The Failure Mechanics of Dealer Banks

Darrell Duffie

Graduate School of Business, Stanford University*

First Draft: May 15, 2009. This draft: July 23, 2009.

Abstract

I explain the key failure mechanics of large dealer banks, and some policy implications. This is not a review of the financial crisis of 2007-2009. Systemic risk is considered only in passing. Both the financial crisis and the systemic importance of large dealer banks are nevertheless obvious and important motivations.

*I am grateful for impetus from Andrei Shleifer and Jeremy Stein, for research assistance from Vojislav Sesum and Zhipeng Zhang, and for helpful conversations with Joseph Abate, James Aitken, John Berry, Robert Bliss, Lucinda Brickler, Jeremy Bulow, John Coates, Bill Dudley, David Fanger, Alessio Farhadi, Peter Fisher, John Goggins, Jacob Goldfield, Jason Granet, Ken Griffin, Robert E. Hall, Brad Hintz, Anil Kashyap, Matt King, Matthew Leising, Paul Klemperer, Joseph Langsam, Raghu Rajan, Manmohan Singh, Glen Taksler, Rick Thielke, Hyun Shin, Jeremy Stein, Paul Tucker, Andrew White, Alex Wolf, Alex Yavorsky, Haoxiang Zhu, and Tatjana Zidulina. I also thank Ann Norman and Timothy Taylor for guidance from the *Journal of Economic Perspectives*.

1 Introduction

I begin with the story of the failure of a bank that is a major dealer in securities and derivatives. Our dealer bank will be unable to stop the drain of cash caused by the departures of its short-term creditors, over-the-counter derivatives counterparties, and client hedge funds. The most immediate examples are the 2008 failures of Bear Stearns and Lehman, but the failure mechanics at work could apply to any major dealer bank, once sufficiently weakened. There are further lessons to be learned from the major dealers that did not fail despite the stresses that they experienced as a result of the recent financial crisis.

We pick up the story several months before the demise of our protagonist, whom we shall call Alpha Bank. Alpha's capital position has just been severely weakened by trading losses. The cause need not be a general financial crisis, although that would further reduce Alpha's chance of recovery. Once weakened, Alpha takes actions that worsen its liquidity position in a rational gamble to signal its strength and protect its franchise value. Alpha wishes to reduce the flight risk of its clients, creditors, and counterparties.

Alpha's first move is to bail out some clients from the significant losses that they suffered through investments arranged by Alpha. This is an attempt by Alpha to maintain the value of its reputation for serving its clients' interests. As time passes, and the cracks in Alpha's finances become more apparent to some market participants, Alpha notices that some of its over-the-counter derivatives counterparties have begun to lower their exposures to Alpha. Their transactions are more and more slanted toward trades that drain cash toward the counterparties. Alpha believes that it must

continue to offer competitive terms on these trades, for to do otherwise would signal financial weakness, exacerbating the flight. Other dealer banks are increasingly being asked to enter derivatives trades, called "novations," that have the effect of inserting the other dealers between Alpha and its original derivatives counterparties, insulating those counterparties from Alpha's default risk. As those dealers notice this trend, they begin to refuse to place themselves in harm's way with more novations. As a result, the market gossip about Alpha's weakness begins to circulate more rapidly.

Alpha has been operating a significant prime brokerage business, offering hedge funds such services as information technology, trade execution, accounting reports, and — more important to our story — a repository for the hedge funds' cash and securities. These hedge funds have heard the rumors and have been watching the market prices of Alpha's equity and debt in order to gauge Alpha's prospects. They begin to shift their cash and securities to better capitalized prime brokers or, safer yet, custodian banks. Alpha's franchise value is thus rapidly eroding; its prospects for a merger rescue or for raising additional equity capital diminish accordingly. Potential providers of new equity capital question whether their capital infusions would do much more than improve the position of Alpha's creditors. In the short run, a departure of prime-brokerage clients is also playing havoc with Alpha's cash liquidity, because Alpha had been financing its own business in part with the cash and securities left with it by these hedge funds. As they leave, Alpha's cash flexibility declines to alarming levels.

Although Alpha's short-term secured creditors hold Alpha's securities as collateral against default losses, at this point they see no good reason to renew their loans to

Alpha. Potentially, they could get caught up in the administrative mess that would accompany Alpha's default. Moreover, even though the amount of securities that they hold as collateral includes a "haircut," a buffer for unexpected reductions in market value, there remains the risk that they could not sell the collateral for enough to cover their loans. Most of them fail to renew their loans to Alpha. A large fraction of these short-term secured loans are in the form of repurchase agreements, or "repos." The majority of these have a term of one day. Thus, on short notice, Alpha needs to find significant new financing, or to conduct costly firesales of its securities.

Alpha's liquidity position is now grave. Professionals in Alpha's treasury department are scrambling to maintain positive cash balances in Alpha's clearing accounts. In the normal course of business, Alpha's clearing bank allows Alpha and other dealers the flexibility of daylight overdrafts. A clearing bank routinely holds the dealer's securities in amounts sufficient to offset potential cash shortfalls. Today, however, Alpha receives word that its clearing bank has exercised its right to stop processing Alpha's cash transactions, given the exposure of the clearing bank to Alpha's overall position. This is the last straw. Unable to execute its trades, Alpha declares bankruptcy.

Although Alpha Bank is a fictional composite, the main objective of this paper is a factual foundation for the key elements of this story. In addition to providing institutional and conceptual frameworks, some policy issues are raised. In some cases, revisions to market infrastructure or regulation are suggested.

2 Background

The basic economic principles at play in the failure of a large dealer bank are not so different from those of a garden-variety run on a typical retail bank, but the institutional mechanisms and the systemic destructiveness are rather different.

A conventional analysis of the stability of a bank, along the lines of Diamond and Dybvig (1983), conceptualizes the bank as a provider of value to assets, say illiquid loans, if held to maturity. Financing the assets with short-term deposits makes sense if the bank is a superior intermediator between depositors, who are interested in short-term liquidity, and borrowers, who seek project financing. The equity owners of the bank benefit, to a point, from leverage. Occasionally, perhaps from an unexpected surge in the liquidity demands of depositors or from a shock to the ability of borrowers to repay their loans, depositors may become concerned over the bank's solvency. If the concern is sufficiently severe, the anticipation by depositors of a run is self-fulfilling.

The standard regulatory tools for treating the social costs of bank failures are: supervision and risk-based capital requirements, to reduce the chance of a solvency threatening loss of capital; deposit insurance, to reduce the incentives of individual depositors to trigger cash insolvency by racing each other for their deposits; and regulatory resolution mechanisms that give authorities the power to restructure a bank relatively efficiently. These regulatory tools not only mitigate the distress costs of a given bank and protect its creditors, they also lower the knock-on risks to the rest of the financial system. We will consider some additional policy mechanisms that more specifically address the failure risks of large dealer banks.

Although I will tend to simplify by treating large dealer banks as members of

a distinct class, in practice they vary in many respects. They typically act as intermediaries in the markets for securities, repurchase agreements, securities lending, and over-the-counter derivatives. They conduct proprietary (speculative) trading in conjunction with these services. They are prime brokers to hedge funds and provide asset management services to institutional and wealthy individual investors. As part of their asset-management businesses, some operate "internal hedge funds" and private equity partnerships, of which the bank acts effectively as a general partner with limited-partner clients. When internal hedge funds and other off-balance sheet entities such as structured investment vehicles and money-market funds suffer heavy losses, the potential for a reduction in the dealer's reputation and franchise value gives the dealer bank an incentive to voluntarily compensate investors in these vehicles.

Dealer banks may have conventional commercial banking operations, including deposit taking as well as lending to corporations and consumers. They may also act as investment banks, which can involve managing and underwriting securities issuances and advising corporate clients on mergers and acquisitions. Investment banking sometimes includes "merchant banking" activities, such as buying and selling oil, forests, foodstuffs, metals, or other raw materials.

Large dealer banks typically operate under the corporate umbrella of holding companies. These are are sometimes called "large complex financial institutions." Some of their activities are therefore outside of the scope of traditional bank-failure resolution mechanisms such as conservatorship or receivership.[1] The U.S. Treasury Department has recently proposed legislation that would extend its ability to restructure large fail-

[1]Bliss and Kaufman (2006) review the distinctions between bank and non-bank failure resolution.

ing bank holding companies and other systemically important financial institutions that were not already covered by traditional resolution mechanisms.[2]

When the solvency of a dealer bank becomes uncertain, its various counterparties and customers have incentives to reduce their exposures to the bank, sometimes quickly and in a self-reinforcing cascade. Although their incentives to exit are similar to those of uninsured bank depositors, the mechanisms at play make the stability of a dealer bank worthy of additional policy analysis, especially considering the implications for systemic risk. Dealer banks are typically considered, with reason, too big to fail. The destructiveness of the failure of Lehman Brothers in September 2008 is a case in point. Although all large dealer banks now operate as regulated banks or within regulated bank holding companies that have access to traditional and new sources of government or central-bank support, concerns remain over the systemic risk that some of these financial institutions pose to the economy. Although access to government support mitigates systemic risk associated with catastrophic failures, the common knowledge that large financial institutions will receive support when they are sufficiently distressed — in order to limit disruptions to the economy — provides an additional incentive to large financial institutions to take inefficient risks, a well understood moral hazard.

Among the institutional mechanisms of greatest interest here are those associated with short-term "repo" financing, OTC derivatives, off-balance sheet activities, prime brokerage, and loss of cash settlement privileges at a dealer's clearing bank. Counterparty treatment at the failure of the dealer is a boundary condition that affects exit decisions.

[2]See United States Treasury Department (2009), the most recent draft of the "Resolution Authority for Systemically Significant Financial Companies Act of 2009."

