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**Financial Stability Monitoring**

**Tobias Adrian, Daniel Covitz, and Nellie Liang**

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# Financial Stability Monitoring<sup>\*</sup>

Tobias Adrian  
Research and Statistics  
Federal Reserve Bank of New York  
33 Liberty Street, New York, NY 10045  
[Tobias.Adrian@ny.frb.org](mailto:Tobias.Adrian@ny.frb.org)

Daniel Covitz  
Research and Statistics  
Board of Governors of the Federal Reserve  
Constitution Avenue, Washington, DC 20551  
[Daniel.M.Covitz@frb.gov](mailto:Daniel.M.Covitz@frb.gov)

Nellie Liang  
Office of Financial Stability Policy and Research  
Board of Governors of the Federal Reserve  
Constitution Avenue, Washington, DC 20551  
[JNellie.Liang@frb.gov](mailto:JNellie.Liang@frb.gov)

## Abstract

While the Dodd Frank Act (DFA) broadens the regulatory reach to reduce systemic risks to the U.S. financial system, it does not address some important risks that could migrate to or emanate from entities outside the federal safety net. At the same time, it limits the types of interventions by financial authorities to address systemic events when they occur. As a result, a broad and forward-looking monitoring program, which seeks to identify financial vulnerabilities and guide the development of pre-emptive policies to help mitigate them, is essential. Systemic vulnerabilities arise from market failures that can lead to excessive leverage, maturity transformation, interconnectedness, and complexity. These vulnerabilities, when hit by adverse shocks, can lead to fire sale dynamics, negative feedback loops, and inefficient contractions in the supply of credit. We present a framework that centers on the vulnerabilities that propagate adverse shocks, rather than shocks themselves, which are difficult to predict. Vulnerabilities can emerge in four areas: (1) systemically important financial institutions (SIFIs), (2) shadow banking, (3) asset markets, and (4) the nonfinancial sector. This framework also highlights how policies that reduce the likelihood of systemic crises may do so only by raising the cost of financial intermediation in non-crisis periods.

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## 1. Introduction

Systemic risk stems from market failures such as moral hazard, coordination failures, adverse selection, other information and agency problems, as well as behavioral biases. These market failures can lead to excessive risk taking, which makes the financial system susceptible to fire sales and an adverse feedback loop, and can result in a financial crisis when adverse shocks hit. Systemic financial crises occur when the financial sector's ability to intermediate funding is impaired, leading to inefficient disruptions in real economic activity.

The Dodd Frank Act (DFA), passed in 2010, attempts to address market failures and the systemic risks they pose by strengthening the supervision and regulation of banking institutions and bringing some nonbank institutions under the regulatory umbrella. In addition, DFA addresses the moral hazard in the financial sector that might arise from expected government support in times of crisis by establishing a new resolution regime and putting new limits the government's ability to support distressed financial institutions during a crisis.

However, DFA also has significant limitations. In particular, the new limits on the ability of the regulatory agencies to address systemic events ex post could increase the severity of financial crises that cannot be averted. In addition, DFA does not address structural problems in wholesale short-term funding markets, such as the susceptibility of money market funds to investor runs or the inherent fragility of repo markets. Moreover, DFA augments incentives for financial intermediation to move to what has been termed the shadow banking system, where maturity transformation takes place without public sector liquidity and credit backstops, and for the development of new innovative risk transformation products and strategies outside of regulatory oversight.

The higher standards for governmental interventions in crisis, the failure to eliminate known structural vulnerabilities, and incentives for risk-taking to move outside the regulated sector all point to a need for a regulatory and supervisory regime that implements policies preemptively to foster greater financial stability. A systemic risk monitoring program that is broad, flexible, and forward-looking is an essential element of that regime. Monitoring helps to measure the degree of vulnerability in the financial system and the extent to which shocks might trigger systemic events. A monitoring program that extends beyond institutions also is an important complement and input to effective supervision of regulated firms, as these firms are deeply interconnected to other parts of the financial system. Macroprudential policies are designed to reduce vulnerabilities to mitigate the amplification of negative shocks, and also to pre-position institutions so that they can absorb shocks.

To organize a broad and flexible monitoring program, we appeal to a stylized systemic risk framework. In this framework, the price of risk falls and risk-taking increases as financial

and economic activity expands, which facilitates intermediation. At the same time, a lower price of risk can plant the seeds for increased vulnerabilities in the financial system and make the system more susceptible to adverse shocks. Vulnerabilities transmit and amplify these adverse shocks. Shocks are difficult to predict and can arise from a variety of sources that may not lie within the control of financial regulators. Thus, this monitor focuses on identifying vulnerabilities, which can generate fire sales, adverse feedback loops, and result in material disruptions in financial and economic activity when adverse shocks hit. This systemic risk framework is motivated by the research on leverage, maturity mismatch, and other amplification mechanisms through which an entity's distress imposes externalities on others through fire sales and adverse feedback loops from interconnections, leverage, runs, contagion, and other coordination failures (see e.g., Geanakoplos (2003), Allen and Gale (2000), Adrian and Shin (2010a), Brunnermeier and Pedersen (2009), He and Krishnamurthy (2012a,b,c), and Adrian and Boyarchenko (2012)).

In our monitoring program, we look for vulnerabilities in four areas: (1) systemically important financial institutions, (2) shadow banking, (3) asset markets, and (4) the nonfinancial sector. The focus on vulnerabilities emphasizes that policymakers might be most effective by focusing their efforts on increasing the resilience of the financial sector to a set of possible shocks, rather than trying to predict the likelihood of particular shocks. This monitoring program is part of a broader effort to promote financial stability, which also involves better data collections, enhanced disclosures, and the meaningful implementation of macroprudential regulatory and supervisory policies designed to target building vulnerabilities and to pre-position the financial system to be better able to absorb shocks.

Financial stability monitoring is distinct from supervision because of its focus on the risks for the whole financial system, in both regulated and non-regulated institutions and markets. In contrast, supervisory monitoring primarily focuses on the financial conditions and risks of regulated firms. Macroeconomic monitoring, on the other hand, traditionally does not focus on the dynamics of the financial sector at all, but rather uses market prices and its effects on household and business spending to model macroeconomic activity. In contrast, financial stability monitoring explicitly links the behavior of financial institutions to financial market prices and risks, and explicitly analyzes the connections between the real and financial sectors.

The remainder of this paper is organized as follows. Section 2 summarizes the new approach to financial stability as defined by DFA. Section 3 discusses lessons learned from the crisis and implications for what we should monitor. Section 4 presents a stylized model of financial stability to motivate the monitoring framework, Section 5 describes the framework in detail, and Section 6 provides a brief discussion of some macroprudential policy tools that could be used to mitigate identified vulnerabilities.

## **2. New DFA legislation and implications for monitoring**

DFA imparts on U.S. financial regulatory agencies an explicit and broad financial stability mandate. Prior to the Act, financial regulators were concerned with the soundness of the institutions and markets in their respective jurisdictions, but no agency was responsible for ensuring the stability of the broader financial system. DFA addresses this regulatory gap by creating a Financial Stability Oversight Council (FSOC), comprised of the leaders of federal and state financial regulatory agencies, and charged with identifying threats to financial stability. The FSOC also has the power to recommend that agencies take specific actions to mitigate identified risks; the member agencies, in turn, are required to explain publically in writing if they choose not to comply with the recommendations. DFA also requires that the FSOC designate nonbank systemically important financial institutions (SIFIs) to be supervised and regulated by the Federal Reserve System, and to designate systemically important financial market utilities (FMUs).

DFA attempts to reduce the moral hazard in the financial industry that might arise from expected governmental support in times of crisis. It mandates that the Federal Reserve impose enhanced prudential standards, including higher capital and liquidity requirements, for banking institutions designated as systemically important, and to conduct regular stress tests for large banking institutions. These enhanced standards could reduce negative systemic externalities by inducing banks with large systemic footprints to lower their default risk.

In addition, the apparent consensus in Congress when DFA was passed was that the actions taken by authorities in 2008 and 2009 to address the financial crisis as it unfolded, while effectively preventing a financial collapse, may have increased moral hazard going forward. Moral hazard in this context refers to the propensity of financial institutions to take excessive risks because their managements (and perhaps their debt and equity investors) believe their losses will be contained by government backstops and interventions. To address moral hazard, DFA requires that emergency lending programs under Sec 13(3) of the Federal Reserve Act must be broad-based and not designed to support a single institution. In addition, DFA requires that the Federal Reserve ensure that taxpayers are protected against losses, a stronger standard than the Federal Reserve Act's requirement that extensions of credit be "secured" to the Federal Reserve's satisfaction. DFA also requires the approval of Congress for the FDIC to implement a debt guarantee program, such as the one created in the fall of 2008.<sup>1</sup> Further, it mandates that the FDIC provide an orderly liquidation mechanism for SIFIs, so that such firms can be allowed to fail without putting the financial system at risk of being dysfunctional. The intent of these

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<sup>1</sup> In this regard, DFA extended and broadened the prohibitions on supporting financial institutions that were first reflected in the Emergency Economic Stabilization Act of 2008 (EESA), which specifically addressed the Treasury's use of the Exchange Stabilization Fund to guarantee money market funds in September 2008.

changes is that firms, understanding this new financial regulatory framework, will take steps to better manage their risks to avoid default.

The enhanced standards on regulated banking and nonbank SIFI firms, but lack of reform in wholesale funding markets may augment the vulnerabilities in “shadow banking,” where shadow banking is defined as chains of financial intermediation that involve maturity, risk, and liquidity transformations that take place without the protection of deposit insurance and access to the lender of last resort (see Pozsar, et al, 2010 and Adrian and Ashcraft, 2012b for descriptions). To be sure, some shadow banking activities are addressed by a combination of recent reforms. For example, FSOC can impose a stricter regulatory regime on nonbank financial firms that they designate as systemically important, though designation does not expand the protections of deposit insurance of lender of last resort. In addition, accounting and banking regulatory reforms mandated by Basel and DFA raise the cost to banks of providing back-up liquidity and credit support to ABCP conduits—vehicles that fund long-term assets with short-term debt—which should reduce maturity transformation without sufficient backstops in the ABCP market. DFA also requires risk retention in securitizations so that securitizers will share in the risk of the asset-backed securities that they create, which will either reduce the volume of securitizations or enhance the stability of this risk transformation (Adrian and Ashcraft, 2012a). However, risk retention in the securitization process fails to fully address all agency conflicts, and the incentive problems of rating agencies remain.<sup>2</sup> Further, money market funds remain prone to runs, the progress to address structural vulnerabilities in the tri-party repo market has been slow, and broker-dealers’ funding models continue to be inherently fragile, especially with respect to less-liquid assets. Moreover, DFA as well as Basel reforms, will increase the costs of traditional banking, which in turn may push components of financial intermediation further away from traditional banking and toward innovative new financial products and intermediaries not subject to the full gamut of newly-enhanced regulation and supervision.

DFA also created the Office of Financial Research (OFR) with a mandate to improve data on the financial sector to mitigate systemic risks. OFR has the authority to collect data that are not available to individual agencies, and so can take a broader system-wide view on some potential risks. The regulatory agencies also have substantially improved data collections and disclosures, which should enhance market discipline. For example, the SEC requires reports of MMF assets and makes them available to the public with a two-month lag. In addition, banking regulators are collecting confidential bank data for supervisory stress tests and both regulators and firms will regularly disclose results of stress tests.

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<sup>2</sup> The securitization process exhibits a variety of agency problems and incentive conflicts, that range from the limited skin in the game of underwriters and servicers, to the regulation of credit rating agencies, the usage of contingent credit lines that support shadow bank credit transformation, as well as the involvement of insurance companies in the securitization chain (see Ashcraft and Schuermann (2008) for an explanation of “the seven sins in structured credit markets”).

It remains to be seen whether the new regulations and the reduction of the government's ability to provide emergency assistance in a financial crisis will sufficiently reduce private sector risk-taking in non-crisis periods, to avoid a build-up in systemic risk. In addition, given that financial crises will still occur with DFA, the restricted crisis management toolkit could make them more severe. Thus, DFA escalates the need for a forward-looking systemic risk monitor, based on a framework of identifying amplification mechanisms for adverse shocks and more comprehensive data, to better implement macroprudential supervision and regulation.

### **3. Lessons from the crisis and implications for systemic risk monitoring**

The financial crisis provides a number of lessons regarding what should be monitored to identify emerging systemic risks. The first lesson is that regulators should broaden their focus from individual regulated financial firms to the broader financial system. Regulators focused on the safety and soundness of *individual* depository institutions and paid insufficient attention to the effects that their distress could have on the broader financial system and economy. For example, during the financial crisis, steep house price declines imposed substantial losses not only on regulated financial firms, but also on shadow bank investors and households.

A second lesson from the crisis is that the failure of large interconnected financial institutions can trigger systemic events through a rise in the price of risk and deleveraging in the broader financial system. For example, the failure of Lehman Brothers in the fall of 2008 triggered a dramatic rise in the pricing of risk across asset markets. Short-term funding markets became dysfunctional, and risk premiums soared to record highs in equities, corporate bonds, leveraged loans, and asset-backed securities. Issuance in many securitization markets ground to a halt, making it difficult for financial institutions to fund loans to households and business, including car loans, credit cards, student loans, small business loans, and residential and commercial mortgages (Campbell, Covitz, Pence, and Nelson, 2011). The deleveraging of the financial intermediary sector acted as a powerful amplification mechanism, a theme that is explored more formally in theoretical models developed by Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Brunnermeier and Sannikov (2011), He and Krishnamurthy (2012a,b,c), Fostel and Geanakoplos (2008), and Adrian and Boyarchenko (2012).

A third lesson from the financial crisis is that short term funding markets in the “shadow banking” system may be subject to run-like coordination failures. The microfoundations of coordination failures in short-term credit markets are explored in theoretical models in Acharya, Gale, and Yorulmazer (2011), He and Xiong (2011), and Brunnermeier and Oehmke (2012); Diamond and Dybvig (1983) and Morris and Shin (2004) are classic references on runs on banks and asset markets. Runs in wholesale funding markets in turn accelerated the collapse of the shadow banking system. Funding markets in the shadow banking sector are vulnerable because

they provide short term, sometimes overnight, funding for long term assets, and so transform maturities. But, this kind of maturity transformation is done without FDIC insurance or access to a lender of last resort, which are the protections that make banks' use of demand deposits to fund loans a more stable kind of transformation. Early in the financial crisis, from August to December 2007, the asset-backed commercial paper (ABCP) market contracted by more than \$400 billion (see Covitz, Liang, and Suarez, 2012). Over roughly the same period, haircuts in the bilateral repurchase market began to climb, leading to fire sales on the securities being funded (Gorton and Metrick, 2010, describe this event as a panic), and signs of strain in the tri-party repo market were emerging (Copeland, Martin, Walker (2011)). Further, in late 2008 and early 2009, the market for auction rate securities—long-term municipal bonds that are repackaged and resold to investors in short-term (often weekly) auctions—collapsed (see Han and Li, 2011). And, MMFs, a critical provider of short term funding, were run in the fall of 2008, though the runs were quelled when Treasury responded quickly by insuring all existing money fund accounts (McCabe (2010) and Wermers (2011)).

A fourth lesson from the crisis is that runs in the shadow banking sector can lead directly to liquidity and solvency problems of the regulated banking sector through direct and indirect interconnections. Financial institutions that sponsored ABCP conduits provided financial support when investors ran, upholding their explicit contractual commitments and also implicit commitments, which added to their own mounting liquidity pressures (see Acharya, Shnabel, and Suarez, 2010). Many banks also supported their sponsored MMFs, likely for reputational concerns (see McCabe (2010); Brady, Anadu, and Cooper (2012)). And, financial institutions, particularly broker-dealers, which relied on funding from repo became vulnerable to a rapid flight of MMFs and other highly risk-averse investors.

The crisis also revealed that the regulatory and legal system was not capable of resolving large financial institutions such as Lehman Brothers and AIG in an orderly fashion. The sheer complexity of the major financial institutions and differences in insolvency and regulatory regimes across states and countries make dismantling such institutions extremely difficult and costly, even without considering the externalities on other financial institutions through the fire sale of assets and other channels. This suggests that a monitoring framework also has to measure the complexity and interconnectedness of individual institutions, including where such relationships cross jurisdictional borders.

