OFR

OFFICE OF FINANCIAL RESEARCH

2012 ANNUAL REPORT

The Office of Financial Research

Establishment of the Office

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) established the Office of Financial Research (OFR) within the Treasury Department.

Section 153(a) of the Dodd-Frank Act charges the OFR with supporting the Financial Stability Oversight Council (Council) and member agencies by:

1. collecting data on behalf of the Council, and providing such data to the Council and member agencies;
2. standardizing the types and formats of data reported and collected;
3. performing applied research and essential long-term research;
4. developing tools for risk measurement and monitoring;
5. performing other related services;
6. making the results of the activities of the Office available to financial regulatory agencies; and
7. assisting such member agencies in determining the types and formats of data authorized by this Act to be collected by such member agencies.

Organizational Structure and Responsibilities of the Primary Programmatic Units

Section 154 of the Dodd-Frank Act establishes within the Office, to carry out the programmatic responsibilities of the Office, the Data Center and the Research and Analysis Center.

The Data Center, on behalf of the Council, shall collect, validate, and maintain all data necessary to carry out the duties of the Data Center. The data assembled shall be obtained from member agencies, commercial data providers, publicly available data sources, and financial entities under certain statutory authority detailed in the law.

The Research and Analysis Center, on behalf of the Council, shall develop and maintain independent analytical capabilities and computing resources—

A. to develop and maintain metrics and reporting systems for risks to the financial stability of the United States;
B. to monitor, investigate, and report on changes in systemwide risk levels and patterns to the Council and Congress;
C. to conduct, coordinate, and sponsor research to support and improve regulation of financial entities and markets;

D. to evaluate and report on stress tests or other stability-related evaluations of financial entities overseen by the member agencies;

E. to maintain expertise in such areas as may be necessary to support specific requests for advice and assistance from financial regulators;

F. to investigate disruptions and failures in the financial markets, report findings, and make recommendations to the Council based on those findings;

G. to conduct studies and provide advice on the impact of policies related to systemic risk; and

H. to promote best practices for financial risk management.

Statutory Requirements for the Annual Report

Section 154(d)(2) of the Dodd-Frank Act requires an Annual Report that assesses the state of the United States financial system including:

A. an analysis of any threats to the financial stability of the United States;

B. the status of the efforts of the Office in meeting the mission of the Office; and

C. key findings from the research and analysis of the financial system by the Office.

Abbreviations for Federal Agencies and Offices Referred to in the Report

- Department of the Treasury (Treasury)
- Financial Stability Oversight Council (FSOC or Council)
- Board of Governors of the Federal Reserve System (FRB or Federal Reserve)
- Office of the Comptroller of the Currency (OCC)
- Consumer Financial Protection Bureau (CFPB)
- Securities and Exchange Commission (SEC)
- Federal Deposit Insurance Corporation (FDIC)
- Commodity Futures Trading Commission (CFTC)
- Federal Housing Finance Agency (FHFA)
- National Credit Union Administration Board (NCUA)
- Federal Insurance Office (FIO)

Preface

The creation of the Office of Financial Research represents a milestone in the efforts to strengthen America's financial system.

The financial crisis made clear that the understanding of the financial system was deficient in many respects. Market participants and regulators broadly misperceived the extent of leverage and maturity transformation. They did not see the migration of such activities to unregulated or lightly regulated financial companies and markets in the so-called shadow banking system. And they collectively underestimated how disruptions could spread horizontally across interconnected companies and markets and impair the functioning of the financial system, with severe consequences for the economy.

Likewise, the crisis revealed significant deficiencies in the data available to monitor the financial system. Financial data collected were too aggregated, too limited in scope, too out of date, or otherwise incomplete. The crisis demonstrated the need to reform the data collection and validation process and to strengthen data standards in order to improve the utility of data both for regulators and for market participants. In contrast with the local jurisdictions of regulators, the global nature of financial markets and institutions complicated that process.

Through the Dodd-Frank Act, Congress addressed many of these shortcomings. It created the Financial Stability Oversight Council (FSOC or Council), consisting of the federal financial regulators and others with oversight responsibilities, to identify threats to the financial stability of the United States, to respond to those threats, and to promote market discipline. It also created the Office of Financial Research (OFR or Office) to serve the needs of the Council and member agencies, to collect and standardize financial data, to perform essential research, and to develop new tools for measuring and monitoring risk in the financial system.

This inaugural Annual Report describes how the OFR is working to satisfy its statutory mandates and mission in four areas:

- **To analyze threats to financial stability.** The Office is developing and implementing metrics for measuring risks to financial stability. The Office is evaluating methods in current use, considering their effectiveness both for individual firms and systemwide. It is our statutory mandate to monitor, investigate, and report to Congress and the Council on changes in those

risks. Gaps in analysis, data, and data standards represent threats to financial stability, and helping to fill those gaps is also part of the OFR's mandate.

- **To conduct research on financial stability.** The Office is conducting research to enable monitoring and investigation of threats to financial stability; to analyze regulation of financial entities or markets; to evaluate and report on stress tests or other stability-related evaluations of financial entities; to investigate and report on disruptions and failures in financial markets; and to conduct studies about and provide advice on the impact of policies related to financial stability. The Office is also collaborating with regulators, market participants, and academics to promote best practices in financial risk management.

- **To address data gaps.** The Office is beginning to help ensure that policymakers as well as market participants, where appropriate, have access to reliable, high-quality financial data in order to understand the state of the financial system, how it is developing and transforming risks, and the nature of its vulnerabilities. The Office is helping the Council and member agencies determine data needs, assess gaps in the scope or quality of available data, and help prioritize and fill those gaps. The Office may require financial companies to submit data, including transaction and position data, as necessary to improve the analysis of financial stability, and will take all necessary and appropriate precautions to ensure that any data so submitted will be stored and used safely and securely.

- **To promote data standards.** The Office is leading efforts to improve financial data and information standards, working closely with financial regulators and the industry. Standardization is essential to improve the quality and transparency of financial data. It will help risk managers and supervisors compare, aggregate, link, and analyze data about financial entities, instruments, and markets, and the threats they pose to financial stability. The Office may promulgate regulations to standardize the types and formats of data reported and collected on behalf of the regulatory agencies. The Office will also produce and maintain catalogues of reference entities and instruments. The first ongoing standardization priority is to establish a Legal Entity Identifier (LEI), a unique, global standard for identifying parties to financial transactions. The LEI initiative has made important progress in 2012 with strong support from both the private sector and the international regulatory community.

A key component of the OFR's mission is to support the Council and its members. The OFR is supporting the Council by providing data and analysis related to the Council's evaluation of nonbank financial companies for potential designation for Federal Reserve supervision and enhanced prudential standards. Much of the OFR's work analyzing financial stability, conducting research, collecting data, and promoting data standards has involved collaboration with Council members.

Unlike the other federal financial agencies in the Council, however, the OFR has no supervisory responsibilities; we are focused purely on research, data, and analysis. That is important for two reasons. First, significant gaps remain in the

analytical work done by the Council member agencies because none of them individually has authority to look across the entire financial system—in other words, to implement a *macroprudential* approach to research and data activities. In part, those gaps arise in financial activities that take place in less-regulated markets and across national boundaries. Congress created the OFR as a separate office to produce the "connective tissue" filling gaps in both information and analytics. That is a key rationale for the Office's separate research and data mission.

A second reason why the Office's separate research and data mission matters is that it permits the Office to offer a different perspective, one that should enhance the Council's peripheral vision. That perspective is critical in identifying threats to financial stability and in evaluating stress tests and other tools in the macroprudential toolkit individually and taken together. It also can help the regulatory community avoid accepting the conventional wisdom when a skeptical look is needed.

Both factors are critical in assessing the OFR's mandates. In particular, they help explain why the OFR should conduct and sponsor financial stability research even when others in the Council are engaged in similar work. In addition, new data collected by the OFR will permit research that previously was difficult to conduct.

Meanwhile, with our broad mandates come significant responsibilities. Three stand out: accountability to Congress and the public; the need to be thoughtful and judicious in collecting data; and a resolute commitment to information security.

The OFR is accountable through several channels. Congress has oversight authority over the OFR: the Dodd-Frank Act requires the Director to testify regularly before Congress, and the OFR provides the Congress with this first Annual Report on its activities to be consistent with requirements under that statute. The Office will also provide a second annual report on its human resources practices later this year. It also published its initial strategic framework earlier this year. In addition, the OFR publishes its budget as part of the President's budget and it is included as part of the Treasury Department's consolidated audit. At the same time, the Dodd-Frank Act provides authority for Treasury's Inspector General, the Government Accountability Office, and the Council of Inspectors General on Financial Oversight to oversee the activities of the OFR.

The OFR will not collect data for collection's sake. Indeed, the Dodd-Frank Act requires that the OFR not duplicate others' data collection efforts. The OFR is working with the federal financial supervisors to inventory the data they already collect and to improve data-sharing among them—creating economies of scale, lowering costs, and reducing regulatory burden. While the opportunities are immense for improving financial data available both to supervisors and to financial companies themselves, the Office is sensitive to the potential costs. And, of course, the Dodd-Frank Act does not contemplate collecting and the OFR will not collect any information from consumers.

Data security is the highest priority for the OFR. As an office of the Department of the Treasury, the OFR utilizes Treasury's sophisticated security systems to protect sensitive data. The OFR is also implementing additional controls for OFR-specific systems, including a secure data enclave within Treasury's IT infrastructure. Access to confidential information will only be granted to personnel that require it to perform specific functions, and the OFR will regularly monitor and verify its use to protect against unauthorized access. In addition, the OFR is collaborating with other Council members to develop a mapping among data classification structures and tools to support secure collaboration and data-sharing. Such tools include a data transmission protocol currently used by other Council members that will enable interagency data exchange and a secure collaboration tool for sharing documents.

The discussions in this Annual Report should make clear the importance, breadth, and scope of the OFR's mandates. They should not obscure the need for humility in pursuing those mandates, because the precise causes of financial crises are fundamentally uncertain. And they should underscore two other facts. First, better analysis and data can help reduce this uncertainty and inform the design of the shock absorbers and guardrails needed to make the financial system more resilient and less prone to shocks. Second, while the OFR's work is well under way, it will take time and resources to build its capabilities in each of these areas. Building a technological infrastructure must be done with care to ensure a secure environment in which confidential data are always protected.

Contents

1 Executive Summary

This inaugural OFR Annual Report details the Office's progress in meeting its mission and statutory requirements. The report must assess the state of the U.S. financial system, including: (1) An analysis of any threats to the financial stability of the United States; (2) The status of the efforts of the Office in meeting its mission; and (3) Key findings from the research and analysis of the financial system by the Office.[1]

Chapters 2 and 3 describe the Office's approach to analyzing threats to financial stability and conducting essential research. Chapters 4 and 5 describe the Office's agenda for addressing data gaps through three types of strategy: (1) Helping to better organize existing data, (2) Promoting data standards, and, (3) Collecting data that are otherwise not available to the OFR and other FSOC members. Chapter 5 focuses on the Office's agenda for promoting data standards, which began with the widely supported initiative to create a global Legal Entity Identifier (LEI).

The OFR's four agendas—analyzing threats to financial stability, conducting research, addressing data gaps, and promoting data standards—are highly complementary. In pursuing them, key principles will guide the Office: Accountability, an emphasis on a cost-effective approach to meeting our mandates, and an unwavering commitment to information security.

Analyzing Threats to Financial Stability

There is an emerging consensus that policymakers need to understand the functioning of the entire financial system—of institutions and markets—in order to assess and monitor threats to financial stability; to appreciate how those threats propagate from one institution to many, or from one market to others; and to evaluate mitigants to address those risks.

"Financial stability" means that the financial system is operating sufficiently to provide its basic functions for the economy even under stress. Our framework includes an analysis of the six basic functions of the financial system—credit allocation and leverage, maturity transformation, risk transfer, price discovery, liquidity provision, and facilitation of payments—and an assessment of how threats may disrupt their functioning. In our taxonomy, such threats to financial stability

can emerge from within or outside the financial system, and they can be either cyclical or structural. Similarly, the FSOC Annual Report describes a taxonomy of internal or external shocks that may interact with structural vulnerabilities in the financial system to disrupt financial stability. Thus both taxonomies are aligned with the important point that, even absent external shocks, financial activity can generate threats to financial stability. Typically those occur when market participants have incentives to take on excessive risks due to a lack of market discipline, opaque (mis)pricing of risk, or other flaws in the policy guardrails that should curb those incentives.

The U.S. economy and financial system today are still recovering from the financial crisis and recession that began in 2007. The slow recovery in both owes importantly to the legacy of the crisis that has also left two key cyclical risks in the financial system—the ongoing weakness in housing finance and the historically low levels of interest rates. Housing finance remains challenged due to still-dysfunctional securitization markets and the consequent lack of private market interest, which has been partly filled by an outsized role for government. Low interest rates, while beneficial to the economy in the near-term, may have long-term adverse consequences if large numbers of market participants take on excessive credit risk or duration risk. Supervisors have expressed concerns in both areas.

Structural vulnerabilities within the financial system remain in short-term funding and derivatives markets. While important reforms are now under way in the derivatives markets, largely in response to Dodd-Frank mandates, short-term funding markets remain subject to run risk, and more needs to be done. External to the financial system, financial stability concerns are focused prominently on the euro area sovereign debt crisis and on the U.S. fiscal outlook. Policymakers have taken measures to promote a housing recovery but the market remains depressed.

Another risk is that the mitigants in place to promote stability in the financial system won't work as intended. Those mitigants include both supervisory monitoring of financial markets and internal risk management within financial companies. Both need to constantly update their approach, including their use of mathematical models, to keep up with rapidly changing business practices.

Most important from the perspective of the OFR's mandate, the lack of high-quality data and weaknesses in data standards still represent a critical potential source of risks to the financial system as, more than ever, both supervisors and company risk managers rely upon such data to carry out their responsibilities.

Conducting Research on Financial Stability

The OFR is required by statute to perform essential research on risks to financial stability and to evaluate responses to those risks. This report provides analysis in three specific priority areas identified in Dodd-Frank: To develop metrics for measuring risks to financial stability; to evaluate stress tests that can aid in financial stability analysis; and to promote best practices in financial institution risk

management. Such a focus must and will be a hallmark of the OFR's research and data efforts going forward.

The academic community has proposed hundreds of financial stability measures since the financial crisis. Some of these measures seek to provide forward-looking indicators of financial stress, for example, by revealing cyclical upswings in the use of leverage or in the level of asset prices; others seek to explain current financial conditions and the vulnerabilities of the system to a shock, for example, by revealing possible sources of contagion in a crisis through connections among financial market participants. The OFR's first published working paper surveyed 31 of these measures in some depth (Bisias and others, 2012). Section 3.1 in this report represents a preliminary effort to take that analysis a step further. We evaluate 11 of these measures by comparing their performance during four historical financial crises—1929, 1987, 1998, and 2008. This exercise illustrates the strengths and weaknesses of different approaches. An overriding message is that gaps in financial data constrain the current generation of measures. Looking ahead, the OFR will work to fill these data gaps in order to improve these analytical tools and will take a careful, thoughtful approach to this work.

Another important development following the financial crisis is the increasing use of stress tests as a financial stability tool. The Federal Reserve, working with other U.S. supervisors, carried out stress test exercises in 2009, 2011, and 2012 that subjected large financial firms to similar theoretical shocks, in some cases revealing capital gaps that companies were required to address. Section 3.2 describes how supervisors can use stress tests to evaluate the vulnerability of the financial system to shocks and how stress tests can be extended to incorporate feedback from the financial system to the economy and contagion effects within financial markets. It also discusses two methodologies that could be useful in the ongoing development of stress tests: agent-based models, which simulate the behaviors of market participants to garner insights into market dynamics during crises, and reverse stress tests, which evaluate the types of scenarios that might produce adverse outcomes.

A third area of OFR research lies in the quality of risk management at large financial institutions, which, of course, has always been a central focus for supervisors. This was the topic of the OFR's second working paper (Flannery and others, 2012). Section 3.3 discusses the evolution of best practices and challenges in counterparty risk management, an important area both for individual firm risk managers and for those concerned with limiting financial contagion during periods of market uncertainty. Counterparty risk arises in any transaction in which firms make commitments to each other—derivatives, short-term funding markets, credit guarantees—and can be an important source of contagion when market participants doubt each other's soundness.

Addressing Data Gaps

The OFR was created in large part to fill knowledge gaps and reduce inefficiencies in supervisors' collection and use of data. The OFR follows a three-step process in

setting its data agenda: (1) Identify financial stability data needs; (2) Determine data gaps and weaknesses; and, (3) Prioritize and fill these gaps by better organizing existing data, promoting data standards, and collecting new data where necessary.

Chapter 4 describes how the OFR will execute its data agenda and ensure a secure data environment. It describes how the Office is working to identify and address data needs and data gaps among regulators and to define best practices that can be leveraged across Council member agencies. The OFR is building a descriptive inventory of data that the Council member agencies already purchase or collect. This inventory will help avoid duplication, trim costs, minimize the regulatory burden, and take advantage of existing data sources to the extent possible.

The Office identifies and prioritizes data gaps in the course of its own research and monitoring, at the behest of the Council, or through interaction with Council agencies and other stakeholders. Section 4.2 examines factors affecting financial stability and the need for more and better data on leverage, liquidity, and interconnectedness, with a focus on derivatives and short-term funding markets. In our judgment, these data are still of low quality, and the policymaking and risk-monitoring payoffs from improving them would be substantial.

Promoting Data Standards

Data standards provide common, clear definitions for financial entities, instruments, positions, and transactions. Common definitions promote *comparability*, which means that information can be reliably combined from different sources and systems and that terms and definitions mean the same thing regardless of where the data come from.

The lack of high-quality, consistent, and accessible data was a key source of risk during the recent financial crisis. As concerns spread about certain assets, particularly those related to subprime mortgages, financial companies often were unable to aggregate their own exposures or evaluate the exposures of their counterparties to those assets. Supervisors were similarly challenged. Even in the ordinary course of business, gaps and overlaps in data standards create unnecessary burdens for managers of financial institutions and their supervisors.

It would be difficult or impossible for the OFR to conduct its essential financial stability monitoring function without better data standards in the financial world. Standardization will allow more consistent and complete reporting, so data available to supervisors will be more accurate, more comparable across firms and industries, and easier to use. It will improve the ability of regulators to respond quickly as needed to new developments that could affect financial stability and to resolve troubled financial institutions.

Better data standards will be equally valuable to risk managers at financial companies. Standards allow risk managers to aggregate individual transactions and positions into a complete and accurate picture of the enterprise. By making it easier to link and aggregate information, standards enable firms to use the same basic data both for reporting to regulators and for managing their business.

Standardization will also improve market discipline by giving market participants a more transparent picture of firms' activities.

Chapter 5 describes the OFR's approach to promoting improvements in data standards used in the financial industry. The OFR's goals for data standards include the need for data integrity and quality control, data security, data-sharing protocols, and data management. The OFR's first priority is to support domestic and global efforts to establish an LEI for the benefit of macroprudential regulators and of researchers and financial market participants. These efforts have made important progress in 2012 with the publication of a new International Organization for Standardization standard and the endorsement by the Group of Twenty Finance Ministers and Central Bank Governors (G20) of a March 2013 deadline for global implementation.

The Agenda Ahead

Our priorities for the coming year include work to develop more robust analytical frameworks for analysis to assess and monitor threats to financial stability, to evaluate mitigants to those threats, and to improve the scope and quality of financial data required for that work. Accordingly, we will focus on the forces that promote the migration of financial activities, including maturity transformation and the creation of money-like liabilities, into unregulated or lightly regulated markets—the so-called shadow banking system—and we will investigate in depth the behavior of short-term funding markets and collect better data on repo markets. We will build on the work on the three topics outlined in this report—indicators of threats to financial stability, stress testing, and risk management. We will employ network analysis and new data to research interconnectedness among financial institutions. Our data agenda is tied closely to our research agenda and includes further work on data standards to improve the quality of existing and new information.

Endnote

1. This report complements the Annual Report of the Financial Stability Oversight Council, to which the OFR contributes in fulfillment of its mandate. The Council report provides a broad overview of the financial system, its risks and vulnerabilities, and the policy recommendations and priorities of the regulatory agencies. The OFR's report more narrowly describes the work of one Office and its in-depth analysis of the financial system and potential threats to stability.

References for Chapter 1

Bisias, Dimitrios, Mark Flood, Andrew W. Lo, and Stavros Valavanis. "A Survey of Systemic Risk Analytics." Working Paper #0001, Washington, DC: Office of Financial Research, January 15, 2012.

Flannery, Mark J., Paul Glasserman, David K.A. Mordecai, and Cliff Rossi. "Forging Best Practices in Risk Management." Working Paper #0002, Washington, DC: Office of Financial Research, March 26, 2012.

2 Analyzing Threats to Financial Stability

Our approach to promoting financial stability focuses on analyzing disruptions to the basic services provided by the financial system. Given the dynamic nature of markets and the propensity for market participants to move risky activities out of the view of regulators, supervisors, and investors, our analysis must be dynamic and flexible. The first section of this chapter describes the OFR's approach to financial stability research and monitoring; the second section applies that approach to the financial system in the summer of 2012.

2.1 Research Agenda

Three broad themes drive the OFR's research agenda: (1) Understand how the financial system is evolving in its provision of basic financial services; (2) Assess emerging risks and vulnerabilities; and (3) Evaluate mitigants, such as risk management, disclosure, supervision, and macroprudential policy.

The financial crisis revealed significant gaps in the analytical and empirical understanding of the financial system, its interaction with the economy, and the role of the financial regulatory structure. Today, it is better understood that the financial system was evolving in ways that changed the behavior of institutions and markets. Financial activity had moved substantially outside the focus of supervisors with responsibilities over specific markets and institutions into the unregulated or lightly regulated shadow banking system—that is, credit intermediation by unregulated financial institutions in combination with the creation of money-like liabilities, involving leverage and maturity transformation, in opaque markets (Pozsar and others, 2012). Regulatory reporting systems had not kept up with the increased interconnections among financial institutions, the heightened reliance on leverage, and the dramatic increase in the variety, complexity, and volume of financial activity. Following the crisis, it is now much more clearly understood that the financial system is prone to instability and that weak links in the chain of intermediation must be strengthened.

Financial supervisors have begun to address these problems in important ways. There is a new consensus that policymakers need to have a comprehensive understanding of how the financial system is arranged and connected, how it performs its key functions, and how those functions are being transformed through the activities of market participants, including the development of new products and markets. Likewise, it is also more clearly understood that policymakers must adopt a *macroprudential* approach to their analysis and policy tools, one that looks across the entire financial system to assess and deal with threats to financial stability. Had the regulatory community known in 2005 what we now know, would the outcome have been different? We think the answer is yes, but humility is essential. Our knowledge today is far from complete, and the constant evolution

BOX A. KNOWNS AND UNKNOWNS IN 2005

What types of data or analysis might have helped policymakers identify the risks and vulnerabilities of the financial system as the seeds of the financial crisis were being sown?

Congress created the Office both to analyze the financial system and to conduct forensic analyses following financial disruptions. Based on those mandates, it is appropriate and essential for the OFR to ask what was known and not known before the crisis; what could have been done to develop a clearer picture of the potential for disaster; what information to look for during such a crisis; and how to learn from the crisis in the aftermath.

This analysis could focus on mid-2005, two years before the first liquidity phase of the financial crisis. At that time, some but not all of the key elements that made the financial crisis so devastating were already in place.

At that time, there was a broad public debate about whether the nation was in the midst of a housing bubble. Policymakers had expressed concerns about underwriting standards and about the potential for economic pain when growth in housing prices inevitably slowed. But the consensus was that this adjustment would be moderate, largely because securitization and other market innovations appeared to transfer credit risks and liquidity risks from the regulated and insured banks to other financial institutions that were presumably better able to bear them.

However, few had done the work to follow the risks to their ultimate bearers—and those risk-bearers were too removed from the information to determine the nature of their own risks. It was not well known that American International Group (AIG), the largest insurance company, had already taken significant exposures to the mortgage market, largely through derivatives and the securities lending market, and that several of the largest commercial banks and investment banks had begun to take similar positions. It was not known that the investors in short-term funding markets (asset-backed commercial paper or ABCP, repurchase agreements or repos, and securities lending), who had helped finance mortgage-backed securities (MBS) and other markets, might panic and pull their money. The nature of leverage in certain markets, particularly collateralized debt obligations (CDOs), derivatives, and repos, was not understood.

An appropriate role for an OFR in 2005 would have been to ask broad questions about how the financial system was conducting its basic tasks—credit allocation and leverage, maturity transformation, price discovery, risk transfer, liquidity provision, and facilitation of payments—and what the risks and vulnerabilities were. Although some data may have been available to explore these questions, an agency with a macroprudential perspective may have realized that more data were needed.

An OFR in 2005 might have focused on how new products and markets were affecting these basic financial tasks. How was credit risk being allocated—were concentrations developing, were new credit products distorting incentives, were risk takers sufficiently capitalized? How was maturity transformation being done—were there excessive maturity mismatches, what types of products or entities could be subject to run risk? These questions would have been as important in 2005 as they would have been in 1925, when the regulatory framework of

a different era similarly found itself unable to cope with imbalances across regulated and unregulated markets.

For 2005, these questions could have led, for example, to requests for more information about CDOs that were taking the riskiest parts of MBS—both by buying those securities and by selling protection on those securities through credit derivatives—and about who was buying the different types of CDOs. Large holdings of CDO securities contributed significantly to the losses for AIG, Citigroup, and other large financial institutions—and these holdings were highly leveraged, meaning the institutions had set little capital aside to back those investments. In an early 2005 report, international supervisors noted the possibility that CDOs and credit derivatives could concentrate credit risks in a small number of institutions but did not recognize the role these products were beginning to play in the mortgage market; they noted as reassurance that "such firms are subjected to regulatory, rating agency, and market scrutiny" (BCBS, 2005). The Financial Crisis Inquiry Commission later reported that CDOs and credit derivatives had stimulated demand for MBS and distorted incentives in the mortgage market, contributing both to the excesses of the boom and the severity of the bust (FCIC, 2011).

These questions could have also led to requests for more information about short-term funding markets that were providing funding for CDO and MBS securities, specifically the repo, securities lending, and ABCP markets. Each of these markets would suffer a crisis of confidence in 2007 and 2008 as investors became concerned about the ability of borrowers to make good on their mortgages. Again, AIG, Citigroup, and other financial institutions would suffer significant losses because of implicit or explicit support they had provided to ABCP programs. The nature, pricing, and risk of those commitments could have been better analyzed. In retrospect, it is better understood that these firms were taking "tail risk"—their losses in these markets, like their losses on CDOs, would only occur in a systemwide crisis. Macroprudential analysis requires a particular focus on the incentives to take this type of risk, particularly at the largest financial institutions.

Since the crisis, financial supervisors have begun to take a more comprehensive approach to monitoring and addressing threats to financial stability. That approach includes an emphasis on continually updating policymakers' understanding of activities outside or on the edge of the regulated periphery. As shown during the crisis, derivatives and short-term funding markets are of particular concern because of their ability to shift risk in unexpected ways and because they create leverage, counterparty risk, and other interconnections among market participants.

The new approach includes a renewed emphasis on large financial institutions whose failure could have systemic implications. It also emphasizes continual improvement in firms' own risk management practices and rigorous stress testing to better understand connections and exposures within the financial system and the potential for contagion in the event of a shock.

As described in this report, the OFR has begun to play an important role in implementing this approach, helping to make sure supervisors and market participants have the data they need to understand the financial system and its risk and vulnerabilities and contributing to the evolution of stress testing and risk management.

Chart 2.1.1 Goals of OFR Research

Understand the Financial System	Assess Risk and Vulnerabilities	Evaluate Mitigants
• Analyze the basic functions and services provided by the financial system • Analyze market developments, particularly in shadow banking and derivatives • Analyze new products and markets	• Assess gaps in analytics and data • Evaluate measures of threats to financial stability • Evaluate stress tests • Monitor financial stability	• Promote best practices in risk management • Promote data standards • Conduct forensic analysis of market disruptions • Analyze macroprudential policy

in financial markets will make it elusive *(Box A: Knowns and Unknowns in 2005)*.

That is why the OFR and other agencies charged with monitoring financial stability must always ask the same questions: How is the financial system changing? Where are risks accumulating? What are the forces driving risk-taking activities and what is the interplay among them? And, do policymakers have sufficient data and information to answer these questions? This report describes supervisors' efforts to address these questions and the roles the OFR has begun to play to support those efforts *(Chart 2.1.1)*.

Of course, we know more now than before the crisis. But there will always be a fundamental uncertainty about the sources and severity of threats to financial stability, so we must be modest about our ability to judge them. Financial innovation aimed at improving efficiency and promoting better risk-sharing potentially can morph into excessive risk-taking, and knowing when, why, and how healthy activity crosses the line to creating systemwide threats is difficult. But better data and analysis can help market participants identify and assess their own risks and make appropriate decisions about them.

Better data and analysis can also help policymakers evaluate and promote mitigants, that is, financial shock absorbers and guardrails, to reduce the risk of crises. Mitigants include indicators of threats to financial stability, risk management systems, and stress tests; macroprudential policy tools that seek to reduce both the structural vulnerabilities and cyclical excesses in the financial system; strong data standards to promote sound analysis; and crisis management and forensic analysis, to mitigate the effects of crises that occur and help draw lessons for the future.

2.1.1 Understand the Financial System

The OFR's financial stability monitoring efforts are driven by the principle that financial activities and risks are constantly shifting. In a short time, an entire market can develop out of a new way to perform an old financial function, as technologies and products evolve and companies experiment with new business models. Such innovation can make the financial system more effective and efficient and can promote economic growth; at the same time, it can create unexpected and hard-to-detect risks.

For that reason, financial stability analysts must always be asking how the financial system is conducting its basic tasks. While those basic tasks can be characterized in various ways, one framework would consist of the following six:

- **Credit allocation and leverage.** A dynamic economy needs a mechanism for making funds available to borrowers with projects or goods that need to be financed. Because of information asymmetries, the financial system provides a valuable service matching

lenders with borrowers. For investors, leverage magnifies financial returns.

- **Maturity transformation.** Many investors wish to commit themselves for only a short period of time, while many borrowers need to finance their investments over a longer period. Responding to those needs, banks and other financial institutions provide maturity transformation, for example, when they accept short-term deposits and invest in long-term loans. But that maturity transformation service is fundamentally unstable because short-term depositors may demand their money on short notice. Since the advent of the FDIC, insured deposits at banks are no longer susceptible to rapid outflows amidst a loss of confidence. However, other forms of market-based maturity transformation became prevalent in the past decade—money market funds, asset-backed commercial paper, repo markets—and also proved susceptible to a sudden loss in funding when investors lost confidence in their underlying assets or in the strength of the financial institutions that backed them.

- **Risk transfer.** Investors may wish to hold relatively safe claims while borrowers are often in the business of taking risks. Financial intermediaries assess borrowers' risks and provide their own capital cushions to transform risky individual loans into lower-risk, diversified portfolios that can offer reliable payoffs. Credit risk transfer became increasingly complex and opaque in the past decade with the advent of credit derivatives and complex structured credit products, and these innovations contributed importantly both to the mortgage market excesses of the 2000s and to the severity of the ensuing financial crisis.

- **Price discovery.** Through the interaction of buyers and sellers, markets perform a valuable social function by determining fair market prices for financial assets. This mechanism is essential for the efficient allocation of credit, maturity transformation, and risk transfer in the financial system.

- **Liquidity provision.** The willingness of investors, borrowers, and lenders to participate in the financial system depends on their ability to execute transactions in a timely fashion. Markets and financial institutions provide the liquidity necessary to fulfill many of the financial system's other roles.

- **Facilitation of payments.** All activities in the financial system depend on the smooth operation of a complex infrastructure for processing transactions and payments. That infrastructure enables market participants to clear and settle transactions and provides documentation for risk monitoring and risk management.

For consumers of financial services, institutions like banks or insurance companies offer the most tangible examples of the value of these financial services. A traditional bank offers low-risk deposits to savers and uses the funds to make riskier loans to borrowers. Risk transformation is accomplished through a combination of diversification and an equity cushion that shelters depositors from default risks. A bank provides maturity transformation and liquidity by allowing investors or depositors to withdraw their funds on short notice, even though the loans they fund are relatively illiquid and mature later. However, nonbanking markets also perform similar functions. For example, securitization has split up the traditional lending process into separate stages of loan origination, pooling, and market funding.

The execution of these six financial system functions is always evolving. Financial services swing between traditional banks and nonbanking markets in response to forces that drive market incentives and behaviors: financial innovations and other competitive forces, industry's perennial efforts to arbitrage official supervision and regulation, and other

policies, such as fiscal policy, monetary policy, and government guarantees such as deposit insurance. In recent decades, as noted above, government supervision focused on the primary providers of intermediation services, while many of the same services were provided through the shadow banking system *(Box B: Shadow Banking—It's Not a New Story)*.

2.1.2 Assess Risks and Vulnerabilities

"Financial stability" simply means that the financial system is sufficiently functioning to provide those six basic tasks for the economy even under stress; in short, the system is resilient to the inevitable shocks and breakdowns in market confidence.[1] A breakdown in any one of these basic tasks can be very dangerous for the economy. Also, the provision of these tasks can be a double-edged sword. For example, although credit allocation and leverage, maturity transformation, and risk transfer are essential to the financial system and the economy, they can also pose risks to financial stability if taken to extreme.

Financial stability does not imply the absence of price volatility or failures of firms in the financial system; rather, it implies that markets continue to function despite such shocks. These shocks can take many forms, but in general can be transmitted through one of three channels: (1) A default by one or more major market participants; (2) A sudden loss of market confidence, which could be caused by new information about a particular type of asset and which could be expressed, for example, through freezing of liquidity or a sudden change in prices; or (3) A disruption in the market infrastructure—the so-called "plumbing" of the financial system, such as systems for payment, clearing, and settling of transactions.

Financial stability is essential for sustainable economic growth and efficient allocation of resources in the economy and the financial system. A stable financial system promotes economic growth and increasing wealth, while an unstable system can be both an independent source of shocks and a source of vulnerabilities to outside shocks.

Prior to the financial crisis, mainstream economic analysis did not routinely incorporate a framework explaining how risks could emerge from within the financial system. To be sure, some theorists had argued that relatively calm periods in financial markets could create an environment in which risk-taking and leverage would build, reinforcing the severity of business cycles and aggravating downturns (Minsky, 1992). But these were not mainstream views. Across the profession, there was a widespread belief in the self-correcting nature of markets and the inherent stability of financial activity. Under this view, risks flowed in one direction, from the economy to the financial system. It was widely believed that the so-called Great Moderation—a period of low inflation and remarkably steady economic growth—had engendered financial stability. If monetary policy could achieve price stability and steady economic growth, financial stability would naturally result. It remained possible that a severe recession would strain balance sheets and cause widespread defaults, but successful monetary policy made this seem unlikely. Moreover, private incentives for diversification would, it was believed, serve to limit the systemic effects of financial intermediaries' difficulties.

The recent crisis served as a painful reminder that the financial system is prone to internal instability resulting from a buildup of leverage, maturity mismatch, and mispriced credit and liquidity risks. The benign economic conditions seen in the Great Moderation created the illusion of financial stability as threats to financial stability proliferated in a climate of complacency and excessive risk-taking.

Traditionally, macroeconomists used analytical frameworks or models that precluded the analysis of such risk buildups, because of simplifying assumptions, for example, that all market participants were identical. Both traditional macroeconomic models and so-called Dynamic Stochastic General Equilibrium

models, which describe how forces of supply and demand can achieve balance in the economy, ignore financial complications such as the possibility of default. Assuming away default and the risks created by leverage is equivalent to assuming that the value of an individual firm is unrelated to the extent of debt or equity financing—that is, to its leverage (Modigliani and Miller, 1958).

But, from a financial stability perspective, debt and equity are not and should not be considered equivalent. Equity or capital provided by investors who are able to bear losses acts as a shock absorber that self-insures lenders against loss, helps contain leverage, and limits contagion in a crisis. In contrast, excessive credit or leverage promotes contagion; during a crisis, defaults tend to exceed the expectations of credit providers. The recent crisis is Exhibit A: It was fueled by badly managed credit and excessive leverage that led to the bankruptcy of individuals and the failure of firms, threatening financial stability as a whole. In the absence of significant capital buffers, the losses from defaults triggered deleveraging and balance sheet contraction.

Macroeconomists have been working to incorporate more robust assumptions about the financial system into their models to explain such internal buildups of risk.[2] Far from being a sterile intellectual exercise, adopting a more realistic analytical framework helps policymakers understand why the downside of credit cycles unfolds much faster than the upside. Equally, such tools help explain how tail risks in stress scenarios manifest themselves.

Taxonomies of Risks and Vulnerabilities

Risks to financial stability can be *internal* or *external* relative to the financial system. An example of an internal threat is the excessive risk-taking, fueled by relatively cheap credit and liquidity, which promoted the unsustainable housing price boom in the 2000s. Examples of external threats are a sovereign debt crisis overseas, a pandemic or other natural disaster, and an international political crisis. Financial stability analysis focuses on (1) the propensity of the financial system to generate risks—in particular, on *procyclicality*, which is the tendency of swings in financial activity, especially downswings, to magnify the business cycle and possibly trigger financial instability—and (2) the vulnerabilities or resilience of the financial system in the event of a shock.[3]

Vulnerabilities in the financial system have both *cyclical* and *structural* components. The buildup of leverage in a credit cycle is an example of how risks can accumulate both in a given financial institution and in the financial system as a whole. Alternatively, crowded trades in an interconnected system are an example of how the structure of the financial system itself exacerbates and transmits risks across investors within the system.

This taxonomy is similar to the approach in the FSOC Annual Report, which describes internal or external shocks interacting with structural vulnerabilities to disrupt financial stability (FSOC, 2012). In both taxonomies, a key point is that financial activity itself can generate threats to financial stability, as periods of calm lead to excess; not all potential threats are external to the financial system.

Cyclical Vulnerabilities. Leading up to the crisis, credit and leverage both grew significantly on the balance sheets of households and financial institutions and in financial markets. Some of the largest investment banks and commercial banks took increasing risks in their trading activities in pursuit of higher returns or incidentally in the course of providing services for their clients. Often those positions involved the use of leverage embedded in or created by financial innovations in derivatives, collateralized debt obligations (CDOs), and asset-backed commercial paper (ABCP) programs. In turn, that leverage amplified price bubbles, particularly in the housing market. In retrospect, it is clear that the management of these companies did not understand the risks they were taking and the dangers of the leverage they were using. Although recent

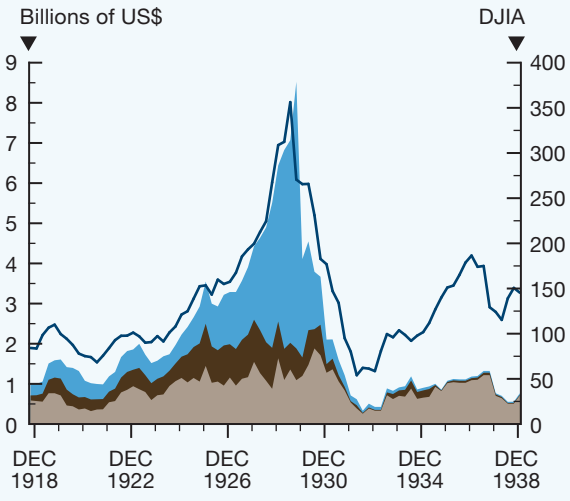
BOX B. SHADOW BANKING—IT'S NOT A NEW STORY

The term "shadow banking" has gained currency since the financial crisis to describe the provision of bank-like services—in particular, credit intermediation, maturity transformation, and the creation of money-like liabilities—by companies and markets other than banks. These activities are generally subject to less supervision and regulation than banks and do not have the benefit of federal deposit insurance. Nonbank banking has been central to the financial system and to financial booms and busts for more than a century. In general, market participants will seek to conduct their activities wherever the regulatory environment is most conducive.

The Panic of 1907 emanated from the call loan market, in which banks and nonbanks invested excess cash on a short-term basis to fund brokers' loans backed by stocks and bonds. The panic consisted largely of a run on the trusts, which were nonbanking institutions that performed services similar to banks without being subject to similar government supervision.

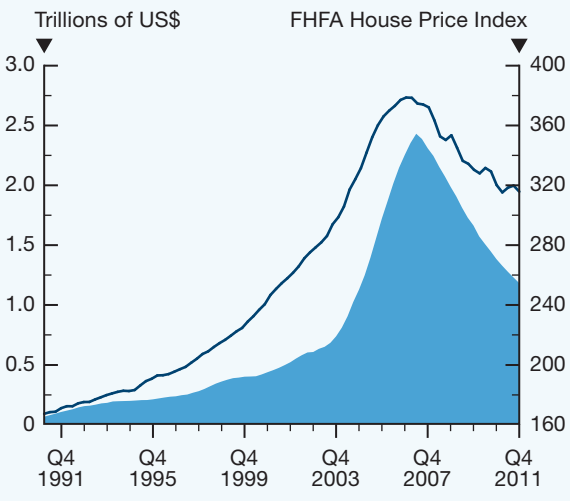
Responding to that crisis, Congress created the Federal Reserve System in large part to hold banks' reserves as an alternative to a nationwide system that channeled much of the banking system's reserves into the New York City call loan market.

Chart B.1 Nonbank Lending Boom of the 1920s



Source: Board of Governors (1943), FRED, FRASER

Chart B.2 Securitized Credit Boom of the 2000s



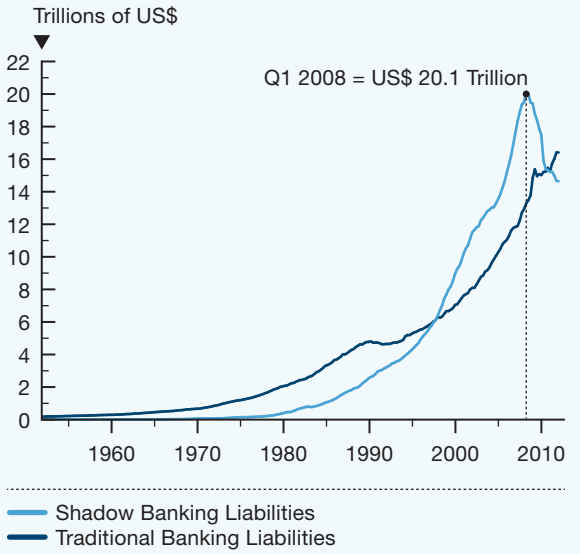
Source: FHFA, FRB, Haver Analytics

The call loan market was also central in the stock market boom in the 1920s. This time, most of the financing was provided by nonfinancial corporations with excess cash (the blue area in ***Chart B.1***), which were attracted to the relatively high returns and the secured nature of the market. This situation is analogous to the role of the securitized credit markets in the housing boom of the 2000s ***(Chart B.2)***. The subsequent crash was made worse by the flight of these investors. Even before the crash, the role played by nonfinancial corporations in fueling the stock market credit boom had been derided as "bootleg banking," and the Federal Reserve had sought in vain to limit the practice indirectly through moral suasion and by attempting to limit access to the discount window for banks that lent to those corporations (Harrison, 1931).

Building and loan associations, precursors to the savings and loan industry that collapsed during the 1980s, led the mortgage market boom during the same period; there was also an early form of private mortgage-backed securities in which mortgages were packaged and sold to investors as securities—clearly an activity that falls within the current generally accepted definition of "shadow banking."

The modern trend toward market-based or shadow banking has its roots in the late 1960s, when caps on deposit interest rates and other regulations encouraged financial markets to develop deposit-like products paying higher interest rates. The commercial paper market grew rapidly, connecting corporate borrowers with large cash investors. By the late 1970s, much of the demand in this market came from money market funds. The U.S. securitization process also began in the 1970s with prime mortgage loans. It expanded to a wide range of other asset types, including auto loans, credit card receivables, lease payments, and, finally, subprime mortgages.

Chart B.3 Shadow Banking vs. Traditional Banking Liabilities



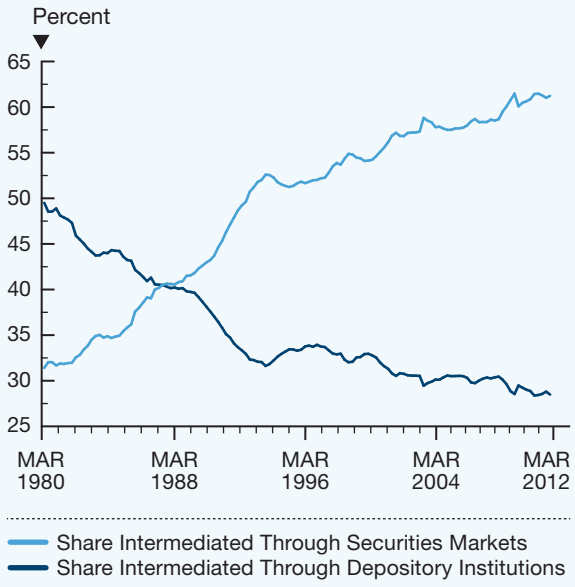
Note: Traditional bank liabilities refer to total liabilities of U.S. chartered depository institutions, foreign banking offices in the U.S., holding companies, banks in U.S. affiliated areas, and credit unions. Shadow bank liabilities (netted from overlaps) refer to the sum of total outstanding open market paper, total repo liabilities, net securities loaned, total GSE liabilities and pool securities, total liabilities of ABS issuers, and total shares outstanding of money market funds.

Source: Pozsar and others (2012), Flow of Funds, Haver Analytics, OFR calculations

The risks of these markets displacing or "disintermediating" the banking sector were widely discussed throughout this period. Academics and policymakers debated whether banks were "dead" (markets could do everything banks could do) or "special" (they provided essential payments services; they continued to innovate; and, in fact, the largest banks tended to be facilitators or financiers in the new markets) (Corrigan, 1983; Boyd and Gertler, 1994). Regulatory changes generally encouraged these developments, as evidenced by the rapid growth of shadow banking liabilities that began at the turn of the last decade ***(Chart B.3)***. The share of total credit

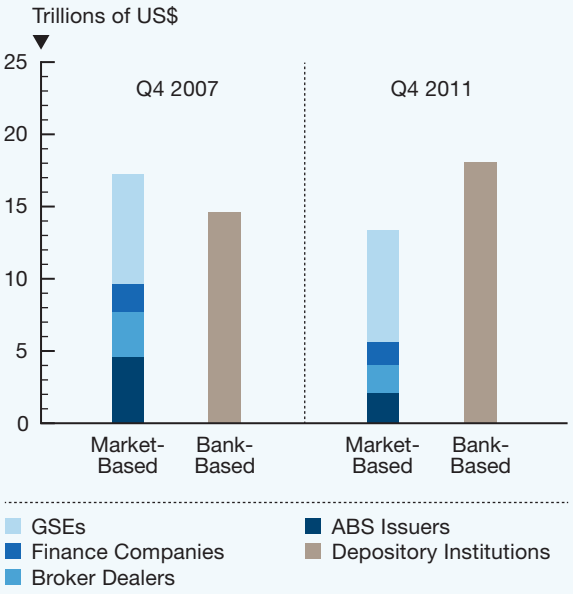
BOX B. SHADOW BANKING—IT'S NOT A NEW STORY - CONTINUED

Chart B.4 Origin of Private Nonfinancial Debt Outstanding



Source: Morgan Stanley calculations based on Flow of Funds

Chart B.5 Bank vs. Market Intermediated Credit Outstanding



Source: Flow of Funds, OFR calculations

intermediated through securities markets rather than banks has grown over the past 30 years, although that trend slowed since the onset of the crisis as some important market-based channels were disrupted ***(Charts B.4 and B.5)***.

The lesson from history is that the provision of basic financial services constantly evolves. An important role for the OFR is to keep track of those changes, particularly when activities increase in markets and institutions that are not being monitored by microprudential supervisors. The OFR's efforts to identify and address data gaps in these types of markets are described further in Chapter 4.

American experience had suggested that mortgages contained only modest credit risk, when the bubble burst, the combination of poor underwriting, faulty risk transfer, and excessive leverage created extraordinary defaults and a cascade of systemic deleveraging.

In the past, the breadth, depth, and liquidity of the U.S. capital markets generally enhanced the resilience of the overall financial system by enabling companies to finance their operations efficiently and promoting the low-cost provision of essential maturity transformation and payments services. They allow investors and savers to have confidence in their ability to access their capital at the time of their choosing without significant cost. Indeed, strong capital markets were widely viewed as a backup pillar of support or a "spare tire" for the financial system in times of banking stress.[4]

However, easy liquidity—and the expectation that it would continue indefinitely—helped make credit available on relatively generous

terms in the 2000s and contributed to what in retrospect was a mispricing of both liquidity risk and credit risk among market participants and traditional lenders. In 2007, credit losses triggered a deleveraging in housing finance markets and market participants suddenly lost confidence in the creditworthiness of mortgage-backed securities and related derivatives, CDOs, and ABCP. Previously cheap short-term funding and liquidity became dear. Fire sales resulted: as individual firms rushed to improve their cash positions, they sold both troubled assets and other assets that were easier to sell, magnifying and reinforcing the effects of the deleveraging on housing, the economy, credit availability, risk appetite, and the very liquidity that had started the cycle.

Structural Vulnerabilities. The financial crisis also provides case studies in structural vulnerabilities. For example, through credit guarantees, structured credit products, and credit derivatives, a small number of large financial institutions sold or provided billions of dollars in protection against losses in the housing market. Yet, structural weaknesses in the global derivatives markets—poor regulation and opacity that undermined market confidence in times of stress—made them poor vehicles for risk transfer. Ad hoc trade execution and risk management meant that users could not gauge product risk, market risk, and counterparty risk, particularly given the proliferation of customized or bespoke transactions. As a result, risk managers who believed that they were appropriately hedging their risks were often crowded into the same risk management strategy, buying protection via credit default swaps. This concentration of credit risk was generally not understood as a threat to financial stability because of the high credit ratings and apparent financial soundness of those financial institutions that provided backstops and guarantees. However, in the housing market meltdown, the losses faced by these institutions posed serious risks to the financial system when investors and counterparties lost confidence and pulled their funding or demanded more collateral.

