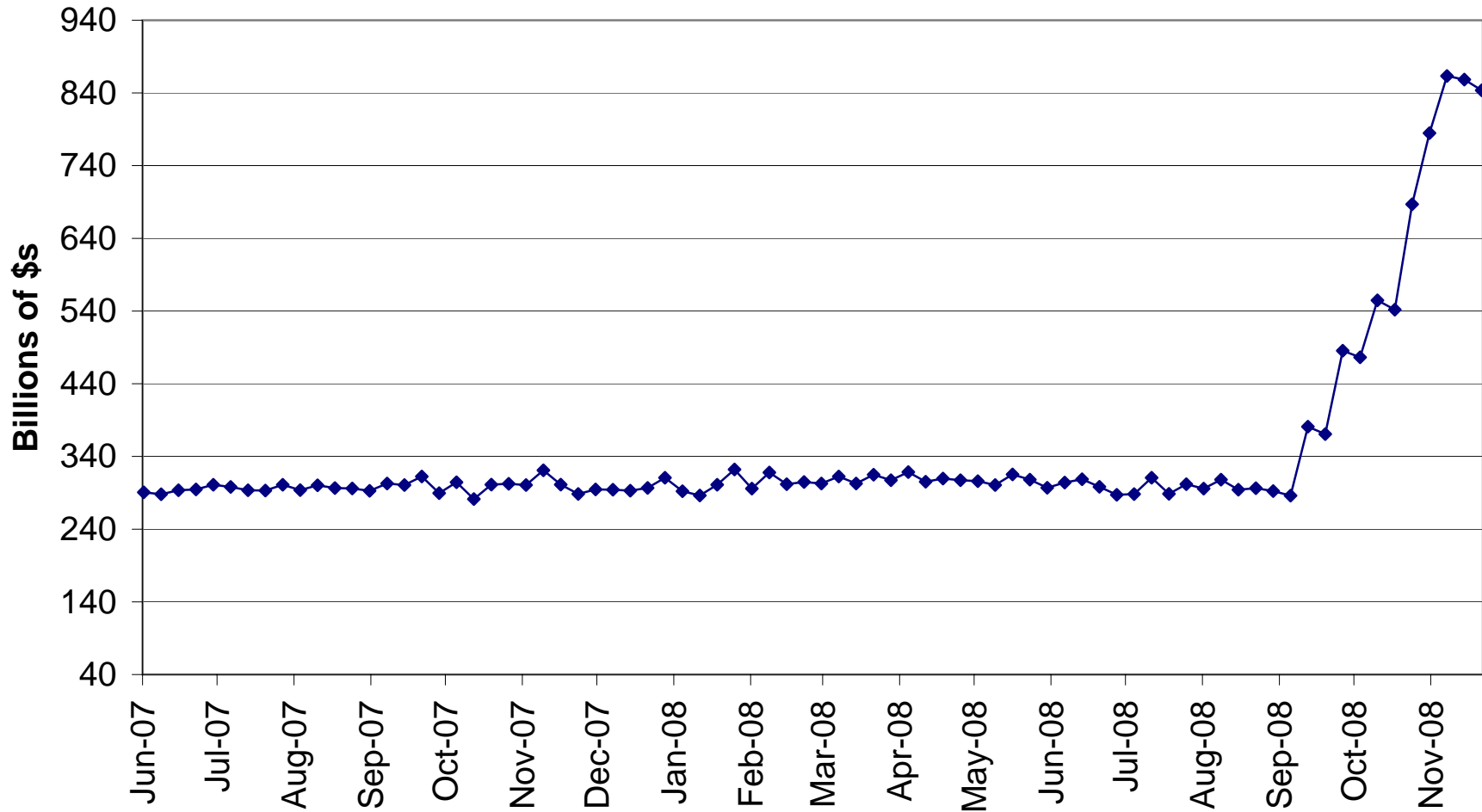


Figure 5: Yield on 3-Month CDs v. Treasuries



**Figure 6: Liquidity Demand by US Banks:
Hoarding Cash**