A final lesson to emphasize is that pre-conditions for crises tend to develop in seemingly benign periods. In the years leading up to the crisis, regulatory bank capital ratios were high, implied volatilities such as the VIX were low, and risk premiums on corporate bonds, leveraged loans, and several categories of asset-backed securities were very narrow. Indeed, it is likely that the low volatility and easy market conditions allowed a build-up of leverage and the pervasive build-up of maturity transformations in the shadow banking sector (for other descriptions of this

volatility paradox, see Brunnermeier and Sannikov, 2012, Adrian and Brunnermeier, 2010, and Adrian and Boyarchenko, 2012). In addition, rising house prices and expectations of further gains likely led households to take out mortgages and financial firms to make mortgages that were unsustainable and poorly underwritten.. The resulting collapse in house prices arguably was the primary trigger for financial crisis.

Closely related, the crisis suggests that regulators be forward looking in assessing systemic risk. In late 2008, all the largest banks were considered to be well-capitalized by regulatory standards, but the forward looking stress tests conducted in early 2009 determined that the industry needed \$185 billion of additional common equity to remain adequately capitalized and able to continue lending if the economy were to experience a hypothetical severe recession. The stress tests revealed that capital for many of the largest BHCs, based on accepted regulatory and accounting treatment of expected losses on loans and securities in the banking book, was not sufficiently forward-looking, and some firms did not have enough capital to remain adequately capitalized if expected future economic losses under a plausible recession scenario for two years were pulled forward.

#### **4. Conceptual framework for financial stability**

The framework for financial stability monitoring is motivated by economic research on amplification mechanisms and builds on lessons learned from the financial crisis. In a number of recent papers, the interactions among the buildup of financial intermediary leverage, the implications for asset prices, and the evolution of tail risks are formally modeled (see Adrian and Boyarchenko (2012), He and Krishnamurthy (2012c), and Gertler and Kiyotaki (2012)). These three papers explicitly incorporate notions of systemic risk in macroeconomic settings with fragile financial intermediaries, including both regulated firms and shadow banks. The key amplification mechanism in these models arises from the time variation in the tightness of intermediary funding constraints. During expansionary booms, funding constraints are loose, and intermediaries can build up leverage and maturity mismatch. The high effective risk appetite of intermediaries in those times leads to a compression in the pricing of risk and an increase in asset price valuations.

However, the higher leverage and liquidity risks of intermediaries in these times also make the financial sector vulnerable to adverse shocks. Such adverse shocks could hit the assets or liabilities of intermediaries. On the asset side, a slowdown of real economic growth prospects can trigger an asset price adjustment, which is likely larger if prices were overvalued. On the liability side, liquidity shocks can force intermediaries to delever, which is sharper if they relied heavily on short-term funding. The condition of financial intermediaries imposes externalities on the welfare of the nonfinancial sector, as the sharp fluctuations in the condition of the

intermediaries amplify credit availability. Due to the presence of externalities, intermediaries do not have the proper incentives to align risk taking with socially optimal levels, generating excessive leverage in the booms and too little leverage in busts, leading to underinvestment.

These equilibrium theories produce a tradeoff between the overall level of systemic risk and the cost of financial intermediation, which in turn determines real activity through credit supply. The theories also highlight that the impact of an adverse shock on the broader financial system will depend on vulnerabilities of the financial intermediary sector. Depending on the strength of the financial sector, a given fundamental shock can be benign, or can generate a systemic financial crisis. To the extent the adverse shocks also harm vulnerable households and businesses, and cause them to contract spending, the effects on the financial sector are amplified further. The philosophy of our monitoring approach is to focus on the vulnerabilities of the financial system which act as amplification mechanisms for adverse shocks, which can harm real economic activity.

Although not explicitly modeled in the aforementioned theories, as discussed in Section 3, interconnections and complexity within the financial system also are vulnerabilities. Like leverage and maturity transformation, interconnectedness, whether through the sheer size of institutions or the chains of intermediation in shadow banking, will tend to lower the cost of financial intermediation when shocks are low, but can also amplify large shocks through direct exposures, fire sales, or contagion. Complexity might also magnify shocks by fueling uncertainty about interconnections or inhibiting orderly liquidations.

These amplification mechanisms can be simplified to a stylized framework. For financial intermediaries, leverage is pro-cyclical, permitting higher economic activity and lower volatility in normal times, but at the cost of a higher probability of systemic risk when shocks are high. The stylized framework has the following assumptions:

1. The price of risk,  $p$ , increases with financial shocks,  $s$ .
2.  $p$  is more sensitive to  $s$  when vulnerabilities,  $v$ , are high.
3. When  $s$  is low,  $p$  is decreasing in  $v$ .

The three assumptions are intended to capture the following intuition. The first assumption reflects the idea that the market-wide price of risk in the financial system is increasing in the adverse impact of negative shocks to the system, regardless of the level of vulnerabilities. Shocks in this context are defined as unpredictable events or triggers—such as the losses from a rogue trader, a spate of defaults on sub-prime mortgages, the popping of an

asset price bubble, a sudden drop in domestic economic growth, or an escalation of a foreign financial crisis.<sup>3</sup>

The second assumption captures the intuition that vulnerabilities---such as leverage, maturity transformation, or risk opacity and complexity---make it more likely that shocks will trigger fire sales or investor runs, which in turn may cause the market-wide price of risk to rise sharply. The distinction between shocks and vulnerabilities is subtle in some instances. For example, the *popping* of an asset price bubble (i.e., inflated valuations) would constitute a shock to the financial system. The popping of a bubble is an event that is difficult to predict and that can trigger a chain reaction that would ultimately impact the price of risk in the financial system and the financial system's capacity to intermediate. The *possibility* of an asset price bubble therefore constitutes a vulnerability: it implies that asset prices could correct sharply downward in reaction to an adverse shock.

The third assumption asserts that the benefit of a more vulnerable financial system is to allow for cheaper financial intermediation (i.e. a lower price of risk) when shocks are low (i.e., in periods of low volatility). For example, the run-up to financial crisis is characterized by low measures of contemporaneous volatility, which allows financial intermediaries to fund assets with short-term debt and leverage. This assumption also captures the notion that regulations intended to reduce system vulnerabilities may come at the cost of a higher price of risk when volatility is low.

Together, the three assumptions imply a trade-off: more vulnerable financial systems have a lower price of risk in periods of low volatility but a higher price of risk, hence a higher probability of systemic risk, when there are large adverse shocks. Conversely, the probability of systemic crisis can be reduced by raising the price of risk in periods of low volatility. Graphically, this framework is illustrated in Figure 1.

In a fully specified model, the socially optimal level of vulnerabilities would account for this trade off, and would also depend on the probability distribution of underlying shocks and the social costs of higher pricing of risk in different states of nature. One might conjecture that social costs are nonlinear in the price of risk, given that a very high price of risk could disrupt the functioning of the financial system.

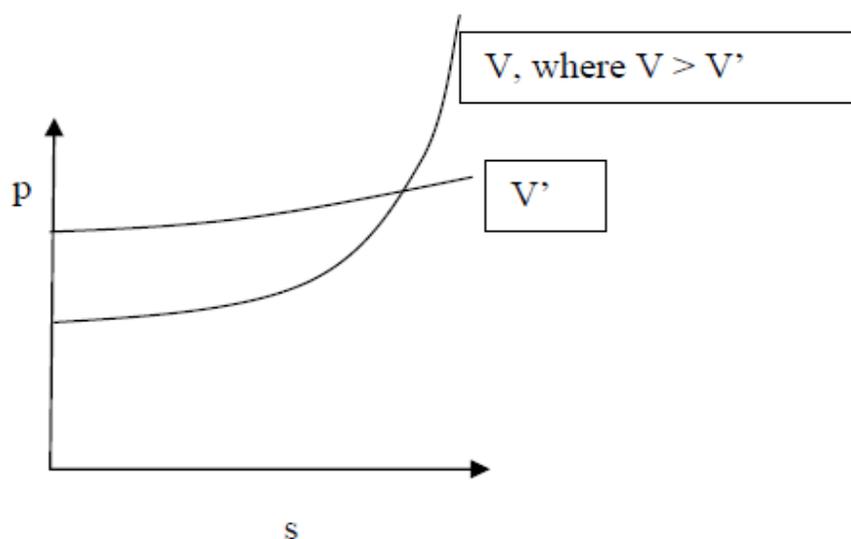
In addition, absent government policies, one might expect that vulnerabilities would exceed socially optimal levels. This might be the case if, for example, private agents understood that their actions would increase vulnerabilities, but also assumed that they could exit before the

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<sup>3</sup> The distinction between triggers and vulnerabilities, as well as the benefits for economic policy of making this distinction are discussed in Bernanke (2012).

price of risk increased. A related possibility is that the increase in vulnerabilities today could increase the expected price of risk for future market participants that would not benefit from the lower price of risk today. Further, private agents could underestimate the likelihood of large shocks. Moreover, it might be the case that one financial institution could lower funding costs by increasing reliance on wholesale short-term funding without increasing the vulnerability of the overall system, but if many financial institutions pursued aggressive funding strategies the risks would be much greater. As a result, vulnerabilities might arise out of an inability of financial institutions to coordinate on relatively expensive but stable funding strategies.

**Figure 1: Financial Sector Vulnerability to Shocks and Pricing of Risk**



**Note:**  $p$  denotes the price of risk,  $s$  the size of the shock, and  $V$  is the vulnerability of the financial system.  $V'$  corresponds to a financial system with tighter regulation than  $V$ .

Policy actions could be designed to reduce the systemic risk by tamping down on vulnerabilities. Macroprudential policies would have the effect of reducing the sensitivity of the price of risk to adverse shocks, so that increases in the price of risk are more moderate when adverse shocks are larger. For example, higher capital and liquidity requirements would make it more likely that financial institutions could absorb rather than amplify a sudden deterioration in domestic economic growth or the popping of an asset bubble. Similarly, policies that lean against domestic asset price increases, for example, by tightening credit underwriting standards or raising risk weights or margins, might reduce leverage-induced asset bubbles and the likelihood of a sharp fall in valuations and corresponding fire sales.

## 5. Program for Monitoring Financial Stability

The purpose of a financial stability monitor is to inform policymakers with regular assessments of the financial system’s vulnerabilities to a range of potential adverse events or shocks.<sup>4</sup> Such monitoring is a critical part of a broader pre-emptive program in the Federal Reserve System to assess and address vulnerabilities in the U.S. financial system.

We look for financial vulnerabilities—leverage, maturity transformation, interconnectedness, and complexity—in four main areas: SIFIs, shadow banking, asset markets, and the nonfinancial sector. A fundamental principle of the framework in Section 4 is that systemic risk arises from many sources. As a result, the monitoring program contains a broad range of metrics and below, we provide only illustrative examples in each area. In addition, the quantitative metrics need to be complemented by institutional knowledge of legal, accounting, and other important standards that might mask underlying risks. More importantly, metrics are not stand-alone indicators of systemic risk and so are incorporated into a broader analysis of how potential shocks could impact a number of vulnerabilities at the same time, and how the vulnerabilities might consequently interact further, which may vary over time.

### A. Systemically Important Financial Institutions (SIFIs)

SIFIs are firms whose distress or failure could disrupt the functioning of the broader financial system and inflict harm on the real economy.<sup>5</sup> SIFIs may arise because their decisions reflect an expectation of government support in failure, they fail to internalize private-sector coordination failures associated with short-term debt, or they are too interconnected with other financial firms and the real economy because of their large size. Disruptions could arise from direct losses imposed on counterparties, contagion, fire sales effects, or a loss of critical services if a SIFI were to become distressed. These effects are increasing in size, leverage, use of short-term non-deposit funding, or complexity.

Standard measures of some of these factors for bank holding companies (BHCs) considered to be systemically important include regulatory capital and leverage ratios, asset liquidity, wholesale short-term funding, and confidential supervisory assessments, but these measures are often viewed as lagging (chart 1 and 2). Market indicators, such as CDS

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<sup>4</sup> See Chairman Bernanke’s speech on lessons from the crisis for financial stability monitoring <http://www.federalreserve.gov/newsevents/speech/bernanke20120413a.pdf>.

<sup>5</sup> SIFIs can be bank or nonbank financial institutions. DFA automatically designates BHCs with total assets over \$50 billion as SIFIs, but the Federal Reserve increases its regulatory and supervisory efforts with the systemic importance of the firms in this group. FSOC is authorized to designate nonbank SIFIs based on a number of criteria that include the size, leverage, maturity mismatch, and potential spillovers of the institution to the broader financial system if it were distressed.

premiums, equity prices, and expected default probabilities based on estimates of asset volatilities and liabilities, provide market participants' forward-looking views about an institution's riskiness and are an important complement to balance sheet and supervisory measures (chart 3 and 4). However, these market-based indicators are only indirect measures of systemic risk and may be confounded by current levels of overall risk pricing.

Three additional types of measures of SIFI systemic risk may address some of the weaknesses of standard measures. The first are information from supervisory stress tests, which attempt to use confidential supervisory information to produce forward-looking measures of SIFI riskiness. The second are financial market-based measures of systemic as opposed to individual-firm risk. The third are network measures of interconnectedness. These categories of measures are discussed, in turn, in the following three subsections.

#### Supervisory stress tests

Supervisory macro stress tests project whether the largest regulated banking firms have sufficient capital to withstand unexpectedly weak macroeconomic and financial conditions. Such tests were initiated in the U.S. at the height of the financial crisis in early 2009 and have been repeated in the past two years to help evaluate the capital distribution plans of BHCs. The post-stress ratios are calculated by projecting losses for the firms' loans, trading assets, and revenues for a two-year hypothetical scenario based on detailed confidential information collected by the supervisors about the characteristics of firms' assets. The stress tests are conducted simultaneously, which allow comparison of loans and trading assets across institutions at the same point in time, imposes consistency on estimated losses across the firms, and imposes a macro constraint on the performance of the largest firms in the aggregate.

To enhance stress tests, supervisors have collected detailed balance sheet data, which has improved supervisors' insights into banking firms' risks, and may also have improved the data and risk management practices of the firms in the stress test. Starting in 2013, DFA has required supervisors to conduct stress tests and disclose results each year for banking and nonbank firms identified as systemically important. In addition, individual firms are required to conduct their own firm-wide stress tests twice a year and disclose their results. In 2012, supervisors disclosed firm-level loss rates for broad categories of assets, as well as the capital ratios under the stress scenarios (chart 5). Significant abnormal stock returns in the days following the announcement of stress test results and capital distribution decisions suggest that such disclosures conveyed useful information to investors.

Stress test results largely have been viewed as information about an individual firm's strength, although they incorporate some elements of how a firm would be expected to fare in a systemic event when many firms could be stressed simultaneously. For example, a feature of the stress tests is to assume that pre-committed liquidity and credit lines, for example those which

would have supported ABCP conduits or VRDOs in 2007, will be drawn. In addition, the projected losses for the trading book include those arising from stressed counterparties, and so they reflect interconnectedness among the firms. While additional important risks, such as liquidity or operational, still need to be considered, post-stress capital aggregated across firms may be a good indicator of the systemic risk of the banking sector.

#### Financial market-based systemic risk measures

Researchers have been developing systemic risk measures for firms based on financial market indicators (chart 6). Conditional Value at Risk (CoVaR) is an estimate of the value at risk of the financial system conditional on a firm's distress, based on co-movement of equity prices in the lower tail of the firm's and market return distributions (Adrian and Brunnermeier, 2008). The distress insurance premium, or DIP, measures the cost of insuring a firm against system-wide distress, measured by losses on a portfolio of financial institutions (Huang, Zhou, and Zhu, 2009). This second measure is derived from CDS premiums and correlations of equity returns of portfolio firms. A third measure, the systemic expected shortfall, or SES, estimates the expected decline in the market value equity of a firm given a market-wide decline in equity prices, and so approximates the propensity to be undercapitalized coincident with the rest of the financial system (Acharya, Pedersen, Phillipon, and Richardson, 2010).