As counterparties and others begin to exit their relationships with a distressed dealer bank, not only is the cash liquidity position of the bank threatened, but its franchise value also diminishes, sometimes precipitously. If the balance sheet or franchise value has significant associated uncertainty, potential providers of additional equity capital or debt financing, who might hope to profit by sharing in a reduction in distress losses, may hold back in light of adverse selection. They would be purchasing contingent claims whose prospects could be much more transparent to the seller (the bank) than to the investor. Debt overhang also has a dampening effect on the ability to lower distress costs through equity raising. Although large potential gains in the total enterprise value of a distressed bank could be achieved by the addition of equity capital, these gains would go mainly toward making creditors whole. In a normal distressed corporation, debt overhang and adverse selection can be treated by a bankruptcy reorganization, which typically has the main effect of converting the debt to equity. Attempts to restructure the debt of a large dealer bank, however, could trigger a rush for the exits by various clients, creditors, and derivatives counterparties. This may lead to a large firesale, disrupting markets for assets and over-the-counter derivatives, with potentially destructive macreconomic consequences. An automatic stay, which tends to preserve the enterprise value of a distressed non-financial company, can also limit the ability of a large dealer bank to manage its risk and liquidity. In any case, in many significant jurisdictions such as the United States, large classes of over-the-counter derivatives and repurchase agreements are exempt from automatic stays.

In this article, I examine some of these failure mechanisms, and look toward po-

tential policy implications beyond those associated with conventional capital requirements, supervision, and deposit insurance. Among the additional mechanisms that might be used to address large-bank failure processes are central clearing counterparties for over-the-counter derivatives, dedicated "utilities" for clearing tri-party repurchase agreements, and forms of debt that convert to equity contingent on distress triggers.

3 Large Dealer Banks

I focus on financial institutions that are significant dealers in securities and over-the-counter (OTC) derivatives. Indicative of this focus are the securities dealers, listed in Table 1, that were invited to participate in a meeting concerning OTC derivatives at the New York Federal Reserve Bank on April 1, 2009. This list overlaps substantially with the list of primary dealers in U.S. government securities.[3] These firms typify relatively large global financial groups that, in addition to their securities and derivatives businesses, may operate large traditional commercial banks or have significant activities in investment banking, asset management, and prime brokerage. The constellation of these activities under the umbrella of one holding company presents a complex array of potential costs and benefits. The relevant research, for example Boot et al. (1999), does not find a strong case for the net benefits of forming large diversified financial conglomerates of this type.[4] There may exist economies of scope in information technology, marketing, and financial innovation. One suspects that some

[3]The primary dealers that are not part of financial groups represented in Table 1 are Cantor Fitzgerald (an inter-dealer broker), Daiwa Securities America Inc., and Mizuho Securities USA Inc. The dealers shown in Table 1 that are not also primary dealers in U.S. government securities are The Royal Bank of Scotland Group, Société Générale, and Wachovia Bank (Wells Fargo).

[4]For potential synergies between commercial and investment banking, see Kanatas and Qi (2003).

of the risk management failures discovered during the financial crisis are associated with diseconomies of scope in risk management and corporate governance. It seems as though some senior executives and boards simply found it too difficult to comprehend or control some of the risk taking activities inside their own firms.[5]

In the remainder of this section, I outline some of the key activities of large dealer banks that play a role in the failure mechanics of concern.

Bank of America, N.A.
Barclays Capital
BNP Paribas
Citigroup
Credit Suisse
Deutsche Bank AG
Dresdner Kleinwort
Goldman, Sachs & Co.
HSBC Group
JPMorgan Chase
Morgan Stanley
The Royal Bank of Scotland Group
Société Générale
UBS AG
Wachovia Bank N.A., a Wells Fargo company

Table 1: Dealers invited to an April 1, 2009 meeting on over-the-counter derivatives hosted by the New York Federal Reserve Bank. Source: New York Federal Reserve Bank.

3.1 Securities Dealing, Underwriting, and Trading

Banks with securities businesses intermediate in the primary market between issuers and investors, and in the secondary market among investors. The driving concept is to buy low and sell high. Profits are earned in part though the provision of liquidity. In the primary market, the bank, sometimes acting as an underwriter, effectively buys equities or bonds from an issuer and then sells them over time to investors. In secondary

[5]For a case example of lapses in risk oversight, see UBS (2008), the "Shareholder Report on UBS's Writedowns," especially Chapter 5, Risk Management and Risk Control Activities.

markets, a dealer stands ready to have its bid prices hit by sellers and its ask prices hit by buyers.

Dealers dominate the intermediation of over-the-counter securities markets, covering bonds issued by corporations, municipalities, certain national governments, and securitized credit products. Over-the-counter trades are privately negotiated. Trade between dealers in some securities, particularly government bonds, is partially intermediated by inter-dealer brokers. Although public equities are easily traded on exchanges, dealers are also active in secondary markets for equities, for example as brokers, custodians, securities lenders, or intermediaries in large block trades.

Banks with dealer subsidiaries also engage in speculative investing, often called proprietary trading, aided in part by the ability to observe flows of capital into and out of certain classes of securities. Although legal "Chinese walls" are designed to insulate proprietary traders from the information generated by securities dealing, there are nevertheless synergies between dealing and proprietary trading, based on common inventories of securities and cash, on common sources of external financing, and on common human resources and infrastructure, such as information technology and trade settlement operations.

Securities dealers also intermediate the market for repurchase agreements, or "repos." A repo is, in effect, a short-term cash loan collateralized by securities. One counterparty borrows cash from the other, and as collateral against performance on the loan, posts government bonds, corporate bonds, agency securities, or other debt securities such as collateralized debt obligations. Repos are frequently used for levered financing. For example, a hedge fund that specializes in fixed-income securities can

finance the purchase of a large quantity of securities with a small amount of capital by placing purchased securities into repurchase agreements with a dealer, using the cash proceeds of the repo to purchase additional securities.

The majority of repurchase agreements are for short terms, typically overnight. For example, from New York Federal Reserve Bank data on Financing by U.S. Government Securities Dealers, [6] of the total amount of dealer financing of treasuries, agency securities, mortgages, and corporate bonds, approximately 70% was financed overnight. In order to hold a security position over time, repurchase agreements are renewed with the same dealer or replaced by new repos with other dealers. The performance risk on a repo is typically mitigated by a "haircut" that reflects the risk or liquidity of the securities. For instance, a haircut of 10% allows a cash loan of $90 million to be obtained by posting securities with a market value of $100 million.

For settlement of their repo and securities trades, dealers typically maintain clearing accounts with other banks. J.P. Morgan Chase and the Bank of New York Mellon handle most dealer clearing. Access to clearing bank services is crucial to a dealer's daily operations.

In order to mitigate counterparty risk, some repurchase agreements are "tri-party." The third party is usually a clearing bank that holds the collateral and is responsible for returning the cash to the creditor. In principle, this facilitates trade and insulates the lender somewhat from the borrower's default. In 2007, according to Geithner (2008), tri-party repos totaled $2.5 trillion. The same two clearing banks, J.P. Morgan Chase and the Bank of New York Mellon, are also dominant in tri-party repos. In Europe, tri-

[6] See "Weekly Release of Primary Dealer Positions, Transactions, and Financing as of June 2009," on the web site the New York Federal Reserve Bank. I am grateful to JA Aitkens for directing me to these data.

party repos are also arranged through specialized repo clearing services, Clearstream and Euroclear.

Securities dealing is risky. Long-run success depends not only on skill, but also on access to a pool of capital that is able to absorb significant losses and fluctuations in cash flows.

3.2 Over-the-Counter Derivatives

Derivatives are contracts that transfer financial risk from one investor to another. For example, a call option gives an investor the right to buy an asset in the future at a pre-arranged price. Derivatives are traded on exchanges and over the counter (OTC). For most OTC derivatives trades, one of the two counterparties is a dealer. A dealer usually lays off much of the net risk of the derivatives positions requested by counterparties by entering new derivatives contracts with other counterparties, who are often other dealers. This is sometimes called a "matched book" dealer operation.

As in their securities businesses, dealer banks also conduct proprietary trading in OTC derivatives markets. Again, the basic idea is to buy low and sell high, on average, over many positions.

The notional amount of an OTC derivative contract is typically measured as the market value – or, in the case of fixed-income positions, the face value – of the asset whose risk is transferred by the derivative. For example, a call option to buy 1 million shares of an equity whose price is $50 per share represents a notional position of $50 million dollars. Currently, the total notional amount of OTC derivatives outstanding is roughly $500 trillion dollars, according to the Bank of International Settlements.

The majority of these derivatives are interest-rate swaps, which are commitments to make periodic exchanges of one interest rate, such as the London Interbank Offering Rate (LIBOR), for another, such as a fixed rate, on a given notional principal, until a stipulated maturity date. The largest OTC derivatives dealer by volume is J.P. Morgan, with a total notional position of $87 trillion, according to **?**.

As opposed to assets held in positive net supply, such as equities, the total supply of any type of derivative is zero. Thus, the total market value of all derivatives contracts is zero, as a mere accounting identity. For example, the call option in our simple example may have a substantial market value to the buyer, say $10 million. The seller in that case has a market value that is negative by the same amount, $10 million dollars. As contingencies are realized over time, derivatives transfer wealth from counterparty to counterparty, but do not directly add to or subtract from the total stock of wealth. Indirectly, however, derivatives can cause substantial net distress losses. For instance, counterparties incurring large losses on derivatives contracts may be forced to incur frictional bankruptcy costs, and their failure may lead to distress costs for their counterparties.

A useful gauge of counterparty risk in the OTC market is the amount of exposure to default presented by the failure of counterparties to perform their contractual obligations. In our simple option example, the current exposure of the buyer to the seller is the $10 million market value of the option, unless the seller has provided collateral against its obligation. If the seller provides $8 million in collateral, the exposure is reduced to $2 million.

Normally, the OTC derivatives trades between a given pair of counterparties are

legally combined under a "master swap agreement" between those two counterparties. The master swap agreements signed by dealers generally conform to standards set by the International Swaps and Derivatives Association (ISDA). Credit support annexes of these master swap agreements govern collateral requirements as well as the obligations of the two counterparties in the event that one of them cannot perform. As the market values of the derivatives contracts between two counterparties fluctuate, the collateral required is recalculated, normally on a daily basis, according to terms stated in the credit support annex of their master swap agreement.

One of the key features of master swap agreements is the netting of exposures and of collateral requirements across different derivatives positions. For example, suppose that the owner of the call option that is worth 10 million dollars in our previous example is a dealer that also holds a foreign exchange forward contract with the same counterparty, whose market value to the dealer is $-\$4$ million. In this case, the net exposure of the dealer to its counterparty is $10 - 4 = 6$ million dollars, before considering collateral. Netting lowers default exposure and lowers collateral requirements. As the financial crisis that began in 2007 deepened, the range of acceptable forms of collateral taken by dealers from their OTC derivatives counterparties was narrowed, leaving over 80% of collateral in the form of cash during 2008, according to International Swaps and Derivatives Association (2009). The total amount of collateral demanded also nearly doubled in 2008, from about \$2 trillion in 2007 to about \$4 trillion in 2008.