While these categories provide a useful framework for thinking about threats to financial stability, there is no bright line separating them. For instance, the housing boom at the heart of the financial crisis was amplified by both forces internal to the financial system (liquid securitization markets, for example) and those external to it (strong housing demand and the belief that home prices would not fall). Of course, the cyclical extremes of the boom were fueled by the interplay between them—easy credit promoted strong housing demand and rising prices, while the price gains encouraged leveraging on attractive terms.

2.1.3 Evaluate Mitigants

Macroprudential regulation should mitigate threats to financial stability by limiting the internal buildup of risk, reducing vulnerabilities, and promoting resilience to shocks. Mitigants can be described as *guardrails*, which set limits or controls on the activities of financial institutions and help to restore market discipline, and *shock absorbers*, which prevent shocks from disrupting the financial system's performance.

Such regulation should counter procyclicality, which is, as noted, the tendency of swings in financial activity to magnify the business cycle. For example, it should lean against the tendency during good times for firms to take excessive risks with thin capital and liquidity buffers and, during bad times, to act in ways that seem rational for a single firm but that have negative systemic consequences when many firms act similarly—for example, by selling assets in fire sales or by reducing lending rather than raising new capital (Hanson, Kashyap, and Stein, 2011).

Best practices for macroprudential policy dictate that policymakers cannot deliver financial stability without a tool to counter each source of financial instability. They also dictate that policymakers should assign to each target the right tool for the job—the one that has the biggest influence on the policy objective—following the "assignment principle" (Mundell,

1962). For example, if policymakers want to combat three targets—excessive leverage, insufficient liquidity, and procyclicality—a satisfactory toolkit must contain tools to address each of the three—such as capital, liquidity, and margin regulations (Kashyap, Berner, and Goodhart, 2011).

Macroprudential policy must also take into account that this toolkit will have macroeconomic consequences, just as monetary and fiscal policy—typically macroeconomic tools—may have macroprudential consequences. While the assignment principle suggests that these spillovers and potential conflicts do not preclude effective policy implementation, both financial instability and macroprudential tools to combat it may alter the transmission mechanism for monetary and fiscal policies in ways that policymakers need to recognize (Carney, 2009). Encouragingly, flexible inflation targeting likely gives central banks the flexibility to deploy macroprudential tools both in crises and in periods of stability (Carney, 2012). However, if a financial crisis impairs the traditional policy transmission mechanisms, the assignment principle may indicate that macroprudential tools be used to restore their functioning and achieve macroeconomic goals.

Mitigants are largely complementary from a microprudential and macroprudential point of view. From a microprudential point of view, the guardrails in the financial system include firm risk management, market discipline and information intermediaries (for example, rating agencies and data providers), and microprudential supervision and regulation; shock absorbers include capital and liquidity standards. From a macroprudential point of view, guardrails include stress tests, living wills for certain financial institutions, and central clearing for swaps and derivatives; systemwide shock absorbers include an orderly liquidation authority, deposit insurance and emergency liquidity provision by the central bank.

The Dodd-Frank Act introduces several measures aimed at strengthening guardrails. For example, it subjects large, complex financial companies to more stringent supervision by the Federal Reserve and it creates a new regulatory framework for derivatives, requiring most derivatives to clear through central counterparties. To strengthen shock absorbers, Dodd-Frank regulations and the Basel III agreement among international supervisors have improved capital standards, and Basel III introduced the first international liquidity standard (BCBS, 2010a; BCBS, 2010b). Dodd-Frank also introduces a new resolution regime that creates a process for breaking up and winding down failing large financial companies, which aims to contain the systemic repercussions of such events. These new guardrails and shock absorbers will also help restore market discipline by reducing the expectation that taxpayers will bail out failing companies.

The OFR must contribute to these mitigants by fulfilling its analytical mandates, which include identifying and filling data gaps; developing and maintaining metrics and reporting systems for risks to financial stability; monitoring, investigating, and reporting to Congress and the Council on changes in systemwide risks; conducting, coordinating, and sponsoring research to support and improve regulation of financial companies; assessing and reporting on stress tests and other stability-related evaluations of financial companies; conducting forensic analyses of market disruptions; conducting studies and providing advice on macroprudential policies; and promoting best practices in firm risk management.

2.2 Current Threats to Financial Stability

Cyclical threats to financial stability today include the lingering weakness in the housing finance market; the extremely low level of interest rates; the possibility of a deterioration in lending standards; and the potential impacts of the euro area sovereign debt crisis on the U.S. financial system and economy. Structural threats remain in the prevalence of data gaps and inadequate data standards in the financial sector; the ongoing challenges to risk management posed by complex trading activities, particularly at the largest financial institutions; and the run risk for money market funds and other short-term funding markets.

To analyze threats to financial stability, we look to the analytical framework laid out in the first part of this chapter. The six basic tasks—credit allocation and leverage, maturity transformation, risk transfer, price discovery, liquidity provision, and facilitation of payments—are all fundamental to the functioning of modern financial systems. The financial system is stable as long as it can provide these basic services for the economy, even under stress. By the same token, shocks can disrupt these basic functions.

As noted, two taxonomies shed further light on the sources of potential shocks. The first draws a distinction between internal and external risks. Internal risks—those arising from within the financial system—include failures of the mitigants described above, such as inadequate risk management among financial firms or insufficient regulatory shock absorbers or guardrails, while external risks include potential contagion from the European sovereign debt crisis. The second taxonomy distinguishes between cyclical and structural risks; although some risks represent a mix of both. Cyclical risks involve the familiar buildup of risks over the credit and business cycle, for example, excessive credit growth and leverage. Structural risks involve risks across the financial system at a point in time, for example, the fixed net asset value that promotes the risk of a run in money-market funds, intraday credit risks in tri-party repo, the continuing presence of large institutions that are perceived as too big to fail, or the forces that promote the migration of activity into unregulated or lightly regulated markets. The European crisis represents a combination of structural risks (a currency union without a fiscal union) and cyclical risks (the current recession).

The intersection of these two taxonomies can be helpful in categorizing the major potential threats that the OFR sees in the financial system today ***(Chart 2.2.1)***.

2.2.1 Internal Risks

Cyclical Concerns

Among risks that might arise within the financial system, the current credit environment poses two types of cyclical concerns: weaknesses in credit intermediation in the housing market and the possibility of excesses in credit markets fueled in part by historically low interest rates.

Consumer Finance. Although housing prices may be at or near the bottom, even seven years past their peak, a key financial imbalance—that is, one that is internal to the financial system—continues to restrain the housing sector. The legacy of the mortgage bust lingers on household and lender balance sheets, weighing on mortgage markets and the availability of mortgage credit. Twelve million homeowners have outstanding balances on their mortgages exceeding the current market value of their homes. Nationally, that so-called "negative equity" has been estimated at $717 billion (CoreLogic, 2012). Lenders continue to work through nonperforming loans originated before the crisis, while continuing to be exposed to the risk of "put backs" and the uncertainty surrounding proposed risk retention rules. Mortgage originations remain depressed, mortgage debt continues to contract, and even creditworthy potential homebuyers continue to have difficulty obtaining financing. As a result,

Chart 2.2.1 Current Potential Threats to Financial Stability

	Internal	External
Cyclical	• Sluggish growth and dependence on government support in housing finance • Low interest rate environment encourages "reaching for yield" • Some evidence of deterioration in underwriting standards, e.g., "covenant-lite" loans	• European sovereign debt crisis • Possible slowdown in emerging markets
Structural	• Data and analytical gaps and lack of data standards • Breakdowns in risk management and other guardrails • Short-term funding and derivatives markets • Too big to fail	• Domestic fiscal policy • Cyber attacks

the government continues to play an outsized role in the market through the Federal Housing Administration and the two government-sponsored enterprises (GSEs), which have been operating under conservatorship by the government since 2008.

Meanwhile, Americans owe $1 trillion on student loans that are predominantly held by the government. While this debt does not present direct risks to financial institutions, consumers with large student debt burdens may spend less and are more likely to have difficulty securing a mortgage. These factors could significantly depress demand for mortgage credit and dampen consumption.

Low Interest Rates. The second major cyclical issue today is the extraordinarily low level of interest rates. In early June, the 10-year Treasury yield fell below 1.5 percent for the first time. Although low rates have made an important contribution to the economic recovery, a low-rate environment creates potential stress for some investors, particularly financial institutions, such as life insurers and pension funds, that need to earn a certain return on their fixed-income portfolios to cover a fixed stream of liabilities. Low interest rates can therefore lead some investors to reach for yield by taking on additional credit risk to enhance their expected earnings.

Financial crises, including the most recent one, often emerge after long periods of low rates during which lending standards deteriorate. Council member agencies are concerned about the potential for such excesses in markets other than housing finance. They have noted recently the increased issuance of "covenant-lite" loans, which are loans that waive the typical restrictions on commercial borrowers with respect to collateral, income, or payment terms. Second, banks could be exposed to losses if they do not hedge their balance sheets to protect against higher rates in the future. The federal banking agencies issued guidance to supervised institutions about interest rate risk management in January 2010 and followed up with clarifications in January 2012 (Board of Governors and others, 2010; OCC and others, 2012).

The MF Global bankruptcy and JPMorgan's recent trading losses suggest that, against the backdrop of low returns on equity, some companies continue to take significant risks in their trading operations. The role of financial stability analysis in such situations is to consider the potential systemic impacts—for example, to determine whether the strategies on which those companies experienced losses were common in the market, whether other firms faced similar control problems, and what the

implications might be for the market if they were to fail.

Structural Concerns

Structural concerns today include the remaining intraday credit risk in the tri-party repo market and the risk of runs on money market funds. Pairing these risks together and with others is important. Structural weaknesses in the tri-party repo market may increase the risks of using short-term funding for illiquid assets. Moreover, the practice of money market funds maintaining a one-dollar net asset value can magnify this type of instability. If investors believed that the one-dollar-per-share value exceeded the true liquidation value of a fund, they would have an incentive to pull out their money before other fund investors.

Short-Term Funding Markets. Before the crisis, secured and unsecured short-term funding markets provided major sources of financing for the portfolio holdings and securities inventories of broker-dealers and other market participants. This ability to mismatch maturities provided a major source of the returns to securitization. The use of short-term wholesale funding has decreased since the crisis but it is still used substantially by large bank holding companies, including those with large broker-dealer operations.

Short-term funding markets are key focal points for the emergence of excessive leverage, liquidity risk, and new forms of interconnectivity among financial institutions, the three vulnerabilities of the financial system highlighted in Section 4.2. Short-term funding, obtained through repos, commercial paper, and prime broker lending, can be a source of instability if lenders, worried about the value of collateral or counterparty risks, make it difficult for borrowers to roll over their maturing short-term debt on economically viable terms. Those terms include the rate and tenor and, for secured funding, the haircuts on collateral. Under stress, lenders shorten tenor and increase haircuts, significantly raising the cost of funding. Swings in repo haircuts add procyclicality to the financial system. Under extreme stress, borrowers funding long-duration illiquid assets with wholesale funding could be forced to sell assets under fire sale conditions. Pressure on asset prices, in turn, reinforces the downward spiral. Short-term funding markets also face run risk in a crisis because they do not benefit from official backstops in the form of federal deposit insurance or the Federal Reserve's discount window.

Some progress has been made in addressing risks in the tri-party repo market and money market funds since the crisis. An industry task force on tri-party repo reform disbanded after some success, but the problem of intraday credit remains. The Federal Reserve is now taking a more direct supervisory approach to making the necessary changes (Tarullo, 2012). Similarly, the SEC made important reforms in money market fund regulation in 2010, including more stringent liquidity requirements, but the risk of runs remains due to the combination of a promised stable net asset value and investments in securities that can default or lose value precipitously (SEC, 2010). The SEC is reviewing further policy options for money market fund reform. Among the options are a capital requirement, in which money market funds would be required to hold a layer of equity that would absorb losses before investors incur losses; restrictions on redemption; and a move away from a fixed net asset value.

Market Integrity. For the financial system to perform its price discovery function through the interactions of buyers and sellers, markets must be transparent, fair to all participants, and not subject to manipulation. U.S. and U.K. regulators recently announced that Barclays Bank PLC, a London-based financial institution, will pay close to half a billion dollars in penalties to resolve violations arising from alleged manipulations of the London Interbank Offered Rate (LIBOR) and the Euro Interbank Offered Rate (EURIBOR). Market participants, risk managers, and regulators have relied on these rates for many years as benchmarks for the cost

of short-term, unsecured funding that in large part reflect counterparty risks.

LIBOR and EURIBOR are calculated as an average of the rates that major banks submit each day. Each bank is supposed to contribute rates that reflect its estimated cost of funds in the unsecured interbank market. An agreement between Barclays and the U.S. Department of Justice (DOJ) stated that Barclays had submitted bids that took into account trading positions of its own derivative traders or reputational concerns about Barclays itself. Regulators have an ongoing investigation into other banks' activities in the market (DOJ, 2012).

LIBOR and EURIBOR are benchmark interest rates that market participants use as the basis for pricing trillions of dollars worth of loans and securities. As the preeminent benchmarks for unsecured transactions, these rates also provide important market signals about counterparty credit risk. This type of manipulation—resulting from an opaque and closed process that allows a small number of firms to have significant influence—poses significant risks to market integrity and investor trust, and will require continuing regulatory focus.

Collateral in Secured Lending Transactions. Securitization involves a chain of activities ranging from origination at one end to financing at the other and is an important part of the shadow banking system. Securities lending and repo financing are two key activities in this chain. Lenders of securities, primarily institutional investors, offer their holdings to banks and broker-dealers who need to borrow them in order to hedge or outright short them. As collateral for the loan, the broker-dealers offer the lenders cash resulting from the short. Broker-dealers finance their securities inventory with repo, done for example with a mutual fund, using the securities as collateral. Leveraged investment funds and other providers of repo financing also play important roles.

These activities pose potential threats to financial stability through three channels:

Maturity transformation and credit risk through cash collateral reinvestment. Securities lenders can reinvest the cash collateral they receive from securities lending transactions and engage in credit and maturity transformation, taking on credit and liquidity risks. If asset prices fall and those investments turn illiquid, and if the borrowers ask for their cash collateral to be returned, these companies can lose their access to market funding. Such bank-like activities create bank-like risks without the safeguards banks enjoy.

Procyclicality of systemwide leverage and interconnectedness. Securities lenders may also obtain leverage that is sensitive both to asset prices and their own counterparty risk, creating procyclicality in securities financing markets. This procyclicality depends importantly on the changes in haircuts applied to those collateral securities, and the extent to which collateral is used more than once (collateral velocity). Haircuts rise with credit and counterparty risk, raising the cost of credit and prompting deleveraging in a downswing. Extensive collateral re-use, or rehypothecation, coupled with leverage, maturity transformation, and interconnectedness among firms, could create several threats to financial stability, including fire sales of less liquid assets. While it appears that such risk-seeking has diminished in the wake of the crisis, the current low level of returns may create pressures to stretch for yield. And the current fraught state of unsecured funding markets has intensified an already high demand for collateral in secured funding markets, one that may intensify this procyclicality.

Lack of transparency. Securities financing markets are often opaque because they are complex and rapidly evolving, and the transactions are usually bilateral. Better data are essential to understand the risks in such activities. More disclosure by market participants would also help, including

disclosures about transactions that are typically "looked through" for the purposes of financial reporting. Better risk reporting by intermediaries to their clients would help them understand the counterparty risk and cash collateral reinvestment risk of their securities lending programs.

Derivatives. When properly managed, derivatives provide value to market participants by allowing them to hedge risks or to gain exposures to real assets without having to hold those assets. Derivatives also offer a relatively cheap way to leverage market positions. But those characteristics—risk transfer and leverage—also make derivatives markets potentially an important source of threats to financial stability, particularly when poorly managed.

The crisis illustrated the dangers of poorly understood derivatives markets, particularly credit default swaps, which shift the credit risk related to a reference entity—such as a corporation, a country, or a specific bond—from a protection buyer to a protection seller. Between 2004 and 2007, credit default swaps referencing different tranches of mortgage-backed securities (MBS) became ubiquitous. CDOs that invested in MBS and synthetic CDOs that took long positions in credit defaults swaps that referenced MBS or other CDO securities also proliferated. These new financial innovations facilitated complex trading strategies that distorted incentives in the mortgage market. They also made it possible for a small number of large financial institutions—prominently, AIG, the nation's largest insurance company, and Citigroup, a commercial bank and investment bank holding company—to take outsized positions in the mortgage market.

The crisis also revealed serious structural problems in the derivatives market. The lack of transparency, limited regulation, and poor risk management created uncertainty during the financial crisis as market participants could not gauge market risk and counterparty risk. In the absence of margin requirements, AIG was able to take on those positions in mortgage-related derivatives without posting margin. The lack of transparency in the markets contributed to the uncertainty during the crisis, as financial institutions tried to understand their exposures to specific counterparties and regulators tried to understand the potential contagion effects of the failure of a large firm.

Regulators and the industry itself have taken important measures to make derivatives markets more transparent and robust. The Group of Twenty Finance Ministers and Central Bank Governors (G20) at the 2009 Pittsburgh Summit agreed that standardized derivative contracts should be traded on exchanges or electronic platforms, as appropriate, and cleared through central counterparties—meaning there is a separate institution that intermediates between the parties to a swap, which improves the management of credit risk. The G20 leaders also agreed that all over-the-counter (OTC) derivative transactions should be reported to trade repositories, which collect and store information about derivatives trades. The Dodd-Frank Act establishes those requirements in the U.S. The U.S. is also working with foreign regulators to introduce global margin standards for OTC derivative contracts that are not centrally cleared.

Since the crisis, there has been a substantial increase in the volume of swaps that are centrally cleared. Trade repositories have expanded, providing previously unavailable transparency for regulators into derivatives exposures. Also significantly improving transparency, the Dodd-Frank Act requires many types of swaps to be traded on a swap execution facility (SEF), defined in the Act as a trading platform that market participants must use to execute swap transactions. The SEC and CFTC have proposed rules for regulating SEFs (SEC, 2012; CFTC, 2012a).

In the spring of 2012, the OFR began to collect data on credit default swaps from a private-sector data repository. The data will allow the OFR and supervisors access to

information about positions that are taken by U.S.-based entities or that reference U.S.-based entities. The OFR anticipates using this data, in cooperation with the agencies, to analyze the aggregate exposures that different types of firms are taking in credit derivatives, to investigate whether undue concentrations of the AIG type are developing, and to respond to specific queries such as the extent to which U.S. entities have sold protection on troubled entities or markets.

Too Big to Fail. Capital injections to save our financial system have led some market participants to believe that some large institutions carry an implicit government guarantee, which could lead to competitive inequities within the financial system. Supervisors have taken important steps to reduce the risks posed by the potential failure of large, complex financial institutions.

Steps taken since the crisis include higher capital standards, particularly for trading activities, a proposed new global liquidity standard, and a tougher supervisory regime for large, complex financial institutions. Dodd-Frank also makes it easier for regulators to liquidate or resolve large, troubled financial companies in a way that minimizes the impact on the rest of the financial system. Title II of Dodd-Frank, which establishes the Orderly Liquidation Authority, also requires that the shareholders and creditors of the failed company and, if necessary, the industry—rather than the taxpayers—cover the cost of these failures. These measures limit the ability of the government to provide extraordinary support to these companies in a crisis. As such, these measures seek to restore market discipline by reducing the implicit government guarantee and the incentive it may create for the management of these companies to take asymmetric risks. The credit rating agencies recently reduced the "uplift" they incorporate in the long-term credit ratings of several large financial institutions to reflect these measures.

2.2.2 External Risks

Cyclical Concerns

The U.S. financial system presently confronts two external risks that are also cyclical: Europe and the domestic housing market.

Europe. While we have classified the European economic crisis, now more than two years old, among cyclical concerns, in reality it is a good example of a risk that has both structural and cyclical elements. The situation resulted from the interplay of three forces.

First, the launch of the common currency in 1999 in the face of significant economic disparities across the euro area sowed the seeds for the development of large economic imbalances. The euro brought about a significant reduction in borrowing costs for the southern European members of the monetary union on the assumption that fiscal policies would converge to the norms established by the core countries. Put simply, the markets misjudged euro area sovereign risk. Mispriced debt allowed the peripheral countries—many of which came into the EU and monetary union with rigid labor markets and poor competitiveness—to borrow heavily at increasingly cheap rates in the run up to the crisis. That borrowing occurred in the public domain in Greece, but in Ireland, Spain and Portugal, the bulk of the borrowing occurred in the private sector, which supported import consumption booms generally and in Spain and Ireland fueled domestic property bubbles. Italy is an outlier—its public debt burden is a legacy from the 1970s and 1980s, which it had some success addressing, having run primary budget surpluses for 17 years until 2008. Its low level of private sector indebtedness also contrasts with other countries in the periphery.

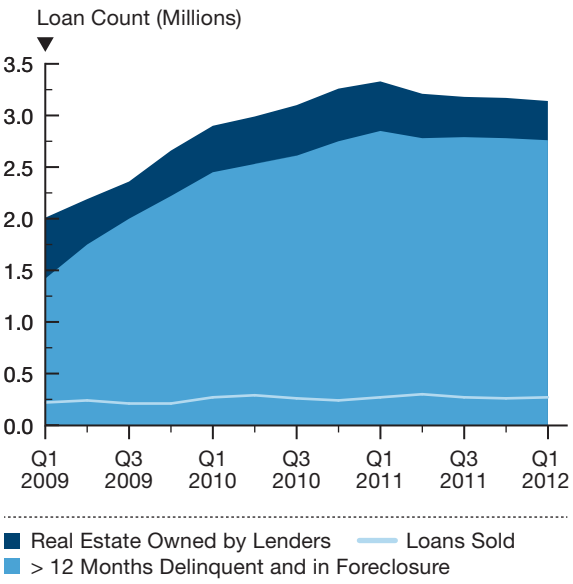
Second, the euro area lacked the necessary institutions to facilitate adjustment of economic imbalances, which became necessary in the wake of the global crisis and the end to private and public sector borrowing binges. Locked into a common currency, the periphery could not deploy monetary policy or benefit from

exchange rate flexibility to help cushion the downturn. A loss of wholesale funding and deleveraging among banks worsened the resulting squeeze on credit. Crucially, the euro area did not have a system of fiscal transfers to offset the recession-related costs in the harder-hit regions of the currency union. In addition, the absence of centralized bank supervision and support meant that national budgets were tapped for bank cleanup costs. Thus, banking sector weaknesses reinforced sovereign credit problems and vice versa.

Finally, the euro area's governance structures, which often require unanimity and must constantly balance widely varying national interests, have made it difficult to develop an effective crisis response and stay ahead of markets. Importantly, however, there has been notable progress to strengthen euro area governance and to develop a robust crisis fighting toolkit. Country fiscal and structural reform efforts are backed by significantly strengthened monitoring mechanisms and supported by resources from European financing mechanisms developed since 2010. There is recognition that more work is needed to develop institutions that enable a more comprehensive crisis response that taps the monetary union's unified strength, fosters greater fiscal and financial integration, and finds a better balance between fiscal consolidation and growth.

Spillovers from Europe to the U.S. financial system can occur through five channels. First, U.S. financial institutions have direct exposures to European banks, mainly through unsecured bank loans and secured repo loans, although these are relatively small. Second, the downturn in European economies will weaken U.S. growth. Exports to Europe account for 25 percent of total U.S. exports, or roughly 3 percent of our gross domestic product (GDP). Third, Europe accounts for half of U.S. overseas corporate profits and about one-sixth of overall U.S. corporate profits. Fourth, a weaker euro (and stronger dollar) will further blunt U.S. exports and the translation into dollars from profits abroad, and boost U.S. imports, although the near-term effects on trade likely will be small. Finally and most importantly, the flight from risky assets in Europe and the efforts of European banks to reduce the leverage on their balance sheets will raise risk premiums in U.S. markets.

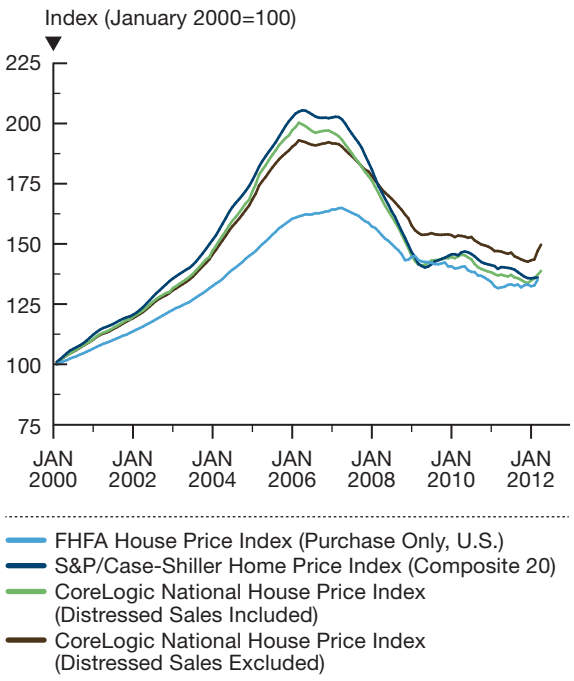
Chart 2.2.2 Shadow Inventory in the Housing Market



Source: Amherst Securities Estimate using CoreLogic Prime Serving Database, CoreLogic Securitized Loan Database, FDIC, Fannie Mae, Freddie Mac, FHA, 1010Data

Real Estate Supply and Demand. A key legacy of the crisis is that the housing market continues to face a supply overhang. Although the inventory of for-sale homes is not high by historical standards, there is a potentially much bigger "shadow" inventory consisting of properties that are stuck in the foreclosure process *(Chart 2.2.2)*. Because foreclosed properties tend to sell at a discount to owner-occupied ones, the backlog of delinquent and foreclosable homes gives buyers an incentive to delay purchases. The anticipation of this discounted shadow inventory depresses prices today. Estimates of this shadow inventory vary significantly, with press reports quoting estimates between 1.6 and 10.3 million homes (Whelan, 2011). A third type of overhang comes from discouraged homeowners who would like to sell but are discouraged by weak demand. Improving

Chart 2.2.3 U.S. House Prices



Source: FHFA, S&P/Case-Shiller, CoreLogic, Haver Analytics

market conditions may well be met with these sellers returning to markets and limiting house price appreciation.

While housing prices may have stabilized in recent months ***(Chart 2.2.3)***, these overhangs of excess supply may continue to contribute to generally depressed home prices and limited new construction activity. The interplay between the financial (internal) and real-economy (external) imbalances has created a vicious cycle in the past. Low home prices and negative equity escalate defaults, which in turn induce losses among lenders and deleveraging by households.

Policy interventions to halt this vicious cycle have included fiscal and monetary policy as well as interventions to support both borrowers and lenders. The primary fiscal intervention was the Federal Home Buyer Credit of 2010, which provided a tax credit to first-time home buyers in an attempt to stimulate housing demand. The Fed's monetary policy—including federal funds rate changes and quantitative easing—have lowered nominal rates significantly, reducing the mortgage burden for households with adjustable rate mortgages and lowering the monthly costs for borrowers who refinance an existing home or purchase a new one.

There have also been interventions to reduce homeowner debts or payments. The largest policy initiative, the Home Affordable Modification Program, attempts to identify needy and non-strategic defaulters for principal reductions and term and rate changes by compensating the lenders for a fraction of the reduced debts. Interventions that support creditors to promote lending have included capital injections to increase bank capital, the government takeover of Freddie Mac and Fannie Mae, the purchase of securitized mortgages, and low- or no-downpayment loans through the Federal Housing Administration and the Department of Veterans Affairs.

Structural Concerns

U.S. Fiscal Policy Outlook. Sovereign credit risks for U.S. Treasuries seem remote. Real (inflation-adjusted) yields and term premiums on 10-year U.S. Treasuries have been negative for nearly a year, reflecting a flight to Treasuries from riskier assets and the portfolio effects of the Fed's large scale asset purchases ***(Chart 2.2.4)***. However, if officials do not come to agreement on policies to deal with the nation's long-term, structural fiscal challenges or on near-term fiscal policy measures, such risk premiums and those on risky assets could rise, potentially weighing on financial and economic stability.

Many policymakers agree that a credible plan for fiscal sustainability is essential to our long-term prosperity. Agreement on such a plan could boost risk appetite, improving prospects both for economic growth and for financial stability.

Before the details of a long-term fiscal consolidation plan can be worked out, however, several fiscal policy issues must be addressed around the end of the year. The Budget Control Act of 2011 mandates significant and automatic fiscal restraint on January 1, 2013. In addition, a

number of tax policies are set to expire. Under current law, the Congressional Budget Office estimates that tax increases and the budget sequestration would swing the government budget toward austerity by about 4 percent of GDP, threatening the economy with renewed recession (CBO, 2012).

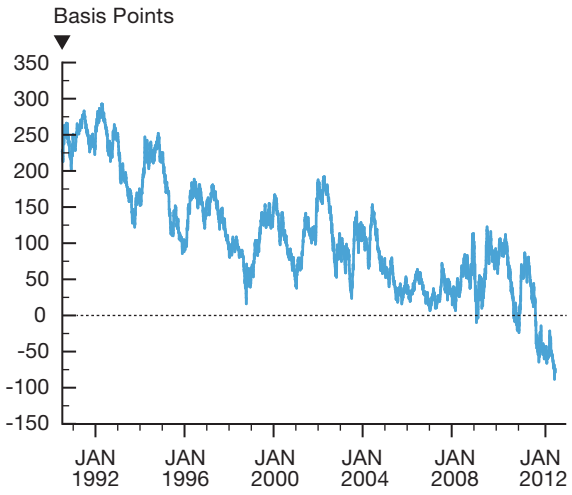
A number of outcomes are possible. On the one hand, policymakers could come to an agreement that would balance the need for near-term support for the economic recovery with longer-term fiscal consolidation. Less favorably, policymakers could choose a path that either puts in place significant consolidation in the near-term at the temporary cost of economic growth or alternatively a path that would fail to make a significant step toward consolidation. The outcome could have a significant bearing on risk premiums and the cost of borrowing.

Risk of Cyber Attack. The Council, in its 2012 Annual Report, identifies the threat of cyber attacks on the financial infrastructure—for example, attempts to gain unauthorized access into networks and systems—as a significant and increasing threat to financial stability (FSOC, 2012). Attacks have become more frequent, more targeted on specific aspects of financial institutions' infrastructure, and more disruptive. They pose particularly significant risks through the potential disruption of transaction, payment, clearing, and settlement systems.

2.2.3 Challenges to Mitigants

Financial stability mitigants share the common challenge of keeping up as technologies evolve, transactions accelerate, financial activities shift to new products and markets or overseas, and traders develop ever-more complex ways to shift risk through derivatives and other opaque products. Financial activities have a natural tendency to move to markets or jurisdictions that are subject to relatively less supervision and regulation. A comprehensive, macroprudential approach to supervision and regulation could limit such regulatory arbitrage.

Chart 2.2.4 U.S. Treasury Term Premium: Calculated for a 10-Year Zero Coupon Note



Source: FRB, Kim and Wright (2005)

Gaps and Weaknesses in Data. Leading up to and during the financial crisis, market participants and their supervisors did not have critical information necessary for assessing the buildup of leverage and liquidity and the nature and extent of interconnections among financial entities. As described in Chapter 4, an important role for the OFR is to help address gaps and weaknesses in the data that financial supervisors use to monitor those risks.

Supervisors have already made substantial progress in improving their ability to monitor the financial system. Regulated institutions, such as banks and thrifts, now file a great deal more information than they did before the crisis about their activities and exposures, both in confidential reports to supervisors and in public regulatory reports. Hedge funds and money market funds are now required to file Form PF and Form N-MFP, respectively, with regulators (CFTC and SEC, 2011; SEC, 2010). Supervisors are also working in conjunction with the International Monetary Fund and Financial Stability Board to promote improvements in data available for monitoring international financial developments.

It will be an ongoing challenge for the OFR and the supervisors to ensure that their sources of data on threats to financial stability keep pace with constantly evolving financial markets, particularly with respect to derivatives markets and other activities that have traditionally resided outside the regulatory sphere.

Need for Data Standards and Better Data Management. The crisis also revealed deep problems with the infrastructure upon which financial institutions depend for the smooth delivery of services, the functioning of markets, and the management of risk. For years, financial sector investment in the back office—where trades are processed and risks are managed—has not kept up with investment in the front office. It is too easy for the managers of financial firms to view the front office as the profit center and the back office as the cost center. Meanwhile, after years of mergers and acquisitions, the presence of redundant computer systems performing similar tasks, but with data that may be dissimilar, is common across the industry. Simply, the quality of data standards and data management in the financial sector has lagged significantly behind where they need to be.

The result is that communication is difficult within firms, among firms, and with regulators. Financial companies lack standards for basic data elements and terms, an acute problem during the crisis. When uncertainty grew in 2007 and 2008 about the risks of mortgage-related derivatives and CDOs, many financial managers were unable to measure and address risks across different desks and legal entities within their own organizations. They could not answer seemingly simple questions, such as their aggregate exposure to the housing downturn or their exposure to specific troubled counterparties. Regulators were unable to understand exposures within individual firms, compare exposures across firms, or analyze the systemic impacts as losses spread from firm to firm.

Currently, a lack of standardization hinders comparison between mortgage datasets at large financial institutions and the GSEs, and the lack of a uniform nationwide system of property identifiers makes matching of liens more difficult. If unresolved, these problems will, among other consequences, continue to affect the willingness of investors to purchase securitized mortgage products.

A critical mandate for the OFR, as described in Chapter 5, is to work with domestic and global financial regulators to promote the use of consistent standards so that financial institutions and their regulators will be able to understand and analyze these types of issues in real-time. The establishment of a global Legal Entity Identifier (LEI), which will help precisely identify parties to financial transactions, is a natural and essential priority in pursuit of that mandate. The LEI project made historic progress in the past year, including the International Organization for Standardization's publication of an LEI standard and the G20 leaders' call for implementation of a global LEI by March 2013 (ISO, 2012; FSB, 2012). The CFTC has already established the CFTC Interim Compliant Identifier (CICI) to identify counterparties in swap transactions (CFTC, 2012b). The OFR continues to promote an LEI, working with domestic and foreign regulators and standard-setters.

Need for Constant Improvements in Risk Management and Stress Testing. Improving data is essential as firms and their regulators seek to modernize the approach to risk management and stress testing in the wake of the financial crisis. Supervisors were quick to identify lessons learned with respect to corporate governance, credit risk and liquidity risk management, and the use and misuse of derivatives and other complex financial products (SSG, 2008; SSG, 2009). But these lessons are still not being applied consistently, as shown by the MF Global failure ***(Box F: Lessons from the Collapse of MF Global)***. Financial managers and their supervisors need to be vigilant as financial markets evolve, creating new risks and new

challenges for risk management. Stress testing, discussed in Section 3.2, suffered from a failure of imagination before the crisis. Supervisors now subject the largest firms to unprecedented annual stress tests. Firms that fail those tests can, among other things, be subject to dividend restrictions or be required to raise new capital. The OFR has an important statutory mandate to promote best practice in these areas by combining new insights about macroprudential oversight with traditional concerns about firms' solvency.

Model Risk. The financial crisis also illustrated the dangers to financial stability posed by the failure to account for the limitations and uncertainties associated with financial risk models. For example, two types of models in particular were implicated.

First, the market for CDOs, which in turn contributed to the bubble in MBS, relied on models that dramatically under-estimated the correlation in the performance of similar MBS, with disastrous results: nearly all CDO securities backed by MBS were ultimately downgraded by the rating agencies. The rating agencies that had used these models did not have strong empirical support for their correlation assumptions and they have since improved their disclosure of the limitations of these models (Heitfield, 2010).

Second, risk managers at financial firms and supervisory capital standards relied on value at risk (VaR) models that measured the potential losses from trading portfolios based on recent historical experience, which was relatively benign, encouraging balance sheet expansion. As the period of financial calm lengthened up to 2007, however, these models provided no indication that market relationships might change in fundamental ways. More recently, the trading losses that JPMorgan Chase announced earlier this year occurred after the company revised its VaR model, a revision that reduced the reported risk by half (Keoun, 2012).

These examples illustrate the challenges that complex models pose to risk management and corporate governance. Going forward, the tendency of financial markets to develop complex new products is likely to result in new types of model risk. Risk managers and supervisors have heightened their attention to model risk, and this will be an important focal point for the OFR.

Endnotes

1. Similar definitions are provided by Rosengren (2011) and Tucker (2011).

2. The Basel Committee on Banking Supervision, a global committee of bank supervisors, issued two relevant working papers in May 2012 that discuss links between the real economy and the financial sector and address ways to improve financial stability monitoring and the identification of potential threats (BCBS, 2012a; BCBS, 2012b).

3. "A common explanation for the procyclicality of the financial system has its roots in information asymmetries between borrowers and lenders. When economic conditions are depressed and collateral values are low, information asymmetries can mean that even borrowers with profitable projects find it difficult to obtain funding. When economic conditions improve and collateral values rise, these firms are able to gain access to external finance and this adds to the economic stimulus. This explanation of economic and financial cycles is often known as the 'financial accelerator'. [This analysis] has a long history." (Borio, Furfine, and Lowe, 2001). The authors also point to the regulatory structure itself—as in the Basel II capital regime—as a source of procyclicality.

4. "Experience tells us that alternatives within an economy for the process of financial intermediation can protect that economy when one of those financial sectors undergoes a shock" (Greenspan, 1999).

References for Chapter 2

Basel Committee on Banking Supervision. *Credit Risk Transfer*. Joint Forum. Bank for International Settlements. Basel: BCBS, 2005.

Basel Committee on Banking Supervision. *Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems*. Bank for International Settlements. Basel: BCBS, 2010a.

Basel Committee on Banking Supervision. *Basel III: International Framework for Liquidity Risk Measurement, Standards and Monitoring*. Bank for International Settlements. Basel: BCBS, 2010b.

Basel Committee on Banking Supervision. *The Policy Implications of Transmission Channels between the Financial System and the Real Economy*. Bank for International Settlements. Basel: BCBS, 2012a.

Basel Committee on Banking Supervision. *Models and Tools for Macroprudential Analysis*. Bank for International Settlements. Basel: BCBS, 2012b.

Board of Governors of the Federal Reserve System. *Banking and Monetary Statistics 1914–1941*. Washington, DC: Board of Governors, 1943.

Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, National Credit Union Administration, Office of the Comptroller of the Currency, and FFIEC State Liaison Committee. *Advisory on Interest Rate Risk Management*. Washington, DC: Board of Governors and others, January 6, 2010.

Borio, Claudio, Craig Furfine, and Philip Lowe. "Procyclicality of the Financial System and Financial Stability: Issues and Policy Options." BIS Papers no. 1, Basel: Bank for International Settlements, 2001.

Boyd, John H., and Mark Gertler. "Are Banks Dead? Or Are the Reports Greatly Exaggerated?" *Federal Reserve Bank of Minneapolis Quarterly Review* 18, no. 3 (Summer 1994).

Carney, Mark. "Some Considerations on Using Monetary Policy to Stabilize Economic Activity." Speech at the Symposium Sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, WY, August 22, 2009.

Carney, Mark. "A Monetary Policy Framework for All Seasons." Speech at the 2012 U.S. Monetary Policy Forum, New York City, NY, February 24, 2012.

Commodity Futures Trading Commission. *Swap Data Recordkeeping and Reporting Requirements*. Final Rule, Federal Register 77, no. 9, January 13. Washington, DC: CFTC, 2012a, 2136–2224.

Commodity Futures Trading Commission. "CFTC Announces Process to Designate the Provider of CFTC Interim Compliant Identifiers." Press release, March 9, 2012. CFTC, 2012b. http://www.cftc.gov/PressRoom/PressReleases/pr6200–12 (accessed July 3, 2012).

Commodity Futures Trading Commission and Securities and Exchange Commission. *Reporting by Investment Advisers to Private Funds and Certain Commodity Pool Operators and Commodity Trading Advisors on Form PF*. Joint Final Rules, Federal Register 76, no. 221, November 16. Washington, DC: CFTC and SEC, 2011, 71128–71239.

Congressional Budget Office. *Economic Effects of Reducing Fiscal Restraint That Is Scheduled to Occur in 2013*. Report, May 22, 2012. CBO, 2012. http://www.cbo.gov/publication/43262 (accessed July 3, 2012).

CoreLogic. "CoreLogic Reports Negative Equity Increase in Q4 2011." Press release, March 1, 2012. http://www.corelogic.com/about-us/news/corelogic-reports-negative-equity-increase-in-q4-2011.aspx (accessed July 3, 2012).

Corrigan, Gerald E. "Are Banks Special?" *Annual Report*. Minneapolis, MN: Federal Reserve Bank of Minneapolis, 1983.

Department of Justice. "Barclays Bank PLC Admits Misconduct Related to Submissions for the London Interbank Offered Rate and the Euro Interbank Offered Rate and Agrees to Pay $160 Million Penalty." Press release, June 27, 2012. DOJ, 2012. http://www.justice.gov/opa/pr/2012/June/12-crm-815.html (accessed July 3, 2012).

Financial Crisis Inquiry Commission. *The Financial Crisis Inquiry Report*. Washington, DC: FCIC, 2011.

Financial Stability Board. *A Global Legal Entity Identifier for Financial Markets*. FSB Report to the G20. FSB, June 8, 2012.

Financial Stability Oversight Council. *Annual Report*. Washington, DC: FSOC, 2012.

Greenspan, Alan. "Do Efficient Financial Markets Mitigate Financial Crisis?" Remarks before the 1999 Financial Markets Conference of the Federal Reserve Bank of Atlanta, Sea Island, GA, October 19, 1999.

Hanson, Samuel G., Anil K. Kashyap, and Jeremy C. Stein. "A Macroprudential Approach to Financial Regulation." *Journal of Economic Perspectives* 25, no. 1 (2011): 3–28.

Harrison, George L. Responding to questioning in *Operation of the National and Federal Reserve Banking Systems, Hearings before a Subcommittee of the Committee on Banking and Currency*. U.S. Senate, January 22, 1931. 71 Cong. Washington, DC: Government Printing Office, 1931, 66.

Heitfield, Erik. "Lessons from the Crisis in Mortgage-Backed Structured Securities: Where Did Credit Ratings Go Wrong." In *Rethinking Risk Measurement and Reporting: Volume II*, edited by Klaus Bocker. Risk Books, 2010.

International Organization for Standardization. "ISO 17442:2012. Financial services–Legal Entity Identifier (LEI)." ISO, 2012. http://www.iso.org/iso/catalogue_detail?csnumber=59771 (accessed July 3, 2012).

Kashyap, Anil, Richard Berner, and Charles A.E. Goodhart. "The Macroprudential Toolkit." *IMF Economic Review* 59, no. 2 (2011): 145–61.

Keoun, Bradley. "JPMorgan's Iksil Said to Take Big Risks Long Before Loss." Bloomberg, June 1, 2012. http://www.bloomberg.com/news/2012-06-01/jpmorgan-s-iksil-said-to-take-big-risks-long-before-loss.html (accessed July 3, 2012).

Kim, Don H. and Jonathan H. Wright. "An Arbitrage-Free Three-Factor Term Structure Model and the Recent Behavior of Long-Term Yields and Distant-Horizon Forward Rates." Finance and Economics Discussion Series 2005–33, Washington, DC: Board of Governors of the Federal Reserve System, August 2005.

Minsky, Hyman P. "The Financial Instability Hypothesis." Working Paper no. 74, Annandale-on-Hudson, NY: Levy Economics Institute of Bard College, May 1992.

Modigliani, F., and M. Miller. "The Cost of Capital, Corporation Finance and the Theory of Investment." *American Economic Review* 48, no. 3 (1958): 261–97.

Mundell, Robert A. "Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability." *International Monetary Fund Staff Papers* 9, no. 1 (1962): 70–79.

Office of the Comptroller of the Currency, Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, National Credit Union Administration, and FFIEC State Liaison Committee. *Interagency Advisory on Interest Rate Risk Management: Frequently Asked Questions*. Washington, DC: OCC and others, January 12, 2012.

Pozsar, Zoltan, Tobias Adrian, Adam Ashcraft, and Hayley Boesky. "Shadow Banking." Staff Report no. 458, New York, NY: Federal Reserve Bank of New York, July 2010, Revised February 2012.

Rosengren, Eric S. "Defining Financial Stability, and Some Policy Implications of Applying the Definition." Keynote Remarks at the Stanford Finance Forum, Stanford, CA, June 3, 2011.

Securities and Exchange Commission. *Money Market Fund Reform*. Final Rule, Federal Register 75, no. 42, March 4. Washington, DC: SEC, 2010, 10060–10120.

Securities and Exchange Commission. *Exemptions for Security-Based Swaps Issued by Certain Clearing Agencies*. Final Rule, Federal Register 77, no. 66, April 5. Washington, DC: SEC, 2012, 20536–20549.

Senior Supervisors Group. *Observations on Risk Management Practices during the Recent Market Turbulence*. SSG, March 6, 2008.

Senior Supervisors Group. *Risk Management Lessons from the Global Banking Crisis of 2008*. SSG, October 21, 2009.

Tarullo, Daniel K. "Regulatory Reform since the Financial Crisis." Speech at the Council on Foreign Relations C. Peter McColough Series on International Economics, New York, NY, May 2, 2012.

Tucker, Paul. "Macroprudential Policy – Building Financial Stability Institutions." Remarks at the 20th Annual Hyman P. Minsky Conference, New York, NY, April 14, 2011.

Whelan, Robbie. "How Many Homes Are in Trouble?" *Wall Street Journal*, November 11, 2011. http://blogs.wsj.com/developments/2011/11/11/how-many-homes-are-in-trouble/ (accessed July 3, 2012).

3 Research on Financial Stability

The sections in this chapter survey three areas that are central to the OFR's research agenda: (1) Efforts to develop indicators of threats to financial stability as tools for policymakers; (2) The use of stress tests as a macroprudential tool; and (3) Counterparty risk management, an aspect of firms' internal risk management that is particularly relevant to containing threats to financial stability.

3.1 Cataloguing Indicators and Models of Risks to Financial Stability

The OFR has a mandate to develop and maintain metrics and reporting systems for risks to financial stability. The Office's first working paper catalogued the state of the art in this field (Bisias and others, 2012). Measures proposed to-date seek to provide insights about an aspect of financial instability, generally informed by the recent crisis: for example, the tendency of asset-price bubbles to emerge, the transmission of financial shocks during a crisis, and the risks posed by rapid systemwide growth in liquidity or leverage. However, these measures tend to be limited by the public availability of data. An important goal of the OFR's work will be to identify data needed to improve these measures. This section describes 11 illustrative examples of specific risk metrics and provides evidence on what they would have shown during four prior crises.

Since the crisis, interest in measuring risks to the financial system—as opposed to risks faced by individual institutions—has grown dramatically. In general, such metrics can have three types of value for policymakers:

- **Predictive or ex ante measures** may be able to provide early warnings of a future crisis, for example, by identifying specific vulnerabilities in the structure of the system that may demand a preventive policy, or by identifying potential shocks to the financial system, such as those arising from asset price misalignments;

- **Contemporaneous measures** can alert policymakers on a real-time basis to the level of risks and vulnerabilities, for example, by identifying individual institutions that pose outsized threats to financial stability, or by helping policymakers understand events as a crisis unfolds; and,

- **Ex post measures** support forensic analysis of crises after they occur and can help supervisors in the orderly liquidation of financial institutions that have failed.

This section categorizes into four groups the financial stability measures that analysts have developed since the crisis: (1) Macroeconomic measures, (2) Measures of the vulnerability of individual firms to a shock, (3) Measures of the vulnerability of the financial system to a shock, and, (4) Measures of the interconnections among financial institutions.

We evaluate 11 specific measures as illustrative examples. Because the next financial crisis will not be identical to the last, it is crucial to understand how these models behave in a variety of conditions. To this end, we compare their performance during four historical financial crises, including the 2008 event. The selected measures represent only a small sample from a literature that has grown to hundreds of papers since the crisis.

The 11 measures may reveal structural vulnerabilities but they are less effective at providing early warnings of impending crises—similar to an automobile's speedometer, which does not predict crashes but is still a useful risk indicator. Any systemic risk measure is also limited by a reliance on realized events; false alarms and failures to alert are only identifiable after the fact. On the other hand, all of the measures illuminate some facet of a complicated system and may play a useful role in informing macroprudential policy and decisions. Analysts should use a range of measures. One of the goals of OFR research will be to develop robust software implementations of the most promising models and document their strengths, weaknesses, and appropriate range of application.

The most important lesson of this exercise is the need for better data. The first generation of systemic risk measures to emerge from the recent crisis relied, by necessity, on existing data. But today's data and information systems were not built to monitor threats to overall financial stability. Academic authors are also limited to what is publicly available; heavy use is made of market prices. Neither accounting data nor market data provide information directly on financial interconnections. Accounting respects the boundaries of the firm, and a market price is only one attribute of a transaction in which the counterparties are typically not publicly identified.

The OFR has an important role in gathering new data where necessary to improve this analysis. The OFR will also standardize such data to facilitate systemwide integration and comparisons.

3.1.1 Summary of Measures

As noted, risks to financial stability can be cyclical (particularly with respect to liquidity, leverage, and asset pricing), or structural (meaning, for example, that risky activities may be concentrated in a small number of firms). Currently available measures reflect this diversity of potential sources of threats to financial stability. We group them here into four broad categories:

(1) Macroeconomic Measures, Using Aggregate Data. These measures approach threats to financial stability from the top down: Is aggregate credit growing too fast? Are credit underwriting standards falling? Are asset prices too high relative to fundamentals? In an internal boom-bust cycle, an initial market upswing entices new investors and rising prices until additional capital or investors' nerves are exhausted (Evanoff, Kaufman, and Malliaris, 2012). This process can be amplified by capital rules that encourage banks to increase leverage when the economy is expanding and loan losses are low (Hanson, Kashyap, and Stein, 2011). In the ensuing bust, a credit crunch can occur as participants switch from lending too much to lending too little (Brunnermeier, 2009).

A selling point for some macroeconomic measures is their early-warning potential, which derives from the view that large-scale systemic imbalances should be visible in appropriately constructed aggregate measures (Alessi and Detken, 2011). For example, the Basel Committee proposed an increase in banks' capital requirements when the ratio of a country's total credit outstanding to its GDP rises above historic norms (BCBS, 2010).

