

## A Map of Funding Durability and Risk

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# A Map of Funding Durability and Risk

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## ALL COMMENTS WELCOME

### Abstract

The dynamics of the financial system and the undercurrents of its vulnerabilities rest on the flow of funding. Analysts typically represent these dynamics as a network with banks and financial entities as the nodes and the funding links as the edges. This paper focuses instead on the funding operations within the nodes, in particular those within Bank/Dealers, adding a critical level of detail about potential funding risks. We present a funding map to illustrate the primary business activities and funding sources of a typical Bank/Dealer. We use that map to trace the paths of risk through four specific financial institutions during historical crises and to identify gaps in data needed for financial stability monitoring. We also introduce the concept of “funding durability,” defined as the effective term of funding in the face of signaling and reputational considerations during periods of stress. Using these tools, the paper highlights the points of potential durability mismatch and resulting funding risks within the Bank/Dealer. It also provides insight into how funding weaknesses can pass from one institution to another and ultimately affect financial stability.<sup>1</sup>

### Keywords:

Collateral, funding liquidity, repo, funding map, funding mismatch, financial stability.

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<sup>1</sup>This paper originated with the Financial Research Advisory Committee (FRAC) of the Office of Financial Research, which recommended that the OFR develop a funding map to “depict the flow of funds among market participants, their inter-linkages, and potential pressure points for key sectors of financial markets” and provided a prototype of this map. Co-author Thomas Wipf is a member of FRAC’s Liquidity and Funding Working Group. All three authors wish to acknowledge the work of the other Liquidity and Funding Working Group members, Ben Golub, Andrew Kuritzkes, and Caryl Athanasiu. We wish to thank Tobias Adrian, Viktoria Baklanova, and Greg Feldberg for helpful comments.

## 1. Introduction

Economic systems are built on interdependencies where funding flows and the related credit and counterparty relationships occur in a complex network involving many diverse institutions. Stresses to one part of the system can spread to others, in an extreme case resulting in a threat to financial stability. Failures from the recent economic crisis — the seizing up of short-term funding in Bear Stearns & Co., the counterparty exposures laid bare in the face of the near-bankruptcy of American International Group, Inc., and the propagation of the fallout from the Lehman Brothers bankruptcy — illustrate the critical need for a fundamental understanding of the structure and dynamics of funding flows and related collateral flows.

In this paper we present a map of funding flows coming into and out of a typical Bank/Dealer (see Figure 1 on Page 5). For the flows of secured funding, it also marks the path of collateral and securities in the opposite direction. The map is descriptive, and is intended to provide a schematic for more detailed modeling of the funding network. For example, the Office of Financial Research (OFR) is applying the funding map in the design of an agent-based model to assess financial vulnerabilities (see OFR, 2013, pages 48-49, and Bookstaber, 2012). The map also can be useful in assessing data needs in depicting the critical flows throughout the financial system.

The funding map shows the path of funding from the key funding sources, such as money market funds, pension funds and corporate treasurers, through the Bank/Dealer to the users of that funding. Flows are not simply shuffled from one institution to another; they are transformed in various ways, and the Bank/Dealers are integral to these transformations. There are maturity transformations, the standard banking function of taking short-term deposits and making longer-maturity loans, and credit transformations, where less creditworthy institutions such as hedge funds access funding sources through intermediary firms with a higher credit standing, such as Bank/Dealers. Other transformations include liquidity transformations, where less liquid assets such as mortgages are structured into debt instruments with liquid tranches, and risk transformations, where the return distribution of assets is changed, for example by using derivatives.<sup>2</sup>

Funding provides the fuel for these transformations. For that reason, the possible loss of funding under stress is a dominant risk to the Bank/Dealer's ability to create or intermediate these transformations.

This paper uses the funding map to introduce the concept and importance of “funding durability,” defined as the effective term of funding in the face of signaling and reputational considerations during periods of stress. When the loans and commitments that the Bank/Dealer makes are more durable than the funding sources used to finance them, there is the risk of a funding shortfall. This can lead to a forced sale of assets – the genesis of an asset-based fire sale, or a sharp pull-back in funding leading to a funding-based fire sale as those downstream must find alternatives for their reduced funding capacity. Without understanding this process of transformations and the implications for funding, an analysis of systemic risk is seeing a snapshot rather than the dynamics of the process.

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<sup>2</sup> A description of some of these transformations in the context of the shadow banking system is presented in Adrian and Ashcraft (2012) and in Pozsar et al. (2010). Berger and Bouwman (2009) look at the related roles of risk and liquidity transformation.

The mismatch of funding for financial market participants is a topic of broadening interest since 2008 for regulators developing metrics to monitor liquidity and for academic work on measuring liquidity mismatch.<sup>3</sup> But during periods of stress, the degree of mismatch might differ from what is apparent based on the term of assets and liabilities because the effective term of funding can differ from its contractual term. A Bank/Dealer could be reticent to withdraw funding because doing so might signal weakness, or might affect its business franchise. For the same reasons, the Bank/Dealer could find itself allowing some sources of funding to be negotiated away before the end of their contractual term. The concept of durability seeks to address these issues.

## 2. The Components of the Funding Map

The dynamics and vulnerabilities of the financial system rest on the flows of funding on the one hand, and of securities and their derivatives on the other. These flows are typically represented as a network with financial entities such as banks as the nodes and funding linkages as the edges. In contrast, the funding map in Figure 1 is a graphical balance sheet view of the primary business activities and funding sources of a single financial institution – a large, hypothetical U.S. Bank/Dealer. It can highlight key risks associated with these activities and funding sources, providing key insight into potential weaknesses that could affect overall market financial stability. And, importantly, the funding map is the stepping stone for the concept of durability that is discussed in the subsequent section of this paper.

The funding map shows the flows of funding and securities from the Bank/Dealer’s primary business activities and funding sources, as well as showing the flows between functional units within the Bank/Dealer. Because flows come into the Bank/Dealer, an extended version of the funding map can encompass the broader banking community and the detailed relationships common to many network-oriented papers on bank interactions.

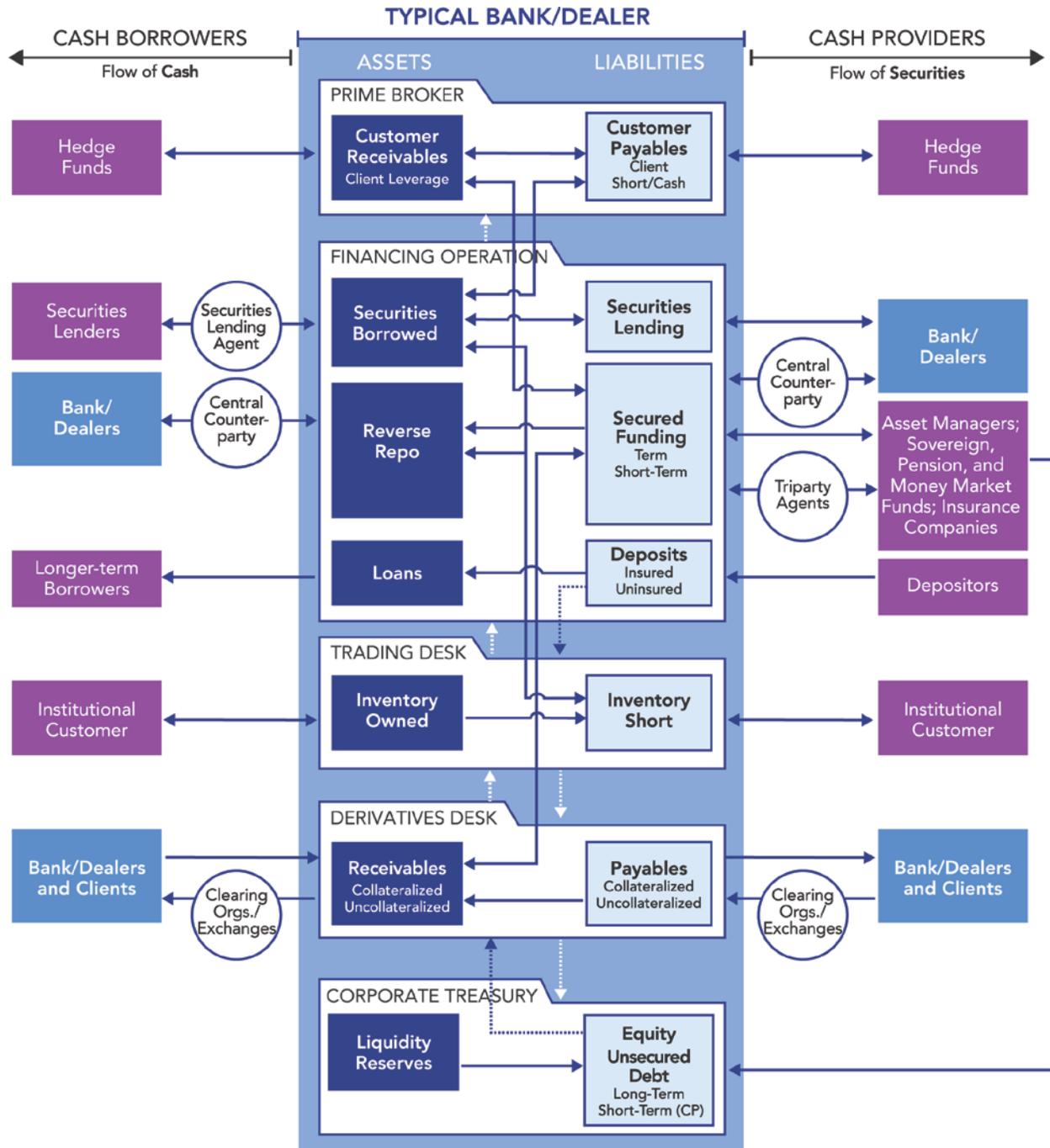
Figure 1 contains more detail than other network analyses in at least two respects.

