OFR

OFFICE OF FINANCIAL RESEARCH

2016 FINANCIAL STABILITY REPORT

From the Director

The Office of Financial Research is an independent office within the Department of the Treasury. Our primary responsibilities are to assess and monitor threats to the financial stability of the United States; improve the scope, quality, and accessibility of financial data; perform essential financial system research; and evaluate policies designed to improve the resilience of the financial system.

This *2016 Financial Stability Report* provides Congress and the public with an in-depth analysis of our outlook for U.S. financial stability. In the first chapter, we frame our assessment of financial stability risks in five risk categories that we monitor regularly. In the second chapter, we analyze seven key vulnerabilities in depth.

As in 2015, this report supplements our *2016 Annual Report to Congress*. The annual report summarizes the financial stability report, reports on key findings of our research, and provides an update on the efforts of the Office in meeting its mission, and fulfills our responsibility under Section 154(d) of the Dodd-Frank Act to report annually to Congress and the public.

Richard Berner

Director, Office of Financial Research

Contents

Executive Summary

This *Financial Stability Report* presents the OFR's annual assessment of potential threats to U.S. financial stability, weighed against an evaluation of financial system resilience. The financial system is far more resilient than before the financial crisis, but vulnerabilities remain.

> Overall, financial stability risks remain in a medium range. Four themes stand out: the potential for disruptions in the global economy to affect U.S. financial stability; risk-taking amid low long-term interest rates; risks facing U.S. financial institutions; and challenges to improving financial data.

The OFR has a mandate under the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 to assess and monitor potential threats to U.S. financial stability. This *Financial Stability Report* is organized in two chapters.

Chapter 1 describes our overall Financial Stability Assessment. We continue to judge that financial stability risks are in a medium range. We frame that assessment using the risk categories that we track regularly in our Financial Stability Monitor — a heat map of indicators of macroeconomic, market, credit, funding and liquidity, and contagion risks. We also base the assessment on our research, analysis, and ongoing surveillance of the financial system.

In 2016, U.S. financial markets proved resilient following shocks in January and June, and the "flash crash" of the British pound in October. In each case, asset prices largely recovered and markets functioned without disruption. The recovery was supported by the orderly functioning of markets and expectations of continuous accommodative monetary policy.

Chapter 2 provides deeper analysis of the seven key threats to financial stability that we have identified. We chose the vulnerabilities that can lead to threats based on four criteria: their potential impact; the probability of their occurring and leading to threats; their proximity or immediacy; and the preparedness of policymakers, regulators, and market participants to mitigate them. We review why these vulnerabilities pose potential risks to financial stability. We then suggest steps policymakers could take to mitigate the risks. In particular, we note ways to increase visibility into now-opaque parts of the financial system. We also concentrate on the need for regulators to actively monitor and stress test financial exposures, and evaluate potential indirect channels for spillovers to the U.S. financial system and real economy.

Four themes are woven through this *Financial Stability Report*: the potential for disruptions in the global economy to affect U.S. financial stability; risk-taking amid low long-term interest rates; risks facing U.S. financial institutions; and challenges to improving financial data. The issues embedded in these themes have been central to our monitoring efforts over the past 12 months. **Figure 1** illustrates how the seven vulnerabilities in Chapter 2 fit in these themes and how they relate to the five core risk categories described in Chapter 1. For example, deficiencies in data can impede analysis across risk categories.

Figure 1. Key Financial Stability Themes in 2016

		Risk Categories (Chapter 1)				
Themes	Vulnerabilities (Chapter 2)	Macro	Market	Credit	Funding/ liquidity	Contagion
Disruptions in the global economy	Potential spillovers from Europe	✓	✓	✓		✓
Risk-taking amid low long-term interest rates	Risks in U.S. nonfinancial corporate credit		✓	✓		✓
Risks facing U.S. financial institutions	Cybersecurity incidents affecting financial firms				✓	✓
	Central counterparties as contagion channels		✓	✓	✓	✓
	Pressure on U.S. life insurance companies		✓		✓	✓
	Systemic footprints of largest U.S. banks		✓	✓	✓	✓
Challenges to improving data	Deficiencies in data and data management	✓	✓	✓	✓	✓

1. Disruptions in the Global Economy

The United Kingdom (U.K.) vote to exit the European Union (EU) has raised uncertainty about the U.K.'s future relationship with the EU and London's future role as a financial capital. That uncertainty may prompt businesses to postpone investment, leading to slower growth and higher inflation in the U.K. over the next few years.

The vote highlights existing vulnerabilities, such as weaknesses in EU banks. Shocks could expose those vulnerabilities, and could spill over to U.S. institutions and markets and thus the economy. Any shock could also aggravate risks to U.S. financial firms from low long-term interest rates and exacerbate reach-for-yield behavior. **Section 2.1** of this report discusses potential spillovers from Europe in greater detail. We conclude that U.S. regulators should continue to expand the scope of their monitoring and stress testing of exposures by including an evaluation of potential indirect channels through which spillovers to the U.S. financial system and economy could arise.

2. Risk-Taking Amid Low Long-Term Interest Rates

We remain concerned about the effects of persistently low long-term interest rates on risk-taking. While long-term rates have risen since mid-2016, they remain near historic lows. Low long-term rates have supported the economic expansion. They have also promoted greater risk-taking by investors, borrowers, and financial institutions. The continuing demand for risky assets is reflected in elevated prices for equities and commercial real estate. Low long-term interest rates also strain earnings of banks and life insurance companies and their ability to generate capital internally. While markets have been resilient to recent market shocks, investors' willingness to take credit, duration, and liquidity risks could expose them to large losses in the face of a bigger shock.

Low long-term rates have supported the economic expansion. They have also promoted greater risk-taking by investors, borrowers, and financial institutions.

Low borrowing costs have also promoted the high level and rapid growth of U.S. nonfinancial corporate debt, including loans and securities (see **Section 2.2**). A severe downturn in this $8 trillion market could threaten financial stability if the exposed counterparties cannot manage the losses and associated erosion of confidence. Banks are the most exposed institutions, but nonbanks now own more than a quarter of U.S. corporate debt, primarily through bond holdings. Insurance companies and pension funds are traditional buyers of corporate bonds, and mutual funds have rapidly increased their holdings over the past decade.

We conclude that exposed financial firms should undergo stress tests for severe corporate defaults. Stress scenarios should also include the possibility

of sharp decreases in U.S. equity and commercial real estate prices, which can coincide with rising U.S. corporate defaults. These risks were included in the Federal Reserve's latest annual large-bank stress test, which is used to determine capital distributions. But broader testing is needed. Depending on the type of firm, stress tests may be the basis for increased capital or other loss-absorbing capacity, improved liquidity reserves and management, and improved risk management. The Securities and Exchange Commission is currently considering how to implement stress testing requirements for large investment advisers and funds.

3. Risks Facing U.S. Financial Institutions

Regulators now require banks to hold more capital and subject them to heightened oversight through regular stress testing requirements, liquidity requirements, and resolution plans. But risks remain in U.S. financial institutions. Chief among those risks are operational risks and cyber threats. In addition, companies remain highly interconnected and key activities are concentrated among a small number of large players.

We group key financial stability risks related to cybersecurity into three categories: the lack of substitutability for the services that many financial companies provide; the potential loss of confidence in a financial company by customers; and the threat to data integrity.

Malicious cyber activity aimed at financial firms has become more common and more sophisticated (see **Section 2.3**). Financial firms are vulnerable. They rely heavily on information technology. Their activities are closely linked to each other and to other parts of the economy. We group key financial stability risks related to cybersecurity into three categories: the lack of substitutability for the services that many financial companies provide; the potential loss of confidence in a financial company by customers; and the threat to data integrity. Financial firms and regulators recognize these risks and are working to prepare for potential incidents. Regulators have also taken steps to build resilience through information sharing and collaboration, and by issuing guidance and rules. Regulators could build on that progress by focusing on links among financial institutions. They should take into account how regulatory boundaries may affect their view of parts of financial networks, especially third-party vendors, overseas counterparties, or service providers. Financial regulators and the industry also need to continue to work together to enhance security, improve network resilience, and increase the capacity to recover.

The growing role of central counterparties (CCPs) in financial markets improves market efficiency, transparency, and financial stability. It may also concentrate risks (see **Section 2.4**). To address these risks, supervisors have introduced international risk management standards for CCPs and other financial market infrastructures. New disclosures that began in 2016 improve transparency. Market-wide stress tests in Europe and the United States also offer new insights on the sufficiency of financial resources. Increased

standardization of the data disclosures and continued, system-wide, stress tests will help monitor system resilience.

Life insurers, having taken on more duration and volatility risk, are increasingly vulnerable to market declines (see **Section 2.5**). Low long-term interest rates strain their earnings. A large common shock to all life insurers or the failure of a large and interconnected insurer could adversely affect U.S. financial stability. Key policy gaps also remain. These gaps include the need for more robust stress testing, liquidity standards, and the evaluation of options for strengthening the resolution framework.

The largest and most interconnected U.S. banks have become more resilient since the financial crisis. Reforms have required new capital and liquidity standards and promoted rigorous stress testing. These efforts have reduced the probability and immediacy of a large bank failure. Still, the largest U.S. banks remain a potential source of risk due to their size, complexity, and interconnectedness. The largest banks also remain concentrated and the potential impact of a large-bank failure remains substantial (see **Section 2.6**). We note that supervisory monitoring and stress testing need to take into account changing business models. Also, supervisors have not approved most of the living wills that global systemically important banks have produced to describe how they would manage their own potential failure. Whether a large bank could go through bankruptcy without extraordinary government support remains unclear.

The largest and most interconnected U.S. banks have become more resilient since the financial crisis. Whether a large bank could go through bankruptcy without extraordinary government support remains unclear.

4. Challenges to Improving Data

Risk managers and regulators today have better data than ever before, thanks to a number of new data collections and data standards initiatives. Still, weaknesses in data scope, quality, and accessibility continue to prevent a full assessment of risks in key markets (see **Section 2.7**). Data management systems are hard pressed to keep pace with financial and technical innovation.

The OFR has a core mandate to improve financial data. We have a particular interest in shadow banking activities, in which credit is extended by nonbank companies or funded by liabilities that are susceptible to runs because they are payable on demand and lack any government backstop.

We conclude that regulators should continue to work together to address remaining challenges. For example, the OFR has argued that regulatory mandates are needed to support industry adoption of standards such as the Legal Entity Identifier (LEI). The LEI is a unique, 20-digit code assigned to legal entities that take part in financial market transactions.

1

Financial Stability Assessment

Overall risks to financial stability remain in a medium range. U.S. financial markets and institutions quickly recovered from substantial market volatility early in 2016 and a confidence shock in June when the United Kingdom (U.K.) voted to exit the European Union (EU).

Our overall assessment of financial stability is organized in the five risk categories that we monitor regularly: macroeconomic, market, credit, funding and liquidity, and contagion. Our Financial Stability Monitor, a heat map of key risk indicators, contributes to this analysis (see Figure 2).

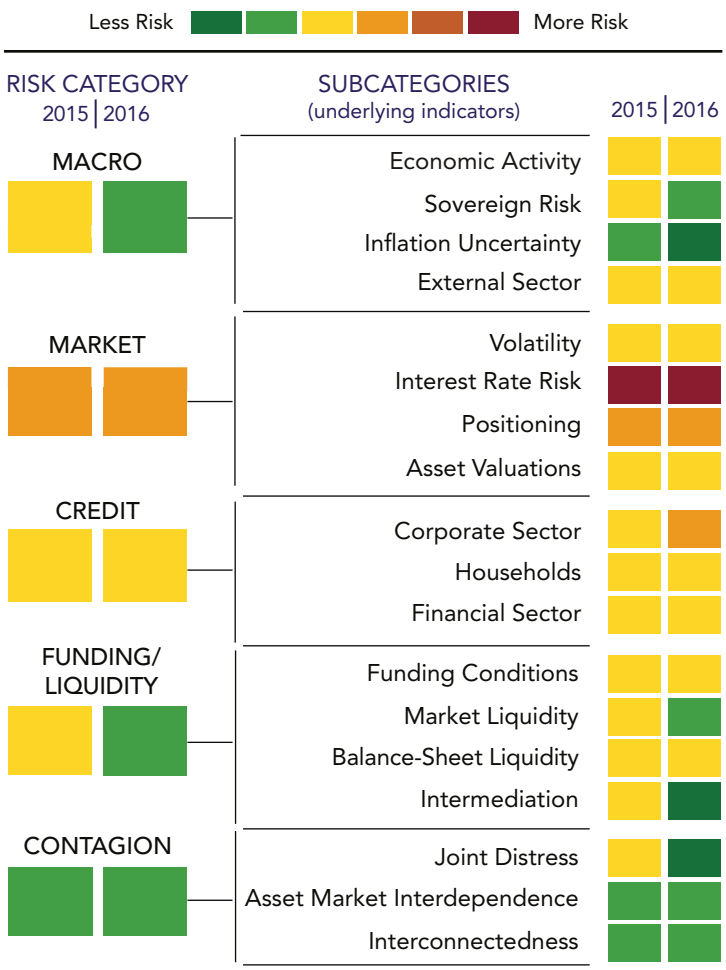
Macroeconomic Risks to U.S. Financial Stability Are Most Likely to Stem from Global Factors

U.S. economic growth since 2010 has been slower than before the financial crisis. It has also been less volatile, even amid a slowdown in global growth. This year, U.S. real gross domestic product (GDP) growth remained in a moderate, post-crisis range of 1.5 to 3 percent (see **Figure 3**). While U.S. inflation has fallen due to low oil prices, U.S. core inflation (which excludes food and energy prices) and long-term inflation expectations are near 2 percent, the level the Federal Open Market Committee considers consistent with its mandate (see **Figure 4**).

We continue to see important downside risks to U.S. growth, though that alone does not threaten financial stability. Specifically, slow global growth and the strong dollar continue to put pressure on U.S. corporate earnings. A Federal Reserve model estimates that a 10 percent dollar

Note: All data cited in this report are as of Sept. 30, 2016, unless otherwise noted.

Figure 2. OFR Financial Stability Monitor



Note: Based on data available Oct. 4, 2016. Third quarter 2015 results reflect data not previously available. The figure summarizes information from underlying indicators of financial stability risk, which are aggregated as subcategories, then categories. The colors reflect the position of risk indicators within their long-term ranges (beginning on Jan. 1, 1990, or earliest available date thereafter). The colors reported here and in past editions are subject to change due to newly reported data, data revisions, or changes in the historical range due to new observations.

Sources: Bloomberg Finance L.P., Haver Analytics, SNL Financial LC, OFR analysis

appreciation reduces the level of real GDP by about 1.5 percent after three years relative to its baseline path (see Gruber, McCallum, and Vigfusson, 2016). Vulnerabilities that originate overseas could spill into global and U.S. markets and institutions. The U.K. vote to exit the EU has created uncertainty about the political and economic environment in Europe.

Other economies are also vulnerable to financial instability. Risks in emerging markets remain elevated. A five-year slowdown in growth continues. Rapid credit growth after the financial crisis produced large private debt burdens. The dollar's recent strength has pressured capital flows. These factors have preceded past crises in emerging markets.

A number of large emerging markets have faced acute financial stress in recent years. China is the largest and most important emerging market in the global economy. Its economy and financial markets have been more stable in recent months, after market stress and unprecedented financial outflows from late 2014 to early 2016, but vulnerabilities remain. Credit growth surged during the past decade while economic growth slowed (see **Figure 5**). This brought China's debt-to-GDP ratio to historically and internationally high levels, especially for a large economy. Such rapid credit growth often portends financial instability (see IMF, 2016). China's credit growth is driven in part by shadow banking activities. At the same time, the transition to more open capital markets is challenging, as shown by Chinese equities' volatility in 2014-2015 and the market's outsized reaction to China's currency move in August 2015.

Figure 3. Real GDP Growth (year-over-year percent change)

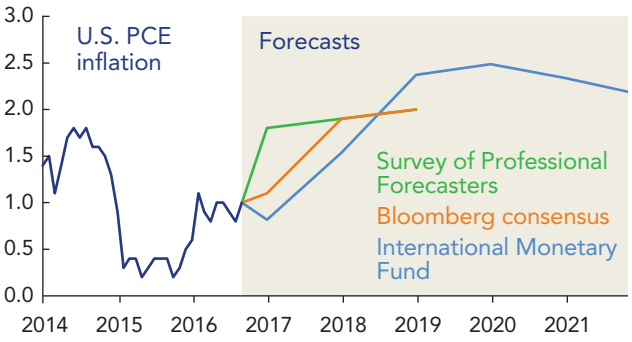
Since 2010, U.S. growth has been moderate amid a slowdown in global growth

Note: U.S. 2016 growth is reported as of the third quarter (four quarters/four quarters). World growth for 2016 is an International Monetary Fund forecast. GDP stands for gross domestic product.

Source: Bloomberg Finance L.P.

Figure 4. U.S. Inflation and Expectations (year-over-year percent change)

Inflation fell with oil prices, but expectations are in a healthy range



Note: PCE stands for personal consumption expenditure, which measures prices for goods and services purchased by consumers.

Sources: Bloomberg Finance L.P., Federal Reserve Bank of Philadelphia, International Monetary Fund World Economic Outlook Database, OFR analysis

Market Risks Remain Elevated Amid Persistently Low Long-Term Interest Rates

Market risks — risks to financial stability due to adverse movements in asset prices — remain elevated. Overseas developments contributed to significant price volatility in 2016. In January, there was a major sell-off in risky assets caused by uncertainty about Chinese and global economic growth, among other factors (see OFR, 2016b). In June, risky assets again sold off after the U.K. voted to exit the EU, known as "Brexit." In both cases, markets rebounded quickly, as shown by high-yield bond prices and equity prices (see **Figure 6**). As of Sept. 30, 2016, year-to-date prices of risky assets were mostly higher, despite the disruptions. European equities and the pound were still weighed down by uncertainty caused by the U.K. vote (see **Figure 7**).

This has been a pattern in recent years — periods of calm interrupted by occasional bouts of turbulence, as investors broadly reassess risks. The market's rapid recovery and market intelligence suggest investors

Figure 5. China's Real GDP Growth (year-over-year percent change) and Corporate Debt (percentage of GDP)

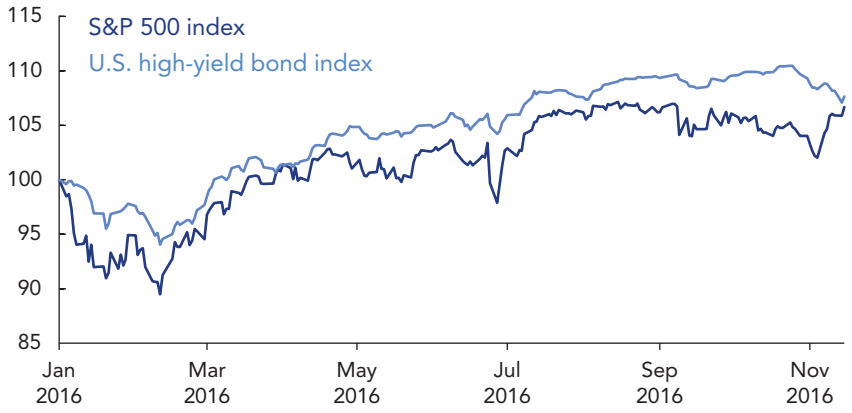
China's corporate debt has increased while its economy has slowed

Note: GDP stands for gross domestic product.

Source: Bloomberg Finance L.P.

Figure 6. U.S. Equity and Corporate Bond Prices (indexes)

U.S. asset prices continued to appreciate in 2016

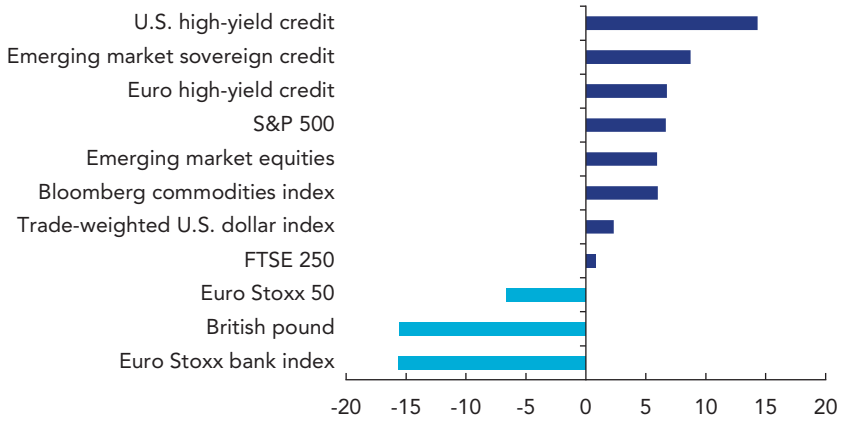


Note: Data as of Nov. 15, 2016. S&P 500 and BofA Merrill Lynch High Yield Corporate index are indexed to 100 on Dec. 31, 2015.

Sources: Bloomberg Finance L.P., OFR analysis

Figure 7. Year-to-Date 2016 Global Asset Returns (percent)

Returns on most risky assets have been positive in 2016



Note: Data from Jan. 1, 2016, to Nov. 15, 2016. Emerging market equities is MSCI Emerging Markets index; credit indexes are Bloomberg-derived indexes.

Sources: Bloomberg Finance L.P., OFR analysis

may expect further accommodative policy from central banks. It also may suggest investors' confidence in the resilience of financial markets.

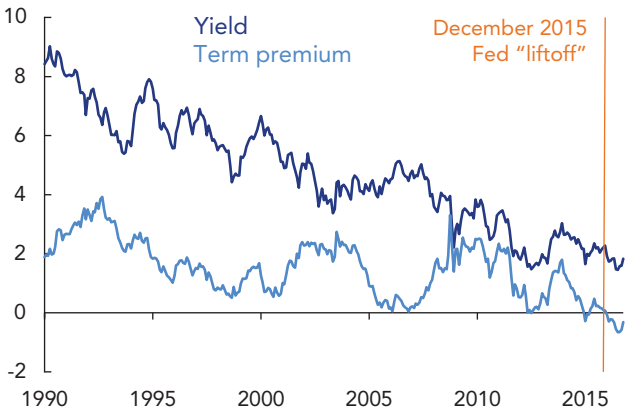
Still, that confidence could be overdone. While low long-term interest rates have supported the economic expansion, they have also promoted high levels of leverage in nonfinancial businesses and excesses in investor risk-taking. Low interest rates may also contribute to weaknesses at some financial institutions.

Long-term U.S. interest rates have been declining along with inflation for decades (see **Figure 8**). They have risen since mid-2016, but remain near all-time lows. They continued to fall despite the end of the Federal Reserve's asset purchases in 2014 and the Federal Reserve interest rate hike in December 2015, the first in 10 years. **Figure 9** shows the rate on the 10-year Treasury that investors expect in 10 years. This rate, known as the 10-year, 10-year forward rate, has also been declining steadily for many years.

The low level of long-term U.S. rates today is partly due to spillover from falling and increasingly negative rates in Europe and Japan. The U.K. vote has pushed European rates even lower. Many key foreign interest rates are now negative, dragging down U.S. rates as global investors hunt for yield. The Bank of Japan is now targeting long-term interest rates at zero. These factors, combined with existing secular trends, could continue to keep U.S. long-term rates low for years.

Figure 8. Ten-Year U.S. Treasury Yield and Term Premium (percent)

Long-term U.S. interest rates fell to historic lows, driving term premiums below zero as the Federal Reserve raised short-term rates



Note: Data as of Oct. 31, 2016. Term premium is the excess yield an investor must receive to purchase a longer-maturity bond over a series of shorter-maturity bonds of the same issuer.

Source: Bloomberg Finance L.P.

Figure 9. U.S. Treasury 10-Year, 10-Year Forward Rate (percent)

Forward rates have followed a consistent downward trend since the 1980s

Note: Data as of Nov. 15, 2016. The 10-year, 10-year forward rate is the interest rate investors expect on 10-year Treasury securities in 10 years.

Sources: Bloomberg Finance L.P., OFR analysis

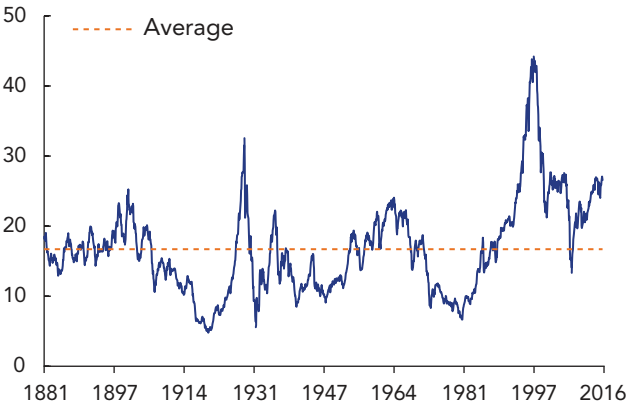
Valuations are high in some key asset classes. U.S. equity valuations remain high based on metrics discussed in a 2015 OFR Brief (see Berg, 2015). The cyclically adjusted price-to-earnings ratio has only reached its current level prior to the three largest equity market declines in the last century (see **Figure 10**). Commercial real estate prices have also climbed, and capitalization rates, one measure of the return expected on a property, are close to record lows. A price shock in one of these markets could threaten U.S. financial stability if the assets were widely held by entities that use high levels of leverage and short-term funding. A price shock that coincided with a sharp increase in U.S. corporate defaults would amplify the risks, as discussed in **Section 2.2**.

Given the low level of interest rates, duration in U.S. bond portfolios is near the top of its long-term range (see **Figure 11**). This leaves investors open to heavy losses from even moderate increases in interest rates.

Low long-term rates may stimulate the economy, but they may also threaten the stability of financial institutions. While interest rates have been falling for some

Figure 10. The CAPE Ratio

The cyclically adjusted price-to-earnings ratio (CAPE) is at levels that have preceded sharp equity price declines

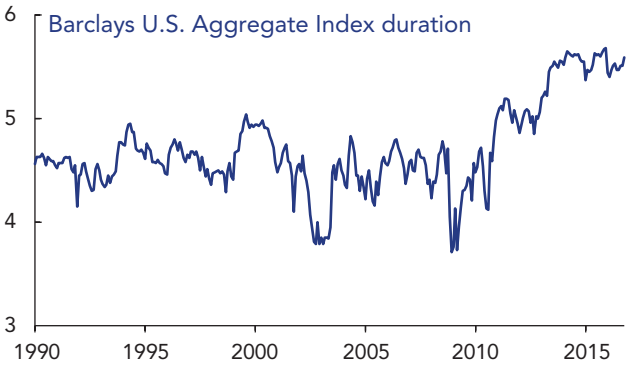


Note: CAPE is the ratio of the monthly S&P 500 index price level to trailing 10-year average earnings (inflation adjusted).

Sources: Haver Analytics; Robert J. Shiller, Yale University, computed with data from Standard & Poor's, Federal Reserve, and U.S. Bureau of Labor Statistics; OFR analysis

Figure 11. Estimated Duration of U.S. Bond Market Investments (years)

The average duration of U.S. bond investments remains at long-term high levels

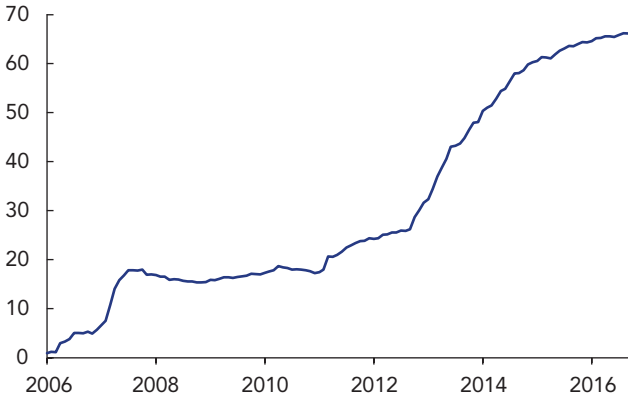


Note: Data as of Oct. 31, 2016.

Source: Bloomberg Finance L.P.

Figure 12. Covenant-Lite Share of Leveraged Loans (percent)

Covenant-lite loans now account for more than two-thirds of total leveraged loans outstanding



Source: Standard and Poor's Leveraged Commentary & Data

time, financial firms may have limited ability at current levels to reprice their liabilities, even as their asset yields continue to fall. Together, these factors can erode firms' ability to generate capital. We are concerned about the market risks facing U.S. banks and insurers, as discussed in depth in **Chapter 2**.

U.S. Nonfinancial Corporate Credit Risks Remain High

Measures of credit risk — the risk of borrowers or counterparties not meeting financial obligations — are elevated in U.S. nonfinancial corporate credit, as debt continues to grow rapidly. The ratio of such debt to GDP is now above its 2007 level. Measures of firms' leverage are also high, as described in **Chapter 2**. Covenant-lite (lacking strict legal covenants) loans have grown rapidly since 2008. Covenant-lite loans now account for two-thirds of corporate leveraged loans outstanding, compared with less than a third during previous cycles (see **Figure 12**). U.S. firms have increased leverage in recent years by issuing debt and buying back their stock. Leverage boosts prices and returns on equity, but also increases credit risks. Those risks are largely borne by U.S. banks, life insurers, mutual funds, and pension funds (see **Chapter 2** and **Monitoring Shadow Banking Risks**).