(2) Measures of Firm-Level Exposures, Using Portfolio Details. These measures use granular information about individual firms' positions and portfolios to estimate cash flows at different times in the future and under varying circumstances, particularly in the complex world

of derivatives and structured products. Measures in this category include portfolio stress tests and value at risk (VaR) models that assess the losses expected on a given market position over a certain period of time, based on the historical distribution of price movements.

Forward-looking metrics that exploit detailed information about positions and portfolios can help focus regulatory scrutiny on emerging risks and exposures before they begin to appear in financial statements. For example, a put option with a large notional value that is deep out of the money may have the same present value as an option with a smaller notional value when the underlying security is trading close to the exercise price. Yet the two options have very different payoff profiles and risk implications; this fact is difficult to judge based on price alone, without access to the contractual terms and conditions that define the notional amounts and exercise prices.

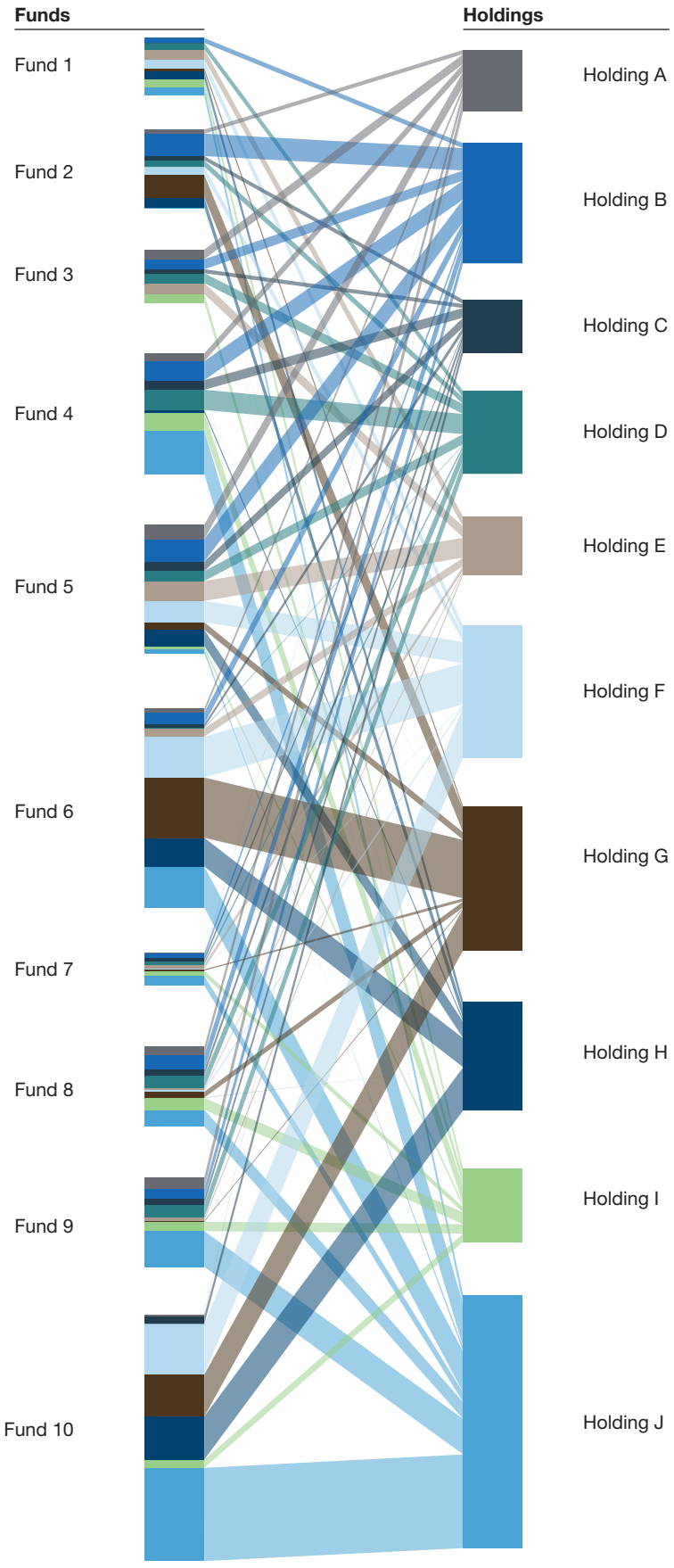
(3) Measures of Market Dynamics, Using Sensitivity Data. These measures go beyond static exposures to gauge the dynamic behavior of market participants, especially in stressful situations when liquidity may be tight.[1] For example, in a crisis, customers may withdraw deposits, and wholesale lenders may refuse to renew their funding. As market participants rush to sell assets to raise liquidity, prices may move precipitously, and the range of possible portfolio adjustments can change markedly. Leverage also magnifies the risk of insolvency.

From a systemic perspective, it is insufficient to consider only firm-by-firm maturity transformation or leverage. Excessive maturity transformation and leverage can arise from within the financial system as investors borrow to profit from rising asset prices, creating a familiar boom-bust pattern. Counterparty exposures also constrain the ability of institutions to adjust their portfolios in a crisis. Ideally, measurement of these dynamic issues would rely on a diverse array of information, including bid-ask spreads, transaction volumes, order flows, and the details of collateral, margin, and netting arrangements. However, such details are not always readily available.

(4) Measures of Interconnectedness, Using Relationship Data. These measures take a network approach to the financial system.[2] To date, these measures have had to make do with traditional data sources, inferring the underlying connections by observing co-movements in market prices. The data requirements for a fully detailed counterparty network model are potentially extensive. A key policy development related to models of interconnectedness is the requirement in the Dodd-Frank Act for large financial institutions to create resolution plans, also known as living wills. These plans must include details on firms' ownership structures, assets, liabilities, contractual obligations, cross-guarantees, collateral pledges, major counterparties, and significant credit exposures. An example of what is possible going forward appears in ***Chart 3.1.1***, which depicts the connections of the largest money market funds to the institutional issuers whose securities they hold. These data only became available in 2010 through the SEC's new Form N-MFP. They can illuminate systemic fragility by revealing which issuers might face funding liquidity issues if a given money market fund experienced a run, or which money market funds would be harmed if an issuer were to default.

These four categories are not discrete; some measures may have characteristics of more than one. They are listed roughly in order of the difficulty of data acquisition. Macroeconomic measures generally use readily available, public data; at the other extreme, the most effective measures of interconnectedness would be informed by confidential information about firms' specific positions, exposures, and counterparty relationships. ***Chart 3.1.2*** shows examples of approaches based on these categories and on the event horizon—that is, whether the value of each measure is ex ante, contemporaneous, or ex post.

Chart 3.1.1 The Money Fund Network: Top 10 Issuers and Top 10 Funds, as of January 31, 2012



Source: SEC Form N-MFP; OFR calculations

US$10 billion

Chart 3.1.2 Examples of Risk Tools by Event Horizon and Data Requirements

	Ex Ante	Contemporaneous	Ex Post
Macroeconomic Measures, Using Aggregate Data	**Macro stress testing** *Alessi and Detken, 2011* *Borio, Drehmann, and Tsatsaronis, 2012*	**Monitoring global funding risk** *Fender and McGuire, 2010*	**Accountability for macroprudential regulators** *Borio, 2010* *Caruana, 2010*
Measures of Firm-Level Exposures, Using Portfolio Details	**Traditional, firm-level stress testing** *Hirtle, Schuermann, and Stiroh, 2009*	**Credit value adjustment, Basel III liquidity rules** *Gray and Jobst, 2010*	**Orderly resolution and living wills**
Measures of Market Dynamics, Using Sensitivity Data	**Monitoring serial correlation and illiquidity** *Getmansky, Lo, and Makarov, 2004*	**Monitoring financial turbulence** *Kritzman and Li, 2010* *Kritzman and others, 2011* *Khandani and Lo, 2011*	**Addressing fire sales in mark-to-market accounting** *Laux and Leuz, 2010*
Measures of Interconnectedness, Using Relationship Data	**Network monitoring, 10x10x10** *Duffie, 2011*	**Systemic risk contributions, CoVaR** *Billio and others, 2010* *Adrian and Brunnermeier, 2011*	**Forensic analysis** *Brunnermeier, Gorton, and Krishnamurthy, 2011*

Efforts to develop these models have already provided some important insights. First, the problem of measuring threats to financial stability is strikingly multifaceted. While crises may play out in a mix of fire sales, institutional defaults, and liquidity crunches, these are typically the final chapter in a longer story. Systemic risk measures tend to focus on the various structural vulnerabilities that may lead to a crisis event, for example, complex network connections among financial institutions, information asymmetries among market participants, asset price bubbles and rapid leverage growth, concentrated or correlated risk exposures, moral hazard and too big to fail institutions, volatility, and external macroeconomic shocks. Financial stability analysts will need to follow a large number of measures. There will never be a single, "bottom-line" index covering everything we need to know.

Second, the recent crisis is a natural focus of attention but is only one data point in a longer history. Measures designed to understand this event may not work as well in others and may produce an undesirable number of false alarms if put to practical use. By applying the measures forensically to a range of historical episodes, we can learn more about both the nature of crises and the measures themselves.

Third, the financial sector and broader economy are complicated, noisy, and continuously evolving; simple aggregates cannot describe the full state of the system. The systemic risk measures described here exploit the structure of the financial system and provide a more detailed understanding of its vulnerabilities.

3.1.2 Evaluation of Measures

For this evaluation, we selected 11 measures that have been proposed by researchers and policymakers and compared their performance. While the analysis is in its early stages and conclusions are preliminary, we can draw some initial lessons. The OFR will publish more detailed analyses, including software implementations, as that research is completed.[3]

The systemic risk measures analyzed are:

- Five **macroeconomic measures:** a set of *financial stress indexes (FSIs),* which use financial market prices to evaluate the level of stress in the financial system at a point in time, and a *GDP stress test,* which tracks large deviations of realized GDP from the forecast level.

- Four measures of **systemic vulnerability:** a *financial turbulence* measure, which measures deviations of stock returns from their joint historical patterns of behavior; an *absorption ratio,* which simplifies the analysis of co-movements in the stock price performance of different financial institutions; and two measures of *market depth,* which estimate the ability of a market to absorb large buy or sell orders without affecting the price quoted for subsequent trades.

- Two indirect measures of **interconnectedness:** the *Conditional Value at Risk (CoVaR)* measure, which estimates the risk to the system posed by individual institutions that have a large market footprint, and the *systemic expected shortfall (SES),* which measures an individual firm's tendency to be undercapitalized during episodes when the financial system overall is undercapitalized.

Every financial crisis has unique causes, yet most current crisis measures, including some of those considered here, were first estimated with the 2008 event in mind. By testing these measures against a range of historical events, we aim to glean some understanding of their sensitivities, forecasting power, reliability, and recommended domain of application.

We analyze each of these measures in four systemic episodes: (1) The 1929 stock market crash that marked the start of the Great Depression; (2) The 1987 stock market crash, an extraordinary shock that had little impact on the economy or financial stability; (3) The 1998 Russian bond default, which contributed to the failure of Long Term Capital Management (LTCM), a large hedge fund, through network connections; and (4) The 2007–2009 crisis, which was marked by excessive leverage, poor underwriting, asymmetric information, network complexity, liquidity crunches, and fire sales.

Chart 3.1.3 shows the results. ***Chart 3.1.4*** summarizes our evaluation of the individual measures, which are described in greater detail below.

Macroeconomic Measures: FSIs

We first consider the financial stress indexes produced by several Federal Reserve Banks, outlined in ***Chart 3.1.5***. These measures have several advantages. First, they measure financial markets directly, rather than extrapolating from GDP forecasts. With the exception of the National Financial Conditions Index, they are derived exclusively from financial market prices. Second, they are higher frequency (daily, weekly or monthly, rather than quarterly), thus providing a more timely signal. Even a few extra days' head start may be enormously valuable in the context of crisis intervention by policymakers.

Developers of FSIs sometimes claim these tools can provide early warnings of financial disruptions. For example, the Cleveland FSI was "flashing red" prior to the Bear Stearns failure in March 2008. The FSIs clearly detected the 1998 and 1987 events. However, even under the best of circumstances, the FSIs cannot be a panacea because they measure the system at an aggregate level. Considerable additional information would be needed to pinpoint the sources of financial stress and to move from an

FSI warning to interventions in specific markets and institutions.

Macroeconomic Measures: GDP Stress Tests

Economy-wide aggregates have two clear advantages. First, many macroeconomic time series are available internationally. Second, while some subtleties are lost in aggregation, systemically threatening imbalances are likely to be large enough to emerge in aggregate data. For that reason, these measures could serve a valuable early warning function.

The aggregate measure we consider is based loosely on the GDP stress test of Alfaro and Drehmann (2009), which seeks to identify large deviations of realized GDP from the forecast level. We consider these GDP surprises as a potential crisis monitoring tool. But there are several reasons not to be hopeful. First, Alfaro and Drehmann note the strong reverse causality as the effects of financial crises feed back to disrupt the real economy. It may be easier to forecast a recession after seeing a financial crisis than to predict a financial crisis after seeing a recession. Second, forecasters typically do not set out to project financial crises at all; rather, they more commonly forecast the mean future level of GDP. Third, forecasting macroeconomic activity—especially turning points such as a financial crisis—is notoriously difficult. For example, in June 2008, after the Bear Stearns failure and just before the failures of Fannie Mae, Freddie Mac and Lehman Brothers, the Federal Reserve's econometric models projected real 2009 GDP growth between 2.0 and 2.8 percent (FOMC, 2008) while the realized value for 2009 turned out to be negative 3.5 percent (BEA, 2012).

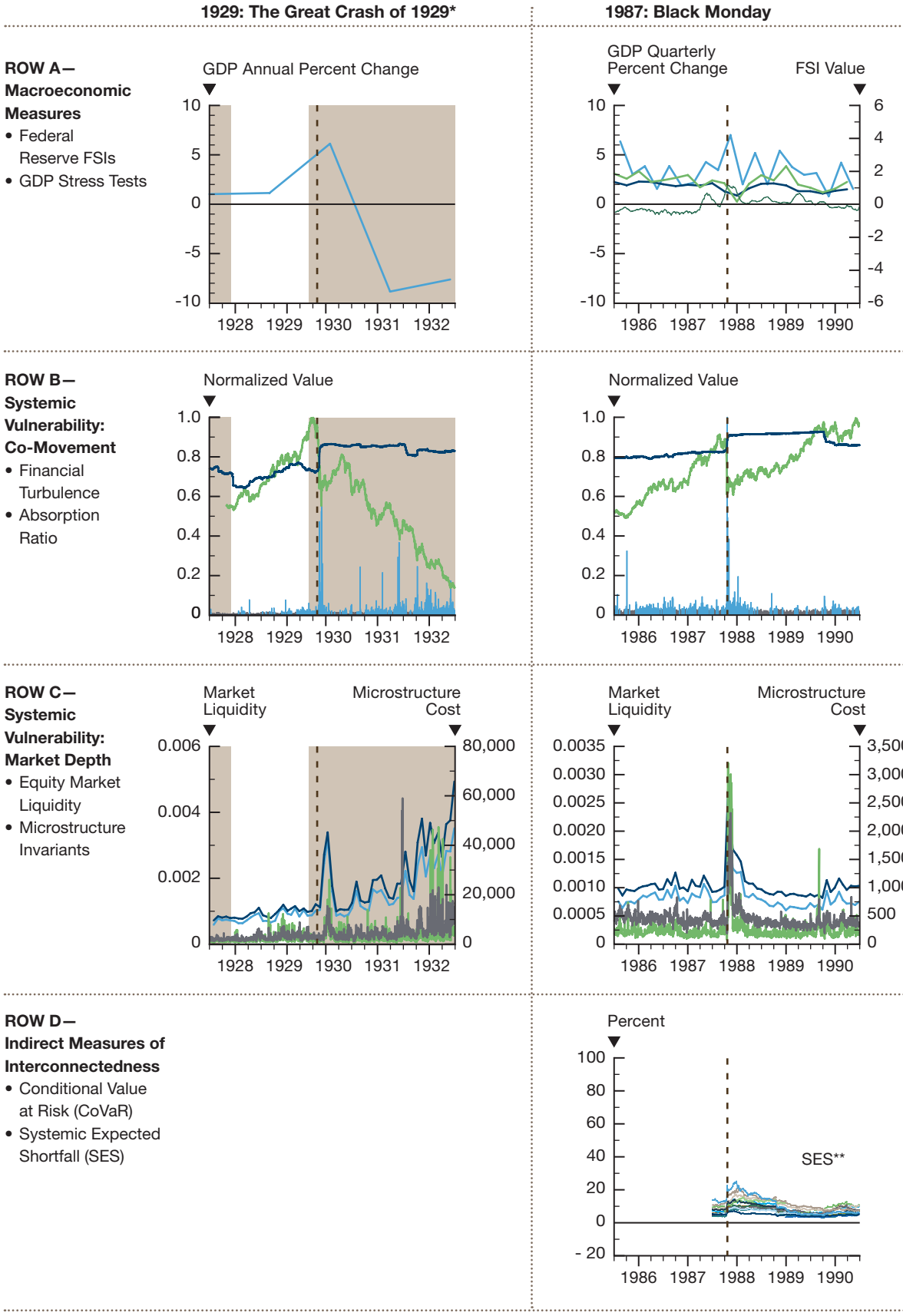
The first row of ***Chart 3.1.3*** compares GDP growth forecasts by professional forecasters with actual GDP growth for the three most recent financial crises. Alfaro and Drehmann average forecast data across 43 crises over many years. Because macroprudential monitors will not have the noise-reducing benefits of averaging over events, we consider only one country and episode at a time. Professional forecasters under-predicted GDP growth before the arrival of recession late in the 1987 and 1998 episodes. Notably, these both turned out to be largely financial-sector events, with little fallout for the real economy, so it is reasonable that forecasters might not predict real-sector implications. For September 2008, forecasts were more accurate leading up to the crisis, but both the timing and magnitude of the GDP shock surprised forecasters, even though the National Bureau of Economic Research would later backdate the start of the recession to the beginning of 2008. The data are much rougher for 1929—professional forecasts are unavailable and, since GDP itself had not yet been defined, GDP has been imputed as an annual number after the fact. With these caveats, we see very high GDP growth in 1929, followed by a sharp collapse in 1930. With hindsight, it is easy for us now to interpret this growth as a reflection of imbalances building up in an overheating economy.

Overall, repurposing GDP forecasts to serve as a financial stability indicator is probably the wrong tool for the job. The same aggregation and averaging that reduces noise, eliminates too much of the nuance and detail necessary for macroprudential risk management. More granular measures are required.

Systemic Vulnerability: Financial Turbulence

The "financial turbulence" measure defined by Kritzman and Li (2010) seeks to identify extraordinary market moves. Specifically, they look for highly unusual combinations of daily asset class returns. When this method is used, simultaneous "big movers" are more likely than isolated outliers to cause a given trading month to register as "turbulent." The blue and gray bars in the charts in the second row of ***Chart 3.1.3*** show the results for monthly returns on a diverse set of domestic and international indexes of stocks, bonds, and commodities. With the confidence interval set at 75 percent, approximately 25 percent of the bars represent turbulent months. There is a clustering of turbulence around the crisis date. The limited evidence in the figures suggests that this measure

Chart 3.1.3 Behavior of the Measures in Four Crises

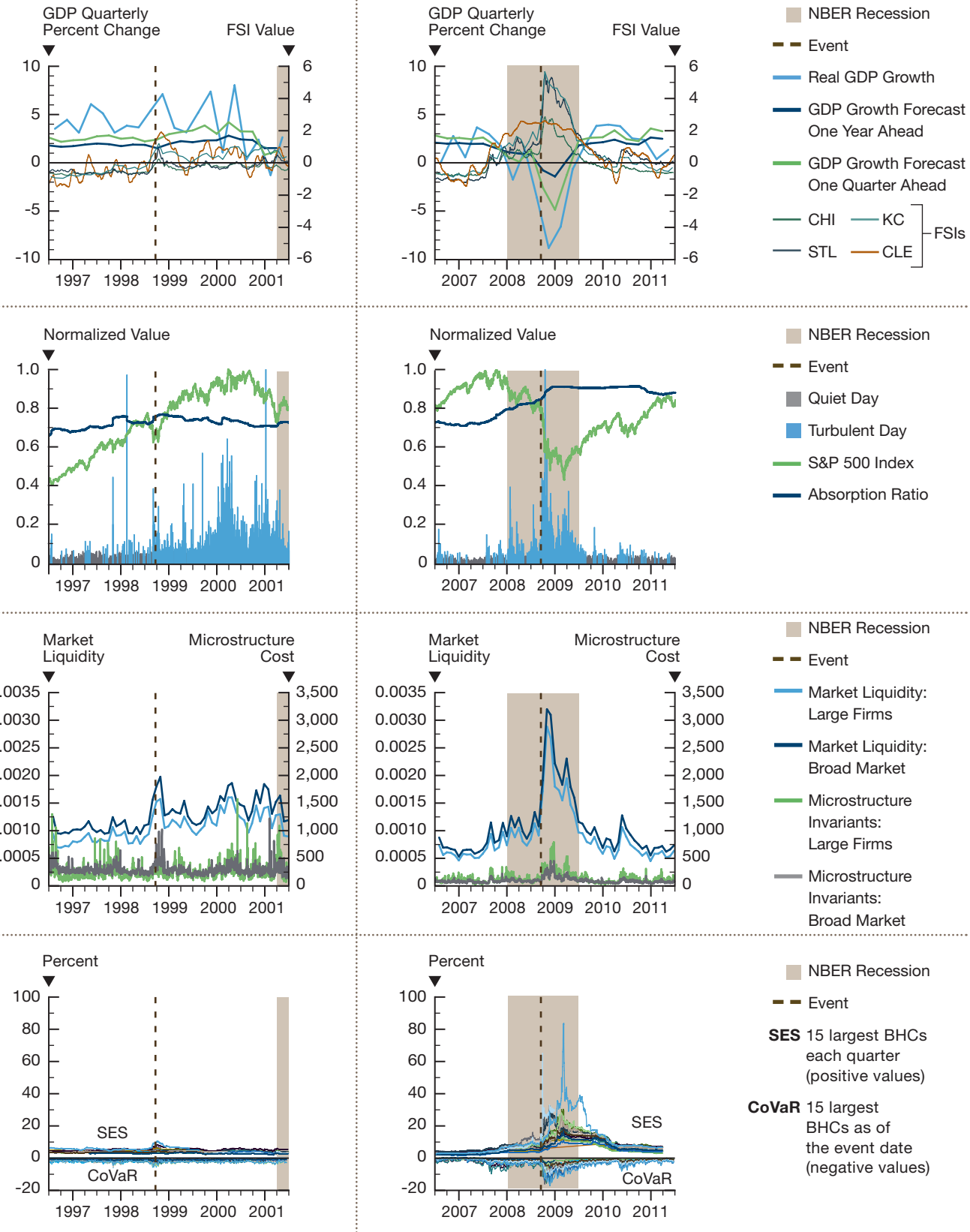


** Notes for 1929: Row A: GDP growth is an imputed rearcast. Row B: a full set of 10 Standard Industrial Classification categories was unavailable. Row C: note the difference in scales.*

***BHC leverage data unavailable prior to Q3 1986.*

1998: LTCM and Russian Bond Default

2008: Lehman Brothers Bankruptcy



Sources: Letters [A, B, C, D] indicate table row: Maddison (2003) [A]; Federal Reserve Bank of Chicago [A,D]; Federal Reserve Bank of Cleveland [A]; Federal Reserve Bank of Kansas City [A]; Federal Reserve Bank of Philadelphia [A]; Federal Reserve Bank of St. Louis [A,B,C,D]; CRSP [B,C,D]; Bloomberg [B,D]

Chart 3.1.4 Evaluation of the Measures

		Description	Evaluation of the Model Output
Macroeconomic Measures	Federal Reserve Financial Stress Indexes (FSIs)	Intended to measure accumulating "stress" in the financial system, these are often put forward as early warning indicators of financial crises.	Calculation frequency varies across the FSIs, from daily (Cleveland Fed) to monthly (Kansas City Fed); daily observations are more conducive to contemporaneous monitoring. Actual crises tend to be much rarer than the stresses identified by the FSIs, so there is a tendency to over-predict.
	GDP Stress Tests	Macro aggregates can reveal system-level imbalances. Original study emphasizes that actual crises tend to be much more severe than plausible ex ante forecasts.	Original study averaged the measures across a range of historical crisis events; this is not possible for ongoing monitoring. GDP observations are quarterly, making real-time monitoring difficult.
Systemic Vulnerability: Co-movement	Financial Turbulence	Daily indicator of unusually turbulent episodes in market prices, emphasizing simultaneous large moves in multiple markets.	Exhibits clustering of turbulence over time. Not promising as an early warning measure, but may be useful for contemporaneous monitoring.
	Absorption Ratio (AR)	A measure of co-movement in market prices. Unlike correlation, which tracks co-movement between bilateral pairings, AR tracks aggregate co-movement in a full system of return series.	Based on our analysis of four events, AR tends to drift upward ahead of the crisis and then jump abruptly on the event date, persisting at the new higher level afterward.
Systemic Vulnerability: Market Depth	Equity Market Liquidity	A measure of the stock market's ability to absorb large one-sided order flow without a large impact on prices. This measure is estimated on a monthly basis.	Price impacts of large orders increase in crises. The magnitude of price impact also varies markedly across crises.
	Microstructure Invariants	A higher frequency measure of the price impact of large order flows. Posits a statistical rule for price impact that works across markets and time.	The magnitude of price impact varies strongly across crises. Moving to daily data increases volatility and heavy tails of the measure, with occasional one-day spikes.
Indirect Measures of Inter-connectedness	Conditional Value at Risk (CoVaR)	A measure of distress afflicting a bank and the system simultaneously. Offered as an indirect measure of interconnectedness.	Relies on public equity returns data on bank stocks and therefore on market perceptions of actual risks. Highly sensitive in 2008 but comparatively non-responsive in 1998, which involved banks less directly.
	Systemic Expected Shortfall (SES)	A measure of the propensity of a bank to be undercapitalized when the system as a whole is undercapitalized.	Like CoVaR, relies on bank stock return data, but incorporates leverage more explicitly. SES is sensitive to the 2008 event and relatively insensitive to 1998 and 1987.

Chart 3.1.5 Federal Reserve Bank Financial Stress Indexes (FSIs)

Measure	Description	References
St. Louis Financial Stress Index (STLFSI)	First principal component in a set of 18 weekly financial time series derived from market prices	Federal Reserve Bank of St. Louis, 2010
Cleveland Financial Stress Index (CFSI)	Daily weighted average of 11 financial time series derived from market prices	Oet and others, 2011 Bianco, Oet, and Ong, 2012
Kansas City Financial Stress Index (KCFSI)	First principal component in a set of 11 monthly financial time series derived from market prices	Hakkio and Keeton, 2009
National Financial Conditions Index (NFCI)	Weekly weighted average of 100 measures of financial activity	Federal Reserve Bank of Chicago, 2012

would be weak as an early warning tool but may be valuable in contemporaneous monitoring.

Systemic Vulnerability: Absorption Ratio

It is widely recognized that correlations between returns tend to spike during financial crises as market participants respond in concert to unusually large common shocks. This behavior can be amplified if one firm's forced liquidation of positions depresses asset prices, provoking mark-to-market margin calls that affect market participants more generally. From a modeling perspective, bilateral correlation measures the co-movement among a pair of return series; the absorption ratio (AR) of Kritzman and others (2011) essentially collapses the matrix of bilateral correlations down to a single measure of the more general co-movement of returns. The AR is the proportion of the variance in the system explained or "absorbed" by a fixed number of factors. A higher AR reveals more tightly coupled markets, suggesting that shocks may propagate through the system more quickly. For the 1998 crisis, in which tight coupling of other markets to the Russian bond market caught LTCM by surprise, there was a gradual increase in the AR before the event and a gradual decrease after. Similarly, the AR rose gradually up to September 2008 but then jumped abruptly by more than 10 percent and remained elevated for two years. There was a similar pattern in 1929. Although the sample of four crises is small, the tendency for the AR to rise in advance of a crisis event suggests some promise as an early warning measure.

Systemic Vulnerability: Market Depth

Market depth metrics measure the liquidity of a marketplace, as opposed to the liquidity of a firm or portfolio, by estimating the ability of a market to absorb one-sided order flow (buying or selling) without affecting the price quoted for subsequent trades. The measures we consider here relate back to Kyle's (1985) "lambda," which measures the trading volume required to move the price of a security by one dollar. Khandani and Lo (2011) measure equity market liquidity by calculating a linear regression of daily returns on the product of price and volume, which are then averaged across a cross-section of firms to calculate marketwide lambda. Kyle and Obizhaeva (2011) adjust the data to account for the higher order arrival rates that typically characterize fast-moving markets. Their metric is microstructure invariant, meaning that the method works for a variety of asset classes, not just equities, and over a variety of historical episodes. Market depth is relatively easy to implement because it can be updated using daily or intraday data on prices and volumes.

The third row of ***Chart 3.1.3*** presents these measures applied to U.S. stock prices for all four historical episodes. For each crisis episode, we run both measures on two subsamples of the full universe of daily returns from the Center for Research in Security Prices (CRSP): the largest 5 percent of firms (by market capitalization) and the largest 20 percent of firms. The stocks of larger firms are more liquid—that is, they show less price impact on any given date. The two measures track each other closely. The equity market liquidity metric is monthly because the lambdas are estimated from monthly regressions. The microstructure invariant metric is presented as a daily time series to illustrate the fundamental tension between signals (significant shocks or other market phenomena) and noise (occasional statistical flukes in the data). Distinguishing signals from noise is likely to be difficult for traditional linear statistical models. Although we present the measures as applied to the overall stock market, they can be applied to other asset classes and narrower market segments. Overall, these metrics demonstrate the benefits from tailoring measurement to more granular details of individual securities and markets, and focusing on a narrow risk type, in this case liquidity.

Interconnectedness: CoVaR and SES

CoVaR and SES attempt to measure the connection of individual firms to the larger financial system. As such, they measure interconnectedness. However, lacking direct observation of the individual exposures that create these connections, both use forms of correlation in traded equity prices as an indirect measure. Because they are driven by market prices, both measures can be updated day to day and minute to minute, which has obvious advantages in a crisis.

Value at risk (VaR) measures the smallest expected loss on a portfolio for a given time horizon and confidence level. Adrian and Brunnermeier (2011) propose to extend the VaR methodology to measure a firm's *conditional* value at risk (CoVaR), defined as the VaR of the financial system as a whole, conditional on the firm in question being in distress. The institution's contribution to systemic risk is in turn defined as the difference between its CoVaR conditional on being in distress and its CoVaR in more "normal" times. CoVaR can indicate risks posed by large, complex financial institutions, as well as by smaller institutions acting in concert.

Systemic expected shortfall represents the propensity of a financial institution to be undercapitalized when the system as a whole is undercapitalized (Acharya and others, 2010). But SES is a theoretical construct that cannot be measured directly; researchers must use proxies. One proposed proxy for SES uses the decline in equity valuations of large financial firms during a crisis, as measured by their cumulative equity returns. Leading indicators of SES, such as leverage, can then track ex ante risk.

A comparison of the 1998 and 2008 events is instructive. Both measures register much more weakly for 1998, reflecting the fact that banks and their leverage were less centrally involved. SES is similarly insensitive for 1987. This underscores that different measures highlight different facets of the system and that some recently proposed measures have been calibrated especially to improve our understanding of the 2008 crisis.

Both CoVaR and SES illustrate the information limitations that afflict most of the first-generation systemic risk measures to appear since 2008. Reliance on market prices in a crisis situation is likely to create false alarms (as well as alarms that fail to sound), because market valuations can be contaminated by fire sale effects, spiking uncertainty and risk aversion, and valuation models that were not calibrated for crisis environments. Ultimately, market-based measures must be supplemented with other measures, including direct measures of interconnectedness based on the position and transaction data that the OFR and other FSOC agencies are beginning to assemble.

Data availability also limits our ability to test these models out of sample by applying them to earlier crises. For example, many of the variables used as controls in the Adrian and Brunnermeier (2011) CoVaR estimation did not exist in the 1980s. Where feasible, efforts should be made to fill these historical gaps, for example, by identifying and collecting a historical database of robust control variables to support CoVaR estimation.

3.1.3 Conclusions

The measures evaluated here represent the first generation of financial stability models to emerge since the recent crisis. As such, they show what is possible with legacy information and technology resources available to scholars and policymakers. These legacy data collections rely heavily on market prices, especially equity prices, and firm-level accounting data. Notably lacking are data from over-the-counter markets such as swaps, bonds, and structured products. Also lacking are direct measures of the insurance industry, which is an important locus of contingent exposures. These gaps underscore once again the need for a more comprehensive picture of the financial system. The failure of supervisors to foresee the 2007–2009 crisis, despite an elaborate combination of aggregate analysis, regular examinations, and continuous monitoring at the largest commercial and investment banks, illustrates the need for further investment and research to improve the information sources that they have available to monitor financial stability.

For example, leverage can be a key factor in crisis dynamics. Traditional accounting gives us a measure of firm-level leverage, and the Basel capital standards have made this a focal point of banking regulation. Unfortunately, traditional capital is not well suited for buffering against concentrated contingent exposures, which continue to expand through the growth in derivatives markets and the structuring and fragmentation of contractual exposures. Stress testing can be one way to assess contingent exposures. Ultimately, proper understanding of contingent exposures requires additional details about specific positions and contractual terms that can have a significant impact on net cash flows.

The OFR is well positioned to advance the state of the art in financial stability metrics because of its mandate to track the fragility of the financial system. In part, this mandate motivates our focus on identifying legal entities and the connections between them as necessary building blocks to understanding the financial system as something greater than a simple aggregation of individual institutions.

A key focus of the OFR's research will be to identify data needed to improve the value of measures of threats to financial stability, and to collect them if they are not otherwise available. Such data could, for example, make use of more granular, albeit confidential, information about the credit exposures that large financial firms have to each other.[4] In collecting data to support systemic risk metrics, the OFR will seek to minimize duplication and the burden or cost to the private sector.

3.2 Stress Testing as a Macroprudential Tool

The Dodd-Frank Act requires the OFR to "evaluate and report on stress tests or other stability-related evaluations of financial entities overseen by the [Council] member agencies." To fulfill this role, the Office can: (1) Help to ensure that the necessary data are available; (2) Help to advance the state-of-the-art in stress test methodologies to move from a microprudential to a macroprudential approach; and (3) Contribute to the development and evaluation of quantitative tools that are used to analyze how a stress scenario will affect the financial system.

Stress tests can provide valuable insights into the vulnerabilities and resilience of financial institutions, markets, and even the financial system as a whole. Recent supervisory stress tests have helped supervisors and firms evaluate and improve the adequacy of capital and the quality of risk management processes at individual institutions. For that reason, stress testing has become a valuable microprudential tool.

Macroprudential stress tests should go beyond the scope of microprudential supervisory analysis. They should aim to determine whether the financial system as a whole has the balance sheet capacity to support a normal path of economic activity. Such tests should focus not just on capital adequacy to buffer loan losses, but also on the individual and collective ability of large, complex financial institutions to fund their activities under stress. A key goal is to develop tools that will help avoid runs in wholesale funding markets and fire sales on securities, which could promote a credit crunch and disrupt the economy.

To be sure, the results of supervisory stress tests have been aggregated to serve a macroprudential purpose. For example, the Supervisory Capital Assessment Program (SCAP) subjected the nation's largest banks—accounting for the majority of lending and market-making activities—to identical shocks. These results were used in the spring of 2009 to gauge the capital buffers needed to keep banks well capitalized and able to lend across a range of economic scenarios, including adverse scenarios. Complemented by government backstops like the Temporary Liquidity Guarantee Program implemented in the fall of 2008, the SCAP helped backstop the stability of the system. The program aimed to reduce uncertainty among investors regarding future losses and capital needs and thereby to help improve the banking system's access to private capital. The program also added to the market's understanding of the potential risks to financial stability that could be transmitted through these banks (Board of Governors, 2009).

However, such an approach, while useful, was not completely macroprudential. An important challenge going forward will be to increase the macroprudential value of supervisory stress testing by, for example, incorporating feedback from the financial system to the economy and enhancing the models to allow for runs and fire sales. Ultimately, a macroprudential stress test would ask whether the system as a whole has the capital and liquidity to support lending and to be resilient to shocks.

3.2.1 Macroprudential Objectives of Stress Testing

Typically, microprudential goals for stress testing are defined for individual institutions in isolation, whereas macroprudential goals are defined based on the effects of distress in institutions and markets on each other, as well as on the system as a whole. For example, from a macroprudential standpoint, banks have to be sufficiently capitalized to avoid significantly contributing to contagion from a shock. This may entail higher capital than is necessary for the bank when considered on a stand-alone basis.[5]

Macroprudential stress scenarios should consider both sides of the balance sheet—both assets and liabilities—and take into account the possibility of fire sales. And, because fire sales are liquidity-induced, liquidity rules should be

added to capital requirements as part of the overall framework of macroprudential oversight.

The design and objectives of stress tests vary based on the roles of the entities applying the tests. Financial firms have used stress tests since the late 1980s to evaluate the risk of losses in their trading operations; in many cases, the risk of complex trading positions can be illuminated only by applying discrete shocks to specific risk factors. The widespread losses following the 1998 Russian debt crisis led to a marked increase in firms' use of stress tests to evaluate more comprehensively their exposures to specific shocks.

Financial supervisors have also increasingly used stress tests to evaluate capital sufficiency and risk management practices at individual firms. In some cases, they have looked at the aggregation of those individual stress test results to gain an understanding of the vulnerabilities of the financial system as a whole. In particular, the results generated by institution-specific stress testing, in combination with the scenarios themselves, can be used to generate inferences regarding the way risks are amplified through links between entities in the financial system and how they propagate through the network via feedback cycles.

Stress tests can provide the following benefits to macroprudential supervision, listed in approximate order from the most easily accomplished to the most difficult:

Create an analytical framework for assessing threats to financial stability. Stress tests can help provide a common understanding about issues related to financial stability by bringing together the various stakeholders—macroeconomists, market and credit risk managers, and prudential supervisors.

Develop policy tools. Stress tests can help policymakers gauge the effects of potential policy actions on the financial system.

Identify vulnerabilities and evaluate crisis management and resolution tools. Stress tests can provide policymakers with insights about the likelihood and form of potential crises so that they can consider alternative responses in advance of an actual event.

Serve as an early warning system. Stress tests can add to the identification of vulnerabilities the anticipation of shocks that might occur, a task that in itself is fraught with uncertainty, and is made more complex because the policy and market responses cannot always be anticipated.

3.2.2 Elements of Traditional Stress Tests

Analogous to the practice in engineering, a stress test generally starts with identifying a set of risk factors to be stressed and developing the scenario of shocks to be applied to those factors. The selection of risk factors partly depends on the objective of the stress test. For financial firms, stresses are applied to loan defaults and market factors such as interest rates, equity prices, and credit spreads. In the case of microprudential supervision, in which supervisors are concerned about an institution's ability to withstand adverse macroeconomic conditions, the risk factors tend to be macroeconomic variables related to an economic downturn, such as GDP, housing and commercial real estate prices, consumer spending, and unemployment, as well as certain financial variables such as equities, currency rates, and interest rates.[6] When it comes to macroprudential supervision, which relates to the broader financial system, supervisors are likely to focus on market factors, such as interest rates and equity prices, and on factors that reflect the condition of the institutions such as counterparty risk, leverage, liquidity, and net capital.

Once a comprehensive set of risk factors is identified, the stress test proceeds to shock these factors based on a stress scenario that hypothesizes a large change in their value that might contribute to an adverse or even catastrophic event. Thus, a stress scenario is

not representative of an expected path for the economy or the financial system but rather is a thought experiment, an exercise intended to depict events that are improbable but plausible.

The selection of shocks is only a first step in the stress test. The shocks must be tied to a model of how the shocks feed through to the markets and the financial institutions of concern. For a firm-specific stress test, shocks generate implications for capital requirements, funding sources, and patterns of customer activity in the entities being tested. For a stress test of the overall financial system, shocks simulate outcomes for the entire network of institutions. For a macroeconomic stress test, the model should delve into real economic effects, for example, on capital formation, credit extension, and consumption.

3.2.3 Limitations of Traditional Stress Tests

Two key limitations of traditional stress tests are: (1) The models don't capture fire sales or runs, so the shocks required to produce scenarios with realistically fat tails—aberrations from historical patterns—are unrealistically large, and (2) The shocks themselves are external to the financial system. In turn, external shocks by design mean that the exercise cannot capture the buildup of internal threats to financial stability or feedback loops such as the feedback from losses to balance sheet shrinkage to reduced credit availability. To be sure, stress tests do not answer every question a macroprudential supervisor might have. Federal Reserve Governor Daniel Tarullo noted recently that "stress testing is no more a panacea for the supervision of large financial institutions than capital requirements themselves, or any other regulatory device. By design, the stress tests to date have not covered other sources of stress, such as funding and interest rate risks, which are the subjects of other supervisory exercises." (Tarullo, 2012).

However narrow or broad the objective of a stress test, its quality depends on the definition of stress scenarios. A commonly used approach in specifying scenarios is to draw on historical episodes. Scenarios might simply replicate historical events or they might be expressed as multiples of standard deviations from a historical distribution. History can provide some insights about the market environment during a crisis because most crises have the same directional effects on the critical risk factors and asset classes. For example, crises tend to include a flight to both quality and liquidity in which equity prices drop, credit spreads widen, short-term rates increase, volatility increases, and correlations among similar assets increase.

But, as implied above, there are limitations to relying on historical scenarios. The world changes both in terms of market structure and regulation, so no past event is likely to repeat itself. Any number of changes in risk factors can be applied in stress tests, but the ones that are relevant after the fact might be considered implausible before the fact. Economic relationships change during times of stress: an unexpected shock creates dynamic behavior among diverse market participants, comparable to what is observed with traffic jams or the panic of crowds, and shocks can have a complex and hard-to-predict impact on pre-existing vulnerabilities in the financial system, such as excessive leverage or funding fragility. While modelers tend to think of a crisis as just a bad draw or a fat-tailed event, an alternative view would consider whether a model that relies only on historical events is appropriate.

Financial innovations complicate the task of designing stress tests. To project the complexities of the 2008 crisis, for example, a modeler would have had to fully identify the interconnectedness and risk of contagion caused by new financial products such as credit derivatives, structured credit products, and certain types of short-term funding, particularly repos and asset-backed commercial paper backed by nontraditional assets. However, the prevailing view prior to the crisis was that these innovations were strictly beneficial to the financial system, promoting market liquidity and shifting risk to entities that were better able and willing to bear it. The temptation to

argue that "this time is different" is especially strong during times of extensive financial innovation because financial innovation often holds out the promise of a much better management of risks. Any argument to the contrary is hard to justify because little historical data exists for new products, and if an innovation grows rapidly enough to pose a threat to the system, it almost certainly has been performing well. So innovations can mask critical financial vulnerabilities.

For these reasons, the design of stress test scenarios has understandably been subject to some fundamental rethinking since the 2008 crisis and has moved away from an historical approach. With the benefit of hindsight, it is clear that stress tests prior to 2008 did not anticipate the extreme shocks that occurred during the crisis, failed to shed light on some of the sectors and risk factors that were instrumental in the development of the crisis, and ignored the dynamics among the sectors that were ultimately affected.[7] The boxes accompanying this section explore agent-based models (ABMs), which provide a methodology to address the dynamic nature of financial crises ***(Box C: Using Agent-Based Models to Analyze Threats to Financial Stability)***, and reverse stress tests, which provide an alternative to historical scenarios ***(Box D: Reverse Stress Testing)***.

More fundamentally, the crisis has promoted a reevaluation of the models used to conduct stress tests, reflecting three considerations discussed above. First, models that allow for default, fire sales, and runs are needed. Second, on a related note, models that capture the internal buildup of risks in the financial system are much more likely to help policymakers understand the tail risks and vulnerabilities in the system in response to the external shocks imposed on it in stress tests. Finally, models that capture the cross-sectional or structural vulnerabilities and that look at the interconnectedness of institutions and markets are much more likely to reveal the effects of those shocks on the financial system as a whole (Greenlaw and others, 2012).

3.2.4 The Evolution of Supervisory Stress Tests

Supervisory stress tests have three components: (1) A specification of the stress scenario, including both macroeconomic and financial market disruptions; (2) An analysis of the impacts of the stress scenario on earnings, capital, and liquidity of individual financial institutions and the financial system overall; and, (3) A supervisory follow-up, which can include public disclosure of the results; requirements that firms raise capital, improve their capital or risk management practices, or adjust their business models; and potentially other supervisory actions.

In the U.S., supervisory stress testing began with the Federal Housing Enterprises Financial Safety and Soundness Act of 1992, which required the regulator of the government-sponsored enterprises (GSEs) to employ a risk-based capital test to determine the capital required in the event of specified shocks to property values, credit losses, and interest rates; however, the regulator was not allowed under the legislation to vary the details of the stress events, limiting the usefulness of the exercise. The Basel II Accord of 2004, though not giving an explicit definition of stress testing, required banks to perform stress tests for credit risk, market risk, and liquidity risk.[8] Here the objective remained microprudential: to encourage sound risk management practices.

The Federal Reserve's SCAP exercise in 2009 used stress testing as a tool to determine capital sufficiency during a crisis, as opposed to evaluating the financial landscape during stable times. The Federal Reserve followed up with the Comprehensive Capital Analysis and Review (CCAR) program that uses stress tests as a tool to help evaluate, improve, and give a forward-looking perspective into the internal capital planning processes for large, complex bank holding companies. Similar programs are employed by the International Monetary Fund (IMF), which uses stress tests in a menu of approaches to examine the soundness of banks and the financial sector in its Financial Sector

BOX C. USING AGENT-BASED MODELS TO ANALYZE THREATS TO FINANCIAL STABILITY

Scientists use agent-based models (ABMs) to explain how the behaviors of individual agents can affect outcomes in complex systems such as the emergence of traffic jams, the patterns of flocks of birds in flight, and the spread of epidemics. These concepts may also improve the modeling of financial stability.

Traditional economic and financial models share certain weaknesses: they take a top-down approach, they assume market participants are homogeneous, and they are guided by history. For example, two traditional risk management techniques, value at risk (VaR) and stress testing, estimate potential losses by replicating historical events or by expressing extreme "tail events" based on an historical pattern. Typical economic models assume equilibrium in supply and demand for specific assets based on the expected behaviors of individuals in markets during normal, non-crisis periods; importantly, they assume representative homogeneous individuals who operate rationally.

But traditional models miss critical points about financial crises. Crises tend to emerge from the unleashing of a new dynamic when economic relationships among individuals can change in diverse and complex ways. Historical patterns are not always relevant, and individuals are heterogeneous.

To address these characteristics, an agent-based model analyzes the actions of autonomous agents to predict the "macro" behavior of the system as a whole.

ABMs specify rules that dictate how individual agents will act based on various factors. The rules can vary from one agent to the next and can allow for less-than-optimal behavior. Once the model has specified the initial conditions and the agents' rules, the "world" is let loose and the subsequent events are driven by interactions among agents. The agents are free to act within their computational world, just as their counterparts do in the real world.

Economists have begun to use ABMs to explain components of the financial system based on the expected behavior of diverse market participants. Gilbert, Hawksworth, and Swinney (2009) use an ABM to investigate shocks in the English housing market by simulating interactions among buyers, realtors, and sellers. Thurner (2011) uses an ABM to explore how excessive leverage can both emerge and dissipate within a financial system. In a boom, individual banks may lend with declining collateral requirements (that is, at higher and higher leverage) as they feel safer about asset valuations; in a bust, as banks get more nervous about rising uncertainty in the world, they may stiffen their collateral requirements, reducing leverage. Rarely are banks able to take into account that they all may be behaving similarly and that, as a result, they could actually create the catastrophe they are each trying to avoid.

The Bank of England pioneered the use of ABMs to analyze payment systems, which handle billions of transactions every day and can pose serious threats to financial stability if they break down (Galbiati and Soramäki,

2008). The Bank of Italy introduced an ABM in which banks operating in the midst of a crisis are unable to perform operations such as payments and interbank loan requests over a given timeframe (Arciero and others, 2009).

The characteristics of an ABM directed toward threats to financial stability might include:

Key Agents. The key agents for analyzing threats to financial stability are those that provide funding, those on the other side that use leverage, and those that provide liquidity. The first of these can be represented by money market funds and banks lending in the repo market. The second can be represented by hedge funds. The third can be longer term, unleveraged investors, such as asset managers and pension funds. One valuable feature of an ABM is that the agents can represent actual entities in the financial system, delving into their policies and procedures for responding to various shocks (for example, how banks alter their haircuts in the face of higher volatility in the collateral) and describing each agent's financial condition (for example, capital, positions, and counterparties).

Policy Levers. These include minimum haircuts, margin requirements, and capital and liquidity ratios for banks. If a model is extended to the housing sector, the levers would include loan-to-value ratios. Policy levers might also include "circuit breakers" that operate to slow down any liquidity and funding demand to a pace closer to that of the decision process for key liquidity and funding providers.

Shocks and Vulnerabilities. The model should allow for the range of shocks that are typical in causing a crisis. These include a seizing up of liquidity; a fire sale in the face of forced deleveraging with the subsequent funding and liquidity effects; a sudden funding impairment, which is often brought on by a shock to real or perceived creditworthiness or liquidity; and, in the extreme case, the failure of a firm.

Policy Applications. Policymakers can use ABMs to explore major policy changes that diverge far from current policy settings. An ABM with adapting, heterogeneous agents provides a virtual policy experiment, exploring the importance of behavioral adjustments in a given situation. And the features of ABMs make them particularly well suited for analyzing an economy in extreme situations where standard empirical models are likely to fail. ABMs can help analyze issues such as leverage, market crowding, modes of intervention during a crisis, and even the type of data and risk metrics that will be of greatest value in evaluating market vulnerabilities.