These measures attempt to uncover, through asset prices, fundamental links between distressed financial firms and the broader financial system, and as such are a direct attempt to uncover the components of  $v$  in our systemic risk framework. Such links could reflect that the failure of a large, interconnected financial institution may cause a generalized loss in confidence in the financial system, which in turn could trigger coordination failures in short-term credit markets; such links could also arise through counterparty relationships with the failing firm, or from the firm's presence or roles in the functioning of certain markets. Of course, as with all market-based measures, these measures of systemic risk are not immune to confounding effects of current levels of overall risk pricing, though they do attempt to capture systemic risks.

Researchers are also exploring risk measures based on options prices for tail events (see Malz, 2012, Aramonte and Schindler, 2012). While such measures are easily computed for a variety of markets and firms, they are confounded by current levels of risk pricing. For instance, when the market price of risk is high, options-implied risk neutral probabilities will be high, even if the physical probabilities of tail events have not increased. In comparison, the CoVaR and SES measures are computed from realized tail events, and thus do not depend on the pricing of risk, while DIP uses a CDS implied insurance costs that do depend on the pricing of risk. Of course, even CoVaR and SES are indirectly influenced by the pricing of risk as realized market prices are partially moved by changes in the pricing of risk. This is a theme that we will discuss in detail in the section 5.C. on asset markets.

The fact that systemic risk measures---and any market based indicators---reflect the pricing of risk is not necessarily a disadvantage. In fact, Kocherlakota (2012) argues that risk neutral probabilities are essential to the formulation of economic policies as such probabilities reflect the value that society places on resources in various states of the world.

### Network measures

Network measures map interlinkages between firms, help to identify key nodes or clusters, and can be used to simulate how a shock, such as the distress of a firm, could be amplified through the network. An example applied to the international banking system based on public data can be found in (Garratt, Mahadeva, and Svirydzenka, 2011) Using this measure, they show how the degree of interconnectedness has changed, from tight linkages among only a few countries to tight linkages among many countries following the introduction of the European union, indicating the potential for greater contagion. Another example is based on detailed data for Brazilian banks for 2007 and 2008 (Cont, Moussa, Santos, 2012). Using data on exposures, they estimate the potential for systemic risk based on the expected loss to the banking network conditional on the default of a firm in a macroeconomic stress scenario, and also provide evidence that counterparty exposures are more important than size in determining the contribution to systemic risk of an institution.

Measures of derivative market networks of central counterparties (CCPs), dealers, and firms can be derived from detailed data on positions in credit default swaps (CDS) reported to the DTCC Trade Information Warehouse (Brunetti and Gordy, 2012) (chart 7). The position data allow the identification of firms that are central to the transfer of risk from buyers to sellers. Based on the snapshot of positions in 2010, they find that CCPs are central to the network, dealers are interconnected among themselves, and non-dealer buy-side firms tend to trade primarily with a single dealer. These types of network measures will be important for monitoring systemic risk as more OTC derivatives transactions are moved to CCPs, away from bilateral transactions.

Network stability may also be impacted by CCP margin requirements. Margins insulate CCPs from shocks to securities values and counterparties, but changes in margins can trigger fire sales as members sell assets to meet their margin calls. Relevant information to monitor includes the level of margins and haircuts, which institutions hold what type of collateral with what clearing counterparty, and how margin/haircut policy might change in response to deteriorating market conditions (chart 8).

## **B. Shadow banking**

Shadow banking generally involves financial intermediation, both credit and maturity transformation, without an explicit government backstop (see Adrian, Ashcraft, Boesky, Pozsar (2010) and Adrian and Ashcraft (2012a,b), Stein (2010), and Sunderam (2012)). The core of the shadow banking system before the crisis consisted of securitized credits, mortgages, and loans, which were sold by originators to various leveraged entities including traditional banks, asset-backed commercial paper (ABCP) programs, and collateralized debt obligations (CDOs). Shadow banking liabilities increased dramatically in absolute size (as well as relative to traditional commercial banking liabilities) in the years leading up to the financial crisis (chart 9), but they plummeted during the crisis, and since then have ebbed even further.

Shadow banking poses a greater systemic vulnerability when market leverage is high, wholesale short-term funding and maturity transformation is high, and new financial products that transform risks through opaque or not-well-understood structures are proliferating. In the run-up to the financial crisis, the shadow banking system involved considerable amounts of maturity transformation and leverage, with illiquid loans to households, businesses, and municipalities ultimately funded with short-term debt in the form of ABCP and repo, which in turn was often held by money market mutual funds (MMFs) whose investors expected liquidity upon demand. The combination of maturity and liquidity mismatches and credit transformations made the shadow banking system highly vulnerable to various shocks. In addition, many of the risks in the shadow banking system were poorly understood by investors or borne by institutions that would provide discretionary support in the event of adverse event (see Gennaioli, Shleifer, Vishny, 2012).<sup>6</sup>

Specific aspects of shadow banking to monitor include wholesale short-term funding markets, dealer-intermediated finance, and securitizations and other new financial products that transform risks. In addition, hedge funds, private equity funds, and other wealth management funds may be monitored to the extent that they engage in some activities that involve transformations of maturity, liquidity, and credit risk. The participation of insurance companies and pension funds in activities such as securities lending and the provision of tail risk insurance in credit markets that facilitate shadow banking should also be monitored.

It is beyond the scope of this paper to explain all aspects of shadow bank vulnerabilities, as the shadow banking system comprises many different entities and activities. In addition, the types of entities and activities which are of particular concern will change in the future, in response to new regulations. Consequently, rather than provide a comprehensive overview, we discuss a number of examples.

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<sup>6</sup> See also Governor Tarullo's speech on shadow banking after the financial crisis <http://www.federalreserve.gov/newsevents/speech/tarullo20120612a.htm>.

### Wholesale short term funding

Tri-party repurchase agreements (repo) and asset-backed commercial paper (ABCP) are two main sources of wholesale short-term funding in the shadow banking system. Financial commercial paper (FCP) and uninsured certificates of deposits (wholesale CDs or brokered deposits) are also a source of runnable funds for financial firms. Other securities that provide significant amounts of maturity transformation in the shadow banking system include variable rate demand obligations (VRDOs) and tender option bonds (TOBs). Primary classes of investors in these funding instruments are 2a-7 MMFs and other cash management funds. We focus on ABPC, tri-party repo, and MMFs for illustrative purposes.

ABCP and tri-party repo volumes rose sharply prior to the financial crisis, and have declined significantly since then (chart 10). ABCP peaked in July 2007 (corresponding to the onset of the first phase of the financial crisis), while repo peaked in September 2008 (corresponding to the second phase). The contractual underpinnings and usage for ABCP and repo differ, but they share the commonality of being fragile markets because they provide maturity transformation without direct, explicit public sources of liquidity or credit backstops. The lack of public backstops makes such funding vulnerable to coordination failures at times, and can represent a source of systemic risk.

ABCP is a means of funding bankruptcy remote conduits which hold loans and receivables or securities such as mortgages and bank debt. Most conduits are overcollateralized and have backup sources of liquidity from sponsoring commercial banks. The rapid expansion of ABCP conduits from 2004 to 2007 was accompanied by fewer protections. For example, many SIVs were marketed without backup liquidity. The vulnerabilities of ABCP conduits have been documented in detail by Covitz, Liang, and Suarez (2012), who show that investor runs on conduits led to a 40% drop in outstanding ABCP in just a few months, and that conduits that were backstopped by weaker commercial bank sponsors or lacked liquidity lines were more likely to be run. In retrospect, the unusually rapid growth in this market indicated an increasing vulnerability of sponsoring institutions to a change in economic conditions. Such conduits were considered off-balance sheet by accounting and regulatory rules until 2011, but changes in accounting rules since then would require firms to now consolidate most such conduits. The trigger for the run on ABCP was likely the possibility of program-level exposures to the collapsing U.S. housing market. However, Covitz, Liang, and Suarez (2012) document that ABCP programs with little if any exposure to the U.S. housing market were also run in 2007, suggesting that the broader market was caught up in the run dynamic.<sup>7</sup>

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<sup>7</sup> Arteta, Carey, Correa, Kotter (2010) and Kacperczyk and Schnabl (2009) for additional insights on the commercial paper market.

While the ABCP market is now notably smaller and has more explicit support, it still can be an amplification channel for adverse shocks. Investors, notably MMFs, are likely to pull back owing to classic coordination failures in short-term funding markets and because conduits may not be transparent, so risks are not well understood. Measures of fragility include increased volumes, weak forms of credit and liquidity support, and illiquid conduit assets.

The tri-party repo market is the main source of funding for the security broker-dealer sector, traditionally secured by Treasury and agency debt as collateral. However, the tri-party repo market experienced a marked decline in the quality of collateral in the run-up to the financial crisis, similar to the deterioration in the ABCP market, with a greater share consisting of ABS, whole loans, and equities. While the share of less-liquid collateral has declined since the financial crisis, there continues to be a significant fraction of such collateral in the tri-party repo market. In addition, a fraction of tri-party repo financing is used to fund the dealer's own securities positions, whether these are held for purposes of making markets or other reasons. The remaining funding from tri-party repo is passed onto the clients of dealers in the form of delivery versus pay repo (DVP repo), and among dealers via general collateral finance (GCF repo).<sup>8</sup>

Tri-party repo refers to an infrastructure provided by tri-party clearing banks that manage the collateral of borrowers. Because repo is a fully collateralized lending transaction, the lender is protected from borrower default. In addition, borrowers believe they are protected from lender default, as the collateral never leaves the tri-party repo platform. However, this protection is primarily about the custody of their collateral; potential credit or liquidity issues in the case of the default of a lender pose a significant credit and liquidity risks. Additional advantages of tri-party repo owe to the fact that the clearing bank extends daily intra-day credit. This intra-day credit is of large value to lenders and borrowers, as tri-party repo transactions are unwound daily. Clearing banks thus extend an implicit, non-contractual guarantee to borrowers during the day, which represents a major concern for financial stability. The clearing banks effectively guarantee over a trillion dollars every day, some of which is against illiquid collateral. In addition, some types of collateral used in tri-party repo are subject to fire sale externalities. If lenders' confidence in repo borrowers evaporates, borrowers might be forced to unwind positions, which makes collateral less valuable in illiquid markets, and thus generates a potentially powerful amplification mechanism of forced deleveraging.

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<sup>8</sup> The importance of repo for the security broker-dealer sector was first documented by Adrian and Fleming (2005) and Adrian and Shin (2010). The mechanics of repo borrowing were described by Fleming and Garbade (2003) for GCF repo, and Garbade (2006) for DVP repo, and Martin, Copeland and Walker (2010) for tri-party repo. An additional source of wholesale funding consists in securities lending transactions, which are described in detail by Lipson, Sabel, and Keane (2012) and Adrian, Martin, Copeland, and Begalle (2013). Krishnamurthy, Nagel, Orlov (2012) report repo market measures based on money market mutual fund filings.

Repo funding is passed on by the security broker-dealer sector in the DVP repo market. The DVP repo market itself is also a source of fragility, a fact that was amply documented by Gorton and Metrick (2012). Haircuts tend to increase sharply in the DVP repo market in times of market stress, which effectively forces repo borrowers to deleverage, an important risk management tool for the dealer sector. In contrast, haircuts tend to be stable in the tri-party repo market, and tri-party repo lenders instead tend to withdraw funding suddenly.

While the repo market is now considerably smaller than in 2008, it remains a critical area to monitor. Signs of increasing vulnerabilities to the financial system include increased volumes, less liquid collateral, lengthened maturities, narrowed haircuts, and thinned capital and liquidity of broker-dealers. Among these determinants, the key ingredients to repo market instability have proven to be the liquidity of repo collateral, and the maturity structure of repo. Since the financial crisis, in addition to the decline in repo market size, the quality of collateral has improved. Additional characteristics that are desirable include the network of counterparties in the repo market, data that is only partially available through filings of money market fund holdings.

The primary lenders into tri-party repo are money market mutual funds or stable-value cash-management products. While a range of such products exist, with correspondingly varied regulatory frameworks, the predominant is a 2a-7 fund. The SEC imposes tight investment restrictions on such funds to protect investors, but such restrictions have no ameliorative impact on the instability of such funds. 2a-7 funds hold assets that entail credit and interest rate risk, but still offer investors a constant net asset value, provided that actual net asset values do not fall more than a half a percent below that constant value. Importantly, this rounding mechanism provides investors with an incentive to redeem shares (i.e., run) if any threat to the value of MMF portfolios emerges.

The potential damage from this flawed business model was forcefully illustrated in the aftermath of the Lehman bankruptcy in September 2008. The Reserve Primary Fund had exposure to Lehman and could no longer maintain a stable NAV, triggering a broad run with nearly half a trillion dollars flowing out of prime MMFs to Treasury-only MMFs by the end of October 2008 (McCabe, 2010). This run, in turn, exacerbated the fragility of short-term funding markets and generated shortages for commercial paper and repo issuers. In response, the Federal Reserve instituted the Asset-Backed Commercial Paper Money Market Mutual Fund Facility (AMLF) to provide a public backstop through commercial banks for ABCP issuers (Duygan-Bump et al, 2013) and a Commercial Paper Funding Facility (CPFF) as a public liquidity backstop for commercial paper issuers more broadly (see Adrian, Marchioni, Kimbrough, 2011). While these facilities supported the CP markets, runs by money market investors were addressed more directly by the public guarantee provided to MMFs by the U.S. Treasury.

Some steps have been taken since the crisis to mitigate the risks arising from money funds, including SEC regulations for stronger liquidity requirements to reduce maturity transformation and greater reporting requirements. MMFs now are required to report their asset holdings to the SEC on a monthly basis, and exposures are subsequently made public by the SEC with a two-month lag. These data allow more effective monitoring of MMFs portfolios. For example, holdings by U.S. prime MMFs of short-term paper (CP and CDs) issued by European financial institutions were substantial at the time reporting started in Dec. 2010, and have declined significantly as the European sovereign and financial debt crisis intensified in 2011 (chart 11). This decline is somewhat reassuring from a financial stability point of view as MMFs fairly quickly reduced their exposures to debt that has been rendered more risky. However, the lack of any loss absorption buffer maintains the risk that a loss in the value of European financial paper will lead to a “break the buck” event by a MMF. Moreover, while the maturities of assets shortened (chart 12), reducing the risk that an individual MMF would have to liquidate assets to meet redemptions, the shortening of asset maturities increases the rollover risk to issuers.

#### Dealer-intermediated finance

The recent crisis illustrated that a significant amount of financing is intermediated outside of the traditional banking system and through, in one fashion or another, the dealer community. Dealers act as intermediaries for the market-based system, covering trading in equities, rates, credit, derivatives, FX, and commodities. Relative to commercial banks, broker-dealers are highly levered. In part, the lower capital ratios for the broker-dealers reflects that the asset side of the balance sheet is quite different, with a high share of assets in very liquid, relatively low-risk securities, and the share of assets in loans, which are less liquid and generally more risky, relatively small. This balance sheet contrasts sharply with that for the commercial banks with a large share of assets in loans. Moreover, liabilities of broker-dealers are primarily wholesale short-term secured funding, which is much less reliable in times of stress than insured deposits.

The leverage of security broker-dealers tend to be highly pro-cyclical, more so than for commercial banks. Data on broker-dealer subsidiaries in the U.S. show a dramatic decline in capital ratios in the years leading up to the financial crisis as perceived risk, often approximated by the VIX or credit spreads, fell to low levels, and accordingly asset values rose to high levels, which permitted more repo financing. Adrian and Shin (2010) document this pro-cyclicality, and point out that financial crises correspond to extreme outcomes in this leverage cycle.

The leverage cycle of security broker-dealers can be viewed as a representation of risk-taking activity in a market-based financial system. When market volatility is low, risk management constraints are low, allowing the buildup of leverage. That leverage tends to compress the market pricing of risk, but makes the market-based financial system vulnerable to adverse shocks. When economic conditions turn, the dealers’ clients are forced to reduce their

risk-taking activities, which is visible as a deleveraging of dealer balance sheets. As a result, risk premia increase and volatility increases endogenously. Deleveraging can be sharp if the broker-dealers are highly levered and funded with more short-term debt, and could generate fire sales especially if the risks are opaque.