Table 2 shows the total gross exposures of major dealers in over-the-counter derivatives of various types, as estimated from dealer surveys by Bank for International Settlements (2009), before considering netting and collateral. The table also shows a

Table 2: Exposures of dealers in OTC derivatives markets by asset class, counterparty type, and single versus multi-name credit default swaps (CDS), as of December 2008. Net exposures do not include CDS. Source: BIS, May, 2009.

Asset class	Exposure ($ billions)
CDS	5,652
Commodity	955
Equity Linked	1,113
Interest Rate	18,420
Foreign Exchange	3,917
Unallocated	3,831
Total	33,889
Total after netting	5,004
CDS by Counterparty	
Dealer to dealer	3,177
Dealer to other financial institution	2,377
Dealer to non-financial customers	98
Total	5,652
CDS by type	
Single name	3,695
Multi-name	1,957
Total	5,652

substantial reduction in exposure through netting.

At least one of the two counterparties of most OTC derivatives is a dealer. It would be uncommon, for example, for a hedge fund to trade directly with, say, an insurance company. Instead, the hedge fund and the insurance company would normally trade with dealers. Dealers themselves frequently trade with other dealers. Further, when offsetting a prior OTC derivatives position, it is common for market participants to avoid negotiating the cancellation of the original derivatives contract. Instead, a new derivatives contract that offsets the bulk of the risk of the original position is frequently arranged with the same or another dealer. As a result, dealers accumulate large OTC derivatives exposures, often with other dealers.

Dealers are especially likely to be counterparties to other dealers in the case of credit default swaps (CDS), which are in essence insurance against the default of a named borrower. When a hedge fund decides to reduce a CDS position, a typical step in executing this offset is to have its original CDS position "novated" to another dealer, which then stands between the hedge fund and the original dealer by entering new back-to-back CDS positions with each. In this fashion, dealer-to-dealer CDS positions grew rapidly. Based on data provided by the Depository Trust and Clearing Corporation (DTCC) in April 2009, of the current aggregate notional of about $28 trillion in credit default swaps whose terms are collected by DTCC's DerivServ Trade Information Warehouse, over $23 trillion are in the form of dealer-to-dealer positions.[7]

3.3 Prime Brokerage and Asset Management

Several large dealers are active as prime brokers to hedge funds and other large investors. In some cases acting through broker-dealer subsidiaries, they provide these clients a range of services, including custody of securities, clearing, cash management services, securities lending, financing, and reporting (which may include risk measurement, tax accounting, and various other accounting services). A dealer may frequently serve as a derivatives counterparty to its prime-brokerage clients. A dealer often generates additional revenues by lending securities that are placed with it by prime brokerage clients. As of the end of 2007, according to data from Lipper, the majority of prime brokerage services was provided by just three firms, Morgan Stanley, Goldman Sachs,

[7]Since mid 2008, when the total notional size of the CDS market stood at over $60 trillion, the total amount of credit default swaps outstanding has been reduced dramatically by "compression trades," by which redundant or nearly redundant positions among dealers are effectively canceled.

and Bear Stearns, whose prime brokerage business was absorbed by J.P. Morgan when it acquired Bear Stearns in mid 2008.

Dealer banks often have large asset-management divisions that cater to the investment needs of institutional and wealthy individual clients. The services provided include custody of securities, cash management, brokerage, and investment in alternative investment vehicles, such as hedge funds and private-equity partnerships that are typically managed by the same bank. Such an "internal hedge fund" may offer contractual terms similar to those of external stand-alone hedge funds, and in addition can wrap the limited partner's position within the scope of general asset-management services.

In addition to the benefit of "one-stop shopping," a limited partner in an internal hedge fund may perceive that a large dealer bank is more stable than a stand-alone hedge fund, and that the dealer bank might even voluntarily support an internal hedge fund at a time of extreme need. For example, near the end of June 2007, Bear Stearns offered to lend $3.2 billion to one of its failing internal hedge funds, the High-Grade Structured Credit Fund.[8] In August of 2007, at a time of extreme market stress and losses to some of its internal hedge funds, Goldman Sachs injected[9] a significant amount of capital into one of them, the Global Equity Opportunities Fund. In February 2008, Citigroup provided $500 million in funding to an internal hedge fund known as Falcon.[10]

[8]See Barr (2007b). As it turned out, both of these internal hedge funds failed in the following month. See Barr (2007a).

[9]See Goldman Sachs (2007).

[10]CNBC (2008) reported that "The Citi-managed fund, known as Falcon, was brought onto the bank's books, which will increase the bank's assets and liabilities by about $10 billion."

3.4 Off-Balance Sheet Financing

In addition to financing asset purchases through traditional bond issuance, commercial paper, and repurchase agreements, among other liabilities, some large dealer banks have made extensive use of "off-balance-sheet" financing. For example, a bank can originate or purchase residential mortgages and other loans that are financed by selling them to a special purpose financial corporation or trust that it has set up for this express purpose. Such a special purpose entity (SPE) pays its sponsoring bank for the assets with the proceeds of debt that it issues to third-party investors. The principal and interest payments of the SPE's debt are paid from the cash flows that, hopefully, it will receive from the assets that it has purchased from the sponsoring bank.

Because an SPE's debt obligations are contractually remote from the sponsoring bank, under certain conditions banks have not been required to treat the SPE's assets and debt obligations as though their own, for purposes of accounting and of regulatory minimum capital requirements. In this sense, an SPE is "off balance sheet." SPEs have therefore allowed some large banks to operate much larger loan purchase and origination businesses, with a given amount of capital, than would have been possible had they held the associated assets on their own balance sheets. For example, at June 2008, Citigroup, Inc. reported over $800 billion in off-balance-sheet assets held in such "qualified special purpose entities."

A form of special purpose off-balance-sheet entity that was popular until the financial crisis is the structured investment vehicle (SIV), which finances residential mortgages and other loans with short-term debt sold to investors such as money-market funds. In 2007 and 2008, when home prices fell dramatically in the United States and

sub-prime residential mortgage defaults rose, the solvency of many SIVs was threatened. The SIVs were in some cases unable to make their debt payments, especially as some short-term creditors to these funds recognized the solvency concerns and failed to renew their loans to SIVs. Some large dealer banks bailed out investors in some of the SIVs that they had set up. For example, in late 2007, HSBC voluntarily committed about $35 billion to bring the assets of its off-balance structured investment vehicles onto its balance sheet.[11] Citigroup followed in December 2007 by bringing $49 billion in SIV assets and liabilities onto its own balance sheet.[12]

As with support provided to distressed internal hedge funds, the equity owners and managers of these banks may have rationally perceived that the alternative of providing no recourse to their effective clients would have resulted in a loss of market value, through a reduction in reputation and market share, that exceeded the cost of the recourse actually given. This amounts to asset substitution, in the sense of Jensen and Meckling (1976), increasing the risk of the bank's balance sheet, leading at the time to a transfer of value from the bank's unsecured creditors to its equity holders. Some of these banks, had they been able to foresee the extent of their later losses during the financial crisis, might have preferred to allow their off-balance clients to fend for themselves.

[11] See Goldstein (2007).
[12] See Moyer (2007).

4 Failure Mechanisms

The relationships between a dealer bank and its derivatives counterparties, potential debt and equity investors, clearing bank, and clients can change rapidly if the solvency of the dealer bank is threatened. As explained in Section 2, the concepts at play are not so different from those of a depositor run.

4.1 Reactions by OTC Derivatives Counterparties

At the perception of a potential solvency crisis of a dealer bank, an OTC derivatives counterparty would look for opportunities to reduce its exposure to the dealer.

Initially, a counterparty could reduce its exposure by borrowing from the dealer, or by drawing on prior lines of credit with that dealer, or by entering new derivatives contracts with the dealer that would offset some of the exposure. A counterparty could also ask to have options that are in the money to be re-struck at the money, so as to harvest some cash from the position and thereby reduce exposure to the dealer. All of these actions reduce the dealer's cash position. A counterparty to the dealer could also reduce its exposure through novation to another dealer.[13] For instance, a hedge fund who had purchased protection from a dealer on a named borrower, using a credit default swap contract, could contact a different dealer and ask that dealer for a novation, insulating the hedge fund from the default of the original dealer.

When Bear Stearns' solvency was threatened in mid 2008, some of Bear Stearns' counterparties asked other dealers for novations, by which those dealers would effec-

[13]See International Swaps and Derivatives Association (2004).

tively absorb the risk of a failure by Bear Stearns.[14] Although such novations are routinely granted by dealers, in this case other dealers naturally began to refuse these Bear Stearns novations. This in turn is likely to have spread alarm over Bear Stearns' difficulties.

Beyond heightening the concerns of investors, a rash of novations could place the original dealer's cash position under additional stress, because novations could be accompanied by removal of the cash collateral that had been placed in the hands of the dealer by its novating counterparties.[15] The cash collateral that derivatives counter-

[14]Kelly (2008) reported that "Hedge funds flooded Credit Suisse Group's brokerage unit with requests to take over trades opposite Bear Stearns. In a blast email sent out that afternoon, Credit Suisse stock and bond traders were told that all such novation requests involving Bear Stearns and any other 'exceptions' to normal business required the approval of credit-risk managers." Burroughs (2008) further reported: "That same day Bear executives noticed a worrisome development whose potential significance they would not appreciate for weeks. It involved an avalanche of what are called 'novation' requests. When a firm wants to rid itself of a contract that carries credit risk with another firm, in this case Bear Stearns, it can either sell the contract back to Bear or, in a novation request, to a third firm for a fee. By Tuesday afternoon, three big Wall Street companies – Goldman Sachs, Credit Suisse, and Deutsche Bank – were experiencing a torrent of novation requests for Bear instruments." Cohan (2009), at page 27, writes of Goldman Sachs' refusal on March 11, 2008 to accept a novation of a credit default swap position between Hayman Capital's Subprime Credit Strategies Fund and Bear Stearns. Gary Cohn, co-president of Goldman Sachs, is quoted as telling the senior leadership of Bear Stearns, " 'If we start taking novations, people pull their business, they pull their collateral, you're out of business.' " Cohan describes Goldman's offer the next morning to accept the novation.