**Figure 7: Liquidity Demand by US Banks:
Commercial Paper moves Back on Balance Sheet**

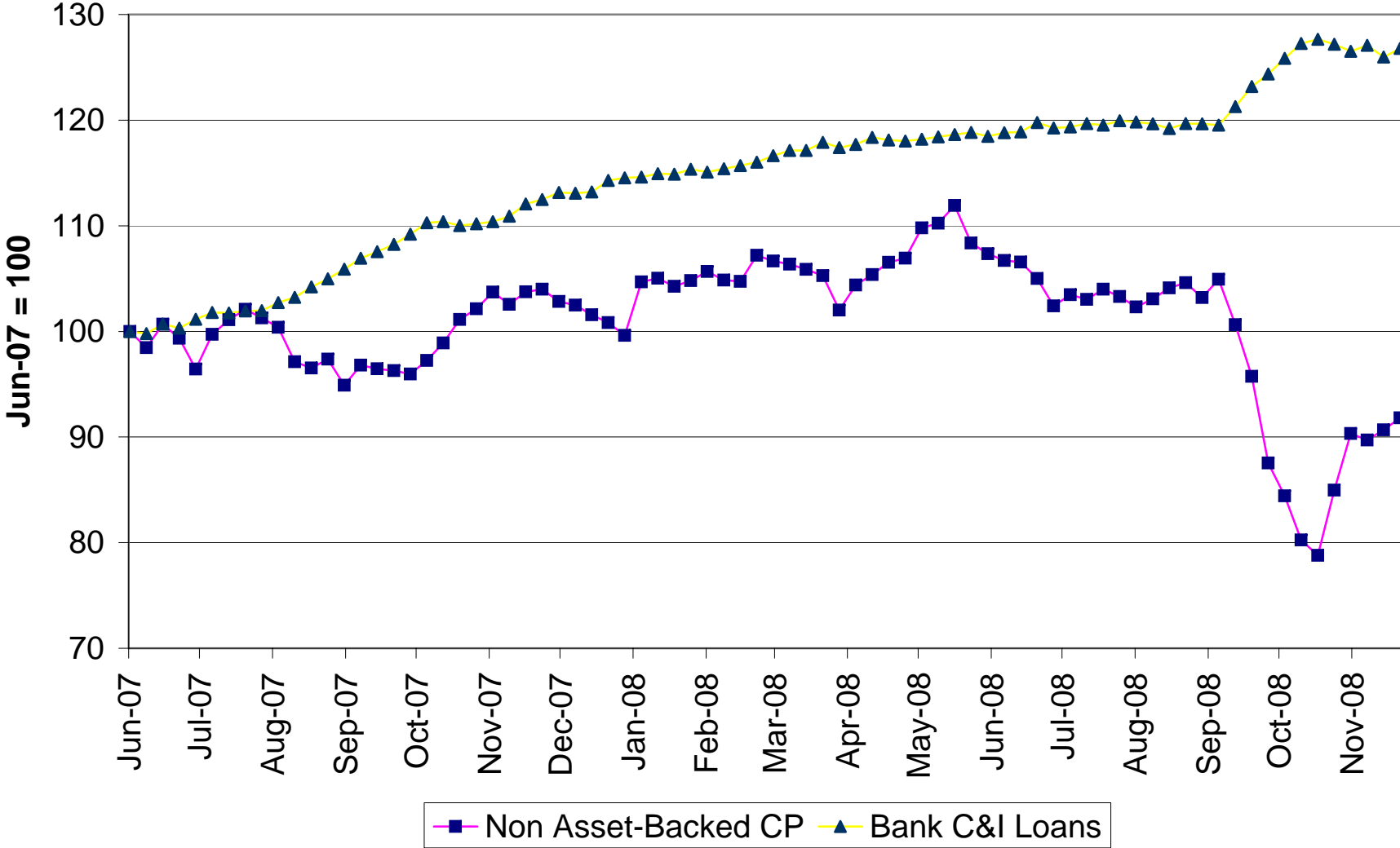
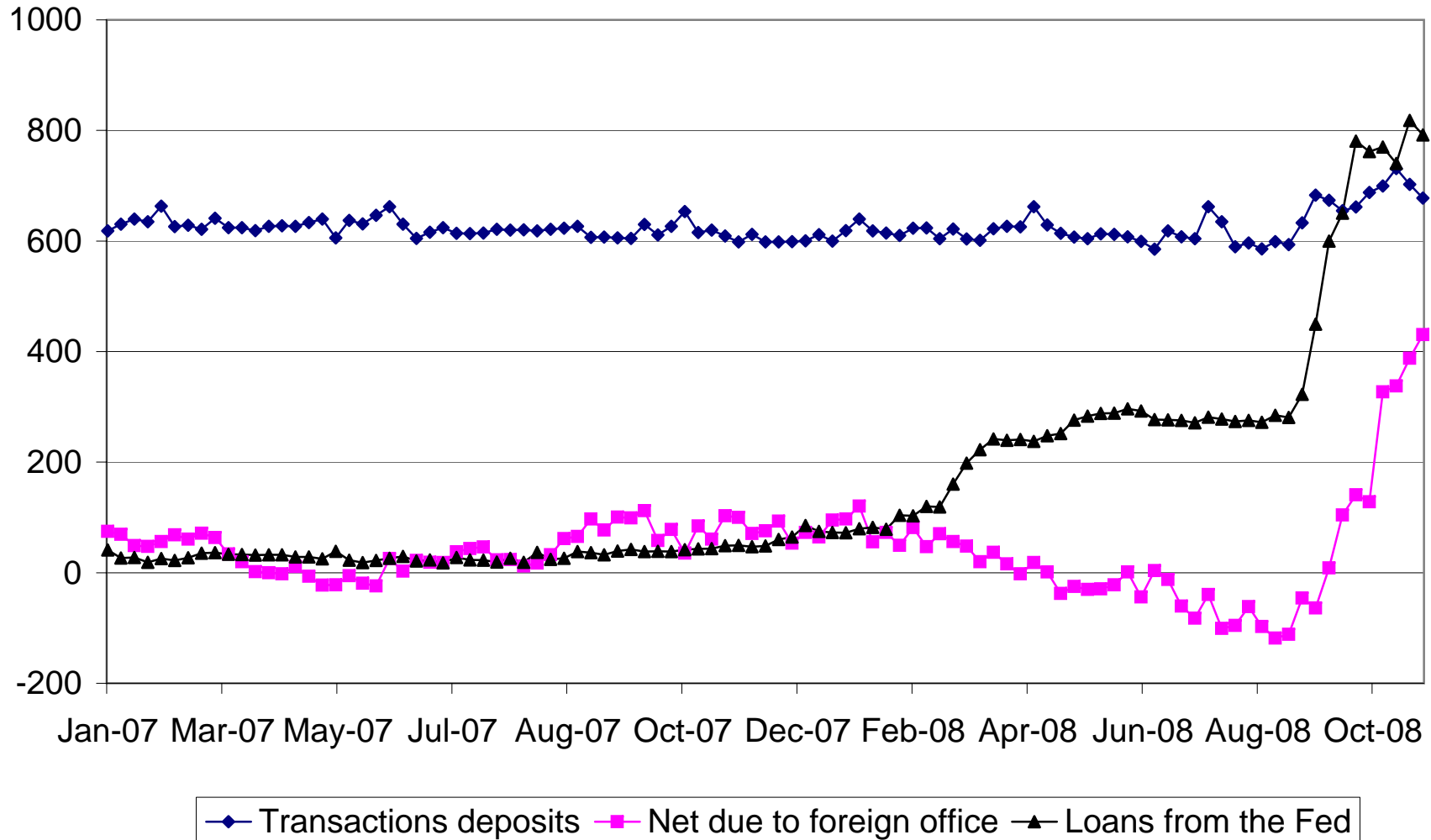