To monitor conditions of dealer intermediated finance, the Federal Reserve started in 2010 a quarterly Senior Credit Officer Opinion Survey (SCOOS), which asks dealers about the provision of credit (Eichner and Natalucci, 2010). The SCOOS is in many ways modeled on the long-established Senior Loan Officer Opinion Survey (SLOOS), which was initiated in the 1960s, and asks commercial banks about their willingness to lend and terms and standards. The SCOOS also allows the qualitative tracking of conditions, as reported by dealers, in markets such as syndicated leveraged loans, prime brokerage, and derivatives trading. Still much more data are needed to track dealer-intermediated financing to monitor leverage in the financial system. For example, new information that will be collected by the SEC on hedge funds and other private funds will be helpful. More detailed data on securities lending by insurance companies, pension funds, and other investors would also help shed light on leverage and maturity mismatch in these markets.

#### Securitizations and New Financial Products

Shadow banking also encompasses financial intermediation that takes place through securities backed by loans that are often originated by depository institutions. The combined quarterly volume of asset-backed security issuance in the form of collateralized debt obligations (CDOs), residential mortgage-backed securities (RMBS), commercial mortgage-backed securities (CMBS), and securities backed by consumer loans (ABS), topped over \$500 billion just prior to the financial crisis, but dropped precipitously during the crisis, and now stands at roughly \$100 billion per quarter (chart 13). Abnormally high volumes of asset-backed security issuance may be an indication of underpriced risk, weak underwriting, and insufficient subordination. High volumes also indicate that the financial system may be relying on a funding model that proved unstable in the financial crisis.<sup>9</sup>

Of course, the risk of structured products can also be measured directly, but doing so is difficult given the complexity and variety of the structures and the assets being funded. In addition, the data necessary to evaluate the credit risk of structured products often are not public. Key determinants of risks include the amount of subordination, the structuring of payment waterfalls, the nature of liquidity or credit backstops from banks and insurance companies, and the quality of the underlying collateral. Since the financial crisis, there has been a move away

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<sup>9</sup> Covitz, Campbell, Pence, and Nelson (2011) argue that runs in short-term credit markets in 2008 led to an evaporation of funding for highly-rated tranches of asset-backed securities.

from using credit ratings to summarize these risks. This move is for two reasons. First, regulators per DFA are no longer allowed to tie regulations, such as the risk-weighting of capital and liquidity standards, to credit ratings. Secondly, experience has shown that credit ratings are an oversimplification of underlying risks. The risks embedded in structured credit products tend to be much more complex and multi-dimensional than the risks of corporate debt. Efforts to make more data about the collateral and the structure of these products to investors are important to reduce the potential for contagion.

A key element of a monitoring program should track the adoption of new structures and products that provide financial intermediation and transform risks in novel ways. Some new products are intended to arbitrage new capital and liquidity regulations, such as short-term liabilities with maturities just beyond the proposed LCR regulatory limits. Others may involve implicit leverage or transformation of risks in opaque ways. One example is synthetic ETFs, which have been growing in number, size, and complexity. While the SEC recently imposed a moratorium on approval of new synthetic ETFs in the U.S., they continue to grow dramatically in Europe, and there are concerns that they could transmit shocks to U.S. markets. A synthetic ETF may replicate the returns of an index by using derivatives, rather than the underlying assets, and thus may be complex and face additional risks, such as counterparty risks. Other examples are bond ETFs, which create liquidity for a basket of underlying stocks, bonds, or derivatives that are likely less liquid than the ETF shares.

### **C. Asset Markets**

Overvalued assets constitute a fundamental vulnerability because the unwinding of high prices can be destabilizing, especially if the assets are widely held and the values are supported by excessive leverage, maturity transformation, or risk opacity. However, it is difficult to determine ex-ante, whether prices are justified by fundamentals, including potential systemic losses in bad tail events. Given these difficulties, a systemic risk monitor has to look beyond mispricing of assets. It needs to consider the level of asset valuations in conjunction with investor leverage and maturity mismatch, liquidity of the securities, underwriting standards, and other sources of evidence for building imbalances that usually accompany mispricing. Moreover, asset valuations may be an indicator of a broader buildup in risk taking.

The abrupt reversal of high asset valuations typically has caused systemic risk when it is accompanied by disorderly deleveraging. For example, the correction of valuations in equity markets in 2000 and 2001 following the tech boom of the 1990s, did not result in systemic risk, as it was not funded with excessive leverage and maturity transformation. In contrast, the collapse of house prices or credit valuations have often been accompanied by systemic financial episodes, as those asset classes typically are funded via highly levered balance sheets that employ substantial amounts of maturity transformation. Asset valuations thus are monitored in

conjunction with the financial institutions and other investors that hold those assets. Adrian, Etula and Muir (2012) and Adrian, Moench and Shin (2009) empirically demonstrate the tight link between asset valuations and balance sheet developments across asset markets.

Asset valuations are assessed with models, non-price measures of “hot markets”, and market commentary. However, survey based expectations of asset price developments are often contrarian indicators, at least in equity markets where analysts typically expect further asset price rises at the peaks of expansions, and further asset price declines at the onset of recoveries (See Amromin and Sharpe, 2008, for an empirical analysis of the cyclicity of investor expectations). In Treasury markets, similar systematic expectations errors have been documented (see Froot (1989), Piazzesi and Schneider (2011), Esupi and Moench (2013)).

Asset valuations consist of two components: the discounted future cash flow using a risk free rate, and a risk premium that compensates investors for the riskiness of future cash flows. Any changes in asset prices reflect both cash flow news due to changes in cash flow expectations and discount rate news due to changes in risk premia. In tracking asset valuations for financial stability purposes, both cash flow and discount rate components contain potentially useful information. For example, the widening of credit spreads will generally reflect investors’ expectation of higher losses, as well as the more expensive pricing of risk of future losses. Asset pricing models formally decompose asset price movements into cash flow and discount rate moves, and thus allow the decomposition of yields and spreads into risk neutral expectations of future cash flows and risk premia. Risk premia are mean reverting, both empirically and theoretically. As such, compressed risk premia that correspond to elevated assets prices are expected to revert, and might pose risks to financial stability.

Risk premia are also key indicators of the buildup of system risk among financial intermediaries. In an environment of lower contemporaneous volatility, financial institutions’ risk taking constraints are looser, allowing them to increase their risk taking. Due to the low effective risk aversion of intermediaries, equilibrium compensation for risk bearing is compressed precisely at times when risk taking is largest. Systemic risk therefore tends to build precisely when market volatility and risk premia are low. The observation that systemic risk can build when measured risk is low is documented by Adrian and Brunnermeier (2008), and modeled by Brunnermeier and Sannikov (2011) and Adrian and Boyarchenko (2012).

The time variation in effective risk aversion (or, its inverse, the risk appetite) happens across financial institutions, but with different mechanisms. For dealers (as explained above), the key constraint that regulates effective risk aversion is the measured risk of securities (as for example measured by the VIX for equities). The institutional constraints for the dealers are risk management constraints such as value at risk or capital constraints from stress scenarios against which the institution needs to be well capitalized. For commercial banks, the risk management

constraints that pin down effective risk aversion are slightly different. In particular, banks tend to manage risk by calculating risk measures on their credit portfolio. As economic conditions and loan performance worsen, banks must increase provisions, reserves, and regulatory capital, thus effectively constraining the ability of banks to provide loans and mortgages. Interestingly, commercial bank lending standards tend to tighten as VIX increases, indicating the constraints that regulate the effective risk taking of banks tend to be surprisingly similar to the constraints on market-based financial institutions such as the dealers (Bassett, Chosak, Driscoll, Zakrajsek (2012)). Other institutions, such as insurance companies, hedge funds, or other asset managers similarly face various risk management and funding constraints that generate time-varying effective risk aversion, which in turn impacts the pricing of risk and the amount of risk. Additional monitoring and research on the risk-taking behavior of these institutions, and the constraints under which they operate, is needed.

A large academic literature over the past decades has documented that the majority of movements in asset prices is due to discount rate news, and thus reflects movements the equilibrium compensation for risk across various securities markets. For example, the time variation in Treasury securities is primarily due to changes in the pricing of risk rather than due to changes in expectations of future short rates (see the seminal contributions of Campbell and Shiller (1984) and Cochrane and Piazzesi (2005)). Similarly, the majority of variation in credit spreads is due to investors' compensation for the risk of potential credit losses in the future rather than expected losses (see for example Elton, Gruber, Agrawal, Mann (2001) and Huang and Huang (2003)). For equity prices and house prices, pricing measures such as the dividend payout or the price-to-rent ratio tend to exhibit large, persistent swings (see Campbell and Shiller (1988) for equity returns and Case and Shiller (2003) and Campbell, Davis, Gallin, Martin (2009) for the housing market) again indicating that risk premia vary over time.

Asset valuations monitoring encompasses the equity market including equity options, interest rates and interest rate volatility, credit markets, real estate markets, commodities, as well as exchange rates. The international counterparts to these markets can also be monitored. While a discussion of valuation metrics for all of these markets is beyond the scope of this paper, we will focus on a number of examples that appear particularly relevant for financial stability.

### Equity Securities

Risk premia have been studied extensively in equity market. Many theories link the level of expected returns to consumption, thus explaining the overall level of equity risk premia with measures of consumption growth, tail risk in consumption, uncertainty about consumption growth, long term consumption growth, or the "habit" in consumption growth. Despite an extensive academic literature, the linkage between consumption and equity risk premia remains difficult to establish empirically. As a result, we propose a pragmatic approach to measure equity risk premia.

The most popular way of computing the equity premium is by using a present discounted value formula (essentially elaborated versions of Gordon's growth formula). A complementary way to identify equity risk premia is by exploiting the insight that any predictability of equity returns must reflect the time variation of compensation for risk if markets are arbitrage free. The predictable component of equity returns can thus be used to back out the equity risk premium. A long literature has shown that variables such as the dividend yield, the short rate, the slope of the yield curve, implied volatility and macroeconomic variables such as inflation have marginal predictive power, in particular at longer horizons.

In order to assess systemic risk vulnerabilities from equity market reversals, the extent to which levered balance sheets are exposed to pricing reversals needs to be investigated. Holdings of equities can be compiled from various sources, including the SEC's 13F filings and other regulatory filings. In general, equities tend to be held by fully funded institutions such as mutual funds or by equity hedge funds which tend to have fairly low leverage. However, the emergence of levered ETFs might give rise to a new class of leveraged equity investors that could be potentially large, and pose significant threats to financial stability. After all, the 1987 crash was caused by the portfolio insurance policies of equity investors, who tended to use dynamic hedging strategies, a form of embedded leverage. While such portfolio insurance strategies have since largely disappeared from the equity investing universe, similar strategies are employed by levered ETFs.

Another example of potential vulnerability in equity markets arises from high frequency trading, which has been rising rapidly in recent years. The Flash Crash in May 2010 illustrates the dangers associated with high frequency trading algorithms. If a large market move gets triggered by a mistake, it could trigger a chain reaction of sales from various algorithms. In the Flash Crash, the Dow Jones fell 600 points in a 5-minute interval (between 2:42 pm and 2:47 pm), before recovering nearly completely by 3:07 pm. A monitor should track the growth of new structures and products designed for regulatory arbitrage or that otherwise seem unstable to better evaluate whether responses might be necessary to reduce potential systemic risks

### Treasury Securities

Treasury valuations are measured by estimating dynamic term structure models that capture the time variation of risk premia in arbitrage free settings (see Campbell and Shiller (1984, 1991) and Cochrane and Piazzesi (2005) for evidence on the time variation of risk premia in the Treasury market). There are a variety of such dynamic models of interest rates, including Kim and Wright (2005), Adrian, Crump, and Moench (2012), and Christenson, Diebold and Rudebusch (2009). All three models are affine term structure models that can be updated daily and exploit the insight from finance theory that when markets are arbitrage free, excess return predictability implies a risk premium. This insight identifies the risk premium as the

forecastable component of Treasury returns relative to the expected returns on the strategy of rolling over investments in short-term risk-free securities. The models vary by the number of state variables used to capture the evolution of the term structure, and the use of other data, such as survey forecasts of future short rates.

Despite differences in assumptions and estimation, the three affine term structure models produce similar estimates of term premiums (chart 14). The estimated 10-year Treasury term premium exhibited a pronounced compression in the run-up to the financial crisis between 2003 and 2006, then widened during the crisis from 2007 to 2009, and has since declined markedly. In particular, term premia currently are at very low levels by historical standards. Such low levels of term premia have not been measured since the 1960s. The low term premia reflect a number of factors: the Fed's large scale asset purchases and the flight to quality away from risky assets into Treasuries. Low Treasury risk premia, if reversed unexpectedly, could give rise to financial instability, if interest rate exposure is high on levered balance sheets. One way to understand this exposure is by pointing out that the amount of leverage to achieve a given ROE target has increased significantly in recent years given lower interest rates. Even though there is anecdotal evidence of lower ROE targets since the financial crisis, the low yield environment in recent years generates incentives to increase leverage in order to increase returns.

### Corporate Debt

Investor risk-taking in corporate fixed income markets can be assessed by evaluating risk spreads on corporate bonds or loans. In addition, the volume of debt issuance and non-price terms, such as covenants, also need to be monitored. A risk-averse investor should require a spread to compensate for expected losses and for investing in a risky security relative to a riskless security. One way to estimate risk-taking behavior is to measure the amount of compensation required for risk as the residual of the risk spread and the compensation for expected losses based on a model of physical expected losses.

Risk-taking behavior can also be approximated from the term structure of corporate bond spreads. Forward spreads on corporate bonds for different periods can be evaluated. One advantage of monitoring corporate bond spreads far out the term structure, such as between years 9 and 10, is that it allows for an assessment of changes in the price of risk without having to control for changes in investor expected-default rates and recovery rates, under the assumption that investor expectations of credit risk far into the future are time invariant (chart 15) of near and far-forward spreads). In the plot, BBB-rated forward spreads between 9 and 10 years ahead were quite low in 1997. This suggests that the price of risk was quite low in 1997. And indeed, this is a time when some have argued ex post that corporate bonds were indeed overvalued (Altman and Armon 2002).

However, because the expected risk of loss can only be estimated, valuations are difficult to gauge in real time with certainty. Trends in non-price terms of debt securities can be used to supplement an assessment of the market's pricing of required returns. Periods of greater issuance by lower-rated firms, accompanied by looser non-price terms, such as rising debt multiples or fewer covenant protections for lenders could be signs of increased investor risk taking (chart 16). The rapid issuance of junk bonds and weakening deal structures in the LBO wave in the late 1980s led to reduced returns (Kaplan and Stein, 1993). Corporate bond returns appear to decline following periods of low-quality bond issuance (Greenwood and Hansen, 2012), and institutional demand pressures that lead to reduced time in syndication for leveraged loans result in lower loan yields (Ivashina and Sun, 2010).

Losses on credit instruments are more likely to be destabilizing to the financial system if they are held by leveraged investors. The losses on junk bonds issued in the late 1980s were amplified because leveraged savings and loans were significant investors in these bonds, a contributing factor to the recession in the 1990s. While real money investors, such as mutual funds, insurance companies, and pension funds, are major investors in debt securities, there also was substantial demand from CDOs and CLOs and other leveraged investors in the run-up to the recent crisis. Moreover, losses could be amplified if corporate debt securities are less liquid than the investment funds that pool these securities, such as mutual funds and ETFs.

### Residential Real Estate Prices

The literature that assesses the valuation of housing prices usually starts with a discounting formula linking the rent to price ratio to the current real interest rate, a house price risk premium, and the expected future capital gain from home ownership (see Campbell, Davis, Gallin and Martin (2009) and Himmelberg, Mayer and Sinai (2005)) (chart 17). Estimates of housing price valuations find that all three components are important determinants of house price movements, and importantly point to the role of risk premia and price expectations. While some observers attributed the run-up in housing prices in the early 2000s primarily to the decline in real interest rates, others pointed out that risk premia and housing expectations were particularly important (see Case and Shiller (2003) for early proponents of the view that housing valuations were reflecting an asset price bubble). With hindsight, too little weight placed by analysts on the likelihood of a bad tail outcome (Gerardi, Lehnert, Sherlund, Willen (2008)) and inflated expectations about future house price growth played an important role in the run-up to the crisis (see Cheng, Raina and Xiong (2012) for indirect evidence on house price expectations by Wall Street professionals).