First, the funding map depicted here provides detail into the internal workings of a Bank/Dealer. It shows how funding and securities move among key elements of the bank: the Prime Broker, which interacts with customers such as hedge funds; the Trading Desk, which provides market-making for customers and hedging for internal risks; the Derivatives Desk; and the Corporate Treasury of the Bank/Dealer, which provides the equity and debt issuance. At the center, where all roads seem to lead, is the Bank/Dealer’s Financing Operation. This is where securities purchased or received from counterparties as collateral are rehypothecated as collateral to obtain funding through the repurchase (repo) market, and where securities are obtained through reverse repo and securities lending transactions to fulfill short requirements, provide financing to clients, or for other internal Bank/Dealer needs (e.g., liquidity investment).

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<sup>3</sup> For the recent regulatory focus on funding liquidity, see Bank for International Settlements (2013). Recent work on evaluating and measuring the risk of liquidity mismatch is presented in Acharya and Rosa (2013), Bai et al. (2014), Banerjee (2012), and Brunnermeier et al. (2012).

Figure 1. Funding Map for a Typical Bank/Dealer



Second, the funding map provides more detail about the nature of the Bank/Dealer's relationships with its customers with respect to sources and uses of funding and securities. The map shows the Bank/Dealer operating within the interbank market, the standard relationship in most network approaches to the financial system, and in a broader financial landscape that includes money market funds, pension funds, hedge funds, and others. The Bank/Dealer obtains securities to lend to clients and to cover exposures in its own trading operations through many of these same parties. The Bank/Dealer is also connected to other entities in its role of providing funding and securities, often to the same types of entities that provide its funding and securities.

The funding map provides a detailed view of the business activities performed by financial market participants with a directional display of the exchange of cash or securities, a representation of the durability of funding sources, and the illumination of the stress triggers and amplifiers of funding-related risks between participants. The objective is to create a funding map that will provide a comprehensive view and understanding of the funding risks within the financial market as a whole and the potential for contagion given the interrelationship of participants.

The funding map is implicitly a collateral map as well. In the case of secured funding, the pathways are two-way streets: when there is funding in one direction, there is a flow of collateral in the other direction, depicted on Figure 1 with connecting lines that have arrows on both ends. One-directional flows of cash or securities are shown on Figure 1 with connecting lines that have arrows only on the left or right, respectively.

## **Bank/Dealer Activities**

The Bank/Dealer shown in the center column of Figure 1 can be thought of as a production plant. Its internal processing facilities include a Prime Broker, Financing Operation, Trading Desk, Derivatives Desk, and the Bank/Dealer's Corporate Treasury. Entities in the other two columns of Figure 1 provide production inputs that are transformed within the Bank/Dealer's various functional units and passed through to consumers of the output.<sup>4</sup>

### ***Prime Broker***

The Bank/Dealer's Prime Broker provides financial services to hedge funds, including leverage through margin loans and securities for short-selling activity. A hedge fund looking for securities to cover its short positions will provide cash to the Prime Broker to source these securities. The Prime Broker is an intermediary between two functions of the hedge fund: its need for financing to leverage its long positions, and its need for borrowing securities for short positions (and in the process providing cash to the Prime Broker). The Bank/Dealer will source the securities through its stock loan desk as collateralized borrowing or will use its own or clients' long positions. A hedge fund looking for leverage provides securities to the Prime Broker to borrow cash on margin. The Bank/Dealer can finance margin loans by rehypothecating the securities in the repo market using other Prime Broker clients' free credits (cash) as funding, or using the securities to cover other clients' short positions.

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<sup>4</sup> The production process analogy is employed by Bookstaber et al. (2014) in applying signed directional graphs, a tool used in chemical plants to explore paths within the plant that can lead to compounding or run-away risks, to a financial system process like that illustrated in Figure 1.

### ***Financing Operation***

The Bank/Dealer's Financing Operation includes secured funding, which is cash borrowed with securities used as collateral. Secured financing is used to fund securities owned by the Bank/Dealer as well as rehypothecatable securities received as collateral from clients.

The Financing Operation also takes an intermediary role in providing clients financing by reversing its collateral from clients and sourcing funding through the repo market. These client financing transactions are typically referred to as the matched book. Through this function, the Bank/Dealer uses its access to secured funding to provide leverage to clients primarily for fixed income products, filling the role that the Prime Broker does for equities.

In securities lending transactions, the lender receives cash or securities from the Bank/Dealer in exchange for lending its securities. This transaction may provide financing to the lender, but it is primarily executed to fulfill the Bank/Dealer's need for securities.

Another primary financing function of the Bank/Dealer is to provide credit to the community through institutional and retail loans. Most funding for this type of activity is from retail and institutional deposits.

### ***Trading Desk***

The Bank/Dealer's Trading Desk manages inventory in its market-making activities, the bulk of which is financed through secured funding. The Trading Desk's inventory includes long exposure from purchasing securities, and short exposures from selling securities. Short positions are covered by borrowing securities from securities lenders, Bank/Dealers or central counterparties). Trading activity also includes repackaging inventory as securitized products.

### ***Derivatives Desk***

The Bank/Dealer's Derivatives Desk executes derivative transactions for itself and for clients to hedge or reduce risk in an underlying position. Derivatives include products such as futures, forwards, swaps, and options. Underlying assets are primarily commodities, interest rates, currencies, stocks, and bonds. Derivatives can be cleared through exchanges or executed bilaterally.<sup>5</sup> Exposure from bilateral derivative trades can be collateralized or uncollateralized according to terms agreed upon by the counterparties.<sup>6</sup> When derivative transactions are collateralized, payable Bank/Dealer exposures require posting collateral to the bilateral counterparty or CCP (and vice versa for receivable exposures).

### ***Corporate Treasury***

The Bank/Dealer's Corporate Treasury raises longer-term unsecured funding by issuing equity and debt, and can also include short-term funding such as commercial paper. Equity provides the capital

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<sup>5</sup> Recent regulation will require that certain products be mandatorily cleared. Mandatory clearing of derivatives will reduce the amount of activity that can continue to be executed bilaterally and therefore any sub-portion that is uncollateralized.

<sup>6</sup> Uncollateralized derivatives transactions require unsecured funding if there is a net receivable position (i.e., derivative uncollateralized receivable mark-to-market positions are larger than derivative uncollateralized payable mark-to-market positions). If uncollateralized derivatives transactions are a net payable position, then there is no unsecured funding requirement (i.e., derivative uncollateralized payable mark-to-market positions are larger than derivative uncollateralized receivable mark-to-market positions).

base for all funding operations, and the equity and unsecured debt are used to fund assets that are difficult to fund by secured funding sources. On the other hand, commercial paper is less durable because it typically has less than 270 days to maturity, and when a firm is under stress it might not be able to reissue commercial paper as existing debt matures. Additionally, the Bank/Dealer may need to buy back commercial paper from investors to avoid a negative signal to the market.

## **Suppliers and Demanders of Funding**

The funding map in Figure 1 shows the connections of a typical Bank/Dealer to various types of financial institutions. The map has more detail than most network depictions because it shows the specific functional areas within the Bank/Dealer where the connections occur:

### ***Hedge Funds***

Hedge funds seek leverage and securities from the Bank/Dealer's Prime Broker or Financing Desk to support their long and short trading positions.

### ***Other Bank/Dealers***

The Bank/Dealer at the center of the funding map has pathways through both cash and securities funding to other Bank/Dealers. The pathways lead to various functional areas in other banks, most notably through derivatives and trading functions. Some indirect connections between Bank/Dealers also are significant as paths of contagion and propagation. For example, a hedge fund will often have a Prime Broker relationship with two or more Bank/Dealers, and a shock that initially affects the hedge fund and one of its Prime Brokers can spill over to the Prime Broker arm of its other relationships.

### ***Cash Providers***

Cash providers to a Bank/Dealer include asset managers, pension funds, insurance companies, securities lenders (which receive cash from lending securities), and most importantly, money market funds. Money market funds are not a source of durable funding because for liquid funding they are limited in the term of their secured funding under the Securities and Exchange Commission's regulation 2a-7.<sup>7</sup> Also, during a stress event, money market fund investors may redeem their shares, requiring the money market fund to liquidate its investments.

### ***Securities Lenders***

Like the cash providers, securities lenders provide the Bank/Dealer with securities and funding. Large securities lenders often interact with Bank/Dealers in both capacities: lending securities to the Bank/Dealer and reinvesting cash in the form of secured funding provided to the Bank/Dealer.

### ***Institutional Customers***

Institutional customers use the Bank/Dealer's market-making function. The customers encompass a wide swath of institutions ranging from asset managers and hedge funds to pension funds, corporations, sovereign wealth funds, and insurance companies.

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<sup>7</sup> This in particular is due to the seven-day put which keeps the repo out of the illiquid securities category, and 2a-7 funds can only invest 5 percent of their portfolios in trades that are illiquid. Illiquid is defined as "any security that cannot be sold or disposed of within seven days at carrying value."

### ***Intermediaries***

The funding map also depicts key funding intermediaries. These include triparty agents like Bank of New York Mellon Corporation, JPMorgan Chase & Co., and Euroclear plc; repo central counterparties like Fixed Income Clearing Corporation, LCH.Clearnet Group Limited and Eurex Repo; and Clearing Exchanges like CME Group Inc., IntercontinentalExchange Group, Inc., and Eurex Clearing.