Figure 8: Liquidity Supply to US Banks comes from Fed Loans, Transactions Deposits & Foreign Deposits



6. REFERENCES

Agarwal, S., Chomsisengphet, S. and Driscoll, J.C. (2004). Loan commitments in private firms, mimeo.

Agarwal, S., Ambrose, B.W., Chomsisengphet, S. and Liu, C. (2006). An empirical analysis of home equity loan and line performance, *Journal of Financial Intemerdiation* 15, 444-69.

Akrelot, G. (1970). The market for lemons, *Quarterly Journal of Economics* 84, 488-500.

Almeida, H., Campello, M. and Weisbach, M. (2004). The cash flow sensitivity of cash,” *Journal of Finance* 59, 1777-1804.

Allen, F. and Gale, D. (2000). Financial contagion, *Journal of Political Economy* 108.

Ambrose, B.W., LaCour-Little, M. and Sanders, A. (2004). The effects of conforming loan status on mortgage yield spreads: A loan level analysis, *Real Estate Economics*, 32, 541-569.

Ashcraft, A., McAndrews, J.J. and Skeie, D. (2007). Precautionary reserves and the interbank market, mimeo, August 2007.

Ayotte, K. and Gaon, S. (2006). Asset-backed securities: Costs and benefits of bankruptcy remoteness, mimeo.