A primary determinant of the pricing of risk in the housing market is the supply of credit, as the vast majority of new home purchases are financed via mortgage credit. In the run-up to the crisis, incentive problems within the SIFI institutions, in the shadow banking system, and among the thrifts combined with lax regulations led to a deterioration of underwriting standards,

although this deterioration is more clear in hindsight (chart 18). As a result of easy lending standards, house prices were pushed up. In fact, cross-sectional studies show that the house price boom and bust was more severe in areas that experienced laxer underwriting standards, had a larger share of subprime borrowers, had a larger share of second liens, and experienced a bigger household leverage cycle (Mian and Sufi (2009, 2010, 2011)). In addition, there is evidence that the failures in underwriting standards enabled more speculative borrowing in the regions that experienced the largest boom and bust cycle (Haughwout, Lee, Tracy, and Van der Klaauw (2011)). This evidence suggests again that house price valuations have to be analyzed in conjunction with underwriting conditions by financial intermediaries. The systemic impact of the house price decline was ultimately attributable to the risk taking behavior of the financial system in the run up to the crisis.

#### **D. Nonfinancial Sector**

Research has identified excessive credit in the private nonfinancial sector as an important indicator for the buildup of systemic risk (see Borio, Drehmann, Tsatsaronis (2011), Borio, Furfine, Lowe (2001), Borio, White, (2003)). A first-order transmission channel for a systemic financial crisis to affect the real economy is via wealth effects of the household and nonfinancial business sectors. The leverage of these sectors, as well as their reliance on short-term nonbank deposits for funds, can amplify the wealth effects. As highly indebted households and nonfinancial businesses are less able to withstand negative shocks to incomes or asset values, they may have to sharply curtail spending in ways that can reinforce the effects of the shocks. For example, in the nonfinancial business sector, leverage, debt defaults, bankruptcy, or covenant violations force firms to cut back on investment or employees, potentially amplifying the initial declines in spending if cutbacks are widespread (Opler and Titman, 1994; Chava and Roberts, 2008; Falato and Liang, 2012; Sharpe, 1994). For households, more highly-levered households are less able to absorb the shock of a house price decline (see Mian and Sufi (2009) who use county-level household data and show the rise in household leverage was a strong predictor of recession severity during 2007 to 2009).

Losses among households and businesses also can lead to mounting losses at financial institutions. Such losses that impair capital adequacy of regulated banks and shadow banks can restrict credit availability and further reduce aggregate demand, through an adverse feedback loop, in which less aggregate demand reduces the value of collateral and makes it more difficult for the nonfinancial sector to service their debt, further increasing losses to the financial sector (see e.g. Benanke and Gertler (1989), Gertler and Kiyotaki (2012)).

Measures of vulnerabilities in the nonfinancial sector include variables such as leverage and debt service burdens. Excessive leverage and mispriced risks are difficult to identify, so a

monitor should also include indicators of credit availability, such as underwriting standards on new credit extensions for households and businesses, which bring additional evidence to bear. In addition, for each sector, it is important to analyze conditions in the tails of the distributions of leverage or net worth, as households with below-prime credit scores or businesses with speculative-grade ratings are more vulnerable than segments with higher income or wealth. Moreover, as the last financial crisis illustrates, debt cycles for the different sectors may not move in lock-step; while rapid household debt growth proved unsustainable in the lead-up to the financial crisis, leverage and the credit quality of most nonfinancial businesses were at moderate levels, and the business sector was not a major vulnerability in the crisis. Of course, some non-financial corporations were involved in shadow banking activities through the ownership of finance companies and special purpose vehicles for the funding of receivables. Many such companies were caught up by the funding problems during the crisis.

#### Aggregate private nonfinancial sector leverage

Nonfinancial sector debt growth and debt-to-GDP ratios are basic aggregate indicators of leverage. Excess leverage can be proxied by high growth rates in excess of GDP growth for sustained periods. Another measure—credit-to-GDP gap ratio—is the difference between the actual and trend credit-to-GDP ratio, where the trend adjustment captures that credit cycles are longer than business cycles (chart 19).

A caveat that applies to credit-to-GDP gap measures is that they are difficult to gauge in real time. Edge and Meisenzahl (2011) document difficulties for the private nonfinancial sector in the U.S. This difficulty of calculating unusual growth in credit-to-GDP in real time comes down to the challenge of distinguishing permanent from transitory shocks, both from a statistical as well as a heuristic point of view. Statistically, the challenge is a potential structural break because sometimes financial innovations occur that are accompanied by a structural shift in credit-to-GDP or other leverage measures. While those structural breaks can be estimated in retrospect, they are very hard to detect in real time, as one has to allocate any movement in the leverage measure as being either permanent or transitory. Heuristically, the challenge is that times of large imbalances are usually accompanied with reasonable stories why such imbalances represent fundamental changes. For example, in the run-up to the recent financial crisis, commentators and policy makers attributed the substantial rise in household leverage to the improved ability of the financial system to distribute risk via securitization techniques and related financial innovations. In fact, the Great Moderation was cited as evidence that the economy was able to support the much greater leverage. In retrospect, those arguments proved wrong, but they were extremely convincing at the time.

### Nonfinancial businesses

Data on balance sheets and income statements for individual firms, in addition to the aggregate nonfinancial sector, provide valuable information about the weaker parts of the sector, which could be masked by aggregate leverage or profits. For example, the aggregate debt-to-asset ratio for nonfinancial businesses has been at moderate levels for the past few years, and the gap between the aggregate and the 90<sup>th</sup> percentile firm is narrow (chart 20). However, in previous periods, such as in 2003, the top decile firm had much greater leverage than the aggregate, indicating greater vulnerability among the weaker firms to a slowdown in activity or other shock at that time than has recently been the case. In addition to indebtedness, businesses that have more short-term funding are more vulnerable, as investors in short-term funding markets tend to pull away at the first sign of trouble, causing firms to have to scramble for funds or to curtail operations or sell assets.

Prolonged periods or excessively loose lending standards and terms on credit may be an indicator of future vulnerability of businesses. For example, in addition to narrow credit risk spreads, high debt-to-earnings multiples at origination could indicate greater risk-taking by lenders and borrowers, and raise the vulnerability of this sector.

Data for the nonfinancial business sector are available in the aggregate from sources such as the FOF, and detailed data for publicly-traded corporations are available based on quarterly and annual reports and other financial statements. For firms that are not publicly-traded, including likely those taken private in leveraged buyouts and are among the riskier firms, firm-level data are not available, and even aggregate data are not available except with a substantial lag.

### Households

As with nonfinancial businesses, data for individual households or segments of the household sector are especially valuable to assessing the vulnerability of the sector. In the run-up to the financial crisis, disaggregated data have shown that increases in debt-to-asset ratios and debt service burdens were more pronounced for lower credit quality borrowers, those least able to accommodate a decline in house prices or employment. Data on the geographic concentration in mortgage debt and LTVs would also be useful, as high LTVs were highly concentrated in specific areas, such as Las Vegas and cities in Florida, making those areas more vulnerable to a downward spiral in the event of a negative shock to house prices.

In the past few years, as the economy has recovered, increases in net worth appear to have been concentrated among households in the upper decile of the wealth distribution, while households in the middle of the distribution (the 40<sup>th</sup> to 59<sup>th</sup> percentile) have seen their net worth decline by 40 percent since mid-2007. This net worth distribution, along with the high

geographic concentration, suggest that segments of the household sector remain quite vulnerable to shocks to income or house prices, which could be amplified to lenders and the broader economy.

For example, the share of mortgages that are underwater and the still tight credit conditions for new residential mortgages since the financial crisis leave the household sector especially vulnerable to a downturn in the economy or further house price declines (chart 21). These stressed households are less able to refinance and take advantage of the lower mortgage rates created by accommodative monetary policies. At the same time, a lack of prudent underwriting standards for student loans likely is contributing to the recent rapid growth in student debt, which may create a substantial financial burden for some households in the future.

Investors and financial stability authorities can monitor underwriting standards for borrowers by credit quality and geographic areas using detailed data from credit bureaus and other data vendors. Such detailed data are important to regaining and preserving confidence in securitized products. In contrast to data for businesses, making the necessary data on households widely available raises important challenges about how to include important protections to maintain privacy.

### Government Debt

The fiscal debt situation in Europe clearly indicates that excessive sovereign debt, or tight linkages of banking and sovereign debt, can lead to systemic risk. Concerns by market participants that sovereign debt is excessive can force governments to impose fiscal austerity measures—raise taxes or cut spending—often when GDP growth is already weak. Such measures can increase the odds of a feedback loop, in which greater austerity causes growth to slow further, making it even more difficult to achieve debt reduction targets. Such a slowdown can also increase risks to the financial sector, especially if the household or business sectors are levered or otherwise vulnerable to a slowdown. In addition, if sovereign debt is held largely by the domestic banking sector, then concerns about the sovereign's ability to service its debt amplifies the risk that banking firms might also not be able to service their own debt, generating a severe adverse feedback loop.

In the U.S., federal government debt has jumped since the crisis to about 70 percent of GDP, near its WWII highs, though it is elevated partly because of the recent below-trend GDP growth. While the level of the current debt-to-GDP ratio may not indicate the sector is especially vulnerable to a pullback from investors and a sharp rise in borrowing costs, the expected growth of entitlements if the programs are left unchanged could lead to greater concerns about the ability to continue to service the debt and remain productive. Nonetheless, the sector is vulnerable if the credit rating agencies were to materially downgrade the debt, to

reflect concerns about the ability of policymakers to make the necessary adjustments to put the country on a sustainable path.

The fiscal condition of state and local governments varies widely, with a number of large states burdened with substantially underfunded pensions (Rauh and Novy-Marx, 2010). State and local pension fund assets were roughly \$2.6 trillion in 2011. An estimate from the CRR suggests that the aggregate actuarial funded ratio of state and local plans was 75 percent in fiscal 2011, based on a discount rate of 8 percent, and the funded status would drop substantially to 50 percent if instead a risk-free rate were used to discount liabilities. The Pew Center for States estimated that unfunded pension liabilities-to-GDP averaged about 5 percent in 2010, but was as high as 12 percent for some states such as Illinois. When these off-balance sheet liabilities are added to explicit on-balance sheet debt, ratios exceeded 30 percent for Illinois and eight other states, and reached 28 to 30 percent in other large states such as California, New York, and Ohio.

While these large unfunded liabilities may not pose an immediate threat to financial stability, they increase the vulnerability of financial markets and the economy to possible shocks, as state and local governments may have to increase pension contributions, make other spending cuts, or increase taxes. Such actions could exacerbate already weak local economic activity. Moreover, those municipalities unable to take these actions or restructure their obligations risk losing access to municipal credit markets, especially if their credit ratings are cut.

The scope and magnitude of this potential problem requires significantly better data to facilitate analysis. Currently state and local governments are required to file only an annual statement, and there is no standardized reporting system and plans generally provide very little detail. GASB approved new accounting and reporting standards in 2012 that will increase transparency about discount rates and require that governments report their net pension liability in their financial statements. Even with these reforms, however, monitoring this sector will continue to require very detailed work to follow actions in various states.

## **6. Pre-emptive Policy Responses to Foster Financial Stability**

A systemic risk monitor is necessary to preemptively address financial stability concerns, as identified systemic threats are often necessary to justify the promulgation of new regulations and more stringent supervisory measures.

Financial stability policies are designed to change the systemic risk return tradeoff, illustrated by the *vulnerability* curves in Figure 1 (Section 4). In this framework, more stringent regulatory and supervisory policies can raise the price of risk in periods when potential shocks

are small in order to reduce systemic risk in the event of large adverse shocks; tighter monetary policy can also be a tool because it reduces overall risk taking. Raising intermediation costs with tighter regulations in expansions (when adverse shocks are low) can raise the price of risk, thus lowering the height of the vulnerability curve when adverse shocks are high. In addition to leaning against the wind, some regulatory and supervisory policies may also build resilience of the financial sector. The balance between the higher pricing of risk and the lower level of systemic risk is the crucial policy choice from a financial stability perspective.

The tradeoff between the pricing of risk and the amount of systemic risk in normal times reflects choices of market participants and institutions. As discussed above, there are many economic reasons why private actors might focus primarily on reducing the cost of credit intermediation in good times, with the consequence of increasing systemic tail risks beyond socially optimal levels. In particular, systemic distress typically involves externalities across actors and time. Market participants on their own thus tend to price risk too low in most states of the world when shocks are small. It follows that policies should reduce distortions between the systemic risk-return tradeoff for the financial system as a whole relative to the systemic risk-return tradeoff of individual market participants.

The possible tools to promote financial stability are varied. Most are microprudential tools applied to serve macroprudential objectives, and target firms or sectors, rather than the financial system as a whole. The macroprudential perspective implies that microprudential objectives might be overruled for the benefit of system-wide objectives.

Most of the proposed reforms in DFA and related international efforts are new regulations designed to address structural rather than emerging or cyclical vulnerabilities. Among the most notable regulations are higher capital and liquidity standards for SIFIs and FMUs, a new resolution regime, greater centralization of derivatives trades, and a consumer financial protection mandate. But microprudential tools have largely been developed and evaluated on the basis of the safety and soundness of individual institutions, not with respect to the effects on financial stability of practices that are common to many institutions, and it will be important to continue to evaluate the effectiveness of these new regulations.

Policies intended to mitigate emerging cyclical vulnerabilities from individual participants becoming more willing to bear risk at a lower price when financial conditions are loosening are both more novel and less well understood in terms of effectiveness. Decisions to implement policies require policy makers to make difficult assessments, such as how quickly financial fragilities can build and how costly it would be to financial stability in the event of a large adverse shock. These considerations suggest a continuum for possible pre-emptive actions, to deploy lower cost tools more frequently and before there is strong evidence of excesses, if by doing so, it can reduce the odds that a vulnerability with systemic consequences, or a

combination of them, get built up. Potential policies vary widely in their costs of implementation: Increased supervisory scrutiny targeted to specific firms and activities, or public recommendations by FSOC to regulators, financial institutions, or market participations are relatively inexpensive actions. At the other end of the cost spectrum, a countercyclical capital buffer would apply to all banking firms and may require some international cooperation and monetary policy would affect all risk taking.

We briefly discuss some possible tools, mostly those designed to address identified emerging vulnerabilities, and whether they can be timely and targeted, and then touch briefly on issues regarding broader policies. This discussion highlights that much research is needed to evaluate the efficacy of such tools. Notable recent contributions that study the macroprudential approach to regulation include Angelini, Neri, Panetta (2011), Angeloni and Faia (2012), Christensen, Meh, and Moran (2011), Goodhart, Kashyap, Tsomocos, and Vardoulakis (2012, 2013), Hanson, Kashyap and Stein (2011), Kiley and Sim (2012), and Stein (2012).

### SIFI policies

If SIFIs were expected to become more vulnerable or shocks to become larger, regulators could take actions to try to mitigate the spillover of distress at these firms to broader markets and the economy. One tool proposed in DFA and Basel III is the systemic capital surcharge, which increases based on the firm's size, complexity, interconnectedness, and other characteristics that would make it more of a systemic risk. A surcharge that increases with these characteristics acts as a disincentive for firms to become or remain systemically risky.<sup>10</sup> The current international proposal imposes a surcharge of up to 2.5 percentage points, above the minimum of 7 percent of risk-weighted assets.