Figure 1 shows the Bank/Dealer's various functions that rely on funding flows and highlights how collateral moves in the opposite direction of the funding flows for secured funding sources.

Although the focus of this paper is on the flow of funds and the counter flows of collateral through a typical Bank/Dealer, the funding map also gives us a template for understanding the key functions of the Bank/Dealer as an intermediary. The transformations the Bank/Dealer performs in its intermediary role affect flows and the feedback dynamics. Examples of these transformations by a Bank/Dealer include:

- transforming short-term deposits into long-term loans;
- transforming safe money market holdings into risky investments by hedge funds and other asset managers;
- transforming collateral and risky borrowing into safe holdings by money market funds;
- transforming less liquid assets and capital into liquid and readily tradable flows through its trading unit; and
- transforming market assets into tranches of assets that have specific risk and credit characteristics through its structured products desk.

### **3. The Durability of Funding**

The funding map provides more detail into the sources and uses of funds than a balance sheet view of the same Bank/Dealer. This detail is important because it shows the building blocks for determining stability during a funding event and how funding terms can change. Durability is introduced to address the fact that during a stress event the sources of funding will experience behavioral changes that can affect the previously assumed length of funding. Similarly, the uses of such funding (i.e., Bank/Dealer's assets) may observe the opposite effect and become more lasting.

For example, Bank/Dealers make markets in their commercial paper and even if the contract term for a particular commercial paper issue is 120 days, if a customer decides to sell the commercial paper a Bank/Dealer may be pressured to take it back onto its books, reducing its funding liquidity. The investor has an incentive to sell the paper when the credit of a Bank/Dealer has deteriorated or when there is a broader liquidity shortage. The Bank/Dealer has an incentive to buy back its own debt to protect its franchise and reputation, despite reducing its liquidity in a time of stress. Furthermore, a Bank/Dealer's failure to buy back the commercial paper could signal weakness that will accentuate any funding issues it is facing. The same reputational and signaling issues mean uncollateralized derivatives payables can have an effective term substantially lower than the contractual term during a period of stress because counterparties might ask a Bank/Dealer to

collateralize those payables. To further exacerbate the issue, most derivative contracts have credit-rating downgrade triggers which may be set off by an idiosyncratic or systemic credit stress. These triggers force a Bank/Dealer to post more margin to a derivative contract's counterparty, creating a liquidity outflow that negates funding previously provided by an uncollateralized derivative payable.

Conversely, a stress event gives some assets a longer effective term than their contractual term. For instance, the term of a Bank/Dealer's Prime Broker margin loans might be longer than contractually determined because the Bank/Dealer would face franchise and signaling risks if it stopped lending to its clients. Similarly, if a Bank/Dealer is providing financing to clients via securities financing transactions, the Bank/Dealer would put both its reputation and the market at risk by propagating the funding stress to its clients.

The differences between the contractual and effective term of assets and liabilities support the need for a measure of Bank/Dealer durability that is not strictly contractual. A Bank/Dealer's durability should be assessed after applying behavioral assumptions to both assets and liabilities. These assumptions adjust the various funding sources and assets from contractual term to effective term, as shown in Figure 2.

Durability reflects the business fact that an apparent match between assets and liabilities might no longer exist in a stress event. In practice, durability can be measured as the number of days a Bank/Dealer can withstand during a crisis without having to sell or unwind its assets. In other words, durability determines how long a Bank/Dealer can remain independently solvent without reducing assets that would create broader market stress. This measure will depend heavily on the assumptions determining how much the effective term of its various funding sources will compress and how much the effective term of its funding uses will extend during a stress event. These assumptions can be made explicit either at the firm or the regulatory level so that durability becomes a measure that is calculated regularly, similar to other stress tests.

Figure 2 illustrates how determining the effective term of some assets and liabilities requires behavioral assumptions. Similar to other liquidity standards, regulators would need to determine the specific behavioral assumption to apply to each line item.

Liquidity standards under the Basel III international banking accord are based on predetermined timeframes, which establish the liquidity or funding horizon that banks must meet under certain assumptions. The liquidity coverage ratio (LCR) addresses net liquidity outflows over 30 days, while the net stable funding ratio (NSFR) proposes to capture adequate stable funding of greater than one year (and in some instances assigns partial benefit to less than one-year funding). Both start with specific timeframes and show if a Bank/Dealer can pass the 100 percent ratio or not.

In contrast, our proposed durability measure provides a bridge between the Basel III liquidity ratio timeframes. Applying predetermined assumptions on the effective term of assets and liabilities will result in a timeframe as the output. This timeline could then be compared across Bank/Dealers to assess the amount of time each could maintain its current asset and liability mix during a stress event. In effect, the durability measure would quantify the amount of time after the stress event before there is a potential market impact from a large Bank/Dealer deleveraging by selling or unwinding assets.

**Figure 2. Durability and Contractual Term versus Effective Term**

Assets	Behavioral/Contractual	Behavioral Assumption	Liabilities	Behavioral / Contractual	Behavioral Assumption
<b>Prime Brokerage Customer Receivables</b>			<b>Prime Brokerage Customer Payables</b>		
Margin Loans	Behavioral Assumption	Assume margin loans provided to clients continue to be renewed	Client Shorts	Behavioral Assumption	Moderate risk of short positions moving to another Prime Broker
			Client Cash	Behavioral Assumption	Large withdrawal risk
<b>Securities Borrowed</b>	Behavioral Assumption	Risk of reduced willingness to lend securities to bank/dealer	<b>Securities Lending</b>	Contractual	
<b>Reverse Repo</b>	Behavioral Assumption	Assume client financing trades for non-high quality assets continue to roll <sup>1</sup>	<b>Secured Funding</b>	Contractual	
<b>Loans</b>			<b>Deposits</b>		
Unfunded	Behavioral Assumption	Risk of borrower drawing on the commitment	Uninsured, not term	Behavioral Assumption	Large withdrawal risk
Funded	Contractual		Uninsured, term	Contractual	
			Insured	Behavioral Assumption	Smaller withdrawal risk
<b>Inventory Owned</b>	Behavioral Assumption	Assume non-high quality assets can not be sold <sup>1</sup>	<b>Shorts</b>	n/a	
			<b>Derivative Payables</b>		
<b>Derivative Receivables</b>	Contractual		Collateralized	Contractual / Behavioral	Risk of clients closing out trades at their side of the market, based on contractual ATE rights upon credit downgrade
			Uncollateralized	Contractual / Behavioral	Same as above, plus risk of clients requesting bank/dealer to collateralize the payable exposure
			<b>Unsecured Debt</b>		
<b>Liquidity Reserves</b>	Contractual		Commercial Paper	Behavioral Assumption	Large buyback risk
			Long-term Debt	Contractual / Behavioral	Smaller buyback risk
			<b>Equity</b>	n/a	

1. Can assume Basel HQLA as guidance for what assets are considered "high quality"

Durability represents the stability of funding from a given source based on the term of the loan and its contractual basis and the liquidity of the asset being funded, its implications for franchise and signaling, and its sensitivity to mark-to-market accounting risk. The most durable of all funding sources is equity because it has no maturity date and a Bank/Dealer has no contractual obligation to return the funding. Long-term debt can be a durable source of funding though certain debt can be issued with call provisions tied to the credit of a Bank/Dealer, which reduce durability. Unsecured debt becomes more durable with greater liquidity; an active secondary market allows the lenders to exit their exposure without depending on the borrower to buy the issue back. Another form of unsecured funding is deposits, which usually do not have a contractual term and can be withdrawn at any time; their durability may vary markedly in a stress scenario based on whether deposits are protected by an organization such as the Federal Deposit Insurance Corporation.

As mentioned above, some sources of funding have no explicit term, but are nonetheless not durable. An example that featured prominently in the collapse of Bear Stearns is the customer payables in a Bank/Dealer's Prime Broker. When a Bank/Dealer's clients take short positions, they post cash to its Prime Broker. This cash can be used to finance other Bank/Dealer activities, typically to fund leverage on the other side of the Prime Broker's ledger (i.e. the prime broker receivables). But cash provided by clients' short positions and their free cash held by the Prime Broker is not durable because clients can quickly withdraw their cash and either close out or move their short positions to accounts at other Bank/Dealers. Indeed, it is now typical for hedge funds to use multiple prime brokers to mitigate against this risk. Making this more problematic is that many clients may have both long and short positions, which means they can reduce funding to the

Bank/Dealer by withdrawing their short positions while maintaining long positions financed through margin loans by the Bank/Dealer.

A general description of the hierarchy of funding durability is in Figure 3, with more durable funding sources in green and less durable in red. More durable funding extends from equity and long-term unsecured debt, which provide the longest funding (typically five years or greater) and can be used to fund illiquid assets on the balance sheet, to term-secured funding, which is shorter in tenor (typically less than one year) but can still provide appropriate term funding for securities.

Less durable funding includes short-term unsecured funding such as commercial paper (usually less than one year in tenor) and short-term secured funding (less than one month in tenor). Secured funding from money market funds falls into this category because SEC regulation 2a-7 limits these funds to providing secured funding for a maximum of seven days. Other less durable funding sources are uncollateralized derivatives payables, which can suddenly decrease given market movements or can require collateralization in times of stress, and uninsured deposits, which are likely to be withdrawn from an institution in distress. Another factor affecting secured funding is the likelihood that investors request additional collateral in the event of collateral devaluation or dealer distress. Investors are contractually locked into the original haircut or discount at which an asset was pledged as collateral, but both parties may agree to raise the haircut during the life of the trade.