Excessive borrowing by households and financial firms played a key part in the financial crisis. Aggregate debt burdens in both areas have declined sharply since then. Leverage ratios have improved for households and some key financial industries. Leverage among banks is declining as banks' capital ratios improve. The ratio of tangible equity to tangible assets for U.S. global systemically important banks (G-SIBs) rose from 5.9 percent in 2010 to 7.2 percent in 2015, although some G-SIBs reported declines in their capital ratios over the same period.

Leverage remains high for some nonbank financial institutions. The 10 largest hedge funds by gross assets have average leverage of 15-to-1, based on the ratio of gross to net assets (see **Figure 15**). Much of this leverage is obtained through short-term borrowing. This ratio may understate funds' leverage because it does not

Monitoring Shadow Banking Risks

The 2007-09 financial crisis was so devastating in part because companies and regulators didn't recognize the risks as activities migrated from banks to new, typically less transparent, and presumably less resilient markets and institutions. Since then, the term "shadow banking" has often been used to describe the extension of credit by nonbank companies, or credit funded by liabilities that are susceptible to runs because they are payable on demand and lack any government backstop.

Shadow banking is still a key source of credit and financial services in the United States. Understanding the incentives that drive these activities and the potential risks and vulnerabilities they may create for financial stability is central to the OFR's work. We are focused on (1) run risks in money market funds and similar vehicles, (2) run risks and fire-sale risks in secured funding markets, and (3) credit risk for nonbank credit providers.

We are focused on (1) run risks in money market funds and similar vehicles, (2) run risks and fire-sale risks in secured funding markets, and (3) credit risk for nonbank credit providers.

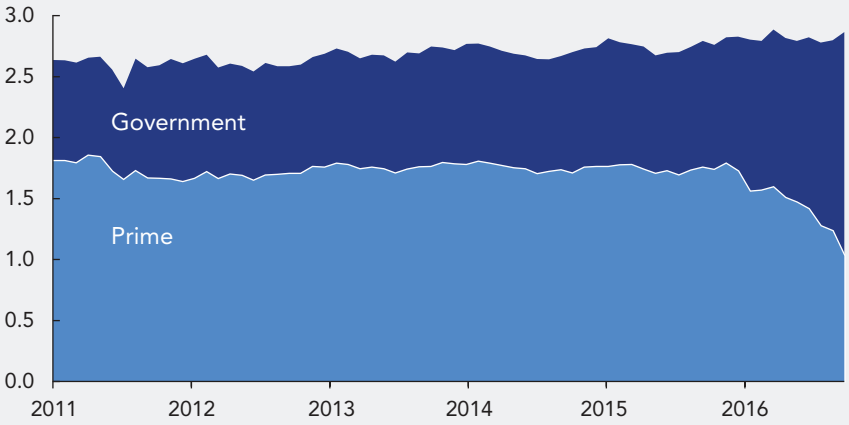
Run risks in money market funds and similar vehicles. Runs on prime money market funds in September 2008 made the financial crisis more severe. A recent SEC rule addresses this risk. The rule requires prime and tax-exempt money market funds with institutional investors to let their net asset values float with the value of the assets they hold. Prime and tax-exempt funds with retail investors may continue to offer a stable net asset value — that is, these funds may be sold and redeemed at a $1 share price. Even then, these funds will have to report the market value of their share prices. Both types of funds will have to adopt liquidity fees and redemption restrictions, though these can be suspended by each fund's board. In anticipation of this rule, which took effect on Oct. 14, 2016, $1 trillion shifted from prime funds to government funds (see Figure 13) (see Schreft, 2016).

In July, the OFR launched our U.S. Money Market Fund Monitor, an online interactive tool that regulators and others can use to explore and display fund investments. It relies on data the funds now file on the SEC's Form N-MFP (see Baklanova and Stemp, 2016).

Similar short-term investment vehicles can be subject to runs. Some of these vehicles report a stable net asset value, although they take credit risks and have no government backstop. These include retail prime and tax-exempt money market funds, some short-term investment funds sponsored by banks, some local government investment pools, and some private liquidity funds. Data are relatively new for some of these vehicles, so not all are included in the series in Figure 16.

Figure 13. Assets Under Management in Money Market Funds
($ trillions)

Investors are shifting out of prime funds and into government funds



Note: Tax-exempt funds are excluded.

Sources: Securities and Exchange Commission Form N-MFP, OFR analysis

However, the data are improving. An OFR paper last year used the SEC's Form PF to analyze private liquidity funds (see Johnson, 2015). The form is comparable to Form N-MFP, allowing comparisons to money market funds. The OFR has also obtained data that the Office of the Comptroller of the Currency collects from national banks about their short-term investment funds. Private liquidity funds and short-term investment funds had more than $500 billion under management at the end of June 2016, according to these new data sources. State-regulated banks and local government investment pools do not report these data.

Run risks and fire-sale risks in secured funding markets. Runs and fire sales in secured funding markets were also a key amplifier in the financial crisis. The OFR is working with other Financial Stability Oversight Council (FSOC) agencies to fill data gaps in these markets. Pilot data collections completed in 2016 shed new light on the potential risks in bilateral repurchase agreement (repos) and securities lending activities (see Baklanova and others, 2016b). The OFR expects to soon announce details of our proposed permanent bilateral repo data collection, which will be followed by a securities lending collection.

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Secured funding markets have been a focus of OFR research. A widely cited OFR paper in 2015 documented a pattern of foreign broker-dealers reducing their repo borrowings at the end of every quarter to make their capital ratios appear stronger (see Munyan, 2015). Another OFR paper served as a reference guide on U.S. repo and securities lending markets (see Baklanova, Copeland, and McCaughrin, 2015).

An earlier OFR paper proposed an accounting framework for measuring sources and uses of short-term funding in the financial system. It noted the largely opaque role played by the trillions of dollars held by institutional cash pools, which include large corporations, central banks, and asset managers (see Pozsar, 2014).

Credit risk for nonbank credit providers. Private asset-backed securities were the major source of funding for subprime mortgages in the run-up to the financial crisis. This type of nonbank credit has declined by almost $1 trillion since 2011. Still, based on our definition of shadow banking, shadow banking remains the major source of credit to U.S. businesses and households, providing close to 40 percent of credit compared with 32 percent provided by depository institutions (see Figure 14). Shadow banking credit in total has grown more than $1.2 trillion since 2011. This growth has been driven by mutual funds and other asset managers. Between 2011 and June 2016, mutual funds that focus on bank loans have risen 63 percent to $89 billion, and high-yield bond funds have risen 28 percent to $248 billion (see Morningstar, 2016).

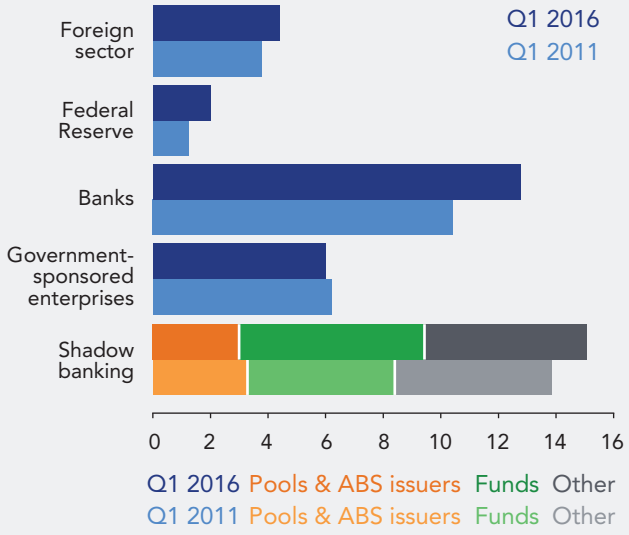
Hedge funds are another growing source of credit intermediation that remains somewhat opaque. Recently adopted reporting requirements have improved transparency. The SEC's Form PF shows that hedge funds' total investments in loans were $138 billion as of June 2016. Their total investments in corporate loans and fixed-income securities were $662 billion, excluding sovereigns. However, Form PF does not identify borrowers or provide further information to help analyze risks.

In addition to hedge funds, a segment of private funds known as private debt funds provides credit by originating loans. Private debt funds file Form PF but don't disclose the size of their loan portfolios. Industry data show that fund-raising in private debt funds providing direct lending grew from $7 billion in 2010 to $32 billion in 2015 (see Preqin, 2016).

Business development companies are another small but growing type of nonbank lender to corporations. There were 66 operating business development companies with more than $70 billion in outstanding loans as of June 2016, according to data from SNL Financial.

Figure 14. Providers of Credit to U.S. Real Economy ($ trillions)

Shadow banking accounts for close to 40 percent of total credit provided in the United States

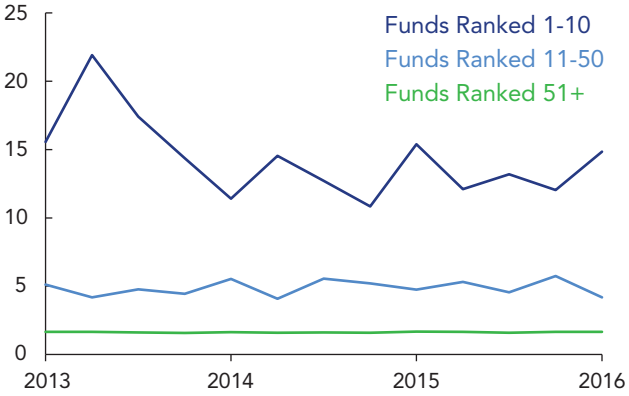


Note: ABS stands for asset-backed securities. "Funds" includes pension funds, money market funds, mutual funds, exchange-traded funds, real estate investment trusts, and private funds. "Other" includes insurance companies, finance companies, and broker-dealers.

Sources: Haver Analytics, OFR analysis

Figure 15. Qualifying Hedge Fund Leverage by Fund Gross Assets (ratio)

The largest hedge funds use more leverage

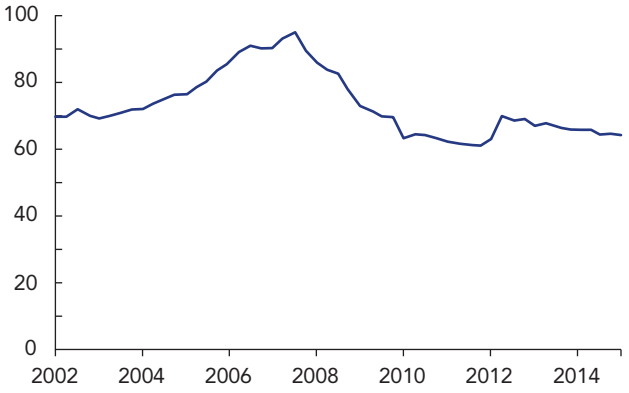


Note: Fund size ranked by gross assets. Leverage is calculated as the ratio of gross assets to net assets. The average of fund leverage ratios are shown for each group.

Sources: SEC Form PF, OFR analysis

Figure 16. Runnable Liabilities in the U.S. Financial System (percent of GDP)

Runnable liabilities declined during the crisis and have not returned to precrisis levels



Note: Data as of Dec. 31, 2015. Runnable liabilities include repurchase agreements (repos), securities lending, commercial paper, money market funds, and uninsured bank deposits. Repos reflect "Federal Funds & Security Repurchase Agreements" from the Financial Accounts of the United States, minus the repo liabilities of the Federal Reserve System and total Federal Funds purchased reported by bank holding companies on Form Y-9C. Uninsured deposits reflect total "Domestic Office Deposits" minus "Estimated Insured Deposits" from the Federal Deposit Insurance Corporation Statistics on Banking. GDP stands for gross domestic product.

Sources: Federal Reserve Board of Governors, Financial Stability Oversight Council, Haver Analytics, OFR analysis

reflect synthetic leverage through the use of derivatives. Life insurers' reported leverage has been stable in recent years. Like hedge funds, their leverage including securities lending, derivatives, and other off-balance-sheet transactions would be higher (see Fitch, 2015).

Funding and Market Liquidity Risks Remain

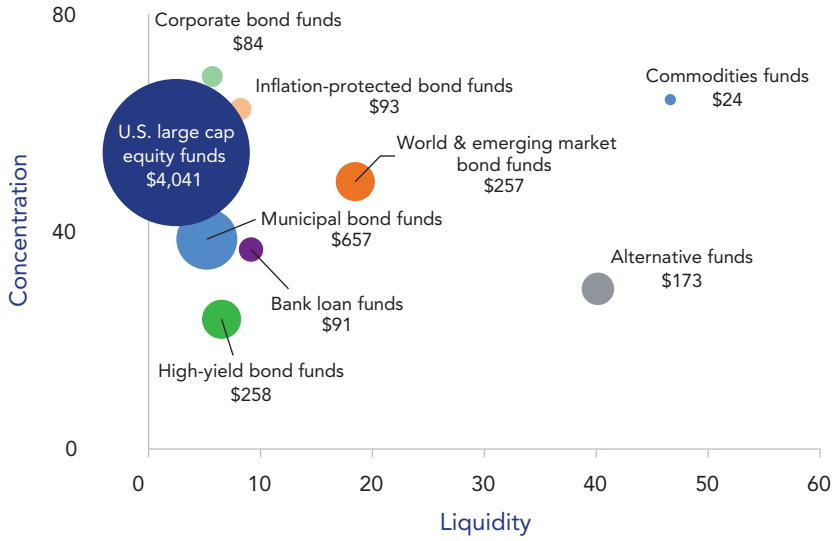
In our assessment, funding and liquidity risks persist in the U.S. financial system. Specifically, in a number of areas discussed below we remain concerned about run risk — the risk that investors will lose confidence and pull their funding from a firm or market — and asset fire sale risk — the risk that market participants won't be able to sell securities without creating a downward price spiral. These risks are structural and slow to change. Meanwhile, our heat map shows some incremental improvement in average liquidity conditions since our 2015 *Financial Stability Report*. In the market liquidity subcategory, average trading volume for major U.S. asset classes edged higher and some trading costs declined. In the intermediation category, the securities inventories of U.S. primary dealers increased.

Figure 16 shows "runnable" liabilities, which are payable on demand and not backed by the government. These liabilities include repurchase agreements, securities loans, commercial paper, money market funds, and uninsured bank deposits. They were the object of runs and fire sales during the crisis, but have declined since then. The decline is partly due to post-crisis reforms that sought to reduce run risk in these markets (see **Monitoring Shadow Banking Risks**). (The increase in 2013 reflects the reclassification of uninsured bank deposits when temporary unlimited deposit insurance under the Dodd-Frank Act ended.)

Liquidity transformation can create a vulnerability for some open-ended mutual funds in the form of redemption risk. The assets under management in this sector were close to $16 trillion in June 2016, nearly doubled since the end of 2008. Potential risks are most acute for funds that hold limited cash buffers and invest in less-liquid asset classes, such as high-yield bonds,

Figure 17. Size, Liquidity, and Concentration of U.S. Open-End Funds in Select Asset Class Categories (percent and $ billions)

Low cash buffers and high fund-manager concentration may pose asset fire-sale risk (size of circle indicates assets under management)



Note: Data as of July 31, 2016. Liquidity is defined as the average percentage of cash and cash equivalents for all funds in each category. Concentration is defined as the top three managers' share of category assets, in percent.

Sources: Morningstar, OFR analysis

bank loans, and municipal bonds. These funds may be challenged to meet investor redemptions in stressed markets. The concentration of fund managers in some asset classes also may make these markets more vulnerable to stress. For example, just three asset management firms manage nearly 40 percent of municipal bond and bank loan funds (see **Figure 17**). The Securities and Exchange Commission (SEC) finalized rules in October 2016 that will require mutual funds and exchange-traded funds that redeem shares in cash to hold more liquid assets as a buffer against large redemptions.

Although market liquidity has generally been sufficient during normal market conditions, it has fallen sharply during some moderate stress events (see OFR, 2015). Steps are underway to improve data to monitor liquidity risk. The U.S. Treasury recently sought public comment on the changing structure of the U.S. Treasury market. Also, the Financial Industry Regulatory Authority (FINRA) recently announced it will expand the Trade Reporting and Compliance Engine (TRACE) to include most secondary market transactions in marketable U.S. Treasuries (see FINRA, 2016b).

Contagion Risks Remain, but Are Difficult to Measure

Contagion risk is the risk that financial stress spreads across markets, institutions, or other entities. A key focus of our research has been to find new ways to measure and assess risk. The potential contagion risks posed by a troubled bank, insurer, or central counterparty (CCP) are discussed in **Chapter 2**.

Figures 18 and **19** show three contagion risk metrics for leading financial firms. The three metrics are the distress insurance premium, SRISK, and conditional Value-at-Risk. Each metric evaluates different aspects of the contribution an individual firm makes to financial stability risk. (These metrics are described further in **Section 2.5**.) All three are market based, and they tend to be coincident rather than predictive measures. In other words, they can help compare the risks posed by individual firms, but they are less reliable at identifying vulnerabilities in advance of a stress — they tend to rise only when risks are realized. Indeed, they may indicate low risks precisely when risks are building.

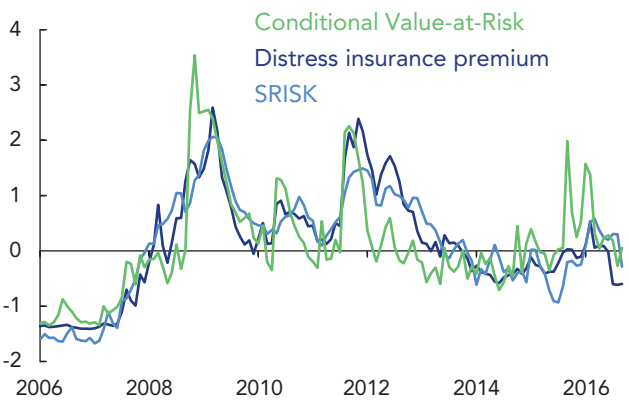
For example, **Figure 18** shows the three metrics were negative for the six largest bank holding companies during the runup to the financial crisis, then jumped in 2008. **Figure 18** also shows that these measures generally register lower risk today than during the financial crisis.

Using the same three risk measures, **Figure 19** compares eight leading U.S. financial firms in the first quarter of 2016, including four banks and four insurance companies. In this figure, larger triangles signal greater risk. The figure shows that banks dominate across all three measures. However, the insurance companies also rank high on some measures. Potential financial stability risks from large U.S. life insurers and banks are discussed in **Sections 2.5** and **2.6**.

An earlier OFR working paper proposed an index that ranks a different aspect of risk — banks' financial connectivity. The index measures the fraction of a bank's liabilities held by other financial institutions. All else being equal, the default of a bank with a higher connectivity rank would have a greater impact as its shortfall would spill over to other connected financial institutions. By this measure, Bank of New York Mellon is the most connected bank. Since 2013, most banks have become less connected; Goldman Sachs and Wells Fargo have become more connected; and Morgan Stanley has become much less connected (see **Figure 20**) (see Glasserman and Young, 2013).

Figure 18. Measures of Joint Distress for the Six Largest U.S. Bank Holding Companies (Z-scores)

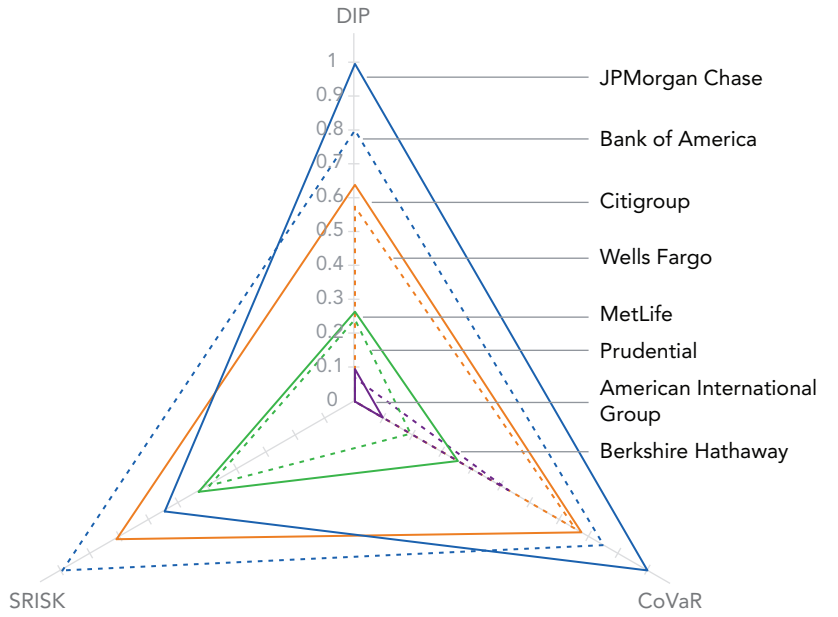
Joint distress metrics jumped in recent equity sell-offs, then quickly reversed



Note: Equal-weighted average. The six large bank holding companies are Bank of America, Citigroup, Goldman Sachs, JPMorgan Chase, Morgan Stanley, and Wells Fargo. Z-score represents the distance from the average, expressed in standard deviations.

Sources: Bloomberg L.P., Markit Group Ltd., the Volatility Laboratory of the NYU Stern Volatility Institute (https://vlab.stern.nyu.edu), OFR analysis

Figure 19. Top Systemic Risk Scores

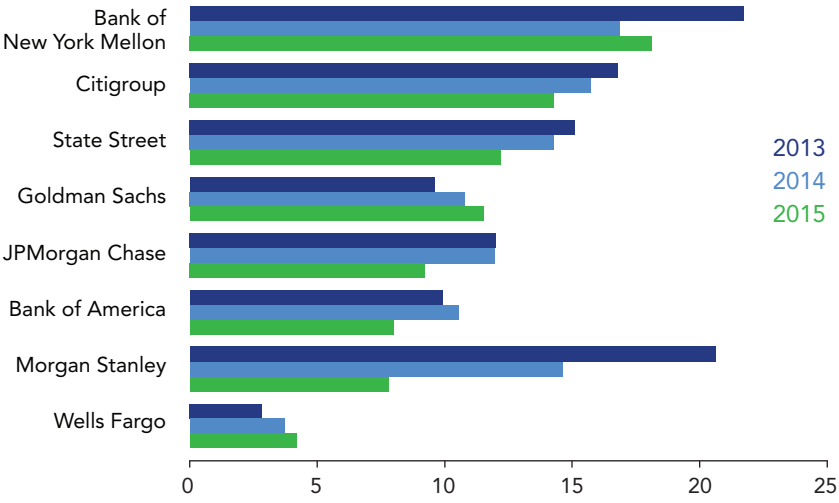


Note: Data as of June 30, 2016. Distress insurance premium (DIP), conditional Value-at-Risk (CoVaR), and SRISK are measures of systemic risk. For purposes of comparison, the normalized systemic risk measures are calculated as fractions of the highest score for each metric at that time.

Sources: Bloomberg Finance L.P., Markit Group Ltd., the Volatility Laboratory of the NYU Stern Volatility Institute (https://vlab.stern.nyu.edu), OFR analysis

Figure 20. OFR Financial Connectivity Index (percent)

Goldman Sachs and Wells Fargo have grown more connected, while Morgan Stanley and others have grown less



Note: G-SIB stands for global systemically important bank. The OFR Financial Connectivity Index measures the fraction of a bank's liabilities held by other financial institutions.

Sources: Federal Reserve Form Y-15, OFR analysis

2

Key Threats to Financial Stability

In this chapter, we analyze seven vulnerabilities that could threaten financial stability.

To select which key threats to analyze in this *Financial Stability Report*, the staff of the OFR cast a wide net. We reviewed data and research, revisited themes in prior OFR financial stability reports and in the annual report of the Financial Stability Oversight Council, and evaluated dozens of issues. Some have proven to be central to bouts of financial instability. Others have that potential due to growth, innovation, and evolving business models.

Our analysis placed the most weight on the magnitude of the impact a threat would have on financial stability if it materialized. We also considered probability, proximity — how immediate is the threat? — and the preparedness of policymakers, supervisors, and market participants. Preparedness encompasses the level of attention given the threat, as well as actions taken to ensure that the system would be resilient if the threat were realized.

While this approach is systematic, it isn't foolproof. These criteria do not have precise or quantitative values. They entail substantial uncertainty.

The analysis pointed to seven key threats, which fit into four themes:

- **The potential for disruptions in the global economy to affect U.S. financial stability.** We focus on potential spillovers from Europe.
- **Risk-taking amid low long-term interest rates.** We focus on risks in U.S. nonfinancial corporate credit.
- **Risks facing U.S. financial institutions.** We focus on cybersecurity incidents affecting financial firms, central counterparties as contagion channels, pressure on U.S. life insurance companies, and systemic footprints of the largest U.S. banks.
- **Challenges to improving data.** We focus on deficiencies in data and data management.

The four themes are not mutually exclusive. Low long-term interest rates are a key factor in the growth of nonfinancial corporate credit, but they also underlie the earnings and funding challenges faced by banks, insurance companies, and others. Data challenges affect our analysis of many of these issues.

Figure 1 on page 2 maps these seven key threats to the risk categories in the OFR's Financial Stability Monitor, described in **Chapter 1**. The systemwide view in **Chapter 1** provides the context for the deeper discussion of specific threats in this chapter. Some risks discussed in **Chapter 1** are not in this chapter. These include the fragility of market liquidity, run risk in money market funds and other short-term funding markets, and credit risks in emerging markets. These vulnerabilities have been discussed in prior OFR annual reports and are topics of ongoing OFR research. They remain potential sources of risk to the U.S. financial system.

The rest of this chapter examines the seven key threats in more depth. We also draw conclusions about how to mitigate these risks. In these conclusions, we concentrate on ways to increase visibility into still-opaque parts of the financial system for supervisors, policymakers, and the public.

2.1 Potential Spillovers from Europe

Disruptions in the global economy could pose risks to U.S. financial stability. In particular, the political and economic environment in Europe is likely to be uncertain for some time in the wake of the United Kingdom's (U.K.) vote to leave the European Union (EU). This uncertainty magnifies vulnerabilities already seen in Europe's financial system. Economic weakness in Europe could spill over to the U.S. economy and cause investors to take excessive interest rate risks, credit risks, and liquidity risks.

Risks to some large European banks appear to be rising, and these banks are substantially interconnected. The potential failure or material distress of a large European bank could have spillover effects in the United States. U.S. financial stability and economic growth could be affected more if European cohesion is threatened in other ways.

Disruptions would most affect those U.S. financial institutions with large direct financial exposures. These exposures could be vulnerable to losses from lower asset prices and increased defaults on debt. Many European financial institutions also operate in the United States. Under stress, they may reduce U.S. operations. Reduced operations could have short-run effects on the U.S. financial services industry and economy, such as through reduced credit.

A shock in Europe could also affect the U.S. financial system through several indirect channels. One is through trade. A European recession that included a material depreciation of the euro would reduce demand for U.S. exports, potentially slowing growth and leading to lower valuations for equities and corporate bonds. Another is through confidence. A loss of investor confidence from a shock in Europe could trigger a decline in prices of U.S. equities and other risky assets. Such confidence shocks can be self-fulfilling. Indirect linkages can be invisible until revealed by stress.

The consequences of low long-term interest rates represent another potential channel. U.S. rates are low partly due to spillover from falling and increasingly negative rates in Europe, as noted in **Chapter 1**. The U.K. vote pushed European rates even lower and will likely prolong negative interest rate policies in the eurozone and elsewhere. U.S. long-term interest rates reached historical lows in the week after the vote. Lower short-term interest rates may stimulate economic activity, but lower long-term rates may also reduce profits for U.S. banks and life insurance companies and hurt their ability to generate capital internally.

The eurozone's sovereign debt crisis in 2010-12 did not destabilize the U.S. economy or financial system. However, those stresses did not pose the existential threat to European cohesion that the exit of an EU member

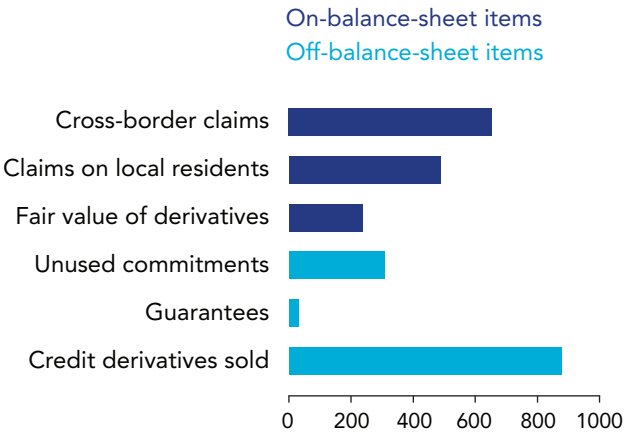
The potential failure or material distress of a large European bank could have spillover effects in the United States. A shock in Europe could also affect the U.S. financial system through several indirect channels.

could. In early 2016, investor concerns focused on European banks' earnings and loan quality. Further weaknesses in European banks could have repercussions on U.S. financial stability and the economy (see **Risks for European Banks Remain High**).

In this section, we consider how potential spillovers from Europe could affect U.S. banks, insurers, asset managers, and money market funds. Due to the magnitude of both direct and indirect exposures, the potential impact of more disruptions in Europe on U.S. financial stability is high. The probability is difficult to judge, although it seems likely that uncertainty will persist for some time. The immediacy of the issue is moderate. It is unclear how prepared regulators and firms are for further disruptions, especially given the unprecedented nature of a country voting to exit the EU after 43 years of membership. U.S. supervisors should continue to monitor and stress test financial exposures.

Figure 21. Total Exposures of U.S. G-SIBs to the EU ($ billions)

Off-balance-sheet items are a significant portion of U.S. G-SIB exposure to the European Union



Note: Data as of June 30, 2016. G-SIB stands for global systemically important bank. Claims are on an ultimate risk basis and include the reallocation of claims such as risk transfers. Croatia, Estonia, Latvia, Lithuania, Malta, and Slovenia are not represented in this sample.