Although ABMs have shown value in other fields, particularly for modeling emergent phenomena such as crowd stampedes or epidemics, it can be, as Axelrod (2006) pointed out, a "hard sell" in the community of academic economists, in which mathematical techniques are more common than computer simulations. The OFR is actively engaged with the research and policy communities to understand whether this method can be useful to the OFR and others with responsibility for modeling vulnerabilities of the financial system (Bookstaber, forthcoming).

BOX D. REVERSE STRESS TESTING

A standard stress test sets a scenario and measures the consequences. In contrast, a reverse stress test poses an adverse outcome and identifies the scenarios that lead to that outcome. OFR research is developing methodologies to implement this approach.

A standard stress test might ask: How much would a money market fund lose under a hypothetical combination of rate and spread movements? A reverse stress test would ask instead: How much would rates and spreads have to move for the fund to "break the buck" and drop below its fixed net asset value of one dollar? Similarly, reverse stress tests could ask: What would make a firm insolvent or breach capital requirements?

Reverse stress testing, which originates from industry practice, focuses efforts on scenarios of key importance to a specific portfolio, institution, or set of institutions. It offers potential advantages for interpretation; although the relevance of a hypothetical stress scenario is often open to debate, all parties can agree on the significance of an adverse outcome. The results of a reverse stress test are also potentially more actionable precisely because they spotlight specific vulnerabilities.

Scenario selection is an integral part of all stress testing; for reverse stress testing, it entails identifying the scenarios that lead to a specified adverse outcome. For both types of stress tests, it is useful to think in terms of "factors"—market rates and economic variables, for example—that drive gains and losses. A stress scenario is then defined by a shock to the factors or possibly a sequence of shocks. Scenario selection is the process of choosing factors and shocks.

The directional effect of a shock is often clear. A house price decline will adversely affect a mortgage lender and a stock market decline will generate losses for a stock portfolio. But for portfolios using derivatives, embedded optionality, or hedging, the directional impact may be obscured. A bank that partially hedges its interest rate risk might be insensitive to a modest increase or decrease in rates and yet be vulnerable to large changes in either direction. Flood and Korenko (forthcoming) develop a method that avoids making assumptions about which directions lead to adverse outcomes and instead seeks to explore directions of potential risk comprehensively.

When the available information is sufficient, interest centers on the most likely scenarios leading to a specified adverse outcome. Glasserman, Kang, and Kang (forthcoming) develop a method for estimating the most likely combinations of factor shocks leading to a given outcome and for identifying important sets of factor shocks, rather than a single scenario. Many different combinations of movements in market factors could produce equally large losses, but historical data may make some combinations more plausible than others. Getting the relative severity of various shocks right is important in determining the proper response to vulnerabilities identified by a stress test.

Chart 3.2.1 Sample Stress Variables Used in CCAR 2012

Variable	Stress Case	Peak-to-Trough for 2008 Crisis
Real GDP	-5.2% (Q3 2011–Q3 2012)	-5.1% (Q4 2007–Q2 2009)
Unemployment Rate	Maximum: 13.0% (Q2 2013)	Maximum: 10.0% (Q4 2009)
Chicago Board Options Exchange Market Volatility Index (VIX)	Maximum: 90.50 (Q1 2012)	Maximum: 80.86 (Q4 2008)
Dow Jones US Total Stock Market Index (DWCF)	-51.8% (Q3 2011–Q4 2012)	-47.2% (Q3 2007–Q1 2009)
CoreLogic House Price Index (HPI)	-21.0% (Q3 2011–Q1 2014)	-33.2% (Q4 2006–Q1 2012)*

*To present; trough not yet established.

Source: Board of Governors (2012), OFR calculations

Assessment Program (FSAP), and the European Banking Authority (EBA), which applied a stress test on macroeconomic variables against all countries in the European Union.

SCAP was a one-time supervisory stress test. The supervisors specified the adverse scenario and determined the resulting loss and revenue estimates on a standardized basis using information submitted by each firm. Its purpose was to restore confidence in large U.S. banks during a time of great market turmoil by measuring how much capital the banks would need in an even more stressed environment and then forcing these banks to increase capital accordingly. In contrast, the CCAR is an ongoing program which has already run through two cycles in 2011 and 2012. The CCAR employs stress tests with scenarios specified by the Federal Reserve Board but run by the banks to fulfill a secondary objective of assessing the banks' internal risk management capabilities and capital planning processes. ***Chart 3.2.1*** presents the stress scenario for several of the key variables in the 2012 test along with the peak-to-trough change in these variables during the 2008 crisis.

The stress tests of the European Banking Authority, the IMF, and CCAR all provide insight into the resilience of the financial system, though differing in the specifics of the scenarios, the data available for the tests, the components of the testing done by the entities versus the regulators, and the regulatory targets (for example, capital and leverage ratios). These programs also use similar methods for determining scenarios, and they base the scenarios on market and economic variables ***(Chart 3.2.2)***.

The recent financial crisis has prompted a critical reassessment of these methods because stress tests before the crisis missed important sources of instability, most notably the effects of liquidity risk and credit risk—both particularly manifest in the banks' exposures to the real estate market and off-balance-sheet risks—and the availability of funding to support the banks' leverage. The crisis also dramatically illustrated the force of contagion and related fire sales and thus the importance of following the path of a shock through the financial system.

Chart 3.2.2 Comparison of Key Stress Test Parameters

	U.S. CCAR 2012	U.S. FSAP (IMF)	EU EBA Stress Test
Date	March 2012	July 2010	July 2011
Scope	31 U.S. BHCs with at least US$50 billion in assets, including the 19 that were subject to the SCAP	53 largest BHCs, representing 85 percent of aggregate BHC assets	90 banks in 21 countries, representing approximately 2/3 of total banking assets
Process	Stress tests for the top 19 were conducted by each bank under the Federal Reserve's adverse scenario, and the Federal Reserve conducted its own tests of the banks under both its baseline and severe stress scenarios	A balance sheet-based macroprudential analysis, without detailed supervisory data, a distress-dependency model using CDS data, and a contingent claims analysis to estimate potential government contingent liabilities	Stress tests for all banks were conducted by each bank based on the established stress scenarios and methodology, and were verified by home country supervisors and EBA staff
Target Capital Ratio	5% Tier 1 Common (FRB rules); 4% Tier 1; 8% Total	6% Tier 1 Common	5% Core Tier 1 (EU Capital Requirements Directive)
Key Parameters	Unemployment rate increases approximately 4 percentage points to a peak of 13 percent; equity prices drop by approximately 50 percent; housing prices decline by an additional 20 percent from Q3 2011 levels	Unemployment rate rises 1.1 percentage point to 10 percent; commercial property prices fall by 8 percent; residential property prices decline by 6.6 percent	For each country: unemployment rate increases 3.2 percentage points; commercial property prices decline by 20–40 percent; residential property prices decline by 5–30 percent
Disclosure	Disclosed on aggregate and bank-level basis using a common template	Many results released on a bank-level basis for this test, with consent of U.S. authorities	Disclosed on aggregate and bank-level basis using a common template

Note: The Tier 1 capital ratios used in the various tests are not directly comparable.

Source: Board of Governors (2012), IMF (2010), EBA (2011)

3.2.5 Stress Test Disclosure

Following the SCAP stress test, the Federal Reserve disclosed details of the results on a company-by-company basis using a common template to ensure comparability across bank holding companies. This disclosure of supervisory data was unprecedented but was regarded by the policymakers as essential for the credibility of the exercise among market participants. Dodd-Frank required the Federal Reserve Board to disclose summary results of supervisory stress tests for large banks.[9] The EBA discloses results of Europe-wide stress tests on both the aggregate and bank level, again with a common template for bank-level results.[10] For comparison, the results of the stress tests performed under the IMF's FSAP are disclosed in a manner to preserve the anonymity of the individual banks or are presented only on an aggregate basis.

There are several key issues that underlie the disclosure decision:

Comparability of stress tests across institutions. This has been accomplished for both the CCAR and the EBA stress tests by adopting a common disclosure template.

Consistency in the stress tests demanded by various supervisory agencies. As stress tests become more common, there may be conflicting disclosures and confusion if different stress factors and scenarios are applied.

Focus on the extreme scenarios. The present supervisory stress tests focus on extreme scenarios because they share the objectives of determining capital adequacy and financial stability in the face of market stresses. One concern is that stress tests might turn into an earnings forecasting exercise if they lose their focus on extreme scenarios.

Consideration of the appropriate level of disclosure during normal versus crisis periods. Normal times may not require the same degree of transparency as is needed in times of crisis, and indeed the same level of disclosure may not be desirable. With the uncertainty about the banking system that can arise during times of crisis, there is an immediate benefit to the supervisors' ready assessment of the health of individual banks and to the ability of the market to better differentiate the healthy banks from the weaker ones. During normal times, more consideration can be given to the effect of disclosure on the behavior of banks and the market generally. Along with the benefits of increased market transparency and discipline that come from bank-level disclosure also come potential costs: banks may make poor portfolio choices in order to increase their chances of passing the test (in other words, window dressing); market participants may place too much weight on the public information of stress test disclosure; or the incentive to produce and analyze other information about the banks may diminish. This behavior might lead to gaming the tests to conform to a particular set of rules, making the stress tests far less informative (Goldstein and Sapra, 2012; Tarullo, 2012).

3.2.6 The Future of Stress Testing

The next generation of supervisory stress tests may improve on the current generation by: (1) Introducing new stress factors, (2) Taking account of financial innovations, (3) Incorporating the dynamics of crisis events and the related feedback cycles and non-linearities, (4) Recognizing the variability in the objectives and behavior of financial agents, and (5) Addressing specific market vulnerabilities, such as the potential for fire sales and runs in wholesale funding markets, which requires stressing both sides of the balance sheet.

(1) Stress Factors

The recent crisis has shown that stress scenarios have to include credit risk and liquidity risk, along with the interaction between the two, for example, when solvency concerns cause a shock to systemic liquidity.[11] Funding can dry up because of increased concern about the risk of default; a drop in asset prices, perhaps due to a leverage-induced fire sale that affects the margin requirements for the banking system, thereby increasing funding costs; or a drop in funding liquidity, because uncertainty over counterparty risk and lower asset valuations induce banks and investors to hoard liquidity.

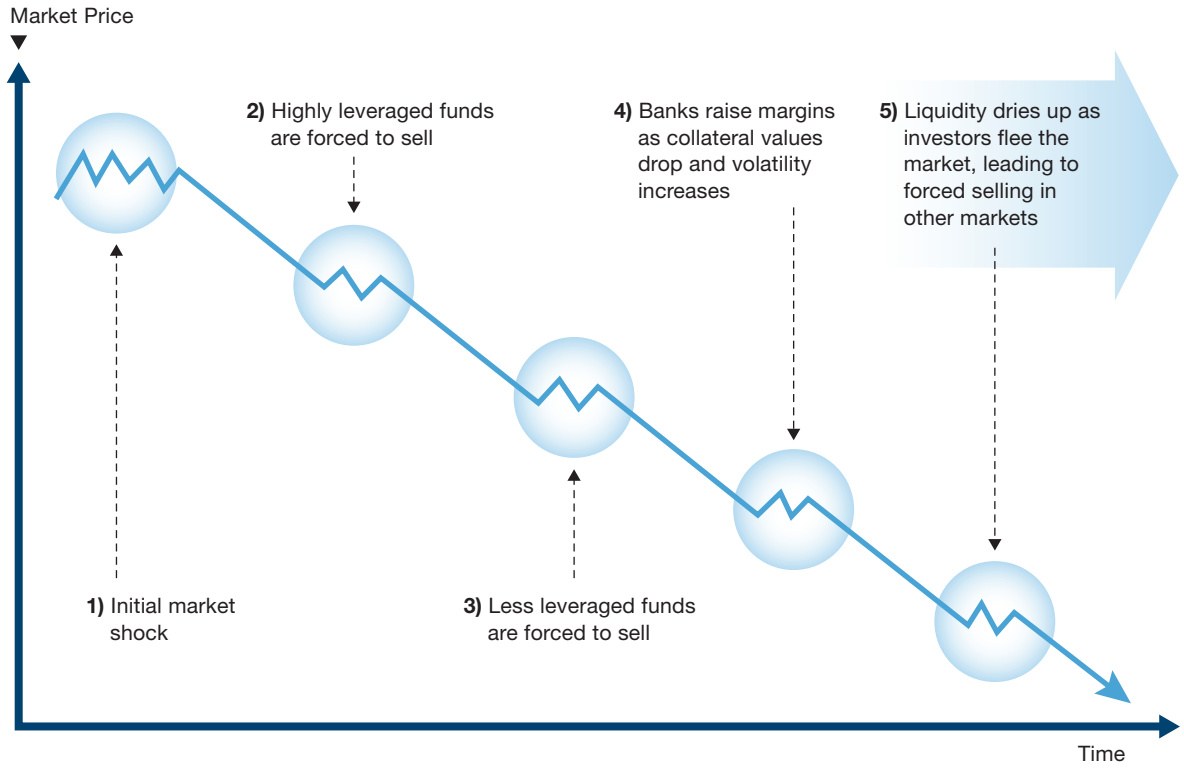
Shocks to individual banks can lead to marketwide reductions in liquidity by increasing counterparty risk or through "liquidity hoarding," in which banks do not extend credit even to high-quality counterparties in order to stay liquid "just in case" during periods of great uncertainty, or sell high-quality assets to meet liquidity needs.[12]

(2) Innovations and Structural Change

Innovations can lead to changes in market relationships and thus may require updates to models employed in stress tests. Innovations also impose difficulties in terms of data. By definition, limited data are available for new products and, further, they are unlikely to span a crisis period, so understanding the

Chart 3.2.3 Fire Sales (Liquidity Cycle)

A fire sale often begins with news that prompts a repricing of assets, combined with a concentration of leveraged funds that are forced to sell to meet margin requirements. As the forced selling sustains downward pressure on prices, margin calls feed back to magnify the effects, forcing additional rounds of selling.



"true" statistical properties is difficult, if not impossible, before the fact. Even less prior information exists about the effect of regulation on new products and markets because of lags in the initiation of regulatory oversight.

(3) Dynamics and Feedback

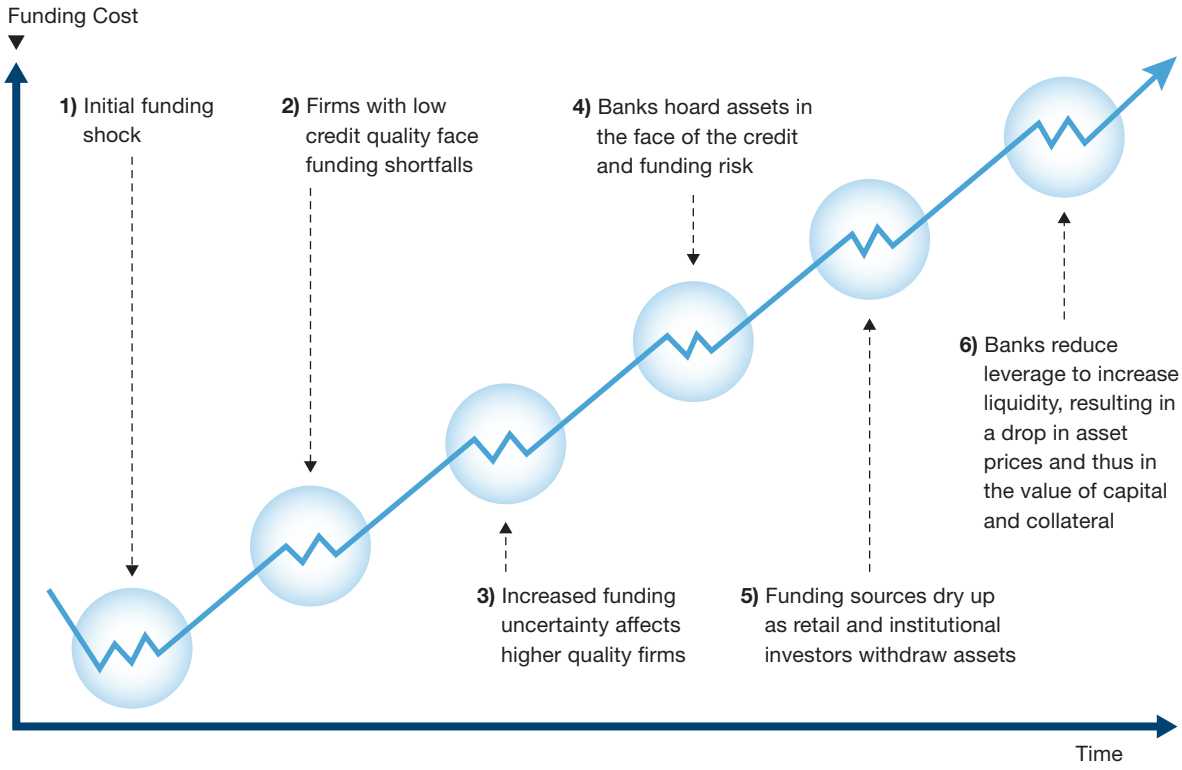
The current approach to stress testing employs models based on the risk models of banks. Risks are taken as external factors and there is no feedback when the actions of banks and others create secondary, ripple effects, or when the initial shocks to the risk factors themselves trigger chain reactions that affect factors outside of the initial set. Feedback effects are difficult to capture because of the granularity of data required, the diversity of behaviors of various market participants, and because current models have difficulty handling their non-linear time-dependent nature.

One important example of feedback relates to simultaneous deleveraging by financial institutions. An attempt by a large number of intermediaries to reduce leverage may backfire as asset prices plunge. Further, financial institutions may have trouble rolling over their short-term funding when the value of their collateral declines, triggering forced sales.

These dynamics can lead to contagion, both across markets and across institutions holding similar assets. And, when liquidation is no longer possible within similar markets, institutions in need of cash may seek to sell assets in unrelated markets, creating the same feedback effects in those markets. These paths for contagion are difficult to anticipate within a conventional framework because the affected markets may not have been correlated historically. ***Charts 3.2.3*** and ***3.2.4*** illustrate the multi-stage feedback dynamics that can occur

Chart 3.2.4 Runs (Funding Cycle)

A run often begins with concerns about counterparty creditworthiness and a drying up of liquidity, which boost funding costs, placing strains on vulnerable firms. The rise in funding costs promotes further concerns about counterparty risk and ever-wider funding spreads.



in the case of a liquidity shock and a funding shock, respectively.[13]

(4) Heterogeneous, Disaggregated Agents

Agents in the financial system operate according to their own governance procedures, risk management structures, and business cultures. Consequently, their reactions to any event will not be uniform and are unlikely to conform to abstract notions of optimal behavior. Such behaviors are complex, and current supervisory models do not attempt to predict them.[14] Instead, today's models generally are estimated at an aggregate level, or use firm-level data and are estimated uniformly across entities.

For issues of financial stability, however, the task of incorporating heterogeneous behaviors into stress tests is not as daunting as it may appear. Such an analysis would have to consider only a small number of representative financial entities, and their "rules of market engagement" can be determined through an analysis of governance structures and interviews with key decision makers. It therefore may be possible to overcome some of the limitations of the paucity of historical data about market participants' behavior during shocks, especially shocks that fall outside the range of recent history.

The heterogeneity of banks can pose problems for aggregating and comparing stress test results. Each bank applies its own models to the exercise, so there is no common frame of reference. One proposal to facilitate an apples-to-apples comparison of stress tests is to have each bank perform a stress test on a standard portfolio that has the sorts of assets the banks tend to hold, and then report the results for the overall portfolio and for segments of the portfolio. The variation of the banks' results for this standard stress test will provide some

transparency into their internal methodology. If a bank shows a loss for this stress test that is small relative to those of other banks, then its other stress test results are likely to be relatively optimistic as well. The standardized test will provide the banks with essential information for moving toward a consistent, comparable set of methodologies (Pandit, 2011).

(5) Stress Scenarios

Stress test scenarios face the difficulty of being most important when complacency is highest. Before the 2008 crisis, few would have taken seriously a test that assumed that credit default swap spreads would rise by as much as a factor of 10. Adverse scenarios thus have to extend beyond the market's comfort zone while at the same time not doing so arbitrarily. An outsized 300 basis point swap spread does not happen without context. The stress test must take into account the broader context and general nature of the current environment—the level of leverage, the areas of crowding, and the sources of funding—and then at a fundamental, structural level show how the interactions of market participants could, due to vulnerabilities in that environment, lead to an unanticipated market result.

3.2.7 Conclusion

It is crucial to enhance stress-testing methodologies to incorporate the modeling of feedback and secondary effects following initial shocks. A shock in one market may propagate into a second, seemingly unrelated market if the institutions with significant exposure in the first market also are heavily positioned in the second. These interactions can lead to an overall effect that is more than the sum of the individual shocks.

Improving stress tests requires a deep understanding of the exposures of various financial entities and the potential for changes in their access to market funding. Simply put, stress tests need to be improved to more accurately capture crisis dynamics. Doing so also requires something more than the partial equilibrium framework of the current generation of models. One line of research involves macroeconomic models that embed a more explicit financial system, including banks and capital markets and allowing for default, fire sales, and runs (Goodhart and others, 2012). Another promising area lies in the application of agent-based models, as described in ***Box C***.

The objectives of stress testing for the OFR represent a second step after the CCAR. CCAR applies a basic set of assumptions about changes in the banks' business lines when confronted with a shock, assuming, for example, no changes in the loan portfolio or in the position on the trading book. A stress test to expose vulnerabilities in the financial system as a whole requires the modeling of interactions. The enhanced stress-testing methodology should account for a host of potential channels of risk propagation, including interdependence among financial firms through clearing and settlement systems, common exposures, collective patterns of behavior, and broader market failures, such as externalities and moral hazard, all of which have the potential to amplify shocks and spill over into the real economy. This is the focus of the OFR's thinking and work.

3.3 Counterparty Risk Management: Best Practices and Unmet Challenges

The Dodd-Frank Act charges the OFR with promoting best practices in risk management, and counterparty risk management is especially important to that mission. Strong counterparty risk management by individual financial institutions provides a stabilizing buffer against the propagation of shocks through the financial system; poor counterparty risk management can turn the failure of an individual firm into a systemic event. As part of its work in this area, the OFR is also contributing significantly to the improvement of counterparty risk management by helping establish a global Legal Entity Identifier (LEI).

The financial system depends on companies honoring their commitments to each other in market transactions. Failure of a company to do so can cause significant losses to its own counterparties and can threaten a chain reaction among interconnected market participants.

This section highlights lessons learned from the financial crisis and ongoing changes in the measurement and management of counterparty risk. This overview covers current trends in this critical area and highlights an evolving focus on credit value adjustment (CVA) as a tool for market participants and financial regulators in quantifying counterparty risk. The financial system and its oversight both stand to benefit from best practices in the implementation and application of this important tool.

Counterparty risk is sometimes construed narrowly to refer to exposures in over-the-counter (OTC) derivatives trading. The discussion here takes a much broader view that includes many other types of counterparty relationships. Domestic prime brokers, for example, are generally prohibited from transacting in OTC derivatives, but their relationships with their hedge fund clients expose both parties to risk. Money market funds face counterparty risk through their exposures to bank deposits, repurchase agreements, and other debt instruments, and through the third-party guarantees that are sometimes attached to these instruments. Failures in any of these and in many other types of counterparty relationships can have ripple effects on financial stability.

A crucial prerequisite to counterparty risk measurement is the proper identification of counterparties. The OFR's work to help establish a global LEI is thus an essential component of the OFR's risk management mandate. While this section focuses on counterparty risk, ***Box E*** highlights the OFR's broader mission to promote best practices in risk management.

3.3.1 Historical Context

Counterparty risk is not a new phenomenon. The collapse of Long-Term Capital Management (LTCM) in 1998 heightened awareness of the risks that market participants face through their exposure to counterparties. LTCM's counterparties were particularly exposed to the hedge fund through OTC derivatives positions. LTCM's failure led to the formation of the Counterparty Risk Management Policy Group, a consortium of commercial and investment banks, which issued its first report in 1999. The principles put forward in that report—on transparency, risk assessment, reporting, documentation, collateral management, and the integration of market and credit risk—remain as relevant today. A second report, published in 2005, put particular weight on improving the operation of the credit default swap (CDS) market, which had grown since the first report from insignificance to become a $10 trillion market. International bank supervisors, working through the Basel Committee on Banking Supervision, introduced a series of requirements for banks to hold extra capital as a buffer against the counterparty risks arising from OTC derivatives, repo transactions, securities lending, and margin lending. Basel III substantially increases these capital requirements.

The recent financial crisis served as a reminder of the importance of counterparty

BOX E. BEST PRACTICES IN RISK MANAGEMENT

The Dodd-Frank Act charges the OFR with promoting best practices in risk management, a mission the OFR pursues through its research and through discussions with industry participants and academic experts.

Effective risk management relies on a combination of quantitative tools, data management, and governance procedures. This box highlights some critical dimensions of best practices in risk management. These topics are further explored in an OFR working paper (Flannery and others, 2012).

Risk Governance and Incentives

A strong culture of risk governance is a necessary ingredient of effective risk management. Key elements of a strong risk culture include adequate resources and independence for the risk function; a board of directors with the proper information and expertise to understand the firm's risk-taking; and compensation schemes that align the risks taken by individual units with the long-term objectives of the firm. Despite some progress, the overall performance of the financial industry on these dimensions needs improvement.

Liquidity Risk Management

Excessive reliance on short-term funding amplifies shocks to the financial system. Repo markets, money market funds, asset-backed commercial paper, securities lending, and rehypothecation—the reuse of collateral by a broker to borrow for its own use—all came under stress during the financial crisis, and firms with the greatest reliance on these funding sources were among those at greatest risk. Avoiding similar errors in the future will require regulatory changes and improvements in firms' management of their funding sources, with appropriate contingencies to function through times of market stress.

risk management. A central episode was the liquidity squeeze experienced by the major investment banks when their counterparties, including hedge funds that were their prime brokerage clients, suddenly demanded their funds. Prime brokers provide a range of services to hedge funds and traditionally earn fees by rehypothecating fund assets held as collateral—that is, re-using the collateral for securities lending or as collateral for the broker's borrowing. During the crisis, investment banks had trouble meeting the large number of requests by hedge funds for cash and collateral. Thus, while the LTCM failure focused attention on the risks that investment banks face in the event of a hedge fund failure, the events of 2008 illustrated the risks that hedge funds face in their dealings with investment banks. The financial industry has responded to heightened concern for counterparty risk with greater use of custody accounts to hold fund assets, tighter controls on rehypothecation, and diversification across multiple prime brokers.

The near-failure of American International Group (AIG) also illustrated the threat to financial stability that can result from inadequate counterparty risk management. Through a combination of over-reliance on credit rating agencies, market opacity, and weak supervision, AIG was able to take on enormous positions by selling credit protection,

Data and Information Technology

The financial crisis has highlighted the varied level of integration that firms have achieved in their risk management infrastructure. Some of the firms that fared best had developed a firmwide view of their risks, aggregated across diverse lines of business. Most large complex financial institutions have not yet fully developed this capability.

Market Risk and Credit Risk

These are the traditional focal areas of risk management and in many respects they are the best developed aspects of the field. An important lesson of the financial crisis is the need to build longer horizons into market risk and credit risk measurement to capture the behavior of financial markets under a range of business conditions.

Operational Risk

As highlighted in the 2012 FSOC annual report, strong cybersecurity is a key element of protecting financial stability and an ongoing challenge for financial institutions. The Flash Crash on May 6, 2010—when the Dow Jones Industrial Average plunged nine percent and then recovered within minutes—pointed to the new types of operational risk that emerge from high-speed trading and highlighted the importance of a sound infrastructure. Ensuring the prevention of unauthorized trading and fraud also should remain a priority for operational risk management.

The Micro-Macro Interface

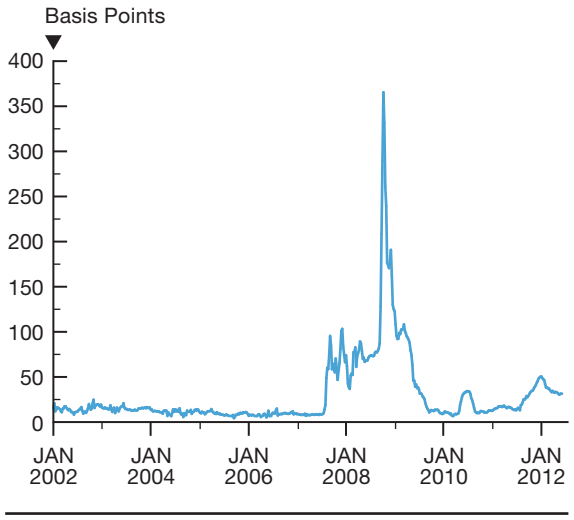
Firm-level risk management focuses on risks to a single institution. But actions that a single institution may take to mitigate its risks—withdrawing funding, selling impaired assets, or exiting a market—can amplify risks in the system as a whole when undertaken simultaneously by many firms, as in the case of a classic bank run. Indeed, risk management practices that may seem sound in isolation can have procyclical effects when widely adopted. Because of its broader mandate, the OFR has a particular interest in the macroprudential implications of firm-level practices.

and its counterparties apparently failed to recognize the magnitude of the accumulating risk until it was too late. This led to a cliff effect as downgrades of AIG triggered collateral requirements it could not meet. The Dodd-Frank Act seeks to prevent the accumulation of risk into such concentrated exposures; in particular, it provides a process for regulators to designate a large financial institution for additional financial supervision based on the systemic implications of its potential failure.

Despite the decade of attention to counterparty risk that passed between the failures of LTCM and Lehman Brothers, the recent crisis changed the market's assessment of counterparty risk, as reflected in market prices and practices. The failures and near-failures of large financial institutions led market participants to demand greater compensation for bearing the risk of potential failures of their counterparties.

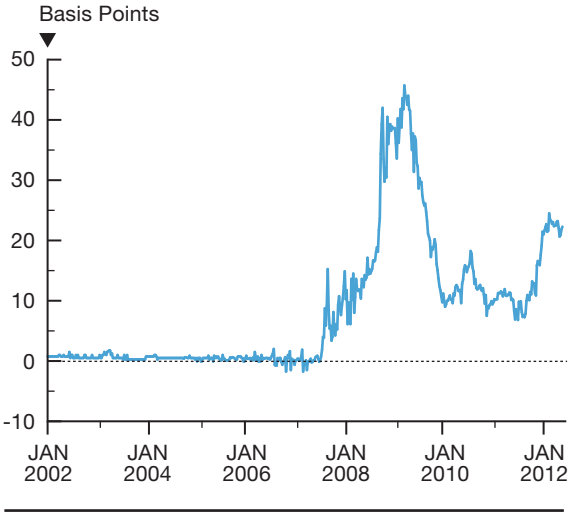
This pattern is evident, for example, in the LIBOR-OIS spread, a measure of counterparty risk in the banking system ***(Chart 3.3.1)***. The OIS (overnight indexed swap) rate is tied to the overnight federal funds rate; the swap involves an exchange of interest payments only, not principal, and thus reflects minimal credit risk. In contrast, three-month LIBOR (the London Interbank Offered Rate) embeds the risk banks face in lending to each other

Chart 3.3.1 Three-Month USD LIBOR-OIS Spread



Source: Bloomberg

Chart 3.3.2 USD LIBOR Basis Swap: Three-Month versus Six-Month



Source: Bloomberg

for three months. The difference is thus widely viewed as a measure of the premium for bank credit risk. The spread was small and stable until the summer of 2007, skyrocketed in 2008, and continues to be larger and more volatile than it has been historically. A similar pattern is evident in the basis swap rate between six-month LIBOR and three-month LIBOR *(Chart 3.3.2)*. This spread measures the risk that a bank—an average bank from the LIBOR panel—will be unable to roll over its short-term debt because of a decline in its credit quality; as noted in Section 2.2, the integrity of the LIBOR setting process has recently come into question.

More recently, the market's new assessment of counterparty risk can be seen in sovereign credit default swap spreads *(Chart 3.3.3)*—historically very low, but now elevated even for developed economies. Sovereigns have traditionally been free from collateral requirements in their swaps with banks, but the debt management offices of Hungary, Ireland, Portugal, and Sweden have agreed to two-way collateral agreements with banks in the past year, and other countries may follow. This trend reflects both a general push toward expanded use of collateral and a change in the market's perception of sovereign risk.

These changes in market prices and practices reflect some of the lessons learned about sources of counterparty risk through the financial crisis. We next describe measures to manage this risk, articulating the OFR's initial areas of focus as we begin to discharge our mandate to develop best practices for risk management and to supply analytical support to policymakers considering choices for improving the rigor of market participants' risk management activities.

3.3.2 Mitigants to Counterparty Risk

Financial institutions mitigate counterparty risk through a combination of firm-specific practices, market structure, and financial transactions. This subsection discusses specific practices, current developments, and issues requiring further attention by firms and regulators.

Internal Controls

Effective counterparty risk management, like all effective risk management, begins with internal procedures, proper controls, and strong risk governance. For counterparty risk, this entails rigorous monitoring of counterparty credit, a thorough procedure for setting and enforcing risk limits, and proper controls for managing collateral and complying with all terms of credit support agreements with counterparties. Achieving these objectives presents data management challenges for large diversified

financial firms that may face the same counterparty or affiliated counterparties across many lines of business. Establishing an LEI will facilitate the process of integrating counterparty risk from multiple affiliates and subsidiaries and will help firms monitor their exposures more consistently and comprehensively.

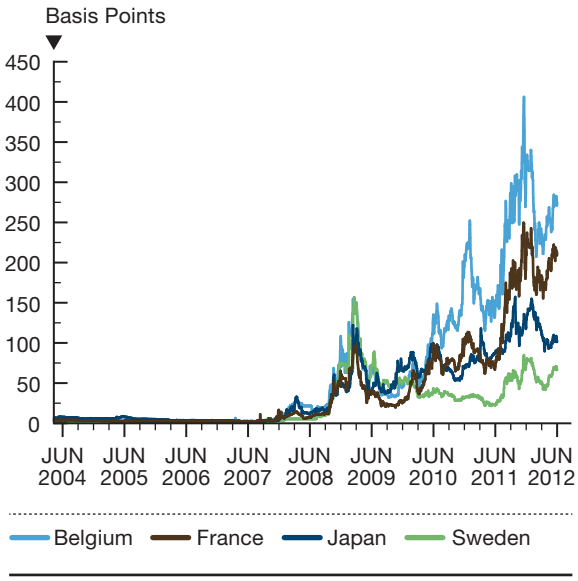
Credit analysis is a core risk management function of nearly all financial intermediation. In eliminating regulatory reliance on credit rating agencies, Section 939A of the Dodd-Frank Act also put greater responsibility on firms to take ownership of credit risk assessment. The financial regulatory agencies issued a series of proposed and final rules in 2011 to address the removal of credit ratings from regulations; a thrust of these rules is to avoid using credit ratings as seals of approval and thus to put greater weight on due diligence. Credit analysis is too critical to be outsourced.

Risk management ultimately relies on proper incentives and governance, a point stressed in a recent OFR working paper (Flannery and others, 2012). The independence, influence, and incentives afforded the chief risk officer matter as much as the methodologies employed. Recent supervisory guidance on counterparty credit risk management begins by detailing the responsibilities of the board of directors, senior managers, the risk management function, and independent auditors in ensuring the effectiveness of firm-level risk management (OCC and others, 2011). ***Box F*** highlights some significant failures of risk governance at MF Global that contributed to its collapse and the loss of funds by its customers.

Netting and Collateral

Regular participants in the OTC derivatives market often accumulate a large number of transactions with a single counterparty, and some of these transactions may partially offset each other. Under a netting agreement, one party pays the other the net amount owed on a portfolio of derivatives, instead of each party making a gross payment to the other. Netting thus reduces the size of the exposure each party faces from a potential default of the other party.

Chart 3.3.3 Sovereign 5-Year CDS Spreads



Source: Bloomberg

Chart 3.3.4 illustrates the idea. Party A owes Party B $100 on one swap, and Party B owes Party A $80 on another swap. Under a netting agreement, the payments would be offset and Party A would pay just the difference of $20 to Party B. This reduces B's exposure to A from $100 to $20, and it eliminates A's exposure to B.

Collateral agreements also protect creditors from loss in the event of default of an obligor. When a swap (or a portfolio of derivatives) is collateralized, the parties to the swap agree to exchange collateral as the market value of the swap moves in favor of one party or the other. With more frequent updating of the collateral level, the payments to be exchanged are typically smaller, and this reduces each party's exposure to a default of the other. Title VII of the Dodd-Frank Act and the OCC's proposed margin rules mandate collateral for most swaps that are exempt from central clearing and call for stricter rules on segregation and rehypothecation of collateral to ensure its availability as a buffer against the spread of shocks through the financial system.

BOX F. LESSONS FROM THE COLLAPSE OF MF GLOBAL

On October 31, 2011, MF Global Holdings Ltd., the parent of the broker-dealer and futures commission merchant MF Global Inc., filed for bankruptcy—the fifth largest failure of a financial institution in U.S. history. The company had placed large bets on European sovereign debt, increasing its exposure as market prices continued to fall. Long after incurring losses, the company was unable to account for $1.6 billion in customers' funds in the aftermath of its failure.

MF Global's high-profile collapse offers lessons in several areas: (1) Compliance and corporate governance, with the company's deficiencies culminating in its failure to safeguard customer funds; (2) Liquidity management, in the use of short-term funds to finance bets on Europe; and (3) Macroprudential analysis, as the incident provides an opportunity to evaluate what helps prevent the failure of a large firm from becoming a threat to financial stability.

Compliance and Corporate Governance

Following its failure, MF Global was unable to account for over $1.6 billion in customer funds amid allegations that the firm used customer assets to cover its losses. The apparent failure to properly segregate customer funds followed a pattern of lapses in compliance and governance.

According to Congressional testimony, as the firm raised its limits on European sovereign debt exposure from $1 billion to $4.75 billion between September 2010 and January 2011, the chief risk officer (CRO) voiced concerns to the chief executive and the board of directors. His concerns went unheeded and he was replaced by a new CRO in January 2011 (Roseman, 2012a). The position was effectively demoted, as the new CRO reported to the chief operating officer rather than to the chief executive, and projects to enhance risk management were shelved (Stockman, 2012). All of this should have been a red flag, signaling a culture in which the CRO position was not sufficiently independent and empowered to restrain decisions by senior management that put the firm at risk.

There had been earlier signals. In 2008, the company incurred a $141 million loss due to unsupervised trading by a single employee. In 2009, the CFTC, its regulator, imposed a $10 million fine on the firm for "significant supervision violations." The commission said that between 2003 and 2008 it had warned MF Global about major compliance issues, noting, "MF Global failed in four separate instances to ensure that its risk management, supervision and compliance programs comported with its obligations to supervise diligently its business as a CFTC registrant." (CFTC, 2009). Repeated incidents of poor internal controls delayed the firm's acceptance as a primary dealer. According to data compiled by the National Futures Association, fines imposed by the CFTC and various exchanges made MF Global one of the highest fined firms among its peers (Beyers, 2011).

Taken together, these and related incidents indicate an environment with a weak culture of

compliance and risk management. A firm with better internal controls and governance could have avoided MF Global's fate and protected customer assets. Better management is a necessary element of proper risk control.

Liquidity Management

MF Global's losses and ultimate collapse resulted from leveraged bets. The firm borrowed to invest in European sovereign debt, financing its purchases through repo agreements. It reportedly used "repo-to-maturity" agreements through which MF Global was able to borrow funds, using the bonds as collateral, until the bonds would come due. Accounting rules permitted these repo transactions to be treated as sales, obscuring the firm's leverage, but ultimately leading to a revision of capital charges in the summer of 2011. In Congressional testimony, the first CRO said the firm engaged in window dressing—presenting the firm favorably in its public financial statements—by reducing leverage at reporting dates, and he noted that this became more difficult as the firm took on less liquid positions (Roseman, 2012b). As the market value of the bonds declined amid continuing concerns about deteriorating circumstances in Europe, the firm received margin calls it could not meet.

Different investors can reasonably have different views on whether to buy particular assets, in this case European bonds. But sound risk management requires anticipating the liquidity needed to sustain an investment strategy and avoiding excessive and opaque leverage. MF Global was ultimately undone by poor liquidity management of a concentrated bet on European sovereign debt.

Macroprudential Analysis: Not a Systemic Event

MF Global's customers have paid a high price for the firm's errors. Nevertheless, it is worth reflecting on why this failure of a major financial firm did not have the systemic repercussions associated with the failures of 2008.

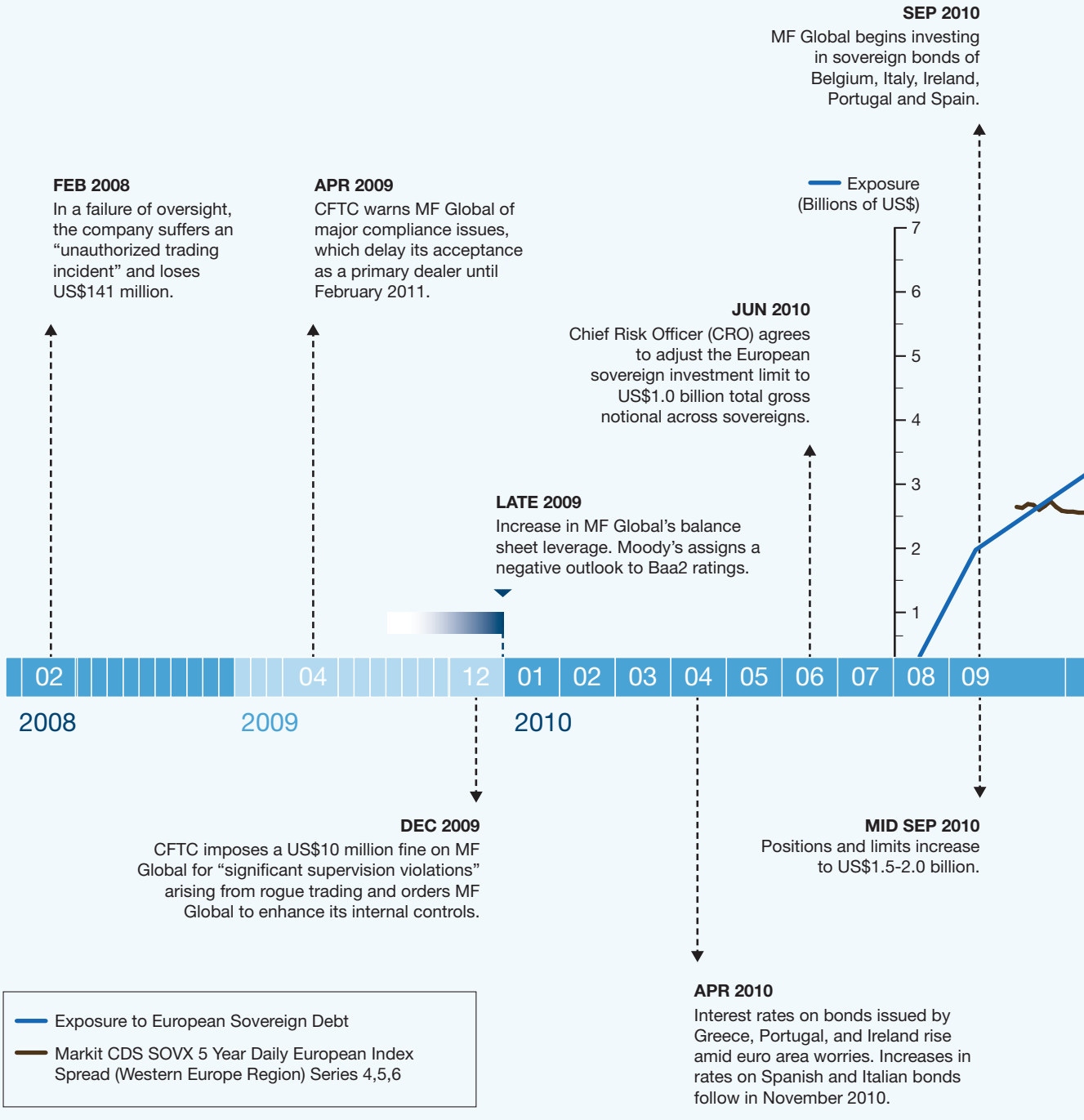
Size is undoubtedly an important factor—at $41 billion in assets, MF Global was roughly a tenth the size of Bear Stearns, which was in turn about two-thirds the size of Lehman Brothers. But concentration of risk is also significant. In 2007-2008, markets grew increasingly aware and concerned about the scope of transactions tied to real estate, particularly subprime lending, and no financial institution seemed safe.

Had many other dealers or hedge funds held large positions similar to MF Global's, the firm's collapse might have resulted in greater spillover effects. Indeed, Jefferies, a firm of roughly similar size and services, suffered a loss of market confidence and a 20 percent drop in its share price in intraday trading as investors feared—without justification, it turned out—that the firm might be engaging in similar activities. Such fears were contained as MF Global's leveraged exposure did not reflect the position of U.S. financial institutions generally.

This episode is an important reminder that greater transparency and effective counterparty risk management are essential principles to counter the threat of contagion and the risk that the consequences of a failure would ripple throughout the financial system. Better data management and data standards would support these principles.

BOX F. LESSONS FROM THE COLLAPSE OF MF GLOBAL CONTINUED

Chart F.1 The Lead-Up to the Collapse of MF Global



Source: Markit, Haver Analytics, Congressional Hearings, and news reports

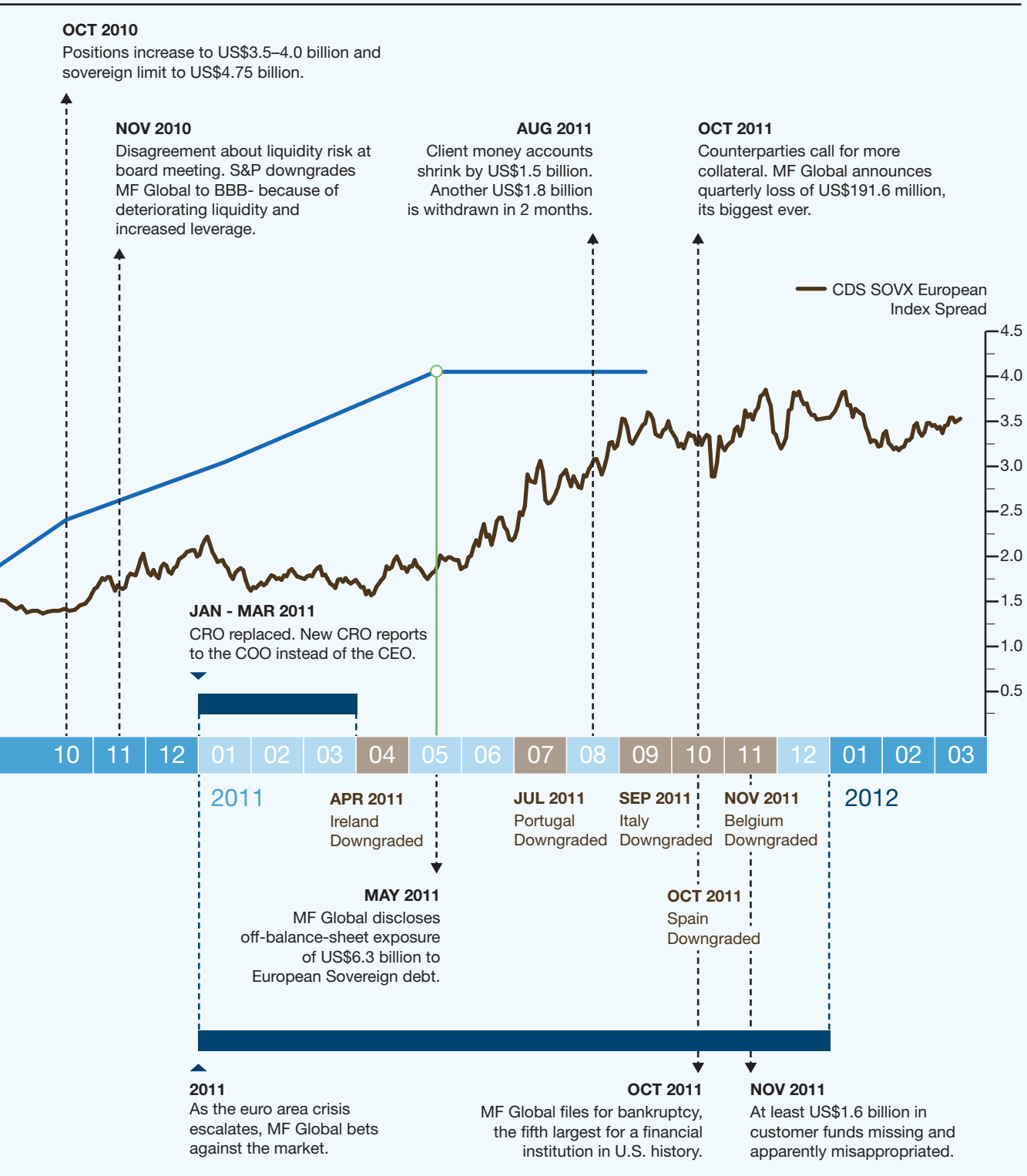

OCT 2010
Positions increase to US$3.5–4.0 billion and sovereign limit to US$4.75 billion.
NOV 2010
Disagreement about liquidity risk at board meeting. S&P downgrades MF Global to BBB- because of deteriorating liquidity and increased leverage.
AUG 2011
Client money accounts shrink by US$1.5 billion. Another US$1.8 billion is withdrawn in 2 months.
OCT 2011
Counterparties call for more collateral. MF Global announces quarterly loss of US$191.6 million, its biggest ever.
CDS SOVX European Index Spread
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
JAN - MAR 2011
CRO replaced. New CRO reports to the COO instead of the CEO.
10 11 12 01 02 03 04 05 06 07 08 09 10 11 12 01 02 03
2011
2012
APR 2011
Ireland Downgraded
JUL 2011
Portugal Downgraded
SEP 2011
Italy Downgraded
NOV 2011
Belgium Downgraded
MAY 2011
MF Global discloses off-balance-sheet exposure of US$6.3 billion to European Sovereign debt.
OCT 2011
Spain Downgraded
2011
As the euro area crisis escalates, MF Global bets against the market.
OCT 2011
MF Global files for bankruptcy, the fifth largest for a financial institution in U.S. history.
NOV 2011
At least US$1.6 billion in customer funds missing and apparently misappropriated.