[15]Yavorsky (2008a) reports that "Any perceived appearance, or actual presence, of significant problems faced by a firm, may lead to a sudden spike in CDS novation requests, as counterparties seek to reduce their exposure to the firm. In addition to the operational burden of processing such requests, a high number of novation requests can become a liquidity-draining event as existing counterparties, with which the firm has a net receivable position, move their trades away and withdraw cash collateral in the process. Similarly, when counterparties, with which the firm has a net payable position, assign their trades to new counterparties, the firm may be required to meet higher collateral requirements, including initial margin While the firm is under no contractual obligation to consent to novation, it may feel pressured to do so in order to satisfy its customers, as well as to preserve the appearance that it has ample liquidity resources (any appearance to the contrary can be immediately devastating to its ability to access other confidence-sensitive sources of liquidity). Such a sudden 'cash call,' if unplanned for, particularly if combined with other difficulties experienced by the firm, can have very negative self-fulfilling consequences. This risk was highlighted by (and likely played a role in) the near collapse of Bear Stearns, which had become an active participant in the CDS market." Leising (2009) reported that "Dealers such as JPMorgan, Goldman Sachs Group Inc. and UBS AG are working with ICE Trust on a framework in which client funds would be granted protections against counterparty default, such as segregated collateral accounts. The lack of segregated accounts led to losses for funds that posted excess collateral with Lehman Brothers last year after the securities firm filed for bankruptcy protection. This 'structural flaw' in the over-the-counter market was evident in the weeks leading to the collapse of Lehman Brothers and Bear Stearns last year, Lubke [Theo Lubke, of the New

parties post with a dealer is not typically segregated from the dealer's own cash, and is therefore a useful source of liquidity to the dealer.

The weakness of a dealer can also be exacerbated if its derivatives counterparties attempt to reduce their exposures to that dealer by entering new trades that cause that dealer to pay out cash. For example, suppose that a dealer with liquidity problems is asked for bid and ask quotations on an OTC option. Suppose further that, if the bid price is accepted, the dealer would be required to settle with a cash payment to the counterparty. In light of its liquidity problems, the dealer could refuse to provide two-sided market quotations, or could provide obviously unattractive quotes, but this would signal its weakness to the market. As a consequence, in the initial stages of solvency concerns, a dealer that believes there is a reasonable chance of surviving a crisis would generally wish to signal its strength by continuing to make two-sided markets, despite the associated movement of cash to those counterparties who are attempting to reduce their exposures to the dealer.

Based on analysis[16] by Singh (2009), the exposures of OTC derivatives counterparties to Citibank, after netting and collateral, fell from $126 billion in March 2008 to $17 billion in March 2009. Over the same period, by comparison, OTC derivatives

York Federal Reserve] said. 'We saw a tremendous outflow of liquidity from each bank,' he said. 'Their buy-side counterparties didnt want to lose their initial margin if there was a bankruptcy proceeding.' " In the United States, Rules 15c3-2 and 15c3-3 of the Securities Exchange Act of 1934 require broker-dealers to segregate 'fully paid securities' and limit a broker-dealers use of "free credit balances." These rules do not, however, apply to collateral held by the broker-dealer affiliates that typically hold the cash posted by derivatives counterparties as collateral. Because the net collateral that is due to be paid to, or received from, a counterparty is calculated daily, based on the positions at the end of the previous day, and because any such cash flows would normally be sent on the day after they are determined, there could be a delay of two days or more between the date on which OTC derivatives positions are eliminated and the date on which the associated cash drain actually occurs.

[16]See a memo titled "Counterparty Risk Post-Lehman Relative to pre Bear Sterns" by Manmohan Singh, May 2009.

exposures to Goldman Sachs fell from $100 billion to $91 billion.

The credit annexes of OTC derivatives master swap agreements call for the posting of additional collateral by a counterparty whose credit rating is downgraded below a stipulated level. A typical threshold for large dealers is a bond rating of A2 by Moodys or A by Standard and Poors.[17] For example, in its 10K filing with the Securities and Exchange Commission dated January 1, 2009, on page 82, Morgan Stanley disclosed that "In connection with certain OTC trading agreements and certain other agreements associated with the Institutional Securities business segment, the Company may be required to provide additional collateral to certain counterparties in the event of a credit ratings downgrade. As of November 30, 2008, the amount of additional collateral that could be called by counterparties under the terms of collateral agreements in the event of a one-notch downgrade of the Company's long-term credit rating was approximately $498.3 million. An additional amount of approximately $1,456.2 million could be called in the event of a two-notch downgrade." The collateral-on-downgrade triggers of the master-swap agreements of AIG Financial Products were the most proximate cause of the need by AIG for a massive U.S. government bailout.

Master swap agreements also include terms for the early termination of derivatives in a selection of contingencies, including the default of one of the counterparties, which typically results in a termination settlement of the derivatives portfolio at what amounts to the replacement cost for the non-defaulting counterparty. For this, third-party prices, or terms for new derivatives with other counterparties, or model-based price estimates, would be obtained for the terminated derivatives positions. The actual

[17]Such thresholds are sometimes stated in terms of the short-term credit rating, and stipulate additional collateral upon downgrade below "prime," which is a rating of P1 by Moodys or A1 by Standard and Poors.

procedures to be followed can be complicated, as appears to be case in the Lehman bankruptcy.[18]

The replacement of derivatives positions may represent a large new liability to a defaulting dealer, above and beyond the net market value of its positions at "mid-market" pricing, that is, at the mid point between bid and ask quotations, which is the basis for normal mark-to-market accounting of derivatives. For example, Citibank has an OTC derivatives portfolio with a total notional size of roughly $30 trillion notional, according to OCC data as of this writing. If the effective termination settlement liability associated with replacing counterparty positions, above and beyond mid-market valuations, is for example 0.2% of the notional position, then the effective new liability would be about $60 billion. Furthermore, because most OTC derivatives are executory contracts that are exempt from automatic bankruptcy stays, the termination settlement of OTC derivatives can proceed immediately, giving derivatives counterparties some effective priority over unsecured creditors whose claims are stayed by the bankruptcy process, such as unsecured bond claimants. The senior unsecured creditors of a major derivatives dealer would therefore view the OTC derivatives book of a dealer as a major incentive to exit their creditor positions, if possible, in the face of any concerns over the dealer's solvency. This could in turn accelerate the dealer's failure.

Although the systemic risk of large dealer bank failures is not our primary focus here, a rush by OTC derivatives counterparties to exit their positions with a weak or

[18]The legal procedures for this process that are to be followed in Lehman's bankruptcy are documented in Lehman Bankruptcy Docket (2008a) and Lehman Bankruptcy Docket (2008b). Dealers work largely under the terms of ISDA's standard 2002 master swap agreement. The 2002 standard agreement is substantially more flexible regarding the method of determining the replacement value of terminated positions than is the 1992 agreement, which bases default settlement claims on third-party quotations. Some OTC derivatives counterparties continue to operate under the 1992 agreement.

failed dealer could be disruptive to derivatives markets and to other financial markets and institutions.[19] This was the case at the default of Lehman Brothers in September 2008, despite the emergency measures taken by dealers to coordinate the replacement of their OTC derivatives positions.[20]

The termination settlement of OTC derivatives portfolios could also be triggered by attempts to resolve a failing financial institution through an out-of-court restructuring. Consider, for example, the resolution of a distressed bank into a good bank and a bad bank, along the lines of the Swedish resolution of Nordbank, as described by Macey (1999). Suppose that the performing assets of a distressed dealer bank were to be transferred to a new "good bank," whose equity would be given to the unsecured creditors of the original bank, a resolution approach proposed by Bulow and Klemperer (2009). Even if the bank's creditors were to agree to such a restructuring outside of a bankruptcy or conservatorship, thereby avoiding the default termination settlement provisions of master swap agreements, the typical master swap agreement also calls for termination settlement in the event that a counterparty transfers the bulk of its assets to another entity in a manner that leaves the counterparty in a materially weaker

[19] See Wall et al. (1996).

[20] Yavorsky (2008b) writes that "During the weekend of September 13-14, as the possibility of Lehman's default began to loom large, major CDS counterparties, including dealers, hedge funds and other buy-side firms, arranged an emergency 'Lehman Risk Reduction Trading Session.' The purpose of the session was to determine a list of derivative trades (including credit, equity, rates, FX and commodity derivatives) to which Lehman was a counterparty, and then close them out by entering into offsetting replacement trades with one another to 'bypass' Lehman. In accordance with a protocol drafted by ISDA, the replacement trades became contingent on Lehman Brothers actually filing for bankruptcy. According to a number of market participants, the close-out session resulted in the replacement of only a relatively limited amount of all the outstanding trades. This reflected, in part, the difficulty of determining and agreeing on the new prices of the trades as participants naturally expected significant price volatility (rising credit spreads, falling equity markets, etc.) the following Monday. It also reflected the sheer operational difficulty of replacing a substantial volume of trades involving multiple counterparties within a limited amount of time. As a result, many of the trades had to be replaced in subsequent days and weeks, with the price of CDS protection, in particular, having by then moved appreciably higher."

condition.[21]

For OTC derivatives that are "cleared," that is, novated to a central clearing counterparty who stands between the original counterparties,[22] the counterparties to the dealer are insulated from the default of the dealer, assuming of course the performance of the central clearing counterparty. Although the dealer itself is subject to its obligations under any cleared derivatives, cleared derivatives should play little or no role in the incentives of counterparties to the dealer to rush for the exits, except perhaps for the incentives of a central clearing counterparty itself to reduce its exposure to the dealer.[23] Further, the incentive of unsecured lenders to a dealer bank to run in the face of the dealer's distress is lowered to the extent that the dealer's OTC derivatives have been cleared. Central clearing also mitigates the systemic risk associated with knock-on effects to the counterparties of a failing dealer that are themselves important financial institutions. Central clearing counterparties can handle only derivatives with relatively standard terms, however, and therefore would not have been in a position to mitigate the counterparty risks associated with the infamous AIG FP credit derivatives, which were highly customized.