Sources: Federal Financial Institutions Examination Council, OFR analysis

U.S. Financial Institutions Have Large Direct Exposures to Europe

Banks. U.S. global systemically important banks (G-SIBs) have more than $2 trillion in total exposures to Europe (see **Figure 21**). Roughly half of those exposures are off-balance-sheet. Under stress, U.S. G-SIBs' unused commitments could be drawn, straining the liquidity and capital of these firms. U.S. G-SIBs have sold more than $800 billion notional in credit derivatives referencing entities domiciled in the EU.

The Brexit vote raised locational and supervisory risks for large internationally active banks. It has led many banks to consider moving operations out of London. The alternatives are unclear and possibly more expensive.

Insurance companies. U.S. insurance companies are exposed to the EU through investments, derivatives, and reinsurance. The top 10 U.S. life insurers have $32 billion of investment exposure to Europe, excluding the United Kingdom.

Gross notional derivatives exposure to EU banks totaled $311 billion for the top 10 U.S. life insurers at the end of 2015. Notional exposures may overstate the potential risks of derivatives. But data on notional exposures also may understate U.S. insurers' links to European banks. For example, American International Group, Inc. (AIG) and Prudential use noninsurance

Risks for European Banks Remain High

Some large European banks face earnings pressure that may limit their ability to generate capital. Low and negative rates have depressed net interest income. Weak economic growth has weighed on banks' asset quality, loan growth, and underwriting (see Figure 22).

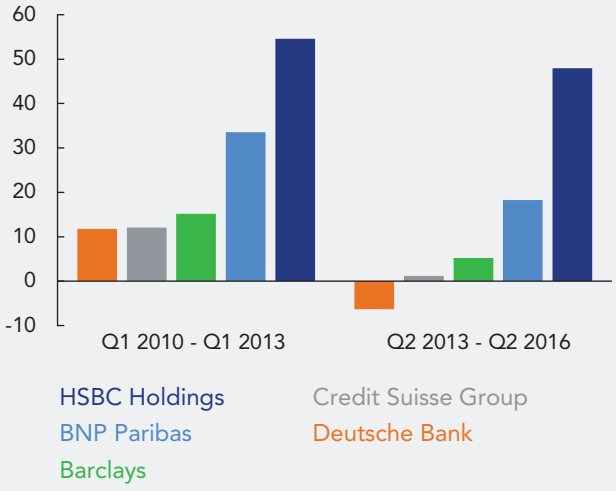
Further weaknesses in European banks could have negative effects in the United States. For example, if European banks lost access to wholesale funding in U.S. financial markets, they could be forced to seek other funding or to reduce lending to U.S. borrowers. The Federal Reserve now requires foreign banks with a significant U.S. presence to establish intermediate U.S. bank holding companies. These entities are subject to U.S. prudential standards.

Some European banks report high risk-based capital ratios but low leverage ratios. This is because their total assets, used to calculate leverage ratios, are substantially higher than their risk-weighted assets. Some research suggests that European banks may arbitrage risk weights to appear more resilient (see Figure 23) (see Efing, 2015).

In early 2016, international regulators began to consider another buffer on top of the 3 percent supplementary leverage ratio requirement for global systemically important banks (G-SIBs). The United States and Switzerland have already enacted such a buffer (see BIS, 2016). The supplementary leverage ratio reflects the ratio of a bank's tier 1 capital to total exposures. Total exposures include on-balance-sheet assets and off-balance-sheet exposures. If that ratio were increased, some European G-SIBs would need to increase capital or reduce total exposures. Increasing capital could be challenging for some European banks, whether through

Figure 22. Cumulative Net Income of Select European G-SIBs ($ billions)

Some large European banks face earnings pressure

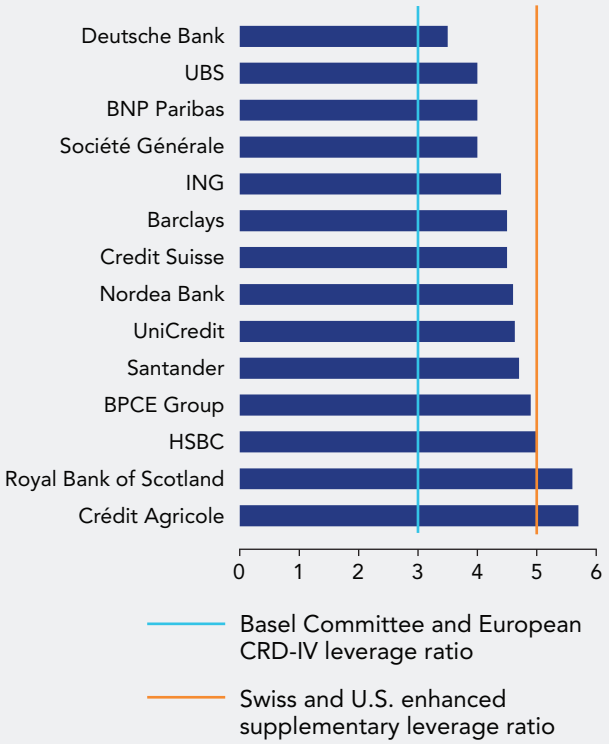


Note: G-SIB stands for global systemically important bank.

Sources: SNL Financial LC, OFR analysis

Figure 23. Basel Committee Leverage Ratios for Large European Banks (percent)

Most large European banks would need to raise capital or reduce exposures to meet an enhanced supplementary leverage ratio requirement



Sources: Basel Pillar 3 Disclosures, OFR analysis

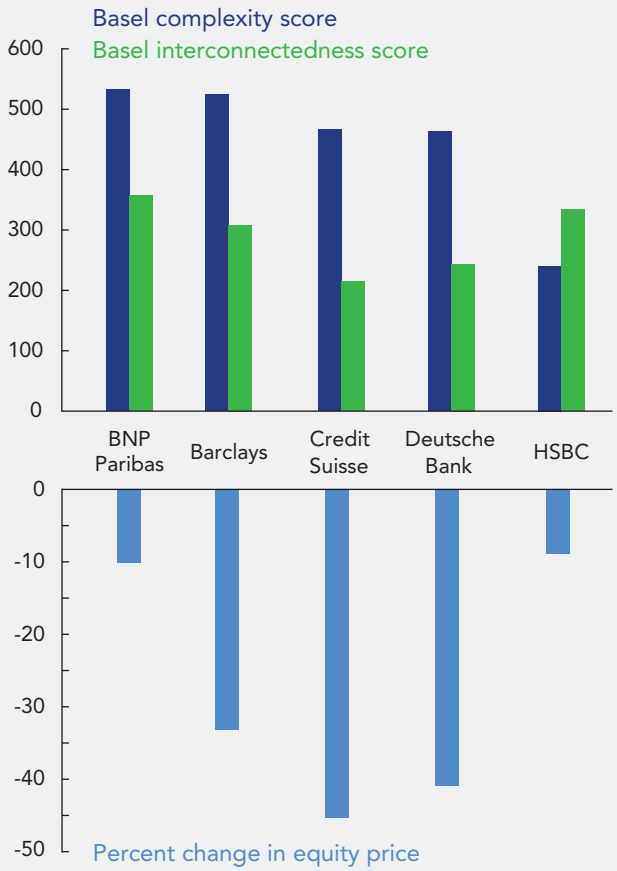
earnings or share issuance. But reducing exposures could hurt European economic growth.

Figure 24 shows some large European banks whose share prices have been under pressure in 2016. The systemic importance scores for G-SIBs, as calculated by the international Basel Committee on Banking Supervision, suggest these firms are relatively interconnected and complex.

Credit default swap market participants appear to believe that large European banks have become more risky even as they appear to believe that investors are less likely to bear losses, according to a recent OFR working paper (see Neuberg and others, 2016). Figure 25 shows that the market-implied probability of default (the light blue line) has increased even as the market-implied probability of a bail-in (the dark blue line) for the 15 European G-SIBs has decreased. (Bail-ins force investors to take losses without the firm formally defaulting. European rules set since the crisis require the bail-in of investors before banks can receive public funds.)

Figure 24. European Bank Complexity, Interconnectedness, and Equity Prices

Complex and interconnected banks in Europe experienced equity price declines in 2016

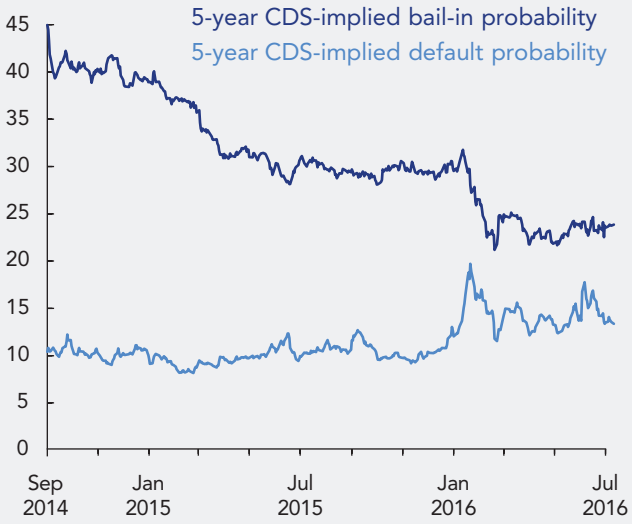


Note: Data for complexity and interconnectedness are as of Dec. 31, 2014. The figure shows the five non-U.S. banks that ranked highest on the scoring system that regulators use to set capital requirements for large banks. Data for change in equity price are from Jan. 4, 2016, through Aug. 9, 2016. Complexity is calculated using over-the-counter derivatives, available-for-sale securities, and level 3 assets. Interconnectedness is calculated using intrafinancial system assets, intrafinancial system liabilities, and securities outstanding.

Sources: Basel Committee on Banking Supervision, SNL Financial LC, OFR analysis

Figure 25. Probabilities of Default and Bail-In for European G-SIBs (percent)

Markets pricing out bail-in even as probability of European G-SIB default rises



Note: Data as of Aug. 1, 2016. CDS stands for credit default swap. G-SIB stands for global systemically important bank.

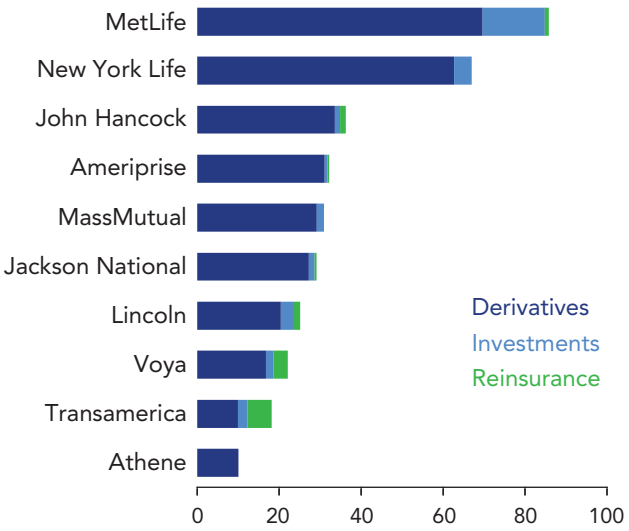
Sources: Markit Group Ltd., OFR analysis

subsidiaries to conduct derivatives transactions. These transactions are not captured in their statutory filings. The top 10 life insurers also have taken $14.2 billion in reinsurance credit with EU reinsurers, with the largest exposures concentrated among German reinsurers (see **Figure 26**). Some of this exposure may be collateralized as required by state law.

However, the direct exposures of U.S. life insurers to the EU are small relative to their $4 trillion in general account assets. Judging by the decline in their equity prices after the U.K. referendum, other factors were likely more important. In particular, spillovers likely arose from sharp post-Brexit declines in interest rates and their effect in depressing earnings and capital. The risk that sustained low interest rates may hurt the health of U.S. life insurers is discussed in more detail in **Section 2.5**.

Figure 26. Top 10 U.S. Life Insurers' Exposure to European Union ($ billions)

Life insurers are exposed to European financial companies through derivatives, investments, and reinsurance arrangements



Note: Data as of Dec. 31, 2015. Insurer exposure to U.K. not included.

Sources: SNL Financial LC, OFR analysis

Asset managers. While shareholders and bondholders of life insurers and banks could face direct losses, asset managers are different in that they act as agents on behalf of their clients. For that reason, potential channels of transmission of risks during a market disruption are different from those in other financial institutions. For example, some asset managers offer products that invest in relatively less liquid securities that are held in funds that offer daily liquidity. This produces a mismatch between the liquidity of the fund's assets and its liabilities. Under market stress, the need for liquidity to meet redemption requests from fund investors or margin calls could increase the likelihood of an asset fire sale.

Brexit provides evidence that less liquid asset classes may be the most at risk from such a fire sale. Right after the U.K. vote, commercial real estate investment trust funds in the U.K. with U.K. and EU exposures experienced the greatest redemptions, with some funds suspending redemptions to avoid asset sales. (Such daily redeemable commercial real estate investment funds do not exist in the United States.)

Future shocks to the EU could play out similarly. Funds with large EU exposures could face a rise in redemptions if the threat of other countries leaving the EU increases.

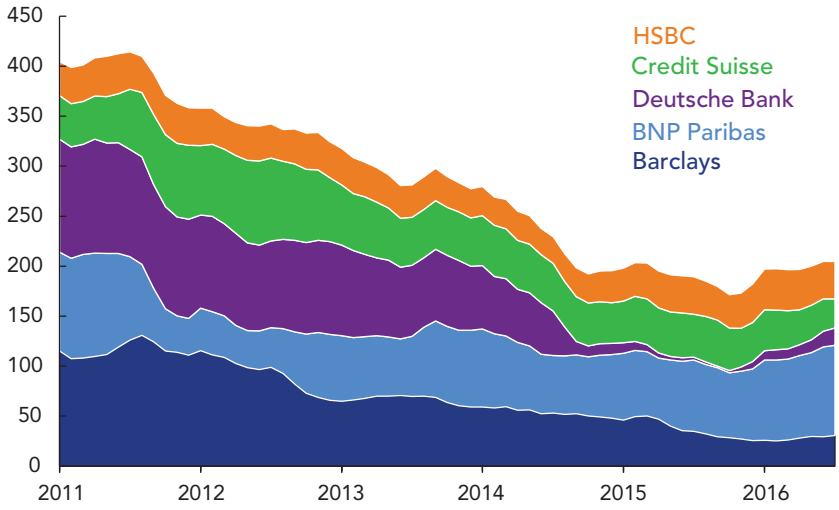
European holdings of U.S.-based money market funds could also be vulnerable to a shock. The possible exit of a European state from the EU could create uncertainty about a fund's holdings of short-term debt issued by banks and corporations in that state. Using the OFR's U.S. Money Market

Fund Monitor, the OFR assessed exposures of U.S. money market funds to large EU banks. Fund exposures to these banks have declined by half over the past five years but remain large for some banks (see **Figure 27**). An EU disruption that makes European assets less creditworthy could stress these funds. However, the effect on U.S. money market funds may be limited. In anticipation of the October deadline for compliance with money market fund reform, some substantially reduced the duration of their overall credit exposures, resulting in less volatile asset pricing.

European financial firms' U.S. operations. Some European financial firms have material U.S. operations. The exit of these firms could have short-run effects on the provision of credit and other financial services in the United States, although other firms may take their place over time. For example, the total assets of U.S. primary dealers with European parents decreased from $1.35 trillion to $0.88 trillion from 2011 to 2015 (see **Figure 28**). Over the same time, the total assets of U.S. primary dealers with U.S. and non-European parents also fell. As a result, U.S. primary dealers' balance sheets shrank overall. A further decline in U.S.-based broker-dealer balance sheets may reduce liquidity in U.S. markets. A small number of European global systemically important insurers own U.S. life insurers. The EU parents are

Figure 27. U.S. Money Market Fund Exposure to Select European G-SIBs ($ billions)

European exposure has declined but remains significant

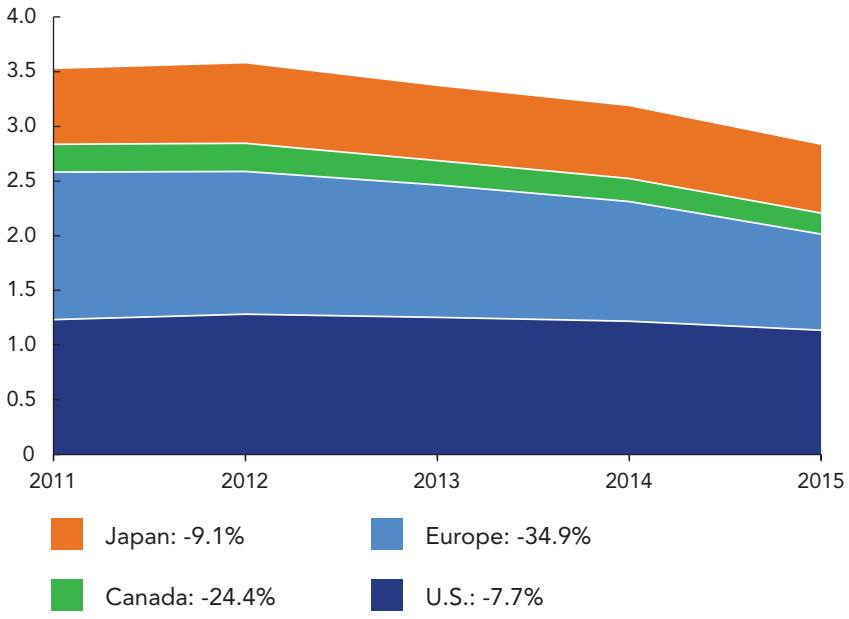


Note: Three-month moving average. G-SIB stands for global systemically important bank.

Sources: SEC Form N-MFP, OFR analysis

Figure 28. U.S. Primary Dealer Assets by Region of Parent ($ trillions and percent decline)

Assets of U.S.-based primary dealers with European parents have declined more quickly than all other regions



Note: Percent decline in assets calculated for 2011-15.

Sources: SNL Financial LC, OFR analysis

based in Netherlands (Aegon), U.K. (Prudential plc), France (AXA), and Germany (Allianz).

Conclusion: EU Risks Remain and Warrant Ongoing Monitoring

Since 2010, the EU has faced a series of sovereign debt and banking crises. To date, these challenges have been addressed through actions taken by the European Central Bank, EU, and International Monetary Fund that have decreased perceptions of tail risk.

Nonetheless, challenges remain. Eurozone bank risks may continue to rise. Measures that entail European government support may affect confidence in public sector solvency. The U.K. exit vote suggested that EU or even European monetary union dissolution risks may be higher than had been understood before. The impact of either of these two scenarios on U.S. financial stability could be substantial. U.S. supervisors should continue to monitor and stress test financial exposures, and to evaluate potential indirect channels through which spillovers to the U.S. financial system could arise.

2.2 Risks in U.S. Nonfinancial Corporate Credit

Risk-taking amid low long-term interest rates has been a top theme for the OFR since our first report on financial stability. One vulnerability that low rates have helped fuel is in U.S. nonfinancial corporate debt. A severe downturn in this $8 trillion market could threaten financial stability if the exposed counterparties cannot manage the losses and resulting erosion of confidence. The role played by nonbanks in this market has grown, driven by mutual funds and other asset managers. Nonbanks, including traditional buyers such as insurance companies and pension funds, own more than a quarter of U.S. corporate debt. Stress testing the most exposed is one way to address the potential financial stability risks. A severe increase in defaults could be made worse by sell-offs in U.S. equity and commercial property markets, as has happened in the past.

As the OFR has shown in previous reports, U.S. nonfinancial corporate debt has grown quickly in the low interest-rate environment of recent years. Since our *2015 Financial Stability Report*, aggregate debt has kept growing across industries and debt types. The ratio of debt to gross domestic product (GDP) has climbed above its 2007 level and is near its all-time high. Elevated levels of aggregate private debt-to-GDP and rapid debt growth are key factors in episodes of financial instability. Firm-level data confirm that borrower leverage has also risen, increasing the risk of default and investor losses.

The recent rapid debt growth and elevated borrower leverage are similar to past cycles. The impact on financial stability will depend on the severity of the next wave of defaults, possible spillovers to other markets, and the ability of investors to manage the fallout.

For these reasons, the vulnerability posed by the growing debt of nonfinancial corporations continues to rank as a top threat to stability. However, while a market downturn of some size is inevitable, a crisis is not. Default cycles are a regular feature of the nonfinancial corporate debt market. The recent rapid debt growth and elevated borrower leverage are similar to past cycles. The impact on financial stability will depend on the severity of the next wave of defaults, possible spillovers to other markets, and the ability of investors to manage the fallout.

Creditors of nonfinancial corporations would be most exposed to a wave of defaults. These creditors mainly include U.S. banks, mutual funds, life insurers, and pension funds. They should undergo stress testing for severe losses in nonfinancial corporate debt and associated liquidity strains and erosion of confidence. The stress testing should include downturns in U.S. equity and commercial real estate prices, which have coincided with rising business defaults during the past three decades.

Credit to U.S. Nonfinancial Corporations Is Elevated and Continues to Grow

Credit to U.S. nonfinancial corporations continues to grow faster than U.S. GDP, and much faster than the debt of households and financial businesses (see **Figure 29**). The ratio of nonfinancial corporate debt to GDP is now 45 percent. That is just above its 2007 level and near its 2009 peak (46 percent), which was the highest since the data series began in 1945.

Higher levels of private debt-to-GDP and rapid growth in this ratio increase the risk of financial instability. But there is no consensus on how much is too much. A common benchmark is a "credit gap," in which the ratio of private debt-to-GDP is measured against its statistically estimated long-run trend. The Bank for International Settlements and the Federal Reserve use this approach as one of many indicators of financial stability vulnerability. The credit gap is also part of the Basel Committee on Banking Supervision guidance for setting countercyclical capital buffers (see Adrian, Covitz, and Liang, 2014; BIS, 2010; Borio and Drehmann, 2009). A weakness in this approach is that it implies the debt-to-GDP ratio can rise to any level. Theory and evidence suggest that, all else equal, greater levels of debt relative to economic activity make the financial system more vulnerable (see Dell'Ariccia and others, 2012; IMF, 2011; Schularick and Taylor, 2009).

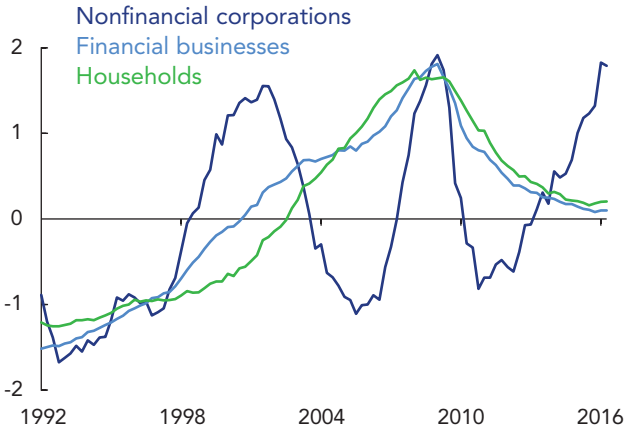
Aggregate nonfinancial corporate debt growth has continued at about the same rate through 2016. That growth is broad-based across industries and debt types. Aggregate debt grew at 7 percent year-on-year, in line with the average rate since 2012 (see **Figure 30**). The growth rate is similar for loans and debt securities, the two main categories of nonfinancial corporate debt (see **Figure 31**).

Debt Growth Has Pushed Firm Leverage to High Levels

Firm-level data on nonfinancial corporations show that debt growth has pushed median firm leverage to high levels. High leverage increases the probability of default

Figure 29. U.S. Private Sector Debt-to-GDP Ratios (Z-scores)

Nonfinancial corporate debt continues to outpace gross domestic product (GDP) growth

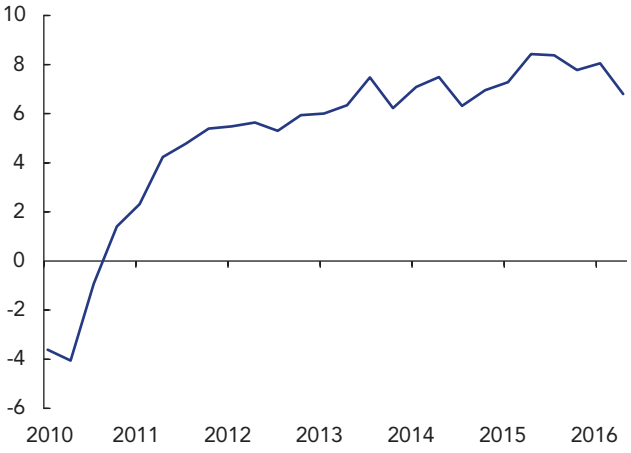


Note: Data as of June 30, 2016. Z-score represents distance from the first quarter 1990 to second quarter 2016 average, expressed in standard deviations.

Sources: Haver Analytics, OFR analysis

Figure 30. U.S. Nonfinancial Corporate Debt Growth (year-over-year percent change)

Since 2012, nonfinancial corporate debt has expanded rapidly

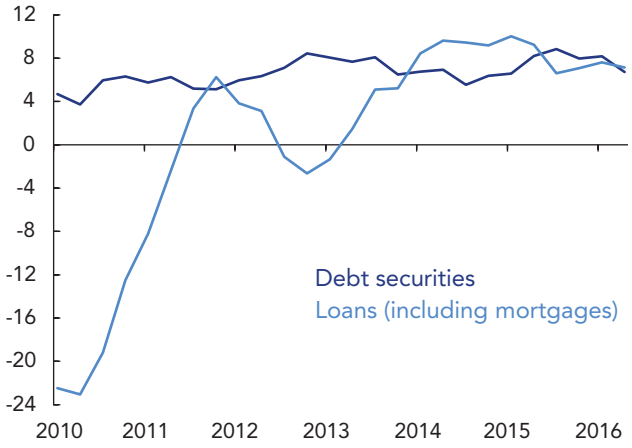


Note: Data as of June 30, 2016.

Sources: Haver Analytics, OFR analysis

Figure 31. U.S. Nonfinancial Corporate Debt Growth by Type (annual percentage change)

Corporate bonds and loans continue to expand at a rapid pace



Note: Data as of June 30, 2016. Does not include trade debt.

Sources: Haver Analytics, OFR analysis

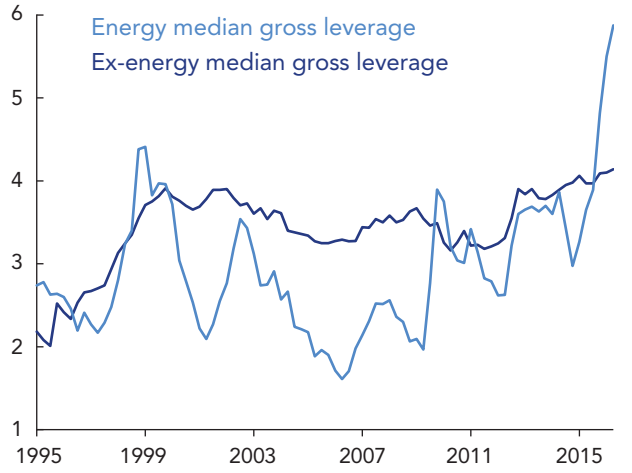
and may lead to lower recovery rates for creditors in the event of default.

Firm leverage as measured by the ratio of debt-to-earnings is historically high and rising. This measure of leverage is driven by debt growth and by the sharp decline in energy firms' earnings since oil prices collapsed. However, the high leverage in this cycle has been broad-based, not just at energy firms (see **Figures 32** and **33**). It has included investment-grade and speculative-grade bonds and loans. For the median speculative-grade firm, the ratio since 2013 has been above its level in previous cycles, both on a gross basis and net of the borrowing firm's cash balances. For the median investment-grade firm, the gross ratio also is at a multi-decade high. The net ratio is elevated but below 2001-03 levels because many investment-grade firms have large cash balances.

The ratio of debt to assets is another measure of firm leverage but is not influenced by earnings volatility. This ratio is elevated for speculative-grade firms,

Figure 32. Speculative-Grade U.S. Energy and Ex-Energy Debt-to-EBITDA (ratios)

Speculative-grade debt-to-earnings is at record highs, even for nonenergy firms

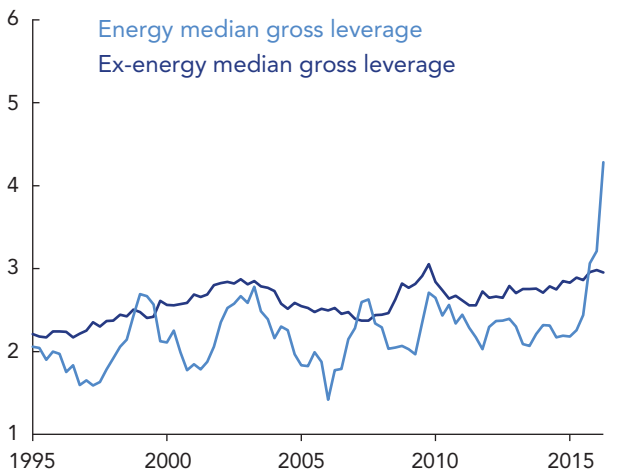


Note: Data as of June 30, 2016; financials excluded. EBITDA is an indicator of a company's operating performance; it stands for earnings before interest, taxes, depreciation, and amortization. Speculative grade includes all firms rated BB+ and below, including firms not rated.