Chart 3.3.4 Illustration of Payment Netting Between Parties A and B

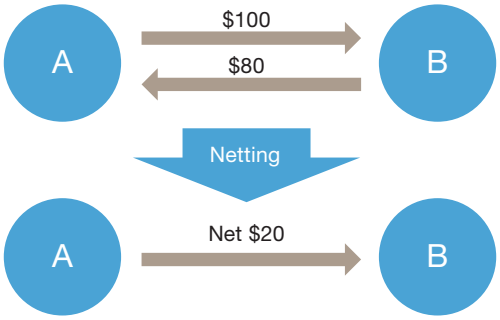
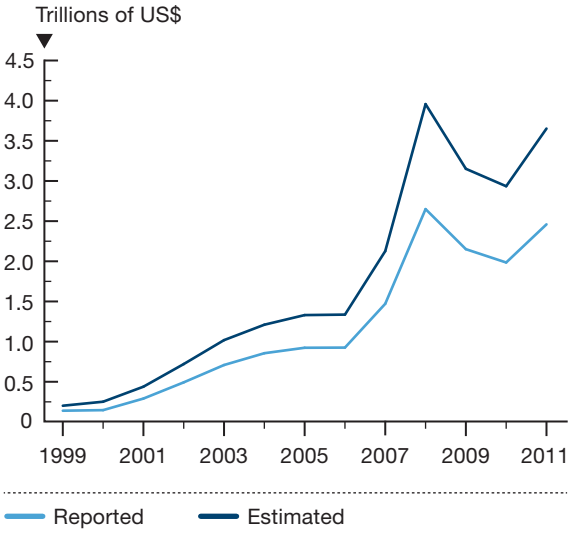


Chart 3.3.5 Total Collateral Outstanding in OTC Derivatives Markets



Source: ISDA

Chart 3.3.5 shows total collateral outstanding in OTC derivatives markets as reported to the International Swaps and Derivatives Association (ISDA) and as estimated by ISDA to correct for nonparticipation in the ISDA survey. The decline following 2008 is due to several factors: the shrinking of the market, counterparty consolidation, and greater use of central clearing. These trends generally enhance financial stability.

Properly managed collateral offers one of the most effective ways to mitigate counterparty risk. However, it also introduces greater liquidity needs for swap participants. The collapse of MF Global was due, at least in part, to the firm's failure to maintain a liquidity buffer to meet collateral needs, for which it allegedly raided customer accounts. The near-demise of AIG in 2008 was accelerated by a cycle of collateral calls by AIG's counterparties triggering rating downgrades, thereby prompting further collateral calls. Thus, collateral can convert counterparty risk to liquidity risk, and the market's evolution toward greater use of collateral must be accompanied by a corresponding focus on new liquidity needs and liquidity risk management. Demands for collateral are also potentially procyclical, reducing the availability of credit in times of elevated market stress.

Central Clearing

The vast OTC swap market is the aggregation of bilateral exposures that are largely opaque to outsiders. ***Charts 3.3.6*** and ***3.3.7*** show the evolution of the gross market value and notional amounts of OTC derivatives outstanding, respectively, as reported by the Bank for International Settlements. These exposures are opaque because participants do not know the counterparties their own counterparties are exposed to, or how those exposures are managed. Title VII of the Dodd-Frank Act requires that eligible swaps be cleared through central counterparties (CCPs), and the CFTC and SEC are formulating rules for swaps and security-based swaps (CFTC, 2011; SEC, 2010). Some customized or bespoke derivatives will continue to trade over-the-counter but these will be subject to higher capital requirements and margin requirements.

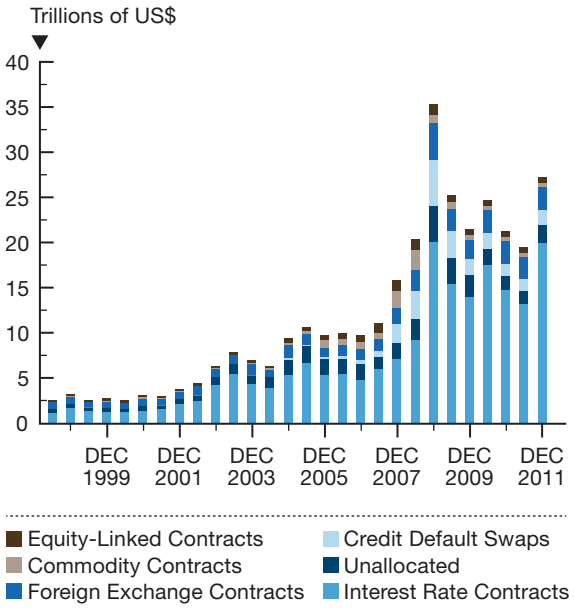
With central clearing, a single trade between two counterparties is replaced by a pair of trades through the CCP. The CCP's positions offset each other, and the two original counterparties face the CCP rather than each other ***(Chart 3.3.8)***. This mechanism is similar to the approach that futures and options exchanges have long taken to guarantee trades through margin requirements, default fund contributions from members, and their own capital. In combination with additional

reporting requirements to regulators and market participants, the move toward central clearing brings greater transparency to the derivatives market and reduces the direct exposures among the dealers that dominate the OTC market. Enhanced price transparency helps level the playing field for end users of derivatives and will enable the OFR to develop a more comprehensive map of potential risks in the financial system.

Central clearing reduces bilateral exposures and bilateral risk, but it also may concentrate risk in clearinghouses. The failure of a major clearinghouse—one to which large financial institutions have significant exposures—is potentially disruptive to the functioning of the financial system. To mitigate counterparty risk, a CCP must be well-capitalized and must have effective operations for pricing, margining, collateral management, and default management. The success of central clearing will depend, in part, on the right mix and distribution of CCPs. Economies of scale and expanded netting opportunities argue for fewer CCPs. On the other hand, a market structure based on a small number of CCPs would present questions about implicit guarantees or moral hazard and would limit the potential benefits to market participants of competition and diversification. Views differ on whether each CCP should specialize in a single product category, like credit default swaps, or provide clearing for a broad range of products (Duffie, 2012).

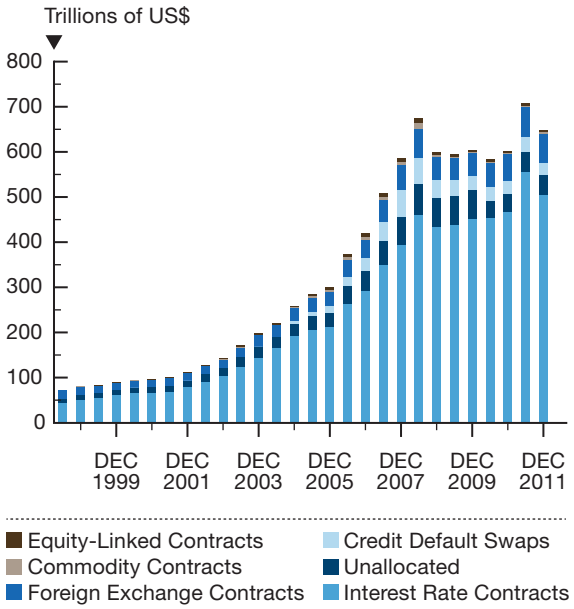
Jurisdictional concerns may trump economics and lead to a proliferation of central counterparties internationally; central banks may insist on oversight of derivatives denominated in their currencies for fear that they may be called upon to provide liquidity to a CCP. The move to central clearing will continue to require the focus of risk managers and regulators as these competing considerations are resolved. To give impetus to a global infrastructure for central clearing, the Financial Stability Board (FSB) has developed four safeguards that are necessary conditions to

Chart 3.3.6 Gross Market Value of OTC Derivatives Outstanding



Source: BIS

Chart 3.3.7 Notional Amounts of OTC Derivatives Outstanding



Source: BIS

Chart 3.3.8 Credit Default Swap OTC and Through a Central Counterparty

Figure 1: OTC Credit Default Swap Between Parties A and B

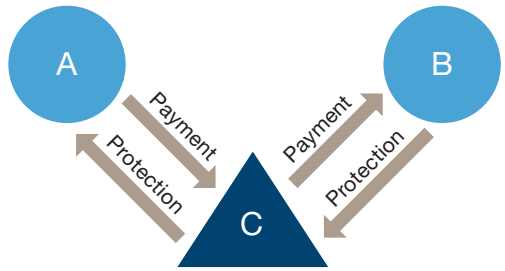
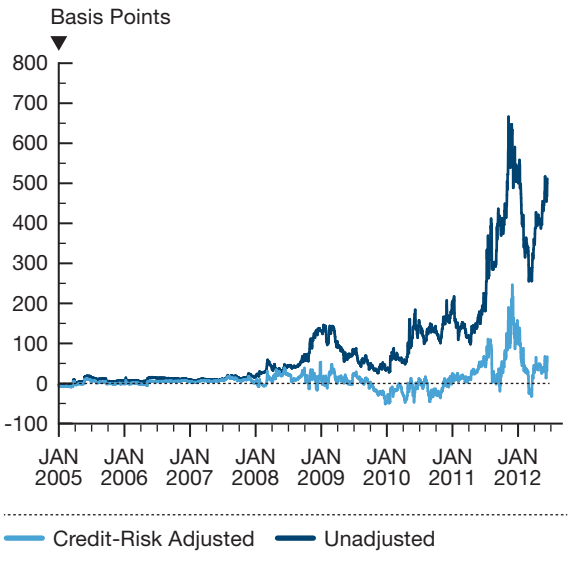


Figure 2: Credit Default Swap Through Central Counterparty C

Chart 3.3.9 Spread Between Italian and German Bond Yields



Source: Bloomberg, OFR calculations

strengthen global CCPs in the areas of access, oversight, resolution, and liquidity. The G20 Leaders endorsed the progress of the FSB at their summit in Los Cabos in June 2012.

Two closely related areas of focus for the OFR are the operation of the tri-party repo market, which is concentrated in two clearing banks, and the securities lending market, which relies on a relatively small number of lending agents. In both cases, the concentration of counterparty risk introduces vulnerabilities.

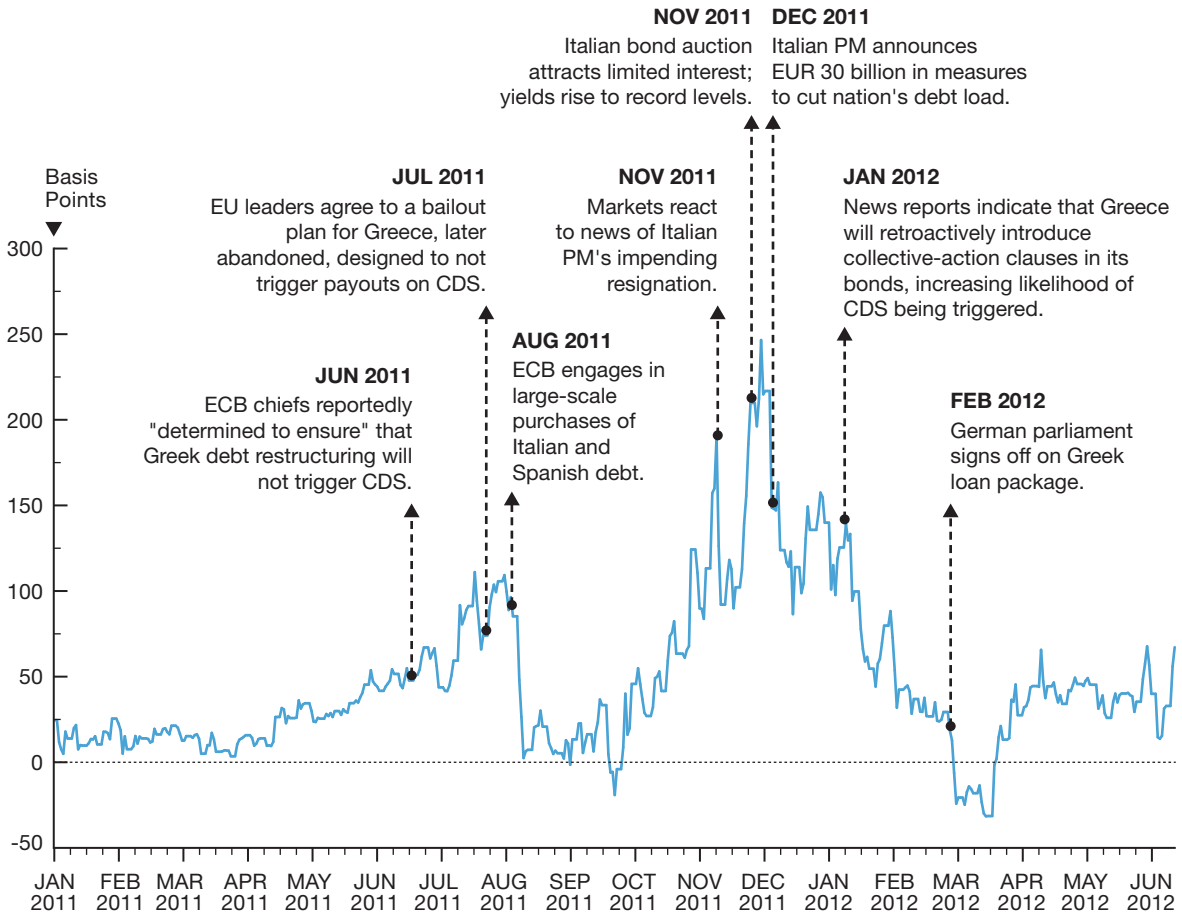
Hedging

Besides collateral requirements, the main tools for hedging counterparty risk, including issuer risk, are various types of third-party guarantees, including bond insurance, lines of credit, mortgage insurance, and credit default swaps. Each of these mechanisms provides a creditor with protection against the default of an obligor; however, each also introduces new counterparty risk through exposure to the guarantor.

Some have argued that sovereign CDS have lost their hedging effectiveness due to political pressures to restructure debt without triggering CDS payouts. Such pressures were alleged in the course of negotiations about Greek debt in 2011 and early 2012, although an ISDA determinations committee ultimately declared an event of default in that case. Uncertainty about the conditions that will trigger a payout reduces the hedging effectiveness of CDS and is likely to result in higher interest costs for the affected sovereigns. ***Charts 3.3.9*** and ***3.3.10*** show the credit-risk-adjusted spread, a measure of the market's view of CDS effectiveness. If market participants expect that CDS on Italy are likely to pay out in an event of default, for example, the credit-risk-adjusted spread between Italian and German bonds should be close to zero. The movement in the spread in recent years reflects market concern that a future Italian default could be structured to avoid triggering CDS.[15]

A simple CDS contract has limited value in hedging the counterparty risk in a swap portfolio because the exposure in the portfolio changes with market rates whereas the payout of the CDS contract in the event of default remains fixed. This issue is addressed by a contingent CDS contract, in which the payout varies with the exposure being hedged. Financial Accounting Standard FAS 157 requires this type of alignment for hedge accounting, and ISDA issued new documentation and procedures for

Chart 3.3.10 Spread Between Credit-Risk-Adjusted Italian and German Bond Yields



Source: Bloomberg, OFR calculations

contingent CDS transactions in February 2012, so this is a market that may have the potential to grow. Like many financial innovations, it carries both potential benefits and risks. The valuation of contingent CDS relies on the joint modeling of credit risk and market risk.

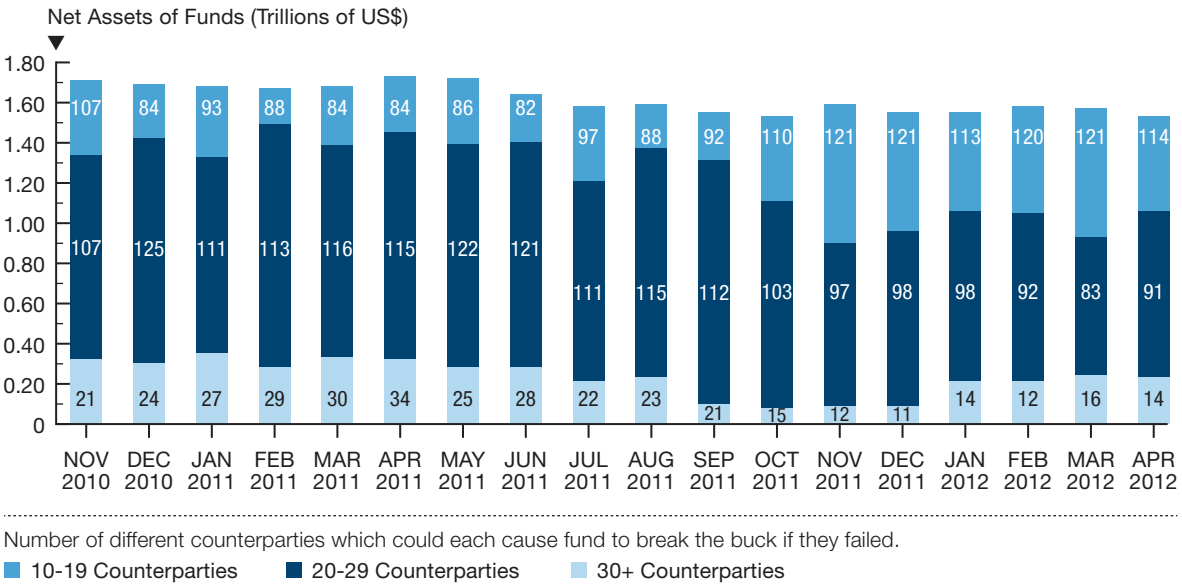
Counterparty Diversification

A simple but important tool in managing counterparty risk is spreading transactions across counterparties. The prudent number of counterparties is heavily dependent on context. As noted in Section 3.3.1, hedge funds traditionally relied on a single prime broker, but since the failures of Bear Stearns and Lehman Brothers, they have increasingly spread their business. In OTC derivatives markets, a handful of major dealers are dominant, making counterparty diversification difficult and creating a greater role for central clearing.

Chart 3.3.11 illustrates counterparty concentration among money market funds. The chart shows the vulnerability of funds to a default of their counterparties. The most vulnerable funds would break the buck—fall below the $1 net asset value by more than half a cent—if any one of 30 or more counterparties defaulted; the less vulnerable funds would break the buck if any one of 10 to 19 counterparties defaulted. The analysis assumes 40 percent recovery on all unsecured lending by the funds and full recovery on all repo transactions. ***Chart 3.3.12*** shows the total exposures of U.S. money market funds to different regions.

These two charts highlight the importance of understanding relationships and affiliations. Even a fully diversified portfolio could present counterparty risks that are not apparent on the surface, if it leads back through a web of

Chart 3.3.11 Prime MMFs' Vulnerability to Counterparty Failure



Note: The height of each bar represents net assets; the number in each bar represents the number of funds in each category.
Note: Excludes exposure through repurchase agreements, ABCP, and VRDN guarantees. Prime funds only, assuming a 40 percent recovery rate, based on the actual net asset value of each fund's stated portfolio.

Source: SEC Form N-MFP, OFR calculations

counterparties to a concentrated set of guarantors.

Intangibles: Confidence and Implicit Guarantees

The most important element of counterparty risk may be the most difficult to quantify—market confidence, which can vanish abruptly and trigger failure. A loss of confidence may be a rational response to new information, and yet it can reach a tipping point unpredictably, leading to a cascade of adverse consequences. A loss of confidence played a role in the failures of Bear Stearns, Lehman Brothers, and MF Global, as it did historically in bank runs. Advancing best practices in risk management and monitoring threats to financial stability require developing a greater understanding of the dynamics of confidence and how greater visibility on capital, liquidity, leverage, and interconnections can promote confidence and stability. These important elements of market psychology fall outside of traditional economic modeling.

Perceived implicit guarantees are, by definition, intangible, and they are potentially destabilizing because they are unfunded and unpredictable in times of stress. The fixed share price offered by money market funds has drawn scrutiny as a perceived guarantee. Mass redemptions by money market fund investors in September 2008, after the Reserve Fund was unable to maintain a fixed share price, prompted the creation of the Treasury's Temporary Money Market Fund Guarantee Program, turning an implicit guarantee into a government guarantee.

Chart 3.3.13 compares asset levels for money market funds that are sponsored by banks and funds that are not. The chart begins at the end of the Treasury's program and distinguishes share classes with minimum investments of at least $100,000 from those with smaller minimum investments, which is a rough measure of the difference between institutional and retail accounts. Among share classes with the smaller minimum investment, the outflow from non-bank-sponsored funds is much larger than from bank-sponsored funds. In contrast, the share classes with a larger minimum investment show a large inflow to non-bank-sponsored funds between June 2010 and May 2011. Many factors influence these flows, including interest rates and the performance of other asset classes, but

the figure suggests the possibility of a perceived guarantee at bank-sponsored funds among smaller investors. The institutional flows are much more volatile and suggest that large investors may be more willing to move between types of funds as yields and perceived risks vary.

3.3.3 Credit Value Adjustment

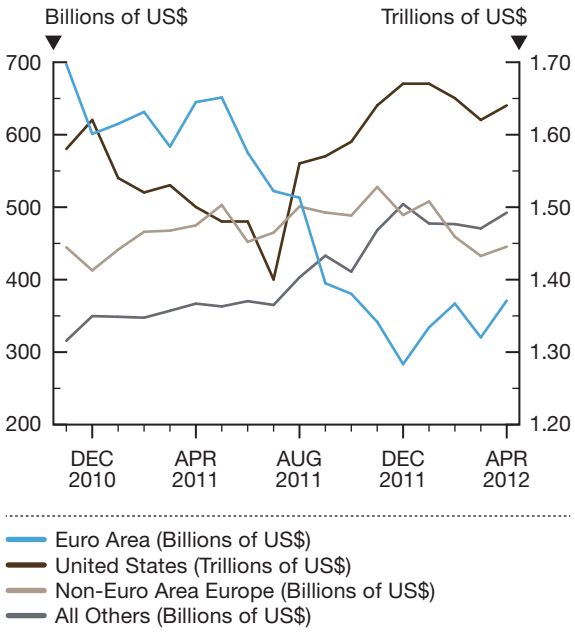
Industry practice and regulatory proposals have adopted credit value adjustment as a key measure of counterparty risk (BCBS, 2011; Cesari and others, 2010). CVA seeks to price the counterparty credit risk incurred by banks and broker-dealers through derivatives portfolios. Strong counterparty risk management is essential to financial stability, and CVA is an important barometer of the level of counterparty risk between pairs of market participants as viewed by the participants themselves. However, the evaluation of CVA presents both practical and conceptual challenges, and the increasing reliance on CVA requires continuing focus on fine-tuning the underlying principles and improving data management and standards.

The CVA Concept

CVA adjusts the market value of a swap or portfolio of swaps to reflect a counterparty's default risk. To illustrate this idea, suppose Party A has entered into an interest rate swap with Party B. In the absence of any default risk, Party A could value the swap off a risk-free yield curve. However, the possibility that Party B may default at some future date lowers the value of the swap to Party A. CVA seeks to quantify this effect.

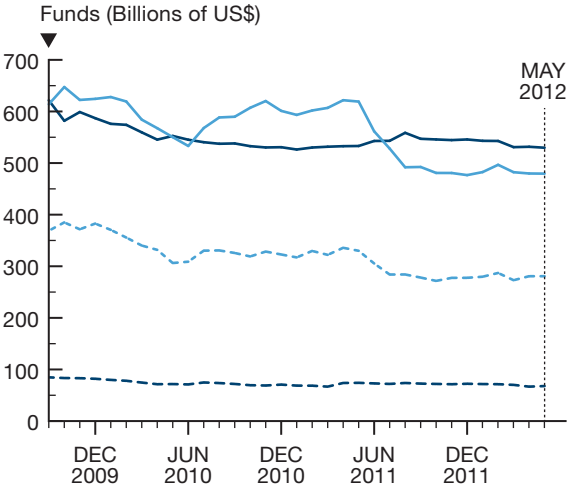
At inception, an interest rate swap is ordinarily designed to have zero net value to both parties. As interest rates vary over time, the swap could take on a positive value for either party. For example, if A is paying a fixed rate and receiving a floating rate from B, then an increase in the floating rate increases the value of the swap to A. The counterparty risk that A faces thus results from the combination of two factors: the possibility that interest rate moves increase the value of the swap to Party A and that Party B defaults. If the same interest rate movements

Chart 3.3.12 Total MMF Exposures by Region



Source: SEC Form N-MFP, OFR calculations

Chart 3.3.13 Money Market Fund Net Assets by Share Class Category and Sponsor Type



Note: Depiction of data starts at September 2009 to coincide with the expiration of the U.S. Money Market Mutual Fund Guarantee Program (September 18, 2009) and the Federal Reserve Money Market Investor Funding Facility (October 30, 2009).

Source: Morningstar, OFR calculations

that increase the swap value to Party A also make it more likely that Party B will fail (perhaps because B has a lot of floating-rate debt), then the combination produces "wrong-way risk" for A. If interest rates moved in the opposite direction, turning the swap into a liability for A rather than an asset, then A would not face any risk from a default by B.

As this example illustrates, a CVA calculation to price counterparty risk requires the integration of the following elements:

- a model of market risk factors (interest rates in the example above);
- a model of default risk (the risk that B will default); and,
- a model of the co-movement of market risk and credit risk factors (because B's default results in a loss to A only if interest rates increase).

The integration of market risk and credit risk—the last of these three elements—is the greatest modeling challenge to effective CVA calculation. The scale of the problem for large financial institutions with thousands of positions also poses a significant computational challenge, with CVA calculations often running overnight.

The foregoing discussion has taken the perspective of firm A; this is a unilateral CVA calculation. If A and B were both dealers, then B would have a mirror image perspective on the swap. The firms would have to use *bilateral* CVA calculations—incorporating the default risk of both parties—in agreeing on a price. This would add a fourth element to the CVA modeling challenge because of the reliance on the co-movement of A's default risk with B's default risk, as well as with market risk factors.

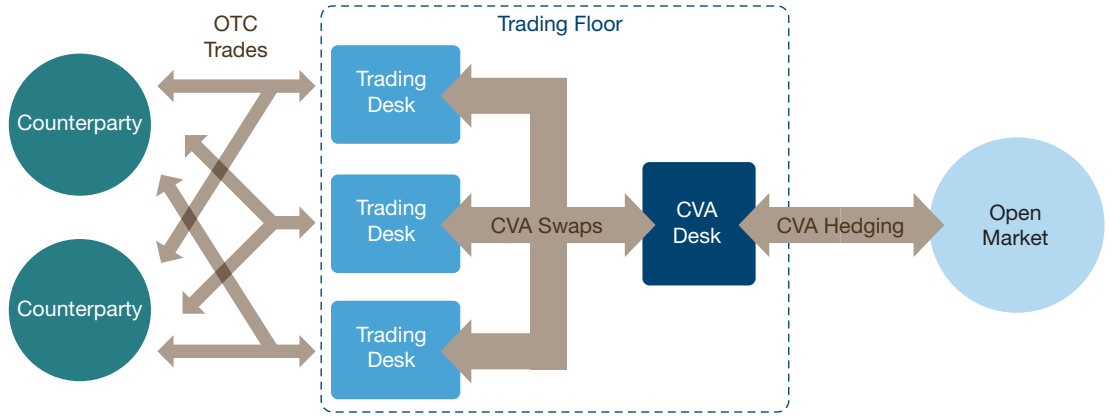
Centralized Counterparty Risk Management and Oversight

An effective CVA calculation aggregates all transactions a firm has with a counterparty, taking into account netting agreements, enforceability of these agreements, and collateral requirements to evaluate the path of future potential exposures. This leads to a single number quantifying the total counterparty risk a firm faces with each of its counterparties.

Financial firms with diverse trading activities are increasingly using this concept to centralize counterparty risk management. Individual trading units transacting with multiple counterparties "swap" their counterparty risk to a central CVA desk, which effectively charges them a fee for off-loading their counterparty risk. This internalizes the cost of counterparty risk at the level of the trading desk and allows the CVA desk to manage firmwide counterparty risk. The CVA desk may, for example, buy CDS protection on counterparties to hedge the firmwide CVA for that counterparty ***(Chart 3.3.14)***. This process allows for comprehensive firm-level counterparty risk management, but it also raises the stakes for the reliability of CVA modeling by pinning the pricing and hedging of counterparty risk on this number. Overreliance on this type of modeling, especially if it contains material flaws, could create a false sense of comfort, leading to greater risk-taking.

Because CVA aggregates and centralizes counterparty risk, it represents a potentially valuable tool for monitoring threats to financial stability arising through inter-firm exposures. From a systemwide perspective, counterparty risk is a network phenomenon—firms are nodes, and nodes are connected when they trade with each other. CVA measures the exposure on each edge of the network as quantified by the firms themselves for their internal risk management. CVA values could be viewed together with gross and net notional exposures to give a more nuanced perspective on potential buildups of counterparty risk. Gross and net exposures measure the sizes of potential losses, but CVA seeks to measure the market price for offloading exposure. As such, it is more sensitive to changes in market conditions as a gauge of financial stability.

Chart 3.3.14 CVA Hedging



Potential Pitfalls

Model Risk. The main obstacle to accurate CVA calculation lies in capturing co-movements between market risk and credit risk. The challenge is magnified by the need to address swap portfolios exposed to multiple sources of market risk with transactions that may extend 5 to 30 years. Little information is available to quantify the correlation between interest rates, exchange rates, and other market factors on one hand and the creditworthiness of a counterparty on the other hand. Moreover, correlation is a limited measure that cannot account for the full complexity of dependence between market risk factors and credit risk factors.

A weakness in integrating market risk and credit risk is that it leaves a firm exposed to "wrong-way risk," the possibility that a counterparty's credit declines just as the exposure to that counterparty increases. This scenario can occur, for example, when a dealer enters into an energy swap with an energy company and the dealer's side of the transaction increases as energy prices fall.

These considerations leave CVA exposed to a high degree of model risk, that is, vulnerability to errors that result from poor modeling assumptions. The OFR is developing methods for incorporating robustness to model uncertainty in risk calculations. These techniques identify model elements that contribute most to model risk and quantify their impact on risk measurement. In the case of CVA, a particular vulnerability lies in the dependence between a counterparty's CDS spread—a measure of its credit risk—and the value of a swap portfolio.

Data Management. Calculating a single CVA number for a counterparty requires aggregating all the ways a firm is exposed to that entity, incorporating all relevant netting agreements, and capturing terms and conditions of all transactions with the counterparty. This presents an enormous data management challenge and requires firms to continue to invest in technology. An LEI standard and the development of instrument identifiers will help simplify the CVA process and, more importantly, enhance its reliability.

Ambiguities. Although conceptually simple as a measure of counterparty risk, CVA poses some subtleties in its implementation and interpretation. For example, default risk in CVA is typically measured through CDS spreads but sometimes through internal credit ratings, particularly when no liquid CDS spreads or bond yields are available for a counterparty. CDS spreads reflect a market price for default risk whereas ratings ordinarily try to capture empirical default frequencies and recovery rates. Market risk measures, such as value at risk, are ordinarily based on empirical observations. Ambiguities also arise in measuring exposure at default. The exposure

is understood to be the replacement value of a derivative, but there is no consensus on exactly what this means and whether, for example, this replacement value should itself reflect default risk in the replacement counterparty. The handling of alternative events that may terminate a swap without a default raises the prospect of further discrepancies. It is in the financial industry's interest to resolve these ambiguities, and the OFR can help promote best practices on these issues.

Incentives. Many media accounts have noted instances of banks reporting mark-to-market profits as a result of a *decline* in their credit quality through a debt value adjustment (DVA). DVA is similar to CVA, but it applies to the price of a firm's own debt. A mark-to-market gain from deteriorating credit quality is an inevitable consequence of CVA and DVA pricing and fair value accounting; it is the mirror image of the loss a bank takes when the credit quality of its counterparties declines. In October 2011, Goldman Sachs reported it was hedging the impact of these fluctuations in its own credit spreads by selling CDS protection on other, presumably correlated financial institutions (Moyer and Burne, 2011). The net effect of such transactions is to increase overall counterparty risk in the financial system solely to modulate fluctuations in accounting figures.

Performance in Extremes. Market risk capital under Basel III includes a charge for counterparty risk tied to a CVA value at risk calculated at 99 percent confidence over a one-year horizon. Indeed, the European Banking Authority found the CVA charge to be one of the main drivers of increased capital needs anticipated for large European banks under Basel III (EBA, 2012). In principle, measuring the CVA value at risk requires recalculating CVA for multiple dates within the one-year horizon across a wide range of potential market scenarios—wide enough to reliably capture the worst 1 percent of potential outcomes. The challenges in calculating CVA at a single point in time, capturing the risk in a potentially large and long-dated portfolio of swaps, are thus greatly magnified when the procedure is extended to map the potential evolution of CVA over a one-year horizon and stressed to the worst 1 percent of market and credit scenarios.

Potential Spirals. CDS spreads are used to calculate CVA and CDS contracts are used to hedge CVA. In the absence of sufficient CDS liquidity, this sets up a potential downward spiral, with widening CDS spreads (for a sovereign, say) increasing the hedging demand, and hedging demand widening the spread.

Myopia. Even if calculated accurately, CVA captures, at best, the immediate cost of a counterparty's default. This is a myopic view in the sense that it does not capture the potential follow-on effects of such a default. One default can trigger financial distress at other firms and elevate counterparty risk across the financial system. A comprehensive macroprudential view of counterparty credit risk must incorporate these rippling, network effects, as well as the direct impact of a default.

3.3.4 Conclusion

The OFR has a mandate to promote best practices in risk management. Under the broad category of risk management, counterparty risk management is of special importance in ensuring the resilience of the financial system because it addresses the linkages of the financial system. Failures of counterparty risk management allow losses at one institution to propagate to others through the interconnections among financial intermediaries; strong counterparty risk management provides a buffer against threats to financial stability.

This chapter has taken a broad view of counterparty risk to include not just risks in over-the-counter derivatives markets but also issuer risk, exposures through third-party guarantees, repurchase agreements, and relationships between prime brokers and hedge funds. These linkages and transactions arise to meet the needs of the financial system and to enable the financial system to provide

services to the broader economy. These same linkages create potential vulnerabilities if not properly managed. The elements of effective counterparty risk management include strong internal controls and governance, netting agreements, collateral, hedging, and central clearing. As the challenges and tools of counterparty risk management continue to evolve, market participants can benefit from a coordinated effort to address some of the challenges highlighted in this section. The OFR's current work in helping establish a global LEI is also an important step in strengthening counterparty risk management by standardizing the identification of counterparties.

This chapter has highlighted an evolving focus on CVA as a key measure of counterparty risk in both market practice and financial regulation. If evaluated correctly, CVA provides a valuable barometer of vulnerabilities in the financial system. But important questions remain around the principles and practice of CVA calculation. Improvements in this area can benefit all market participants and enhance supervision. The OFR, working with other FSOC members and the financial services industry, can help advance these efforts.

Endnotes

1. CGFS (2011) examines the macroprudential issues surrounding liquidity crises and liquidity management. Tirole (2011) surveys the underlying economics.

2. Eisenberg and Noe (2001), Billio and others (2010), and Gai, Haldane, and Kapadia (2011) seek to understand contagion effects caused by financial firms' contractual relationships, such as counterparty credit risk exposures or liquidity guarantees. Cont, Moussa, and Santos (2010) and Haldane (2009) also consider the ramifications of network complexity as a factor in systemic fragility.

3. The historical approach has also been adopted recently by others, including Kyle and Obizhaeva (2012), Brave and Butters (2012), and Lo and Zhou (2012). CoVaR and systemic expected shortfall cannot be applied to the 1929 event, because investment banks from the period did not trade publicly, while commercial bank stock prices are not readily available in digital form.

4. For example, Duffie (2011) proposes asking 10 large financial institutions to report their 10 largest net bilateral exposures and to stress them under 10 scenarios. Brunnermeier, Gorton, and Krishnamurthy (2011) propose a two-step "risk topography" analysis. First, regulators would accumulate a panel of participants' individual risk exposures (changes in firm value) as well as liquidity sensitivities (changes in "effective cash") to various shock scenarios defined on a space of external factors. The second step would aggregate firms' individual valuation and liquidity responses into a systemwide picture of risks, where those exposures diversified in the cross-section of firms should be of less concern than systemically concentrated exposures. Both proposals combine forward-looking risk analytics and network effects and neither can be implemented with the data available today.

5. This also means that from a macroprudential standpoint, "even solvent banks may be required to refrain from depleting capital if the system as a whole does not meet the higher macroprudential criteria. For shareholders, one dollar inside the bank should be worth more than one dollar in dividends. But, in any case, supervisors should consider more than just private benefits and costs. Had U.S. supervisors suspended dividends in the summer of 2007, $80 billion of capital could have been retained in the 19 banks that were subject to the 2009 Supervisory Capital Assessment Program. That sum is roughly half of the public recapitalization funds that these banks received." (Greenlaw and others, 2012).

6. In the CCAR, large BHCs must perform four stress tests to provide an indication of the effect of the stresses on revenues, losses, reserves, and pro forma capital levels: a BHC-defined baseline scenario, a supervisory baseline scenario specified by the Federal Reserve, a BHC-defined adverse scenario, and a supervisory adverse stress scenario specified by the Federal Reserve. The Federal Reserve scenarios are defined over 25 variables, including measures of economic activity and prices (gross domestic product, unemployment, disposable income, and inflation), financial factors (two house price indexes, an equity index, and a market volatility index); interest rates (three-month Treasury bills, 10-year Treasury notes, 10-year BBB corporate bonds, and fixed-rate 30-year mortgages); and international measures, each provided for four country blocks (change in real GDP, change in inflation, and exchange rates) (Board of Governors, 2012).

7. The IMF's stability assessment for Iceland had stated prior to the crisis in that country: "The banking system's reported financial indicators are above minimum regulatory requirements and stress tests suggest that the system is resilient" (IMF, 2008). For evaluations of stress test practices, see Borio, Drehmann, and Tsatsaronis (2012) and Alfaro and Drehmann (2009).

8. Specifically, the Basel II document states that banks should perform "rigorous, forward-looking stress testing that identifies possible events or changes in market conditions that could adversely impact the bank" (BCBS, 2004).

9. The new disclosure regime based on Section 165(i) of Dodd-Frank began with CCAR 2012; the first CCAR exercise, in 2011, displayed a lower level of disclosure than the SCAP, with no bank level results

being published. The stress scenario disclosure for CCAR 2012 included results based on the projections made by the Federal Reserve of each bank holding company's losses, revenues, expenses, and capital ratios over the planning horizon.

10. See EBA (2011). In addition to the results of the stress test under the baseline and adverse scenarios, institution-specific disclosures contain information on credit exposures and exposure to sovereigns.

11. Recent research on liquidity risk includes papers published by the Bank of England (Aikman and others, 2009), the Hong Kong Monetary Authority (Wong and Hui, 2009), the Dutch National Bank (Van den End and Tabbae, 2009), and the IMF (Schmieder, Puhr, and Hasan, 2011). Systemic episodes emerging from credit risk and funding risk are provided in Gorton and Metrick (2009) and Afonso, Kovner, and Schoar (2011). Barnhill and Schumacher (2011) observe that a systemwide liquidity shock is more likely to happen in the presence of a shock to fundamentals that depresses asset values and makes the market reluctant to fund these assets and the institutions holding them.

12. Afonso, Kovner, and Schoar (2011) examine the connections between solvency and liquidity during the crisis and conclude that counterparty risk played a larger role than liquidity hoarding.

13. Brunnermeier and Pedersen (2009) and Diamond and Dybvig (1983), respectively, provide models of liquidity shocks and funding shocks.

14. "The stress scenario projections do not make explicit behavioral assumptions about the possible actions of a bank holding company's creditors and counterparties in the scenario, except through the Supervisory Stress Scenario's characterizations of financial asset prices and economic activity" (Board of Governors, 2012).

15. The credit-risk-adjusted German or Italian bond yield is defined as the yield offered to an investor purchasing a five-year German or Italian bond and five-year CDS protection on that bond. The credit-risk-adjusted spread is the spread between the credit-risk-adjusted Italian and German bond yields.

References for Chapter 3

Acharya, Viral V., Lasse Heje Pedersen, Thomas Philippon, and Matthew P. Richardson. "Measuring Systemic Risk." American Finance Association 2011 Denver Meetings Paper, May 2010.

Adrian, Tobias, and Markus K. Brunnermeier. "CoVaR." NBER Working Paper no. 17454, Cambridge, MA: National Bureau of Economic Research, October 2011.

Afonso, Gara, Anna Kovner, and Antoinette Schoar. "Stressed, Not Frozen: The Federal Funds Market in the Financial Crisis." Staff Report no. 437, New York, NY: Federal Reserve Bank of New York, March 2010, Revised May 2011.

Aikman, David, Piergiorgio Alessandri, Bruno Eklund, Prasanna Gai, Sujit Kapadia, Elizabeth Martin, Nada Mora, Gabriel Sterne, and Matthew Willison. "Funding Liquidity Risk in a Quantitative Model of Systemic Stability." Working Paper no. 372, London: Bank of England, June 2009.

Alessi, Lucia, and Carsten Detken. "Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity." *European Journal of Political Economy* 27, no. 3 (2011): 520-533.

Alfaro, Rodrigo, and Mathias Drehmann. "Macro Stress Tests and Crises: What Can We Learn?" *BIS Quarterly Review* (December 2009): 29–41.

Arciero, Luca, Claudia Biancotti, Leandro D'Aurizio, and Claudio Impenna. "Exploring Agent-Based Methods for the Analysis of Payment Systems: A Crisis Model for StarLogo TNG." *Journal of Artificial Societies and Social Simulation* 12, no. 1 (2009).

Axelrod, Robert. "Agent-based Modeling As a Bridge Between Disciplines." In *Handbook of Computational Economics, Vol. 2: Agent-Based Computational Economics*, edited by Kenneth L. Judd and Leigh Tesfatsion. North Holland, 2006: 1565–584.

Barnhill Jr., Theodore, and Liliana Schumacher. "Modeling Correlated Systemic Liquidity and Solvency Risk in a Financial Environment with Incomplete Information." Working Paper WP/11/263, Washington, DC: International Monetary Fund, November 2011.

Basel Committee on Banking Supervision. *International Convergence of Capital Measurement and Capital Standards: A Revised Framework*. Bank for International Settlements. Basel: BCBS, June 2004.

Basel Committee on Banking Supervision. *Guidance for National Authorities Operating the Countercyclical Capital Buffer*. Bank for International Settlements. Basel: BCBS, December 2010.

Basel Committee on Banking Supervision. *Basel III Counterparty Credit Risk—Frequently Asked Questions*. Bank for International Settlements. Basel: BCBS, November 2011.

Beyers, Tim. "The MF Global You Don't Know but Probably Should." The Motley Fool, November 15, 2011. http://www.fool.com/investing/general/2011/11/15/the-mf-global-you-dont-know-but-probably-should.aspx (accessed July 3, 2012).

Bianco, Timothy, Mikhail V. Oet, and Stephen J. Ong. *The Cleveland Financial Stress Index: A Tool for Monitoring Financial Stability*. Report, March 21, 2012. Federal Reserve Bank of Cleveland, 2012. http://www.clevelandfed.org/research/data/commentary/2012/2012-04cfm (accessed July 3, 2012).

Billio, Monica, Mila Getmansky, Andrew W. Lo, and Loriana Pelizzon. "Econometric Measures of Systemic Risk in the Finance and Insurance Sectors." NBER Working Paper no. 16223, Cambridge, MA: National Bureau of Economic Research, July 2010.

Bisias, Dimitrios, Mark Flood, Andrew W. Lo, and Stavros Valavanis. “A Survey of Systemic Risk Analytics.” Working Paper #0001, Washington, DC: Office of Financial Research, January 15, 2012.

Board of Governors of the Federal Reserve System. *The Supervisory Capital Assessment Program: Overview of Results*. Washington, DC: Board of Governors, May 7, 2009.

Board of Governors of the Federal Reserve System. *Comprehensive Capital Analysis and Review 2012: Methodology and Results for Stress Scenario Projections*. Washington, DC: Board of Governors, March 13, 2012.

Bookstaber, Richard. “Using Agent-Based Models for Analyzing Threats to Financial Stability.” Working Paper. Forthcoming.

Borio, Claudio. “Implementing a Macroprudential Framework: Blending Boldness and Realism.” Working Paper, Basel: Bank for International Settlements, July 22, 2010.

Borio, Claudio, Mathias Drehmann, and Kostas Tsatsaronis. “Stress Testing Macro Stress Testing: Does It Live up to Expectations?” BIS Working Papers no. 369, Basel: Bank for International Settlements, January 2012.

Brave, Scott, and R. Andrew Butters. “Diagnosing the Financial System: Financial Conditions and Financial Stress.” *International Journal of Central Banking* 8, no. 2 (2012): 191-239.

Brunnermeier, Markus K. “Deciphering the Liquidity and Credit Crunch 2007–2008.” *Journal of Economic Perspectives* 23, no. 1 (2009): 77–100.

Brunnermeier, Markus K., Gary Gorton, and Arvind Krishnamurthy. “Risk Topography.” Working Paper, Princeton, NJ: Princeton University, March 30, 2011.

Brunnermeier, Markus K. and Lasse Heje Pedersen. “Market Liquidity and Funding Liquidity.” *Review of Financial Studies* 22, no. 6 (2009): 2201–2238.

Bureau of Economic Analysis. “National Income and Product Accounts Table: Table 1.1.1. Percent Change From Preceding Period in Real Gross Domestic Product.” BEA, 2012. http://www.bea.gov/national/index.htm#gdp (accessed May 28, 2012).

Caruana, Jaime. “Macroprudential Policy: Could It Have Been Different This Time?” Speech at the People’s Bank of China Seminar on Macroprudential Policy, in Cooperation with the International Monetary Fund, Shanghai, October 18, 2010.

Cesari, Giovanni, John Aquilina, Niels Charpillon, Zlatko Filipovic, Gordon Lee, and Ion Manda. *Modelling, Pricing, and Hedging Counterparty Credit Exposure: A Technical Guide*. Heidelberg: Springer, 2010.

Committee on the Global Financial System. “Global Liquidity – Concept, Measurement and Policy Implications.” CGFS Papers no. 45, Bank for International Settlements. Basel: CGFS, 2011.

Commodity Futures Trading Commission. *Process for Review of Swaps for Mandatory Clearing*. Final Rule, Federal Register 76, no. 143, July 26, 2011. Washington, DC: CFTC, 2010, 44464-75.

Commodity Futures Trading Commission. “CFTC Sanctions MF Global Inc. $10 Million for Significant Supervision Violations between 2003 and 2008.” Press release, December 17, 2009. CFTC, 2009. http://www.cftc.gov/PressRoom/PressReleases/pr5763-09 (accessed July 3, 2012).

Cont, Rama, Amal Moussa, and Edson Bastos e Santos. “Network Structure and Systemic Risk in Banking Systems.” Working Paper, New York, NY: Columbia University, December 1, 2010.

Diamond, Douglas W., and Philip H. Dybvig. “Bank Runs, Deposit Insurance, and Liquidity.” *Journal of Political Economy* 91, no. 3 (1983): 401–19.

Duffie, Darrell. “Replumbing Our Financial System: Uneven Progress.” Working Paper, Stanford, CA: Stanford University, March 17, 2012.

Duffie, Darrell. “Systemic Risk Exposures: A 10-by-10-by-10 Approach.” NBER Working Paper no. 17281, Cambridge, MA: National Bureau of Economic Research, August 2011.

Eisenberg, Larry, and Thomas H. Noe. “Systemic Risk in Financial Systems.” *Management Science* 47, no. 2 (2001): 236–49.

European Banking Authority. *2011 EU-wide Stress Test: Technical Background Explanatory Note to the EBA Common Disclosure Templates*. London: EBA, July 15, 2011.

European Banking Authority. *Results of the Basel III Monitoring Exercise as of 30 June 2011*. London: EBA, April 4, 2012.

Evanoff, Douglas D., George G. Kaufman, and A. G. Malliaris, ed. *New Perspectives on Asset Price Bubbles: Theory, Evidence and Policy*. New York: Oxford University Press, 2012.

Federal Open Market Committee. *Minutes of the Federal Open Market Committee, June 24-25, 2008*. Board of Governors of the Federal Reserve System. Washington, DC: FOMC, 2008.

Federal Reserve Bank of Chicago. *Financial Indicators in the NFCI*. Table. 2012. http://www.chicagofed.org/digital_assets/others/research/data/nfci/nfci_indicators_list.pdf (accessed July 3, 2012).

Federal Reserve Bank of St. Louis. *National Economic Trends: Appendix*. January 2010. http://research.stlouisfed.org/publications/net/NETJan2010Appendix.pdf (accessed July 3, 2012).

Fender, Ingo, and Patrick McGuire. "Bank Structure, Funding Risk and the Transmission of Shocks across Countries: Concepts and Measurement." *BIS Quarterly Review* (September 2010): 63–79.

Flannery, Mark J., Paul Glasserman, David K.A. Mordecai, and Cliff Rossi. "Forging Best Practices in Risk Management." Working Paper #0002, Washington, DC: Office of Financial Research, March 26, 2012.

Flood, Mark, and George Korenko. "Systematic Scenario Selection." Working Paper. Forthcoming.

Gai, Prasanna, Andrew Haldane, and Sujit Kapadia. "Complexity, Concentration and Contagion." *Journal of Monetary Economics* 58, no. 5 (2011): 453–70.

Galbiati, Marco, and Kimmo Soramäki. "An Agent-based Model of Payment Systems." Working Paper no. 352, London: Bank of England, August 2008.

Getmansky, Mila, Andrew W. Lo, and Igor Makarov. "An Econometric Model of Serial Correlation and Illiquidity in Hedge Fund Returns." *Journal of Financial Economics* 74 (2004): 529–609.

Gilbert, Nigel, John C. Hawksworth, and Paul A. Swinney. "An Agent-Based Model of the English Housing Market." Association for the Advancement of Artificial Intelligence, Spring Symposium, Stanford, CA, March 23-25, 2009: 30–35.

Glasserman, Paul, Chulmin Kang, and Wanmo Kang. "Stress Scenario Selection by Empirical Likelihood." Working Paper. Forthcoming.