Bagehot, W. (1873). *Lombard Street: A Description of the Money Market* (reprinted, Dodo Press, 2006).

Brunnemeir, M. and Pedersen, L. (2007). Market liquidity and funding liquidity, forthcoming at the *Review of Financial Studies*.

Berger, A.N. and Bouwman, C.H.S. (2006). The measurement of bank liquidity creation and the effect of capital, available at SSRN: <http://ssrn.com/abstract=672784>.

Berger, A.N., Miller, N., Petersen, M., Rajan, R.G. and Stein, J. (2005). Does function follow form? Evidence from the lending practices of large and small banks, *Journal of Financial Economics*.

Berger, A. N. and Udell, G. (1992). Some evidence on the empirical significance of credit rationing, *Journal of Political Economy* 100, 1047-77.

Berlin, M. and Mester, L.J. (1999). Deposits and relationship lending, *Review of Financial Studies* 12, 579-607.

Bernanke, B. S. (1983). Nonmonetary effects of the financial crisis in propogation of the Great Depression, *American Economic Review* 73(3), 257-276.

Bernanke, B. S. and Lown, C. (1991). The credit crunch, *Brookings Papers on Economic Activity* 2, 205-247.

Calomiris, C. (1989). The motivations for loan commitments backing commercial paper, *Journal of Banking and Finance* 13, 271-277.

Calomiris, C. (1994). Is the discount window necessary: A Penn Central perspective, *Federal Reserve Bank of Saint Louis Review*, 31-55.

Calomiris, C., and Kahn, C. (1991). The role of demandable debt in structuring optimal banking arrangements, *American Economic Review* 81, 497-513.

Calomiris, C. and Mason, J.P. (1997). Contagion and bank failures during the Great Depression: The Chicago banking panic of June 1932, *American Economic Review* 87, 863-84.

Calomiris, C. and Mason, J.P. (2004). Credit card securitization and regulatory arbitrage, *Journal of Financial Services Research* 26, 5-27.

Chava, S. and Purnanandam, A.K. (2006). The effect of banking crisis on bank-dependent borrowers, EFA 2006 Zurich Meetings Available at SSRN: <http://ssrn.com/abstract=821804>.

Cole, R. A. (1998). The importance of relationship to the availability of credit, *Journal of Banking and Finance* 22(6/8), 959-977.

Cole, R. A., Goldberg, L.G. and White, L.J. (2004). Cookie cutter vs. character: The micro structure of small business lending by large and small banks, *Journal of Financial and*

Quantitative Analysis 39(2), 227-251.

Demyanyk, Y. and O. Van Hemert, 2008, “Understanding the subprime mortgage crisis,” mimeo, http://papers.ssrn.com/sol3/Papers.cfm?abstract_id=1020396.

Dennis, S. A. and Mullineaux, D.J. (2000). Syndicated loans, *Journal of Financial Intermediation* 9, 404-26.

Demarzo, P. (2005). The pooling and tranching of securities: A model of informed intermediation, *Review of Financial Studies* 18, 1-35.

Diamond, D. (1984). Financial intermediation and delegated monitoring, *Review of Economic Studies* 51, 393-414.

Diamond, D., and Dybvig, P. (1983). Bank runs, deposit insurance, and liquidity, *Journal of Political Economy* 91, 401-419.

Diamond, D., and Rajan, R.G. (2001). Liquidity risk, liquidity creation and financial fragility: A theory of banking, *Journal of Political Economy* 91, 401-419.

Drucker, S. and Puri, M. (2005). On the benefits of concurrent lending and underwriting, forthcoming at the *Journal of Finance*.

Drucker, S. and Puri, M. (2007). On loan sales, contracting and lending relationships, available at SSRN: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=920877.

Edwards, F. (1999). Hedge funds and the collapse of Long-Term Capital Management, *Journal of Economic Perspectives* 13, 189-209.

Estrella, A. (2002). Securitization and the efficacy of monetary policy, Federal Reserve Bank of New York, *Economic Policy Review*, 1-13.

Fama, E. F. (1985). What's different about banks? *Journal of Monetary Economics* 15, 29-39.

Flannery, M. (1994). Debt maturity and the deadweight costs of leverage: Optimally financing banking firms, *American Economic Review* 84, 320-331.

Frame, W. S. and White, L.J. (2005). Fussing and fuming about Fannie and Freddie: How much smoke, how much fire? *Journal of Economic Perspectives*, Spring 2005.