Sources: S & P Capital IQ, OFR analysis

Figure 33. Investment-Grade U.S. Energy and Ex-Energy Debt-to-EBITDA (ratios)

Investment-grade debt-to-earnings also high and rising for nonenergy firms



Note: Data as of June 30, 2016; financials excluded. EBITDA is an indicator of a company's operating performance; it stands for earnings before interest, taxes, depreciation, and amortization. Investment grade includes all firms rated BBB- or higher.

Sources: S & P Capital IQ, OFR analysis

but less so for investment-grade firms. For the median speculative-grade firm, the ratio reached multi-decade highs in 2013 and has climbed steadily since (see **Figure 34**). For the median investment-grade firm, the ratio is above financial crisis highs, but climbing more slowly and still below levels of the late 1990s (see **Figure 35**).

Potential Related Risks: Elevated U.S. Equity Prices and Commercial Real Estate Prices

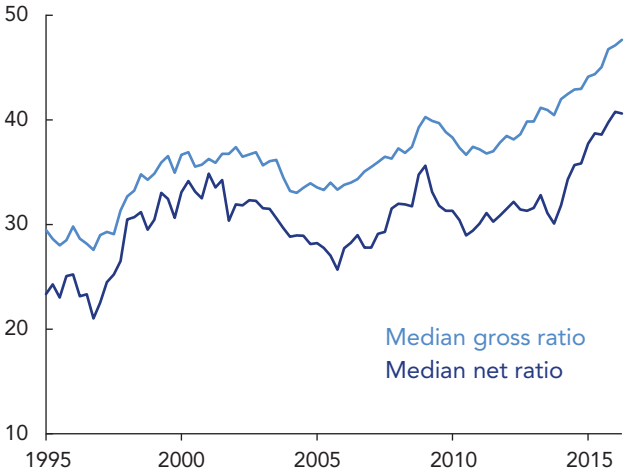
The financial stability risks from a sharp increase in defaults on nonfinancial corporate debt could be made worse by declines in U.S. equity prices and commercial real estate prices. Both have risen rapidly in recent years and appear elevated by some metrics (for more on equities, see **Chapter 1**; for more on real estate, see **Commercial Real Estate Prices Have Risen Rapidly**). If corporate defaults rise, equity prices would be expected to decline, as both the debt and equity of defaulting firms are exposed to losses. Commercial real estate values might also decline, as current property values reflect the level of business activity sustained by ample credit, a condition that would change in a downturn.

In the last three decades, corrections in corporate debt, equity prices, and commercial real estate prices have often coincided. Each spike in corporate default rates since 1980 has coincided with a sell-off in U.S. equity markets. Each correction in commercial real estate prices has coincided with a surge in default rates on corporate bonds and commercial real estate debt, and a sell-off in equity prices (see **Figure 36**).

Continued low interest rates likely have strengthened the links among these markets. Low long-term interest rates have increased incentives for businesses to take on debt and for investors to pay more for higher-yielding assets such as equities and commercial real estate. Economic theory suggests that correlations among asset prices should be greater when real interest rates are low. Asset prices reflect the net present value of

Figure 34. Speculative-Grade U.S. Nonfinancial Corporate Debt-to-Assets (percent)

Speculative-grade debt-to-asset ratios are also at record highs

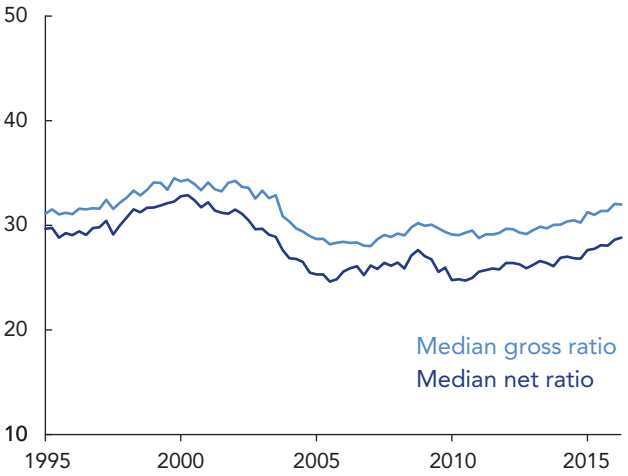


Note: Data as of June 30, 2016. Excludes unrated firms. Net ratio is the ratio of net debt to earnings before interest, taxes, depreciation, and amortization (EBITDA), where net debt is total debt less cash and short-term investments.

Sources: S & P Capital IQ, OFR analysis

Figure 35. Investment-Grade U.S. Nonfinancial Corporate Debt-to-Assets (percent)

Investment-grade debt-to-asset ratios are higher than previous cycle but below historic peak

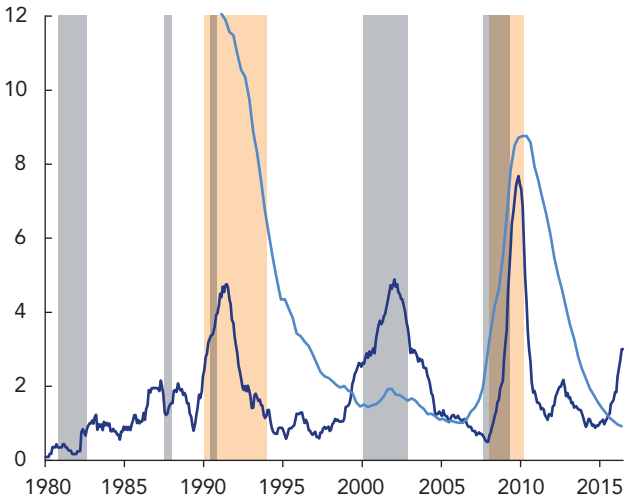


Note: Data as of June 30, 2016. Net ratio is the ratio of net debt to earnings before interest, taxes, depreciation, and amortization (EBITDA), where net debt is total debt less cash and short-term investments.

Sources: S & P Capital IQ, OFR analysis

Figure 36. U.S. Corporate Bond Default Rates (percent); Commercial Real Estate Loan Delinquencies (percent); and Equity and Commercial Real Estate Sell-Offs (shaded periods)

Corporate default waves coincided with equity and commercial real estate sell-offs



Note: Data as of June 2016. Commercial real estate deliquency data begin in 1990. U.S. equity sell-offs are defined as declines of 20 percent or more in the S&P 500. U.S. commercial real estate sell-offs are defined as declines of 20 percent or more in the inflation-adjusted Federal Reserve Board commercial property price index.

Sources: Haver Analytics, Moody's Default and Recovery Database, Standard & Poor's

future returns, discounted by real interest rates. Small changes in low interest rates create large changes in net present values. Thus, when interest rates are low, their shifts are a more important common factor driving prices across asset classes.

Sharp declines in equity and commercial real estate prices during a debt default wave could compound investor losses and further shake confidence. The risk to financial stability could rise in turn.

Default Risks Could Threaten Financial Stability

A severe increase in defaults in nonfinancial corporate debt could cause financial instability. It has happened before. During the U.S. savings and loan crisis of the 1980s and 1990s, the exposed institutions could not manage their losses on commercial lending and commercial real estate. Widespread failures of these institutions disrupted credit to the real economy and cost U.S. taxpayers billions.

The impact on financial stability would depend on the ability of exposed creditors to manage credit losses, market losses, spillovers to the equity and commercial property markets, and any erosion of confidence from their own investors and creditors. Today, the major creditors of U.S. nonfinancial corporations are U.S. banks, mutual funds, life insurers, and pension funds (see **Figure 37**). Evaluating whether these other entities are resilient enough to manage the fallout from a severely adverse scenario is critical. Their distress could impair the flow of credit to the economy. It could also amplify and propagate stress through fire-sale dynamics in the tradable segments of these markets.

Higher capital levels and stronger liquidity have made the U.S. banking system far more resilient than before the crisis. Still, some large U.S. banks have combined concentrations of commercial real estate and commercial and industrial (C&I) loans of more than 200 percent of capital (see **Figure 38**). A severe increase in defaults affecting both could significantly erode some large banks' capital adequacy.

The risks that exposed nonbank firms face vary and are different from those of banks, given different business models and liability structures. For example, mutual funds face a well-known liquidity mismatch in their

investments in corporate debt. Many of their corporate debt investments cannot be sold quickly, but their liabilities can be withdrawn on demand and do not have a government guarantee. In a severe default wave, they could face investor redemptions that force sales of these instruments in increasingly illiquid markets.

Conclusion: Broader Stress Testing Could Reduce Financial Stability Risks

One way to mitigate the financial stability risks from rising defaults would be to require exposed firms to undergo stress tests for a scenario of severe corporate defaults with sharp declines in U.S. equity and commercial real estate prices.

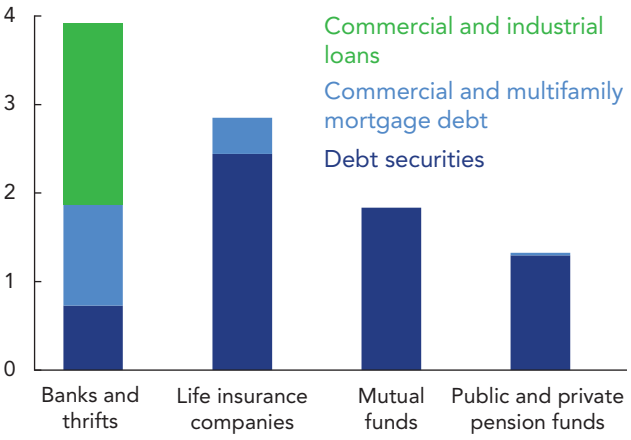
The Federal Reserve leads annual stress tests to evaluate the capital adequacy of the largest bank holding companies. In the 2016 stress test required by the Dodd-Frank Act, the severely adverse scenario included a 50 percent drop in equity prices and a 30 percent drop in commercial real estate prices. For the 33 participating banks, the projected aggregate losses in that scenario reached 6 percent of commercial loans and 7 percent of commercial real estate loans (see Board of Governors, 2016b).

These large-bank stress tests are important, but broader testing is needed. At a minimum, regulators could require stress tests of the largest exposed groups of firms: banks, mutual funds, life insurers, and pension funds. The Securities and Exchange Commission is currently considering stress tests for large investment advisers and funds (see White, 2016).

Systemwide stress testing requires a differentiated approach among firm types, given differences in business models. Agencies would need to agree upon common scenarios to ensure consistency across types of firms. Such stress tests could be the basis for increased capital or other loss-absorbing capacity, improved liquidity reserves and management, and improved risk management. Stress tests can shed light on the risk that exposed creditors and investors amplify or transmit the stress of defaults to other financial institutions, markets, or the real economy.

Figure 37. Financial Institutions' Holdings of U.S. Nonfinancial Business Debt ($ trillions)

Banks and life insurance companies have the largest exposures

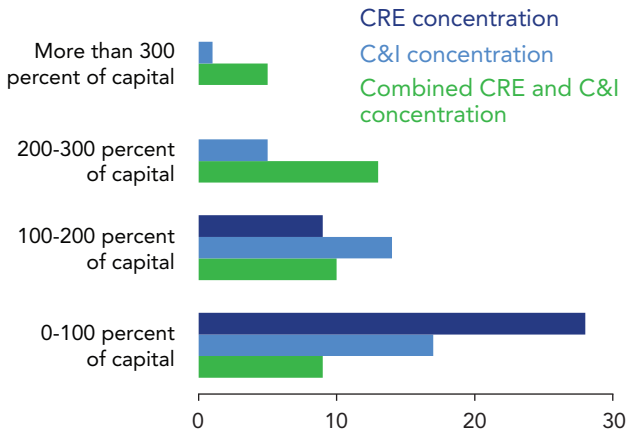


Note: Data as of June 31, 2016. Mortgages and commercial and industrial loans include debt of corporate and noncorporate, nonfinancial businesses.

Sources: Haver Analytics, Mortgage Bankers Association, OFR analysis

Figure 38. Large U.S. Banks by Commercial Real Estate and Commercial and Industrial Loan Concentration (number)

Almost half of large bank holding companies have a combined CRE and C&I concentration of more than 200 percent of capital



Note: Data as of June 30, 2016. U.S. bank holding companies with more than $50 billion in assets. CRE stands for commercial real estate. C&I stands for commercial and industrial.

Sources: Federal Reserve Form Y-9C, OFR analysis

Commercial Real Estate Prices Have Risen Rapidly

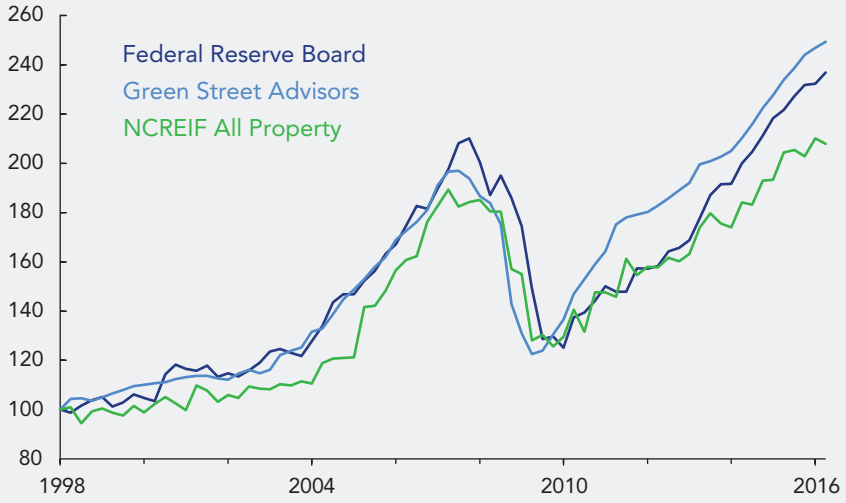
Commercial real estate prices have risen rapidly for six years (see Figure 39). About $3.6 trillion of nonfinancial business loans are collateralized by commercial real estate. Most of these loans are to noncorporate businesses. If the value of that collateral falls, lenders risk loss. Such collapsing values, and the defaults that followed, played a role in the savings and loan and banking crises of the 1980s and 1990s. Commercial real estate values collapsed dramatically in 2008 and contributed to losses during the financial crisis.

Commercial real estate values tend to move along with broader economic cycles because cash flows to investors are tied to their tenants' fortunes. Property values are also sensitive to interest rates. The acceptable expected return on commercial real estate investments falls as other investments become less lucrative. The low interest rates in the United States and abroad, increased interest in U.S. real estate among foreign buyers, and relatively strong U.S. economic growth have supported commercial property price appreciation. A change in these factors, spillover from corporate defaults, or other shocks could cause prices to drop.

Lenders face additional risk when prices drop substantially. Banks remain the major source of commercial mortgage credit despite the increased role of commercial mortgage-backed securities (CMBS) and real estate investment trusts (REITs) in the past 20 years. Banks are particularly dominant in nonresidential lending — offices, retail, and industrial property — which means banking regulators supervise much of commercial real estate lending.

Figure 39. U.S. Commercial Real Estate Prices (index)

Commercial real estate prices have risen above pre-crisis levels



Notes: Data as of June 30, 2016. Index = 100 at first quarter of 1998. The Federal Reserve Board index is most recently based on the CoStar Commercial Repeat Sale Index. The NCREIF All Property index is transaction-based, and the Green Street Advisors index is a value-weighted, appraisal-based index of properties owned by real estate investment trusts.

Sources: Haver Analytics, OFR analysis

In response to the rapid escalation in prices and lending, bank regulators signaled increasing scrutiny of commercial real estate lending in 2015 (see Board of Governors, FDIC, and OCC, 2015). Commercial real estate loans represent a relatively small share of assets for large banks, at about 8 percent. However, commercial real estate lending remains a large business for many small and midsized banks. Nearly half of bank-held commercial real estate loans are owned by banks with less than $10 billion in assets. As a share of those banks' assets, commercial real estate mortgages are comparable to pre-crisis levels, at 27 percent; the 90th percentile of those banks holds over 90 percent of assets in commercial real estate.

Other regulatory changes are affecting the industry. CMBS issuers are preparing to comply with new risk retention rules that go into effect in December. The rules require issuers to retain a 5 percent stake in these securities. Ratings agencies have also tightened standards for securitized products such as CMBS since the crisis.

Through 2018, commercial real estate investors will continue to reckon with headwinds from credit decisions made before the financial crisis in the form of loans packaged into CMBS at the height of the booming pre-crisis market. More than $200 billion in 10-year CMBS loans (about a third of CMBS outstanding) will mature during the next two years. If lenders do not underwrite the maturing mortgages, the loans will be liquidated. As commercial real estate lending tightens in response to regulatory pressures, maturing loans may face difficulty refinancing, liquidation rates may rise, and borrowers may need to pay higher interest. Even so, the volume at risk of liquidation is low enough that it is easily absorbed absent external factors. The values of these securities have already deteriorated because refinancing problems were anticipated. Any abrupt change in the liquidity or performance of these legacy assets is unlikely to spill over into broader financial markets.

In the event of a decrease in prices, potential losses for lenders are highest on real estate loans originated near the peak. These loans will have the least equity and will be more likely to default and to face greater losses given default than would loans originated when prices were lower. Losses on residential loans originated near the peak in residential prices were a key factor in the financial crisis.

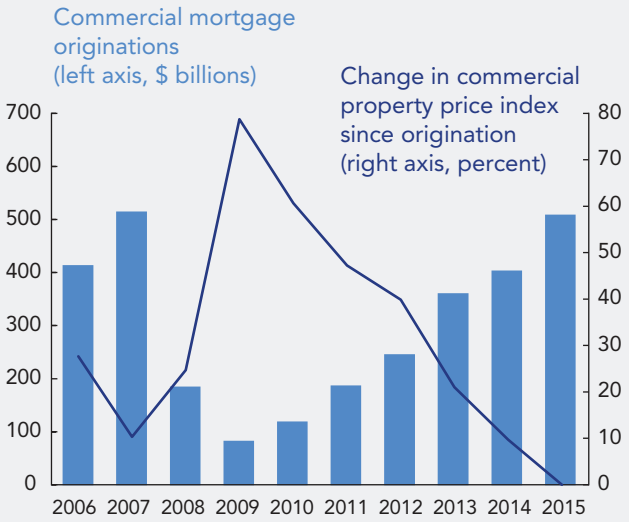
However, the residential real estate market was more vulnerable before the crisis than the commercial real estate market appears today. In 2005, more than half of residential mortgage debt outstanding had been originated in 2004 and 2005, when prices peaked. In contrast, only about 25 percent of outstanding commercial real estate loans today were originated during the past two years, when prices have been relatively high (see Figure 40).

The commercial mortgage market is only about one-third the size of the residential real estate loan market before the crisis. This market-share size limits the scope for financial instability arising exclusively from commercial real estate lending. The vigilance of regulators and lenders since the crisis is another limiting factor.

However, a default wave in the wider nonfinancial corporate debt market could spill into commercial real estate. If credit contracts, vacancy rates may increase, rents may fall, and valuations may deteriorate. Losses on commercial real estate could compound those from the broader loan and bond markets and threaten financial stability in a severely adverse scenario. Small and midsized banks with larger concentrations of commercial real estate and commercial lending would be at greatest risk. Risks of losses on commercial real estate loans are high on recent and pre-crisis vintages that were originated when prices were highest. Those risks may rise as lenders continue to originate and refinance loans at the current low interest rates and high prices.

Figure 40. Commercial Mortgage Originations ($ billions and percent)

Recent and pre-crisis vintages are the largest and most vulnerable to price declines



Sources: Federal Reserve Commercial Real Estate Price Index, Haver Analytics, Mortgage Bankers Association, OFR analysis

2.3 Cybersecurity Incidents Affecting Financial Firms

Financial institutions, like other businesses, are under constant threat of malicious cyber activity. They are especially vulnerable because of their reliance on information technology (IT) and their many links to each other, to financial markets, and to other parts of the economy. Malicious cyber activity that targets financial firms has become more common and more sophisticated. Incidents can disrupt services, reduce confidence in firms and markets, and damage the integrity of key data.

Malicious cyber activity that targets financial firms has become more common and more sophisticated. Incidents can disrupt services, reduce confidence in firms and markets, and damage the integrity of key data.

The OFR ranked vulnerability to malicious cyber activity as a top threat with substantial potential impact. Quantifying the magnitude of these risks or measuring the resilience of institutions is difficult. Still, cybersecurity incidents clearly have the potential to cause real harm. Some financial institutions play unique roles. If their IT systems were compromised, that could disrupt payment systems or markets and trigger a cascade of operational and financial losses.

Financial firms already fight off malicious cyber activity on many fronts (see White House, 2013). They may spend heavily to defend themselves. Regulators have also taken steps to increase cyber-resilience. They have encouraged information-sharing and collaboration and issued guidance and rules for financial firms. U.S. regulators could also consider developing a shared risk-based approach to guide financial firms in their IT security practices. Although firms are primarily responsible for the security of their systems, regulators should provide guidance and oversight and work to ensure that the financial system can recover quickly.

Cybersecurity Incidents Come in a Variety of Forms

Cyberattacks are deliberate efforts to disrupt, steal, alter, or destroy data on IT systems. Tactics include finding hidden weaknesses in widely used software (called zero-day vulnerabilities) to get into IT systems, targeting e-mail accounts to steal passwords (spear-phishing), targeting websites to infect users with malicious software (malware), and implanting software that locks companies out of their own IT systems (ransomware). The growth in Internet links provides more ways for attackers to enter proprietary IT systems and networks.

Detailed data about frequency, tactics, and results of cybersecurity incidents are scarce. In part, data are lacking because firms and authorities avoid reporting them due to reputation concerns or concerns over giving insights to potential hackers (see OFR, 2015; U.S. Congress, 2016). Cybersecurity

worries show up in industry surveys, reports from technology providers, regulatory filings, and responses to high-profile incidents (see Symantec, 2016).

Profit often motivates malicious actors targeting the financial system. On the black market, cyber criminals can sell stolen credit card data and buy software and other tools to launch new infiltrations. But hackers may seek to break into firms for other reasons. Some break in for foreign policy or espionage reasons, such as the 2014 attack on Sony, which was carried out by hackers linked to North Korea (see FBI, 2014). Such incidents may be matters of national security, especially when they have foreign government support.

Intruders are showing more technical sophistication and a more nuanced understanding of how firms operate. For example, there are reports that malicious actors in 2013 used off-the-shelf malware delivered over the Internet via a vendor's system to break into the IT system of Target, a retailer. They planted the malware three months before they stole Target's credit card records (see Krebs, 2014). This year, malicious actors broke into Bangladesh Bank and stole central bank funds (see **Hackers Breach Bangladesh's Central Bank**).

Intruders are showing more technical sophistication and a more nuanced understanding of how firms operate.

Cybersecurity Incidents Threaten Financial System Stability on Multiple Fronts

Cybersecurity threats impose direct costs on firms. These costs include the loss of funds or customer records, added IT spending, remediation costs, reputational costs, and legal expenses.

Cybersecurity incidents also can pose a broader risk to financial stability. Financial institutions work within complex networks and rely on electronic transactions, often on a rapid just-in-time basis. They are linked digitally to each other and to nonfinancial entities, including third-party service providers. Some markets and systems depend on a few key firms, and those firms must run properly. Other markets and systems may be decentralized, either by design or because participation is not concentrated. Spreading havoc among those operations may be harder for hackers. However, defending a decentralized network that has many entry points can also be more difficult (see Rosengren, 2015).

This increase in digital links also gives rise to financial stability risks. A cybersecurity incident that disrupts a large firm could trigger second-order effects. For example, a large troubled firm could default on obligations to

Hackers Breach Bangladesh's Central Bank

Hackers in February 2016 penetrated Bangladesh's central bank and stole $81 million from its reserve accounts at the Federal Reserve Bank of New York.

According to public information, the infiltration resulted in the sending of fraudulent payment messages using the SWIFT network that were authenticated over SWIFT as legitimate messages of Bangladesh Bank. The intruders did not compromise the SWIFT network. Still, the incident highlights concerns about end-user security and network security.

The breach showed the patience, technical skills, and global span of the intruders. It also highlighted the role of end users in maintaining security. The intruders reportedly were able to break into Bangladesh Bank's IT network and use its SWIFT access codes to generate fraudulent payment messages. SWIFT carries more than 25 million payment messages daily among banks. The intruders placed fraudulent orders on a Thursday, just before the start of the weekend in Bangladesh. That slowed discovery of the theft until after the weekend in New York (see Mallet and Chilkoti, 2016). Also, the male ware suppressed generation of transaction logs used for confirmation and reconciliation, hiding the fraud and giving the thieves time to launder the stolen funds (see Zetter, 2016). The thieves tried to steal almost $1 billion.

Although most of the fraudulent payment messages were not executed, four messages made it through. The stolen funds then moved through banks in the Philippines and were withdrawn via Philippine casinos. Philippine authorities later got back $15 million from a casino tour operator. As of mid-November 2016, Bangladesh Bank officials are expecting to recover $30 million more of the stolen $81 million (see Paul, 2016).

The episode suggests that cybersecurity incidents could have macroeconomic consequences, particularly in emerging economies. Bangladesh had foreign exchange reserves of $27 billion at the end of 2015. The loss of nearly $1 billion in reserves could have shaken confidence.

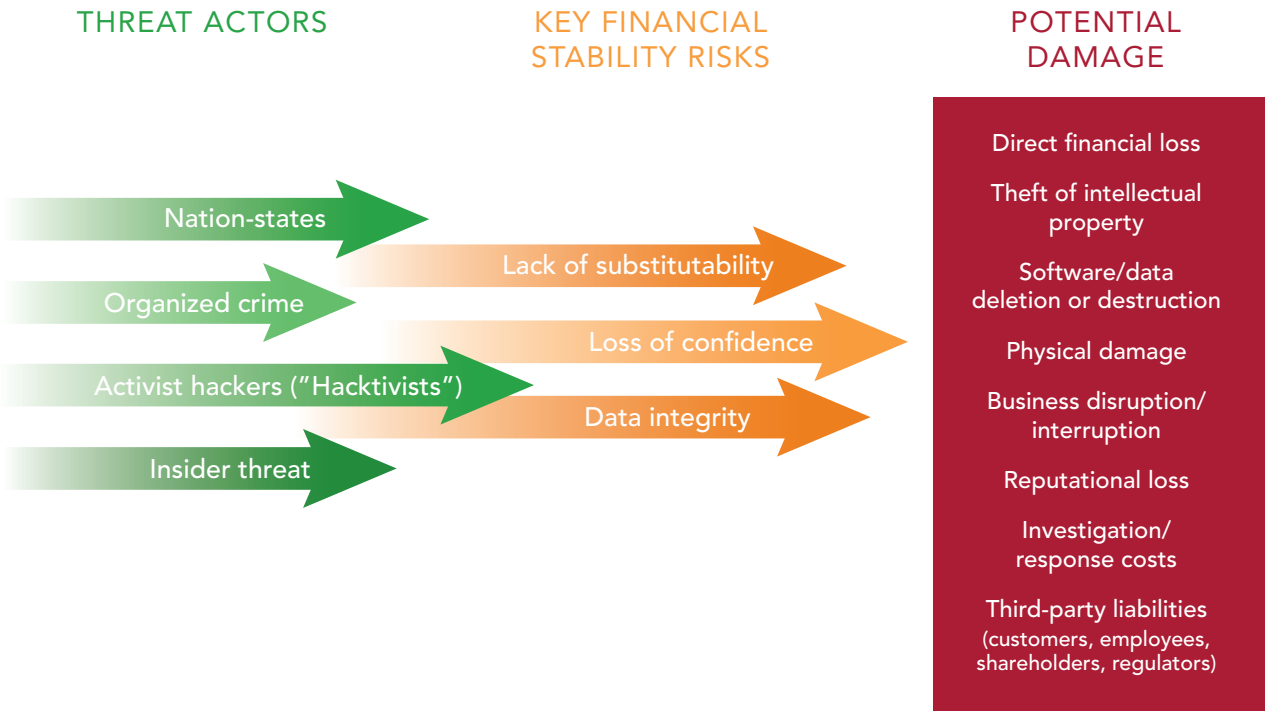
This incident showed the ability of cybersecurity intruders to bypass complex business controls. It also showed that cybersecurity threats require responses at the end-user and the system level. SWIFT has since started a customer security program. It is developing new tools and raising awareness on best practices and security features in its products. The network said it may sanction noncompliant institutions by reducing or suspending access (see Arnold, 2016). Attempts to infiltrate SWIFT members are reported to be an ongoing problem (see Schwartz, 2016).

counterparties or impair market liquidity. Key financial stability risks related to cybersecurity can be grouped into three categories (see **Figure 41**):

- **Lack of substitutability.** The financial services industry relies on a robust IT infrastructure to complete transactions or move payments. In many networks, a few firms or utilities serve as key hubs. These include custodian banks and payment, clearing, settlement, and messaging systems. An incident that brings down a key hub could lead to counterparty defaults, liquidity shortfalls, or other market effects. Policies that boost substitutability can reduce systemic risk and should be considered.

- **Loss of confidence.** Malicious actors often target customer account information. Although unfortunate, so far most of these hacks have been one-off events, hurting just the victim firm and its customers. A wide-reaching theft, however, could cause a broader loss of confidence. This occurred in South Korea in 2014. Customer names, credit card data, and phone numbers were stolen from a consumer credit rating firm, the Korea Credit Bureau. The news triggered a run on the country's banks, and many people cancelled credit cards. However, reaction to the breach did not grow into a full-blown crisis (see Sang-Hun, 2014).
- **Data integrity.** The integrity of financial data is critical. Financial institutions need robust backup data they can recover soon after a cybersecurity incident. However, there can be tension between recovering quickly and ensuring that recovered data are safe and accurate and do not transmit cyber risks, particularly for markets that process orders rapidly. For example, data corruption could disrupt such activity and may be hard to reverse or recover.