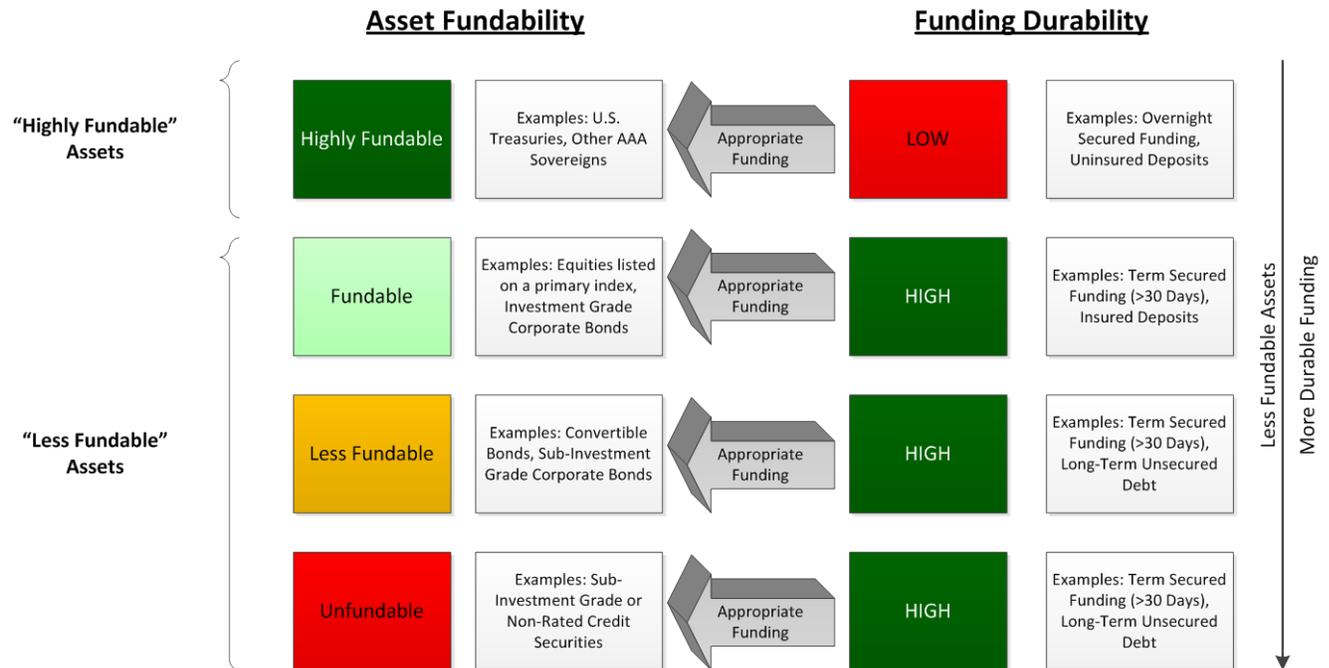
The importance of durability is a constant undercurrent in our funding map. One function of the map is to help detect points where a mismatch between the durability of funding and the fundability of assets creates risk for the network. If certain assets are harder to fund in a normal environment, they should be funded with more durable sources to prepare for stressed market environments when credit is scarcer. The fundability of an asset can be measured by the number of counterparties willing to accept the asset as collateral or by the level of margin (haircut) requested on the collateral. If less durable funding is used to fund an asset that is difficult to fund in normal environments, there is a risk that funding might be pulled away in a stressed environment while the exposure that is being funded remains. What is more concerning is that funding will tend to disappear at times when a Bank/Dealer finds itself in financial distress and needs the funding the most, draining its liquidity and potentially leading to inventory fire sales. The Bank/Dealer will then find itself searching for replacement funding for clients' long positions – most likely its own liquidity.

**Figure 3. Funding Durability**

<b>More Durable</b>	<b>Equity</b>	Equity investors provide the most durable source of funding. Equity has no contractual term and is actively traded in the secondary markets.
	<b>Long-Term Unsecured Debt</b>	Long-term unsecured debt is a durable source of funding as investors provide generally 5 to 10-year cash and have the ability to trade debt on the secondary market.
	<b>Term Secured Funding</b>	Secured funding with longer term for less liquid securities is a durable source of funding, depending on tenor. In the event that the borrower enters bankruptcy, the lender has the right to monetize the collateral, which includes a haircut to protect against market value deterioration.
	<b>Insured Deposits</b>	Low likelihood of deposits being withdrawn in a stress event if they are insured by a deposit insurance organization, such as the FDIC.
<b>Less Durable</b>	<b>Unsecured Short-Term Funding (e.g., Commercial Paper)</b>	Commercial Paper, with normally less than 270 days in term, is a less durable source of funding, given the credit sensitivity to the borrower. In a stress event, maturities may not be able to be replaced with new issuances. Additionally, there is the risk that the borrower may have to buy back the debt from investors to avoid the risk of negative signaling to the market.
	<b>Short-Term Secured Funding</b>	Secured funding trades for less liquid assets are less likely to roll in a stress event and therefore should be longer in tenor. Thus, money market funds should not be relied upon as providers of secured funding for less liquid assets, since under SEC rule 2a-7 they are limited to providing a maximum of 7-day secured funding.
	<b>Uncollateralized Derivatives Payables</b>	Uncollateralized derivatives payables are a less durable source of funding because the mark-to-market payable exposure can decrease based on external economic factors (e.g., a change in interest rates). Additionally, the counterparty can request to novate or terminate the trade early in certain situations (e.g., the legal agreement between both parties includes a credit rating trigger), requiring the Bank/Dealer to settle the payment prior to maturity.
	<b>Uninsured Deposits</b>	High risk that deposits are withdrawn in the event of a stress if they are not insured by a deposit insurance organization, such as the FDIC.
	<b>Prime Brokerage Client Shorts</b>	In the event of a stress, clients with short positions may move their account to another Prime Broker. Durability is difficult to predict, as a single client may also have a combination of short and long positions.
	<b>Prime Brokerage Free Credits (i.e., excess cash)</b>	Unreliable funding source in the event of a stress, as clients are likely to withdraw any available cash in their Prime Brokerage accounts.

Figure 4 highlights the implications of durability for securities financing. It shows less durable funding should be used for more fundable securities that are either highly liquid – and likely to remain liquid in a credit or market dislocation – or where the term of the asset is similar to that implied by the durability of the funding. On that basis, funding with low durability should be limited to securities such as U.S. Treasuries and other top-quality sovereign debt, while only highly durable funding should be used for illiquid securities such as sub-investment grade asset-backed securities and longer-term, illiquid obligations. The funding map can be used to monitor the risk of funding flows by examining each node to determine if the durability of the funding inflows is appropriate for funding the assets and obligations residing in that node.

**Figure 4. Asset Fundability vs. Funding Durability**



#### 4. Assessing Vulnerabilities

Systemic events generally occur in two forms. Asset-based fire sales occur when a stress on a sector of the market depreciates asset values and owners of these assets are forced to sell. Funding-based fire sales, or funding runs, occur when funding is reduced to a leveraged entity, forcing it to reduce its loans or sell its assets. If the leveraged entity relied on less durable funding, then it must draw down liquidity to service its debt. This reduces the entity’s creditworthiness, leading to further reductions in funding and liquidity. If the entity defaults, creditors holding collateral from the defaulted entity will hold a fire sale to recover cash they were owed. As with an asset-based fire sale, there is often contagion to healthy institutions.<sup>8</sup>

It is difficult to anticipate the shocks to the system that may trigger fire sales and funding runs, but we can assess points of vulnerability to possible shocks. These include sizable durability mismatches; a constriction in funding flows that will have large downstream effects; collateral and credit sensitivity that may fuel contagion; and structural vulnerabilities such as capacity limitations.

The funding map can assist in this task. Taking a processing plant analogy, it shows flows of different types, quality, and durability running through the pipes of the financial system. The funding map illustrates how a Bank/Dealer’s production facilities on the funding side provide

<sup>8</sup> Models of these dynamics are discussed in Shleifer and Vishny (2011), Brunnermeier and Pedersen (2009), and Fostel and Geanakoplos (2008), Adrian and Boyarchenko (2013), and Gorton (2010).

different grades of inputs, and how the securities side produces different grades of product measured by liquidity, funding, and risk transformations.

The funding map is a valuable resource for understanding the routes to a financial crisis because the bank's interactions with its customers and funding sources are the pathways to the broader risk dynamics in the financial system. For example, the path between hedge funds and a Prime Broker are critical to fire sales. The paths connecting cash providers to a Bank/Dealer's Financing Operation and commercial paper, and from hedge funds to the Prime Broker receivables of a Bank/Dealer, are critical to understanding credit events and funding runs. The funding map identifies funding sources, potential stress points, and risk amplifiers within the bank and through the bank's interaction with its funding sources and customers.

In general, any negative change in a borrower's credit standing or a decline in its credit rating brings into question the borrower's ability to repay debt. This change primarily affects the borrower's ability to borrow unsecured cash. However, changes in a borrower's creditworthiness may also affect its ability to raise secured cash if the lender does not feel comfortable with the quality and amount of collateral securing the loan. Changes in a firm's credit rating may also trigger an obligation to post cash to derivative counterparties or allow these counterparties to terminate their trades at their side of the market.