Another tool is a countercyclical capital buffer, which is designed to build up in boom times when the cost of equity is relatively cheap. As a result of the higher capital buffer, SIFIs would be better equipped to withstand large adverse shocks, such as the bursting of an asset bubble, which are more likely when economic boom times are extended. The countercyclical capital buffer is built in booms when it is cheap for SIFIs to build up capital, and is deployed in crisis when the accumulation of capital is expensive. A release of the countercyclical capital buffer mitigates the pressure of SIFIs to delever, thus mitigating the potentially adverse amplification of forced deleveraging during an economic downturn.<sup>11</sup> There are notable

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<sup>10</sup> Another option would be to cap the size of firms, perhaps by limiting the amount of uninsured liabilities. See Daniel Tarullo, "Financial Stability Regulation," Distinguished Jurist Lecture, University of Pennsylvania Law School, Oct. 10, 2012. <http://www.federalreserve.gov/newsevents/speech/tarullo20121010a.htm>

<sup>11</sup> There are no provisions for the cyclical variation of liquidity requirements, but in principle, the tightness of such liquidity requirements could be varied over the cycle, thus effectively regulating the amount of allowable maturity transformation.

challenges with such a buffer, including the timing of the build-up and release. In particular, an early build-up of a buffer would risk imposing unnecessary increases in the costs of credit; also, firms and supervisors may be reluctant to begin a release to promote credit availability if there were high uncertainty about the economic outlook. In principal, the buildup and release of the buffer should be a function of the pricing of risk, while microprudential supervision should be focused on the evolution of expected risk.

A tool that is similar to the adjustment of countercyclical capital requirements, but that works in a more targeted fashion, is the variation of sectoral capital requirements. Sectoral capital requirements would be built and released like a countercyclical buffer, but higher or lower capital charges would be for specific asset class. A related tool is dynamic provisions, as practiced in Spain. Such dynamic provisions are loan loss provisions that are built up in times of booms, when specific provisions are low, and are released precisely when specific provisions are built up. While the implementation of dynamic provisions in the U.S. is not currently planned, a reform of provisioning practices to make them more forward looking has been debated for some time.

Other tools include supervisory guidance and stress tests, though these also suffer from the same problem of determining when to turn policies on and off. However, because they involve more discretion, they may be less costly than rules. Supervisory guidance, which could be used to signal a need to improve risk management practices around potential future risks, is, by design, flexible. Supervisory stress tests can address emerging vulnerabilities by adjusting the severity of the macroeconomic and financial scenarios and by highlighting potential risks, such as those identified in this systemic risk monitor. Supervisors are required to produce scenarios annually, and firms are required to conduct stress tests twice a year, which permits frequent adjustments.<sup>12</sup> Increased required disclosures from supervisors and firms will provide investors more information, which may allow a greater role for markets to also exert discipline.

An issue with the regulation of SIFIs is that any tightening of prudential requirements—whether they are structural or cyclical—is expected to push credit transformation activity into the shadow banking system. This suggests that macroprudential policies aimed at SIFIs should be complemented by prudential policies for the shadow banking system.

### Shadow Bank policies

Macroprudential policy tools that affect shadow banking are much less well defined, and vastly more heterogeneous. One important tool created by DFA is the designation by FSOC of nonbank financial firms as systemically important, if their distress is also expected to materially

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<sup>12</sup> It should be noted that smaller banks are not required to conduct stress tests.

disrupt other financial activity and inflict substantial harm on economic growth. Designation addresses the important structural vulnerability that some important financial intermediaries not backed by the government sector are vulnerable to investor runs. But designation is a deliberate and lengthy process, and is not well-suited to addressing emerging vulnerabilities that arise from a reduced price of risk by private market participants.

While FSOC has not yet designated any firms as systemically important, it has issued a rule and is in the process of reviewing firms that meet certain size and risk criteria to determine how that firm's distress could impose costs on others through direct counterparty losses, through potential fire sales or contagion, or loss of the provision of a critical financial service. Firms that are designated would then be supervised by the Federal Reserve, and would be expected to comply with the enhanced prudential standards applied to bank holding companies, tailored to their specific businesses. Through this, they would be subject to the same tools to counter emerging risks as bank-designated SIFIs, including countercyclical capital, stress tests, and supervisory guidance. However, despite the designation, DFA does not allow for designated nonbank SIFIs to have access to the discount window or other facilities designed specifically for banks.

Much of shadow banking is not conducted in a firm, but facilitated by markets. Wholesale short-term funding markets without government backstops, such as deposit insurance, still pose substantial systemic risks. The FSOC has recognized the fragilities of shadow banking in its annual reports, and has called for reform of 2a-7 MMFs and the tri-party repo market. William Dudley (2013) proposes some specific reforms for tri-party, including consideration of restricting collateral to high-quality "open market operation" eligible collateral and the creation of a facility to reduce the fire sale risk of collateral if a dealer were to default. In addition, the FSOC recently issued a proposed "Section 120" recommendation for comment which offers three alternatives to mitigate the first-mover advantage for investors in MMFs arising from its stable net asset value (NAV) feature. The three alternatives include a floating NAV, a small loss-absorbing buffer with a redemption holdback, and a larger stand-alone buffer; the FSOC also asked for other proposals that could result in meaningful reform.

In addition, the Financial Stability Board, as directed by the G20 Leaders, has been developing policy recommendations to strengthen the oversight and regulation of the shadow banking sector. The set of proposals attempt to: 1) limit the spillover of shadow banking risks to the banking sector, 2) reduce or eliminate the first-mover advantage in U.S. money market mutual funds that makes them vulnerable to runs, 3) assess and mitigate risks of other shadow banking entities, 4) assess and align the incentives in securitization, and 5) dampen risks and the pro-cyclical incentives in secured financing.

The first four proposals focus primarily on structural reforms, and some elements of the fifth set are tied more directly to addressing the emerging imbalances that would be identified in this systemic risk monitoring framework. In particular, to address pro-cyclical incentives in secured funding markets, such as repo and sec lending, they propose minimum standards for haircut practices, to limit the extent to which haircuts would be reduced in benign markets. Other elements of this proposal include consideration of the use of central clearing for sec lending and repo markets, limiting liquidity risks associated with cash collateral reinvestment, addressing risks associated with re-hypothecation of client assets, strengthening collateral valuation and management practices, and improving report, disclosures, and transparency.<sup>13</sup>

Another set of tools for the regulation of shadow banking activities that has not been put into practice is the explicit regulation of margins and haircuts for macroprudential purposes. Margins and haircuts are set by exchanges, clearing houses, brokers, dealers, and in repo transactions. They effectively regulate the maximum amount of leverage that borrowers can take on. However, such margins and haircuts are set from a purely microeconomic risk management perspective. Macroprudential considerations would promote higher through-the-cycle margins if they materially reduce the ability of shadow banking participants to take on excessive leverage in expansions.

A more targeted way forward on policies to address emerging systemic risks from shadow banking would be to improve data collections. The SCOOS is useful for providing systematic qualitative information on trends at dealers, but substantially more could be done. For example, while BHCs play a large role in facilitating shadow banking, regulatory reports provide little information on risks from these activities. Reports could be expanded to include types of collateral and maturity of repo transactions. In addition, efforts could be made to reduce fragmentation in the data that different regulators can access. Data for all U.S. broker-dealers, which are at the heart of shadow banking, are available only to the SEC, and data for broker-dealers that are part of BHCs are also available to the Fed. But neither the SEC nor the Fed would have data on the shadow banking activities of both broker-dealers and BHCs. Another area for improved data collections and dissemination is the repo market (tri-party, DVP, and GCF). No regulator has the authority to collect transactions data in all of the segments, and thus none can develop a robust system-wide perspective on that activity.

### Asset Markets

Building imbalances in the valuations of debt products, such as loans and mortgages, can be addressed through actions to tighten underwriting standards on the assets, to the extent these

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<sup>13</sup> Hypothecation is the practice where intermediaries use client collateral in their own borrowing transactions as collateral.

assets are originated or distributed through regulated financial firms. These asset valuations, as well as those for equities, bonds, or other securities, may also be addressed through regulated banks and broker-dealers by tightening standards on implicit leverage through securitization or other risk transformations, or by limiting the debt they provide to investors in either unsecured or secured funding markets, if the asset prices are being fueled by leverage. In principle, such actions could include tighter supervisory oversight, imposition of countercyclical capital buffers, or higher risk weights or sectoral capital buffers.

However, the efficacy of these tools to counter building imbalances is yet to be determined. In particular, the size of the additional countercyclical capital buffer needed to offset building asset bubbles might be unreasonably large when asset values are rising quickly, and may be more effective at building the resilience of the financial institution rather than mitigating a building asset bubble. Even limits on leverage of investors may be insufficient since when asset prices are rising, leverage measures often are understated relative to measures after risk tolerance has declined and asset values have fallen. If the asset valuation problems are in limited sectors, countercyclical capital may not be sufficiently targeted to address a narrow asset. In the U.S., changing risk weights would be more targeted, but would likely require a rule-making, which can be a lengthy process. Even then, these tools would only affect lending by regulated entities.

A number of countries have increased loan-to-value ratios on residential mortgages to mitigate rising real estate prices. For example, Hong Kong has increased LTVs on residential mortgages in recent years, in a concerted effort to mitigate the house price boom. Korea has imposed LTV and DTI restrictions on households, which appears to have reduced mortgage loans, housing transactions, and house prices in the six months after implementation. In the U.S., standards for LTVs or debt-to-income ratios on mortgages or other credit for households, which may be imposed by the new Consumer Financial Protection Bureau, potentially could be varied over time to address emerging imbalances.

#### Nonfinancial sector

Tools to address emerging imbalances in asset valuations likely would also address building vulnerabilities in the nonfinancial sector. For example, increasing LTVs or DTIs on mortgages, which could reduce a leverage-induced rise in prices, could also limit an increase in exposures of households and businesses to a collapse in prices, thereby bolstering their resilience. For example, authorities in Korea have employed a mix of LTV and DTI restrictions to restrain a build-up in household leverage.

An important structural reform for the government sector would be to address accounting standards that obscure costs or variability of costs. For example, accounting standards that have permitted state and local governments to discount pension liabilities by a long-run expected

return has masked the variability in underfunding, which allowed problems to build and go unaddressed for long periods. The current attention to this problem has raised the cost of credit for some states and municipalities, which has increased their vulnerability to new possible risks. The new GASB pension accounting reforms are important steps, but many pension funds still operate with target returns that do not adjust commensurately with changes in current conditions.

### Broader policies

The policies discussed above are designed to target specific identified vulnerabilities on an ex ante basis. A broader tool that could be applied is monetary policy. In general, the degree of monetary accommodation has a direct impact on the risk taking of financial institutions (see Dell'Ariccia and Marquez (2012) for an overview of the “risk taking channel of monetary policy” and Holmström and Tirole (1998) for the classic reference on liquidity injections). Monetary policy acts on the pricing of risk via the risk-taking behavior of financial institutions. Monetary policy also would affect the rates for all financial institutions, even the ones in the shadow banking system that cannot be targeted via typical supervisory or regulatory actions. In addition, the monetary policy channel is particularly powerful in times of liquidity crisis, when institutions are funding constrained. For example, the federal funds target was cut aggressively following the LTCM crisis in 1998 and the Lehman failure in 2008. In addition to the cut in interest rates, liquidity crisis are mitigated by lending of last resort by central banks.

While it is beyond the scope of this paper to address comprehensively the interactions between monetary policy and financial stability, it is worth noting that it is possible, in principle, to subsume financial stability into the “dual mandate” that legally governs monetary policy in the U.S. The dual mandate, defined in the Federal Reserve Act, requires that monetary policy should be conducted to achieve maximum employment and price stability. Monetary policy thus does not have an explicit financial stability objective. However, to the extent that assessments of tail risks change the expected outlook for inflation or real activity, financial stability considerations could indirectly enter into monetary policy decisions. This has been observed more formally within the context of a macroeconomic setting by Stein (2012), and also Woodford (2011). In Stein’s setting, financial intermediation activity is distorted due to fire sales during financial crisis, which affects monetary policy decisions in equilibrium. Woodford embeds Stein’s mechanism within a traditional new Keynesian model of monetary policy. These models effectively introduce a risk-taking channel of monetary policy into a macroeconomic setting. Empirical support for the risk-taking channel is provided by Adrian and Shin (2008), Jiménez, Ongena, Peydró and Saurina (2012), and Paligorova and Santos (2012).

In practice, however, it is difficult to aggregate risks to financial stability by embedding them into a dual mandate framework. To do so would require monetary policy makers to assess not only expected output and inflation, but to make determinations about the tails of the outcome distributions. In addition, policy makers would need to be able to evaluate which distributions

are optimal. For example, policy makers would need to assess whether higher expected employment and higher downside risk would be preferred to lower expected employment and lower downside risk. In addition, the blunt nature of monetary policy may make it a poor tool for targeting tail outcomes, whereas regulatory and supervisory tools may be able to more directly address some financial vulnerabilities, particularly when vulnerabilities emanate from specific markets or institutions. The counterargument to this, made in Stein (2013), is that supervisory and regulatory tools, due to their narrow focus, may simply end up pushing vulnerabilities into other parts of the financial system where only monetary policy is an effective policy tool.

A discussion of policies towards financial stability should also consider the broader question of whether ex-ante policy tools are adequate to mitigate systemic risks, or whether new government backstops would be more efficient. That is, are the new regulations in DFA and other proposed reforms sufficient to reduce systemic risks? Bank deposit runs of past decades were addressed with government deposit insurance and, given ensuing moral hazard, necessary supervision and regulation. But now more credit intermediation and maturity transformation is conducted through nonbank financial institutions and securities-based markets without government backstops. For example, Gorton and Metrick (2010) and Ricks (2011) propose alternatives to bring securitization and repo funding, or other short-term IOUs under a regulatory umbrella that includes regulations on asset holdings and insurance for short-term liabilities. These types of proposals differ from the more-targeted policies discussed above, and would involve an expansion of government backstops from the current system in order to bring shadow banking into the regulated sector.

There are drawbacks to introducing new government backstops to address the risks arising from shadow banking. First, any expansion would require a new regulatory structure to prevent moral hazard, which can be expensive and difficult to implement effectively. Second, an expansion of regulations does not reduce the incentives for regulatory arbitrage, but just pushes it beyond the existing perimeter. Third, there is a limited understanding of the impact that such a fundamental change would have on the efficiency and dynamism of the financial system without a better understanding of shadow banking, such as the provision of near-cash assets. At the same time, it seems clear that policies that promote only greater disclosure would not be sufficient to effectively guard against systemic risk build-up; for example, the incentive for investors to shorten debt as risk increases is an externality that can lead to systemic risk, and is only partially mitigated by disclosure. As a result, one should expect that even with full disclosure the level of vulnerabilities from systemically important institutions, maturity transformation without backstops, asset bubbles, and leverage would still be too high from a social welfare perspective.

Given these considerations, we argue that at this juncture with current authorities under DFA, the best path forward for promoting financial stability is a program for monitoring systemic risks, based on improved data collections and enhanced disclosure, and the implementation of meaningful pre-emptive regulatory and supervisory policies to address specific risks. When excesses appear to be broad, monetary policy also may be appropriate. As noted, however, much additional research is needed to evaluate the efficacy of tools in terms of timeliness, effectiveness, and scope for arbitrage.

## **7. Conclusion**

In this paper, we document a program for financial stability monitoring and briefly discuss policies towards financial stability. The program is motivated by a conceptual framework that models the tradeoff between the pricing of risk in benign times and the potential for systemic distress when adverse shocks hit. Policies towards financial stability generally balance the cost of intermediation against the amount of financial system risk. Financial stability policies can be evaluated by the degree to which they mitigate the increase of risk pricing during crisis, at the cost of more expensive credit intermediation in normal times.

We focus on four areas to look for evidence of low pricing of risk. First, the risks of SIFIs are assessed using stress tests, market-implied assessments of the SIFIs, network measures for exposures, and regulatory filings of the institutions. Second, the risks in the shadow banking sector are assessed using a variety of data sources on short-term and secured funding markets, securitizations, and new products. Third, the level of asset valuations is gauged across asset classes, including equity, credit, Treasuries and TIPS, housing values, commodities and farmland, exchange rates, and foreign markets. The assessment of asset valuations is tightly linked to the observed risk taking of SIFI and shadow banking institutions. Fourth, the risks of the nonfinancial sector are assessed in connection with the financial sector developments.

The new regulatory landscape since the implementation of DFA has made financial stability monitoring an important complement to supervisory and macroeconomic monitoring. Financial stability monitoring focuses on the whole financial system, both in regulated or non-regulated institutions and sectors, whereas supervisory monitoring primarily focuses on the financial conditions and risks of individual firms. Macroeconomic monitoring traditionally summarizes the financial sector only with market prices to model macroeconomic activity. In contrast, financial stability monitoring explicitly links financial institution behaviors to financial market prices and risks, and explicitly analyses the connections between the real sector and the financial sector.