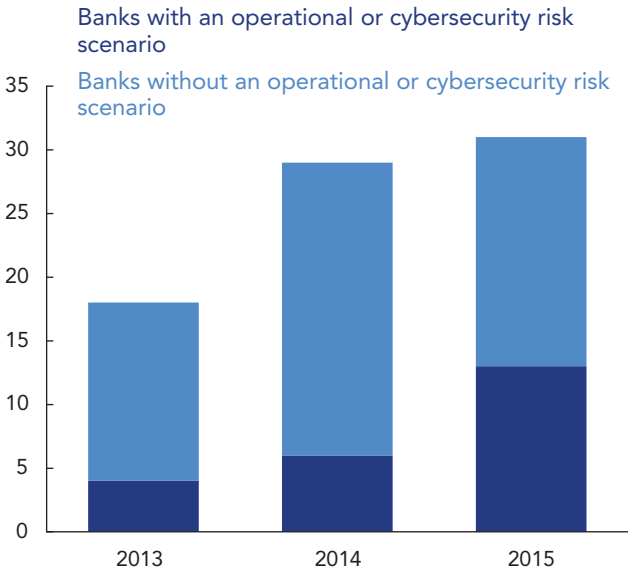
Figure 41. How Cybersecurity Incidents Threaten Financial Stability



Sources: Her Majesty's Government and Marsh Ltd. (2015); Securities and Exchange Commission; OFR analysis

Figure 42. Banks that Include an Operational Risk or Cybersecurity Scenario in Dodd-Frank Act Stress Tests (number)

Use of operational risk and cybersecurity scenarios is growing

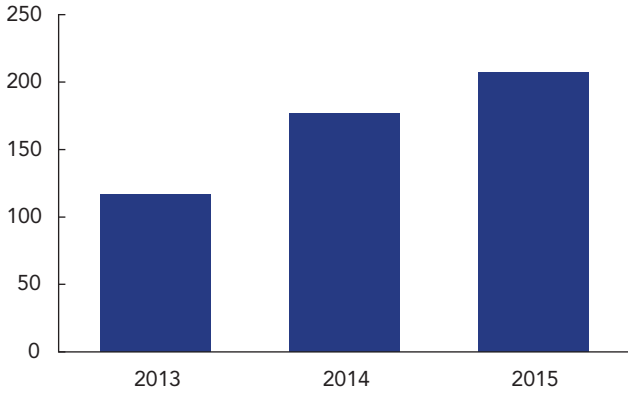


Note: Based on mid-cycle Dodd-Frank Act stress tests.

Source: OFR analysis

Figure 43. Mentions of "Cyber" in Large U.S. Financial Firms' Form 10-Ks (number)

Cyber risk is rising for systemically important U.S. financial firms and government-sponsored enterprises



Note: Form 10-Ks for firms in the sample grew on average 2.5 percent in page count from 2013 to 2015.

Sources: Securities and Exchange Commission Form 10-K, OFR analysis

Financial Firms Increasingly See Cybersecurity Incidents as a Key Risk

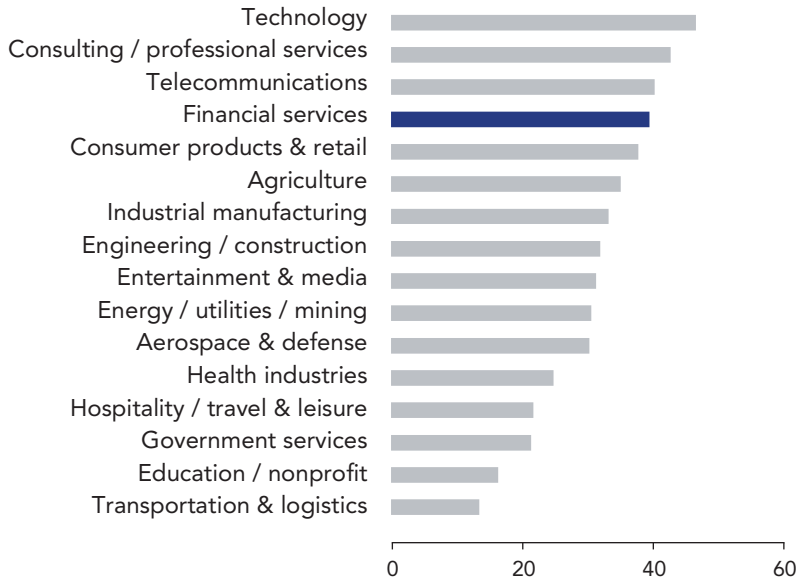
The threat of cyber incidents is widely recognized. Two-thirds of global regulators and market experts surveyed in 2015 ranked the threat as a top financial stability risk. It placed second among all potential threats in the survey (see Worner, 2015). Similarly, half of bank chief risk officers and board members responding to a 2016 survey placed cybersecurity risk among the top issues requiring their attention (EY and IIF, 2016). Increasingly, banks voluntarily include cyber risks and operational risks in the scenarios they submit to regulators as part of stress testing. Banks prepare these scenarios as part of mid-cycle stress tests required under the Dodd-Frank Act (see **Figure 42**).

A number of U.S. financial firms reported cybersecurity as a key risk in 2015 10-K filings reviewed by the OFR. The analysis covered U.S. global systemically important banks, global systemically important insurers, central counterparties, and government-sponsored enterprises. Cybersecurity references in 2015 Form 10-Ks were nearly double those in 2013 10-Ks (see **Figure 43**). These filings typically note that cyber incidents can come from a variety of bad actors, including organized crime, foreign governments, and insiders. They also note that cybersecurity incidents can arise when clients, third-party service providers, retail partners, or counterparties are targeted. Incidents can spread cyber risks to business partners of the firm.

Financial firms are integrating cybersecurity preparedness into their risk management. They are investing in information security to address cybersecurity risks. About 40 percent of financial services firms in North America with more than $1 billion in revenue budgeted $10 million or more for information security, according to a 2016 survey (see PricewaterhouseCoopers, 2016). That is more than most other industries (see **Figure 44**).

Figure 44. North American Firms that Budget $10 Million or More for Information Security, by Industry (percent)

Large financial firms make significant investments in information security compared with many other industries



Note: Survey results as of June 12, 2015. Responses from firms with more than $1 billion in gross revenue.

Source: PricewaterhouseCoopers (2016)

Many firms are using the National Institute of Standards and Technology (NIST) Cybersecurity Framework as a starting point for managing cybersecurity risk (see Fitzgibbons, 2016). The Framework is voluntary, but, according to the same 2016 survey, more than half of large financial firms have one or more of the following safeguards that align with elements of the NIST framework:

- Overall security strategy.
- Security standards and baselines for third-party service providers.
- A Chief Information Security Officer in charge of IT security.
- Formal collaboration with others in the industry.
- Active board participation in the firm's overall cybersecurity strategy.

The industry is working with the public sector to build resilience — in this case, the ability to quickly respond to cybersecurity threats and recover from cyber incidents (see **Figure 45**). One program is developing a platform that companies can use to share threat intelligence (see DTCC, 2015). That program is called Soltra. It is run by a partnership of the Depository Trust & Clearing Corp., which, through its subsidiaries, provides clearing and settlement services to the financial markets, and the Financial Services – Information Sharing and Analysis Center. Industry, government, and academia also held exercises to improve the readiness of the financial services industry to respond to systemwide incidents, known as the Quantum Dawn series (see Deloitte and SIFMA, 2015). Other government-run simulations for enhancing communication, collaboration, and response are the Hamilton series of exercises and international work with the U.K. through Operation Resilient Shield (see Treasury and HM Treasury, 2015; Waterman, 2016).

Stances of U.S. Financial Regulators Vary

U.S. regulators clearly recognize the threat of cyber incidents to financial firms. Regulators have placed more emphasis on cybersecurity threats in their public statements and in guidance to the financial institutions they supervise. Regulators have progressed in developing specific assessment standards and in setting enforceable regulatory expectations on cybersecurity. They have begun incorporating those standards into their work by

Figure 45. Major Public and Private Groups Addressing Cyber Risks

Organization	Description
Financial Services Sector Coordinating Council for Critical Infrastructure Protection and Homeland Security (FSSCC)	Group of trade associations, financial utilities, and financial companies that works with the public sector on policy issues related to resilience and response to cybersecurity issues, natural disasters, and terrorism.
Financial and Banking Information Infrastructure Committee (FBIIC)	Group of federal and state financial regulators created after the 9/11 attacks to improve coordination and communication among regulators, enhance resilience of the financial sector, and promote public-private partnerships.
Financial Services – Information Sharing and Analysis Center (FS-ISAC)	Nonprofit center that provides member financial services firms with anonymous, global information sharing about cyber and physical threat intelligence.

Source: OFR analysis

setting benchmarks. **Figure 46** lists key U.S. financial regulatory guidance and standards on cybersecurity.

These regulatory approaches reflect different priorities. Risk profiles differ among financial institutions. Regulators' statutory authority varies.

Bank regulators conduct IT examinations that factor cybersecurity preparedness into stress testing, resolution planning, and safety and soundness supervision. The IT standards reach beyond banks to third-party vendors and contractors that provide key services to the same extent as if they were performed by the bank itself on its own premises (see U.S. Congress, 2010). The regulators also introduced a Cybersecurity Assessment Tool in June 2015 that banks may voluntarily use to assess their risk and cybersecurity preparedness (see FFIEC, 2015). The tool supplements existing standards for examining banks' IT management. It establishes a measurable process that banks can use to assess their preparedness across several types of risk over time. However, the tool on its own is not an enforceable standard.

More recently, the Federal Reserve, OCC, and FDIC issued a proposed rule in October 2016 to establish enhanced cybersecurity standards for large financial institutions. The proposed rule would apply to banks with assets greater than $50 billion, nonbank financial institutions that are designated by FSOC and subject to Federal Reserve supervision, financial market utilities, and third-party service providers. The proposed rule sets enforceable standards for governance and management of cybersecurity risks. It also sets expectations for resilience and recovery from cybersecurity incidents (see Board of Governors, OCC, and FDIC, 2016).

The SEC's Regulation SCI mandates corrective action by covered firms (including registered clearing agencies, alternative trading systems, and plan processors) if there is a cybersecurity or other operational risk event (see SEC, 2015). It came into effect in November 2015. Regulation SCI focuses on assessing the business continuity and disaster recovery abilities of firms. It aims to assure recovery within two hours after an incident for critical systems such as clearing and settlement. The regulation also requires prompt notice of an event. However, compared with bank regulators, the SEC has more limited authority over third-party vendors that sell services to its regulated firms (see FSOC, 2016b). The SEC has also issued a draft rule that would set cybersecurity expectations for investment advisers in the context of business continuity planning.

In contrast with other regulators, insurance regulators focus on securing customer data. Criminals have targeted customer records in several hacks on health insurance firms. The National Association of Insurance Commissioners is concerned that more breaches of customer data could reduce confidence in the industry. Customers could withhold certain information from insurers, which would hurt the ability of insurers to assess risk. Regulators are starting baseline cybersecurity assessments of insurers. They

Regulators have progressed in developing specific assessment standards and in setting enforceable regulatory expectations on cybersecurity. These regulatory approaches reflect different priorities. Risk profiles differ among financial institutions. Regulators' statutory authority varies.

Figure 46. U.S. Financial Regulatory Guidance on Cybersecurity

Regulatory Body	Relevant Cybersecurity Guidance	Institution
Federal Financial Institutions Examination Council (FFIEC) member agencies (Consumer Financial Protection Bureau, Federal Deposit Insurance Corporation, Federal Reserve Board of Governors, National Credit Union Administration, Office of the Comptroller of the Currency, FFIEC State Liaison Committee)	Cybersecurity Assessment Tool and *IT Examination Handbook*	Banks
		Bank holding companies
		Federal savings associations
		Credit unions
Securities and Exchange Commission	Regulation SCI	Registered clearing agencies
		Stock and option exchanges
		Municipal Securities Rulemaking Board
		High-volume alternative trading systems
		Securities information processors
		Financial Industry Regulatory Authority
	Regulation S-P	Broker-dealers
		Investment companies
		Investment advisers
State insurance regulators via National Association of Insurance Commissioners (NAIC)	*Financial Condition Examiners Handbook* and *Market Regulation Handbook*	Insurers
Federal Housing Finance Agency	Advisory Bulletin 2014-05, Cyber Risk Management Guidance	Government-sponsored enterprises
		Federal Home Loan Banks
	Policy Guidance PG-01-002, Safety and Soundness Standards for Information	Government-sponsored enterprises
Commodity Futures Trading Commission	System Safeguards Testing Requirements	Designated contract markets
		Swap execution facilities
		Swap data repositories
	System Safeguards Testing Requirements for Derivatives Clearing Organizations	Derivatives clearing organizations
National Futures Association	Interpretive Notice 9070	Futures commission merchants
		Commodity trading advisors
		Commodity pool operators
		Introducing brokers
Financial Industry Regulatory Authority	Report on Cybersecurity Practices	Broker-dealers

Note: Several proposed rules are related to financial institution cybersecurity: the SEC's Adviser Business Continuity and Transition Plans Rule (June 2016); the Federal Reserve, Office of the Comptroller of the Currency, and Federal Deposit Insurance Corporation joint proposed rule for Enhanced Cyber Risk Management Standards (October 2016); and NAIC's Data Security Model Law (March 2016).

Source: OFR analysis

also are working with insurers that have experienced breaches. They have drafted a model law for states that would set higher standards for data protection. This model law is out for public comment until September 2016.

Similarly, the Commodity Futures Trading Commission (CFTC) issued draft rules in December 2015 proposing five types of cybersecurity testing requirements for derivatives clearing organizations, designated contract markets, swap execution facilities, and swap data repositories. The CFTC rules were finalized in September 2016.

In June 2016, the Committee on Payments and Market Infrastructures and the board of the International Organization of Securities Commissions (CPMI-IOSCO) proposed international guidelines on cyber resilience. The guidelines stress the need for financial market infrastructures to preempt cyber incidents, respond rapidly and effectively, and achieve faster and safer target recovery objectives (see BIS and IOSCO, 2016a). As members of CPMI-IOSCO, the Federal Reserve, the SEC, and the CFTC were involved in developing the guidance. U.S. regulators have yet to adopt rules to apply these standards.

Conclusion: Need to Continue to Enhance Security, Improve Resilience, and Increase Capacity to Recover

To date, the emphasis across the U.S. government has been on sharing information about cybersecurity threats. Recent innovations such as the Cybersecurity Assessment Tool and Regulation SCI can help regulators measure how well financial institutions can defend their IT systems. IT defense can help ensure business continuity and recovery after cybersecurity incidents. Progress has been made in these tasks, particularly in working to ensure continuity of key systems at the institution level.

Regulators could build on their progress with a broader approach to resilience that focuses on key links among financial institutions. As noted, the OFR sees three financial stability risks that cyber incidents pose: lack of substitutability, loss of confidence, and data integrity. Regulators may gain from more collaboration to develop a common lexicon and a shared risk-based approach, reflecting the universal nature of cybersecurity threats and the connections among sectors, as well as collaborating to update standards and guidance. There also may be lessons to learn from other industries such as technology, energy, and communications. Finally, regulators should take into account how regulatory boundaries may affect their view of parts of financial networks, especially third-party vendors, overseas counterparties, or service providers.

Regulators could build on their progress with a broader approach to resilience that focuses on key links among financial institutions.

Cyber incidents are a growing strategic challenge to financial firms and the financial system. Awareness of the issue influences risk management. However, as large firms pay more attention to security, risks may move toward smaller firms or firms beyond the reach of U.S. supervisors. Such firms may have fewer resources to fight threats. They may operate in jurisdictions with less rigorous regulatory oversight. There have been tests of industry-wide capabilities in information sharing, business continuity, and disaster recovery, including exercises such as the Quantum Dawn series. Regulators and the industry need to continue to work together to enhance security, improve network resilience, and increase the capacity to recover.

2.4 Central Counterparties as Contagion Channels

The growing role of central counterparties (CCPs) in financial markets will improve market efficiency, transparency, and financial stability, but will also concentrate risks. Distress at a CCP could impose losses on its clearing members, which include the largest and most interconnected financial institutions. New public data releases and stress test results in 2016 shed light on the potential for a distressed CCP to transmit financial instability.

Distress at a CCP could impose losses on its clearing members, which include the largest and most interconnected financial institutions. New public data releases and stress test results in 2016 shed light on the potential for a distressed CCP to transmit financial instability.

Since the financial crisis, regulators across the world have worked to move derivatives from bilateral transactions to central clearing through CCPs. The use of CCPs promotes product standardization and greater transparency.

The role of CCPs in clearing derivatives transactions has grown greatly since the crisis. About 75 percent of transactions in swap markets supervised by the CFTC are now centrally cleared. That is up from about 15 percent in 2007 (see Massad, 2016). Swaps markets now clear 97 percent of new transactions in forward rate agreements and 89 percent in fixed-float interest rate swaps (see CFTC, 2016b).

Derivatives CCPs reduce counterparty credit risk in over-the-counter (OTC) derivatives markets, reducing some of the financial stability risks of bilateral trading. CCPs could lower trading costs, improve price discovery, and reduce counterparty exposures through multilateral netting.

However, in the process, CCPs will also concentrate counterparty default risk. For this reason, if not well managed, they may pose systemic risks. To address these risks, supervisors have coordinated and introduced international risk management standards for CCPs and other financial market infrastructures. As reliance on central clearing grows, the risk management practices and regulation of CCPs become more important. A CCP is vulnerable to the default of its clearing members. Clearing members are typically large and interconnected banks acting as dealers and clearing agents for many clients.

CCPs manage risks through collateral requirements, membership standards, close surveillance of members, and legal procedures to address any default by clearing members. If CCP risk management proves inadequate, a distressed CCP may impose losses directly on remaining clearing members. A distressed CCP could also affect markets indirectly. Unwinding of portfolios as part of default management, either through auctions or liquidation, may aggravate price volatility.

New data that CCPs across the world began disclosing this year provide insights about CCP risks. The data are useful for sizing up the effects of CCPs on financial stability. Still, gaps remain. European supervisors also

released the results of an unprecedented market-wide stress test of CCPs. Similar tests in the United States could boost confidence in U.S. CCPs.

New Disclosures Shed Light on Derivatives CCP Risks

Until recently, there have been little data available to the public to assess the risks of derivatives CCPs. In 2016, new data shed light on these risks (see BIS and IOSCO, 2015c). CCPs provide the data in accord with standards set by international regulators on the Committee on Payments and Market Infrastructures and the International Organization of Securities Commissions (CPMI-IOSCO).

All major U.S.-registered derivatives clearing organizations and 25 of 32 major CCPs around the world have provided information under the new reporting standards. Of the other seven, five European Union (EU) CCPs have provided disclosures under European standards. Two of the CCPs have not made public disclosures. Although supervisors and clearing members still get confidential information, CCPs now publicly disclose quantitative and qualitative information consistent with the CPMI-IOSCO standards. Although the data have some weaknesses, these may be viewed in part as typical of new reporting standards.

Figure 47: How the Typical Central Counterparty Default Waterfall Works

Note: CCP stands for central counterparty.

Source: OFR analysis

Default waterfalls. CCPs face credit risk in their exposure to the failure of a clearing member. The new disclosures provide information on the resources that make up each CCP's default waterfall. The default waterfall is the protocol for the order a CCP uses those resources to cover losses. It serves as a buffer against failure if one or more clearing member defaults.

Although the sequence may vary among CCPs, a typical waterfall structure works as shown in **Figure 47**. To cover losses after a clearing member default, the CCP would first draw on the margin in the defaulter's account. If the defaulting clearing member's amount of margin is not enough, the CCP next draws on the defaulting member's prepaid contribution to the guarantee fund.

The next layer of loss absorption typically comes from the CCP's equity, sometimes called "skin in the game." This equity represents the CCP's own prepaid contribution to the default waterfall. If that were used up, the losses then would be covered mutually by drawing proportionally on the prepaid contributions made by the nondefaulting clearing members to the guarantee fund. If those prepaid funds are not sufficient, the CCP may call on the clearing members for more resources, known as assessments. More steps may be taken in cases where the losses exceed these resources.

The new quarterly disclosures show amounts held in each part of the waterfall: required initial margin (by house and customer accounts), CCP equity, prepaid default funds, and callable assessments on clearing members.

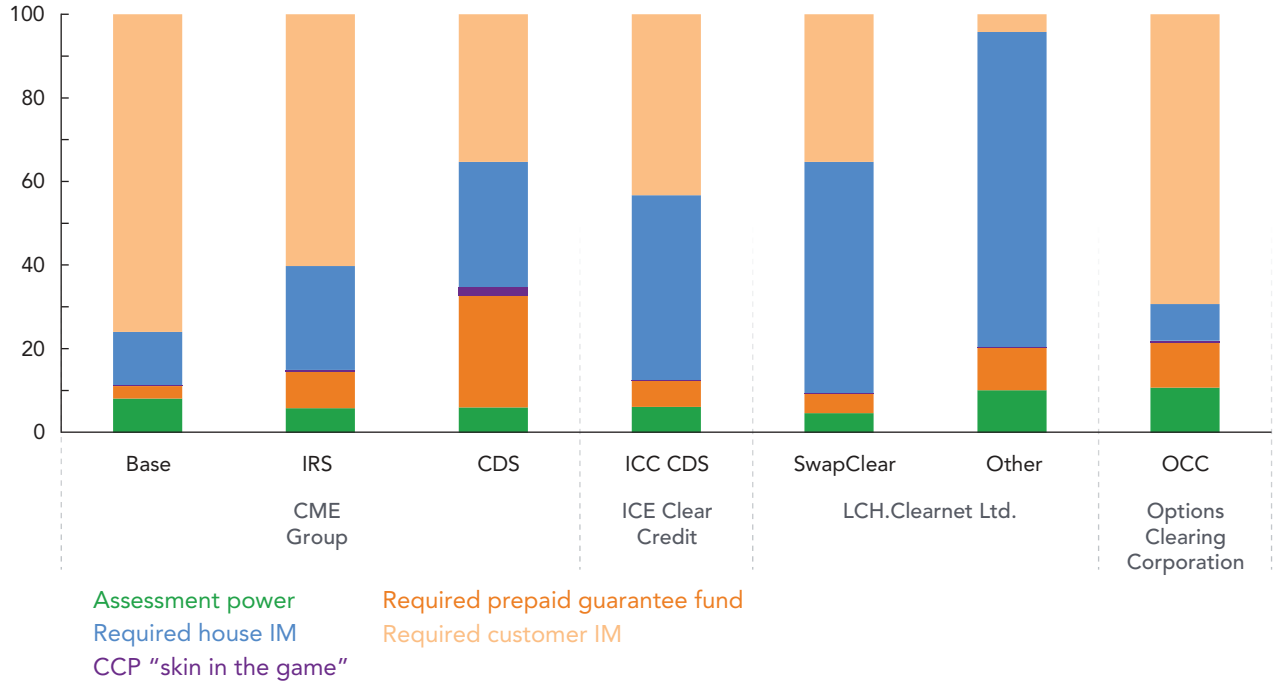
Based on those data, **Figures 48** and **49** show the amounts and proportions of resources at the four largest derivatives CCPs with U.S. clearing members. The data do not reflect the amount of margin held in any one account. Although the amount of aggregate initial margin is large at each CCP, only the defaulting clearing member's portion of that amount can be used to absorb losses from its default. The margin accounts of other clearing members (or their customers) are protected from being used to cover losses in other members' accounts.

In contrast, the prepaid guarantee fund and the callable assessments are designed to mutualize losses once the defaulter's margin plus guarantee fund contributions and the CCP's equity are exhausted. The guarantee fund and callable resources shown in the figures should reflect resources available to absorb losses if the CCP collects all callable assessments.

The public disclosure data give information on the amount of margin the CCP holds. The disclosure data also show the amount of CCP equity relative

Figure 48. CCP Margin and Default Resources (percent)

Proportion of initial margin (IM) in total central counterparty (CCP) resources varies significantly among CCPs



Note: Data as of June 30, 2016. The CME Group provides three clearing services. Two of them, named CDS and IRS, focus on clearing over-the-counter transactions in credit derivatives and interest rate swaps respectively. The third, named Base, clears the exchange-traded futures and options derivatives that form the core of CME's business.

Sources: Individual CCP responses to the CPMI-IOSCO Principles for Financial Market Infrastructures Public Quantitative Disclosure Standards for Central Counterparties

Figure 49. CCP Default Waterfall ($ billions)

	CME			ICE Clear Credit	LCH.Clearnet Ltd.		Options Clearing Corporation
	Base	IRS	CDS	ICC CDS	SwapClear[a]	Other	OCC
Required customer initial margin[b]	$83.37	$19.66	$0.86	$9.57	$36.62	$0.69	$36.98
Required house initial margin	$14.13	$8.10	$0.73	$9.76	$57.35	$12.27	$4.70
Total initial margin held less required initial margin		$11.76[c]		$1.13	$27.33[c]		$14.23[d]
CCP "skin in the game"	$0.10	$0.15	$0.05	$0.05	$0.06	$0.02	$0.25[e]
Required prepaid guarantee fund	$3.28	$2.85	$0.65	$1.37	$4.85	$1.65	$5.75
Guarantee fund held in excess of requirement	$0.19	$0.16	$0.02	$0.22	($0.00)	($0.00)	$0.42
Assessment power	$9.01	$1.91	$0.15	$1.37	$4.85	$1.65	$5.75

a Some items are reported by LCH.Clearnet Ltd. by product class rather than by clearing service. The OFR has used figures for OTC IRS (over-the-counter interest rate swaps) to represent the SwapClear clearing service.

b This row reflects gross required initial margin (IM), except for LCH.Clearnet Other. In that case, the OFR used net required margin because the gross amount was not reported. OCC reports part of its required IM amount on a net basis.

c Total initial margin held is reported at the CCP level for CME and LCH.Clearnet, and thus aggregates across multiple clearing services.

d This figure is calculated using post-haircut amounts for instances in which pre-haircut amounts were not reported by OCC. The figure also includes $4.85 billion in secured cash on deposit at commercial banks (such as reverse repo transactions), which was reported in OCC's explanatory notes.

e In 2015, OCC increased its capital after it became a systemically important financial market utility. As provided for in OCC's bylaws, Article VIII, Section 5(d), OCC could contribute its corporate capital in the event of a default. For this reason, OCC's end-of year value in 2015 of $247 million of equity has been included in OCC's potential skin-in-the-game contribution. These funds would be available once the rest of the waterfall had been exhausted.

Note: Data as of June 30, 2016. The CME Group provides three clearing services. Two of them, named CDS and IRS, focus on clearing over-the-counter transactions in credit derivatives and interest rate swaps respectively. The third, named Base, clears the exchange-traded futures and options derivatives that form the core of CME's business. LCH.Clearnet Ltd. provides seven clearing services, the largest of which is SwapClear. The column titled Other aggregates information from the remaining six clearing services.

Sources: Individual CCP responses to the CPMI-IOSCO Principles for Financial Market Infrastructures Public Quantitative Disclosure Standards for Central Counterparties

to the size of the resources available to each CCP (see **Figure 50**). That ranges from 0.8 percent to 5.8 percent of prepaid and callable default resources.

Initial margin resources. Margin requirements are set by the CCP's modeled estimates of potential losses on a member's derivatives portfolio. The requirements apply to clearing members' own house accounts and to those of their customers. Clearing members are responsible for meeting the minimum collateral requirement on behalf of their customers.

The proportion of total collateral that clearing members post for their customers varies among U.S. CCPs, according to the new data. The split between customer and house collateral should reflect their positions and risk exposures. **Figure 49** shows that customer margin accounts are relatively large for traditional futures and options markets, such as Options Clearing Corp. and CME. Options Clearing Corp.'s customer accounts were 88 percent of total required initial margin. CME's were 82 percent. Customer margin accounts are relatively small for markets for interest rate swaps and credit default swaps: 50 percent of total margin at ICE Clear Credit and less than 39 percent at SwapClear.

The disclosure also reports the number of times that a CCP's margin requirement failed to cover changes in the mark-to-market value of an account. Such shortfalls create an intraday or end-of-day exposure for the CCP to the clearing member. Of the four CCPs in **Figure 49**, three reported shortfalls in their disclosures for the second quarter of 2016. CME reported that shortfalls had occurred 10 times, LCH 521 times, and OCC 39 times. None reported a shortfall in 2015.

Liquidity resources. Derivatives CCPs' major liquidity risk results from the nature of their payment flows. Clearing members are required to make variation margin payments to the CCPs to cover the effects of price changes to their customers' and their own positions.

The new quarterly disclosure data show the amounts of liquid assets, defined as either cash or Treasury securities, held by each CCP as margin and guarantee funds. The data show the average and peak variation margin payments required by a CCP during the previous quarter. They also show the impact from the hypothetical failure of the CCP's one or two largest clearing members. In addition, they report any daily losses exceeding existing margin accounts.

OFR analysis of the U.S. CCPs' filings shows they hold the majority of margin and guarantee funds in liquid assets. For example, CCPs' initial margin funds range from 83 percent to 99 percent invested in liquid assets. The one exception is Options Clearing Corp., which allows referenced securities, such as the underlying stock in a covered call transaction, as collateral when writing such options.