The collateral in a secured debt transaction is intended to limit a lender's exposure to a borrower's credit risk. The amount of collateral received by the lender includes a haircut based on the quality of the collateral, which protects the lender if the borrower defaults. If there is a market or product-specific stress, lenders of secured debt may believe the collateral they hold is insufficient to make them whole because of price deterioration in the collateral. This may trigger lenders to request more collateral, or cause them to halt lending altogether. Haircuts can vary depending on the borrower's credit, which makes it more likely for a lender to feel uncollateralized if the borrower is experiencing credit issues. Collateral quality is an important component to secured transactions. Credit and liquidity stress events usually lead to a flight to quality, as investors seek to hold high quality collateral. This, in turn, means investors who have extended debt against lower quality collateral or collateral that has recently deteriorated in value may no longer feel comfortable lending against this type of asset. However, the level of haircut and credit standing of the borrower will also play a role.

The risks for each of the Bank/Dealer's functions, its customers, and its funders are described in the examples below.<sup>9</sup>

### **Prime Broker**

By obtaining a margin loan, a hedge fund is exposed to the credit and funding durability of the Prime Broker within the Bank/Dealer. If that Prime Broker relies heavily on other clients' cash or short positions as well as short-term repo, then the Prime Broker's funding sources are at risk and therefore, so are the loans it is extending.

Conversely, a Bank/Dealer is exposed to the collateralization level, collateral quality, and collateral price volatility of securities provided by the hedge fund, given that the Bank/Dealer relies on these securities to borrow funding.<sup>10</sup>

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<sup>9</sup> Duffie (2010) details the role of many of these channels in the routes to failure for Bank/Dealers.

## **Financing Operation**

If repo funding is short-dated, there is a risk that it may not roll over in a stress event, particularly if it is collateralized with less liquid assets. That exposes the Bank/Dealer to investors pulling away due to overall market sentiment or a particular negative view of the Bank/Dealer's stability. If the Bank/Dealer cannot roll over its secured funding, it cannot roll over the financing offered to its clients (albeit at the expense of drawing from its own liquidity reserve), propagating the funding stress to other entities.

In securities lending, the Bank/Dealer is also exposed to the underlying security provider's unwillingness to lend, driven by a marketwide or specific Bank/Dealer stress. The Bank/Dealer therefore would not be able to source securities to cover its clients' short positions – which may lead to reduced client business in future when a normal environment returns.

Secured funding counterparties are exposed to the level, quality and price volatility of the collateral received by the Bank/Dealer. The cash provider relies on this collateral to recover its cash in the event of Bank/Dealer bankruptcy or any price deterioration in the value of those assets.

## **Derivatives Desk**

For OTC uncollateralized derivative transactions, the derivative counterparty is exposed to the Bank/Dealer's credit rating. The Bank/Dealer may be subject to a credit rating trigger that will require it to post initial margin to the counterparty, or may allow the counterparty to terminate or novate the trade at his side of the market.<sup>11</sup> In the case of exchange-traded derivatives, Bank/Dealers, as members of the exchange, are exposed to the financial health and stability of any of its members, given they all may share a loss in the event of a member default.

## **Corporate Treasury**

Lenders of unsecured cash to the Bank/Dealer are exposed to the Bank/Dealer's credit, which is managed, along with funding liquidity and leverage, by its Corporate Treasury. Any credit concerns or credit ratings downgrades will lead investors to withdraw their cash (in the case of uninsured deposits) or sell their stock or bond holdings. The Bank/Dealer is, therefore, reliant on the investor confidence in the Bank/Dealer's creditworthiness.

To understand the full extent of these vulnerabilities we need a more comprehensive view of the financial system than we present here, identifying the paths of feedback across the set of agents and flows in the broader financial system. For example, in most cases the pathways are two-way streets so when there is a flow of cash in one direction, there is a flow of securities in the other. Often the flow of securities is in the form of collateral for the secured cash flow. (In cases where the flow is one way, it is because the funding flow is unsecured, and does not require an exchange of collateral). Also, the funding map in Figure 1 is centered on just one Bank/Dealer, while in practice the network is extended across many Bank/Dealers, each with similar internal complexity. A more

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<sup>10</sup> A broad view of the role of the prime broker in the potential for failure of both hedge funds and bank/dealers is presented in Aikman (2010).

<sup>11</sup> The counterparty who is in-the-money may request to terminate or novate his derivative trade if the Bank/Dealer is experiencing credit issues or if it has been downgraded. Similarly, the contract governing the derivative transaction may contain specific credit rating triggers that are legally enforceable, where the counterparty may be entitled to initial margin or could break the trade at a favorable price (creating a loss for the Bank/Dealer).

complete view of the points of vulnerability will involve extending the funding map to a fuller picture of collateral flows and imposing the funding map on a full network of the financial system. This paper stops at providing the essential schematic to impose on the nodes of that more complete network.

## 5. Crisis Scenarios in the Context of the Funding Map<sup>12</sup>

In this section, we will apply the funding map to trace the path of four past crisis scenarios at Bear Stearns Asset Management, Bear Stearns & Co., Long-Term Capital Management LP, and American International Group, Inc. The initial shock in these cases came from a sudden drop in asset prices, the specter of a Bank/Dealer default, or a drop in a Bank/Dealer's credit rating. The proximate result of the shock can have the following impact on businesses within a Bank/Dealer:

- Prime Broker demands more collateral from hedge funds and some funds pull out from the Prime Broker;
- Trading Desk liquidates inventory under funding pressures;
- Financing Operation reduces commercial lending as clients withdraw deposits;
- Derivatives Desk loses money from mark-to-market changes or counterparty novations; and
- Corporate Treasury sees the market for shorter-term unsecured funding dry up and liquidity reserves are drained.

We will put these scenarios in historical context by looking at the financial shocks that led to crisis for various financial entities.

The examples will not encompass the full extent of the propagation of shocks because, to keep the funding map tractable, we have not expanded the funding map to a broader network of multiple Bank/Dealers and other entities. However, even in this limited schematic we can see how the flow of funds — and collateral in the opposite direction — passing through the various agents carries the effects of the initial shock. Of course, the analysis here has the benefit of hindsight. The critical question that remains open is how well the key points of vulnerability could have been discovered *ex ante*.

### Bear Stearns Asset Management

#### ***Stress on financing triggered by a decline in the value of assets***

In 2006, Bear Stearns Asset Management (BSAM) launched the High-Grade Structured Credit Strategies Enhanced Leverage Fund (Enhanced Leverage Fund) to augment its High-Grade Structured Credit Strategies Fund (High-Grade Fund). Both hedge funds invested primarily in mortgage-backed securities and thinly traded collateralized debt obligations (CDOs) largely based on subprime mortgages. Soon after its launch, the Enhanced Fund ran into trouble as a benchmark

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<sup>12</sup> This section borrows heavily from *Hedge Funds, Leverage, and the Lessons of Long-Term Capital Management*, a report by the President's Working Group on Financial Markets (1999) and from the *Financial Crisis Inquiry Report* (2011) for the discussion of Bear Stearns and AIG. In addition, for AIG see Fleming and Sarkar (2014).

index for its holdings fell 4 percent in the last quarter of 2006, dropped another 8 percent in January 2007, and then tumbled 25 percent in February 2007. Investors began to leave both the Enhanced Leverage Fund and the High-Grade Fund.

To defend its franchise, BSAM provided support to the funds. It moved \$4 billion of CDO assets off the hedge funds' books and into a CDO-squared deal, an investment backed by a pool of CDO tranches rather than bonds or credit instruments and financed mostly through the sale of commercial paper. By the end of April 2007, the estimated value of the two hedge funds was down 50 percent and the flood gates of investor redemptions were opening. On June 7, 2007, BSAM froze redemptions.

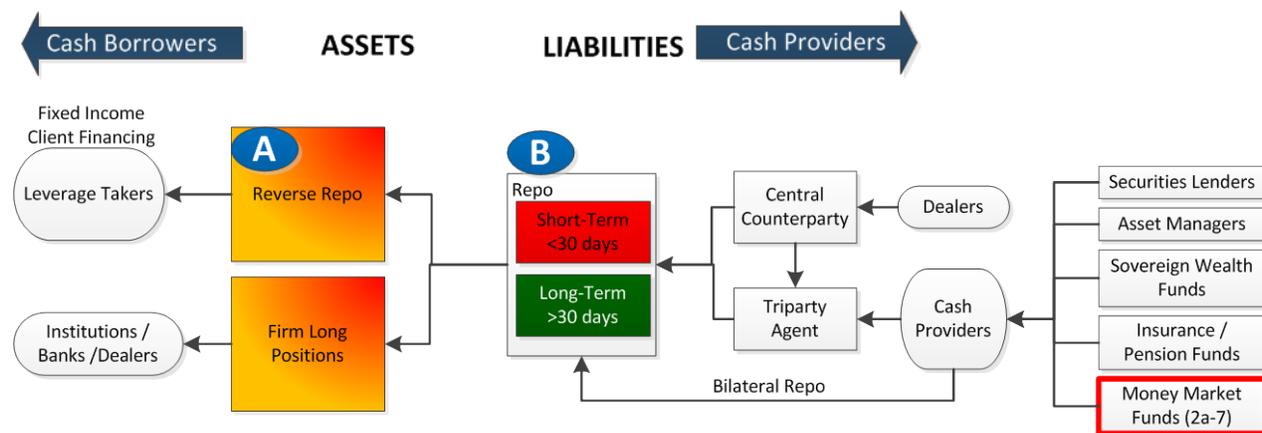
More serious than the redemptions were the margin calls. The hedge funds did not have the cash to meet margin calls, and unsuccessfully sought to have repo obligations converted into 60-day term repo. This forced the funds to sell assets, dropping prices even further, and increasing investor redemptions.