4.2 The Flight of Short-Term Creditors

Large dealers tend to finance significant fractions of their assets with short-term repurchase agreements. The counterparties of these repos are often money-market funds,

[21]This trigger is known as "credit event upon merger," although it does not require a merger.

[22]See Bank for International Settlements (2007), Bliss and Steigerwald (2006), Hills et al. (1999), and Ledrut and Upper (2007).

[23]At the default of Lehman, Global Association of Central Counterparties (2009) describes the performance of central clearing counterparties in processing the closeout or novation of some of Lehman's derivatives positions.

Table 3: Quarter-end financing of broker-dealer financial instruments before the failures of Bear Stearns and Lehman (dollars, in billions) Source: King (2008).

	May-08 Morgan Stanley	May-08 Goldman Sachs	May-08 Lehman	June-08 Merrill Lynch	Feb-08 Bear Stearns	2nd Qtr Total
Financial instruments owned	390	411	269	289	141	1,501
pledged (and can be repledged)	140	37	43	27	23	271
pledged (and cannot be repledged)	54	121	80	53	54	362
not pledged at all	196	253	146	208	64	868
Fraction pledged	50%	39%	46%	28%	55%	42%

securities lenders, and other dealers. Repos with a term of one day, called "overnight repo," are common, as they offer maximal flexibility and, normally, the lowest market financing rates available. As an example, under normal pre-crisis conditions a dealer bank might have been able to finance most of its holdings of agency securities, treasuries, corporate bonds, mortgages, and collateralized debt obligations by daily renewal of overnight repos with an average haircut of under 2%. The dealer could therefore hold these assets on its balance sheet with almost no incremental capital. Before their failures, Bear Stearns and Lehman had leverage ratios of over 30, with significant dependence on short-term repo financing. By amalgamating on-balance-sheet accounting data with information from 10Q footnotes, King (October, 2008) estimates that in the first half of 2008, about 42% of the financial instruments of dealer banks were financed through repo or repo-equivalent transactions, as shown in Table 3. For Bear Stearns, this fraction was 55%. At the end of 2007, the total dealer fraction was 48%, according to King's estimates.

Although the repo creditors providing cash to a dealer bank have recourse to the collateralizing assets, often with a haircut that protects them to some degree from fluctuations in the market value of the collateral, they may have little or no incentive

to renew repos in the face of concerns over the dealer bank's solvency. In the event that the dealer counterparty fails to return their cash, the repo creditors would have an incentive, or could be legally required,[24] to sell the collateral immediately, could discover a shortfall in the cash proceeds of the collateral sale, and could potentially face litigation over allegations of improper disposal of the assets. The repo creditors can avoid these threats, and other unforseen difficulties, simply by re-investing their cash in new repos with other counterparties. If a dealer bank's repo creditors fail to renew their positions en masse, the ability of the dealer to raise sufficient cash by other means on such short notice is doubtful, absent emergency too-big-to-fail support from a government or central bank. Tucker (2009) has emphasized the importance of broad and flexible lender-of-last-resort financing. Asset firesales may result, with potentially destructive impacts on other market participants through adverse marks to market on their own repo collateral. The proceeds of an asset firesale might be insufficient to meet cash demands, especially if the solvency concerns were prompted by declines in the market values of the collateral assets themselves. Even if the dealer bank could sell enough assets quickly to meet its immediate cash needs, the firesale could lead to fatal inferences by other market participants of the weakened condition of the dealer.

A dealer bank's financing problems could be exacerbated during a general financial crisis, when the declining transparency of some forms of repo collateral, or increases in the volatility of collateral valuations, could prompt dramatic increases in repo haircuts, which in turn lead to firesales, price declines, and increases in haircuts. This adverse

[24]In the United States, money market funds, typically operating under Rule 2a-7 of the Securities and Exchange Commission, have restrictions on the types of assets that they are permitted to hold, and would be required to immediately sell many of the forms of collateral that they could receive in the event that a repo counteparty fails to perform.

feedback is modeled by Brunnermeier and Pedersen (2008). During the autumn of 2008, haircuts on even investment-grade corporate bonds rose to as much as 20%, while repo financing of many forms of collateralized debt obligations and speculatively-rate corporate bonds became essentially impossible.[25] Abate (2009) reported that corporate bond repo transactions (which include non-Agency mortgage backed securities) fell approximately 60% between March 2008 and March 2009.

Facing a dealer whose resources appear to be threatened, counterparties could attempt to raise haircuts specifically to that dealer, or reduce the range of acceptable collateral from that dealer, or dispute the pricing of the dealer's collateral. During the week leading up to the failure of Bear Stearns, for instance, Cohan (2009) reports on the increasing set of Bear Stearns' normal repo counterparties who told Bear Stearns that they would not be renewing their repo financing to Bear, or were applying more onerous haircuts and disputing collateral valuations.

A tri-party clearing bank would normally monitor the intra-day "net free equity" of a dealer counterparty, checking that the total market value of the dealer's cash and securities (including commitments) remains positive, but traditionally allowing "daylight overdraft" cash transfer privileges. This allows dealers to more easily manage the sequencing of settlements of its transactions during the day.[26] The clearing bank

[25]Fisher (2008) states that "I would also suggest that the prevalence of repo-based financing helps explain the abruptness and persistence with which the de-levering has been translated into illiquidity and sharp asset price declines." Ewerhart and Tapking (2008) and Hordahl and King (2008) review the behavior of repo markets during the financial crisis. Gorton (2009) provides estimates of the haircuts applied to various classes of securities before and during the financial crisis. In July 2007, corporate bonds and structured credit products of many types, both investment grade and non-investment grade, had haircuts of 2% or less. From the second quarter of 2008, many classes of these securities had haircuts in excess of 20%, while a number of classes of securities are shown by Gorton's source to have no financing in the repo market.

[26]The intra-day credit exposure of the clearing bank to the dealer is mitigated by the "delivery versus payment" (DVP) settlement protocols. For example, in settling trades involving U.S. Treasury and agency securities, the FedWire system holds up the payment of federal funds to one counterparty and securities to

normally maintains the legal right to refuse to process cash payments when the dealer's creditworthiness is of concern.

If concerns over the creditworthiness of a dealer do come to light, the clearing bank that handles its tri-party repos, as well as the repo counterparties providing cash to the dealer, are likely to consider the implications of a failure by the dealer to return the cash due on its repos. If that were to happen, the cash-providing counterparty might be given the securities posted by the dealer in lieu of the cash. Particularly for money-market funds, this is not a desirable outcome. The money market fund may therefore demand its cash at the first opportunity that day and fail to renew the repo. The clearing bank is then exposed during the day to the extent that the market value of the dealer's securities is not adequate. If the dealer fails, the clearing bank could itself be forced to sell the securities, or to use the securities as collateral on a secured loan from another bank or from its central bank. In order to avoid the prospect of this undesirable contingency, the clearing bank may also decline to participate in the dealer's tri-party repos. Thus, an expectation that a dealer may not meet its repo obligations could be self-fulfilling, for a dealer would be unlikely to be able to continue its daily operations if its ability to finance its securities in the repo market were to suddenly disappear. This exemplifies the importance of the various credit facilities initiated by the New York Federal Reserve Bank in 2008. The Primary Dealer Credit Facility, for example, effectively extended to investment banks a source of financing for securities that had previously been available only to regulated banks through the discount window.

---

the other until both the cash and the securities have been sent to it.

A dealer bank can mitigate the risk of a loss of liquidity through a run by short-term creditors by establishing lines of bank credit, by dedicating a buffer stock of cash and liquid securities for emergency liquidity needs, and by "laddering" the maturities of its liabilities so that only a small fraction of its debt needs to be re-financed within a short period of time. In the face of doubts by its counterparties, a dealer bank that in actuality has sufficient balance sheet flexibility may have enough time to raise capital and arrange alternative lines of financing, thereby controlling its need to conduct firesales and allowing it to weather a solvency storm. Major dealer banks have teams of professionals that manage liquidity risk by controlling the distribution of liability maturities and by managing the availability of pools of cash and of non-cash collateral that is acceptable to secured creditors.

Dealer banks may have access to secured financing from central bank facilities. The European Central Bank (ECB) provides repo financing to Eurozone banks through regular auctions, by which the ECB accepts a wide range of collateral at moderate haircuts. This repo facility acts as a liquidity backstop. Research by Cassola et al. (2008) shows that from August 2007, when the range of collateral that was acceptable in the over-the-counter repo market narrowed after a rash of sub-prime mortgage defaults, Eurozone banks bid significantly more aggressively for financing in ECB repo auctions. The United States Federal Reserve has always provided secured financing to regulated banks through its discount window. Discount-window financing, however, is available for a restricted range of high-quality collateral and is believed to stigmatize any banks that are so weak as to need to use it. Dealers that were not regulated financial institutions did not have access to the discount window. During the financial

crisis, special credit facilities were established by United States Federal Reserve banks, allowing even non-bank dealers to arrange financing of a range of assets, or to exchange a range of less liquid assets for treasury securities.[27] Almost immediately after the failure of Lehman, the last two large dealers that had not been regulated as banks, Morgan Stanley and Goldman Sachs, became regulated bank holding companies, giving them access to the discount window, among other sources of government support, such as FDIC deposit insurance and loan guarantees. Tucker (2009) describes a range of new secured financing facilities of the Bank of England.

The extent to which a dealer bank is financed by traditional insured bank deposits may lessen its need, during a solvency crisis, to replace cash that is lost from the exits of repo counterparties and other less stable funding sources. Insured deposits are less likely to run than are many other forms of short-term liabilities. Under Rule 23A of the Federal Reserve Act, however, U.S.-regulated banks may not use deposits to fund broker-dealer affiliates.

4.3 The Flight of Prime Brokerage Clients

For some dealer banks, prime brokerage is an important source of fee revenue. Under normal conditions, dealer banks can also finance themselves in part with the cash and securities that clients leave in their prime brokerage accounts.