Figure 50: CCP Ratios and Amounts for Liquidity and Concentration

Margin accounts are relatively large for traditional options and futures markets

	CME			ICE Clear Credit	LCH.Clearnet Ltd.		Options Clearing Corp.
	Base	IRS	CDS	ICC CDS	SwapClear[a]	Other	(OCC)
Liquidity							
Customer initial margin (IM) held as liquid assets[b]	$92.18 billion			$9.85 billion	$36.33 billion		$18.61 billion
House initial margin (IM) held as liquid assets[b]	$22.96 billion			$10.30 billion	$94.06 billion		
Peak variation margin (VM) paid to the CCP on any one day in the previous year	$13.01 billion			$1.08 billion	$15.81 billion	$1.55 billion[d]	0.00
Total liquid IM / total IM	83.1%			98.5%	97.1%		33.3%[c]
Total liquid IM / average daily VM (ratio)	34.3x			101.9x	37.2x		-
Total liquid IM / peak daily VM (ratio)	8.8x			18.7x	- [d]		-
Concentration							
Exposures: Top 5 member share of daily average exposure	52.7%	65.4%	66.2%	44.0%	28.2%	77.8%	54.0%
IM: Top 5 member share of daily average IM	48.8%	65.4%	68.8%	42.0%	23.3%	73.1%	39.0%
IM: Top 5 member share of peak daily IM	49.9%	65.4%	68.8%	45.0%	24.1%	75.8%	42.0%
GF: Top 5 member share of daily average guarantee fund (GF)	49.6%	49.3%	38.5%	38.0%	15.7%	62.4%	42.0%

a Some items are reported by LCH.Clearnet Ltd. by product class rather than by clearing service. The OFR has used figures for OTC IRS (over-the-counter interest rate swaps) to represent the SwapClear clearing service.

b OFR defines liquid initial margin (IM) as IM held in central banks, secured and unsecured deposits with commercial banks, and government bonds.

c OCC allows the use of referenced equity securities to collateralize covered calls. If its posted equity assets were included as liquid assets, its initial margin would be 98.13 percent liquid.

d LCH.Clearnet Ltd. reports peak variation margin exposures by product class rather than as a joint exposure to the entire CCP, but reports liquid asset classifications on an aggregate basis. If those peak variation margin exposures were summed, reflecting a perfect correlation across product classes, the resulting ratio would be 7.51x.

Note: Data as of June 30, 2016. The CME Group provides three clearing services. Two of them, named CDS and IRS, focus on clearing over-the-counter transactions in credit derivatives and interest rate swaps respectively. The third, named Base, clears the exchange-traded futures and options derivatives that form the core of CME's business. LCH.Clearnet Ltd. provides seven clearing services, the largest of which is SwapClear. The column titled Other aggregates information from the remaining six clearing services.

Sources: Individual CCP responses to the CPMI-IOSCO Principles for Financial Market Infrastructure Public Quantitative Disclosure Standards for Central Counterparties

One measure of a CCP's liquidity adequacy is the ratio of total liquid margin to the average daily variation margin payments. The data show that the amount of liquidity far exceeds average daily needs. The ratio varies among U.S. CCPs from 35 to 101 times. A stricter measure is the ratio of total liquid margin to the peak variation margin payment in the previous 12 months. That ratio ranges from 14 to 28 among U.S. CCPs. (OCC did not report the peak amount of variation margin payments.)

Counterparty concentration. CCPs face the risk that their outstanding exposures become concentrated in one or a few large counterparties. This concentration would pose potential systemic risks, in the event of default of a large clearing member, because mutualized losses on these exposures are transmitted elsewhere in the financial system and because the unwinding of large, concentrated positions aggravates market volatility.

The disclosure data provide new but limited information about the degree of concentration in CCPs. **Figure 50** shows that the largest five clearing members accounted for roughly half of outstanding exposures at most clearing services. That ratio was 27 percent for SwapClear, whose members are mainly dealers in the interest rate swap market. The figures show aggregate margin amounts for the five largest firms on an average daily and peak day basis. The peak amounts differ little from those of the average. This implies that the largest five firms do not change position sizes much or that they do not change them much more than others in the market. The absence of a large difference between these figures mitigates concerns about the potential for concentration risk to intensify when markets become volatile.

Data shortcomings. Some problems with the data are typical of new reporting standards. The CCPs left many elements blank. Inconsistent responses among CCPs show that some fields are still open to interpretation. This ambiguity limits comparisons among CCPs. For example, CCPs inconsistently reported the average daily volume and average daily outstanding amounts of cleared transactions. CCPs' reported total figures are not always consistent with other data sources that measure market activity. Also, not all reported items refer to the same range or point in time, making it difficult to answer key questions. For example, CCPs must report the largest estimated stressed losses from the previous 12 months, but they report available default resources only at the end of each quarter.

These incomplete and inconsistent disclosures may reflect the failure to use a common readable file template. They may also reflect differences in interpretation that result in inconsistencies in the choice of reporting forms, field identifiers, levels of aggregation, interpretation of definitions, or completeness of reporting figures. In some cases, disclosures refer to external documents that may be hard to locate. Some of these inconsistencies may

cause more-prudent CCPs to appear more precariously positioned than less-prudent CCPs.

Regulators Conduct Stress Tests

Clearing members and regulators can use stress tests to evaluate the vulnerability of CCPs and the potential systemic impacts of a distressed CCP. Disclosure of stress test results helps the public assess the resilience of CCPs. Although stress tests use confidential data, publishing the results of stress tests need not violate confidentiality.

In April 2016, European regulators published results of the first market-wide stress test of European CCPs (see ESMA, 2015). The tests used data from the CCPs for three days in the fourth quarter of 2014. The results included a description of the methodology and "reverse stress tests." The reverse tests described the number of clearing member failures that would be required to exhaust the prefunded amount and callable resources of a CCP. The stress test focused on counterparty credit risk. It did not consider liquidity, operational risk, or reinvestment risk. The test identified potential shortcomings. The report on the results also made recommendations to national supervisors.

The stress test involved 17 CCPs in the EU that clear securities or derivatives, including the European subsidiaries of U.S.-based CME, ICE, and Nasdaq. Together, the CCPs had more than 900 clearing members. Thirteen consolidated financial firms belonged to more than 10 CCPs.

The methodology differs from stress testing of large banks in that it reflects the network effects between CCPs and their clearing members. The network of clearing members can be stressed only if two things happen at the same time. First, common exposures result in a sharp loss in value on broad classes of assets. Second, at the same time, there is a failure of particular clearing members whose credit risks had been mutualized through the guarantee fund and callable obligations to the CCPs.

In the EU stress test, 74 percent of default resources among all 17 CCPs came from margin or collateral. About 17 percent came from callable assessments on clearing members, followed by 9 percent from paid-in guarantee fund contributions, and 0.2 percent from the CCPs' own equity. These proportions suggest that default waterfalls of EU CCPs are similar to those of U.S. CCPs, based on the quantitative disclosures.

The stress test results also provided information about concentration in CCPs. The test found that the largest 10 clearing members accounted for 50 percent of all the paid-in guarantee fund contributions in the system. The report concluded that individual CCPs face higher degrees of concentration than the system as a whole.

The reverse stress test showed that the system could absorb the largest 10 clearing member failures with no shortfall in total resources and a €100 million ($112 million) shortfall in prefunded resources. A breach in excess of €100 million would occur after the four largest clearing members at each CCP failed.

The report also included a more severe stress scenario in which every CCP's two largest clearing members failed at the same time. The severe test showed a shortfall in prefunded resources. The shortfall reached €10 billion ($11 billion), and then increased to €40 billion ($45 billion) when up to 10 clearing members defaulted under other, harsher scenarios defined by larger asset price movements and default frequencies.

The report concluded that even under extreme stress scenarios, there would be no uncovered losses and the maximum amount of assessments beyond the guarantee fund would be €1.9 billion ($2.1 billion).

This first EU-wide stress test represents a clear advance in assessing stability in financial market infrastructure. Limitations, mentioned in the report, include the small number of days during which the exposures were measured and stressed, as well as the sole focus on credit risk to the exclusion of liquidity, operational, and other risks. The stress scenarios did not include the dynamic effect of a change in market exposures from increased market volatility that might precede the failure of one or more large clearing members.

In November 2016, the CFTC published the results of a joint stress test of the five largest CCPs registered with the agency: CME Clearing, ICE Clear Credit,

ICE Clear Europe, ICE Clear U.S., and LCH.Clearnet Limited. The test used data from April 29, 2016, and included the 15 largest clearing members and their affiliates at each CCP. The CFTC developed a set of stressful scenarios based on price changes and correlations across markets that occurred on days of extreme volatility, including the day of the Lehman Brothers collapse and the day after the Brexit vote. Futures, options on futures, and swaps, both on financial contracts and on physical commodities, are cleared in these CCPs. The stress test studied the sufficiency of CCP prepaid funds, assuming that no additional resources would be available from clearing members. It showed that under all scenarios, CCPs had sufficient prepaid funds to withstand losses to the two clearing members with the biggest exposures in every scenario.

The stress test showed that clearing members are diversified across CCPs — clearing members do not face simultaneous losses across all CCPs in any scenario. The stress test also showed that the clearing member with the largest exposure varied across scenarios.

The CFTC stress test shares the limitations of the ESMA stress test, but improves upon it by considering a larger number of scenarios. Reporting the results of the stress test helps the public assess the vulnerability to interconnected losses through multiple CCP clearing memberships.

Conclusion: New Data and Stress Tests Provide Valuable Insights, but More Is Needed

Supervisors have access to data that allow them to evaluate the resources of CCPs. The new CCP disclosures enhance the capacity of market participants to assess the resilience of the market infrastructure. Still, the data are too aggregated to conduct robust analyses of CCP concentration risks. They do not include enough information about the sum of exposures and the sensitivity to market prices that would support a more complete stability assessment. More consistent data are also needed.

The systemwide stress tests conducted by ESMA and the CFTC in 2016 present a road map for the future. Expanding them across CCP supervisors in the United States, and potentially across jurisdictions across the world, would require cooperation. Carrying out and publicly reporting the results of such tests would have the potential benefit of boosting market confidence in the resilience of the global financial system.

Supervisors have access to data that allow them to evaluate the resources of CCPs. The new CCP disclosures enhance the capacity of market participants to assess the resilience of the market infrastructure. Still, the data are too aggregated to conduct robust analyses of CCP concentration risks.

2.5 Pressure on U.S. Life Insurance Companies

Life insurance companies could pose systemic risk. Low long-term interest rates continue to strain their earnings. They are also increasingly vulnerable to equity market declines. A large common shock to all life insurers or the failure of a large and interconnected insurer could adversely affect U.S. financial stability. Our research suggests that life insurers' systemic risk measures are related to their exposures to low interest rates and to their use of derivatives.

U.S. life insurance companies could pose financial stability risks through three main channels. First, life insurers are exposed to common factors. These include low interest rates and a decline in equity values that could reduce their profits and capital adequacy. The insurance resolution regime has not been tested for multiple failures, but is instead geared toward idiosyncratic failures.

Second, the failure of a large insurer could lead to failures outside the industry or cause spillover effects due to asset fire-sales. Material financial distress at a large life insurer could result in contagion, which could impair other financial firms and markets. Life insurers are interconnected with global systemically important banks and other financial institutions of all sizes through institutional products and capital markets.

We ranked life insurance as a key threat because of the vulnerabilities of the industry and because of its relative unpreparedness for widespread failures.

Also, some insurers are involved in nontraditional life insurance businesses, such as assuming large private pension plan obligations, writing variable annuities, and issuing long-term care insurance. These obligations are exposed to declines in long-term interest rates and asset returns.

The impact of shocks through these channels could be substantial. We ranked life insurance as a key threat because of the vulnerabilities of the industry and because of its relative unpreparedness for widespread failures. Steps to reduce risk could include more robust stress testing industry-wide, a liquidity standard to address short-term liquidity risks posed by activities such as derivatives and securities lending, and a stronger resolution framework.

Insurers Face Common Risks

Sustained low long-term interest rates put pressure on life insurers' earnings. Potential declines in the value of equities and other assets can put pressure on solvency. This double-hit scenario of low rates and a decline in asset prices is made worse by some firms' growing exposures to retirement products, including variable annuities and private pension obligations, where earnings can be stressed by both risks at the same time.

Sustained low long-term interest rates. Low interest rates are pressuring life insurers' earnings and solvency. Life insurers invest the funds they get from premiums. They rely on income from these investments to pay claims later. When interest rates fall, higher-yielding assets that mature are replaced with lower-yielding ones, cutting insurer income.

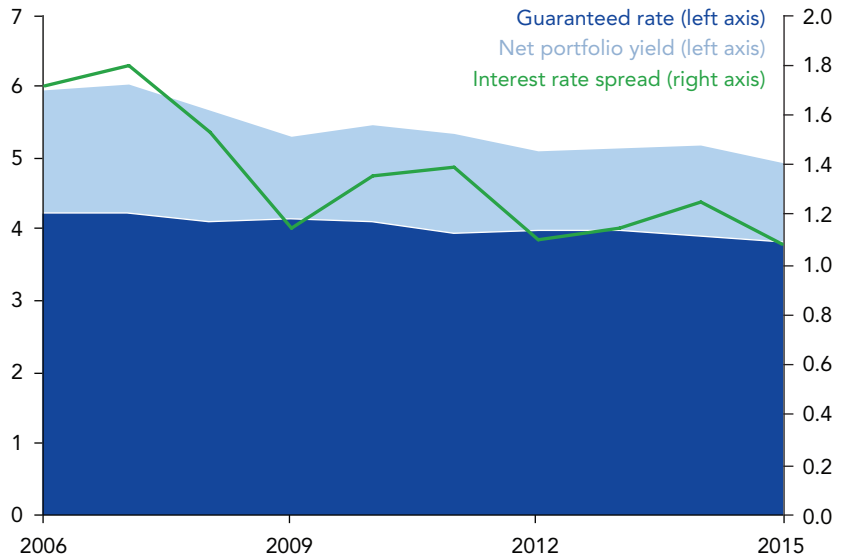
Lower interest rates raise the values of most assets and liabilities on the balance sheet. However, because the average duration of insurers' liabilities tends to be longer than that of assets, the value of liabilities tends to rise more than the value of assets when interest rates fall.

Interest rate spreads, the difference between the rate insurers earn on assets and the rates they pay on liabilities, drive insurance company profitability. **Figure 51** shows the net interest rate spread of insurers' portfolio yields over their minimum rates paid to policyholders. U.S. life insurers' net interest rate spread (green line) has fallen by one third since 2006. This decline is due to lower portfolio yields (shaded light blue) and little change in the guaranteed rate paid to policyholders (shaded dark blue). If interest rates on insurers' assets remain low, interest margins would shrink more. This shrinking would further erode profits. In September, Fitch Ratings, Inc. revised its outlook for the U.S. life insurance industry from stable to negative. It cited declining interest rates as a macroeconomic challenge (see Fitch, 2016).

Generally Accepted Accounting Principles (GAAP) permit U.S. insurers to spread the costs of underwriting new business or acquiring insurance liabilities from other firms over time. If the expected profits do not emerge, the insurer must at some point recognize shortfalls. The accounting recognition of these losses occurs in large discrete steps as assumptions are updated. For example, Moody's Investors Service downgraded the ratings of Genworth Holdings and its life insurance subsidiaries in 2015 after the company took $494 million in after-tax charges related to its long-term care insurance business. Large write-downs can reduce customer and investor confidence.

Figure 51: Interest Rate Spread for U.S. Insurer Portfolios (percent)

Interest rate spread decreased by more than a third from 2006 to 2015



Note: Interest rate spread is defined as the difference between the net portfolio yield and the guaranteed rate to policyholders.

Source: National Asssociation of Insurance Commissioners

The experience of Japan's life insurers during the late 1990s is informative (see **Low Interest Rates and Declining Equity Prices Drove Failures of Japanese Life Insurers**). European regulators also ran a stress test of their insurers in 2014 that included a low-rate scenario. The results showed that roughly one quarter of European Union (EU) insurers would have trouble meeting their obligations to policyholders in 8 to 11 years. Importantly, the scenario assumed interest rates well above those currently prevailing in Europe. The stress test also included a more severe scenario that assumed low rates and falling asset prices. In that scenario, 44 percent of EU insurers would not have enough capital (see EIOPA, 2014). European regulators are running another stress test this year. U.S. regulators need consolidated data to stress-test U.S. insurance companies to evaluate the impact of falling asset prices while interest rates remain low.

Low Interest Rates and Declining Equity Prices Drove Failures of Japanese Life Insurers

Japanese life insurers have been dealing with low interest rates and declining equity markets for two decades. Their experience may offer a window into the future of the U.S. life insurance industry.

Seven Japanese life insurers failed from 1997 to 2001 (see Figure 52) (see Kobayashi, 2014). These failed firms accounted for about 10 percent of the industry's assets (see A.M. Best, 2016). The 1997 life insurer failure was the first in Japan in more than 50 years (see Yamashita and Finnegan, 1997). That failure at first was considered an isolated event, unlikely to be followed by more failures. As other insurers failed, though, policyholders withdrew money to avoid losses.

Low rates and declining asset prices squeezed Japanese life insurers' net interest margins. Margins turned negative. Some insurers paid more to policyholders than they earned on supporting assets. To stabilize the industry, Japan's government took several actions. A voluntary industry guaranty fund was created, then a mandatory guaranty fund. Ultimately, the Japanese government announced up to ¥400 billion ($4 billion) in government-guaranteed loans the Bank of Japan could extend

Figure 52. Failures of Japanese Life Insurance Companies (assets in trillion of yen)

Seven life insurers failed in Japan between 1997 and 2001

Company	Date of Failure	Assets
Nissan Mutual	April 1997	¥1.8 trillion
Toho Mutual	June 1999	¥2.2 trillion
Daihyaku Mutual	May 2000	¥1.3 trillion
Taisho Life	August 2000	¥0.2 trillion
Chiyoda Mutual	October 2000	¥2.2 trillion
Kyoei Life	October 2000	¥3.7 trillion
Tokyo Mutual	March 2001	¥0.7 trillion
Total		**¥12.1 trillion**

Note: Assets are as of date of failure.

Source: The Geneva Association

Market risk. Life insurers have increased their exposure to market risk. The long-term decline of defined-benefit pension plans in the United States has affected the insurance industry. The decline in defined-benefit plans has resulted in insurers taking on many of the risks that had once been covered by these plans.

First, the decline of defined-benefit pension plans led households to protect themselves against longevity and market risk in retirement in different ways. U.S. insurers increasingly offer retirement-related products that guarantee policyholders a certain return. These include variable annuities (VAs) with guaranteed living benefits. VAs with guaranteed living benefits have grown since the late 1990s. The Insured Retirement Institute estimates that more than $1 trillion of the $1.8 trillion of VA assets (about 56 percent) are covered by lifetime income benefits (see Insured Retirement Institute,

to backstop the safety net. Although the lending facility was not drawn on, the announcement was viewed as helpful in stabilizing policyholder confidence (see Nakaso, 2001).

A long period of low interest rates put pressure even on Japan's strongest life insurers. The industry responded with more aggressive investments. Insurers lengthened the maturity of bond holdings to improve portfolio yields. They modified new products to protect against declining rates. In 2013, interest margins for some insurers finally turned positive. More recently, negative rates on Japanese government bonds are again putting pressure on net interest margins.

Japan's life insurers are connected with U.S. firms. Most of Aflac, Inc.'s business is in Japan. Prudential and MetLife earn a substantial portion of their revenue there. Conversely, three major Japanese life insurers have made large U.S. life insurance acquisitions (see Figure 53). Interest rates in Japan affect all of these insurers.

Figure 53. Significant U.S.-Japanese Cross-Border Life Insurance Operations

Several large insurers have operations in both the United States and Japan

U.S.-based life insurers with significant Japanese operations	Japanese subsidiary
Aflac, Inc.	American Family Life Insurance Co. of Columbus (branch)
MetLife, Inc.	MetLife Insurance K.K.
Prudential Financial, Inc.	The Gibraltar Life Insurance Co. Ltd.
	The Prudential Gibraltar Life Insurance Co. Ltd.
	The Prudential Life Insurance Co. Ltd.

Japan-based life insurers with significant U.S. operations	U.S. subsidiary
Dai-ichi Life Insurance Co.	Protective Life Corp.
Meiji Yasuda Life Insurance Co.	StanCorp Financial Group, Inc.
Sumitomo Life Insurance Co.	Symetra Financial Corp.

Source: OFR analysis

2015). These benefits are effectively long-dated put options (options to sell). They give policyholders the option to exchange their VA accounts for guaranteed life-time income payments. VAs with guarantees can leave insurers with exposure to equity markets because the benefits they guarantee to policyholders are typically triggered when equity values are down. When asset values fell during the crisis, insurers that offered VAs with guarantees saw pressure on their capital (see Barnes, Bohn, and Martin, 2015).

Second, certain insurers engage in pension risk transfer transactions, taking over the defined-benefit pension liabilities of employers. Since 2012, employers have transferred about $137 billion of pension liabilities to U.S. life insurers through these transactions (see Ericson, 2016). As a result, insurers are exposed to the risks of promised guaranteed returns.

Additionally, insurers with long-term care businesses are facing challenges from lower long-term interest rates. In addition, some insurers have inadequate reserves for their long-term care policies because they assumed fewer customers would retain the coverage (see NAIC, 2016).

Interconnectedness. The failure of a large, interconnected insurance company could have direct and indirect adverse effects on financial institutions and markets. The $182 billion government assistance to American International Group, Inc. (AIG) in 2008 provides evidence of the potential risks of such spillovers.

Since the crisis, insurance companies that are nonbank financial companies designated by FSOC have become subject to heightened regulation. The Federal Reserve has issued a draft rule describing how it would regulate these firms, as required by the Dodd-Frank Act. U.S. life insurers are connected to the rest of the U.S. financial system through several channels. These include derivatives and securities lending transactions.

Life insurers may use derivatives to hedge market risk or to assume economic exposure. At the end of 2015, U.S. life insurers' derivatives exposure, as reported in statutory filings, totaled $2 trillion in notional value. This $2 trillion does not include derivative contracts held in affiliated reinsurers, non-insurance affiliates, and parent companies that do not have to file statutory statements. Details on these entities' derivatives positions are not publicly available.

During the crisis, an AIG non-insurance subsidiary lost billions of dollars on credit derivatives. This unit was using derivatives to assume economic exposure, rather than to hedge risks. The sudden demand for margin by AIG's counterparties threatened AIG's liquidity. The government stepped in to help ensure that AIG could repay its creditors. Additionally, several other insurers, including Lincoln Financial, Voya (then ING Americas), and Aegon, met with increases in margin requirements on their derivatives hedging programs

due to credit downgrades, and later received government assistance (see Barnes, Bohn, and Martin, 2015).

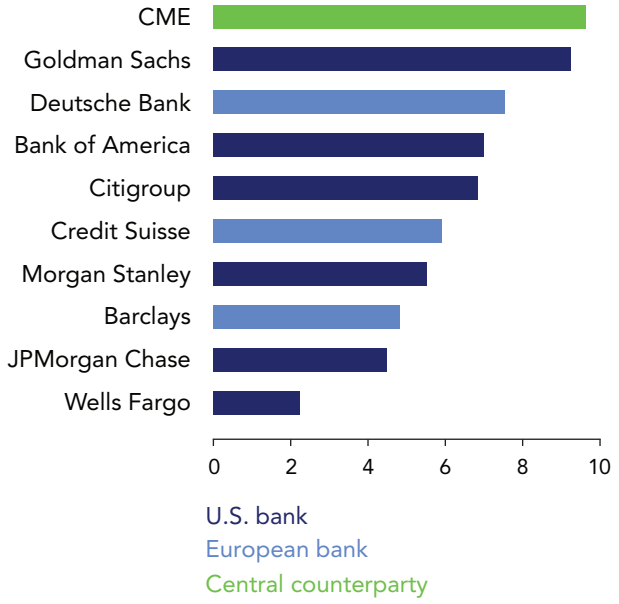
Greater use of central clearing is meant to reduce the ability of derivatives market participants to build up losses as large as those that AIG faced in 2008 (see **Section 2.4**). According to statutory data on insurance company legal entities, nine large U.S. and European banks are counterparties to about 60 percent of U.S. life insurers' $2 trillion in notional derivatives (see **Figure 54**). These data show that despite central clearing, derivatives interconnectedness between the U.S. life insurance industry and banks remains substantial.

Insurance companies also engage in activities that may be considered shadow banking. For example, some life insurers engage in securities lending, which can be a channel of financial contagion (see **Drivers of Insurers' Systemic Risk Indicators**). AIG's losses from securities lending in several life insurance entities added to its difficulties in 2008. AIG managed its securities lending program centrally through a noninsurance subsidiary for the benefit of its insurance companies (see AIG, 2006). The life insurance companies provided securities that were lent to banks and broker-dealers for cash. In turn, AIG reinvested some of this cash in securities backed by subprime home mortgages. As AIG experienced distress, securities lending counterparties sought to end the agreements. However, AIG had reinvested the cash in securities that lost value. AIG could not generate funds to meet redemption requests and return the cash (see McDonald and Paulson, 2015). In the end, AIG's securities lending counterparties were owed $43.7 billion, compared with $52 billion the firm owed its credit default swap (CDS) counterparties (see AIG, 2009).

Insurers' required reporting of securities lending began in 2010. Securities lending activity is concentrated among the larger life insurers. Although securities lending activity for the industry appears flat between 2012 and 2015, more U.S. life insurers started engaging in this activity at the time that AIG de-risked itself (see **Figure 55**).

Figure 54. U.S. Life Insurers' Derivatives Exposure by Counterparty (percent)

Some 64 percent of the notional amount of derivatives held by life insurers is concentrated in 10 counterparties



Note: Data as of June 30, 2016.

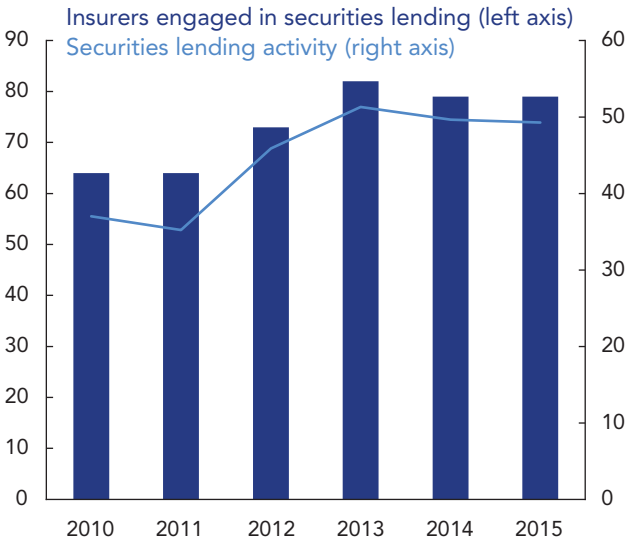
Sources: SNL Financial LC, OFR analysis

Market-Based and Systemic Risk Indicators for U.S. Life Insurers Are Rising

Since the crisis, researchers have proposed new metrics to quantify the potential contribution that individual firms make to systemwide risk (see Adrian and Brunnermeier, 2016; Brownlees and Engle, 2016; Huang, Zhou,

Figure 55. Life Insurance Securities Lending Activity ($ billions) and Insurer Participation (number of insurers)

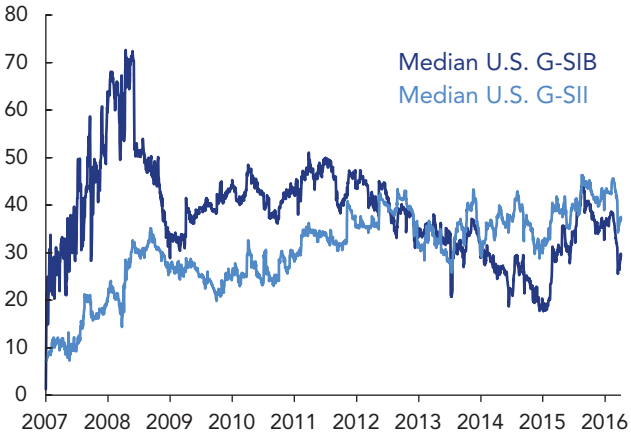
More insurers are participating in securities lending



Sources: SNL Financial LC, OFR analysis

Figure 56. SRISK Capital Shortfall ($ billions)

The median U.S. G-SII SRISK measure is above that of the median U.S. G-SIB



Note: SRISK is a widely cited measure of a financial firm's contribution to systemic risk, and is an estimate of the capital a firm would need in a severe market decline. G-SII stands for global systemically important insurer. G-SIB stands for global systemically important bank.

Sources: The Volatility Laboratory of the NYU Stern Volatility Institute (https://vlab.stern.nyu.edu), OFR analysis

and Zhu, 2011). These include conditional Value-at-Risk (CoVaR), distress insurance premium (DIP), and SRISK (see **Systemic Risk Metrics**). All three rely on publicly available market and financial data, including the market value of equity; book value of equity, assets, and liabilities; and control variables.

Using these metrics, the contribution to systemic risk from U.S. global systemically important insurers (G-SIIs) appears to be rising. In some cases, it may be higher than for some U.S. global systemically important banks (G-SIBs) (see Kaserer and Klein, 2016). **Figure 56** shows the SRISK capital shortfall measure for the median U.S. G-SIB and median U.S. G-SII. For example, the contribution to systemic risk of the median U.S. G-SII based on the SRISK measure has steadily increased during the past decade. As of March 2016, it stood above that of the median U.S. G-SIB pre-crisis.