Goldstein, Itay, and Haresh Sapra. "Should Banks' Stress Test Results Be Disclosed? An Analysis of the Costs and Benefits." Working Paper Prepared for the Committee on Capital Markets Regulation, April 2, 2012.

Goodhart, Charles A.E., Anil K. Kashyap, Dimitrios P. Tsomocos, and Alexandros P. Vardoulakis. "Financial Regulation in General Equilibrium." NBER Working Paper no. 17909, Cambridge, MA: National Bureau of Economic Research, March 2012.

Gorton, Gary B., and Andrew Metrick. "Securitized Banking and the Run on the Repo." NBER Working Paper no. 15223, Cambridge, MA: National Bureau of Economic Research, August 2009.

Gray, Dale F., and Andreas A. Jobst. "Systemic CCA–A Model Approach to Systemic Risk." International Monetary Fund, Paper Presented at a Conference on "Beyond the Financial Crisis: Systemic Risk, Spillovers and Regulation," October 28–29, 2010.

Greenlaw, David, Anil K. Kashyap, Kermit L. Schoenholtz, and Hyun Song Shin. "Stressed Out: Macroprudential Principles for Stress Testing." Chicago Booth Research Paper no. 12-08, Chicago: University of Chicago, February 13, 2012.

Hakkio, Craig S., and William R. Keeton. "Financial Stress: What Is It, How Can It Be Measured, and Why Does It Matter?" *Federal Reserve Bank of Kansas City Economic Review* (Second Quarter 2009): 5–50.

Haldane, Andrew G. "Rethinking the Financial Network." Speech delivered at the Financial Student Association, Amsterdam, April 28, 2009.

Hanson, Samuel G., Anil K. Kashyap, and Jeremy C. Stein. "A Macroprudential Approach to Financial Regulation." *Journal of Economic Perspectives* 25, no. 1 (2011): 3–28.

Hirtle, Beverly, Til Schuermann, and Kevin Stiroh. "Macroprudential Supervision of Financial Institutions: Lessons from the SCAP." Staff Report no. 409, New York: Federal Reserve Bank of New York, November 2009.

International Monetary Fund. *Iceland: Financial System Stability Assessment Update*. IMF Country Report no. 08/368, Washington: IMF, August 19, 2008.

International Monetary Fund. *United States: Publication of Financial Sector Assessment Program Documentation—Financial System Stability Assessment*. IMF Country Report no. 10/247, Washington: IMF, July 9, 2010.

Khandani, Amir E., and Andrew W. Lo. "What Happened To The Quants In August 2007?: Evidence from Factors and Transactions Data." *Journal of Financial Markets* 14, no. 1 (2011): 1–46.

Kritzman, Mark, and Yuanzhen Li. "Skulls, Financial Turbulence, and Risk Management." *Financial Analysts Journal* 66, no. 5 (2010): 30–41.

Kritzman, Mark, Yuanzhen Li, Sébastien Page, and Roberto Rigobon. "Principal Components as a Measure of Systemic Risk." *Journal of Portfolio Management* 37, no. 4 (2011): 112–126.

Kyle, Albert S. "Continuous auctions and insider trading." *Econometrica* 53, no. 6 (1985): 1315–1335.

Kyle, Albert S., and Anna A. Obizhaeva. "Market Microstructure Invariants: Empirical Evidence from Portfolio Transitions." Working Paper, College Park, MD: University of Maryland, May 8, 2011.

Kyle, Albert S., and Anna A. Obizhaeva. "Large Bets and Stock Market Crashes." Working Paper, College Park, MD: University of Maryland, March 15, 2012.

Laux, Christian, and Christian Leuz. "Did Fair-Value Accounting Contribute to the Financial Crisis?" *Journal of Economic Perspectives* 24, no. 1 (2010): 93–118.

Lo, Andrew W., and Amy Zhou. "An Empirical Comparison of Systemic Risk Measures." Unpublished Presentation, Consortium for Systemic Risk Analytics Research Meeting, Cambridge, June 11, 2012.

Maddison, Angus. *The World Economy: Historical Statistics*. Paris, France: Development Centre of the Organisation for Economic Co-operation and Development, 2003.

Moyer, Liz, and Katy Burne. "Goldman Sachs Hedges Its Way to Less Volatile Earnings." *Wall Street Journal*, October 18, 2011. http://blogs.wsj.com/deals/2011/10/18/goldman-sachs-hedges-its-way-to-less-volatile-earning/ (accessed July 3, 2012).

Oet, Mikhail V., Ryan Eiben, Timothy Bianco, Dieter Gramlich, and Stephen J. Ong. "The Financial Stress Index: Identification of Systemic Risk Conditions." Working Paper no. 11-30, Cleveland: Federal Reserve Bank of Cleveland, November 2011.

Office of the Comptroller of the Currency, Federal Deposit Insurance Corporation, Board of Governors of the Federal Reserve System, Office of Thrift Supervision. *Interagency Supervisory Guidance on Counterparty Credit Risk Management*. OCC and others, June 29, 2011.

Pandit, Vikram. "Remarks by CEO Vikram Pandit at Bretton Woods Gathering." Citigroup, Washington, DC, September 23, 2011.

Roseman, Michael K. "Testimony." In *The Collapse of MF Global: Part 2, Hearing before the Oversight and Investigations Subcommittee of the Committee on Financial Services*. U.S. House of Representatives, February 2, 2012. 112 Congress. Roseman, 2012a. http://financialservices.house.gov/UploadedFiles/HHRG-112-BA-WState-MRoseman-20120202.pdf (accessed July 3, 2012).

Roseman, Michael K. Responding to questioning in *The Collapse of MF Global: Part 2, Hearing before the Oversight and Investigations Subcommittee of the Committee on Financial Services*. U.S. House of Representatives, February 2, 2012. 112 Congress. Video Archive, 1:48:30. Roseman, 2012b. http://mfile3.akamai.com/65722/wmv/sos1467-1.streamos.download.akamai.com/65726/hearing020212.asx (accessed July 3, 2012).

Schmieder, Christian, Claus Puhr, and Maher Hasan. "Next Generation Balance Sheet Stress Testing." Working Paper WP/11/83, Washington, DC: International Monetary Fund, April 2011.

Securities and Exchange Commission. *Process for Submissions for Review of Security-Based Swaps for Mandatory Clearing and Notice Filing Requirements for Clearing Agencies; Technical Amendments to Rule 19b-4 and Form 19b-4 Applicable to Self-Regulatory Organizations.* Proposed Rule, Federal Register 75, no. 250, December 30, 2010. Washington, DC: SEC, 2010, 82490–82533.

Stockman, Michael G. "Testimony." In *The Collapse of MF Global: Part 2, Hearing before the Oversight and Investigations Subcommittee of the Committee on Financial Services*. U.S. House of Representatives, February 2, 2012. 112 Congress. http://financialservices.house.gov/UploadedFiles/HHRG-112-BA-WState-MStockman-20120202.pdf (accessed July 3, 2012).

Tarullo, Daniel K. "Developing Tools for Dynamic Capital Supervision." Speech at the Annual Risk Conference, Federal Reserve Bank of Chicago, Chicago, IL, April 10, 2012.

Thurner, Stefan. "Systemic Financial Risk: Agent Based Models to Understand the Leverage Cycle on National Scales and Its Consequences." Working Paper IFP/WK/FGS(2011)1, Organisation for Economic Co-operation and Development International Futures Programme, January 14, 2011.

Tirole, Jean. "Illiquidity and All Its Friends." *Journal of Economic Literature* 49, no. 2 (2011): 287–325.

Van den End, Jan Willem, and Mostafa Tabbae. "When Liquidity Risk Becomes a Macro-prudential Issue: Empirical Evidence of Bank Behaviour." DNB Working Papers no. 230, Amsterdam: De Nederlandsche Bank, November 2009.

Wong, Eric, and Cho-Hoi Hui. "A Liquidity Risk Stress-Testing Framework with Interaction between Market and Credit Risks." Working Paper no. 06/2009, Hong Kong: Hong Kong Monetary Authority, 2009.

4 Addressing Data Gaps

The first section of this chapter describes how the OFR will fill gaps in data needed for financial stability analysis and improve the scope and quality of those data. The second section describes recent progress and initiatives to improve measures of leverage, liquidity risk, and interconnectedness among financial institutions. The OFR's highest immediate data priorities lie in short-term funding markets; over-the-counter derivatives, particularly credit default swaps; and asset management.

4.1 Data Agenda

Implementing the OFR's data agenda follows a three-step process: (1) Identify financial stability data needs; (2) Determine gaps and weaknesses; and, (3) Prioritize and fill the gaps by better organizing existing data, promoting data standards, and sourcing new data where necessary ***(Chart 4.1.1)****. To avoid duplication, reduce regulatory burden, and take advantage of existing data sources to the extent possible, the OFR is building a comprehensive inventory of data that the Council member agencies already purchase or collect. To assure data security and confidentiality, the OFR is building a secure enclave for data storage and use.*

4.1.1 Identify Financial Stability Data Needs

Financial stability data needs may arise from efforts to answer questions coming from several sources. Among them: (1) Work in support of the Council; (2) Other data needs identified through interactions with Council agencies, for example through the Council's Data Committee coordinated by the OFR; with the OFR's Financial Research Advisory Committee; or with other stakeholders; (3) The Office's own monitoring and metrics analysis of the financial system and its vulnerabilities; and, (4) The Office's risk management, stress testing analysis, crisis forensics, and other research activities.

Section 4.2 describes examples of that process in analyzing threats to financial stability posed by excessive liquidity and leverage and the interconnections among financial institutions, and discusses some of the key markets that can create those risks.

4.1.2 Determine Data Gaps

The Dodd-Frank Act requires that the OFR rely on data already collected by Council member agencies, where possible, before requesting additional data for financial stability analysis and monitoring. To take stock of available data, the OFR has developed a comprehensive inventory of financial data collected or purchased by Council member agencies. Where there are gaps in the available data, the Act provides that the Office could help fill them by requiring financial companies to submit these data, including transaction and position data.

Gaps and weaknesses in financial data arise in several ways. First, market participants cannot know what specific information will turn out to

Chart 4.1.1 Addressing Data Gaps

Identify Financial Stability Data Needs	Determine Data Gaps	Prioritize and Fill Data Gaps
Work in support of the Council	Inventory data available to supervisors	Organize data
Other collaborations	Search external data sources	Promote data standards
OFR monitoring	Analyze existing data standards	Source data
OFR research		Manage data
Ensure security, confidentiality, and privacy of data		

be critical for assessing the risks of new products or transactions. Second, supervisors cannot foresee all uses of the information they collect for the analysis of financial stability. Third, the data they collect are frequently not comparable, which stymies analysis of links among different structures and entities. Finally, while financial data are dynamic, it is costly and difficult to change information systems and collection rules.

Chart 4.1.2 illustrates sources of such gaps. At the most basic level, a financial institution may not be collecting and reporting the relevant data about terms and conditions of all financial contracts. It may be difficult for management to keep track of the activities and risk positions of its own trades in the case of customized transactions—key information on such trades is often described in text form on contracts and in large text documents rather than in structured digital form—or to know the correct amount of information required to hold and trace the lineage of some products in order to understand the risks inherent in new products.

Even if a firm collects relevant data, it may not be able to use them effectively. For example, if all of the units in the firm do not use common definitions for similar financial exposures, its risk managers will have difficulty comparing different products, evaluating the firm's aggregate exposures, or making linkages—such as linking structured products to their underlying components. Circa 2006, a large financial institution may have had various business units that originated and acquired mortgages, following waves of corporate mergers and acquisitions, but each of those units may have had its own definition for a term like "subprime." One unit may have considered any mortgage with a FICO score below 620 as subprime, while another may have used 660; or the definition could have been based on income, on the identity of the lender, or on the interest rate the borrower paid. Each institution also might have stored different amounts of details on the transactions, rendering these data incomplete across all participants.

Other barriers to comparative analysis would be the lack of a common identifier separating subprime mortgages from other types of loans or insufficient descriptive information about the details of the mortgages. Or, the firm may not be collecting the data in a standard format—the various units may use the same definitions but may be storing the data on incompatible computer platforms. In each case, the financial institution has the data but is not collecting them in a consistent and comparable way across the organization. These examples highlight the importance of data and data standards to assist with robust risk analysis and development of internal systems.

At the next level, the data may not be available for sharing across companies or supervisors. Comparing information across companies could help supervisors identify crowded trades, excessive growth in a particular sector, or other systemic issues that are difficult to discern at a single institution. Finally, supervisors may be collecting data from more than one institution, but those datasets cannot be merged with datasets from other companies or industries. For example, regulatory reports filed by banks and securities firms do not have fully comparable data categories or nomenclature, which makes it difficult to get a picture of the consolidated exposures of a complex institution with both bank and securities firm subsidiaries.

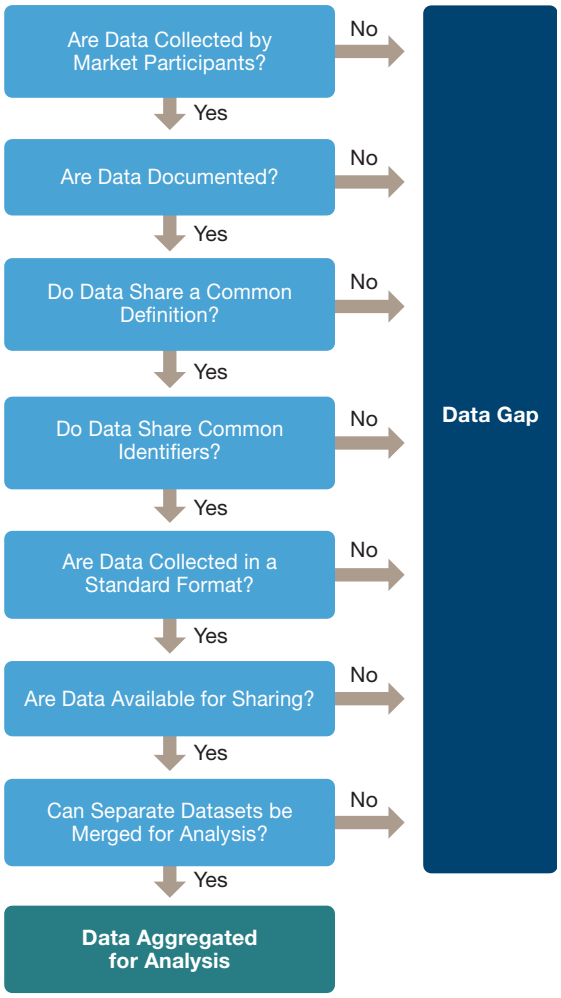
Only after all of these potential gaps have been addressed can data be consistently aggregated for comparative analysis by financial supervisors.

Interagency Data Inventory

The data inventory initiative is helping the Office identify data sources, data gaps, overlaps, and areas where data need to be made more consistent and comparable. It covers three types of data: *purchased data* (data procured from vendor sources); *collected data* (data collected from financial service firms and other sources by supervisors and regulators or directly by the OFR); and *derived data* (data derived from the previous two sources, alone or in combination).

The data inventory will allow the Office and the Council agencies to quickly locate data that can be used to analyze threats to financial stability, ensuring that they can leverage the information efficiently as allowed by the contract terms for the data. To date, the purchased data have been catalogued and metadata—data describing the data—have been stored in a searchable repository. The OFR is in the process of collecting metadata about the agencies' collected data and will follow up with derived data, including definitions of these data, to complete this inventory. It will be updated on a regular basis.

Chart 4.1.2 Possible Sources of Data Gaps



Data from the data inventory have already been and will continue to be used by researchers in the OFR. They will also be made available, where possible, to Council member agencies to assist in identifying data sources for their research or other needs. The OFR expects to provide a service to the FSOC agencies in describing where information exists before a given agency decides to procure it and before requesting new information from financial market participants. The inventory will promote efficiency and data-sharing across the agencies and avoid unnecessary burdens on financial service firms. As a part of this effort to serve the Council, the Office is working with private market vendors, where possible, to secure access to identified missing data, to simplify the process, to fill the gaps, and to increase efficiencies.

This data inventory will also afford the OFR a unique perspective on the aggregate reporting requirements facing financial institutions. Furnished with such information, the OFR can work with Council member agencies to reduce and eventually eliminate duplication in data collection. In addition, in conjunction with work on data quality and data standards, this information can help the Council to simplify and streamline the information collection process. Together these initiatives will improve the scope and quality of data collected while reducing the reporting burden.

4.1.3 Prioritize and Fill Data Gaps

The OFR has three strategies for filling data gaps:

(1) Help organize and integrate existing data gathered by the agencies. The OFR's approach begins with organizing existing data. Organizing means not only identifying and cataloguing the data, but understanding where the data are sourced and in some cases derived; what the components of the data really mean in the context of the financial contract; and how they fit into our understanding of the financial system. This activity is central to the Office's ability to monitor and assess the financial system because it is crucial to have an up-to-date picture of the processes that move capital, ownership, control, and risk among investors and financial institutions. To understand capital and risk flows, the effective macroprudential analyst must have the ability to combine data reported from different sources and to rely upon the data for analysis. For example, the OFR receives transaction and pricing data about the credit default swap (CDS) market from separate sources; a near-term objective is to connect and update reliably these two sources for monitoring purposes.

(2) Promote data standards. In some cases, data gaps can be addressed by improving the quality of data already collected through standardization. The benefits of standards are significant, and they accrue to both market participants and supervisors. The OFR will seek to enhance the quality and usability of existing data to enhance risk management along with microprudential and macroprudential supervision. The Office will work closely with industry, Council member agencies, and international bodies to achieve a higher quality and standardization of data collections, as described in Chapter 5.

(3) Source additional data that are not currently available. Where data gaps cannot be closed through better use of already collected data or through better standards, the OFR will work with industry participants and Council member agencies to collect the necessary information and data to fill those gaps. By coordinating with other Council agencies, the Office intends to create efficiencies in future collections and mitigate burdens on those reporting the data. When collecting such data, the Office will establish and facilitate standards for those collections so that they may be used to their fullest potential.

In pursuing all three of these strategies, the overriding concern will be to take an approach that considers the burdens associated with these activities.

4.1.4 Manage Data

In many cases, the OFR will acquire, manage, and distribute economic statistics; financial industry data on companies, products, transactions, and positions; and other data required for ad hoc FSOC requests and forensic analyses.

Database management demands secure processes to extract data from sources, transform data for use, and load data into permanent storage, such as in a data warehouse and other databases optimized by data type and into analytic tools for use by researchers. The Office will work to achieve appropriate data quality on the data it manages so that all data can be used without modification or correction by all users. Wherever the data come from, the OFR

will validate that they are accurate, complete, and available for use by researchers. Metrics, including data quality and usage metrics, will be kept and reviewed on a regular basis. The Office has begun a Data Maturity Model project to measure data maturity capabilities and define best practices that will serve as a benchmark. This will help to ensure the highest quality and integrity of the data.

The Office will look to increase the transparency and accessibility of the data, particularly to researchers in the Office and Council, and also to member agencies and the public where possible. Accessibility will be based on the sensitivity of the data and the terms of the agreements or data contracts. The Office will maintain an electronic library that will contain a catalogue of all information collected that can be searched and made available based on appropriate security and access rights. This catalogue will be extended to include research papers, data, and other information in order to improve efficiency across Council members' organizations, allowing immediate access to the data, and to improve the ability to support the mission of analyzing threats to financial stability.

4.1.5 Ensure Security, Confidentiality, and Privacy of Data

Keeping data safe and secure is the highest priority for the OFR. One of the biggest challenges in analyzing threats to financial stability is to collect and store, in a secure environment, a significant amount of confidential data. Robust security for data requires strong technology, governance, and processes.

The OFR currently uses a secure analytic environment and is designing a robust data and technology infrastructure that will support traditional analysis as well as the ability to rapidly secure and analyze large amounts of data. The analytical environment rests on the foundation of technical requirements that are well-established by the federal government *(Box G: Building a Secure Infrastructure)*. Through the use of such techniques as role-based access and dual factor authentication, the OFR seeks to ensure that the technology supports data protection and secure access. The Office has several initiatives to ensure security for the data it manages:

- As part of the Treasury, the OFR inherits and can leverage the secure Treasury environment, including its infrastructure and policies and procedures.

- The OFR is putting in place additional controls for the data in the form of hardware, software, policies and procedures, and access rights, including granting access on a "need-to-know" basis.

- The OFR is in the process of defining and will publish a standard data security classification in order to map data acquired from multiple sources, including the public or other agencies. This is needed to ensure that the data can be catalogued, tagged, and handled properly with the required appropriate security measures. In addition, access control will be maintained in a central location, monitored on a continual basis, and updated as needed.

- The need to assure data confidentiality and security will restrict the scope of disaggregated data that can be directly shared with external researchers. The OFR is investigating sophisticated techniques to aggregate, mask, and make data anonymous in order to assure the security of the raw information while making the derived data available to researchers (Abbe, Khandani, and Lo, 2012).

However, even advanced technologies can be defeated by poor governance, processes, and monitoring. The OFR understands this and is developing robust reporting and monitoring

BOX G. BUILDING A SECURE INFRASTRUCTURE

Essential to the success of the OFR is the protection of the data it receives, derives, stores, and transmits. The keystone requirement for the deployment of appropriate security controls is the proper categorization of both systems and information and the related proper data handling procedures.

The OFR is developing a comprehensive security categorization methodology based on National Institute of Standards and Technology (NIST) Publication 199 and will adhere to all other NIST guidance for the deployment of baseline controls (NIST, 2004). The OFR will supplement the baseline controls specified by NIST with additional handling instructions for each category of information. These additional handling instructions provide a hardened set of security controls.

This commitment to the protection of data is emphasized in the guiding principles of our Information Security Program. Those principles include:

- Strict adherence to a data categorization and sensitivity classification methodology based on the Federal Information Security Management Act of 2002 (FISMA) and NIST Publication 199;
- Safeguarding of data that we receive, store, and distribute at least as well as they are safeguarded by the data's owner;
- Least privileged access, whereby access to systems and information is granted on an as-needed basis and only to the extent necessary for an individual to accomplish his or her mission;
- A culture of awareness whereby security is a primary concern of all personnel;
- Compliance with and subordination to higher office policies and guidance, such as FISMA, NIST, and Treasury Departmental Offices;
- Leveraging the protections inherited as part of the Treasury network and supplementing those protections to attain a higher level of protection where appropriate;
- Supplementing and strengthening the policies and controls specified by higher offices where appropriate;
- Similar security controls that reinforce each other in a layered manner; and,
- Well-defined roles and responsibilities for executing the security program with clear lines of accountability, responsibility, and authority.

An example of the OFR's commitment to an enhanced security posture is the recent construction of our secure network enclave. The OFR shares data center space with and is part of the Treasury Departmental Offices local area network, and, as such, inherits the high degree of protection provided by this network. The OFR has built additional security measures to segregate its systems from the rest of the Departmental Offices.

policies and procedures. Every member of the OFR staff who has access to confidential position and transaction data certifies that they understand that they are subject to the post-employment restrictions set out by Dodd-Frank. Staff are not given access without explicit assent from a supervisor.

4.2 Examples of Financial Stability Data Gaps

To an important extent, the OFR's research and monitoring activities, in collaboration with the regulatory agencies, will inform its identification of data gaps. The OFR views leverage, liquidity, and interconnectedness as among the most important factors affecting financial stability. Measuring and assessing these three risk factors, among others, will always be important to the OFR's mission. Excessive leverage leaves market participants vulnerable to declines in asset values, creating the potential, in a crisis, for distressed asset sales and thus a spread of losses to other asset holders. These effects are exacerbated by liquidity mismatches when illiquid long-term assets are funded through short-term liabilities. In a crisis, losses may propagate from one institution to another through the many links that connect financial institutions in networks, including lending and liquidity provision. These factors affecting financial stability are thus interrelated and are a primary focus for the OFR's research agenda.

This section discusses leverage, liquidity, and interconnectedness in turn, emphasizing the diverse nature of these factors and identifying key information needed for comprehensive monitoring. The data needed to measure potential threats, like the factors themselves, cut across different parts of the financial system.

Based on these risk factors, the OFR's highest data and research priorities lie in short-term funding markets, including money market funds, repurchase agreement or repo markets, and securities lending; and over-the-counter (OTC) derivatives, particularly credit default swaps. Structural weaknesses in markets for both short-term funding and OTC derivatives contributed to the recent financial crisis. Both are vast and traditionally opaque. The OFR is also interested in addressing data gaps about the asset management industry.

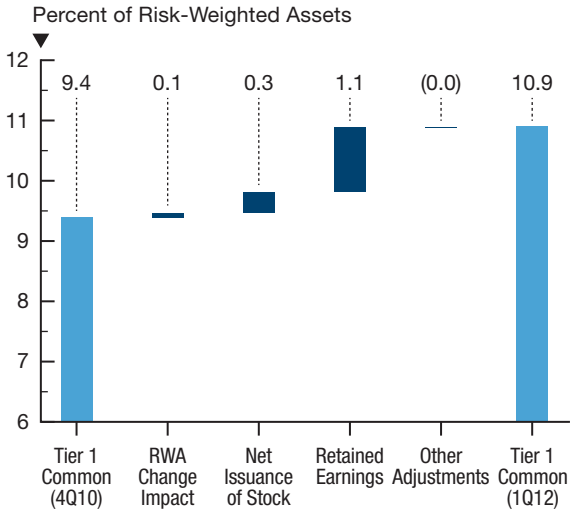
Recent reforms have brought greater transparency to these markets, but important data gaps remain to be filled, and further analysis is needed to understand how to further enhance the resilience of the rest of the financial system to potential vulnerabilities in these markets. What follows reflects the OFR's analysis of the data needed to support these research priorities. Identification of data needs is just the first step in the OFR's process for setting its data agenda; that process also includes setting priorities while remaining sensitive to the potential costs, considering the appropriate form of OFR involvement, and defining how to share the data.

4.2.1 Leverage

Excessive leverage is a frequent precursor to financial crises. Just as leverage multiplies gains from rising asset values, it also magnifies sensitivity to adverse events. Leverage amplifies asset bubbles as easy borrowing enables speculators to bid up prices. Of course, credit also supports economic growth. Because leverage can accumulate almost anywhere in the financial system, in both regulated and unregulated sectors, a comprehensive view is needed to identify the proper balance.

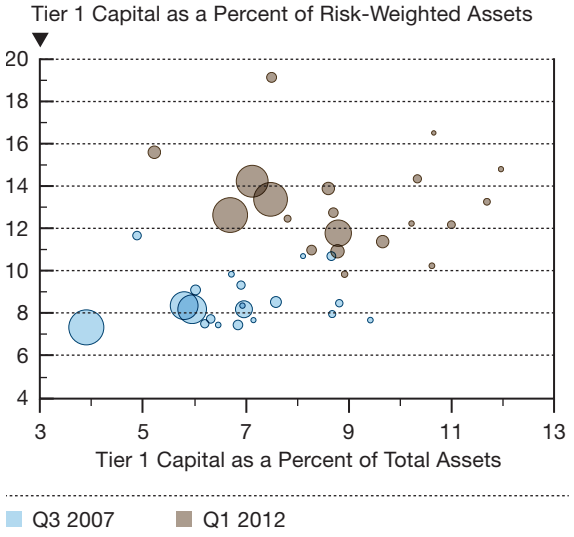
Monitoring trends in leverage requires measures of both overall leverage and the leverage in new transactions, in order to understand trends. In real estate, for example, the overall loan-to-value ratio of outstanding mortgages provides an important measure of total leverage in this sector; but the loan-to-value ratio on new mortgages provides a better indication of

Chart 4.2.1 Change in Tier 1 Common Ratios for 19 Largest BHCs



Source: FSOC (2012)

Chart 4.2.2 Tier 1 Capital Ratios for Major BHCs



Note: Top 20 BHCs by total assets as of Q3 2007 that are still in existence. Bubble sizes reflect relative total assets.

Source: FR Y-9C filings via SNL Financial, OFR calculations

current conditions. Geanakoplos and Pedersen (2011), for example, report that new leverage falls just before a crisis, while a decline in total leverage may lag by two years or more. As this observation suggests, tracking changes in marginal leverage along with total credit across many types of lending is an important component of macroprudential oversight.

The following subsections discuss drivers of leverage and data needed for measuring and monitoring leverage. Again, further work remains with respect to setting data acquisition priorities.

Bank Leverage

Leverage in the banking system is controlled through capital requirements and monitored by banking supervisors. New capital standards set by the federal banking agencies and Basel III will increase both the quantity and quality of capital by assigning higher risk weights for certain asset classes and narrowing the types of liabilities that may be counted as capital. From the fourth quarter of 2010 to the first quarter of 2012, the 19 largest U.S. bank holding companies increased their Tier 1 common ratios, a key measure of capital, from 9.4 percent to 10.9 percent of risk-weighted assets *(Chart 4.2.1)*. In addition, the financial crisis demonstrated the importance of limiting leverage based on total assets as well as risk-weighted assets. Fixed risk weights inevitably miss changes in asset riskiness, as they did with mortgages and sovereign debt; an overall cap on leverage reduces opportunities for banks to exploit such gaps. While U.S. banks have been subject to a leverage ratio based on total assets for two decades, under the proposed Basel III rules, large firms would also be subject to an international leverage ratio that will capture off-balance-sheet exposure.

Chart 4.2.2 shows ratios of Tier 1 capital to total assets and risk-weighted assets for the largest U.S. BHCs. The bubble sizes reflect relative total assets. Values from 2007 are indicated in blue and values from 2012 in brown. The chart shows

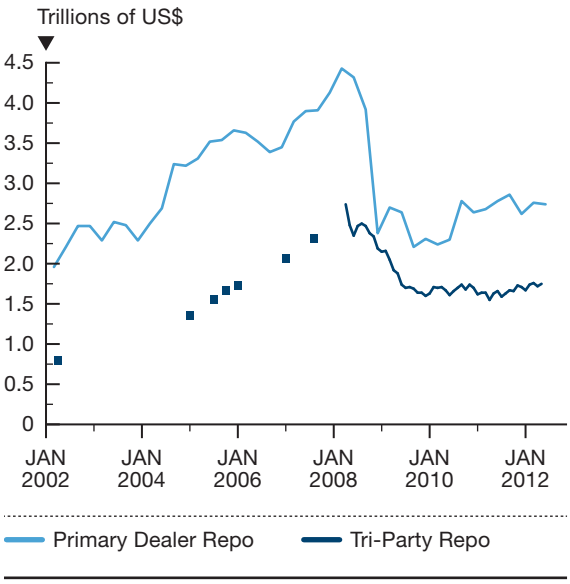
stronger capital ratios on both measures for the more recent period.

Most of a depository institution's borrowing comes from deposits and other forms of debt, but banks can also create off-balance-sheet leverage through derivatives. Off-balance-sheet leverage is more difficult to monitor, particularly because the leverage in derivative positions is often implicit and can change with market prices: swaps can change from assets to liabilities, and leverage in options depends on the strike price relative to a changing spot price. The Federal Reserve's Form Y-14, adopted in 2012, collects more granular information than previously available about off-balance-sheet exposures at bank holding companies, information that can help assemble a more comprehensive view of leverage in the banking system. This is an important positive development; however, the information on sensitivities to risk factors collected through this form can miss the effects of sudden large movements in market prices. For complex structured products in particular, sensitivities provide an incomplete picture of risk and embedded leverage. Detailed information about off-balance-sheet exposures thus remains an important data gap.

The information from Form Y-14 is a key input to the Federal Reserve's annual Comprehensive Capital Analysis and Review (CCAR). This review provides an essential perspective for monitoring leverage by publicly disclosing information about the effectiveness of bank capital and capital plans in sustaining losses under stress conditions. Information from the CCAR thus goes beyond a current snapshot of bank leverage to shed light on how leverage might evolve under adverse conditions and where additional capital might therefore be required.

Short-term wholesale funding remains a potential source of leverage and liquidity risk in the banking system. Regulatory reports, through the Call Reports filed by banks and the Y-9Cs filed by bank holding companies, provide limited insights into these risks—they are filed

Chart 4.2.3 Estimated Value of the Repo Market



Source: FSOC (2012)

only quarterly and they aggregate overnight borrowing with 90-day borrowing, obscuring the bank's exposure to a freeze in short-term funding markets. The Federal Reserve and OCC have begun to collect more granular information about liquidity exposures at the largest bank holding companies on a confidential basis through the Federal Reserve Bank of New York's daily liquidity monitoring ***(Box H: Improvements in Financial System Monitoring)***.

Repo and Securities Lending

Repo markets provide a critical channel for securitized short-term lending against financial assets. Leverage through repo is moderated by haircuts or over-collateralization: a larger haircut reduces the amount a borrower can borrow against the value of an asset posted as collateral. As haircuts compress and widen, repo leverage expands and contracts. A sharp increase in haircuts has the potential to trigger a rapid deleveraging. Repo leverage is difficult to measure and monitor because bilateral repo transactions are widely dispersed, as opposed to operating through a single venue or platform. Even the size of the repo market is difficult to quantify. ***Chart 4.2.3*** shows the scale of repo

BOX H. IMPROVEMENTS IN FINANCIAL SYSTEM MONITORING

Financial supervisors have taken important steps to expand their knowledge of the financial system in recent years. Hedge funds and money market funds are now required to file confidential new reporting forms, and thrifts now file the same public Call Reports that banks file. Also, a small group of large banks are now required to file an extensive confidential financial report as part of the Federal Reserve's new annual capital assessment exercise and stress test.

Since the crisis, financial supervisors have improved their ability to monitor developments in the financial system in important ways. Those improvements encompass new reporting requirements for institutions that are subject to federal supervision, such as banks and thrifts. In some cases, as required by Congress, supervisors have also introduced new reporting requirements for institutions that they do not supervise directly for safety and soundness, such as hedge funds.

Banks and Bank Holding Companies

Regulatory reports filed by depository institutions have been expanded. The Call Reports and the comparable forms filed by bank holding companies (the Y-9Cs) have been expanded to include, for example, more granular information about securities holdings, derivatives and trading activities, off-balance sheet commitments, and nonperforming loans. Also, starting with their March 31, 2012 filings, thrifts now file the same Call Reports that banks file. Under the Dodd-Frank Act, the Thrift Financial Report was eliminated, and thrifts became subject to the same reporting requirements as banks. Also, supervisory oversight for federal savings associations was assumed by the OCC; federal oversight for state-chartered savings associations was transferred to the FDIC; and oversight of thrift holding companies was transferred to the Federal Reserve. As a result, these financial institutions are now subject to similar regulatory regimes as banking organizations.

The OCC has taken the lead in several large-scale projects to collect and aggregate loan-level data from large banks reflecting their exposures in mortgages, home equity, credit card, and commercial real estate loans, often working closely with the other federal supervisors. The OCC shares that information with the other supervisors and, in the case of mortgage data, with the public in the quarterly Mortgage Metrics Report. The Federal Reserve Board, the OCC, and the FDIC are working to modernize the Shared National Credit program, a longstanding interagency effort that creates and disseminates aggregate information about banks' credit exposures to large syndicated loans.

As part of its Comprehensive Capital Analysis and Review, the Federal Reserve introduced a new regulatory form, the Y-14, to be filed by the large banks that participate in the program, to support supervisory stress tests, and to improve monitoring capabilities. The Y-14 requires these companies to provide more data about various asset classes—securities risk, retail risk, wholesale risk, trading—and categories of pre-provision net revenue on a quarterly basis.

Unlike most other federal regulatory reports, the companies provide the data on a confidential basis; however, the Federal Reserve publicly releases information about the results of the stress tests performed on each bank.

Similarly, since the financial crisis the Federal Reserve Bank of New York has been collecting daily information from a small number of large bank holding companies about their liquidity exposures, including exposures in derivatives and short-term funding markets and information about counterparties.

Nonbank Financial Institutions

This year, hedge fund advisers and other private fund advisers are filing Form PF for the first time with regulators, either the SEC for investment advisers with registered private funds or the CFTC for certain commodity pool operators and commodity trading advisers dually registered with the SEC and CFTC. Form PF, a confidential reporting form implementing a mandate from Congress in the Dodd-Frank Act, requires detailed information about assets under management, the use of leverage, counterparty credit risk exposure, and trading and investment exposures. Data from the form should be available on a confidential basis to supervisors by early 2013.

The OFR monitors money market fund holdings through the funds' monthly SEC filings. The filings are required of all 2a-7 funds—funds covered by Rule 2a-7 of the Investment Company Act of 1940. Form N-MFP provides valuable disclosure on money market fund investments.

International Exposures and Data Gaps

To enhance information on sovereign debt exposures, the SEC's Division of Corporation Finance issued in January 2012 disclosure guidance on registrants' direct and indirect exposures to European sovereign debt. The purpose of the SEC's guidance was to provide investors with greater clarity and comparability in substance and presentation between registrants. The federal banking agencies' Interagency Country Exposure Review Committee (ICERC) is also currently working on a project to enhance disclosures on the Country Exposure Report (FFIEC 009) that may lead to a proposal for comment.

In November 2009, the Financial Stability Board and the International Monetary Fund issued 20 recommendations for international cooperation to fill data gaps. They issued progress reports in May 2010 and June 2011 (FSB and IMF, 2009, 2010, and 2011). Their recommendations include further investigation of measures of systemic risk (similar measures are discussed in Section 3.1 of this report); improved data on shadow banking (including disclosures on asset-backed securities); greater reporting of data on derivatives, particularly credit default swaps; and a common template for reporting by large, complex financial institutions.

transactions conducted by primary dealers and through the tri-party repo market.

The repo market is broadly divided into three components. First, the tri-party repo market operates through two large clearing banks, Bank of New York Mellon and JPMorgan Chase. Each participant in this market maintains a cash account and a securities account with one of these clearing banks. When a repo transaction occurs, the clearing bank transfers cash from the lender's cash account to the borrower's and transfers securities (collateral) from the borrower's securities account to the lender's. Second, in the Delivery versus Payment repo market, dealers engage in bilateral repo transactions with a variety of customers and with one another. Third, the General Collateral Finance (GCF) market is a blind-brokered interdealer market in which the Fixed Income Clearing Corporation (FICC) plays the role of central counterparty. Trades are netted out each day, and FICC reports net clearing amounts to the tri-party clearing banks.

The OFR tracks money market fund transactions through data collected monthly by the SEC's Form N-MFP. This is a limited but important window into repo markets. The concentration of the tri-party repo market in two clearing banks provides an opportunity for more comprehensive coverage of tri-party repo transactions that would allow the OFR to monitor potential threats in this critical component of short-term funding markets. The Federal Reserve Bank of New York currently reports aggregate weekly statistics on volumes, interest rates, and haircuts for tri-party repo, based on information collected directly from the clearing banks; these reports do not include information on the counterparties to the transactions.

But a complete understanding of the U.S. repo market is not feasible without corresponding information about bilateral repo transactions and the GCF market. Bilateral repos are currently included in aggregate data provided by primary dealer banks to the Federal Reserve in a weekly report (the FR 2004)—although supervisors do not know how much bilateral repo business takes place outside the primary dealers—and the Depository Trust and Clearing Corporation makes monthly aggregate data on the GCF market available on its website. The OFR is engaged in acquiring and analyzing more frequent and detailed data on these markets.

Securities lending is similar to repo in that both involve a temporary exchange of securities and cash, with an interest payment when the exchange is reversed. The difference is that repo is mainly a mechanism for collateralized lending and borrowing, while securities lending is driven primarily by demand for holding a security temporarily—for example, for purposes of short selling. Typical securities borrowers are hedge funds and dealers; typical lenders are insurance companies, pension funds, and investment companies. As it is with repo, the over-collateralization required on securities lending is an important governor on leverage. There is no central information source in the securities lending market comparable to the two clearing banks in the tri-party repo market. Supervisors receive very little information about securities lending, and private vendors of information about the market rely on voluntary reporting by market participants.

A complete picture of these markets requires better data on all repo and securities lending transactions, including the parties to the transaction, collateral, haircuts, and maturities. Given the prominence of these markets in the financial crisis and their anticipated renewed importance as lending rebounds, the absence of a complete picture presents a significant data gap. The OFR will work closely with FSOC agencies to develop strategies to close this gap and will set priorities after weighing the relative advantages of different strategies.

Derivatives Markets

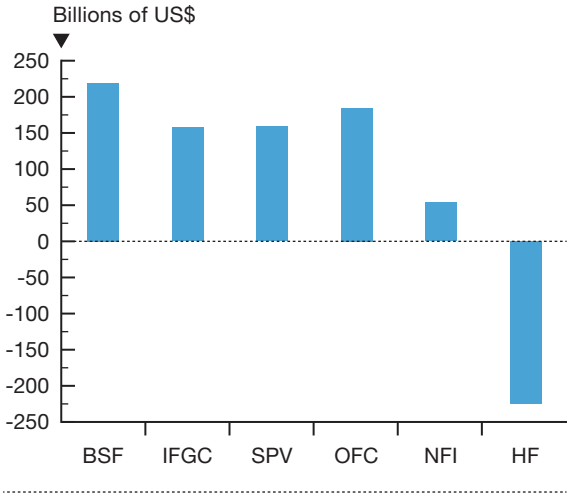
Derivatives, both exchange-traded and OTC, are sources of leverage. Because there is no purchase price to enter into a futures contract, the initial margin required by an exchange is

an important constraint on leverage. Margin requirements are public information, but there is no comprehensive database that tracks margins across exchanges and products; such a database is a potentially valuable element of a systemwide leverage monitor.

Margins on OTC derivatives are more difficult to track. As trading moves to swap execution facilities and central clearing, these markets will become more transparent and margin requirements will be easier to monitor. Indeed, Title VII of the Dodd-Frank Act requires that the details of swap transactions be reported to trade repositories. In addition to margins, total exposures through derivatives are indicators of overall leverage. Many derivatives—options, for example—are effectively equivalent to prepackaged trading strategies that use leverage to trade in the underlying assets, so increased derivatives volume is similar to increased leverage. Like leverage, greater use of swaps and options can magnify the market's overall sensitivity to fluctuations in underlying prices.

Chart 4.2.4, updating data in Vause (2011), illustrates both progress and remaining gaps in the available data on OTC derivatives transactions. This information has become available through international coordination to improve reporting. The chart shows net credit protection bought by dealers reporting to the Bank for International Settlements (BIS), broken down by type of counterparty. The chart indicates that dealers are net sellers of protection to hedge funds and net buyers of protection from other counterparties—banks and securities firms, insurance and financial guaranty firms, special purpose vehicles, other financial institutions, and non-financial firms. This type of breakdown has become available through the BIS only since 2010, in response to heightened concerns about the opacity of the credit default swap market. At the same time, the chart points to remaining data needs—in particular, the BIS data do not include information about counterparty concentrations. The risk in the CDS market is often greater when protection sellers and reference entities

Chart 4.2.4 Net Credit Protection Bought by Dealers From Different Counterparty Groups—December 2011



BSF = Banks and Securities Firms
IFGC= Insurance and Financial Guaranty Companies
SPV = Special Purpose Vehicles
OFC = Other Financial Companies
NFI = Non-Financial Institutions
HF = Hedge Funds

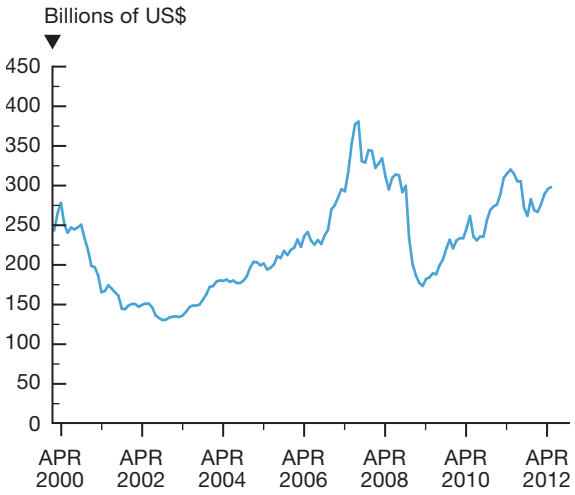
Source: BIS, OFR calculations

are in the same sector and when added contractual complexity makes CDS difficult to value. Granular data on these aspects of the CDS market are not available through the BIS statistics.

One of the important historical impediments to understanding aggregate counterparty risk associated with OTC derivatives was that even where transactional data might be available to a regulator, each party to the transaction might keep records with different identifiers for counterparty and reference asset. The global effort endorsed by the OFR to establish the Legal Entity Identifier (LEI), a single, universal naming convention for legal entities, will help mitigate the risk that supervisors will miss a buildup in these instruments.

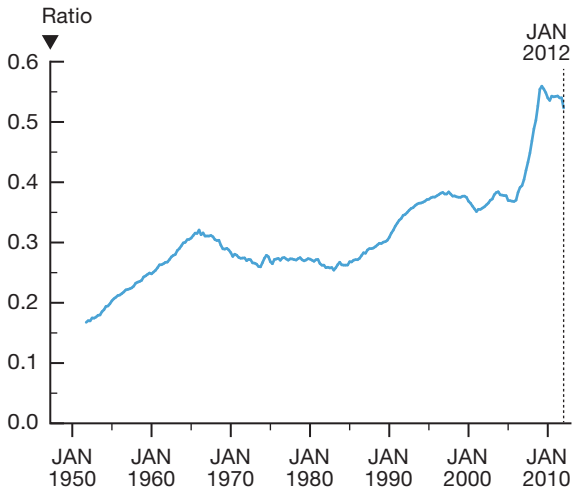
The OFR is in the process of acquiring and securing transaction, position, and pricing information on CDS contracts in collaboration with other FSOC members. Even with these data in place, important data gaps will remain, including information about collateral and netting arrangements between CDS

Chart 4.2.5 Debit Balances in Margin Accounts at Broker-Dealers



Source: NYSE, Haver Analytics

Chart 4.2.6 Ratio of Home Mortgage Liabilities to Real Estate Assets, Household Sector



Source: FRED, Flow of Funds, OFR calculations

counterparties. As these markets are global, the OFR will need to acquire data relating to foreign transactions as well, particularly for affiliates of U.S. financial institutions. For this reason, the OFR is involved in international working groups to align data acquisition and data-sharing protocols and works closely with primary regulators in the U.S. as they promulgate their rules.

Hedge Funds

Hedge fund leverage—and the fear of a rapid deleveraging—prompted the Federal Reserve Bank of New York in 1998 to coordinate the response of creditors of Long Term Capital Management to prevent a disorderly failure of that hedge fund. Fourteen years later, hedge funds have grown much larger, yet little more is known about the risks they pose to the financial system. In early August 2007, stock prices dropped sharply in a wave of hedge fund deleveraging, contributing to the nascent financial crisis.

Chart 4.2.5 shows total debit balances in margin accounts at broker-dealers, an aggregated indicator of leverage in stock market investments. The chart shows a steady buildup through mid-2007, followed by a decline to early 2009 and then another buildup to April 2011. More granular data on lending by prime brokers to hedge funds would provide regulators with an important tool in monitoring hedge fund leverage.

Through a joint effort of the SEC and CFTC, Form PF for confidential private fund risk reporting, discussed in ***Box H***, now requires fund advisers to provide regulators with information regarding size, leverage, investor types and concentration, liquidity, and fund performance. The OFR has provided input into the data requirements for these rules and is preparing to obtain the data from these forms as they become available. This information will significantly expand the FSOC's ability to monitor hedge fund leverage and assess its potential impact on financial stability. Whether this information will be sufficient to monitor threats posed by hedge

funds will likely be reassessed by all involved once the data have been collected.

Households and Real Estate

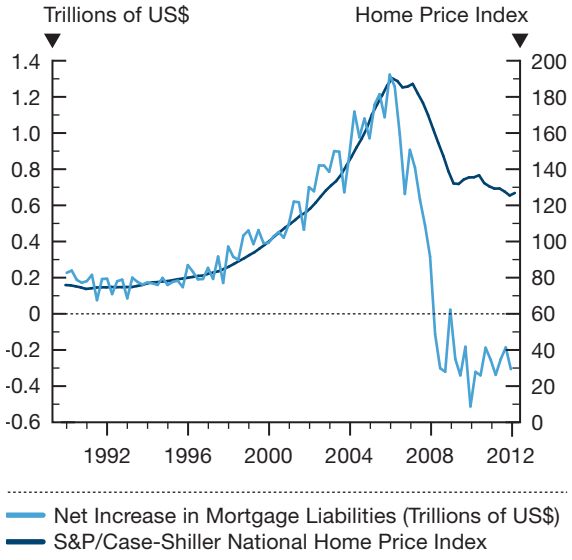
Households use debt financing for real estate and automobiles while relying on revolving credit for a wide range of purposes. Loan-to-value ratios, downpayment requirements, and credit limits provide measures of leverage in this sector. ***Chart 4.2.6*** tracks the ratio of home mortgage liabilities to real estate assets and shows a dramatic steepening near the end of 2005 and building up to the peak of the financial crisis. As noted previously, it is important to track these types of measures for new credit as well as for total credit outstanding. ***Chart 4.2.7*** shows the net increase in mortgage liabilities dropping earlier and more quickly than the house price index. ***Chart 4.2.8*** shows credit limits on credit card originations to subprime borrowers declining from a peak in 2006 through 2009 but climbing steadily since early 2010.

The Federal Reserve Bank of Philadelphia, with infrastructure support from the Federal Reserve Bank of Kansas City, has created an extensive warehouse of data on consumer credit. This data warehouse helps to improve information about securitization. The OFR is closely following rulemakings and policy work by primary regulators as they consider how to collect and aggregate more complete data.