In the United Kingdom, securities and cash in prime brokerage accounts are generally commingled with the prime broker's own assets, and thus available to the prime

[27]These facilities include the The Single-Tranche OMO Program, the Term Discount Window Program, the Term Auction Facility, transitional credit extensions announced on September 21, 2008, the Primary Dealer Credit Facility, the Term Securities Lending Facility, the Commercial Paper Funding Facility, and the Term Asset-Backed Securities Loan Facility.

broker for its business purposes, including secured borrowing. Cash in London-based prime brokerage accounts is, for practical purposes, equivalent to uninsured deposits. Prime brokers operating under United States rules may or may not fully segregate their client's cash, depending on the situation, according to Rule 15c3-2 governing the treatment of "free credit balances," the amount of cash that a client has a right to demand on short notice.[28] Under Rule 15c3-3, however, a U.S.-regulated prime broker must aggregate its clients' free credit balances "in safe areas of the broker-dealer's business related to servicing its customers" or otherwise deposit the funds in a reserve bank account to prevent commingling of customer and firm funds.[29] The ability to aggregate cash associated with clients' free credit balances into a single pool, although separate from the prime broker's own funds, provides flexibility to a prime broker in managing the cash needs of its clients through the ability to use one client's cash balances to meet the immediate cash demands of another. For example, suppose for simplicity that a dealer has two prime brokerage clients. It holds cash belonging to Hedge Fund A of $150 million and has given a cash loan to Hedge Fund B for $100 million. The excess cash of $50 million must be held in a reserve account. If Hedge Fund A moves its prime brokerage account to another dealer, then the original prime broker must come

[28]Rule 15c3-2 of the Securities and Exchange Act of 1934, "Customers' Free Credit Balances," states that "No broker or dealer shall use any funds arising out of any free credit balance carried for the account of any customer in connection with the operation of the business of such broker or dealer unless such broker or dealer has established adequate procedures pursuant to which each customer for whom a free credit balance is carried will be given or sent, together with or as a part of the customer's statement of account, whenever sent but not less frequently than once every three months, a written statement informing such customer of the amount due to the customer by such broker or dealer on the date of such statement, and containing a written notice that (a) such funds are not segregated and may be used in the operation of the business of such broker or dealer, and (b) such funds are payable on the demand of the customer: Provided, however, That this section shall not apply to a broker or dealer which is also a banking institution supervised and examined by State or Federal authority having supervision over banks. For the purpose of this section the term customer shall mean every person other than a broker or dealer."

[29]See Securities and Exchange Commission (2002).

up with $100 million of cash from new sources.

Prime brokers provide financing to their clients, typically hedge funds, secured by client assets. For U.S. regulated prime brokers, the amounts of such margin loans are limited by advance rates that are set according to asset classes. For example, the maximum amount of cash that can be advanced for equities is 50% of the market value of the equities. Margin loans can be financed using the client's own assets as collateral. Specifically, the prime broker can obtain the cash that it lends a client, as well as additional cash for its own purposes, by re-hypothecating the client's securities as collateral on a secured loan from another lender. For each $100 of margin cash, the dealer is permitted to re-hypothecate $140 worth of the client's assets. Because haircuts rarely reach 40%, it follows that re-hypothecation of securities received from prime brokerage clients can be a significant source of financing for the prime broker.

When a dealer bank's financial position is weakened, hedge funds may move their prime brokerage accounts elsewhere. Failure to run, as Lehman's London-based clients learned, could leave a client unable to claim ownership of assets that had not been segregated in the client's account and had been re-hypothecated to third parties.[30] In the United States, ironically, a prime broker's cash liquidity problems can be exacerbated by its prime brokerage business *whether or not* clients run. Under its contract with its prime broker, a hedge fund could continue to demand cash margin loans from the dealer backed by securities that it has left in its prime brokerage account, but a prime broker whose solvency is known to be questionable may not itself be able to obtain the necessary cash by using those same securities as collateral with other lenders. The

[30]See, for example, Farrell (2008), Mackintosh (2008), and Singh and Aitken (2009).

dealer's potential repo counterparties, as explained earlier, could find it preferable to lend elsewhere. Thus, the *absence* of a run by prime brokerage clients could temporarily exacerbate a dealer's liquidity crisis, through an effective expansion of the dealer's need for cash. A dealer could therefore even have an incentive to "fire" a prime brokerage client in order to avoid providing cash margin financing to the client. If prime brokerage clients run, however, the cash that they pull from their free credit balances is no longer available to meet the demands of other clients on short notice, so the prime broker may be forced to use its own cash to meet these demands.[31]

The exit of prime brokerage clients whose assets had been used by the prime broker as collateral for securities lending can eliminate a valuable source of liquidity to the prime broker. Even clients that do not move to another prime broker may, in the face of concerns over their broker's solvency, move some of their securities into custody accounts or otherwise restrict the access of the prime broker to the securities.

Singh and Aitken (2009) calculate from 10Q and 10K reports that between August 2008 and November 2008, the securities that Morgan Stanley had received from its clients that were available for Morgan Stanley to pledge to others declined by 69%, from $832 billion to $294 billion. For Merrill Lynch and Goldman Sachs, the corresponding declines in re-pledgeable client collateral over this short period spanning the default of Lehman were 51% and 30%, respectively. Singh and Aitken (2009) emphasize that the significant recent general reductions in the availability of pledgeable collateral securities may lead to a systemic shortage of collateral, which could lead to liquidity problems.

The flight of prime-brokerage clients in the face of a dealer bank's financial weakness

[31]Shortfalls are covered, up to limits, by the Securities Investor Protection Corporation (SIPC).

could raise concerns over the dealer's long-run profitability among potential providers of emergency capital. Immediately after the failure of Lehman, some hedge funds moved away from Morgan Stanley[32] and Goldman Sachs for at least a portion of their prime brokerage services. In the days immediately following Lehman's default, CDS rates for Morgan Stanley went above 1000 basis points, meaning that the cost of covering $100 million of senior unsecured Morgan Stanley debt against default losses began to exceed $10 million per year. Some analysts[33] believe that hedge funds are likely to further diversify their sources of prime brokerage, and in the future to place more of their assets with custodian banks rather than with traditional prime brokers.

4.4 Loss of Cash Settlement Privileges

The final step in the collapse of a dealer bank's ability to meet its daily obligations could be a simple refusal by its clearing bank to process transactions that could bring the cash balances in the dealer's clearing account below zero during the course of a business day, *after subtracting* any potential exposures of the clearing bank to the dealer.

[32]See "Morgan Stanley Prime Brokerage Loses One-Third Of Assets," posted September 29, 2008. The article, drawn from the *Financial Times*, states that "Morgan Stanleys prime brokerage lost almost one-third of its assets last week amid fears that the Wall Street giant would face a Lehman Brothers-style collapse.Several clients have indicated they are likely to return to the fold now that the firm has become a bank holding company regulated by the Federal Reserve, and with a U.S. government bailout of Wall Street imminent. But the loss of hundreds of billions in prime brokerage assetsincluding about half of its assets in Londonmay cripple one of Morgan Stanleys most profitable divisions. Just 10 days ago, only 10% of the firms hedge fund clients had pulled their money or announced plans to do so. Hedge funds are no longer fleeing Morgan Stanley in such great numbers, with the cash outflow slowing to a trickle, the *Financial Times* reports. Among the beneficiaries of Morgan Stanleys woes are Barclays Capital, Citigroup, Credit Suisse, Deutsche Bank, JPMorgan Chase and UBS. Morgan Stanley had pushed executives at other banks not to make a play for its clients as it struggled to survive this month, though competitors said marketing their services did not prove necessary. 'We didnt have to call them,' one told the FT. 'They called us.' "

[33]I refer to King et al. (September, 2008) and Hintz et al. (2009).

In the normal course of business, a clearing bank would extend daylight overdraft privileges to creditworthy clearing customers. For example, the cash required to settle a securities trade on behalf of a dealer client could be wired to the dealer's counterparty (or that counterparty's own clearing bank) before the necessary cash actually appears in the dealer's clearing account on that day, under the premise that the dealer will receive sufficient cash from other counterparties during the day in the course of settling other transactions. Meanwhile, the dealer has securities in its clearing account with a market value that is likely to be more than sufficient to cover any potential shortfall. This daylight overdraft privilege is based in part on the overnight settlement convention of the interbank loan market, by which one has met one's cash settlement obligations for a given day provided that the cash due is sent before the end of the business day. Interest is not typically calculated on the basis of intra-day balances, although daylight overdrafts are sometimes assessed a small proportional fee.[34] Abate (2009) estimates that the intraday peak level of overdrafts occurs at about 10am, and "easily exceeds several hundred billion dollars."

When a dealer's cash liquidity comes into doubt, however, its clearing bank could apply its "full right of offset," a legal right that is normally granted by clearing account holders, giving the clearing bank the right to offset against the account holder's cash balances its potential exposures to the account holder through other obligations. This gives the clearing bank the right to discontinue making cash payments that would re-

[34]In the U.S. interbank market, cash payments are settled by FedWire electronic transfer of federal funds from one bank's account with the Federal Reserve to another's. As far as the interest earned on its federal funds and its reserve requirements, what matters to a clearing bank on a given day is its federal funds balances as of 6:30pm Eastern. The Fed charges banks a small fee such as 15 basis points, for daylight overdrafts of federal funds. Clearing banks, in turn, may assess a similar fee to dealer's, although the clearing bank's overdraft in federal funds would typically be smaller than the sum of the overdrafts of its client dealers, given positive and negative dealer balances can be netted.

duce the account holder's cash balance below zero during the day, after accounting for such offsets. In the case of Lehman's default, for instance, it has been reported that Lehman's clearing bank, J.P. Morgan Chase, invoked this right, refusing to process Lehman's instructions to wire cash needed to settle Lehman's trades with its counterparties, relying on agreements by which J. P. Morgan had the right to offset Lehman's obligations across a range of repo, broker-dealer, and OTC derivatives activities.[35] Lehman was unable to meet its obligations on that day, and entered bankruptcy.