Figure 57 compares several large U.S. insurers to six of the U.S. G-SIBs. As of June 2016, two of the insurers, Prudential and MetLife, were among the top five riskiest firms according to SRISK and the top six according to DIP. These insurers rank above Goldman Sachs and Morgan Stanley based on SRISK. They rank roughly equal to those investment banks based on DIP. These market-based measures of systemic risk, combined with other factors, suggest the need for vigilance in monitoring the risks of some large U.S. insurers (see **Drivers of Insurers' Systemic Risk Indicators**).

Regulatory Policies Improving

Regulators have taken several policy steps to address the risks posed by insurance companies since the financial crisis. These actions include new requirements for firms that are nonbank financial companies designated by the Financial Stability Oversight Council, the Federal Reserve's proposed capital standards for insurers under its supervision, and a requirement that insurers provide state regulators with a risk and solvency assessment. In June 2016, the Federal Reserve proposed enhanced prudential standards for designated insurers related to liquidity and risk management. It also proposed capital

Systemic Risk Metrics

Three widely used metrics take different approaches to measuring systemic risk:

- **Conditional Value-at-Risk (CoVaR).** An institution's contribution to systemic risk, calculated as the difference between the Value-at-Risk of the financial system when the firm is under distress and the VaR of the system when the firm is in its regular, median state (see Adrian and Brunnermeier, 2016).
- **Distress insurance premium (DIP).** The hypothetical contribution a financial institution would make to an "insurance premium" that would protect the whole financial system from distress (see Huang, Zhou, and Zhu, 2011).
- **SRISK.** The capital that a firm is expected to need if there is another financial crisis. SRISK is short for systemic risk (see Brownlees and Engle, 2016).

standards for designated insurers and for other insurance firms under its supervision.

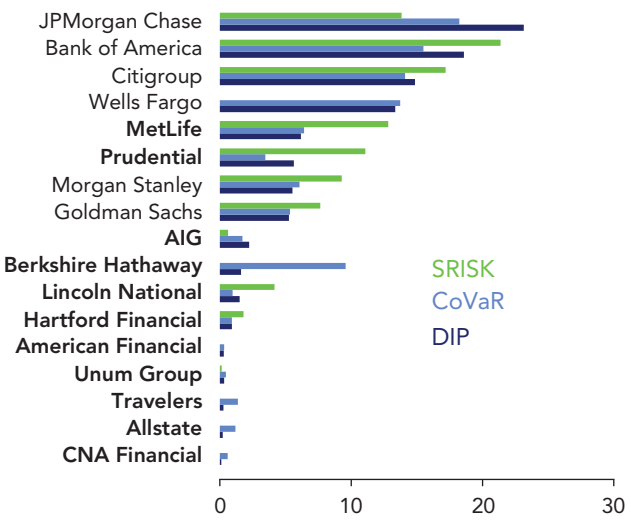
Insurance stress testing. The National Association of Insurance Commissioners' Own Risk and Solvency Assessment (ORSA) model law went into effect on Jan. 1, 2015. As of Oct. 26, 2016, 40 states have adopted the model law. It requires insurers to analyze reasonably foreseeable and material risks that could affect an insurer's ability to meet policyholder obligations under normal and severe stress scenarios. Submissions began in January 2016. Large and medium-size U.S. insurers and insurance groups must perform an ORSA at least annually.

The ORSA framework differs in several ways from the U.S. bank stress tests or the EU's insurance company stress tests. Unlike these stress tests, the ORSA process does not routinely prescribe a consistent set of scenarios, stress tests are solely performed by firms as opposed to regulators, and there is no standardized reporting template for results. Also, although the ORSA framework is applied on a group-wide basis, there is no requirement that firms' own stress testing be performed on either the parent or on a consolidated basis.

Existing resolution framework. The risk of industry-wide problems due to common factors such as low

Figure 57. Normalized Systemic Risk Measures (percent share of systemic risk)

Some large insurers appear to be as risky as some U.S. G-SIBs



Note: Data as of June 30, 2016. The normalized systemic risk measure is calculated as the proportion of the total systemic risk of the sample set attributable to a given firm. Names of insurers are in bold type. G-SIB stands for global systemically important bank. SRISK, conditional Value-at-Risk (CoVaR), and distress insurance premium (DIP) are measures of systemic risk.

Sources: Bloomberg Finance L.P., Markit Group Ltd., the Volatility Laboratory of the NYU Stern Volatility Institute (https://vlab.stern.nyu.edu), OFR analysis

Drivers of Insurers' Systemic Risk Indicators

The European Central Bank in its most recent *Financial Stability Report* noted a rise in the volatility of eurozone insurers' credit default swap spreads (see ECB, 2016). The OFR examined what may be driving up systemic risk indicators for insurers.

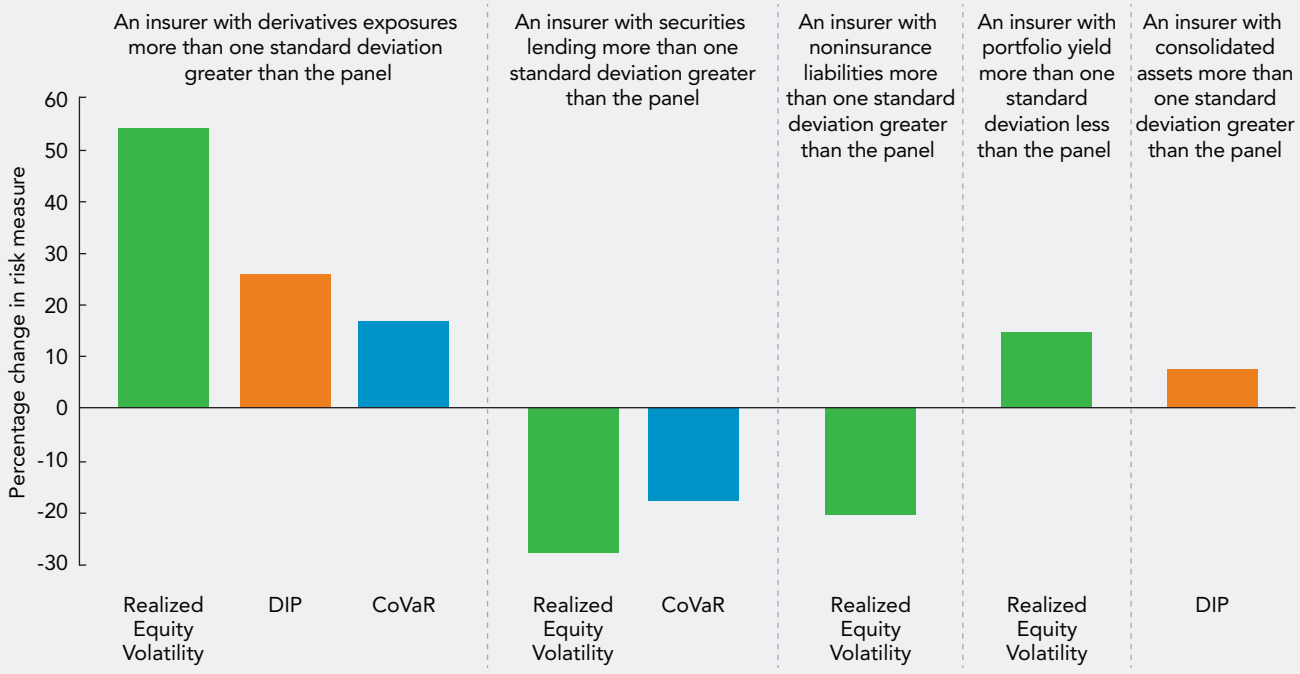
The analysis considered performance variables for 11 U.S. publicly traded insurance companies with more than $50 billion in assets during the preceding five years. The goal was to determine the impact of various factors on risk indicators. The systemic risk indicators cover different kinds of risk. The analysis also considered insurers' realized equity volatility, a more traditional risk measure. Two systemic risk indicators (CoVaR and DIP) were calculated on a monthly basis, and then aggregated on a quarterly basis. Insurers' equity volatilities were estimated using daily prices and then aggregated on a quarterly basis.

The six performance variables consisted of four categories: *liabilities* (variable annuities, non-insurance liabilities), *risks from low interest rates* (portfolio yield), *interconnectedness* (consolidated derivatives exposure, securities lending), and *size* (total consolidated assets). Data were quarterly from the fourth quarter of 2010 to the fourth quarter of 2015.

The results showed that five of the six variables listed above had a statistically significant effect across one or more of the risk indicators (see Figure 58). We found that an increase in an insurer's consolidated derivatives

Figure 58. Drivers of Systemic Risk Indicators and Realized Equity Volatility in U.S. Insurers

Higher derivatives exposures, lower portfolio yields, and higher consolidated assets are associated with increased systemic risk



Note: Distress insurance premium (DIP) and conditional Value-at-Risk (CoVaR) are measures of systemic risk.

Sources: Bloomberg Finance L.P., Markit Group Ltd., Morningstar, SNL Financial LC, Standard & Poor's, OFR analysis

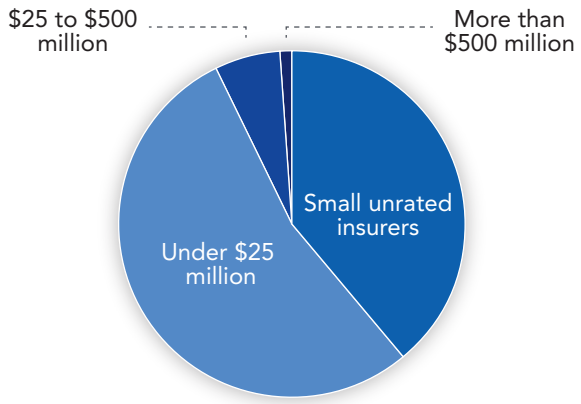
exposure consistently is associated with an increase in systemic risk indicators and in realized equity volatility.

Consolidated assets are also correlated with an increase in insurers' systemic risk as measured by DIP. By contrast, a decrease in portfolio yield, non-insurance liabilities (a proxy for non-insurance businesses), and securities lending are correlated with an increase in realized equity volatility for U.S. insurers. The effect on portfolio yield is suggestive of risks due to low long-term interest rates and consistent with some other research suggesting low interest rates may pose a risk to the U.S. life insurance industry (see Hartley, Paulson, and Rosen, 2016).

There was no apparent positive correlation between systemic risk metrics and securities lending and non-insurance liabilities. However, due to lack of data, this analysis does not capture AIG's activities during the crisis. These results may suggest that equity markets reward insurers for these nontraditional activities. These activities can increase and diversify an insurer's profits and strengthen its capital, but they may pose risks if done to excess, as the example of AIG illustrates.

Figure 59. Distribution of Life Insurers Subject to Regulatory Action by Size of Company's Capital (percent)

Most life insurers subject to regulatory action have been small



Note: Data are from 1969-2014. Excludes companies identified as solely offering health insurance. Size is defined as capital and surplus of the company at the date of regulatory action. A.M. Best Co. designates an insurer as a financially impaired company the first time an insurance department officially deems that the insurer's ability to conduct normal insurance operations is adversely affected, capital and surplus are deemed inadequate to meet legal requirements, or general financial conditions trigger regulatory concerns.

Sources: A. M. Best Co., OFR analysis

interest rates is worrisome because the U.S. resolution framework for insurers relies largely on state guaranty funds. The state guaranty funds are not prefunded and rely on surviving firms in that state to cover shortfalls to policyholders of a failed insurer. The state-based guaranty fund system has not faced an industry-wide solvency crisis (see Cummins and Weiss, 2014). Past failures have been small and firm-specific, so the state guaranty fund system remains untested for failures of larger firms or for an industry-wide event (see **Figure 59**).

Conclusion: Gaps remain

Life insurance companies could pose financial stability risk. While regulators have adopted measures since the crisis, key policy gaps remain. These gaps include the need for more robust stress testing industry wide, the adoption of a liquidity standard to address short-term liquidity risk for insurers materially engaging in activities such as derivatives and securities lending, and the evaluation of options for strengthening the resolution framework. As of Aug. 31, 2016, only 14 U.S. states had adopted legal changes necessary to permit group supervision of internationally active insurance groups (see Schwarcz, 2015). This policy gap hinders the regulatory oversight of insurers' enterprise-wide risk-taking.

2.6 Systemic Footprints of Largest U.S. Banks

The largest U.S. banks lie at the center of the financial system, and the potential impact of a large bank failure remains substantial. A number of metrics suggest the systemic footprint of U.S. global systemically important banks (G-SIBs) in the U.S. financial system has changed little since the crisis. Persistently low long-term interest rates challenge earnings and may motivate risk-taking. Regulators have criticized resolution plans, called "living wills," for these firms as unrealistic, and this essential financial stability safeguard still needs policymaker attention.

Reform efforts have reduced the probability and immediacy of a large bank failure. However, the largest U.S. banks remain a potential source of systemic risk because of their size, complexity, and interconnectedness.

The largest and most interconnected U.S. banks have become more resilient since the financial crisis. Reform efforts have focused on capital, liquidity, and stress testing. These efforts have reduced the probability and immediacy of a large bank failure. However, the largest U.S. banks remain a potential source of systemic risk because of their size, complexity, and interconnectedness.

Moreover, G-SIB business models and risk profiles are evolving in response to earnings challenges from low interest rates, competition from shadow banks, and enhanced regulatory requirements. Low net interest income could spur these banks to seek higher-margin — and often riskier — income sources. Over time, more risk-taking at U.S. G-SIBs could undermine higher capital buffers if that risk is not captured by higher capital standards or stress tests.

Changes in business models at individual U.S. G-SIBs could also lead to more similar risk profiles over time. Some U.S. G-SIBs are expanding their fee income from investment banking and asset management as commercial banking income declines. Increasing convergence in business models could create new channels of contagion as these banks become more vulnerable to common shocks. Supervisory monitoring and stress testing will need to evolve to keep pace.

Recent research highlights that a variety of U.S. G-SIBs' market indicators are inconsistent with the view that enhanced regulation has reduced their riskiness (see Sarin and Summers, 2016). We might expect enhanced regulatory capital and liquidity requirements to result in large declines in measures of large U.S. banks' market risk. However, no such declines are seen.

Also, weaknesses in U.S. G-SIBs' living wills suggest managing a large bank failure under the U.S. Bankruptcy Code may still be difficult. The orderly liquidation authority of the Dodd-Frank Act provides an alternative resolution mechanism. However, the authority has significant preconditions, including consultation with the President. Better living wills would enhance financial stability, particularly if risks at large banks stay high.

Systemic Risks Remain Concentrated Among U.S. G-SIBs

Internationally, bank regulators now impose a capital surcharge on G-SIBs based on their systemic importance. The surcharge is calculated using a methodology set by the Basel Committee on Banking Supervision. In 2016, the OFR introduced an interactive tool for visualizing G-SIBs' systemic importance data using that methodology (see OFR, 2016a).

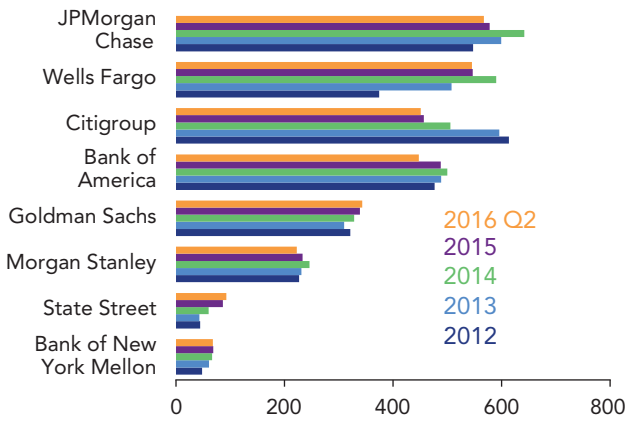
Despite significant reforms, the eight U.S. G-SIBs remain large, complex, and interconnected enough to pose potential risks to the U.S. financial system (see Loudis and Allahrakha, 2016). The eight companies account for nearly three-quarters of total U.S. bank holding company assets. They also remain deeply connected to the rest of the financial system (see **Figure 60**).

The Basel Committee methodology measures banks' complexity in part by looking at data on notional derivatives positions. These data reflect the nominal value of underlying derivatives contracts. They have been volatile since 2012 but remain highly concentrated among the five largest banks (see **Figure 61**). As with OFR findings on insurance (see **Section 2.5**), OFR analysis suggests higher derivatives exposures for banks are associated with greater systemic risk (see **Interest Rates and Derivatives Exposures Drive Banks' Systemic Risk Indicators**).

Substitutability is also a concern in determining whether a bank is systemically important. The Basel Committee's measure for substitutability will not reflect recent changes in the provision of settlement services for government securities and related repos in the United States. JPMorgan Chase announced in July that it will close its government securities settlement business by the end of 2017. This decision could concentrate such activities in Bank of New York Mellon (BNY Mellon) (see Burne, 2016). Concentration of these activities could raise financial stability concerns. A failure of, or loss of confidence in, a clearing bank may cause broad market disruptions. However, even if BNY Mellon's substitutability metrics were to rise because of JPMorgan's exit, it would not be captured in the bank's

Figure 60. U.S. G-SIB Securities Outstanding ($ billions)

Securities outstanding, a measure of interconnectedness, have been high since 2012

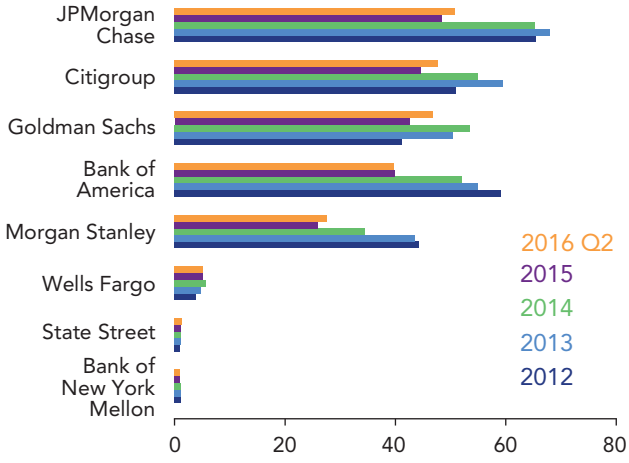


Note: G-SIB stands for global systemically important bank. Securities outstanding include all debt and equity securities issued by the company.

Sources: Federal Reserve Form Y-15, OFR analysis

Figure 61. U.S. G-SIB Notional Amount of Derivatives Positions ($ trillions)

Derivatives holdings, a measure of complexity, have been high since 2012



Note: G-SIB stands for global systemically important bank.

Sources: Federal Reserve Form Y-15, OFR analysis

Interest Rates and Derivatives Exposures Drive Banks' Systemic Risk Indicators

The OFR analyzed what may be driving systemic risk for large U.S. banks. The results show a flatter yield curve and higher derivatives exposures are associated with greater systemic risk. The results also highlight the difficulty of quantifying risks associated with particular noncommercial-banking activities using public data.

The analysis considered 19 U.S. bank holding companies with consolidated assets of $50 billion or more. The goal was to identify drivers of two systemic risk indicators: Conditional Value-at-Risk (CoVaR) and SRISK (see **Systemic Risk Metrics** in **Section 2.5**). CoVaR was calculated internally. SRISK was obtained from New York University. Each indicator was measured monthly by firm and then aggregated on a quarterly basis from the first quarter of 2010 through the first quarter of 2016.

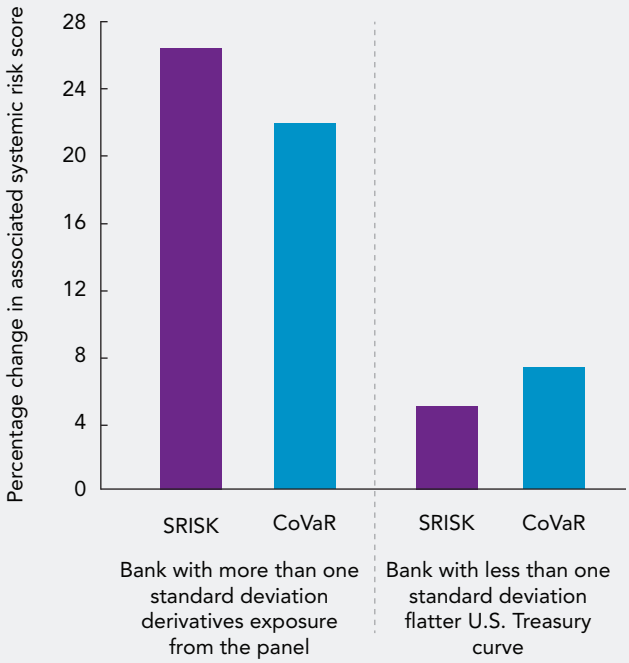
The five performance variables investigated as potential drivers of large banks' systemic risk were in three categories: (1) slope of the Treasury curve (the yield spread between 10-year and 1-year Treasuries); (2) complexity and interconnectedness (a bank's total gross notional derivatives exposure relative to total consolidated assets); and (3) business structure (fiduciary income, brokerage activities income, and investment banking income relative to pretax operating income).

At a 5 percent level, the first two of the five variables were found to be statistically significant drivers of CoVaR and SRISK — an increase in a bank's derivatives exposure and a flatter Treasury curve (see Figure 62). The Treasury curve is related to earnings risk because it proxies for banks' opportunity to generate net income from the spread between interest earned on loans and interest paid on deposits. Its significance as a driver of systemic risk highlights banks' earnings challenges when long-term interest rates are low.

The business structure variables studied did not prove to be drivers of either of the two systemic risk indicators. These volume-based measures of noncommercial-bank business activity likely did not capture the associated risk profiles. Also, derivatives exposure may have already captured some business structure-related risks.

Figure 62. Drivers of Systemic Risk Indicators in Large U.S. Banks

Higher derivatives exposures and a flatter yield curve are associated with increased systemic risk



Note: SRISK and conditional Value-at-Risk (CoVaR) are measures of systemic risk.

Sources: Bloomberg Finance L.P., Federal Reserve Form Y-9C, the Volatility Laboratory of the NYU Stern Volatility Institute (https://vlab.stern.nyu.edu), OFR analysis

G-SIB capital surcharge because U.S. regulators capped the substitutability metric's impact on a bank's surcharge (see Board of Governors, 2015).

More reliance on BNY Mellon's services raises financial stability concerns because it historically has been difficult to lessen the risks that come from lack of substitutability. For example, in 1985, BNY Mellon, then the Bank of New York, received a $23 billion discount window loan from the Federal Reserve to avert the spillovers from an operational failure in this market (see Ennis and Price, 2015). The loan was unprecedented in size at the time and in excess of the bank's balance sheet, because the firm had also pledged customers' holdings of Treasury securities. Industry efforts to plan for a "new bank" to replace a troubled clearing bank as part of post-crisis repo market reforms were never fully realized (see FRBNY, 2010). More recently, in April 2016, bank regulators said BNY Mellon needs to clarify in its living will the viability of its proposed bridge bank strategy, which is meant to allow the firm to maintain critical operations in resolution (see Board of Governors and FDIC, 2016).

Even as the systemic importance of U.S. G-SIBs remains high, living wills are still weak. In April 2016, U.S. regulators determined that seven of the eight U.S. G-SIBs' 2015 living wills were "not credible or would not facilitate an orderly resolution under the U.S. Bankruptcy Code" (see FDIC and Board of Governors, 2016). An OFR analysis of the limited data in the public portions of U.S. G-SIBs' living wills found little evidence of firms simplifying their operations (see Bright and others, 2016). Public data on U.S. G-SIBs' number of legal entities — layers within the corporate hierarchy and interconnections across material legal entities — suggest resolution of a U.S. G-SIB would be challenging. More detailed and standardized public disclosures are needed to improve confidence that a G-SIB failure would not be disorderly and spread risk.

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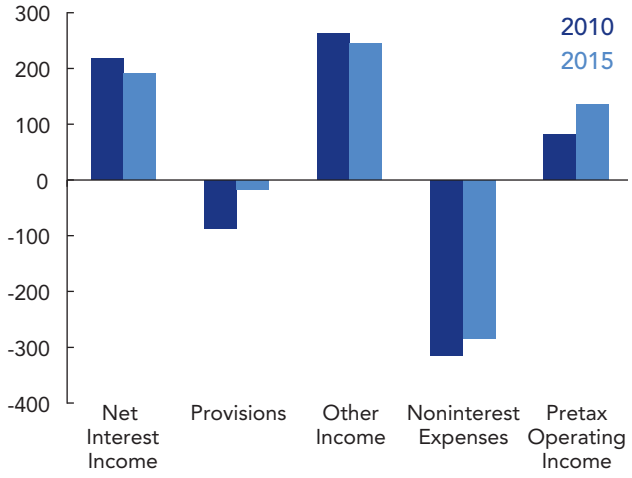
U.S. G-SIBs' Business Models Evolving Due to Earnings and Regulatory Pressures

Years of low long-term interest rates have hampered bank earnings, putting pressure on business models and encouraging firms to take risks in new ways that can be hard to monitor. This pressure is likely to continue because U.S. interest rates remain at or near historical lows and rates in other advanced economies continue to fall further below zero.

Profits from traditional bank services — taking deposits and making loans — have been undermined by sustained low interest rates, growing competition from shadow banks, and other factors. The U.S. G-SIBs' income from the spread of interest earned on loans over interest paid on deposits fell $29 billion from 2010 to 2015, with little offset from other sources of net interest income (see **Figure 63**). Other sources of income,

Figure 63. Components of U.S. G-SIBs' Operating Income ($ billions)

Declines in provisions and expenses have exceeded income declines since 2010

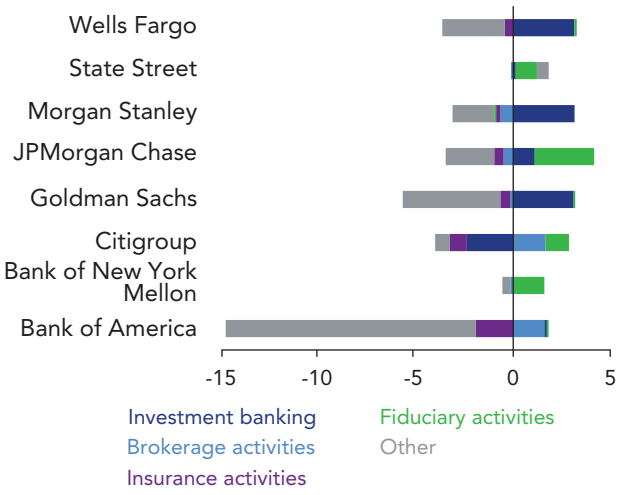


Note: Pretax operating income equals net interest and other income less provisions and noninterest expenses. Other income includes noninterest income and securities gains or losses. G-SIB stands for global systemically important bank.

Sources: SNL Financial LC, OFR analysis

Figure 64. Change in Components of U.S. G-SIBs' Noninterest Income, 2010-2015 ($ billions)

The greatest growth came in investment banking and fiduciary activities



Note: G-SIB stands for global systemically important bank.

Sources: SNL Financial LC, OFR analysis

including noninterest income and securities gains, also declined from 2010 to 2015. Declines in provisions for loan losses and noninterest expenses more than offset these income losses, boosting U.S. G-SIBs' pre-tax operating income in 2015 as compared to 2010. Given the risks of higher defaults on commercial real estate and nonfinancial corporate loans, provisions may rise, further eroding profits from lending (see **Section 2.2**).

Some U.S. G-SIBs are responding to the net interest income challenges by expanding their fee income from noncommercial-banking activities. **Figure 64** shows that there has been growth in investment banking and fiduciary (asset management) activities and, to a lesser extent, securities brokerage. Most other sources of noninterest income have declined. Public regulatory reporting is insufficient to determine how these changes affect the banks' risk profiles.

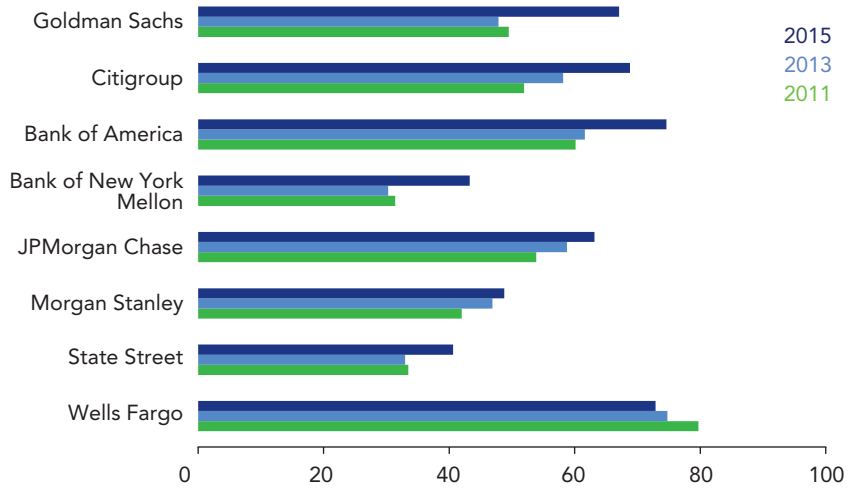
Commercial banking risks historically centered on bad loans and the potential for depositor runs, mitigated by deposit insurance. Different risks arise from securities dealing, underwriting, trading, over-the-counter derivatives, and prime brokerage and asset management services.

The ratio of risk-weighted assets to total assets can be a useful gauge of risk-taking. The ratio provides information about the average risk weighting the bank applies to positions. For example, a ratio of 20 percent would be consistent with a bank assigning positions an average risk weight of 20 percent, which is the weighting of a senior agency mortgage-backed security. From 2011 to 2015, that ratio increased for seven of the eight U.S. G-SIBs (see **Figure 65**). To what extent the increase has come from increased risk-taking or more stringent U.S. risk-based capital rules is not easy to determine. (As noted in **Section 2.1**, risk weights can be subject to arbitrage.)