Financial stability monitoring is in turn an input into both supervisory and macroeconomic policy decisions. For supervisory policies, financial stability monitoring

provides a complementary, system-wide view of financial stability risks that can be translated into particular supervisory actions. For example, certain forms of supervisory guidance can be based on the insights gained from financial stability monitoring. In addition, countercyclical capital requirements, and the severity of stress test scenarios can be based on the financial stability assessment. Financial stability assessments also enter into the monetary policy decision process, as one of the important transmission channels of monetary policy is the risk-taking behavior of financial institutions. Monetary policy thus affects the systemic risk return tradeoff, which has to affect supervisory decisions. Financial stability monitoring is situated to serve as a bridge between macroeconomic policies and microprudential supervisory policies.

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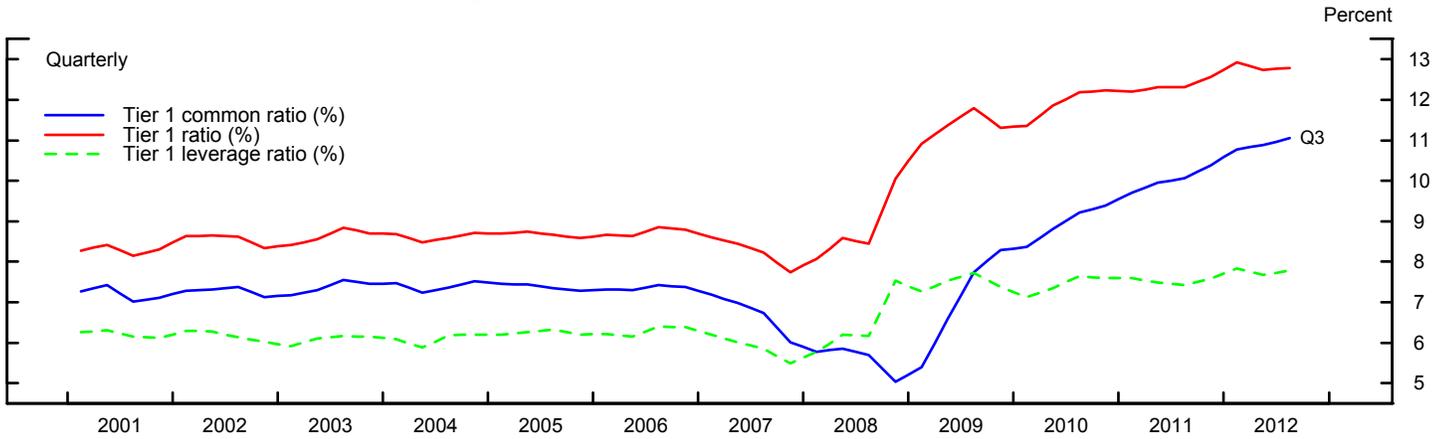
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# Systemically Important Financial Institutions (SIFIs)

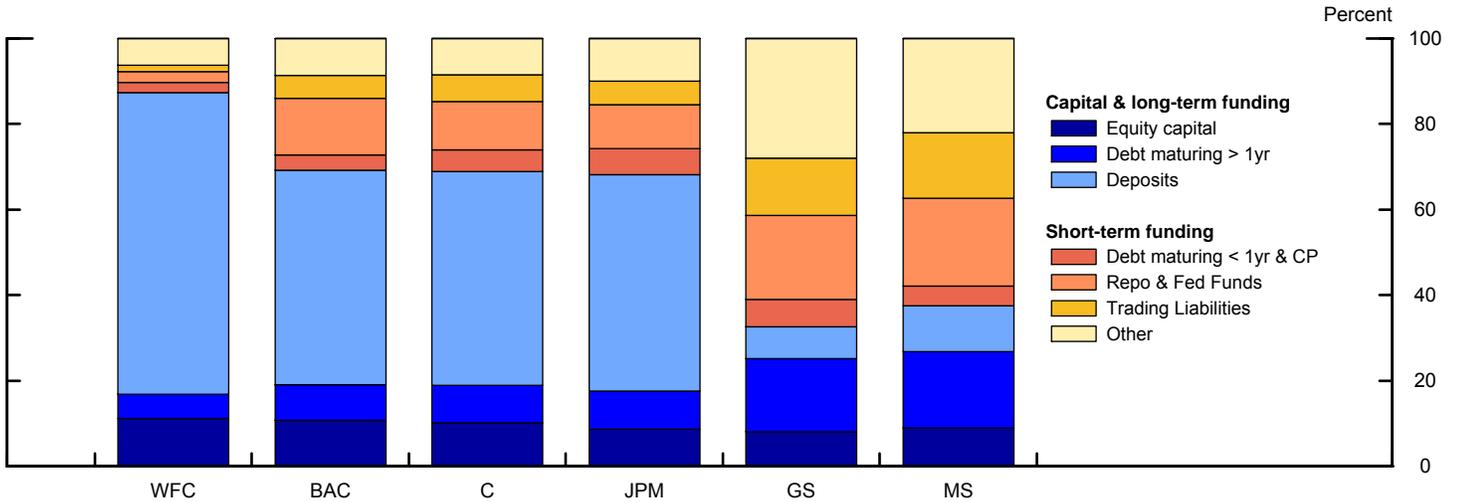
Chart 1  
Capital Ratios of SCAP 19 Bank Holding Companies (BHC)



Note: In May 2009, 19 BHCs were assessed in the Supervisory Capital Assessment Program (SCAP). In this chart, GS, MS, Ally, and Amex are excluded prior to 2009, as they were not yet bank holding companies.

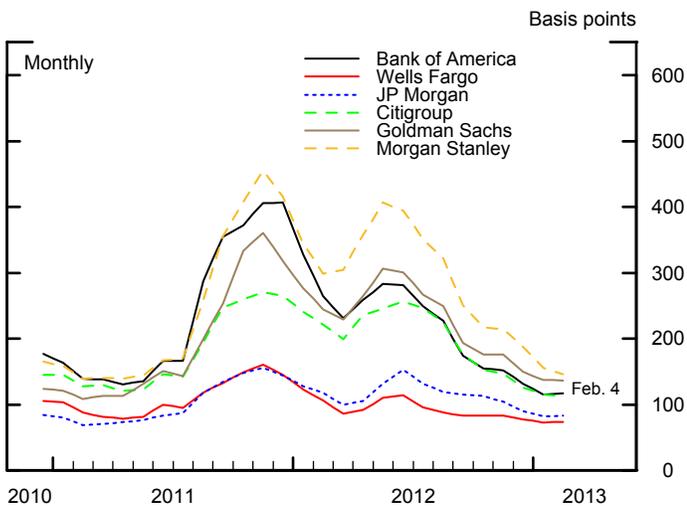
Source: FR Y9-C.

Chart 2  
BHC Liability Structure 2012Q4



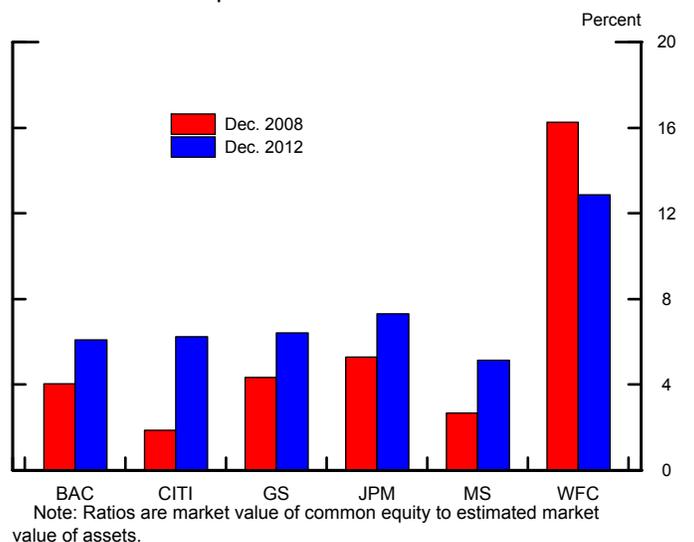
Source: FR Y-9C.

Chart 3  
5-Year CDS Premiums for Select U.S. BHCs



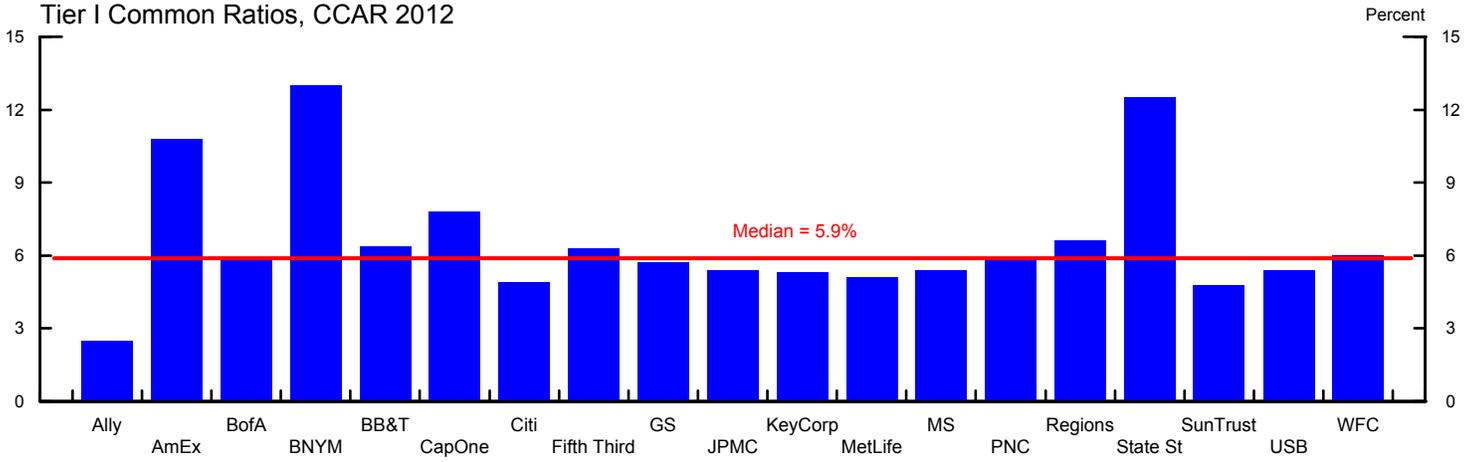
Source: Markit.

Chart 4  
Market-based Capital Ratios for BHCs



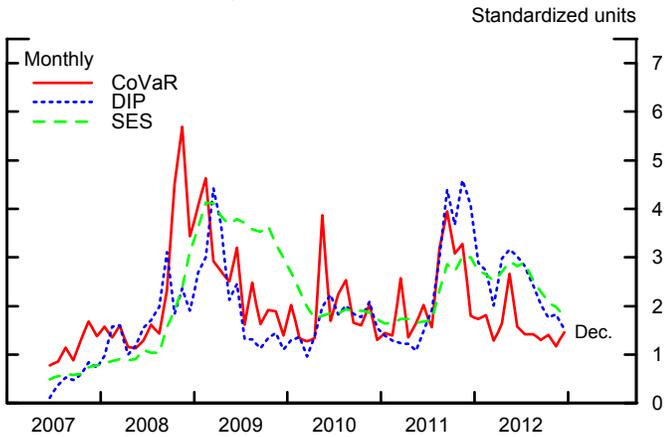
# Systemically Important Financial Institutions (SIFIs)

Chart 5  
Post-stress Capital Ratios BHCs,  
Tier I Common Ratios, CCAR 2012



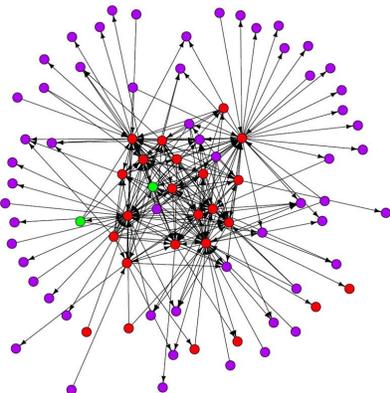
Source: Federal Reserve estimates from the 2012 Comprehensive Capital Assessment Review (CCAR).

Chart 6  
U.S. LISCC Firm Systemic Risk Measures



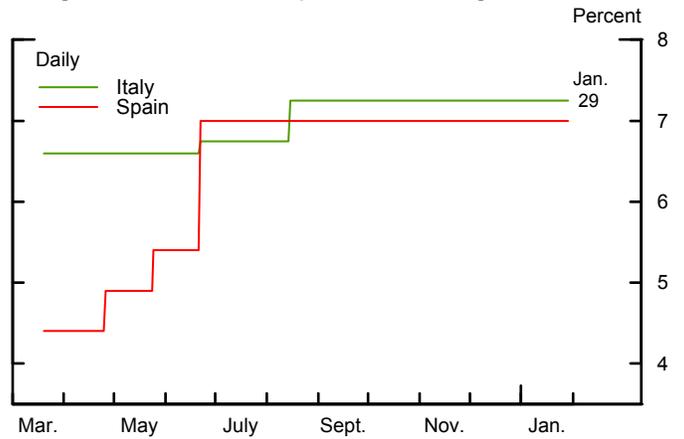
Note: Each risk measure is averaged across the six largest LISCC BHCs (Bank of America, Citigroup, Goldman Sachs, JP Morgan, Morgan Stanley, and Wells Fargo). Each resulting time-series is then re-scaled by its standard deviation.

Chart 7  
Interconnectedness of CCPs, Dealers,  
and Non-dealers in CDS



Source: Chelso Brunetti and Michael Gordy, June 2012.

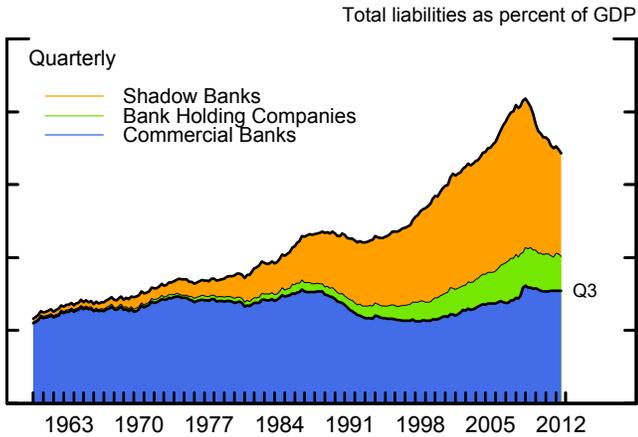
Chart 8  
Margins on Italian and Spanish Sovereign Bonds



Note: Maturities of 3.25-4.75 years.  
Source: LCH.Clearnet SA.

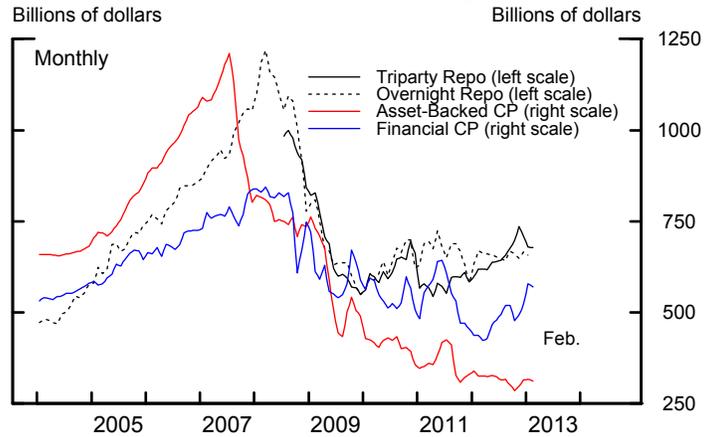
# Shadow Banking

**Chart 9**  
Financial Sector Liabilities



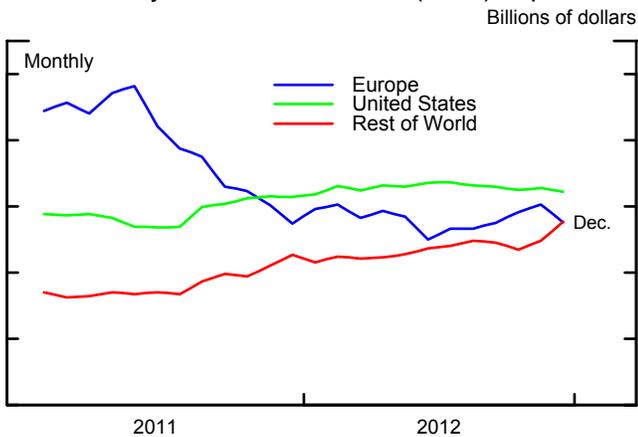
Note: Bank Holding Company liabilities include the liabilities of Broker Dealers.  
Source: Federal Reserve Flow of Funds.