5 Conclusions and Policy Issues

The most obvious cause for the failure of a financial institution is an excess of liabilities relative to assets. Even in perfect markets, however, this is neither necessary nor sufficient for failure. The direct test of its ability to continue operating is whether the financial institution can meet its transactions obligations on a given day. A financial

[35]Dey and Fortson (2008) writes that "The giant American bank is alleged to have frozen $17 billion (£9.6 billion) of cash and securities belonging to Lehman on the Friday night before its failure." See, also, Teather (2008) and Craig and Sidel (2008). Sender (2009) reports that "In addition to serving as its clearing agent, J.P. Morgan was also Lehmans biggest counterparty on billions of dollars of derivatives trades. In such transactions, each side tots up its net exposure every night, demanding additional collateral when the amounts owed exceed a certain threshold. If Lehman defaulted, according to the agreements, the value at which these trades were automatically closed out was determined by J. P. Morgan. On August 26, J. P. Morgan reworked its existing credit agreements with Lehman so that the parent guaranteed the obligations of the broker-dealer and also provided collateral to secure that guarantee. ... Then, on September 4, J.P. Morgan was briefed on Lehmans upcoming earnings results and was told it expected to report a $4bn loss, according to people familiar with the matter. Five days later, J.P. Morgan signed another agreement with Lehman in which the Lehman parents guarantee covered not just its failing broker-dealer but all Lehman entities and covering all transactions, including the large book of derivatives trades. ... The creditors committee now alleges that J.P. Morgan had collected about $17bn in collateral from Lehman in the first two weeks of September 2008. A filing on behalf of unsecured creditors states that as of the Friday before the bankruptcy petition, the Lehman holding company had 'at least $17bn in excess assets in the form of cash and securities' that were held by J.P. Morgan and subsequently frozen by J.P. Morgan. 'JPMCs refusal to make those assets available to [Lehman] and its subsidiaries in the days leading up to the bankruptcy filing may have contributed to Lehmans liquidity constraints,' the filing claims."

institution whose liabilities[36] are significantly in excess of the market value of its assets can, in some cases, regain solvency over time. In imperfect markets, several types of frictions can lead to a failure of a dealer bank to meet the direct test of transactions solvency, whether or not its assets are in principle sufficient to cover its liabilities in an orderly liquidation of its balance sheet.

First, the forced sale of illiquid assets in order to meet one's cash obligations can generate additional losses. In addition to the price impact caused by sliding down the short-run demand curve of the pool of immediately available buyers, the liquidation values of assets can be further reduced by adverse selection. As explained by Akerlof (1970), the potential buyer, knowing less than the seller about the future asset cash flows, should offer a price so low that the buyer's informational disadvantage is not an issue. The same principle limits the bank's ability to raise cash by issuing debt or equity. As a mitigating factor, if the seller is known to be experiencing a liquidity crisis, the probability of adverse selection at a given price is lowered. In a financial crisis, however, the potential bidders who would normally be in the best position to make use of the assets are themselves likely to be in a cash constrained position, and may themselves wish to sell the same types of assets.

One of the policy objectives of the U.S. Treasury Department's 2008 Troubled Asset Relief Program (TARP), as instituted in the 2009 Public Private Investment Partnership (PPIP), is to mitigate the effect of adverse selection in the market for "toxic" assets held by banks, such as collateralized debt obligations backed by sub-prime mortgages. The PPIP, in effect, subsidizes bidders by offering below-market

[36]The market value of liabilities is not relevant to this test, of course, because of the limited liability of equity, which leaves the market value of liabilities always less than or equal to the market value of assets.

financing rates, with leverage, to investors in "toxic" assets, and by absorbing losses beyond a given level.

An alternative to raising cash from the outright sale of assets is to use assets as collateral for secured borrowing. As a bank's solvency prospects dim, however, the opportunity to obtain even secured financing is reduced. When a dealer experiences a liquidity crisis, it can be given discriminatory terms for haircuts and collateral pricing. The room for maneuvering through a liquidity crisis diminishes as the inventory of unpledged high quality collateral, such as treasury securities, is reduced. Eventually, the repo market can cease to provide the financing necessary to keep assets on the dealer bank's balance sheet. By this point, even a firesale of assets is unlikely to stave off failure. Bankruptcy can follow quickly, as it did for Lehman.

During the financial crisis, the United States Federal Reserve System and the Bank of England provided a range of new secured lending facilities as backstop sources of financing to large dealer banks, as explained by Tucker (2009). The European Central Bank's conventional repo operations continued to provide financing for a wide range of assets.

Short-term tri-party repos are a particularly unstable source of financing in the face of concerns over a dealer's solvency. Because tri-party clearing banks have an incentive to limit their exposures to a dealer bank through both repo and non-repo positions, they may have an incentive to limit the access of a weakened dealer bank to repo financing and to clearing account functions. Bernanke (2008) has pointed to the potential benefits of a tri-party repo "utility," which would have less discretion in rolling over a dealer's repo positions and fewer conflicting incentives. Operational controls

might be more cleanly monitored.[37] Whether with the advent of new repo utilities or with current tri-party clearing approaches, new standards could be established for the documentation of trades, for margin, and for the daily substitution of collateral that takes place over the course of term repos.

Abate (2009) mentions the potential for insurance of tri-party repo transactions, to be provided by the Federal Reserve. Another approach under discussion is an "emergency bank," financed by repo market participants, that could manage the orderly unwinds of repo positions of weakened dealers. The emergency bank would have access to discount-window financing from the central bank, and would insulate systemically-critical clearing banks from losses in the course of the unwinding process.

The separation of tri-party repo clearing from other clearing-account functions would likely reduce a dealer's cash-management flexibility, and thus lower its potential leverage under normal operating conditions. The maximum achievable leverage of a dealer bank is likely to be further reduced by recent or likely-to-be-enacted changes in regulatory capital requirements, including the capital required for off-balance-sheet entities. At least in Europe, banks sponsoring securitization deals will also be required to hold at least a minimum level of exposure to the securitized cash flows. Some degree of flexibility in the capital structure of a large financial institution might be recovered through forms of debt that, contingent on stipulated distress triggers, convert to equity.[38] This may mitigate moral hazard, costly and systemically disruptive asset firesales, and — after conversion — debt overhang.

[37] See also Bernanke (2009).

[38] Specific examples have been proposed by Flannery (2005) and by Squam Lake Working Group on Financial Regulation (2009).

Beyond the liquidity risks represented by its assets and liabilities, a large dealer bank's liquidity can be worsened by the flight of prime brokerage clients, and by various defensive actions by over-the-counter derivatives counterparties, who may rationally seek to reduce their exposures by cash-draining transactions, including new trades and novations to other dealers.

The threat posed by flight of OTC derivatives counterparties can be lowered by central clearing, which reduces the incentives of derivatives counterparties to run. A central clearing counterparty could, however, seek to reduce its own exposure to a weakened dealer. Sufficiently extensive clearing can nevertheless reduce the total exposure to the dealer that would need to be managed, through the effect of multilateral netting of positive against negative exposures that occurs with clearing, provided that clearing is sufficiently centralized, as explained by Duffie and Zhu (2009). Obviously, the financial strength of large central clearing counterparties is crucial, as is their implicit government backing.

Currently, the majority of OTC derivatives positions are not cleared. Even the recently established central clearing counterparties for credit default swaps (CDS) will not easily treat a large quantity of CDS positions that are not standard enough to be cleared. There are currently no plans for clearing significant quantities of OTC derivatives that are based on equities, commodities, and foreign exchange. Although a large quantity of interest-rate swaps are cleared, the majority are not. As mentioned, even exposures between central clearing counterparties and dealer banks need to be managed during a solvency crisis.

Large dealer banks are typically deemed "too big to fail." Although the various

new government facilities that appeared during the financial crisis of 2007-2009 may have prevented some extremely damaging failures, some of these facilities may turn out to be costly to taxpayers and are likely to increase moral hazard in the risk taking of large dealer banks going forward, absent other measures. Improvements in supervisory approaches and capital regulations are under way.

Mechanisms for the resolution of failing large dealer banks at the level of their holding companies are not yet effective in some important respects, as explained by Bliss (2003). Because of the financial crisis, new resolution mechanisms are likely to receive significant attention. The current approach to resolving traditional banks, through bridge banks and receiverships, may be extended to large bank holding companies and other systemically important financial institutions. AIG, a type of financial institution that is not within the scope of this study, is a prime example of a large financial institution that was judged too big to fail, and was extremely costly to resolve with only the methods available at the time. It is not clear, however, whether the proposed resolution mechanisms will effectively treat dealer banks with large amounts of overnight repo financing and with significant uncleared over-the-counter derivatives portfolios, which in any case are likely to remain outside of these new resolution schemes, for reasons explained by Bliss (2003) and Edwards and Morrison (2005).

References

Abate, Joseph, "Money Markets: Tri-party Repo Concerns," Barclays Capital, Research, US Economics & Rates, Strategy, March 12, 2009.

Akerlof, George, "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics*, 1970, *84* (3), 488–500. http://www.econ.ox.ac.uk/members/christopher.bowdler/akerlof.pdf.

Bank for International Settlements, "New Developments in Clearing and Settlement Arrangements for OTC Derivatives," technical report, Bank of International Settlements, March 2007. www.bis.org/publ/cpss77.htm.

_ , "OTC Derivatives Market Activity in the Second Half of 2008," BIS Monetary and Economic Department, Basel, May 2009. http://www.bis.org/publ/otc_hy0905.pdf.

Barr, Alistair, "Bear Stearns' Credit Hedge Funds Almost Wiped Out — Leveraged Fund Worth Nothing; 'Very Little Value' Left in Larger Fund, Letter Says," *MarketWatch*, July 18, 2007. http://www.marketwatch.com/story/bear-credit-hedge-funds-almost-wiped-out-sources-say.

_ , "Bear to Lend $3.2 Bln to One of its Hedge Funds — But Bank Doesn't Lend Money to Other, More Leveraged, Hedge Fund," *MarketWatch*, June 22, 2007. http://www.marketwatch.com/story/bear-to-lend-up-to-32-bln-to-troubled-hedge-fund-it-runs.

Bernanke, Ben, "Reducing Systemic Risk," Speech at Jackson Hole Conference August 2008. http://www.federalreserve.gov/newsevents/speech/bernanke20080822a.htm.

_ , "Financial Reform to Address Systemic Risk," Speech at the Council on Foreign Relations March 10 2009.

Bliss, Robert R., "Resolving Large Complex Financial Organizations," in George G. Kaufman, ed., *Market Discipline in Banking: Theory and Evidence*, Vol. 15, Amsterdam: Elsevier Press, 2003, pp. 3–31.

_ **and George G. Kaufman**, "U.S. Corporate and Bank Insolvency Regimes: An Economic Comparison and Evaluation," Working Paper WP-06-01, Federal Reserve Bank of Chicago, 2006.