Franke, G. and Krahen, J.P. (2004). Default risk-sharing between banks and markets: The contribution of collateralized loan obligations," in Mark Carey and René Stulz (eds.), *Risks of Financial Institutions*, Chicago, IL: University of Chicago Press, 603-31.

Furfine, C. (2002). The costs and benefits of moral suasion: Evidence from the rescue of Long-Term Capital Management, forthcoming, *Journal of Business*.

Garber, P., and Weisbrod, D. (1990). Banks in the market for liquidity, working paper no. 3381, National Bureau of Economic Research.

Gatev, E. (2006). Liquidity risk and limited arbitrage: Are taxpayers helping hedge funds get rich? Working paper, Carroll School of Management, Boston College.

Gatev, E. and Strahan, P.E. (2006). Banks advantage in hedging liquidity risk: Theory and evidence from the commercial paper market, *Journal of Finance* 61, 867-892.

Gatev, E. and Strahan, P.E. (2007). Liquidity risk and loan syndicates, mimeo.

Gatev, E., Schuermann, T. and Strahan, P.E. (2006). How do banks manage liquidity risk? Evidence from the equity and deposit markets in the Fall of 1998,” in Mark Carey and René Stulz (eds.), *Risks of Financial Institutions*, Chicago, IL: University of Chicago Press, 105-127.

Gatev, E., Schuermann, T. and Strahan, P.E. (2007). Managing liquidity risk: How deposit-loan synergies vary through market conditions, forthcoming at the *Review of Financial Studies*.

Goodfriend, M. and King, R. G. (1988). Financial deregulation, monetary policy and central banking, Federal Reserve Bank of Richmond, *Economic Review* (May/June), 3-22.

Gorton, G. (1988). Banking panics and business cycles, *Oxford Economic Papers* 40(4), 751-781.

Gorton, G. and G. Pennacchi (1995). Bank loan sales: Marketing non-marketable assets, *Journal of Monetary Economics* 35, 389-411.

Gorton, G. and N. Souleles (2005). Special purpose vehicles and securitization, in M. Carey and R. Stulz (eds.), *Risks of Financial Institutions*, Chicago, IL: University of Chicago Press, 549-97.

Greenspan, A. (2004). Testimony before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 24, 2004.

Gropp, R., Schulz, J.K. and White, M.J. (1997). Personal bankruptcy and supply and demand for credit, *Quarterly Journal of Economics* 112, 217-51.

Güner, Barak (2006). Loan sales and the cost of corporate borrowing, *Review of Financial Studies* 19, 687-716.

Higgins, E. J. and Mason, J. R. (2004). What is the value of recourse to asset backed securities? A clinical study of credit card banks, *Journal of Banking and Finance* 28, 857-74.

Holmstrom, B. and Tirole, J. (1997). Financial intermediation, loanable funds, and the real sector, *Quarterly Journal of Economics* 112, 663-691.

Ivashina, V. (2006). Agency effects on syndicated loan rates, unpublished working paper, Harvard Business School.

Ivashina, V and D. Scharfstein. (2008). Bank lending during the financial crisis of 2008, unpublished working paper, Harvard Business School, November 5, 2008.

Ivashina, V. and Sun, Z. (2007). Institutional stock trading on loan market information, mimeo.

Iyer, R. and Puri, M. (2007). Who runs? The importance of relationships in bank panics, mimeo.

Jensen, M. (1986). Agency costs of free cash flow, corporate finance and takeovers, *American Economic Review* 76, 323-29.

Jimenez, G., Lopez, J.A. and Saurina, J. (2007). Empirical analysis of corporate lines of credit, mimeo.

Jones, J., Lang W. and Nigro, P. (2005). Agent bank behavior in bank loan syndications, *Journal of Financial Research* 28, 385-402.

Kane, E. and Demirguc-Kunt, A. (2002). Deposit insurance around the world: Where does it work? *Journal of Economic Perspectives* (Spring), 175-95.

Kane, E. (2007). Incentive conflict in central-bank responses to sectoral turmoil in financial hub countries, mimeo.

Keys, B. J., Mukerjee, T. K., Seru, A. and V. Vig, 2008, "Did securitization lead to lax screening? Evidence from sub-prime loans," mimeo,
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1093137.

Khwaja, A. I. and Mian, A. (2005). Tracing the impact of bank liquidity shocks, mimeo, June 2005.

Kindleberger, C. P., 2000, *Manias, Panics and Crashes: A History of Financial Crises*, MacMillan, London, 5th edition.