**Chart 10**  
Commercial Paper and Repo Financing



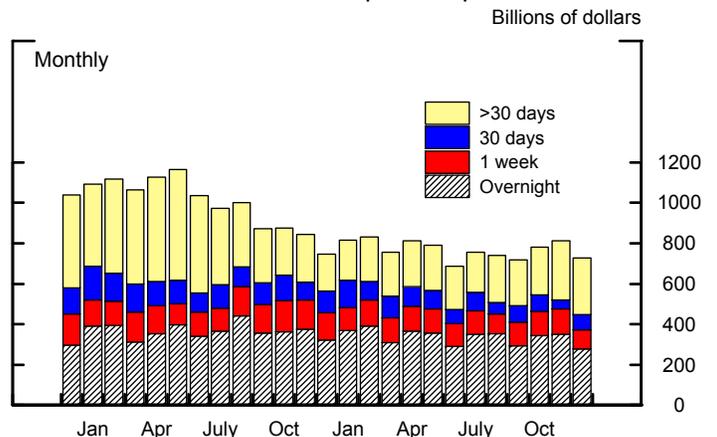
Source: FRBNY and Federal Reserve Board.

**Chart 11**  
Prime Money Market Mutual Fund (MMF) Exposures



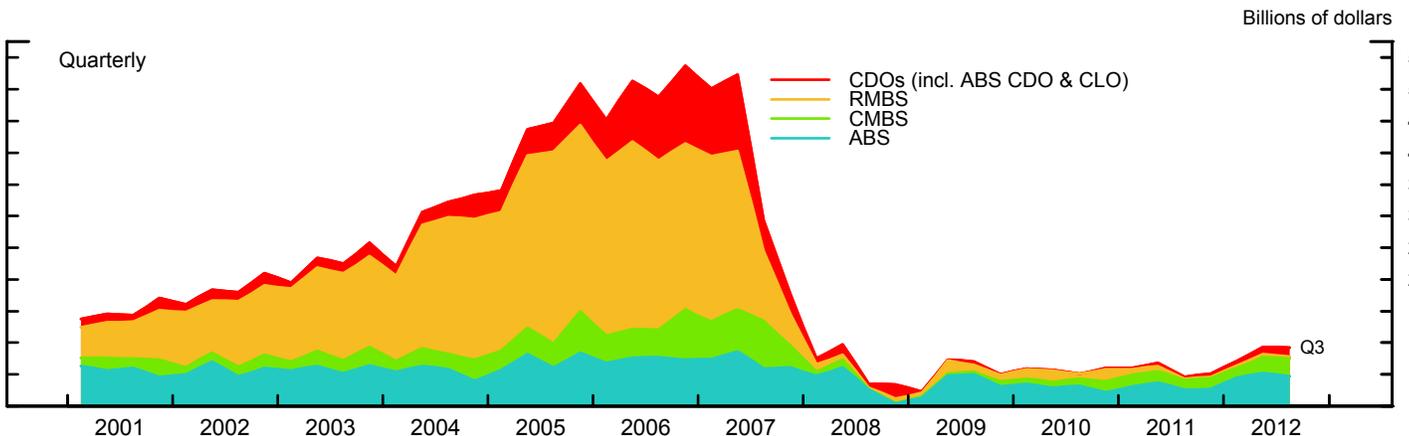
Source: SEC form N-MFP.

**Chart 12**  
Maturities of Prime MMF European Exposures



Source: SEC from N-MFP filings.

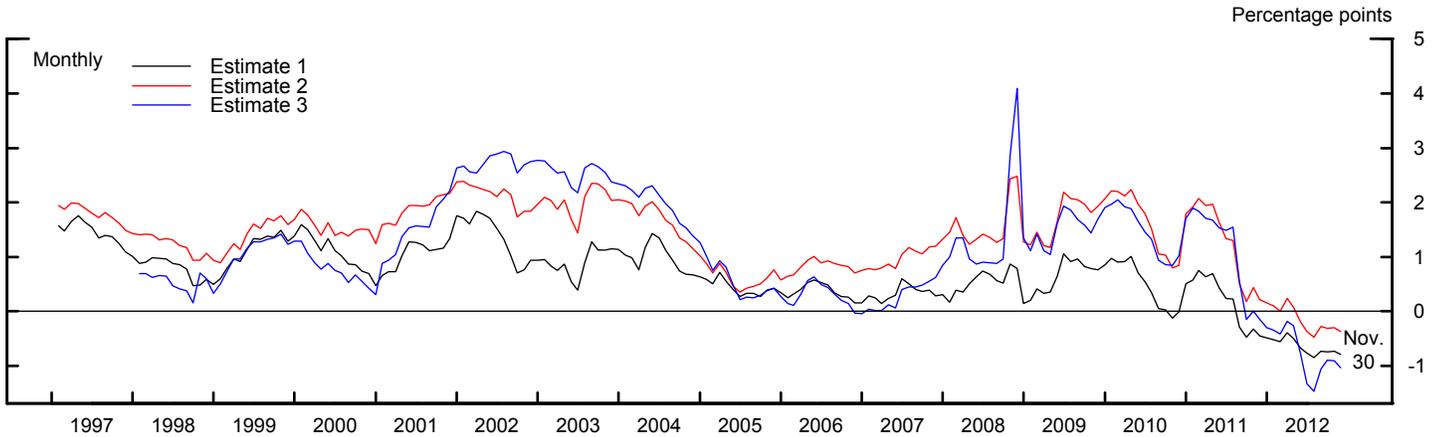
**Chart 13**  
U.S. Securitization Issuance



Note: CLO refers to all securities backed by loans or bonds issued by businesses. CMBS and RMBS refer respectively to securities backed by commercial and residential mortgages. ABS refers to securities backed by consumer loans.  
Source: Asset-backed Alert, Commercial Mortgage Alert.

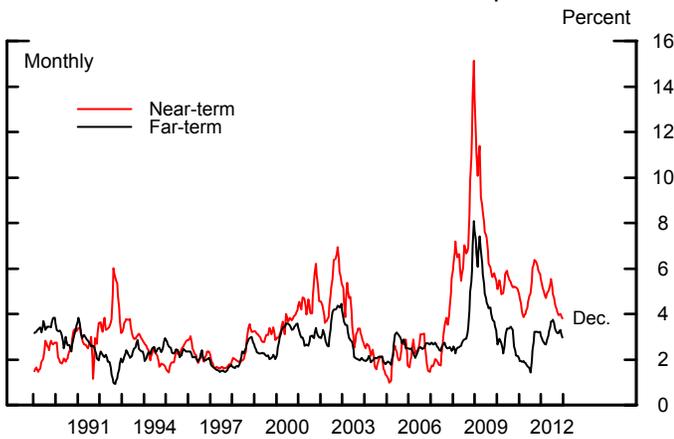
# Asset Markets

**Chart 14**  
Ten-Year Nominal Yields and Term Premium Estimates



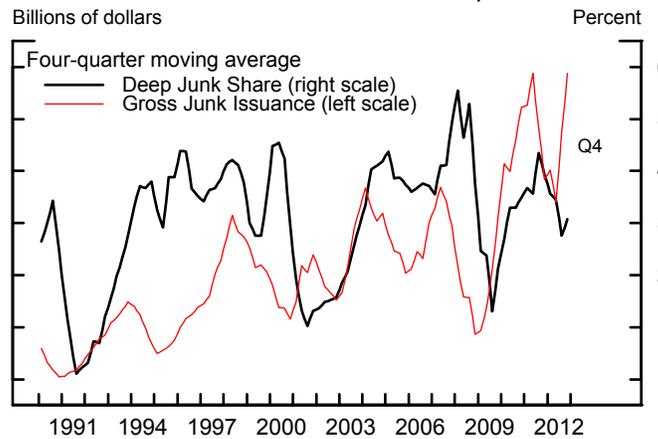
Note: Term premia are estimated by: Estimate 1: three-factor term structure model combining Treasury yields with SPF interest rate forecasts (Kim and Wright, 2005), Estimate 2: a four-factor term structure model using Treasury yields only (Adrian, Crump, and Moench, 2012), and Estimate 3: a three-factor model using Treasury yields only (Christensen, Diebold, and Rudebush, 2009).

**Chart 15**  
Near- and Far-Term BB Forward Credit Spreads



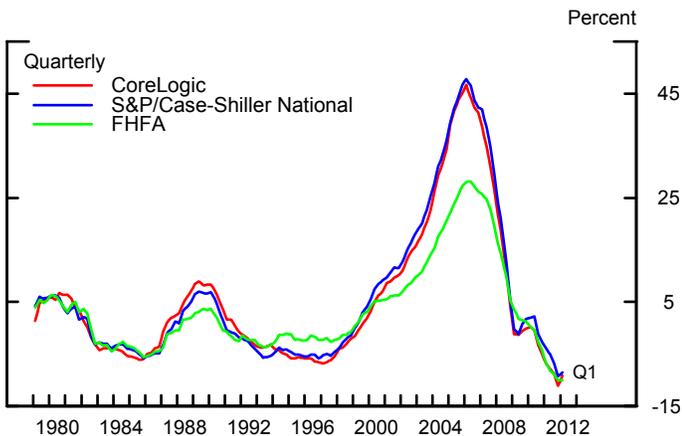
Note: Near-term forward spread between years two and three, far-term forward spread between years nine and ten.  
Source: Staff estimates.

**Chart 16**  
Gross Junk Issuance and Share of Deep Issuance



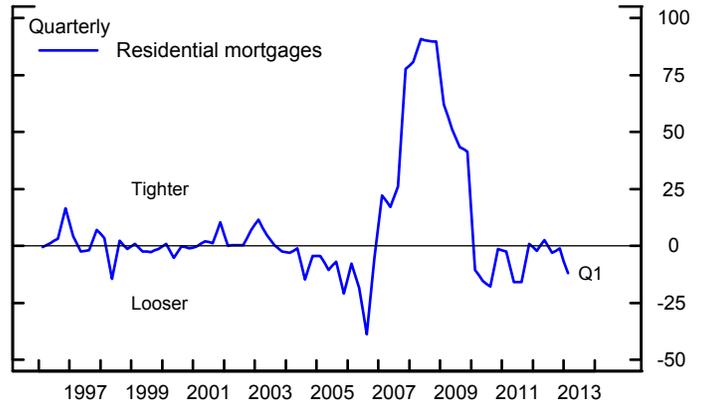
Note: Deep Junk Share is the fraction of bonds rated B- or lower over total nonfinancial junk issuance. Gross Junk Issuance includes public, 144a, euro, and MTN issues.  
Source: Security Data Company.

**Chart 17**  
House Price Overvaluation Measures



Note: Overvaluation measured as deviation from long-run relationship between house prices and rents.

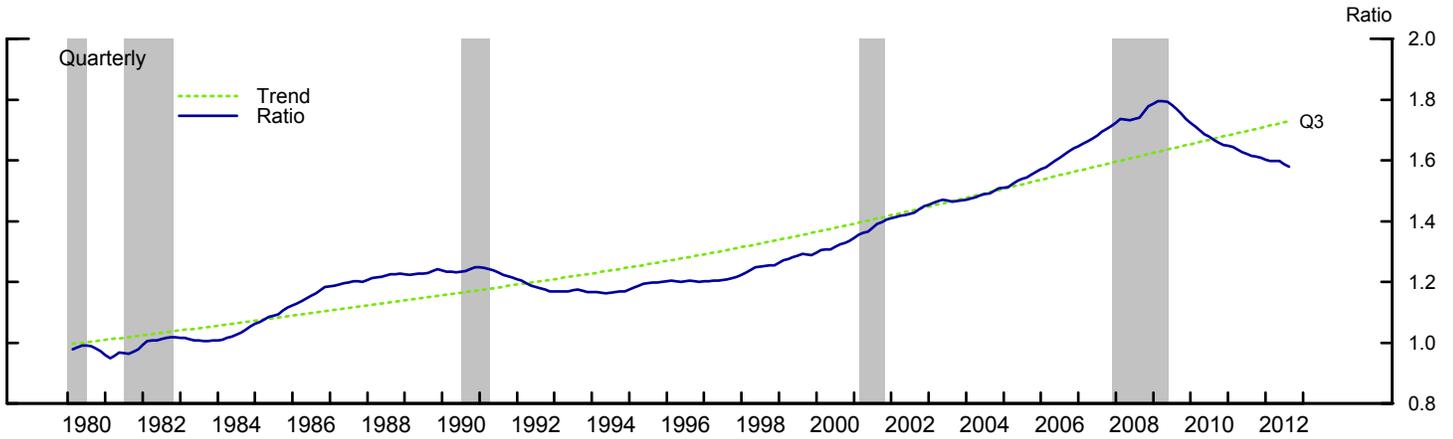
**Chart 18**  
Loan Standards, Weighted by Value of Outstanding Loans



Note: Net percent of banks reporting tightening standards.  
Source: Senior Loan Officer Opinion Survey on Bank Lending Practices.

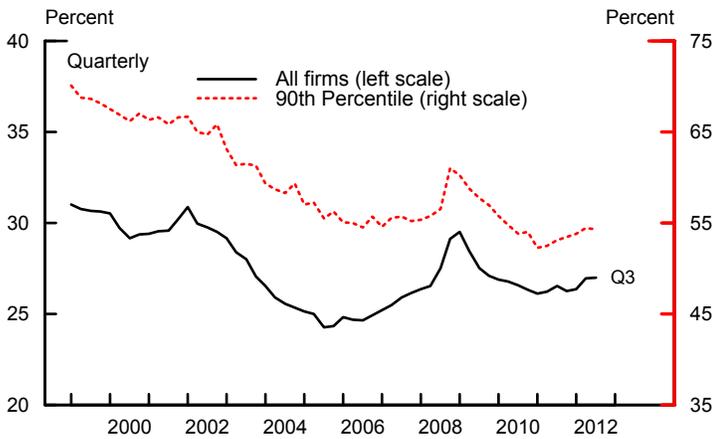
# Nonfinancial Sector

Chart 19  
Private Nonfinancial Sector Credit-to-GDP Ratio



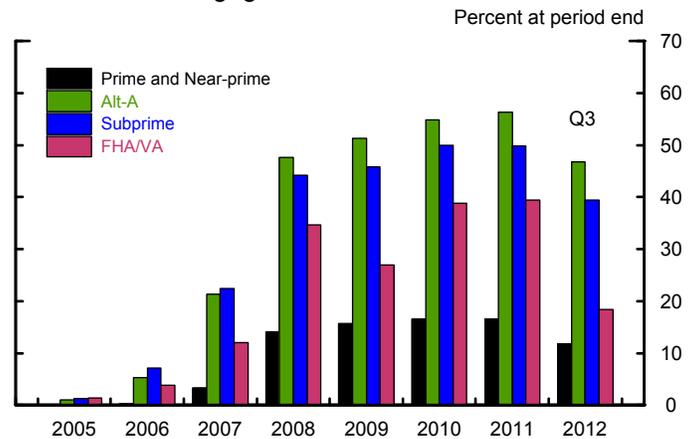
Note: Calculated using an HP filter. Shaded areas denote NBER recessions.  
Source: FOFA, NIPA, and staff calculations.

Chart 20  
Debt-to-assets Ratio



Source: Compustat.  
Note: Ratio of the book value of total debt to total assets. 90th percentile is calculated from subset of 3000 largest firms, by assets.

Chart 21  
Underwater Mortgages



Note: Prime and Near-prime also includes Alt-A.  
Source: Corelogic and LPS.