Sovereign Debt

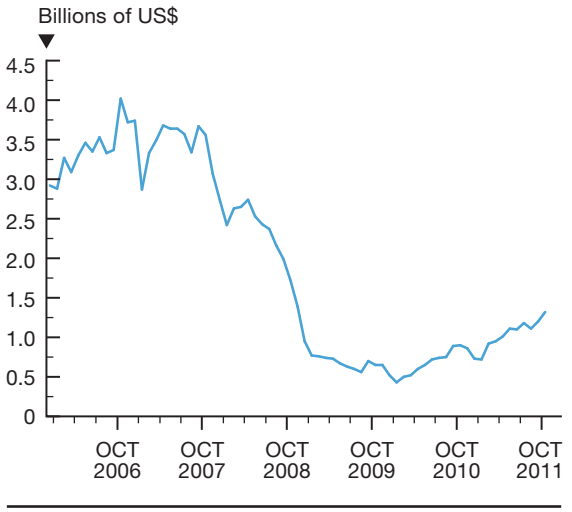
Persistent large government deficits are potentially destabilizing. As demonstrated by the chain of events set off by fears of a Greek default, the consequences of unsustainable sovereign debt growth can spread quickly across borders. The U.S. continues to enjoy historically low funding rates on its debt, but the risk of a sharp change in demand for Treasury securities must be counted among the potential threats to financial stability facing the nation. Net purchases of U.S. debt by foreign investors has become more volatile, as indicated in ***Chart 4.2.9***, and a sharp pullback by these investors is potentially destabilizing. ***Chart 4.2.10*** compares

Chart 4.2.7 Net Increase in Mortgage Liabilities: Household Sector



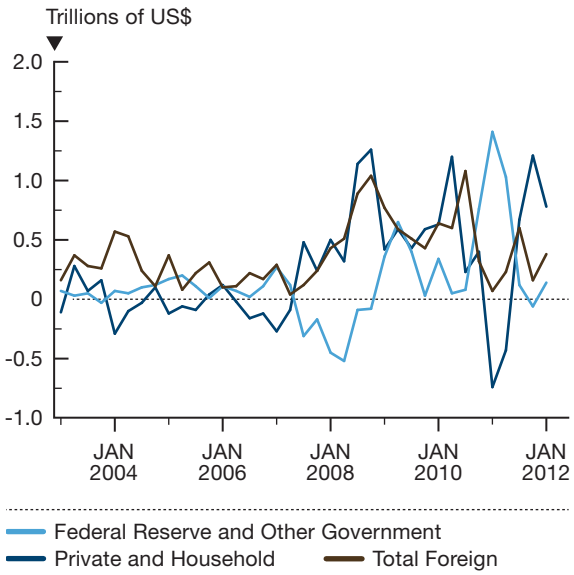
Source: Flow of Funds, S&P/Case-Shiller, Haver Analytics

Chart 4.2.8 Aggregate Credit Limit on Bankcard Originations to Subprime Borrowers



Source: Equifax

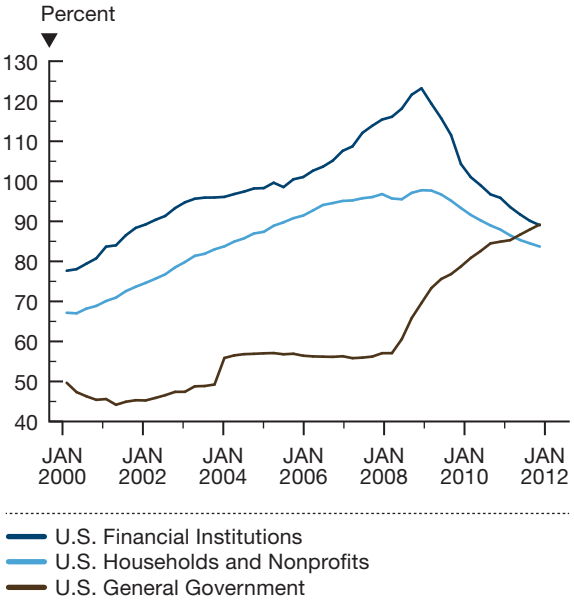
Chart 4.2.9 Net Purchases of U.S. Treasury Debt



Note: The "Federal Reserve and Other Government" category includes purchases by the Federal Reserve, state and local governments, government retirement funds, and GSEs.

Source: Flow of Funds, Haver Analytics, OFR calculations

Chart 4.2.10 Debt Outstanding as a Percent of GDP



Source: FRB, Haver Analytics

debt outstanding as a percentage of GDP for the U.S. government, financial institutions, and household sector.

Many state and local governments are also struggling to balance their budgets. Trouble in the municipal debt market could potentially spread to or from other sectors through linkages between markets. Money market funds and municipal issuers have tight and almost symbiotic connections; the municipal bond market also relies on guarantees and demand features provided by third parties—typically banks and often European banks. These considerations make government debt at all levels a necessary element of a comprehensive view of leverage.

Chart 4.2.11 shows CDS spreads for the U.S. and six states. The CDS spreads are an indication of the market's perception of credit risk in these jurisdictions. The figure suggests linkages that require further analysis: the spreads for Florida, Massachusetts, New York, and Ohio have moved in lock step, and those of California and Illinois have followed similar patterns at higher levels. For the most part, the state spread movements show comparatively little relation to that of U.S. sovereign debt.

A significant data gap in assessing the leverage of the public sector results from government accounting procedures. Accounting standards differ across government entities, and governments do not ordinarily provide fair value estimates on activities like insurance programs, pension benefits, and contingent liabilities (Lucas, 2011). The joint report of the Financial Stability Board and the International Monetary Fund discussed in ***Box H*** includes recommendations for standardizing government finance data and creating a public sector debt database.

4.2.2 Liquidity

Liquidity has different meanings in different contexts. It is particularly important to distinguish *market* liquidity—the ability of a market to absorb large and frequent

transactions with limited price impact and low transactions costs—from *funding* liquidity, which is the ready availability of credit to finance the purchase of financial assets or to redeem liabilities. Liquidity risk can refer to the risk that an asset may become less liquid and thus harder to sell, but it can also refer to the risk of a cash shortfall resulting from a mismatch between the timing of cash flows generated by an asset and the cash needed to fund the asset.

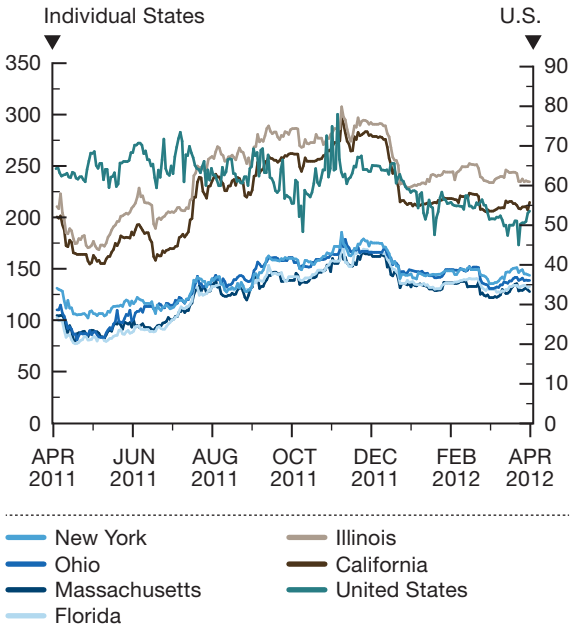
The discussion in this subsection focuses primarily on funding liquidity risk, but the two notions of liquidity risk are closely linked. If an asset has a high degree of market liquidity, it can be sold to avert the consequences of a loss of funding liquidity. Conversely, funding liquidity is of particular concern in financing the purchase of an illiquid asset. Moreover, as funding liquidity dries up, it becomes harder for leveraged investors to buy the asset, and this impairs its market liquidity.

As noted in the discussion of stress tests in Section 3.2, the two kinds of liquidity live on the two sides of institutions' balance sheets, with market liquidity on the asset side and funding liquidity an issue for liability management. Collecting data on both sides of the balance sheet is thus not just important to reconcile the books; it is critical for assessing threats to financial stability.

Short-Term Funding Markets

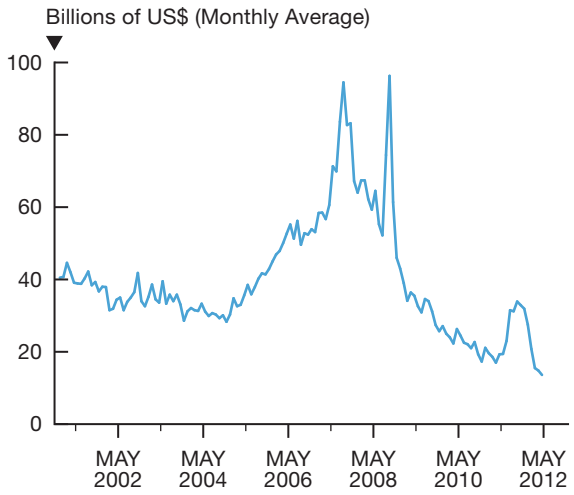
Short-term funding markets are the primary locus of funding and liquidity risk, particularly when they are used to finance illiquid long-term assets. This risk created by maturity mismatch is illustrated by a structured investment vehicle (SIV), a type of entity popular before the crisis that issued short-term commercial paper and medium-term notes and used the proceeds to invest in securities such as illiquid securitizations. Liquidity risk arose from the need to repeatedly roll over the short-term funding as it matured. A sudden pullback in funding provided by investors, triggered by uncertainty about the quality of the underlying investments, caused many SIVs to fail in 2007.

Chart 4.2.11 10-Year CDS Spreads: U.S. and Selected States



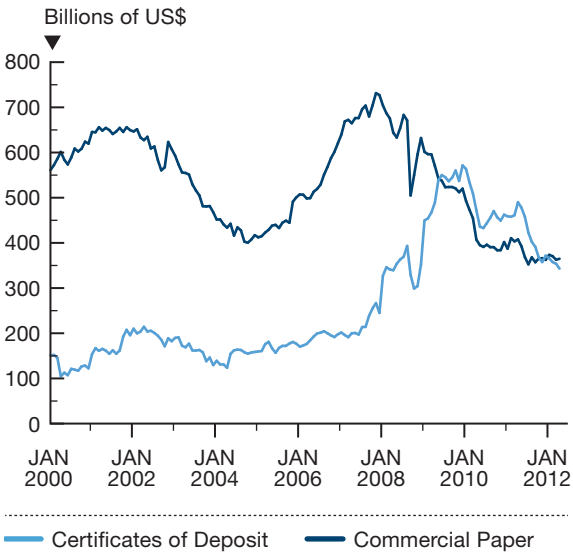
Source: Markit

Chart 4.2.12 AA Asset-Backed Commercial Paper Issuance



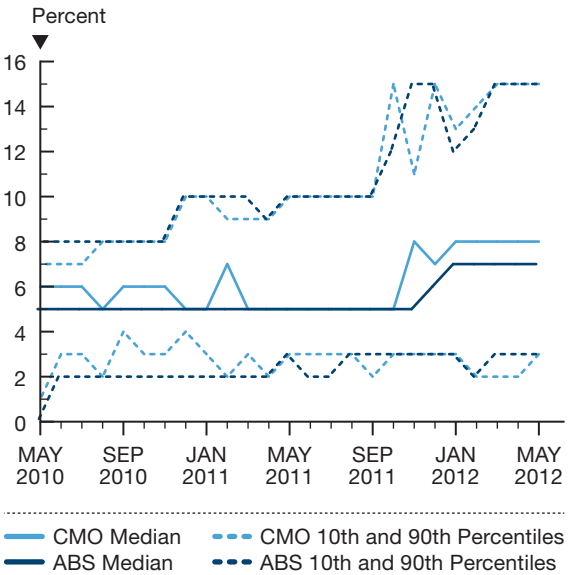
Source: FRB, Haver Analytics

Chart 4.2.13 Taxable Money Market Fund Assets



Source: Investment Company Institute, Haver Analytics

Chart 4.2.14 Margin Requirements for ABS and CMO Tri-Party Repo Collateral



Note: Some values were calculated by OFR and reflect the averages of the margins at a given percentile for investment and non-investment grade collateral.

Source: Tri-Party Repo Infrastructure Reform Task Force, OFR calculations

Investors suffered losses in some cases when SIVs sold assets at distressed prices; in other cases, SIV sponsors rescued investors despite having no prior obligation to do so.

While the SIV market came to an end in 2007, the yield spread generated through this type of maturity and liquidity transformation provides a persistent incentive for the development of products that capture this yield. Tracking the growth of financial innovations designed for maturity and liquidity transformation is a necessary part of monitoring the economy's overall liquidity risk.

Chart 4.2.12 plots the issuance of AA-rated asset-backed commercial paper, showing a collapse in late 2008. ***Chart 4.2.13*** shows the buildup and subsequent decline in money market fund investments in commercial paper, starting in 2004. The pullback from commercial paper that starts in 2007 is offset in part by an increase in certificates of deposits, creating a tighter link—and thus greater liquidity risk—between banks and money market funds.

The repo and securities lending markets discussed above are key components of short-term funding markets. Just as the magnitude of haircuts provides a measure of leverage, the volatility of haircuts—the extent to which they fluctuate—provides a measure of liquidity risk. With volatile haircuts, the amount a borrower can borrow against assets posted as collateral can drop sharply, forcing the borrower to find an alternative source of funds quickly. In 2007–2008, haircuts on asset-backed securities widened, triggering rapid sell-offs and contributing to falling prices. In quieter times, haircuts fluctuate little and therefore provide little information about changing sentiments. ***Chart 4.2.14*** shows increased volatility in margin requirements for repo collateralized by asset-backed securities and collateralized mortgage obligations in late 2011. More research is needed to understand the dynamics in different parts of the repo market that lead to spikes in haircuts, to "repo runs," and thus to sudden

contractions in short-term funding (Martin, Skeie, and Von Thadden, 2012).

Money Market Funds

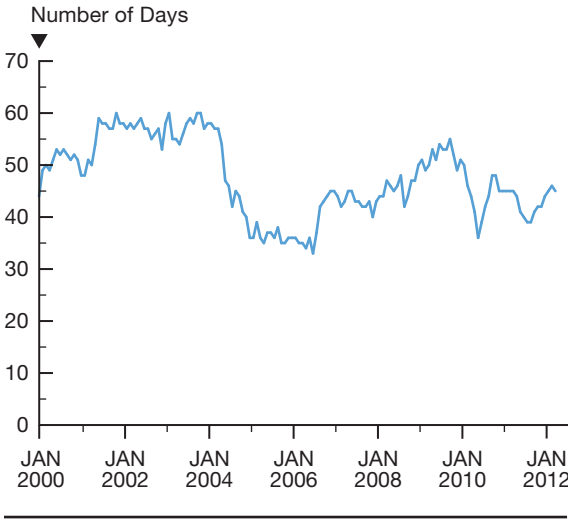
Money market funds are a major source of short-term funding, with over $2.5 trillion in assets under management. They also transmit liquidity risk between the funds' borrowers and investors. Banks and other financial institutions are large borrowers from money market funds; a sudden withdrawal from money market funds by investors, particularly large institutional investors, thus reduces short-term funding to the financial sector. The municipal bond market also relies heavily on money market funds and is thus vulnerable to a liquidity shock hitting the funds.

A simple but important measure of liquidity in money market funds is the weighted average maturity of their assets. ***Chart 4.2.15*** shows that this increased between July 2006 and October 2009, dropped sharply in 2010, and is currently around 45 days. However, a more complete picture of liquidity risk requires information on investor concentration: a fund dominated by a small number of large institutional investors will generally need greater liquidity than one with a broad base of small retail investors.

The OFR monitors money market fund holdings through monthly SEC filings. The filings are required of all funds covered by Rule 2a-7 of the Investment Company Act of 1940 (2a-7 funds). Form N-MFP provides valuable disclosure on money market fund investments. Remaining data gaps include the lack of information on a fund's investor characteristics, better information on repo collateral and collateral pricing, separate reporting of coupons on investments, and more consistent reporting of issuers—a task that will be facilitated by the adoption of an LEI.

Services similar to those of money market funds are provided by funds and separate accounts just outside the 2a-7 umbrella. With stricter liquidity requirements added to 2a-7 rules in 2010, liquidity risk may have migrated to non-2a-7 funds that invest at slightly longer maturities and take on greater credit risk.[1] The absence of data on these near substitutes for regulated money market funds could represent a data gap in monitoring liquidity and run risk in this important channel for short-term funding. The OFR will continue to work with the SEC and other FSOC members to consider this migration and its implications for risk monitoring.

Chart 4.2.15 Taxable Money Market Funds: Average Maturity of Portfolio



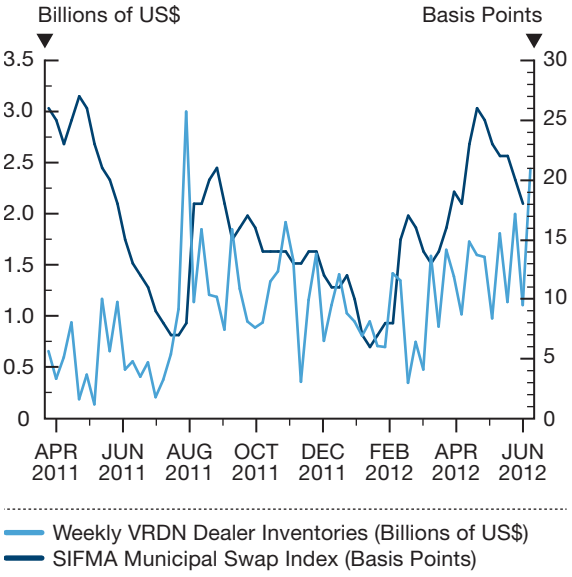
Source: Investment Company Institute, Haver Analytics

Liquidity Guarantees

Liquidity guarantees—typically in the form of guarantees from third parties to provide emergency short-term funding—can protect investors and can serve as buffers against temporary mismatches in cash flows between assets and liabilities. However, guarantees are also a potential transmission channel for liquidity risk if not carefully managed and monitored. A widespread call on guarantees is likely to coincide with other stresses on the market, creating the potential for amplified risk. Moreover, skittishness regarding whether implicit guarantees will be honored can create market stress.

SIVs have lost favor with investors, but legacy asset-backed commercial paper (ABCP)

Chart 4.2.16 VRDN Dealer Inventories and SIFMA Municipal Swap Index



Source: Bloomberg

conduits continue to operate on a large scale. Approximately 7 percent of prime money market fund assets are invested in ABCP and 4 percent of money market fund assets overall. A key difference between the two structures is that ABCP conduits carry a committed liquidity guarantee from a sponsor, usually a bank. An SIV typically has a much more limited liquidity backstop or just an implicit guarantee based on the sponsor's reputation. Citigroup bailed out its SIVs even though it had not provided liquidity facilities or guarantees to these vehicles. In defining the scope of new liquidity requirements, the Basel III liquidity coverage ratio specifically identifies non-contractual contingent funding obligations that a bank may incur to avoid reputational damage.

Most money market fund investments in municipal securities take the form of variable rate demand notes (VRDNs). The demand feature allows the holder to put the security back to a liquidity provider at par, typically on a weekly basis; this feature transforms a medium- or long-term municipal security into an investment eligible for a 2a-7 fund to buy. VRDNs are usually backed by a letter of credit or a standby bond purchase agreement from a third party, typically a bank. The potential systemic concern is the possibility of a sudden and widespread exercise of the demand option, straining the resources of liquidity providers at a time of other stresses in the financial markets. In the summer of 2011, with concerns rising over events in Europe and uncertainty about the debt ceiling in the U.S., dealer inventories of VRDNs climbed as investors seeking liquidity exercised their demand option (see ***Chart 4.2.16***, which also shows the SIFMA Municipal Swap index, reflecting the rate demanded for new issues).

Monitoring liquidity guarantees is an essential element of monitoring liquidity risk. There is currently no mechanism for aggregating financial guarantees across markets. Guarantees are often difficult to observe before they are invoked, and this is particularly true of implicit or perceived guarantees. Identifying where a breakdown in an implicit guarantee has the potential to create significant disruptions to the financial system presents a difficult but important research challenge.

The freezing of the auction rate securities market in 2008 illustrates the potential risk. The major dealers in these securities had traditionally supported the market by participating in the auction when necessary. But in February 2008, weakened by a worsening financial crisis, the investment banks declined to bid, allowing a string of auction failures. Investors sued, alleging that the auction rate securities had been sold as risk-free—sold with an implicit guarantee—leading dealers to buy back many of the securities they had sold. The freezing of this market aggravated the deterioration of funding liquidity as investors moved to safer assets. With greater clarity in advance, both investors and dealers would have been better prepared for the disruption in the market.

Hedge Funds and Liquidity

Hedge funds can affect and be affected by both market and funding liquidity in numerous ways. Many hedge funds hold illiquid assets; many

also constrain their investors' liquidity through limits on redemptions, but the potential for a liquidity mismatch remains. With high leverage, the risk of such a mismatch is magnified, as a rapid deleveraging and sell-off of illiquid assets may trigger a financial crisis. Crowded trades in the form of similar positions held by many funds increase the risk of a simultaneous sell-off and point to the need for increased reporting through Form PF. Hedge funds often rely on prime brokers for short-term funding, making the funds—and their highly leveraged investments in illiquid assets—vulnerable to liquidity shocks affecting dealers that might otherwise have no direct impact on the funds. These types of interconnections in the financial system, and their implications, are the focus of the next subsection.

4.2.3 Interconnectedness

Monitoring threats to financial stability requires understanding the network of connections through which financial distress can propagate through the financial system. In fact, the same financial institutions are linked through multiple networks defined by multiple types of connections. As a result, firm failure can present a shock in the market.

One-way Credit Extension. Institutions are linked through borrowing and lending. The failure of a borrower causes a loss to the lender. Since most lenders are themselves also borrowers, large undiversified losses can cascade.

Swaps. Swap transactions create networks of counterparties. Swaps are a form of two-way credit extension because a swap initially valued at zero may become an asset for one party and a liability for the other, depending on changes in market variables. Failures can propagate through this network as well.

Ownership. A parent and a subsidiary can be a source of strength or a source of vulnerability to each other. Understanding these relationships requires the ability to track ownership networks—networks with thousands of nodes for even a single large, complex financial institution. An important data gap preventing the understanding of financial networks is the lack of comprehensive and standardized information on ownership and various types of affiliations. The LEI helps to fill this gap, as discussed further in Chapter 5.

Service Provision. Financial institutions are interlinked through the many services they provide to each other, including mortgage servicing, custody, clearing and transfer services, brokerage, and investment management. The failure of a large, complex service provider could disrupt the functioning of many other financial institutions.

Contingent Exposures. The links in a network of contingent exposures are latent until activated by a contingency. An undrawn and uncommitted line of credit provides an example. Other examples include options embedded in other transactions and events such as downgrades that trigger collateral calls.

Guarantees. As noted in several places in this chapter, both contractual and implicit guarantees create important and sometimes vulnerable links between financial institutions. Reliable guarantees can enhance financial stability, but poorly managed guarantees can provoke a loss of confidence, and implicit guarantees can contribute to moral hazard.

Correlation and Concentration. Financial institutions operate in a shared market and are thus subject to common shocks. Investors of various types are interconnected, even if they do not transact with each other, through correlations in their asset returns. These correlations may lead them to unwind their positions simultaneously, creating a cascading decline in prices. This risk is exacerbated by crowded trades, that is, through the concentration of similar positions by many market participants. Such concentration creates fragility in the financial system and, with existing data, is difficult to detect. The development of standard product identifiers will help support the detection of risky concentrations.

These types of interconnections are illustrated through credit default swaps, short-term funding markets, and hedge funds.

Credit Default Swaps. A current focus of the OFR is the CDS market, which exhibits interconnectedness between protection buyers and protection sellers, and between CDS counterparties and reference entities. Interconnections in the CDS market have traditionally been opaque. They represent a potential threat to financial stability. Government intervention to prevent an AIG bankruptcy was prompted at least in part by fear of the potential impact on AIG's CDS counterparties. The OFR can help avert the need to make crisis decisions with limited information through ongoing analysis and monitoring of financial networks.

Short-term Funding Markets. These largely unregulated markets connect banks with funding sources that can quickly pull back in times of stress. Money market funds are a potential source of vulnerability for banks and others that rely on them for short-term funding *(Chart 3.1.1)*.

Hedge Funds. Hedge funds were among the first financial institutions hit by the collapse of subprime mortgage-backed securities in 2007, and the multiple roles of hedge funds in this episode illustrate the need for better data to monitor interconnections in the financial system. Many hedge funds took leveraged positions in subprime mortgage-backed collateralized debt obligations (CDOs) and faced a liquidity squeeze as falling prices led to margin calls from investment banks. This liquidity squeeze also affected long-short equity funds with no direct subprime exposure. As market conditions worsened and investors pulled out of hedge funds, the funds withdrew assets from their prime brokers, sharply reducing liquidity at the largest broker-dealers.

Hedge funds were also active managers of CDOs and among the largest investors in first-loss positions in these pools. Their participation was thus essential to the growth of the subprime mortgage market. Many hedge funds engaged in correlation trading, which involved taking long and short positions in different tranches of CDOs. The lack of transparency on the funds' multiple and potentially conflicting roles has led to accusations of impropriety. The many interconnections between hedge funds and the investment products at the heart of the financial crisis reinforce the need for better data on these linkages to improve the monitoring of networks in the financial system.

Across all of these instruments and markets, the ability to assess the degree and potential impact of interconnectedness depends upon the ability of financial stability analysts to uniquely define counterparties, financial products, and terms and conditions. An established LEI and similar common unique global identifiers for financial instruments would enable the aggregation of risks to identify exposures regardless of the source of the transaction data. These data standards, combined with standardized definitions and disclosures of terms such as collateral and haircuts where appropriate, are the building blocks of transactions, positions, and ownership interests. They describe the form of the connection between financial market participants and they provide insights into the mechanism by which financial instability can be transmitted and amplified.

Endnote

1. In this regard, the OCC issued a proposed rulemaking in April 2012 that would partially align the requirements for short-term bank common and collective investment funds with the SEC's revisions to Rule 2a-7 (OCC, 2012).

References for Chapter 4

Abbe, Emmanuel A., Amir E. Khandani, and Andrew W. Lo. "Privacy-Preserving Methods for Sharing Financial Risk Exposures." Working Paper, November 19, 2011.

Financial Stability Board and International Monetary Fund. *The Financial Crisis and Information Gaps*. Report to the G-20 Finance Ministers and Central Bank Governors, FSB and IMF, October 29, 2009.

Financial Stability Board and International Monetary Fund. *The Financial Crisis and Information Gaps: Progress Report, Action Plans and Timetables*. FSB and IMF, May 31, 2010.

Financial Stability Board and International Monetary Fund. *The Financial Crisis and Information Gaps: Implementation Progress Report*. FSB and IMF, June 30, 2011.

Financial Stability Oversight Council. *Annual Report*. Washington, DC: FSOC, 2012.

Geanakoplos, John and Lasse Heje Pedersen. "Monitoring Leverage." Working Paper no. 1838, New Haven, CT: Cowles Foundation, Yale University, November 1, 2011.

Lucas, Deborah. "Evaluating the Government as a Source of Systemic Risk." Paper prepared for the Conference on Systemic Risk and Data Issues, The Center for Financial Policy at the University of Maryland, Washington, DC, October 5, 2011.

Martin, Antoine, David Skeie, and Ernst-Ludwig Von Thadden. "Repo Runs." Staff Report no. 444, New York: Federal Reserve Bank of New York, January 2012.

National Institute of Standards and Technology. *Standards for Security Categorization of Federal Information and Information Systems*. Federal Information Processing Standards Publication 199. Gaithersburg, MD: NIST, February 2004.

Office of the Comptroller of the Currency. *Short-Term Investment Funds*. Notice of Proposed Rulemaking, Federal Register 77, no. 68, April 9. Washington, DC: OCC, 2012, 21057–21065.

Vause, Nicholas. "Enhanced BIS Statistics on Credit Risk Transfer." *BIS Quarterly Review* (December 2011): 85–89.

5 Promoting Data Standards

Stronger and more consistent financial data standards will enhance financial stability by addressing a major deficiency that impairs decision-making. Data standards, when implemented appropriately, will promote data transparency, comparability, and quality, enabling aggregation of risks, financial stability monitoring, and better firm risk management. Congress mandated the OFR to standardize the types and formats of data reported and collected. We have focused initially on one of the most fundamental standards: the need for a global Legal Entity Identifier (LEI).

5.1 What Are Data Standards?

Consumers and businesses are familiar with the value of data standards to promote understanding and comparability by providing common, clear definitions—examples include nutrition information published on packaged foods, the bar codes that, through the use of scanners, identify products at supermarket checkout lanes, and destination and other information on shipping containers. Standards also promote efficiencies and economies of scale—for example, note the growth of the Internet following common acceptance of the Internet Protocol.

The financial services industry and financial regulators have long employed data standards. There are common identifiers for registered securities, regulated legal entities, and certain financial transactions. Financial data vendors also use identifiers for their products, some of which have become de facto standards.

But these standards, while widespread in some cases, are not global or universal and are often plagued by gaps and overlap. They are sometimes subject to limits on use when they are proprietary, there is no common vocabulary or mapping to navigate among them, and they were not conceived or operated with a systemic perspective. There is also no consistent standard used to measure data quality.

The lack of high-quality, consistent, and accessible data was a key source of risk in the financial crisis. Risk systems designed to assess counterparty risk, interconnections, and short-term funding were strained because, in part, the data they required and even the reports they generated lacked standards for basic data identifiers, elements, and terms. Regulators and policymakers were caught trying to aggregate information from disparate systems, each with proprietary naming conventions for counterparties and instruments. Differences in the amount and consistency of information on terms and conditions of the data meant that even when common transactions were identified, there was limited assurance that they could be compared with certainty. The lack

of consistent and high-quality data not only exacerbated the buildup of risks, it also limited the ability to act decisively in the crisis. In sum, the market lacks standards on how to exchange, transport, and aggregate financial data.

Better data standards can solve many of these problems. Standard entity identifiers can uniquely identify parties to financial transactions; standard product identifiers can allow for comparability across financial products; and semantic standards about terms of contracts can provide precise definitions to describe the meaning of data. In addition, data can be assessed based on the quality of the information.

Each of these standards promotes *comparability*, which means that information can be reliably combined from different sources and systems and that terms and definitions mean the same thing—with no ambiguity—regardless of where the data came from.

Data standards sometimes evolve organically, as markets coalesce around a dominant convention, and they sometimes are set by industry organizations either through informal cooperation—such as the development of the Financial products Markup Language (FpML)—or formal consensus bodies like the International Organization for Standardization (ISO). Financial companies should welcome data standards: they reduce operating costs; they promote automation, so that information does not have to be manually checked and cleaned; they allow companies to aggregate their activities for analysis; and they promote straight-through processing, meaning that a transaction can be tracked consistently from the front office to the back office. For all these reasons, standards promote sound risk management.

In the short run, however, implementing formal data standards presents a collective action problem. Like national defense, data standards represent a public good—something available to everyone, whether or not he or she has borne any of the costs of providing them. Many in industry recognize the benefits of data standards and are eager to benefit from them. However, those benefits—for internal economic and operational risk management, for prudential supervision, for measuring and protecting financial stability—are long-term and diffuse, while the costs—incurred as a result of changing processes and systems to adapt to the standards—are immediate and concentrated for market participants, companies, and regulators themselves. Consequently, as with some other public goods, data standards require appropriate governance and oversight from public authorities.

That is why Congress assigned to the OFR the responsibility to promote and facilitate the development of financial data standards. The OFR has begun this important work, focusing initially on the need for a global LEI. We are now working to implement the global LEI and also are developing our priorities for further standards work.

This responsibility will require constant vigilance as financial markets and products evolve and standards grow obsolete ***(Box I: The Growth of Financial Market Data)***. The OFR and financial supervisors will not be able to monitor financial stability and financial companies will not be able to manage their risks if data standards don't keep up with these developments. At the same time, the requirement of any new standard should only be introduced after a thoughtful, careful analysis. The OFR is committed to engaging with the private sector and industry standard-setting bodies and working with regulators to align standards, as appropriate in well-defined cases.

There are many financial data standards in use today. One way to view financial data needs and standards can be by what they describe: entities, financial instruments, financial and business reporting, and transactions.

5.1.1 Entities

The financial crisis brought attention to the lack of comparability and consistency among entity identification standards.

Market participants—and their regulators—were unable to aggregate and then analyze their credit exposures to troubled financial institutions with many legal subsidiaries because there were no unique global entity identification standards in place that would facilitate the construction of definitive ownership or legal entity hierarchies. A large financial institution might have thousands of legal entities, each with their own names. Moreover, while there were identification methods in use in the market, they were diverse, incomplete, overlapping, and not directly comparable; this presented additional problems because of differing maintenance protocols, such as in describing the surviving entity of a corporate merger, the distinctions between different kinds of entities, or the reuse of identification numbers. As described further below, the OFR has made the establishment of a global and unique LEI one of its top early priorities and is active in the global LEI development effort overseen by the Financial Stability Board and endorsed by the G20.

A wide variety of entity identification schemes are used today to identify business, financial, and other entities that are involved in financial transactions. A number of regulatory standards have been established by agencies, including the Research Statistics Supervision Discount Identification (RSSD ID), which is a primary identifier used by the bank regulators, and the Central Index Key, which is used by the SEC to identify issuers, funds, and certain shareholders who have filed disclosures. The Financial Industry Regulatory Authority also has standards that it uses to identify broker-dealers and investment advisers who register with them. Various private sector organizations, vendors, and market participants also maintain proprietary entity identification standards that have met with varying levels of acceptance and adoption in particular markets, sectors, or applications. Some of these private standards have been accepted by the ISO.

Broad use of an LEI and the further spread of entity standards across the financial system could help market participants and regulators understand the linkages and relationships among legal entities. The incorporation of LEIs into hierarchies of related entities—based upon underlying factors such as ownership, control, or different types of exposure—would further facilitate aggregation. Ultimately, it would be a powerful tool to facilitate the analysis of such phenomena as network effects and spillovers in a crisis.

5.1.2 Financial Instruments

As with entity identifiers, there are multiple schemes both for the identification and for the description of the several million financial instruments that are currently in the marketplace. The impetus for financial instrument identifiers in the United States came from the "paper crunch" of the late 1960s, when trading volumes overwhelmed the ability of market participants to process and clear trades that were paper-based. This event led to the creation in 1968 of the CUSIP Service Bureau, a for-profit joint venture of Standard & Poor's and the American Bankers Association. CUSIP provides a common language for identifying financial instruments such as stocks and bonds. There is also an ISO standard for individual securities known as the International Securities Identification Number (ISIN). The CUSIP Service Bureau is the American member of the international association that maintains the ISIN standard.

But the CUSIP standard is primarily used for stocks, bonds, and some other instruments. Not all products have definitive standards. In the past decade, the evolution of specialized over-the-counter (OTC) markets such as credit default swaps has led to a proliferation of proprietary standards in this space. As with entity identifiers, extensive investment in software, data, and expertise has been required to maintain relatively "clean" and usable identifiers; nonetheless, errors and mismatches occur regularly. Because financial instruments, like entities, are not static, the data describing these instruments must be updated and maintained as corporate actions occur.

BOX I. THE GROWTH OF FINANCIAL MARKET DATA

The size and complexity of financial data has grown exponentially, reflecting the growth and complexity of financial activity. These changes pose increasing challenges to data managers.

The growth of the financial sector in the United States has been extraordinary. From 1952 to 2011, nominal GDP grew by 4,100 percent and financial sector assets grew by 16,000 percent, according to Flow of Funds data. The sector has also become extraordinarily complex with the growing ubiquity of derivatives and other risk-shifting products.

These developments create data management challenges because they increase the amount of data that has to be taken in, organized, and assessed. For example, every purchase of a share of stock is associated with a trade order; electronic quotes indicating the willingness of market participants to buy or sell a given amount at a given price; confirmation messages that the trade has been completed and settled; entries into the accounts at broker-dealers, mutual funds, or other agents; and data that gets wrapped into risk reporting of financial intermediaries.

Where all this data goes—and how effectively it is used, compared, and aggregated—determines how well the financial system manages risk. Any risks that are introduced in a balance sheet, trading book, or personal portfolio because of data gaps and a lack of data standards only grow more significant and potentially costly as the amount of data increases.

The charts illustrate the growth in financial sector data in the U.S. in the 2000s. ***Chart I.1*** shows the growth in electronic messages for the equities and options markets. Electronic messages include quotes and orders reported to 15 different markets. They are reported as the number of electronic messages per second for the busiest minute of the day; in essence, this reflects the peak strain on the electronic systems that are the backbone of these trading platforms. Since 2000, this measure has increased from about 7,000 to 2,400,000 messages per second.

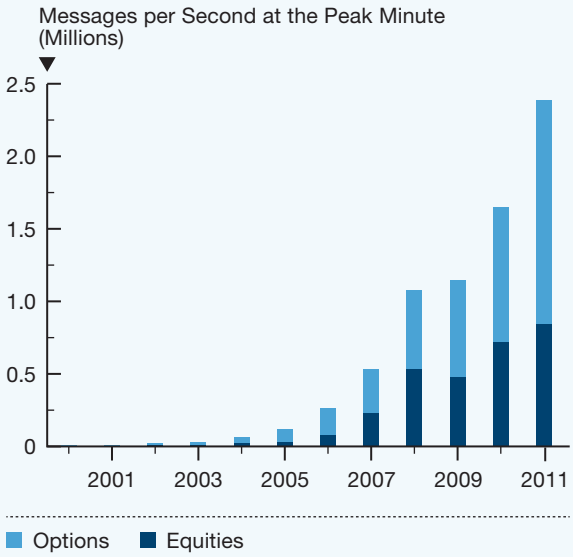
The growth in message traffic that creates these new data demands is not driven primarily by increases in the number of trades; between 2000 and 2011, annual trade volume in equities rose just 10 percent. Rather, it reflects increases in the number of quotes—indications that a market participant is willing to buy or sell—made possible by technological developments. Technology has increased the capacity of market participants to evaluate financial instruments and generate quotes, enabled algorithmic and high frequency strategies that play out across multiple trading venues and financial instruments, and increased the speed with which information can be processed. In 2000, options markets transmitted about 350

quotes for every trade. By 2011, that number had increased to about 7,750 ***(Chart I.2)***.

Meanwhile, options and equities are just a part of the financial markets. Similar trends are playing out in markets for fixed-income securities, futures, swaps, and other derivatives. And these financial instruments are often fundamentally related to one another—for example, options on the same underlying asset, or exchange-traded funds and the underlying stocks in their portfolios. Large and increasing volumes of data are generated by dozens of trading venues and hundreds of financial institutions across these markets and internationally.

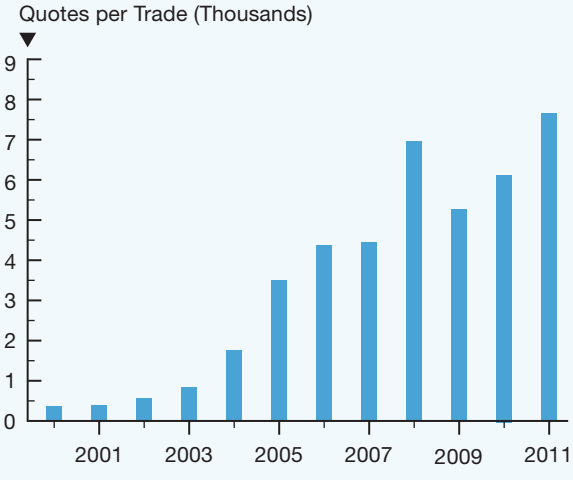
What is the implication of this data explosion for financial markets? Increased complexity and risk. The financial system needs to be able to compare, aggregate, and rely on millions of records created daily by different computer systems with different identifiers, different naming conventions, and different definitions. Such a complex and interconnected system is designed to fail without strong data standards and a common dictionary and definitions.

Chart I.1 Peak Messaging for Options and Equities Markets



Source: Statistics compiled by the Financial Information Forum with data from BATS, Direct Edge, SIAC, NASDAQ and NYSE Arca

Chart I.2 OPRA Maximum Quote to Trade Ratio



Source: Statistics compiled by the Financial Information Forum with data from SIAC

Derivatives pose special problems for standardization because they derive their value from underlying instruments. Asset-backed securities similarly represent collections of instruments, such as credit card receivables or mortgages. Tracing the contents of a product like a mortgage-backed security is especially difficult because there is no standard way to identify and link the specific underlying mortgages to the security. Other complex securities, such as collateralized debt obligations based on managed pools of assets, pose problems because of their complexity. Bilateral swaps can also pose difficulty because of their customized nature.

5.1.3 Financial and Business Reporting

Companies report information in public financial disclosures (such as 10Ks for the SEC), regulatory performance reporting (such as Call Reports for banks and Focus Reports for broker-dealers), and reporting of fund portfolios and positions. These reports have been dominated by standards imposed by regulators or other standard setters and implemented by vendors of accounting and portfolio software systems. This has been valuable for internal purposes for companies and institutions, but even post-merger integration of companies with systems provided by different vendors have been remarkably difficult to combine, even after years of effort. This will remain an issue until standards are adopted and used on a widespread basis.

The implementation of XBRL (eXtensible Business Reporting Language) is an important example of cooperation between the regulatory and business community to improve data standards with broad benefits. Developed in 1998 by a team of accountants and technologists, XBRL is maintained by XBRL International, Inc. and its units at the national level, and it is used extensively in the financial markets. In practice, standardized lists ("taxonomies") of definitions ("tags") are developed, maintained, and used for reporting. The taxonomy for U.S. GAAP (Generally Accepted Accounting Principles) reporting to the SEC, which required all publicly listed companies to report using XBRL starting in 2009, is maintained by the Financial Accounting Standards Board, while the taxonomy for the Call Reports is maintained by the Federal Financial Institutions Examination Council (FFIEC) *(Box J: Case Studies in the Adoption of Data Standards by U.S. Regulators)*.

5.1.4 Transactions

Financial transactions represent an area in which the industry has developed standards without government intervention, although there are gaps and weaknesses in those standards. The Financial Information eXchange (FIX) protocol was developed in 1992 out of the trading relationship between Fidelity Investments and Salomon Brothers; it was incorporated as an independent standards organization, FIX Protocol, Ltd., which now oversees a standard for the communication of electronic messaging and transactions. This is an example of how a de facto standard has become a global standard used widely in financial market transactions. The FIX standard has become ubiquitous in the electronic trading of listed securities, including equities, bonds, commodities, currencies, options, and other listed derivatives.

Similarly, FpML was developed from eXtensible Markup Language in 1997 at JPMorgan to provide a methodology to consistently transact derivatives instruments and has become a de facto standard for transactions in derivatives. An FpML organization was created in 1999 to maintain the standard. Again, derivatives and complex securities pose particular problems in standardizing transactions data, but these problems are tractable.

Financial market infrastructure systems used for payment, clearing, settlement, and collateral management are typically based on a combination of FIX, FpML, and the SWIFT (Society for Worldwide Interbank Financial Telecommunication) messaging protocol, depending on the types of instruments and the trading venues. The use of ontologies and

semantics is a promising new avenue to resolve discrepancies in this area.

5.1.5 Definitions of Common Concepts

Behind the preceding discussion of entities, products, reporting, and transactions is the notion that consistent definitions and representations of common concepts across the financial system reduce risk and enhance financial stability. In general, every reader has a shared idea of what the words "bond" or "stock" mean when used in the context of a financial instrument. The commonly shared concepts of these terms ensure the speaker and listener agree to their meanings in conversation without further elaboration or definition. But other terms in the financial lexicon are often murky and undefined. The definitions and terms of a structured product or an OTC derivative are examples where the lack of consistency in terminology can prove costly.

Within the context of electronic systems that capture the data associated with financial transactions, instruments, and positions, the ability for multiple systems to rely on the common definitions of terms and the meanings of names would provide important benefits for aggregation and operational consistency. Users of the combined data could rely on the fact that differences are not attributable to differences in data design or definition. Data could be more easily aggregated to evaluate firmwide, marketwide, or systemwide exposures.

Common definitions often reside within a single type of transaction, financial product, report, or entity. For example, the term "net income" can be defined in a common calculation for all annual 10-K accounting reports, or a "call feature" can be designed to include similar characteristics or types of terms for all callable bonds. They also can also reside across transactions, products, reports, or entities. The same description could be assigned to the term "net income" in any and all reports where net income is reported.

The value of common concepts exists at a very granular level for data collections. It is exactly at this building block level where differences in definitions limit comparability as data are combined and aggregated. Financial innovation often occurs by changing, often slightly, the terms and conditions of an existing instrument to create something new. But when the way the data are collected and stored does not capture differences in the definition of commonly shared terms, risks can be aggravated.

5.1.6 Libraries and Repositories: Keeping Track of Concepts and Structures

As standards are developed for entities, transactions, reporting positions, definitions, and other dimensions of the financial system, it is important to establish a strong and well-designed system for tracking definitions, ensuring that where possible there are consistent definitions and mapping across standards, and that there is a pool of existing concepts, definitions, and tags to draw from when new data models are being characterized or built. OFR has the mandate, in coordination with other agencies and institutions, to develop a library or repository for data representations and metadata.

BOX J. CASE STUDIES IN THE ADOPTION OF DATA STANDARDS BY U.S. REGULATORS

The OFR will increasingly work with the regulatory agencies to help promulgate and encourage the adoption of data standards that facilitate the sharing of data among agencies and promote the transparency of financial activity. The concept of interagency collaboration is not new; the U.S. financial regulatory agencies have been sharing data with one another for decades and have moved in recent years to better standardize the collection and distribution of data.

The Central Data Repository (CDR) provides one example of an interagency collaboration project aimed to improve the intake, management, and distribution of data through the adoption of common data standards. The banking agencies on the Federal Financial Institutions Examination Council (FFIEC)—the Federal Reserve, FDIC, and OCC—collaborated to build the CDR, a data collection and distribution system for Call Report data built on eXtensible Business Reporting Language, or XBRL.

The business case for the project was clear and compelling. Prior to the CDR and the use of XBRL, the process of collecting, managing, sharing, and publishing Call Report data was inefficient, had multiple handoffs among participants in the data collection process, required significant time to achieve high data quality, and lacked process transparency. Validation of adherence to reporting requirements and the quality of data submissions were not uniformly applied to all submissions because of the multiple systems involved in the process. Thus, accurate data could only be achieved at the expense of the timeliness of the data.

By adopting the use of XBRL within the CDR, the agencies were able to achieve a transformation in the data management process for Call Report data. Reporting requirements and data quality requirements are now expressed electronically and in machine readable format using XBRL and can be shared among all participants of the data supply chain. This revolutionary way to share reporting metadata among the agencies, reporting institutions and report preparation vendors enabled the agencies to realize tangible business benefits, including cleaner data, faster data inflow, increased productivity, and seamless throughput.

Soon after the implementation of the CDR, the agencies released a Public Data Distribution (PDD) system built on the CDR to modernize and standardize the way Call Report data are distributed to the public. The PDD system leverages the CDR's internal metadata and XBRL taxonomies to automate the flow of information directly from the data intake point, through validation, to direct publication to the public after the data pass certain validation criteria. This automated throughput increases the timeliness of the data for public consumption as well as the transparency of the standards used to validate the quality of the data.

Another example is provided by the effort to improve information about money market funds (MMFs).

The SEC in 2009 mandated that MMFs file monthly a new Form N-MFP with detailed information about their holdings, among

other information, in a file using XML and a standardized set of tags and definitions. This made such information available for the first time—and in a format that the OFR's Data Center can take in from the SEC for use by researchers and for reporting to the FSOC. The OFR can share the transformed MMF data back to the SEC and other FSOC agencies, saving them effort and preserving comparability.

However, lack of a standard, universal set of identifiers makes it difficult to ensure that securities issued by multiple entities that are related, but which have different names, are in fact the same entities; because of this, aggregating exposures is slower than it should be and prone to errors that would disappear with a proper entity identifier. The lack of consistent identification standards for the entities associated with portfolio securities was and will continue to be a barrier to effective analysis and monitoring of the MMF sector.

5.2 Benefits of Data Standards

Improved data standards would create important benefits for market participants, regulators, and the OFR in its mission to analyze threats to financial stability.

5.2.1 Benefits to Industry

Standardization significantly reduces costs and risks for private companies. Institutions spend billions of dollars simply to cleanse, correlate, link, and maintain vital but complex information on entities, securities, transactions, and other financial information, most of which are dependent on one or more existing standards. But since each financial company creates its own master list of entity and product identifiers, each set depends on different standards, and multiple standards schemes are required to gain full coverage of a domain, for example, across instruments or entities. Businesses spend a great deal of money on technology, tools, and staff to index and map records across different standards—including the often-necessary internal standards across their organization—and to ensure that data integrity is maintained.

Even after a company makes such investments, there remain gaps and inaccuracies. For example, a major cause of failed trades is the use of inaccurate standardized data such as company or product identifiers. And, if the quality of institutional data is poor—say, about its own counterparties and their ultimate parent companies—then a financial institution's own risk management will be inaccurate, which could contribute to erroneous decisions and inappropriate risk-taking.

In short, improved standards are important tools for institutions to advance their own resilience to risk, via better and stronger reporting tools, reporting data quality, and more timely information. The expense of improved industry standards and adoption of global standards could be outweighed by benefits to the gathering, maintaining, cleansing, and use

of critical data for the industry's own operations, risk management, and regulatory compliance.

Industry practitioners have long been aware of these issues but are hampered by both collective action problems and internal incentive issues.

5.2.2 Benefits to Regulators

Data standards are a vital and powerful tool that the Council and its member agencies can use to reduce the complexity of sharing and using data and to improve the information provided to policymakers.

Among the U.S. banking regulators on the FFIEC, there is some standardization of collections in the bank Call Reports and other regulatory data, using the XBRL data standard and a set of common definitions for financial terms. However, agencies vary widely in the complexity of their data analysis requirements and corresponding data management systems. There are many opportunities to converge on existing standards or to develop new ones where none exist. This is essential to understand a financial system dominated by large, complex financial institutions that cross agency lines. Common standards will save money for regulators, increase regulatory productivity and improve outcomes at both the microprudential and macroprudential levels.

The opportunities for sharing information, savings, improved productivity, and better analysis and analytical tools are as great for the Council as the benefits can be for the OFR and for industry. There has been enthusiasm among the Council agencies about the opportunity to develop common standards and to share existing data. The OFR has been working with the agencies, directly and through the Council and its Data Committee, in order to facilitate greater interagency data sharing and to promote data standards.

5.2.3 Benefits to Financial Stability Monitoring

The OFR's ability to research and monitor the financial system is hindered by the fact that financial data are fragmented into innumerable sets, each with its own technical, definitional, classification, identification, and other standards. Financial stability monitoring and analysis are hindered when data from multiple institutions, sectors, or markets cannot be linked, integrated, and analyzed on a timely or accurate basis.