_ **and Robert Steigerwald**, "Derivatives Clearing and Settlement: A Comparison of Central Counterparties and Alternative Structures," *Economic Perspectives*, 2006, *30* (4), 22–29. http://ssrn.com/abstract=948769.

Boot, Arnoud, Todd Milbourn, and Anjun Thakor, "Megamergers and Expanded Scope: Theories of Bank Size and Activity Diversity," *Journal of Banking and Finance*, 1999, *23* (2), 195–214. http://ideas.repec.org/a/eee/jbfina/v23y1999i2-4p195-214.html.

Brunnermeier, Markus K. and Lasse Heje Pedersen, "Market Liquidity and Funding Liquidity," *Review of Financial Studies*, December 2008, *22* (6), 2201–2238. http://www.princeton.edu/ markus/research/papers/liquidity.

Bulow, Jeremy and Paul Klemperer, "Reorganising the Banks: Focus on the Liabilities, Not the Assets," web comment, March 21, 2009. http://www.voxeu.org/index.php?q=node/3320.

Burroughs, Bryan, "Bringing Down Bear Stearns," *Vanity Fair*, August 2008, pp. 106–111.

Cassola, Nuno, Ali Hortacsu, and Jakub Kastl, "Effects of the Subprime Market Crisis on the Primary Market for Liquidity," Stanford Unviversity, Economics Department, Working Paper 2008.

CNBC, "Citigroup to Bail Out Internal Hedge Fund," CNBC.com, February 23, 2008. http://www.cnbc.com/id/23308202.

Cohan, William D., *House of Cards*, Doubleday, New York, 2009.

Craig, Susanne and Robin Sidel, "J.P. Morgan Made Dual Cash Demands," *Wall Street Journal*, October 8, 2008. http://online.wsj.com/article/SB122342716816213665.html.

Dey, Iain and Danny Fortson, "JP Morgan brought down Lehman Brothers," *The Sunday Times*, October 5, 2008. http://business.timesonline.co.uk/tol/business/industry_sectors/banking_and_finance/article4882281.ece.

Diamond, Douglas W. and Philip H. Dybvig, "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy*, 1983, *91* (3), 401–419.

Duffie, Darrell and Haoxiang Zhu, "Do Central Clearing Counterparties Reduce Counterparty Risk?," Stanford Unviversity, Graduate School of Business, Working Paper, March 2009.

Edwards, Franklin and Edward R. Morrison, "Derivatives and the Bankruptcy Code: Why the Special Treatment?," *Yale Journal on Regulation*, 2005, *22* (1), 91–122.

Ewerhart, Christian and Jens Tapking, "Repo Markets, Counterparty Risk, and the 2007 / 2008 Liquidity Crisis," Working Paper 909, European Central Bank 2008.

Farrell, Sean, "Hedge Funds with Billions Tied Up at Lehman Face Months of Uncertainty," *The Independent*, October 6, 2008. http://www.independent.co.uk/news/business/news/hedge-funds-with-billions-tied-up-at-lehman-face-months-of-uncertainty-952586.html.

Fisher, Peter, "Comments on Franklin Allen and Elena Carletti 'The Role of Liquidity in Financial Crises'," Jackson Hole Conference, August 2008. http://www.kc.frb.org/publicat/sympos/2008/fisher.09.01.08.pdf.

Flannery, Mark J., "No Pain, No Gain? Effecting Market Discipline via Reverse Convertible Debentures," in Hal S. Scott, ed., *Capital Adequacy Beyond Basel: Banking, Securities, and Insurance*, Oxford: Oxford University Press, 2005, pp. 171–196.

Geithner, Timothy, "Reducing Systemic Risk in a Dynamic Financial System," Speech, June 9, 2008. www.bis.org/review/r080612b.pdf.

Global Association of Central Counterparties, "Central Counterparty Default Management and the Collapse of Lehman Brothers," technical report, CCP12, The Global Association of Central Counterparties 2009.

Goldman Sachs, "Goldman Sachs and Various Investors Including C.V. Starr & Co., Inc., Perry Capital LLC and Eli Broad Invest $3 Billion in Global Equity Opportunities Fund," Goldman Sachs Press Release, August 13, 2007. http://www2.goldmansachs.com/our-firm/press/press-releases/archived/2007/2007-08-13.html.

Goldstein, Steve, "HSBC to Provide $35 Billion in Funding to SIVs — Citigroup Reportedly Under Pressure to Move Securities onto its Balance Sheet," *MarketWatch* November 27, 2007. http://www.marketwatch.com/story/hsbc-to-provide-35-billion-in-funds-to-structured-vehicles.

Gorton, Gary, "Slapped in the Face by the Invisible Hand: Banking and the Panic of 2007+," in "Federal Reserve Bank of Atlanta's 2009 Financial Markets Conference: Financial Innovations and Crisis" May 2009. http://www.frbatlanta.org/news/CONFEREN/09fmc/gorton.pdf.

Hills, Bob, David Rule, Sarah Parkinson, and Chris Young, "Central Counterparty Clearing Houses and Financial Stability," *Financial Stability Review, Bank of England*, June 1999, *6* (2), 122–134.

Hintz, Brad, Luke Montgomery, and Vincent Curotto, "U.S. Securities Industry: Prime Brokerage, A Rapidly Evolving Industry," Bernstein Research March 13, 2009.

Hordahl, Peter and Michael R King, "Developments in Repo Markets During the Financial Turmoil," *BIS Quarterly Review*, December 2008, pp. 37–52.

International Swaps and Derivatives Association, "User's Guide to the 2004 ISDA Novation Definitions," ISDA Technical Document, New York, 2004.

_ , "ISDA Margin Survey 2009," ISDA Technical Document, New York, 2009.

Jensen, Michael and William Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," *Journal of Financial Economics*, December 1976, *3* (4), 305–360.

Kanatas, George and Jianping Qi, "Integration of Lending and Underwriting: Implications of Scope Economies," *Journal of Finance*, June 2003, *58* (3), 1167–1191.

Kelly, Kate, "Fear, Rumors Touched Off Fatal Run on Bear Stearns," *Wall Street Journal*, May 28, 2008. http://s.wsj.net/article/SB121193290927324603.html.

King, Matt, "Are the Brokers Broken?," Technical Report, Citi, European Quantitative Credit Strategy and Analysis, October, 2008.

_ **, Michael Hampden-Turner, Peter Goves, and Hans Lorenzen**, "Where Should Hedge Funds Keep their Cash?," Citi, European Quantitative Credit Strategy and Analysis, September, 2008.

Ledrut, Elisabeth and Christian Upper, "Changing Post-Trading Arrangements for OTC Derivatives," *BIS Quarterly Review*, December 2007, pp. 83–95.

Lehman Bankruptcy Docket, "Notice of Debtors' Motion for an Order Pursuant to Sections 105 and 365 of the Bankruptcy Code to Establish Procedures for the Settlement or Assumption and Assignment of Prepetition Derivative Contracts Fed Seeks

End to Wall Street Lock on OTC Derivatives," Docket Number 1498, November 13, 2008.

_ , "Order Pursuant to Sections 105 and 365 of the Bankruptcy Code to Establish Procedures for the Settlement or Assumption and Assignment of Prepetition Derivative Contracts," Docket Number 2257, December 16, 2008.

Leising, Matthew, "Fed Seeks End to Wall Street Lock on OTC Derivatives," *Bloomberg.com*, May 6, 2009. http://www.bloomberg.com/apps/news?pid=20601087&sid=adyRr4PP035U.

Macey, Jonathan, "Are Bad Banks the Solution to a Banking Crisis?," unpublished paper, Cornell University, SNS Occasional Paper Number 82, 1999. http://ideas.repec.org/a/eee/jfinec/v54y1999i2p133-163.html.

Mackintosh, James, "Lehman Collapse Puts Prime Broker Model in Question," *Financial Times*, September 24, 2008. http://www.ft.com/cms/s/0/442f0b24-8a71-11dd-a76a-0000779fd18c.html.

Moyer, Liz, "Citigroup Goes It Alone To Rescue SIVs," *Forbes*, December 13, 2007. http://www.forbes.com/2007/12/13/citi-siv-bailout-markets-equity-cx_lm_1213markets47.html.

Securities and Exchange Commission, "Rule 15c3-3: Reserve Requirements for Margin Related to Security Futures Products," 17 CFR Parts 200 and 240 [Release No. 34-50295; File No. S7-34-02] RIN 3235-AI61 2002.

Sender, Henny, "Lehman Creditors in Fight to Recover Collateral," *Financial Times*, June 21, 2009. http://www.ft.com/cms/s/0/909ba63c-5e99-11de-91ad-00144feabdc0.html.

Singh, Manmohan and James Aitken, "Delveraging after Lehman — Evidence from Reduced Rehypothecation," unpublished, Working Paper WP/09, International Monetary Fund 2009.

Squam Lake Working Group on Financial Regulation, "An Expedited Resolution Mechanism for Distressed Financial Firms: Regulatory Hybrid Securities," Working Paper, Council on Foreign Relations, April 2009.

Teather, David, "Banking Crisis: Lehman Brothers: JP Morgan Accused over Bank's Downfall," *The Guardian*, October 6, 2008. http://www.guardian.co.uk/business/2008/oct/06/jpmorgan.lehmanbrothers.

Tucker, Paul, "The Repertoire of Official Sector Interventions in the Financial System: Last Resort Lending, Market-Making, and Capital," Speech Delivered to the Bank of Japan 2009 International Conference on Financial System and Monetary Policy: Implementation, Bank of Japan, May 27-28, Tokyo 2009.

UBS, "Shareholder Report on UBS's Writedowns," UBS, Zurich April 18, 2008.

United States Treasury Department, "Resolution Authority for Systemically Significant Financial Companies Act of 2009," U.S. Treasury Department, 2009.

Wall, Larry D., Ellis W. Tallman, and Peter A. Abken, "The Impact of a Dealer's Failure on OTC Derivatives Market Liquidity During Volatile Periods," Working Paper 96-6, Federal Reserve Bank of Atlanta, 1996.

Yavorsky, Alexander, "Credit Default Swaps: Market, Systemic, and Individual Firm Risks," Special Comment, Moodys Investor Services October 29, 2008.

_ , "Credit Default Swaps: Market, Systemic, and Individual Firm Risks in Practice," Moodys Finance and Securities, Investor Report, Special Comment, Moodys Investor Services, October 2008.