Kashyap, A., Rajan, R.G. and Stein, J. (2002). Banks as liquidity providers: An explanation for the co-existence of lending and deposit-taking, *Journal of Finance* 57(1), 33-73.

Krishnamurthy, A. (2008). The financial meltdown: Data and diagnoses, working paper,
<http://www.nber.org/~confer/2008/cff08/krishnamurthy.pdf>

Lee, S. and Mullineaux, D.J. (2004). Monitoring, financial distress, and the structure of commercial lending syndicates, *Financial Management* 33, 107-30.

Leland, H. and Pyle, D.E. (1977). Information asymmetries, financial structure and financial intermediation, *Journal of Finance* 32(2), 371-387.

Loutskina, E. (2005). Does securitization affect bank lending? Evidence from bank responses to funding shocks, mimeo, March 2005.

Loutskina, E., and Strahan, P.E. (2007). Securitization and the declining impact of bank financial condition on loan supply: Evidence from mortgage acceptance rates, forthcoming, *Journal of Finance*.

Loutskina, E., and Strahan, P.E. (2008). Informed and uninformed investment in housing: The Downside of diversification, working paper, September 2008.

McAndless, G., Gabrielli, M.F. and Rouillet, M.J. (2003). Determining the causes of bank runs in Argentina during the crisis of 2001, *Revista de Analisis Economico* 18(1), 87-102.

McAndrews, J. J. and Potter, S.M. (2002). Liquidity effects of September 11, 2001, Federal Reserve Bank of New York, *Economic Policy Review* 8(2), 59-79.

McAndrews, J. J., Sarkar A. and Z. Wang (2002). The effect of the term auction facility on the London Inter-Bank Offered rate?, working paper, Federal Reserve Bank of New York.

Mester, L., Nakamura, L. and Renault, M. (2006). Transactions accounts and loan monitoring, forthcoming, *Review of Financial Studies*.

Morgan, D. P. (1998). The credit effects of monetary policy: Evidence from loan commitments, *Journal of Money, Credit and Banking*.

Myers, S. C., and Rajan, R.G. (1998). The paradox of liquidity, *Quarterly Journal of Economics* 113, 733-71.

Nandy, D. and Shao, P. (2007). Institutional investment in syndicated loans,” mimeo.

Norden, L. and Weber, M. (2007). Checking account information and the credit risk of bank customers,” mimeo.

O’Hara, M., and Shaw, W. (1990). Deposit insurance and wealth effects: The benefit of being too big to fail, *Journal of Finance* 45, 1587-1600.

Paravisini, D. (2007). Local financial constraints and firm access to external finance, forthcoming, *Journal of Finance*.

Passmore, W., Sherlund, S.M. and Burgess, G. (2005). The effect of housing Government-Sponsored Enterprises on mortgage rates, *Real Estate Economics* 33, 427-63.

Pennacchi, G. (2006). Deposit insurance, bank regulation and financial system risk, *Journal of Monetary Economics* 53, 1-30.

Purnanandam, A., 2008, “Originate-to-Distribute Model and the Sub-Prime Mortgage Crisis,” http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1167786.

Saidenberg, M. R., and P. E. Strahan (1999). Are banks still important for financing large

businesses? Federal Reserve Bank of New York's *Current Issues in Economics and Finance* 5(12), 1-6.

Standard & Poors (2006). *A Guide to the Loan Market*, September 2006.

Sufi, A. (2007a). Information asymmetry and financing arrangements: Evidence from syndicated loans, *Journal of Finance*, April 2007, 62(2), 629-668.

Sufi, A. (2007b). Bank lines of credit in corporate finance: An empirical investigation, forthcoming, *Review of Financial Studies*.

Mian A. and A. Sufi, 2008, "The consequences of mortgage credit expansion: Evidence from the 2007 mortgage crisis," mimeo, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1072304.

Rochet, J. C. and Vives, X. (2004). Coordination failures and lender of last resort: Was Bagehot right after all? *Journal of the European Economic Association* 2, 1116-47.

Townsend, R. M. (1979). Optimal contracts and competitive markets with costly state verification, *Journal of Economic Theory* 21, 1-29.

Udell, G. (2004). *Asset-Based Finance: Proven Disciplines for Prudent Lending*, New York: Commercial Finance Association

Wittenberg-Moerman, R. (2006). The role of information asymmetry and financial reporting quality in debt contracting: Evidence from secondary loan market, mimeo.