For example, the analysis of interconnectedness among large, complex financial institutions requires aggregation of data about counterparty risk exposures for large numbers of complex and ever-changing positions. While the data describing some securities—say, exchange-traded equities or basic plain vanilla swaps—are relatively standardized, data on some of the most important securities are non-standard or have multiple non-integrated standards. This can happen because of convention or because there are multiple service providers, each with its own proprietary standard. Even where there is a data standard, the lack of other, related standards prevents reliable analysis of the data.

Data scrubbing and other traditional approaches can be adequate for some analytical purposes that require limited information, for example in studies of single sectors of securities or markets. However, given OFR's financial stability mission and its forward-looking posture, traditional matching and maintenance techniques are not likely to produce actionable data fast enough. In order to use data for research or for monitoring on behalf of the Council, OFR would have to carry out activities that might be prohibitively expensive, extremely time-consuming, and even then likely to yield incomplete and imprecise data. Where strong data standards exist, the OFR has been able to gather and analyze data swiftly, as in the case of the data about money market funds contained in the SEC's new Form N-MFP.

Data standards become even more crucial when it comes to complex markets or products, such as OTC derivatives, or for combining data for securities that are traded across multiple markets. For example, despite the fact that repos

are major funding vehicles for large, complex financial institutions, data standards do not exist. As a result, it remains difficult to gather and compare these important securities with respect to portfolio holdings, trading, and their other characteristics. To the extent that the repo market is vital to the stability of the financial markets, analysts must be able to routinely and precisely access data about this market.

Fueled by globalization and advances in computer power, derivative markets have exploded in size and complexity over the past 20 years. Techniques for structuring securities composed of multiple underlying instruments have led to an almost infinite possible number of connections among firms, their counterparties, and the underlying assets at risk. This complexity has tended to overwhelm the more mundane accounting and back-office processing systems in the supply chain, creating what has been described as a "data fog," where specific, discreet answers to questions about who owes who and how much are incredibly difficult to resolve (Tett, 2012). Data standards are not a panacea, but they are a necessary and required part of any solution.

With better standards, the Council and the OFR will be able to conduct more and more reliable research into the sources of threats to the financial system. Researchers will also be better situated to evaluate the efficacy of the guardrails and shock absorbers put in place to limit the buildup of risks. Policies for consideration by the Council can be developed more confidently, practically, and on a timely basis.

5.3 The LEI Initiative

A Legal Entity Identifier (LEI) is a unique code to identify legally distinct entities that engage in financial market activities. Longstanding issues with incompatible systems have contributed to delays and errors in risk assessments for both supervisors and industry participants. Building on earlier work by Treasury staff and the industry in 2010, OFR staff initiated discussions with the FSB in July 2011, leading to a global initiative to address the issue. This initiative, endorsed by the G20 and led by an FSB Expert Group of foreign and U.S. authorities, including the OFR, made substantial progress in the past 12 months and is an impressive example of cooperation among diverse regulators, standard-setters, and private market participants in pursuit of a standard with deep and clear benefits. In May 2012, the ISO published an LEI standard, consisting of a 20-character alphanumeric code and a minimal set of reference data. In June, the G20 endorsed the FSB's recommendations calling for the implementation of a global LEI by mid-2013, consistent with the ISO standard. OFR staff will continue to play a leading role as this process moves forward.

Historically, the financial industry has lacked a globally accepted standard to identify the parties to financial transactions or the legal entities that create financial instruments. Over time, market participants and the supervisory community created a variety of public and proprietary entity identifiers that address specific needs but none that provides a single industry-wide or global solution.

This gap in standards has made it difficult for risk managers and the supervisory community to analyze counterparty risks, credit exposures, and the relationships between large financial companies and their subsidiaries. Market participants have borne the expense of building and maintaining custom applications that translate and map among systems of identifiers—but these applications require

significant effort, particularly in updating identifiers following corporate mergers and acquisitions, and often relate to only narrow segments of the market. The lack of a standard entity identifier has made it difficult for supervisors to monitor and analyze threats to financial stability, and risk managers have been unable to manage firmwide risks on a timely basis.

While the lack of a universal global entity identification system has been a problem for decades, the financial crisis exposed the depth of the problem. When Lehman collapsed in 2008, neither financial regulators nor private sector risk managers were able to view the total extent to which important market participants were exposed to Lehman and its many legal entities, nor how market participants were connected to each other in global markets.

Industry proposals to address the lack of a standard for entity identification go back at least 20 years. Collective action problems and structural incentive issues have prevented private industry from solving this problem on its own. It is generally agreed that regulators can and should play a role in assisting in the creation and global adoption of a standard when this occurs by requiring standards for regulatory reporting.

In 2010, a task group of U.S. regulatory agencies published a discussion paper on the need for a standardized global LEI (Bottega and Powell, 2011). Several of the contributors to that report have since joined the OFR. Based on its authority under Dodd-Frank and leveraging the strong interagency and private industry consensus on the need for a global LEI, the OFR's first policy statement in November 2010 called for the establishment of a universal standard for identifying entities through a consensus process including the financial industry and international standard-setting bodies (OFR, 2010). In the same month, the SEC and CFTC proposed rules, also under Dodd-Frank, for the reporting of swaps and security-based swaps that would require a unique identifier for counterparties, should one be available.

The response to the OFR, SEC, and CFTC statements among the industry, international bodies, and foreign regulators has been very positive. In 2011, a global coalition of financial services firms and trade associations published a proposal for industry requirements for a global LEI solution (SIFMA, 2011). Beginning in July 2011, the OFR helped lead the U.S. engagement with national and global authorities, standard-setters, and industry organizations to advance the LEI initiative on the international level. With the endorsement of the G20, the FSB coordinated efforts of the global regulatory community to begin to develop governance and standards recommendations for a global LEI.

The FSB held a multi-day workshop in Basel, Switzerland in September 2011 inviting all stakeholders, public and private, to engage in a range of discussions on the development and implementation of a global LEI. Following the workshop, in December 2011 the G20 endorsed the creation of the FSB LEI Expert Group to study the issue in an expedited fashion and to create recommendations for delivery to the G20 Leaders Summit in June 2012. OFR's engagement through the FSB LEI Expert Group was deep and extensive, chairing and co-chairing working groups and actively working with public and private stakeholders to develop consensus. The culmination of these efforts was the delivery of the LEI Expert Group recommendations to the FSB Plenary meeting on May 29–30, 2012, addressing critical issues of governance, operating principles, and structure for an LEI and recommending its implementation (FSB, 2012).

In May 2012, ISO published its LEI standard, ISO 17442-2012. ISO 17442-2012 describes a 20-character alphanumeric code and a limited set of reference data that enable unique identification of global entities and defines robust open governance of the issuance and maintenance of the LEI data. The LEI will be available worldwide and is scalable. LEI codes

will be unique and will persist with their entities over time (ISO, 2012). OFR staff participated in the ISO LEI standard-setting process and initiated ISO Secretariat interactions with the FSB LEI Expert Group.

On June 20, 2012, the G20 leaders endorsed the FSB recommendations on next steps for implementing the global LEI proposal, consistent with the ISO standard. Following that endorsement, the FSB established the LEI Implementation Group to follow through on the timetable set forth in the recommendation for the global LEI system to be operational by March 2013. OFR is the primary lead for the U.S. regulatory community, working with U.S. regulators and private industry, and is the co-chair of the FSB Implementation Group for the Americas.

The OFR is also working closely with the Council agencies to prepare for the availability of a global LEI. For example, it is working closely with the CFTC to facilitate development and implementation of the CFTC Interim Compliant Identifier (CICI) for swaps. The CICI is compliant with the ISO standard and represents an early implementation of the global LEI system.

References for Chapter 5

Bottega, John A., and Linda F. Powell. "Creating a Linchpin for Financial Data: Toward a Universal Legal Entity Identifier." Finance and Economics Discussion Series 2011-07, Washington, DC: Board of Governors of the Federal Reserve System, January 21, 2011.

Financial Stability Board. *A Global Legal Entity Identifier for Financial Markets.* Report to the G-20 Finance Ministers and Central Bank Governors. FSB, June 8, 2012.

International Organization for Standardization. "ISO 17442:2012. Financial services—Legal Entity Identifier (LEI)." ISO, 2012. http://www.iso.org/iso/catalogue_detail?csnumber=59771 (accessed July 3, 2012).

Office of Financial Research. *Statement on Legal Entity Identification for Financial Contracts*. Federal Register 75, no. 229. Washington, DC: OFR, November 30, 2010, 74146-74148.

Securities Industry and Financial Markets Association. *Requirements for a Global Legal Entity Identifier (LEI) Solution*. SIFMA, May 3, 2011.

Tett, Gillian. "Guiding light needed to cut through the data fog." *Financial Times*, March 8, 2012.

6 The Agenda Ahead

For the coming year, the OFR will continue to assess and monitor threats to financial stability, to evaluate mitigants to those threats, and to improve the scope and quality of financial data required for that work, focusing on repo and other short-term funding markets. We will conduct further research on financial stability measurement, stress testing, and risk management, and we will begin new research applying network analysis to the study of the financial system. We will also work toward implementation of the Legal Entity Identifier (LEI) in 2013 and initiate further work on financial data standards.[1]

This first Annual Report describes the foundational work to fulfill the OFR's statutory mandates. To date, the OFR has developed frameworks to understand the financial system and conduct research on financial stability; to monitor developments and sources of vulnerability in the financial system; to identify data needs for research and monitoring and to address data gaps; to build an infrastructure to support the Council and its own researchers; to promote and help implement data standards; and to build the institution to facilitate that work.

Getting the foundations right represents only the first of many steps toward achieving these goals. The architecture of the financial system will continue to change and evolve rapidly in response to market and regulatory forces. The more we learn about the financial system and its relationship to the economy, the more new metrics and questions will dominate the debate. Thus, the agenda ahead involves continuing to build on those foundations while expanding our ability to take on new projects that respond to the expectations of the statute and the evolving needs of the Council.

This report describes in separate chapters our agendas for assessing financial stability, conducting research, addressing data gaps, and promoting data standards, but it is important to note that these activities are closely interwoven. Good research and monitoring depends on good data, but research questions determine data needs and help identify the gaps where data may need to be organized, standardized, linked, or collected. Data gaps may also be identified by Council agencies or through interactions with other stakeholders.

As discussed in Chapter 2, three broad themes currently drive our data and research agendas: To understand how the financial system is evolving, to assess emerging threats to financial stability, and to evaluate mitigants to potential threats. While measuring, monitoring, and analyzing the stability of the financial system will always require agility due to the constant innovation and evolution in institutions and markets, we expect that these themes will continue to serve as a compass for our work in the future.

To pursue a complex and evolving research agenda, the Office will continue to build our capabilities for monitoring, investigating, and reporting on potential threats to financial stability. The research agenda will focus on how each of the six basic functions of the financial system—credit allocation and leverage, maturity transformation, risk transfer, price discovery, liquidity provision, and facilitation of payments—are conducive to risk buildups and how they behave under stress.

We are particularly interested in the forces that promote the migration of activity into unregulated or lightly regulated markets, the so-called shadow banking system. Experts disagree on the precise boundaries of the term "shadow banking." In our view, it would always encompass credit intermediation by unregulated financial institutions—even in conjunction with or on behalf of regulated financial institutions—in combination with the creation of money-like liabilities, involving leverage and maturity transformation, in opaque markets.

Short-term funding markets, especially for secured repo transactions, play a pivotal role in this chain of intermediation and can propagate distress across the financial system during market disruptions. We plan to focus extensively on understanding and collecting better data on repo markets in the coming year ***(Box K: Improving Research and Data on Repo Markets)***.

The three research topics that are highlighted in Chapter 3 of this annual report—financial stability indicators, stress tests, and risk management—will always be top priorities for the Office, as mandated in the statute.

Two dimensions of stress-testing technology will be immediate concerns. First, the Office will investigate practical steps to help practitioners and supervisors validate their models against one another. The Comprehensive Capital Analysis and Review (CCAR) exercise generated two sets of stressed results for each institution, one using the institution's internal models and another using supervisory models. Comparing an institution's estimated losses with those implied by CCAR models should permit both parties to improve the quality and consistency of their modeling—contributing to the state of the art in risk measurement. Second, the CCAR process generates a significant amount of institution-specific data which has not yet been aggregated for macroprudential analysis. We intend to evaluate how individual institutions' CCAR results can be combined to identify potentially disruptive shared risk exposures.

Other important themes for future research include characteristics of credit cycles and connections and feedback loops between the financial system and the economy. Housing finance has been and will continue to be a key source of such

connections and feedback loops. In light of the international nature of financial activities, we will also be very interested in improving our understanding of cross-border transactions and positions.

Another theme is the nature of financial networks, which can be described either by instruments and obligations (what is being traded) or by counterparties (who is trading with whom). The OFR needs to understand how networks work in order to analyze behaviors such as contagion during financial crises. Network analysis can help uncover latent connections among market participants—who typically know their own exposures to counterparties but not the exposures of their counterparties to other counterparties—and foster understanding of how those interconnections can break down during a crisis. Of course, the application of network analysis to financial systems presents novel analytical challenges. There are many participants of different sizes and different roles and an ever-increasing number of instruments that allow risk to be transferred. Stress testing such a system is very complex but could help us identify specific structural elements that are most vulnerable to shocks and most likely to transmit shocks through the network. That knowledge, in turn, could allow for construction of early warning models to provide policymakers with information about potential threats to financial stability.

Each of these research themes will contribute to our understanding of risks and vulnerabilities in the financial system and the interconnections among companies that can contribute to contagion in a crisis. Each will also help us identify gaps where supervisors need data to be better organized, standardized, or collected. In the coming year, the Office will continue our working paper series; subsequent working papers are forthcoming on the use of agent-based modeling as a tool for stress tests, contingent capital as a countercyclical tool, and macroprudential policy. We will also continue to strengthen our ties with the community of academic and other financial experts, building on the conference on the macroprudential toolkit that we hosted in December 2011 (Gudmundson, 2011). The OFR's Financial Research Advisory Committee will promote a broad perspective on financial stability issues and provide further opportunities for collaboration.

The OFR's data agenda is closely tied to our research agenda. We have a very important mandate to address gaps in the data needed to monitor threats to financial stability. FSOC member agencies' data collections provide an important first source of information that has yet to be fully utilized for the purposes of macroprudential policy. In the coming year, we will focus on ways to catalogue, connect, and share among agencies what is newly or already collected, creating additional benefits to financial stability analysis while minimizing duplication and the burden or cost to the private sector.

As noted in Section 4.2, we will focus our near-term data efforts on understanding metrics for the sources of leverage, liquidity risk, and interconnections among financial firms—particularly as they emerge in the derivatives and shadow banking markets. The experience of the past 10 years has proven the systemic dangers that can emerge when supervisors do not follow risks that are building in these

BOX K. IMPROVING RESEARCH AND DATA ON REPO MARKETS

The OFR believes that understanding the repo market is crucial to assessing vulnerabilities in the financial system and designing policy tools to mitigate them.

For years before the financial crisis, repos provided a stable and liquid market in which companies could fund long-term assets with short-term debt. The presence of high-quality, liquid collateral seemed to assure that borrowers would be able to continue to roll over their funding. Repo lenders could rely on both the counterparty's creditworthiness and the collateral underlying the transaction.

Yet, in 2007 and 2008, repo financing dried up for companies like Countrywide, a mortgage lender, and Bear Stearns, an investment bank. The conventional wisdom is that money market funds and other repo lenders withheld funding from these companies and others because of the real or perceived costs related to seizing and selling collateral, or because of concerns about runs by their own investors. This behavior surprised market participants and supervisors and had contagion effects in financial markets.

Why did the apparent security of repo liabilities disappear? Were money market funds more likely than other repo lenders to pull their funds? As counterparties' creditworthiness became more questionable, why didn't repo lenders simply increase their required haircuts, to make the collateral provide more protection? Was this funding withdrawal preceded by other signs of tightening, such as a change in rates or haircuts? In general, should regulators view repo finance as equivalent to unsecured credit?

Following on the experience during the crisis, supervisors would like to understand the extent to which repo lenders rely on the borrower's creditworthiness rather than on the value of collateral posted in the transaction. Understanding the repo market requires collection of transactions-level data about the repo market—information that is presently unavailable to regulators.

Although the repo data collected by the Federal Reserve Bank of New York have improved considerably since the crisis, that data remain insufficient to understand when and how repo financing conditions are changing in ways that might affect financial stability (Adrian and others, 2012). Research needs to encompass all three repo markets: tri-party, Delivery versus Payment, and General Collateral Finance. The behavior of these markets differed starkly in the crisis.

The benefits of repo market analysis will accrue to both on-site supervisors and to those monitoring threats to the financial system more broadly. A more granular view of the repo markets would help improve macroprudential policy in three ways. First, it would provide information about the degree of stress in financial markets as a whole. Second, it would help inform policy—for example, there have been proposals to address the procyclicality in repo markets by introducing policies on haircuts, akin to the margin requirements that the Federal Reserve imposes under Regulation T in the stock market. Third, it would allow financial stability analysts to learn more about the mechanics of funding markets, such as the transfer of risk or trade segregation within prime brokerage transactions, and in the relationship between repo financing and securities lending (FSB and IMF, 2012).

markets (Tarullo, 2012). While significant progress has been made, particularly in the emergence of swaps trade repositories, the level of transparency in these markets must improve. Failure to address data gaps in these areas is and will remain a threat to financial stability and a significant focus for the OFR and financial supervisors. To that end, we have also begun to receive data about credit derivatives, money markets, and repo markets, and we expect that these data will be the source for valuable OFR research, in collaboration with Council member experts, in the coming year.

To promote data standards, the OFR will continue to lead the initiative among U.S. regulatory agencies toward the establishment of a global Legal Entity Identifier (LEI), working with the international regulatory community and private industry. The International Organization for Standardization's publication of an LEI standard and the G20 leaders' March 2013 deadline are historic developments in an international public-private collaborative effort to promote transparency and efficiency for financial institutions and their regulators.

While the LEI initiative is the top OFR standards priority at this time, future agenda items are being identified and considered. Standards gaps that may be considered include product classifications and identifiers, semantic standards, and quality standards. OFR will maintain and continually update its understanding of the standards priorities of its researchers, the Council agencies, and the industry. The OFR is also obligated by statute to standardize and publish lists of entities, products, and their associated reference data, as a standards activity that will have immediate benefit for the public. We plan to get these efforts under way in the coming fiscal year.

The OFR will continue to develop and refine its technology architecture, policies, and procedures, and to add analytic tools to allow for the further acquisition, cataloging, validation, aggregation, and distribution of data. This will provide the ability to quickly respond to new requests for data while ensuring the confidentiality, security, and proper use and distribution of the data it collects.

In each of our activities, the OFR is collaborating closely with the Council member agencies that have a role in financial stability supervision and regulation. The OFR has begun to provide data and analytical services to the Council and its member agencies, such as the analysis to support the Council's work in identifying criteria for designating asset management companies for enhanced prudential supervision by the Federal Reserve as required by Dodd-Frank. We have supported the establishment of the Council Data Committee as a forum to discuss data-related issues among member agencies. There is also an important international component to all of our work; for example, we are working to promote improved data collection and data standards through international bodies such as the Financial Stability Board and the G20.

Success in all of these endeavors will depend on building a strong professional organization and a secure and robust technological infrastructure. In all cases, we will carefully consider costs and make sure that the technological and data infrastructure is secure before receiving sensitive data already available to regulators or undertaking any new data collections.

Endnote

1. The OFR's Strategic Framework, issued in March 2012, described our near-term objectives: (1) Ramp up services to FSOC, its member agencies, and their staffs, (2) Begin to publish OFR data and analysis, (3) Accelerate work to establish the secure information technology platforms and business systems critical to achieving our mission, and (4) Continue to build and reinforce the OFR's institutional infrastructure (OFR, 2012).

References for Chapter 6

Adrian, Tobias, Brian Begalle, Adam Copeland, and Antoine Martin. "Repo and Securities Lending." Staff Report no. 529, New York: Federal Reserve Bank of New York, January 2012.

Financial Stability Board and International Monetary Fund. *Securities Lending and Repos: Market Overview and Financial Stability Issues*. Interim Report of the FSB Workstream on Securities Lending and Repos. FSB and IMF, April 27, 2012.

Gudmundson, Erika. "Reflections from Attendees of 'The Macroprudential Toolkit' Conference." U.S. Department of the Treasury, December 7, 2011. http://www.treasury.gov/connect/blog/Pages/Reflections-from-Attendees-at-The-Macroprudential-Toolkit-Conference.aspx (accessed July 3, 2012).

Office of Financial Research. "Strategic Framework: FY 2012-2014." Treasury Notes, U.S. Department of the Treasury, March 15, 2012.

Tarullo, Daniel K. "Shadow Banking After the Financial Crisis." Speech delivered at the Conference on Challenges in Global Finance: The Role of Asia, Federal Reserve Bank of San Francisco, San Francisco, June 12, 2012.

Appendix A: Progress in Institution Building

Overview

The OFR has made substantial progress in building the institutional architecture to support its core research and data-related mandates. Key upfront objectives have included defining the OFR's strategic framework—starting from the foundation established in the legislation and building through outreach and broad-based consultations—and building the organizational structures to support sound human resource and financial management.

Establishing a Sound Strategic Framework

The OFR Strategic Framework: FY2012–2014, published in March 2012, outlines the mission, goals, objectives, and implementation priorities that will help to ensure that the OFR's efforts and investments are well targeted. The framework reflects substantial consultations in the period since enactment of the Dodd-Frank Act with a full range of stakeholders, including Council members, their agencies and staff, members of Congress, industry representatives, as well as academics, financial authorities, and other researchers. Under this framework, the OFR has identified a core set of priorities linked to five strategic goals:

1. Support the Council through the secure provision of high-quality financial data and analysis needed to monitor threats to financial stability.
2. Develop and promote data-related standards and best practices.
3. Establish a center of excellence for research on financial stability and promote best practices for financial risk management.
4. Provide the public with key data and analysis, while protecting sensitive information.
5. Establish the OFR as an efficient organization and world-class workplace.

Operational Framework

The OFR is establishing a secure data and technology infrastructure, ramping up its hiring, and making progress in building its institutional framework—all essential to delivering on its core research and data-related mandates.

Human Resources

The OFR plans to build to steady state staffing levels of 275–300 within the next two to three years. The organization recognizes the broad range of core competencies required by the Office, including macroeconomics, finance, statistics and risk management, and applied sciences; data management, analytic and support services, information standards, information technology, program management, and relationship management; and law, communications, strategy, policy, and resource management.

The Dodd-Frank Act emphasized use of efficient and innovative structures to attract and retain needed talent, including fellowships and partnerships with outside experts. Foundational work on the OFR's human resources strategy was articulated in the OFR's first report to Congress on these issues in September 2011; the second annual report on human resources later this year will provide an update on the OFR's plans for recruitment and retention, training and workforce development, and workforce flexibility.

Policies and Procedures

The OFR's financial management follows Treasury protocols, with the organization's financial activities and controls reviewed as part of the Department's Consolidated Audit and the budget developed in line with Circular A-11

guidance as part of the President's Budget. The Office has also developed additional controls, project review mechanisms, and decision-making protocols to ensure spending is well targeted and effectively monitored.

Through July 20, 2012, the OFR and the Council have been funded through transfers from the Board of Governors of the Federal Reserve System. Thereafter, OFR and Council funding comes from assessments on bank holding companies with total consolidated assets of $50 billion or more and nonbank financial companies supervised by the Board of Governors. A Treasury rule to establish this assessment schedule was published on May 21, 2012, and a notice of fees was published on June 29, 2012, with the first assessment to be collected on July 20, 2012.

Building on Treasury and Treasury Departmental Offices policies where appropriate, the OFR is also expanding initial policies and procedures to support sound and efficient operations and rigorous internal controls. The Office of the Inspector General and the Government Accountability Office periodically audits the OFR's activities, and the Director of the OFR will testify annually on these issues.

Informational Infrastructure

The OFR's data and analytical mandates require the establishment of secure analytical and database platforms, implementation of sound business systems, and the steady expansion of data acquisition—through both shared procurement and efficient collection from financial institutions, consistent with the need to avoid duplicative and unnecessary requests. The OFR has sought to make rapid progress in systems implementation but also recognizes the need to ensure that investments in information technology and business processes, infrastructure, and security structures are well designed and cost-effective. To meet these twin needs, the OFR has leveraged existing Treasury systems and established a secure short-term data and analytical IT environment to meet immediate needs, while initiating the design and planning of a long-term information and security architecture. As part of these efforts, the OFR is establishing robust controls and best-practice procedures, including strong data and information security protocols.

Appendix B: OFR Activities and Collaboration

Overview

Successful achievement of the OFR's research and data-related mandates requires strong collaboration with a wide range of stakeholders, including Financial Stability Oversight Council members, their agencies and staff, industry representatives, academics, other researchers, and the public.

Collaboration with the Council and its Member Agencies

A key goal for the OFR is to support the Council through research and data-related services. In this context, the OFR is collaborating with researchers at other Council agencies on both data and analytical activities, supported by ongoing work to reinforce secure information sharing technology and protocols. The OFR is also actively supporting the Council Data Committee as a forum for collaboration and input on the OFR's data-related activities, including, for example, informal working groups on information technology and on establishing an inventory of data held by Council member agencies as a first step to strengthen data-sharing and to identify data gaps.

Financial Research Advisory Committee

In April 2012, the OFR announced that it will establish the Financial Research Advisory Committee. Chosen from a highly distinguished pool of more than 150 applicants, the Advisory Committee will include eminent researchers and risk experts, as well as those with noted expertise in the fields of data and technology. Committee members are being selected based on their expertise in economics, financial institutions, and markets, statistical analysis, financial markets analysis, econometrics, applied sciences, risk management, data management and information standards, technology, and other areas related to OFR's duties and authorities. The committee will serve as an invaluable resource that will broaden the OFR's analytical perspective and provide a critical link to diverse knowledge, experience, and perspectives.

Network for Collaboration

The OFR has emphasized high-level interactions with academics and practitioners in its efforts to build a virtual research community. This collaboration has already been informed by OFR publications and a high-level conference in late 2011. As part of this initiative, the OFR Fellowship Program will also be used to attract expertise to supplement the permanent workforce, keeping OFR on the cutting edge of research and data management.

Working Paper Series and Research Seminar Series

The OFR has developed the Working Paper Series and Research Seminar Series as communication tools for sharing its work with external constituents. Both of the communication outlets have been implemented as a platform for presenting OFR staff research, as well as collaborative research conducted by OFR staff and outside experts.

The OFR launched the Working Paper Series in January of 2012. The Working Paper Series offers staff and outside co-authors an opportunity to disseminate their preliminary research findings in a format intended to generate discussion and critical comments. The goal is to inform and improve the quality of the

analysis conducted by the OFR. To date, two studies have been published:

- *A Survey of Systemic Risk Analytics*, coauthored by Dimitrios Bisias (MIT Operations Research Center), Mark Flood (OFR), Andrew W. Lo (MIT Sloan School of Management), and Stravros Valavanis (MIT Laboratory for Financial Engineering)

- *Forging Best Practices in Risk Management*, coauthored by Mark J. Flannery (University of Florida and OFR), Paul Glasserman (Columbia University and OFR), David K. A. Mordecai (Risk Economics, Inc., and NYU Courant Institute of Mathematical Sciences), and Cliff Rossi (University of Maryland and OFR)

The OFR Research Seminar Series provides a forum for staff of Council member agencies, other financial authorities, academics and other researchers to discuss in depth analysis on topics related to threats to financial stability, and for the OFR to solicit feedback on current and future research initiatives. The OFR has held dozens of widely attended seminars since the fall of 2011.

Conference

On December 1 and 2, 2011, the OFR and the Council hosted a conference, entitled *The Macroprudential Toolkit: Measurement and Analysis*, in Washington, DC, which brought together thought leaders from the financial regulatory community, academia, public interest groups, and the financial services industry to discuss data and technology issues and analytical approaches for assessing, monitoring and mitigating threats to financial stability. The conference also provided an invaluable opportunity to receive broad-based input on strategic priorities for the OFR.

Glossary

2a-7 Funds
Rule 2a-7 of the Investment Company Act of 1940 lays out requirements specific to money market funds. It defines accounting practices that permit a fund to report a stable net asset value of $1 per share and sets investment rules (see *Money Market Fund*).

Absorption Ratio (AR)
A summary measure of the degree of co-movement in asset prices, from Kritzman and others (2011) (see References for Chapter 3).

Agent-Based Models (ABM)
A simulation model that tracks the actions of agents with specified rules of behavior as they interact over time.

Arbitrage
A combination of purchases and sales of the same asset that yields a profit from the differences in prices across markets with little or no risk.

Asset-Backed Commercial Paper (ABCP)
Short-term debt that has a fixed maturity of up to 270 days and is backed by some financial asset, such as trade receivables, consumer debt receivables, auto and equipment loans or leases, or asset-backed securities.

Asset-Backed Security (ABS)
A debt instrument that is backed by specific financial assets that generate the cash flow used to service the debt instrument.

Bank for International Settlements (BIS)
An international financial organization that serves central banks in their pursuit of monetary and financial stability, helping to foster international cooperation in those areas and acting as a bank for central banks.

Bank Holding Company (BHC)
Any company that has direct or indirect control of one or more banks and is regulated and supervised by the Federal Reserve in accordance with the Bank Holding Company Act of 1956. BHCs may also own nonbanking subsidiaries such as broker-dealers and asset managers.

Basel Committee on Banking Supervision (BCBS)
An international committee of bank supervisors that develops and issues international standards on bank capital adequacy. In 1988 the BCBS introduced a capital measurement system commonly known as the Basel Capital Accord or Basel I. In 2004 the BCBS issued a revised framework that is commonly referred to as Basel II. Following the financial crisis, the BCBS developed new global standards for the banking system that are collectively referred to as Basel III.

Broker-Dealer
An entity that is engaged in the business of buying and selling securities for itself and others.

Call Report
A report of a bank's condition and income that all federally insured depository institutions in the U.S. must file on a quarterly basis.

Central Clearing
A settlement system in which securities or derivatives of a specific type are cleared by one entity, a clearing house or central counterparty, which guarantees the trades. It is an alternative to bilateral or over-the-counter trading (see *Over-the-Counter*).

Central Counterparty (CCP)
An entity that is interposed between the initial participants to a bilateral transaction and becomes the buyer to every seller and the seller

to every buyer of a specified set of contracts or financial instruments.

Clearing Bank
A commercial bank that facilitates payment and settlement of financial transactions, such as check clearing or facilitating trades between the sellers and buyers of securities or other financial instruments or contracts.

Collateral
Any asset pledged by a borrower to guarantee payment of a debt.

Collateralized Debt Obligation (CDO)
A type of structured asset-backed security that has tranches with distinct interest rates, payment flows, and risk levels.

Commercial Paper (CP)
Short-term (maturity of up to 270 days), unsecured corporate debt.

Comprehensive Capital Analysis and Review (CCAR)
A regular cross-institution study, most recently completed in March 2012, conducted by the Federal Reserve and other supervisors of the capital plans and capital planning processes of the 19 largest U.S. bank holding companies.

Conditional Value at Risk (CoVaR)
A measure of the value at risk to the financial system conditional on distress at a single financial institution, from Adrian and Brunnermeier (2010) (see References for Chapter 3).

Contingent Liability
A liability that is only incurred depending on the outcome of a future event.

Countercyclical
Movement of a financial or macroeconomic variable in the opposite direction of the business cycle. A variable is *procyclical* if it tends to increase when the economy is growing and decrease when it is shrinking.

Credit Cycle
The rise in credit creation during the expansion phase of the business cycle, often accompanied by a relaxation of underwriting and other credit standards, and the subsequent decline in the availability of credit during economic contractions.

Credit Default Swap (CDS)
A derivative contract in which one party (the protection seller) agrees to make a payment to another party (the protection buyer) in the event of default of a third party (the reference entity), in exchange for fixed payments from the protection buyer to the protection seller (see *Swap*).

Credit Risk Transfer
A financial transaction, typically through credit default swaps, that changes who bears the risk of default or changes in the creditworthiness of a counterparty or debtor.

Credit Value Adjustment (CVA)
An adjustment made to the value of an OTC derivative transaction to reflect the risk that the counterparty to the transaction could default.

Crowded Trade
A trade in which the market participants have large and similar positions, creating the risk that there will be insufficient liquidity should market participants seek to unwind their positions simultaneously.

Cyclical Risk
Any financial or economic risk that is closely tied to the business cycle.

Debt Value Adjustment (DVA)
An adjustment made to the value of a firm's liabilities as a result of a change in the firm's own creditworthiness.

Derivative
A financial contract, such as a swap, option, or futures contract, that derives its value from the price of some other security, commodity, or other asset.

Discount Window
The Federal Reserve facility for extending credit directly to eligible financial institutions.

Distressed Asset Sale
Refer to *Fire Sale*.

Duration Risk
The sensitivity of the prices of bonds and other fixed-income securities to changes in the level of interest rates.

European Union
An economic and political confederation of 27 nations.

Euro Area
An economic region that is comprised of all of the European Union countries that use the euro as their national currency.

Exchange-Traded Fund (ETF)
An investment fund whose shares are traded on an exchange. ETFs offer continuous pricing, unlike mutual funds which offer only end-of-day pricing. ETFs are often designed to track an index or a portfolio of assets.

Federal Financial Institutions Examination Council (FFIEC)
An interagency body that prescribes uniform principles, standards, and report forms for the federal examination of financial institutions. The FFIEC makes recommendations to promote uniformity in the supervision of financial institutions. Members include the Federal Reserve, the FDIC, the NCUA, the OCC, the CFPB, and a representative of state financial supervisors.

Federal Funds Rate
The interest rate at which depository institutions trade balances held in their reserve accounts at the Federal Reserve, usually overnight. The Federal Open Market Committee establishes the target rate for trading in the federal funds market and the Federal Reserve Bank of New York implements it.

Financial Accounting Standards Board (FASB)
A not-for-profit organization responsible for developing and updating the GAAP that governs American accounting.

Financial Contagion
The process by which losses at one institution spread to other institutions through the financial system.

Financial Intermediation
Any financial service in which a third party (the intermediary) matches lenders and investors with entrepreneurs and other borrowers in need of capital. Often investors and borrowers do not have precisely matching needs, and the intermediary's capital is put at risk to transform the credit risk and maturity of the liabilities to meet the needs of investors.

Financial Stability
The condition in which the financial system is sufficiently functioning to provide its basic tasks for the economy even under stress.

Financial Stability Board (FSB)
An international coordinating body that monitors developments in the international financial system on behalf of the G20 nations. The FSB was established by the G20 in 2009 at the London summit. The FSB is the successor to the earlier Financial Stability Forum.

Fire Sale
The disorderly liquidation of assets to meet margin requirements or other urgent cash needs. Such a sudden sell-off drives down prices, potentially below their intrinsic value, when the quantities to be sold are large relative to the typical volume of transactions.

Fixed Net Asset Value (Fixed NAV)
Net asset value is the value of a mutual fund's or ETF's assets divided by the number of its shares. The NAV is set daily, usually at the close of the market. Under Rule 2a-7, money market funds are allowed to round their NAV,

maintaining an effective fixed NAV of $1 per share, unless the value of the fund's assets fall below $0.995 per share.

Form N-MFP
A monthly disclosure of holdings by money market funds. SEC Rule 30b1-7 establishes the technical and legal details of N-MFP filings.

Form PF (Form Private Funds)
A reporting form to the CFTC and SEC that provides information on the activities and holdings of hedge fund managers, private equity fund managers, and related entities. Depending on fund size, reporting is annual or quarterly.

Funding Liquidity
The availability of credit to finance the purchase of financial assets.

Futures
A standardized, exchange-traded contract to buy or sell an underlying asset at a specified date and price.

General Collateral Finance (GCF)
An interdealer market in which the Fixed Income Clearing Corporation plays the role of intraday central counterparty. Trades are netted at the end of each day and settled at the tri-party clearing banks (see *Tri-Party Repo*).

Generally Accepted Accounting Principles (GAAP)
The accounting and financial reporting standards set by FASB for publicly-traded companies in the United States.

Government-Sponsored Enterprise (GSE)
A privately owned financial institution that has a federal charter authorized by law and a mission to promote the flow of credit to the housing market, student loan, or other specific sectors.

Gross Domestic Product (GDP)
The broadest measure of aggregate economic activity, measuring the total value of all final goods and services produced within a country's borders during a specific period.

Haircut
The discount at which an asset can be pledged as collateral. For example, a million dollar bond with a 5 percent haircut would collateralize a $950,000 loan.

Interest Rate Swap
A swap in which the parties swap interest rate cash flows, typically between a fixed rate and a floating rate (see *Swap*).

International Monetary Fund (IMF)
An international organization created at the end of World War II to stabilize exchange rates and support international payment systems. The IMF provides credit to developing nations and those in economic distress, typically conditional on economic and financial reforms.

International Organization for Standardization (ISO)
The world's largest developer of voluntary international standards in products, services, and good practices.

International Swaps and Derivatives Association (ISDA)
A trade association of over-the-counter derivatives participants. The ISDA Master Agreements standardized derivative terms to simplify netting and reduce legal risks.

Legal Entity Identifier (LEI)
A uniform system that identifies parties to financial transactions.

Leverage
The use of borrowed money to finance investments or conduct financial activities.

Liquidity
See *Market Liquidity* and *Funding Liquidity*.

Liquidity Coverage Ratio (LCR)
A Basel III standard to ensure that a bank maintains adequate unencumbered, high-quality

liquid assets to meet its anticipated liquidity needs for a 30-day horizon under a liquidity stress scenario specified by supervisors.

Loan Origination
The point in the loan process in which the borrower applies for a loan and the lender approves or declines the loan.

Loan-to-Value (LTV) Ratio
The ratio of the amount of a loan to the value of an asset, typically expressed as a percentage. This is a key metric when considering the financing of a mortgage.

London Interbank Offered Rate (LIBOR)
The interest rate at which banks can borrow unsecured funds from other banks in London wholesale money markets, as measured by daily surveys of the British Bankers' Association. The published rate is a trimmed average of the rates obtained in the survey. Many contracts are tied to the level of LIBOR, making it an important benchmark.

Long Term Capital Management
A highly leveraged fixed-income arbitrage hedge fund that failed in 1998 during the Asian and Russian financial crises.

Macroprudential Supervision
Supervision aimed at promoting the stability of the financial system as a whole (see *Microprudential Supervision*).

Margin Requirement
Rules governing the necessary collateral for a derivative, loan, or related security required to cover, in whole or in part, the credit risk one party poses to another.

Market Depth
The ability of a market to absorb excess demand to buy or sell a security without affecting the price quoted for subsequent trades. A market with a lot of depth will have low price impact from trading.

Market Liquidity
The ability of a market to absorb large and frequent transactions with limited price impact and low transaction costs.

Maturity Transformation
The funding of long-term assets with short-term liabilities. This creates a balance-sheet mismatch that can pose risks when short-term funding markets are constrained.

Metadata
Data that provide information about the structure, format, or organization of other data.

Microprudential Supervision
Supervision of the activities of a firm to ensure soundness and honest dealings (see *Macroprudential Supervision*).

Money Market Fund (MMF)
A fund that typically invests in government securities, certificates of deposit, commercial paper, or other highly liquid and low-risk securities. Some MMFs are governed by Rule 2a-7.

Option
A financial contract granting the holder the right but not the obligation to engage in a future transaction on an underlying security or real asset. The most prominent examples are an equity call option, which provides the right but not the obligation to buy a block of shares at a fixed price for a fixed period, and an equity put option, which similarly grants the right to sell a block of shares.

Overnight Indexed Swap (OIS)
An interest rate swap that serves as a measure of investor expectations of an average effective overnight rate over the term of the swap (see *Interest Rate Swap*).

Over-the-Counter (OTC)
A method of trading that does not involve an organized exchange. In over-the-counter markets, participants trade directly with

each other, typically through voice or computer communication.

Prime Broker
Brokerage that provides a range of services to hedge funds, including securities lending, financing, trade execution, and cash management.

Procyclical
See *Countercyclical.*

Regulatory Arbitrage
The practice of taking advantage of differences between regulatory regimes to avoid their costs or constraints.

Rehypothecation
The reuse by a broker of collateral posted by a client, typically a hedge fund, for the broker's use for securities lending or as collateral for its own borrowing.

Repo Run
A situation in which repo investors lose confidence in the market—due to concerns about counterparties, collateral, or both—and respond by pulling back their funding or demanding larger haircuts.

Repurchase Agreement (Repo)
A transaction in which one party sells a security to another party, while agreeing to repurchase it from the counterparty at some date in the future at an agreed price, often done on an overnight basis as a form of liquidity for banks. The net effect is essentially a collateralized loan.

Risk Management
The business and regulatory process of identifying and measuring risks and then responding to them. Categories of risk include operations, credit, market, control, liquidity, model, and regulatory.

Risk Premium
The difference between the expected return of an asset and that of a risk-free asset. It is the investor's premium for bearing the risks of holding that asset.

Risk Transformation
A form of financial intermediation in which an intermediary raises funds from risk-averse investors and then uses those funds to provide capital to borrowers for risky ventures. Risk is retained by the intermediary and its capital serves as a buffer against losses for its investors.

Securities Industry and Financial Markets Association (SIFMA)
A securities industry trade group representing securities firms, banks, and asset management companies.

Securities Lending/Borrowing
The temporary transfer of securities from one party to another for a specified fee and term, in exchange for collateral in the form of cash or securities.

Securitization
A financial transaction in which assets such as mortgage loans are pooled and securities representing interests in the pool are issued.

Shadow Banking System
Credit intermediation by unregulated or lightly regulated financial institutions in combination with the creation of money-like liabilities, involving leverage and maturity transformation, in opaque markets.

Short-Term Wholesale Funding
Funding instruments that are typically issued to institutional investors to raise large amounts of funding for short periods. Examples include large checkable and time deposits, commercial paper, and repurchase agreements.

Sovereign Debt Crisis
A financial crisis created by the potential or actual default of government debt.

Stress Test
A modeling exercise where asset prices are shocked a pre-specified amount, sometimes

along with other financial and economic variables, in order to observe the effect on financial institutions or markets.

Structural Risk

Aspects of the design of the financial system that make it vulnerable to a shock. Structural risks could include excessive leverage or liquidity, crowded trades, large credit concentrations, poor governance, overreliance on one or a small number of essential service providers, or data and analytical gaps.

Structured Investment Vehicle (SIV)

A specific type of off-balance-sheet entity, popular before the financial crisis of 2007–2009, that issued short- and medium-term securities and invested the funds in a mix of assets, including asset-backed securities. SIVs sought to profit from the credit spread between long-term and short-term financial products.

Supervisory Capital Assessment Program (SCAP)

A stress test, conducted in 2009, designed to estimate the capital needs of U.S. bank holding companies with assets exceeding $100 billion under an adverse macroeconomic scenario; it was administered by the Federal Reserve, OCC, and FDIC.

Swap

An exchange of cash flows agreed by two parties with defined terms and over a fixed period.

Swap Execution Facility

A term defined in the Dodd-Frank Act as a trading platform which market participants use to execute and trade swaps by accepting bids and offers made by other participants.

SWIFT Messages

Payment and account reconciliation messages transmitted over the SWIFT (Society for Worldwide Interbank Financial Telecommunication) network, a secure platform designed to promote standards for international communication and fund transfers.

Systemic Expected Shortfall (SES)

The propensity for a financial firm to be undercapitalized when the system as a whole is undercapitalized, from Acharya and others (2010) (see References for Chapter 3).

Tail Risk

The risk of an extreme drop in the value of an asset. These risks are particularly difficult to model because they require estimating rare events with limited precedence.

Term Premium

The excess yield an investor must receive in order to purchase a longer maturity bond over a shorter maturity bond of the same issuer.

Tier 1 Capital Ratio and Tier 1 Common Capital Ratios

Two measures of banking capital adequacy defined in the Basel accords in which capital is compared to total risk-weighted assets. Tier 1 capital includes common stock, preferred stock, and retained earnings. Tier 1 common capital is more narrowly defined and excludes preferred stock.

Too Big To Fail

The assumption among market participants that some financial institutions are so large and interconnected that the government would rescue them in a crisis due to the perceived threats that their failure could pose to financial stability.

Tri-Party Repo

A repurchase agreement in which a third party agent, such as a clearing bank, acts as an intermediary to facilitate the exchange of cash and collateral between the two counterparties. In addition to providing operational services to participants, the tri-party agents in the U.S. tri-party repo market extend large amounts of intraday credit to facilitate the daily settlement of tri-party repos.

Underwriting Standards

Terms, conditions, and criteria used to determine the extension of credit in the form of a loan or bond.

Value at Risk (VaR)

An important tool for market risk management that measures the risk of loss of a portfolio. The VaR projects the maximum expected loss for a given time horizon and probability. For example, the VaR over 10 days and with 99 percent certainty measures the most one would expect to lose over a 10-day period, 99 percent of the time.

Variable Rate Demand Note (VRDN)

A type of security that allows a municipality to borrow over the long run while paying short-term interest rates.

XBRL (eXtensible Business Reporting Language)

A global reporting standard that enables the free and open exchange of business and financial information. The language is XML-based and uses XML syntax.

XML (eXtensible Markup Language)

A markup language that defines a set of rules for encoding documents or data structures that are both human-readable and machine-readable.

Abbreviations

ABCP	Asset-Backed Commercial Paper
ABM	Agent-Based Model
ABS	Asset-Backed Securities
AIG	American International Group
AR	Absorption Ratio
BCBS	Basel Committee on Banking Supervision
BHC	Bank Holding Company
BIS	Bank for International Settlements
CBO	Congressional Budget Office
CCAR	Comprehensive Capital Analysis and Review
CCP	Central Counterparty
CDO	Collateralized Debt Obligation
CDR	Central Data Repository
CDS	Credit Default Swap
CFPB	Consumer Financial Protection Bureau
CFSI	Cleveland Financial Stress Index
CFTC	Commodity Futures Trading Commission
CGFS	Committee on the Global Financial System
CICI	CFTC Interim Compliant Identifier
CMO	Collateralized Mortgage Obligation
CoVaR	Conditional Value at Risk
CRO	Chief Risk Officer
CRSP	Center for Research in Security Prices
CUSIP	Committee on Uniform Security Identification Procedures
CVA	Credit Value Adjustment
DJIA	Dow Jones Industrial Average
DOJ	Department of Justice
DVA	Debt Value Adjustment
DVP	Delivery versus Payment
DWCF	Dow Jones U.S. Total Stock Market Index
EBA	European Banking Authority
ECB	European Central Bank
EU	European Union
EURIBOR	Euro Interbank Offered Rate
FASB	Financial Accounting Standards Board

FCIC	Financial Crisis Inquiry Commission
FDIC	Federal Deposit Insurance Corporation
FFIEC	Federal Financial Institutions Examination Council
FHA	Federal Housing Administration
FHFA	Federal Housing Finance Agency
FICC	Fixed Income Clearing Corporation
FICO	Fair Isaac Corporation
FIO	Federal Insurance Office
FISMA	Federal Information Security Management Act of 2002
FIX	Financial Information eXchange
FpML	Financial products Markup Language
FRASER	Federal Reserve Archival System for Economic Research
FRB	Federal Reserve Board (Board of Governors of the Federal Reserve System)
FRED	Federal Reserve Economic Data
FSAP	Financial Sector Assessment Program
FSB	Financial Stability Board
FSI	Financial Stress Index
FSOC	Financial Stability Oversight Council
G20	Group of Twenty Finance Ministers and Central Bank Governors
GAAP	Generally Accepted Accounting Principles
GCF	General Collateral Finance
GDP	Gross Domestic Product
GSE	Government-Sponsored Enterprise
HAMP	Home Affordable Modification Program
HPI	House (or Home) Price Index
ICERC	Interagency Country Exposure Review Committee
IMF	International Monetary Fund
ISDA	International Swaps and Derivatives Association
ISIN	International Securities Identification Number
ISO	International Organization for Standardization
KCFSI	Kansas City Financial Stress Index
LEI	Legal Entity Identifier
LIBOR	London Interbank Offered Rate
LTCM	Long Term Capital Management
MBS	Mortgage-Backed Securities
MMF	Money Market Fund
NCUA	National Credit Union Administration

NFCI	National Financial Conditions Index
NIST	National Institute of Standards and Technology
NYSE	New York Stock Exchange
OCC	Office of the Comptroller of the Currency
OFR	Office of Financial Research
OIS	Overnight Indexed Swap
OPRA	Options Price Reporting Authority
OTC	Over-the-Counter
PDD	Public Data Distribution
RSSD ID	Research Statistics Supervision Discount Identification
RWA	Risk-Weighted Assets
SCAP	Supervisory Capital Assessment Program
SEC	Securities and Exchange Commission
SEF	Swap Execution Facility
SES	Systemic Expected Shortfall
SIAC	Securities Industry Automation Corporation
SIFMA	Securities Industry and Financial Markets Association
SIV	Structured Investment Vehicle
STLFSI	St. Louis Financial Stress Index
SWIFT	Society for Worldwide Interbank Financial Telecommunication
TBTF	Too Big to Fail
VaR	Value at Risk
VIX	Chicago Board Options Exchange Volatility Index
VRDN	Variable Rate Demand Note
XBRL	eXtensible Business Reporting Language
XML	eXtensible Markup Language

Notes on the Data

Glossary of Certain Government Data Sources

Flow of Funds: Data release compiled and published by the Federal Reserve.

FR Y-9C: Consolidated financial statement filed with the Federal Reserve by domestic bank holding companies.

FR 2004: Financial report filed with the Federal Reserve by primary dealers in U.S. government securities about their market activity.

FRED: The Federal Reserve Bank of St. Louis maintains the Federal Reserve Economic Data (FRED) database, which contains economic time series data from a variety of data sources.

FRASER: The Federal Reserve Bank of St. Louis maintains the Federal Reserve Archival System for Economic Research (FRASER), which contains historical data on the U.S. economy and financial system.

Other

Certain data were obtained through Haver Analytics.

Certain data were obtained through the Center for Research in Security Prices (CRSP).

Tri-Party Repo Infrastructure Reform Task Force: Industry working group sponsored by the Federal Reserve Bank of New York to address vulnerabilities in the tri-party repo market.

Office of Financial Research
U.S. Department of the Treasury
www.treasury.gov/ofr