Thus a run on the two funds commenced; investors and repo lenders increased collateral requirements or refused to roll over their loans. Bear Stearns, the parent company, decided to increase its equity investment in the more troubled fund, the Enhanced Leverage Fund. Soon after, Bear Stearns decided to become the sole repo lender to the High-Grade Fund.

By the end of July 2007, the run on the funds and the collapse of their markets forced both funds to file for bankruptcy. Not surprisingly, the dynamics did not end with the collapse of two funds. Repo lenders tightened credit extension to other borrowers by increasing the haircut on subprime collateral, increasing the margin requirements on institutions with mortgage exposure, and shrinking the term of their loans.

In the example in Figure 5, a Bank/Dealer from the funding map (not Bear Stearns) played the role of financing provider (A), tightening its lending of secured cash to BSAM (a leverage taker) or tightening credit extended to other clients affected by the propagation of the stress. The Bank/Dealer itself was impaired in its ability to raise funding for asset-backed securities (B) through bilateral repos or through the triparty repo market. In this and the following figures, the sources of funding with low durability are shown in red, and those that are more durable are shown in green.

Figure 5.



## **Bear Stearns Broker/Dealer**

### ***Funding stress on trading function driven by stress on dealer***

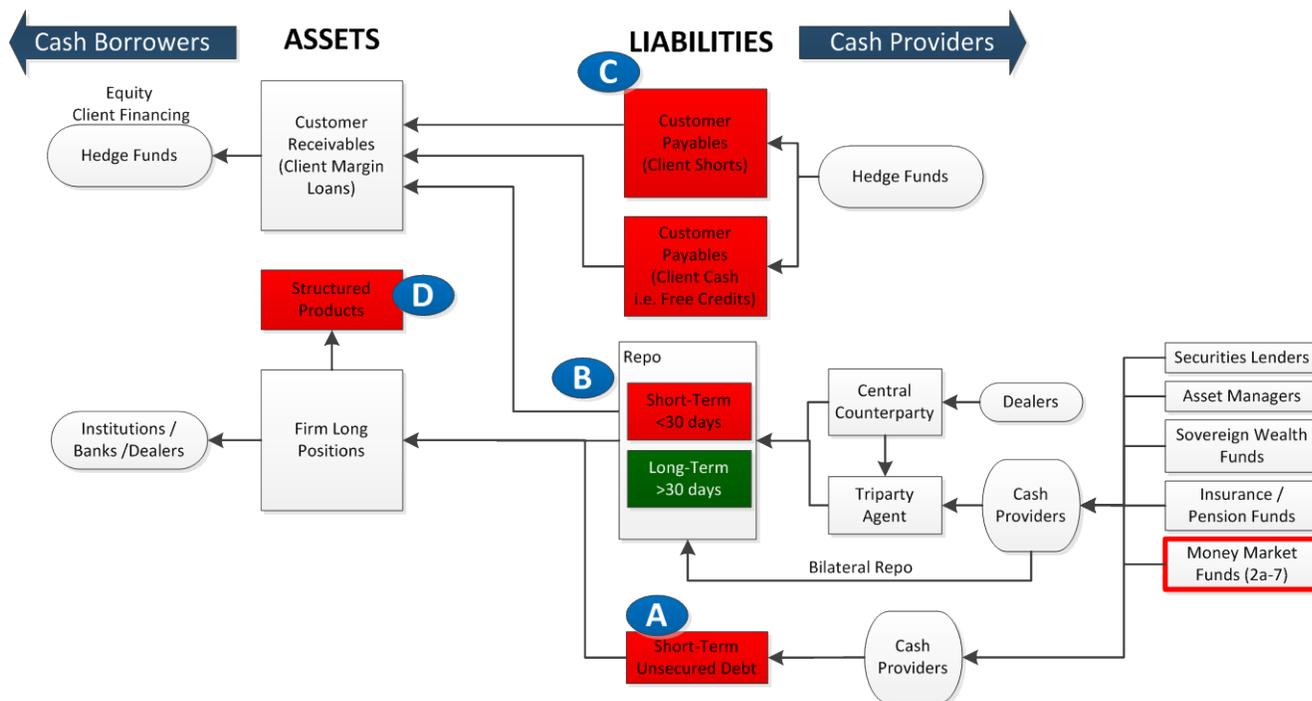
Because Bear Stearns had taken the High-Grade Fund's repo exposures onto its own book, the market dislocations passed through to it as well. Bear Stearns was heavily exposed to similar subprime assets that had led to the demise of the two hedge funds. Mortgage securitization was the biggest piece of Bear Stearns' fixed income operation, the company's most-profitable division and Bear Stearns was one of the top underwriters of CDOs. After the two Bear Stearns hedge funds declared bankruptcy, credit rating firm Standard & Poor's placed Bear Stearns on a "negative outlook," citing the failed funds, the company's mortgage-related investments, and its relatively small capital base.

Figure 6 shows how after the credit rating shock, money market funds started to drop Bear Stearns as a counterparty for unsecured commercial paper (A), preferring to extend credit on a secured basis through repos. Bear Stearns replaced most of its commercial paper funding with repo. Over the course of 2007, its commercial paper dropped from \$20 billion to \$4 billion while its repo borrowing rose from \$70 billion to over \$100 billion — illustrating why repos had traditionally been seen as a more reliable funding source than commercial paper. However, the increased dependence on repo borrowing meant a greater dependence on the quality of its collateral and subjected Bear to the shorter-term, less durable nature of this funding source (B). At the same time, the interest rate Bear Stearns had to pay in the repo market climbed, giving a signal to the market that the company was in distress. Thomas Marano, Bear Stearns' then-head of mortgages and asset-backed securities, said he worried that this could "make our problems turn into a death spiral."

A perception of weakening creditworthiness further constricted the company's funding channels. Hedge fund clients using Bear Stearns' prime broker became concerned that it would be unable to return their cash and securities and started to withdraw (C) — from January to April 2008 the assets held by Bear Stearns' prime broker dropped over 40 percent. The company was the second biggest prime broker in the country, and its prime broker operations were not only a strong profit center, but the prime broker payables were also a key source of funding. In mid-March 2008, Moody's Investor Service downgraded mortgage-backed securities issued by Bear Stearns (D). Derivatives counterparties who sought to reduce their exposure by assigning their positions with Bear Stearns found few takers. Other banks began to refuse Bear Stearns as a counterparty, stoking concerns about default. The downgrades and concerns in the derivative market fed back to the repo market and repo lenders increased demands for collateral (B).

In March 2008, Bear Stearns' ability to borrow in the repo market began drying up as some repo lenders were unwilling to lend even against U.S. Treasuries collateral. Counterparties pulled away, and liquidity dwindled until ultimately Bear Stearns was sold to JPMorgan in a government-brokered rescue plan. The collapse of Bear Stearns was not a solvency issue; it was caused by a lack of funding liquidity and is a clear example of a failure that can be traced to critical flows within the funding map.

Figure 6.



### Long-Term Capital Management LP

**Bank/Dealer exposed to leveraged hedge fund in distress, falling asset values led to funding stress**

Two events were the catalysts for the 1998 collapse of Long-Term Capital Management (LTCM), a highly leveraged hedge fund. Several key markets froze in anticipation of a flood of securities when Salomon Brothers closed its proprietary trading operation in July 1998. The following month, the Russian government announced it was rescheduling its debt payments and imposed a moratorium on payments by Russian banks on various obligations. Together, both events depressed credit spreads and liquidity.

LTCM was highly exposed to the credit spread widening and was the most highly leveraged of major hedge funds. The widening of the spreads forced the firm to sell assets. Given its size and the reduced market liquidity, LTCM's selling pushed spreads even wider, creating an asset-based fire sale. LTCM's capital base stood at \$4.1 billion at the end of July 1998, down 15 percent from the start of the year, then fell to \$2.3 billion one month later, forcing the hedge fund to appeal to its investors for a capital injection. By early September 1998, LTCM's outlook was uncertain amid further losses and difficulty selling its large positions due to eroded market liquidity.

Figure 7 shows a schematic of the impact of LTCM's leverage from OTC derivatives (A), and from exchange-traded derivatives, securities loans, and securities repurchase agreements (B). Before the crisis, the hedge fund enjoyed favorable credit arrangements, such as two-way collateral, rehypothecation rights, high loss thresholds, and low — at times even zero — initial margin requirements. As LTCM's condition deteriorated, these credit arrangements became more rigid and the daily mark-to-market valuations for collateral calls by counterparties became more rigorously enforced. LTCM's prime broker, Bear Stearns, required LTCM to collateralize potential settlement exposures, and its repo and derivatives counterparties sought more collateral through the daily

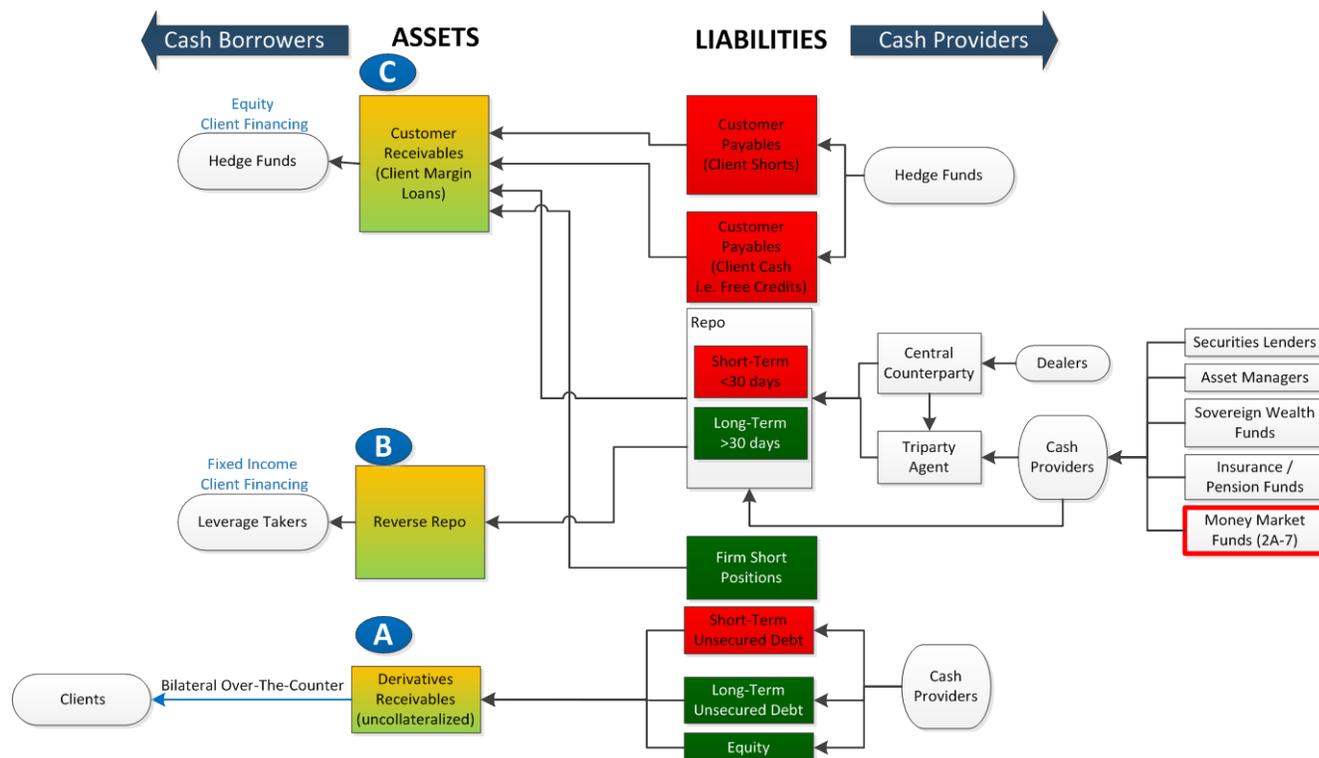
margining process (C), in many cases by applying possible liquidation values to mark-to-market valuations. These actions increased liquidity pressures and raised concerns that LTCM might collapse.

Many major financial institutions were exposed to an LTCM default. They included LTCM's funding sources and counterparties; Swiss bank UBS AG, a major investor in LTCM; and sell-side firms. Bear Stearns was LTCM's prime broker and a clearing firm for LTCM's U.S. exchange-traded futures, and Merrill Lynch was its clearing firm for foreign futures exchange trades. Both had significant credit exposure because they guaranteed LTCM's positions with futures clearinghouses. LTCM also engaged in repo transactions with approximately 75 counterparties and in OTC derivative transactions with about 50 counterparties.

If LTCM defaulted, its counterparties would have to rebalance their portfolios to reduce risk and reestablish positions and hedges related to any defaulted contracts. The cost of closing out these positions might have proved greater than the value of the collateral, and the risk of loss would have been particularly high for derivatives counterparties exposed to illiquid risk positions. Finally, credit providers that gave largely unsecured syndicated lines of credit to LTCM would have lost nearly all amounts outstanding if LTCM defaulted.

Under the circumstances, collateral held by LTCM counterparties had diminished value because any liquidation would exacerbate the weakness in prices and rates and further reduce market liquidity, making it more difficult to manage risks. Ultimately, this could affect the counterparties' own credit standing and increase funding costs. On September 23, 1998, a group of 14 of the world's largest banks and securities firms — each a major counterparty to LTCM — agreed to recapitalize the hedge fund to avoid its disorderly liquidation. The group contributed \$3.6 billion and received 90 percent ownership of LTCM.

Figure 7.



## American International Group, Inc. (AIG)

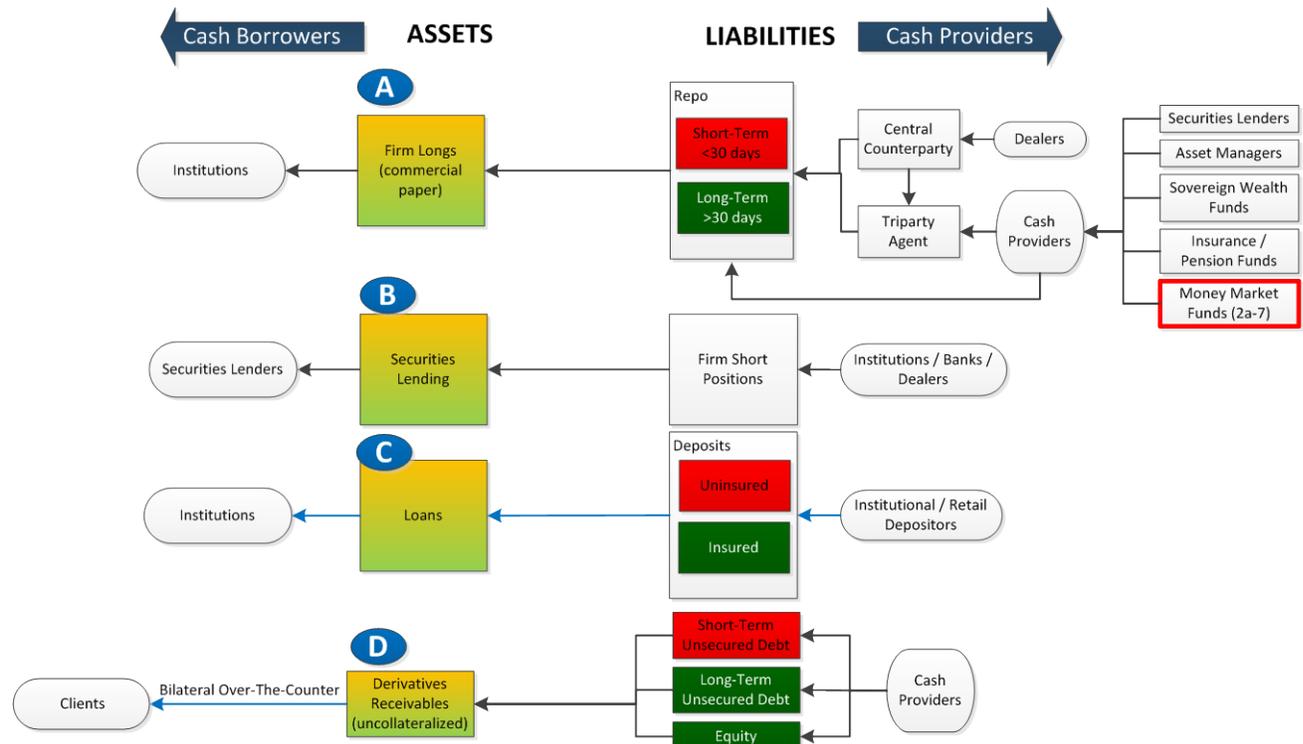
### Bank/Dealer exposed to a financial services firm in distress

In September 2008, as the Federal Reserve Bank of New York (FRBNY) was grappling with the impending bankruptcy of Lehman Brothers, regulators learned that AIG, a global insurer with over \$1 trillion in assets, had only one to two weeks before running out of liquidity. On September 12, 2008, AIG told FRBNY it was “facing serious liquidity issues that threaten its survival” and a looming credit rating downgrade would trigger billions of dollars in collateral calls, liquidity puts, and other liquidity needs.

After Lehman’s bankruptcy filing on September 15, 2008, the rating agencies downgraded AIG, triggering \$13 billion in cash collateral calls on AIG Financial Products unit’s credit default swaps. A syndicate of banks that had agreed a week earlier to provide assistance to AIG withdrew, saying they had to maintain liquidity to protect their own balance sheets. Figure 8 shows the impact on a hypothetical Bank/Dealer when AIG could no longer access the short-term commercial paper market (A). As with the other figures in this section, the green and red boxes indicate more durable and less durable funding, respectively.

The FRBNY knew AIG’s failure would affect the largest U.S. and foreign banks, which had exposure to AIG ranging from bank lines (C) to derivatives (D) to securities lending (B). A failure would raise the capital requirements of European banks because they would lose the protection of their AIG credit default swaps (CDS) and the overall CDS market would face severe dislocations. On September 16, 2008, the Federal Reserve Board announced it would loan \$85 billion to AIG so the insurer could meet its immediate obligations. This soon proved insufficient and the Treasury Department stepped in to help. By the time the dust settled, \$182 billion of taxpayer money was committed to AIG.

Figure 8.



AIG's problems came from several directions. Collateral calls were triggered by credit rating downgrades. Funding dried up, first in AIG's unsecured commercial paper, then in its secured repos, and eventually from its weakened secured lending operations. On September 12, 2008, AIG had to fund \$1.4 billion of its commercial paper because investors balked at unsecured exposure to the company. In the secured funding market, some banks refused to provide repo funding because of AIG's low quality collateral, mostly in mortgage-related securities.

AIG's securities lending business also suffered. In August 2008, AIG had to provide \$3.3 billion to its struggling securities lending subsidiary, and counterparties demanded \$24 billion to offset the shortfall between the cash collateral provided and the diminished value of the securities. AIG had to accept below-market terms, sometimes accepting cash equal to only 90 percent of the value of the securities it loaned.

AIG also had mark-to-market losses and resulting margin calls on its CDS products. Liquidity puts written by AIG forced it to buy back some debt securities at face value amid falling market prices. Meanwhile, AIG provided liquidity puts for its customers' commercial paper, and also acted as a reinsurer for this market. For example, AIG wrote more than \$7 billion in CDS to protect Société Générale against the risks on liquidity puts that the French bank itself wrote on commercial paper.

## 6. Determining Data Needs

The funding map suggests the data required to evaluate the shocks presented in Section 5, data that are granular, complete, broken out by the functional areas, and with specific company-level detail. The data detail must be sufficient to evaluate funding durability, which requires a breakout at the Bank/Dealer's functional business level. For example, Bank/Dealers could provide the amount of Prime Broker client cash (free credits) used to fund other clients' margin loans, while securities lenders could provide the volume of securities loaned, cash and non-cash collateral accepted, and indemnified repo provided back to broker-dealers.

The data we have from the public and regulatory side do not meet this need. For example:

- Flow of Funds data, collected by the Federal Reserve, are aggregated at a high level with a macroeconomic focus, and exclude derivative transactions.
- Government Securities Dealers Reports' data are aggregated by the Federal Reserve and include only primary dealers.
- Bank-specific reporting in 10-Qs filed with the Securities and Exchange Commission, Focus reports filed with the Financial Industry Regulatory Authority, and FR Y-9C reports filed with the Federal Reserve give an incomplete picture due to netting, lack of detail, and off-balance sheet issues.

Data are incomplete because Bank/Dealers report secured funding for cash transactions on their balance sheet and only after allowable netting. Non-cash transactions, such as when a Bank/Dealer lends equities and receives U.S. Treasuries, and netted cash transactions are not reported on the balance sheet. Customer receivables also do not show the full amount of Prime Broker margin loans because of allowable collateral and counterparty netting.

Figure 9 identifies balance sheet line items that have limited value for a funding map because of off-balance sheet components and netting.

**Figure 9. Bank/Dealer Balance Sheet Items That Lack Netting, Off-Balance-Sheet Components**

		Related Off-Balance-Sheet Items	Netting
Assets	Repo Securities Purchased	x	x
	Securities Borrowed	x	x
	Loans	x	
	Customer, Other Receivables		x
	Financial Instruments Owned	x	x
	Federal Funds Sold	x	x
	Other Assets	x	
Liabilities	Repo Securities Sold	x	x
	Securities Loaned	x	x
	Other Secured Financings	x	x
	Customer, Other Payables		x
	Financial Instruments Sold But Not Yet Purchased	x	x
	Unsecured Short-Term Borrowings *	x	
	Unsecured Long-Term Borrowings	x	

\* Includes current portion of unsecured long-term borrowings.

New liquidity and funding ratios set by the Basel Committee allow comparison across banks on liquidity and funding safety. The Net Stable Funding Ratio (NSFR) requires banks to maintain sufficient stable funding to support the types of assets they hold. Basel, and ultimately regional regulators, assigns different weights to the liabilities of a Bank/Dealer to calculate the amount of stable funding at a given institution, with the weights representing the durability of liabilities. The durability distinctions are similar to the funding durability hierarchy in this paper’s Figure 2. For instance, the NSFR assigns an available stable funding factor of 100 percent to regulatory capital and under one-year liabilities, which include unsecured long-term debt. On the other hand, it only assigns a factor of 50 percent to secured funding with maturity between six months and one year, and assigns a factor of zero percent to secured funding inside six months if provided by financial investors.<sup>13</sup> However, because the NSFR metric is reported as a ratio, it gives no insight or transparency to investors into the components of liabilities driving the results. If a Bank/Dealer had an NSFR ratio greater than 100 percent but relied on a large portion of uninsured deposits, which in the worst case scenario receive a 90 percent credit as “stable funding,” there is still a risk of a run on uninsured deposits that is not transparent to investors.

Transparency of key funding sources of Bank/Dealers requires higher resolution, disaggregated data such as those listed in Figure 10. Metrics of this sort would provide a view of gross liabilities across

<sup>13</sup> Under January 2014 proposed Basel rules.

firms, drawing a distinction between durable and fragile funding sources. The asset breakdown would complement the funding breakdown and help determine whether a Bank/Dealer has sufficient durable funding for less liquid assets on its balance sheet.

**Figure 10. Financial Data Needed to Analyze a Bank/Dealer’s Funding Durability**

Assets	Liabilities
<b>Securities Inventory</b> High-Quality Liquid Assets (HQLA) Non-HQLA  <b>Derivatives Receivables</b> Uncollateralized Collateralized  <b>Loans</b> Residual Term < 1 year  Residual Term > 1 year  <b>Borrowed Securities and Reverse Repos (Gross) *</b>  Non-HQLA Assets with Residual Term 0 to 30 days Non-HQLA Assets with Residual Term > 30 days  <b>Prime Broker Margin Loans (Debits)</b> Term 0 to 30 days Term > 30 days Margin Excess (Off-Balance-Sheet)  <b>Other Trading Assets</b>	<b>Unsecured Debt</b> Structured Notes Long-Term Debt Commercial Paper  <b>Derivatives Payables</b> Uncollateralized Payables Collateralized Payables  <b>Deposits</b> Insured Uninsured Term Deposits  <b>Secured Funding from Non-HQLA Repo and Securities Lending (Gross) *</b> Residual Term > 30 days  Residual Term 0 to 30 days  <b>Prime Broker Credits</b> Excess Cash Used to Fund Debits Short Position Proceeds Used to Fund Debits

\* Includes non-cash transactions.

## 7. Conclusion

The 2007-09 financial crisis has spurred research into financial network models with nodes representing market entities and links between the nodes showing funding, credit, and assets. The networks tend to focus on counterparty risk and credit relationships; central counterparty clearing networks; funding liquidity through the interbank, repo, and federal funds markets; and the role of

the central bank in mediating interbank payments.<sup>14</sup> But these network models do not show the flow of information and how multiple agents respond and interact, or the inner workings of an institution summarized by a single node.

The key issue that makes the analysis of systemic risk difficult in a network setting is not the size of the network, but the inner workings of each node or institution as it transforms funding flows. Without understanding this process, analysis of systemic risk is seeing a snapshot rather than tracking a dynamic network. In the extensive research to date on funding networks, there is little analysis of the plumbing of the financial system showing the sources and uses of funding, the movement of cash and collateral in opposite directions for secured funding, the durability of funding, and the flows of unsecured funding. Network analysis has treated the nodes — the banks and other financial services firms — essentially as black boxes. To understand and measure the risks of various funding sources, we need to also look at the durability of funding flows and identify vulnerabilities in the plumbing between the various inputs and outputs, and between the transformation processes within the Bank/Dealer. The network approach, as currently applied, does not allow for insight into the plumbing of the system because doing so requires more than connecting the dots. While the edges of the network show the paths that risk travels, it is the transformations executed within the entities that generate and compound the risks. The flows and connections are important, but the picture of risk creation and contagion is incomplete without understanding the details.<sup>15</sup>

The funding map allows us to understand the funding sources and key functions of a Bank/Dealer. It identifies the entities that provide the Bank/Dealer with funding, and their client relationships to the Bank/Dealer. Furthermore, it takes the concept of durability, which we have introduced in this paper, and applies it to each funding source to highlight the risks of using less durable funding to fund less fundable assets. The funding map is a tool that can be used to assess a Bank/Dealer's funding practices and determine the systemic risk imposed on the broader financial system.

Our funding map can be used as a schematic for identifying the data that are needed to track funding and related collateral flows through different entities linked to a Bank/Dealer. Once populated with the required data, this model will emphasize funding-related vulnerabilities and trace possible paths of contagion, as well as highlight alternative paths for critical funding and securities flows if one path becomes congested. The map can also be used to detect areas of increased volume and speed of flows, showing how the financial system might be evolving and where capacity constraints are becoming problematic.

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<sup>14</sup> Network research has included systemic failures from contagion of counterparty risk and credit relationships, Acemoglu et al. (2013) and Glasserman and Young (2013), and the related central counterparty clearing networks, Song et al. (2012). Also, networks of exposures of banks through the interbank and repo markets, Allen and Babus (2009), and the distribution of liquidity through the federal funds market, Bech et al. (2008).

<sup>15</sup> In terms of the expansion of the network approach provided by the funding map, the funding map is being used as a template for the agent-based modeling effort currently underway at the OFR to provide a simulation framework to do “what-if” stress analysis, positing various shocks and constrictions in the plumbing of the funding network to expose these vulnerabilities.

The funding map presented in this paper focuses on funding flows through a single Bank/Dealer. A more complete funding map would include other Bank/Dealers to create a detailed picture of the plumbing that connects the financial network. Extending the funding map to other agents and sub-agents in the financial system could build network models of the flows of securities and funding. The funding map could eventually include clearing and settlement utilities, exchanges and other trading venues, insurance companies, mortgage originators, credit insurance, and possibly the central bank. International linkages could also be added to show how U.S. money market funds are funding sources for major non-U.S. banks and broker-dealers.

Overall, the funding map approach may be a useful structure for policy analysis with the potential of tracing a policy action as it winds its way through the pipes, functional units, and transformations of the U.S. financial system. The funding map's visual representation of the financial system can augment research models as a particularly useful crisis management tool.

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