However, with the leverage ratio acting as the binding regulatory constraint, some U.S. G-SIBs may be letting their risk-weighted assets rise.

Figure 65. Risk-Weighted Assets as a Share of Total Assets for U.S. G-SIBs (percent)

Risk-weighted asset densities rose at seven of eight U.S. G-SIBs from 2011 to 2015



Note: G-SIB stands for global systemically important bank.

Sources: SNL Financial LC, OFR analysis

New Regulations May Pose Unintended Consequences

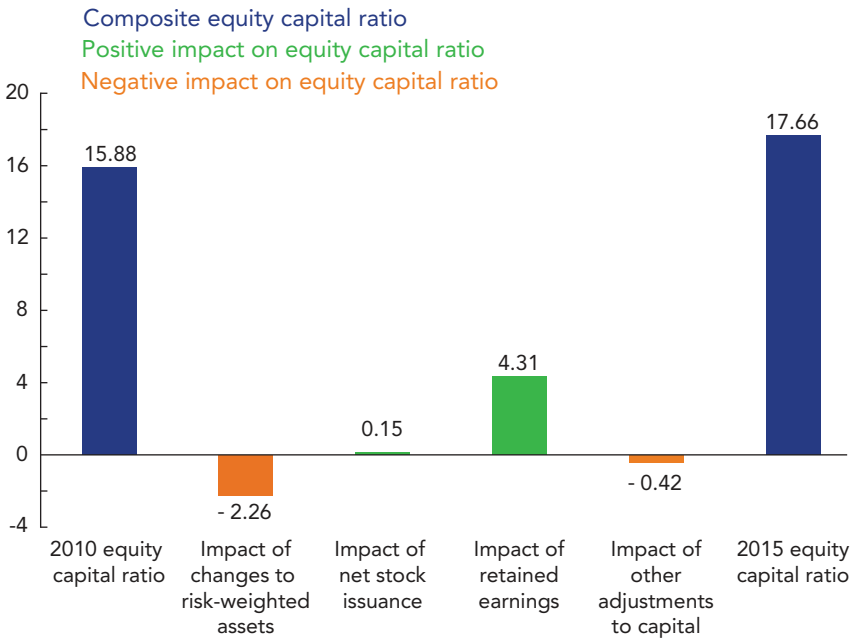
New capital and other standards aim to make U.S. banks more resilient and reduce the risks large banks take. However, some of these changes, in combination with the pressure on G-SIBs' core earnings from low interest rates and competition from shadow banks, may have unintended consequences. Retained earnings have been the main way these banks have met higher capital requirements since the crisis.

The Federal Reserve evaluated the potential impact of negative rates on U.S. banks in its 2016 stress test, the Comprehensive Capital Analysis and Review (CCAR) (see Board of Governors, 2016a). These tests assess capital adequacy. No U.S. G-SIB failed the test's severely adverse scenario, which included negative interest rates in the United States.

However, higher capital requirements are phasing in. They are not yet fully reflected in CCAR's minimums. Bank regulators have introduced a new concept of capital buffers, an extra cushion on top of regulatory minimums to meet unexpected shocks (see Board of Governors and OCC, 2013). This so-called capital conservation buffer applies to all banks. G-SIBs also face an additional capital buffer requirement tied to their systemic importance (see Loudis and Allahrakha, 2016). The buffers go into effect in stages over the next three years.

Figure 66. Five-Year Changes to G-SIB Composite Equity Capital Ratio (percent)

Growth in G-SIB equity capital ratios has been driven by retained earnings



Note: Annual data from 2011 to 2015. G-SIB stands for global systemically important bank.

Sources: Federal Reserve Form Y-9C, OFR analysis

G-SIBs already meet these buffer requirements (see Heltman, 2016). However, it is not yet clear how the new buffers will fit into CCAR. G-SIBs may need to boost capital if they have to keep these higher levels under stress. This need may be more difficult in the current earnings environment, because retained earnings account for much of the improvement in G-SIBs' regulatory capital post-crisis (see **Figure 66**). For some G-SIBs, raising new equity could also prove difficult.

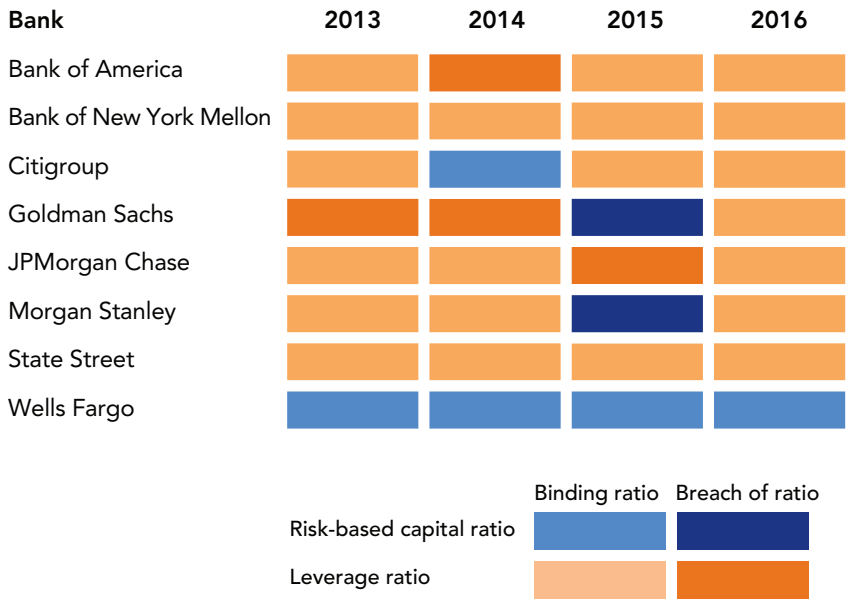
In 2012, regulators introduced the supplementary leverage ratio, an additional minimum for banks with assets greater than $250 billion or with $10 billion or more in foreign exposures. A minimum ratio of 3 percent was set for all banks meeting this criteria, with an additional 2 percent buffer added for banks with more than $700 billion in assets or $10 trillion in assets under custody. The supplementary ratio includes off-balance-sheet items that weren't part of the pre-crisis U.S. leverage ratio. All U.S. banks must maintain a leverage ratio minimum of 4 percent of on-balance-sheet assets.

The leverage ratios are meant to complement risk-based capital requirements, which can potentially be subject to misspecification or model risk. Although simpler than risk-based capital requirements, a possible downside of the leverage ratio is encouraging banks to take risks. In a recent working paper, OFR researchers found an increase in some risk-taking after the introduction of the supplementary leverage ratio. Bank holding companies' broker-dealer affiliates decreased overall repo borrowing but increased their use of repo backed by more price-volatile collateral (see Allahrakha, Cetina, and Munyan, 2016). This change in repo activity may have implications for these firms' short-term funding risk. Other researchers have similarly found that a more binding leverage ratio may encourage the broker affiliates of bank holding companies to raise their risk profiles (see Kiema and Jokivuolle, 2014). Although higher capital requirements could be assumed to reduce the risk of failure, some research suggests regulatory capital measures have been poor predictors of bank failure (see Bulow and Klemperer, 2013).

The Federal Reserve's CCAR has forced several G-SIBs to revise their capital plans. Some of these banks had reported regulatory capital ratios well above required minimums. CCAR has resulted in those banks holding additional capital. In the 2016 CCAR severely adverse scenario, seven of the eight U.S. G-SIBs were closer to a breach of the leverage ratio than they were to a breach of any of the regulatory minimums for risk-based capital standards. The more stringent supplementary leverage ratio is now being phased in. CCAR does not yet measure banks' ability to meet this new standard. Potential changes in banks' business models bear monitoring, because the 2016 CCAR results suggest that U.S. G-SIBs are more constrained by leverage standards than risk-based capital standards (see **Figure 67**). Possible inclusion in CCAR minimums of additional risk-based capital buffers, including the G-SIB buffer, which are also phasing in now, could also affect large bank behavior.

Figure 67. Binding Ratios Under the Comprehensive Capital Analysis and Review

Large banks in the United States are more constrained by the leverage ratio than by risk-based capital ratios



Note: Breach of ratio indicates the bank's regulatory ratio fell below regulatory requirements during the stressed period. If there was no breach of the bank's regulatory ratio, the ratio that came closest to a breach is indicated as the binding ratio.

Sources: Federal Reserve Board of Governors, OFR analysis

Conclusion: Macroprudential Supervision and Resolution Planning Need Attention

Supervisory monitoring and stress testing need to adapt to increasing noncommercial-banking activities at some U.S. G-SIBs. Supervisors need to monitor whether recent regulatory changes affect banks' behavior in unanticipated ways or make U.S. G-SIBs more uniform over time. Banks may look safe from a microprudential perspective, but the system as a whole may be more vulnerable to common shocks. This problem argues for a macroprudential approach to monitoring these banks.

Living wills for G-SIBs have not met supervisors' standards. Data gaps in the public portions of living wills may increase uncertainty about what would happen if a U.S. G-SIB were to fail. These data gaps also raise questions about whether exceptional government support for large U.S. banks might occur again in the future.

2.7 Deficiencies in Data and Data Management

The OFR has a mandate to improve financial data. Risk managers and regulators today have better data than ever before, thanks to several new data collections and data standards initiatives. Still, deficiencies in data scope, quality, and accessibility continue to prevent a full assessment of risks in key markets and innovation in financial markets means that new gaps in the data required by risk managers will continue to arise. Additionally, whether data management systems are keeping pace with financial and technological innovation and the growing volume and variety of data is unclear.

The global financial crisis revealed serious problems in the data available to monitor and assess financial risks. Regulators and risk managers did not have the data they needed, when they needed them, about markets at the heart of the crisis. Their data management systems also could not keep up with demands.

Since the financial crisis, there have been several successful efforts to improve and collect new financial data, led by U.S. and other regulators and backed by private industry. This work is ongoing.

Since then, there have been several successful efforts to improve and collect new financial data, led by U.S. and other regulators and backed by private industry. Financial regulators and the OFR now have access to detailed information about key markets and firms that were largely opaque a decade ago. These include shadow banking activities such as hedge funds, money market funds, and securities financing. New data about central counterparties that became publicly available this year are analyzed in **Section 2.4**. Data about banks and mortgage markets have also been significantly expanded, for the public and for confidential use by supervisors.

At the same time, the quality of financial data has improved. International work underway to standardize and share data can help support the changing needs for data as global markets evolve. Regulators also are focusing more on improving firms' internal data management processes.

This work is ongoing. Deficiencies in data and data management remain a critical vulnerability. Data needs remain unfilled, particularly in shadow banking markets. Many of the new data are not ready or available for analysis. Despite progress, the probability remains high that data deficiencies will again prevent risk managers and regulators from assessing risks before it is too late. The immediacy of this threat is unclear and depends on the market where risks may be building.

Granted, regulators, policymakers, and researchers will never have all the data they need in every scenario, given the speed of financial innovation and the gaps new products create. As markets change, new data needs will emerge. The OFR will continue to play a leading role in initiatives to address these issues.

Despite Improvements, Deficiencies Remain in Data Scope, Quality, and Access

Financial data must have three attributes to support risk management and financial stability analysis. Data must: (1) have sufficient scope (comprehensive and granular); (2) be of high quality (complete, accurate, and timely); and (3) be accessible to those who need them (shared and secured).

At the same time, managing increasingly complex data requires ever more resources and attention. Regulators have cooperated internationally to improve the scope, quality, and accessibility of financial data since the crisis. But data still fall short on these three key attributes. Because financial markets are global, many regulators and jurisdictions are involved. International coordination requires sustained effort and resources.

Scope, Quality, and Access

Financial data need three attributes to be useful for policymakers and market participants to support financial risk management, measurement, and reporting:

- **Scope.** Data must cover all relevant financial markets, institutions, and products, with data sufficiently granular to monitor and assess risks.
- **Quality.** Data must be complete, accurate, and timely. They must be easily usable by parties through different systems, and they must be supported by adequate information technology and data architectures.
- **Access.** Data must be purposefully and securely shared among stakeholders, taking into account privacy and confidentiality.

Scope. Regulators have started new data collections since the financial crisis from key firms and markets (see **Figure 68**). These include activities such as hedge funds and money market funds. But regulators still lack granular data on key markets. Data on shadow banking activities are incomplete and product innovation leads to new gaps. The OFR is working with U.S. and international regulators to improve data about securities financing transactions.

Figure 68. Examples of Key Post-Crisis Regulatory Data Collection Initiatives

Firm/market	Initiatives
Banks and bank holding companies	New monthly, quarterly, and annual reporting on Form Y-14 by large bank holding companies since 2012. Expanded Call Report (banks) and Y-9C (bank holding companies) reporting on securitization activities, allowance for loan losses, capital, and derivatives and other activities since 2012. New daily (for U.S. global systemically important banks) and bimonthly (for other large U.S. bank holding companies) reporting on selected assets, liabilities, funding activities, and contingent liabilities material to liquidity profiles since 2014.
Insurance companies	Annual schedule added to statutory filings of life insurers for term and universal life reinsurance activities filed in 2015. The new schedule allows for analysis of captive reinsurance.
Money market funds	Monthly reporting on Form N-MFP since 2010, used as the basis for the OFR's U.S. Money Market Fund Monitor. After 2014 money market fund reform, Form N-MFP was updated with new reporting fields that were required to be submitted starting April 2016.
Mutual funds and exchange-traded funds	Proposed monthly portfolio reports on Form N-PORT. Proposed annual report for registered investment companies on Form N-CEN.
Private funds (including hedge funds) and commodity pool operators	New reporting on Form PF since 2012, used by the OFR, Securities and Exchange Commission, and Commodity Futures Trading Commission in analysis of private fund and commodity pool operator activities.
Derivatives markets	Detailed credit derivatives data provided to regulators since 2008, used by the OFR in several working papers. Swap data repositories began to collect data on over-the-counter derivatives in 2013.
Mortgage markets	Mortgage Metrics report published by the Office of the Comptroller of the Currency since 2008 using confidential banking data. New data collected from mortgage lenders under Regulation C of the Home Mortgage Disclosure Act. New data collected from mortgage loan originators and servicers in the Mortgage Call Report. New data collected from government-sponsored enterprises, used by the Federal Housing Finance Agency. New monthly reporting on Form Y-14M by large bank holding companies on their mortgage portfolios and performance since 2011. New reporting to Federal Deposit Insurance Corporation by failed banks under loss-sharing agreements since 2012.
Securities financing markets	Aggregated data about triparty repurchase agreements (repo) available to the public on the Federal Reserve Bank of New York website since 2010. Pilot data collections from bilateral repo market participants and securities lending agents conducted by the OFR and other agencies in 2014-16 as the basis for permanent collections.
Registered investment advisers	Enhanced reporting on Form ADV starting 2017 will include aggregate data on types of assets held by separately managed accounts and the use of borrowing and derivatives.

Source: OFR analysis

Quality. A major initiative since the crisis is the legal entity identifier (LEI). The LEI is now required by derivatives markets regulators around the world. However, in other markets, adoption has been less consistent. The LEI experience shows that relying on market participants to voluntarily adopt a standard may not be enough. Broader regulatory mandates are required (see **Broader Adoption of Data Standards Needed**).

Much has been done to ensure standardized reporting in new data collections. Some of the new regulatory forms demand consistency from filers, such as the Form Y-14 filed by large bank holding companies and the proposed Form N-PORT to be filed by mutual funds and exchange-traded funds (ETFs). In other cases, inconsistent and inadequate data still obstruct analysis. More public- and private-sector collaboration is needed to set and use data standards.

Access. Some of the new post-crisis data are publicly available, such as the Form N-MFP filed by money market funds. But confidentiality concerns preclude public distribution in most cases, and regulators continue to face difficulties in securely sharing confidential data with each other (see **Better Regulatory Sharing Needed**). Regulators need timely access to data leading up to and during stress events and for analysis afterward. Confidential data can support financial stability monitoring and analysis. For example, the OFR has used Form PF data to study leverage and concentration risk in hedge funds.

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Securities Financing

Borrowing and lending securities support price discovery, secondary market liquidity, and risk management (see Lipson, Sabel, and Keane, 2012). The OFR, Federal Reserve, and SEC have worked since 2014 on pilot projects to collect data on U.S. bilateral repurchase agreements (repos) and securities lending activities (see Baklanova and others, 2016a; Baklanova and others, 2016b). The three agencies are preparing for a permanent collection.

Regulators are also working across borders through the Financial Stability Board to coordinate national data collections and create global aggregated data. We have shared OFR data templates and the lessons learned from our pilots to support these efforts. European regulators issued regulations in December 2015 to promote transparency in shadow banking. They also proposed a reporting framework for securities financing transactions. Such a framework would include data fields, definitions, and formats.

Challenges remain. National regulators tend to gather data only in their jurisdictions, and reporting rules vary. Multinational firms report different pieces of their global activities to different regulators, and these differences increase the difficulty of comparing data across borders. Some regulators

Broader Adoption of Data Standards Needed

The legal entity identifier provides a case study in how even an important standard with strong industry support is adopted only slowly when regulatory requirements are uneven or when regulators rely on voluntary implementation.

Regulators invest heavily in promoting data standards, whether through influence or through direct development. When data standards are widely used, regulators, market participants, and others can communicate precisely about data. They can also collect, compare, aggregate, share, link, and integrate data. The measure of success for data standards comes not just from their development, though. To be a success, standards must be adopted or used in the financial system where they prove their value.

Financial transaction standards are more rapidly developed, adopted, and maintained if they directly support business revenues. Standards targeting other needs, such as risk analysis and management, tend to be adopted more slowly if reporting requirements introduce ambiguity in interpretation, regulators are not thoughtful in determining which standards are mandatory, and regulators do not speak with one voice in standards advocacy. Regulatory mandates can spur wide use of a data standard.

The legal entity identifier provides a case study in how even an important standard with strong industry support is adopted only slowly when regulatory requirements are uneven or when regulators rely on voluntary implementation.

The LEI is a unique, 20-digit, international code assigned to a legal entity that takes part in financial market transactions. In its current format, a publicly accessible global LEI database provides "business card" information such as legal name, address, country, legal form, and business registry information (see ISO, 2012).

Soon after the 2007-09 crisis, regulators and the financial industry worked to set up a global framework for the LEI. The OFR helped lead this effort. The CFTC, SEC, and regulators in other countries mandated its use in derivatives markets. The SEC has also proposed mandating its use in connection with regulatory reporting by registered investment companies. Recently, the U.S. Treasury adopted a rule requiring use of the LEI in qualified financial contracts record-keeping.

However, use of the LEI in markets where it's not mandated is spotty, despite early industry support and potential cost savings for firms. Few major financial services companies have registered all of their subsidiaries, which contrasts with other industry standards such as the Financial Information eXchange (FIX) or Financial Products Markup Language (FpML). For those standards, large companies worked together to standardize electronic trading and OTC product descriptions. The problem the LEI addresses — the precise identification of counterparties — remains unresolved.

The LEI is required in only a few U.S. market segments, such as derivatives data recordkeeping and reporting. Industry adoption has been largely limited to where regulators require its use (see Figure 69). The OFR backs universal adoption of the LEI in all financial markets and plans to mandate its use in its data collections.

European regulators have more broadly mandated the LEI for financial transactions in markets beyond derivatives. Under new rules known as Markets in Financial Instruments Regulation (MiFIR), trades in equities, bonds, and other instruments will require LEIs for all parties by January 2018 (see King, 2016).

The LEI will be increasingly valuable as use grows. The LEI system will add information about the parent and subsidiaries of each entity, to be phased in beginning in late 2016 (see LEIROC, 2016). This information will help fulfill the promise of the LEI. The system will serve as an additional tool to analyze the complex structures of large financial services companies and their holdings.

Figure 69. U.S. Agencies Requiring or Planning to Require Use of the Legal Entity Identifier

Agency	Rule	Companies affected
Commodity Futures Trading Commission	Swap Data Recordkeeping and Reporting Requirements (Effective December 2012)	Swap counterparties
	Trade Options (Effective March 2014)	Swap dealers that are trade option counterparties
Consumer Financial Protection Bureau	Home Mortgage Disclosure (Regulation C) (Effective January 2018)	Banks and financial entities
Department of the Treasury	Qualified Financial Contracts Recordkeeping Related to Orderly Liquidation Authority (Effective Dec. 30, 2016)	Financial companies defined in the rule as "records entity"
Federal Energy Regulatory Commission	Data Collection for Analytics and Surveillance and Market-Based Rate Purposes (Effective date to be determined)	Market-based rate sellers and entities trading virtual products or holding financial transmission rights in the organized wholesale electric markets
Securities and Exchange Commission	Regulation SBSR – Reporting and Dissemination of Security-Based Swap Information (Effective date to be determined)	Counterparties in security-based swaps reported to a registered swap repository

Note: Under other rules, a variety of agencies request that reporting entities use the legal entity identifier as an identifier if they already have one, or allow optional use of the identifier.

Source: OFR analysis

Better Regulatory Sharing Needed

The ability to share data is constrained by legal concerns, difficulty in finding information on what data exist and who owns them, and the technical infrastructure needed to enable secure sharing.

A lack of timely data sharing limited regulators' ability to understand the risks building up before the financial crisis and to respond to rapidly changing events during the crisis. Data sharing is also essential for system-wide analysis that crosses markets and institutions overseen by different regulators.

The December 2015 removal of the Dodd-Frank Act indemnification requirements from the Commodity Exchange Act and Securities Exchange Act has reduced the number of barriers to regulatory information sharing for certain derivatives data, but others remain. For example, regulators must successfully negotiate data-sharing memoranda of understanding to address confidentiality and the legal, policy, and operational constraints under which each regulator operates.

The value of data sharing was demonstrated when regulators began analyzing an unprecedented surge of volatility in the U.S. Treasury market on Oct. 15, 2014. The analysis required collaboration among five U.S. regulators overseeing different parts of the market. A lack of comprehensive market data and initial challenges in sharing existing data across regulators slowed that analysis.

Regulators took nine months to publish their final report on the event. With better technical infrastructure, appropriate agreements, and established practices for collaboration and data sharing, regulators could have more quickly assessed and addressed any underlying vulnerabilities. As these regulators develop new collections to fill data gaps, they also are developing an information sharing agreement (see Treasury, Board of Governors, FRBNY, SEC, and CFTC, 2015).

The FSOC stresses the importance of sharing data. The 2016 FSOC annual report emphasized basic operational needs that could be addressed by member agencies to ease sharing: "Data sharing improvements may include developing stronger data sharing agreements, collecting common data using standard methodologies, developing and linking together data inventories [metadata catalogs], and promoting standard criteria, protocols, and appropriately strong security controls to streamline secure sharing of datasets." In support of the FSOC, the OFR is facilitating a working group to review data sharing agreements to identify areas that can be standardized.

The OFR also is enhancing its own metadata catalog to add information and make nonconfidential portions viewable by other regulators and the public. A metadata catalog lists information about financial datasets, such as the names and definitions of data elements, who owns a dataset, and where it resides. The OFR plans to link the catalog to other agencies' metadata catalogs. A reliable source of reference information such as linked metadata catalogs will support sharing.

A lack of timely data sharing limited regulators' ability to understand the risks building up before the financial crisis and to respond to rapidly changing events during the crisis.

collect transaction-level data. Others call for specific aggregated data. Regulators do not consistently use data standards or common standards, including for entities, products, or transactions. These factors make compliance more complex for firms and slow the integration of data.

Derivatives

The Group of 20 (G-20) nations said in 2009 that over-the-counter (OTC) derivatives transactions globally should be reported to data repositories (see FSB, 2014). But regulators still cannot get a full picture of the risks. There are no consistent standards for reporting the data. Lack of standards prevents aggregating and analyzing system-wide risk.

The Group of 20 nations said in 2009 that over-the-counter derivatives transactions globally should be reported to data repositories. But regulators still cannot get a full picture of the risks.

Each regulator developed its own disclosure requirements. Some did not explicitly state all trade terms required, which left the interpretation to repositories and market participants. Regulators globally now better understand that they must commit to common data requirements and adopt clear definitions of trade terms. They are now working to set specific requirements for how trade repositories gather, structure, and validate data.

The OFR, CFTC, Federal Reserve, and SEC are part of the international Working Group for Harmonization of Key OTC Derivatives Data Elements. This group's activities are an important component of OTC derivatives markets reform. Work focuses on three efforts: (1) defining and standardizing a unique product identifier, (2) defining and standardizing a unique transaction identifier, and (3) standardizing more than 80 data elements critical for data aggregation and risk analysis, such as settlement methods, valuation dates, and notional amounts (see BIS and IOSCO, 2015a; BIS and IOSCO, 2015b; BIS and IOSCO, 2016b).

Pension Funds

Pension funds are typically long-term investors. They are a major source of stable funding for capital markets. In recent years, low interest rates have put pressure on pension funds to increase their allocations to higher-yielding asset classes, such as alternative assets.

Regulatory data reporting differs between private and public pension funds. Private pension funds are required to file data annually on Form 5500. In July 2016, the agencies that collect the data proposed modifying that form to better capture information on alternative investments, hard-to-value assets, investments through collective investment vehicles, complex derivatives, and securities lending activities. The proposed rule would also require reporting data in a structured format and would improve analysis of investments across funds.

The U.S. Census Bureau surveys public pension funds quarterly and annually. Aggregated data are available through data providers. But public pension funds do not have a standardized reporting framework. Better alignment of reporting would improve visibility into both solvency risks and asset allocation shifts that could affect financial markets.

Mutual Funds

Regulators need visibility into investment activities across entities. Asset management has been replacing banking in some areas of financial intermediation for years.

In an April 2016 public update, the Financial Stability Oversight Council outlined some financial stability concerns that asset management products and activities may introduce. The FSOC's review of liquidity and redemption risks focused on pooled investment vehicles in which investor redemption rights and underlying asset liquidity may not match (see FSOC, 2016b). The FSOC continues to study these risks, as well as risks that could arise from leverage, operational functions, securities lending, and resolvability and transition planning (see FSOC, 2016a; FSOC, 2016b).

Data on asset management activities have improved in recent years. The SEC now requires standardized and structured reporting for money market funds. The Office of the Comptroller of the Currency (OCC) has similar rules for short-term investment funds at banks and thrifts that it regulates.

But structured data are not collected on mutual funds and other investment companies (aside from money market funds) or most bank trust funds. There also are gaps in reporting. Reporting requirements for investment companies were set decades ago and do not include now-common newer products. For instance, they do not include granular data about derivatives trading and securities lending.

Efforts are under way to improve data about parts of the asset management industry. In October 2016, the SEC finalized new disclosures for mutual funds, other funds it oversees, and investment advisers. The final rule will require structured reporting on portfolio holdings and various fund characteristics. The SEC also finalized rules expanding reporting on liquidity management, risk management, and derivatives use. In August 2016, the SEC adopted amendments to Form ADV to collect data from investment advisers on assets in separately managed accounts.

These rules will improve visibility into investment companies and advisers regulated by the SEC. However, the SEC doesn't regulate banks offering collective investment vehicles. The OCC regulates the asset management activities of federally chartered banks. The OCC requires national banks and federal savings associations to submit data monthly to the OCC and fund participants on short-term investment funds. For all collective investment funds, some aggregated, structured data is included in the Call

Report that insured banks must file. State authorities collect little data on funds run by state-chartered banks. Regulators need to continue working with each other and to collaborate with the industry on reporting standards.

Hedge Funds and Private Funds

The SEC's Form PF collects unprecedentedly detailed data from private fund advisers, including hedge funds. Public access to granular Form PF data is limited due to confidentiality concerns.

Hedge funds report detailed information on asset class exposures, portfolio and funding liquidity, counterparty exposures, collateral posted from and to the fund, sources of borrowing, and investor composition. These data begin to address a key data gap for risk analysis.

However, an OFR analysis found the information is still not sufficient to fully assess the economic exposure of funds and the risks they face from some investments. For economic exposures, OFR researchers found that simulated hedge fund portfolios that invested in equities and equity options and which appear identical based on Form PF could carry different levels of market risk. That range was particularly wide for funds that used options, a staple of many hedge funds (see Flood and Monin, 2016). The variation narrowed significantly if funds reported using a risk gauge called Value-at-Risk (VaR) (see **Figure 70**). Form PF gives advisers leeway in the measures they report, and funds are not required to use VaR to measure portfolio risk.

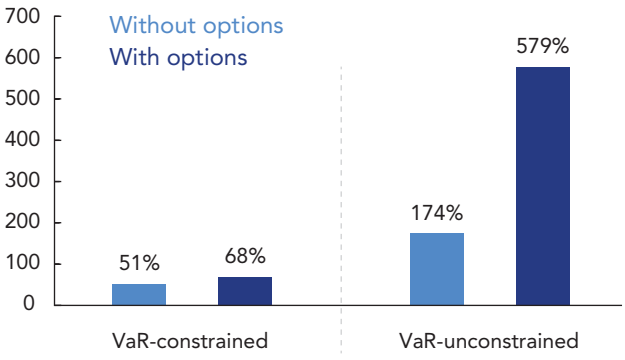
Form PF provides new information about funds' credit exposures to counterparties. But the data are not sufficient to fully assess counterparty exposures. To understand collateral agreements, regulators may need additional data on mark-to-market exposures, including the amount of posted margin and contract terms. The form also asks for detailed data about hedge funds' repo transactions, but not on securities lending.

Some data in Form PF are difficult to compare. For example, portfolio, financing, and investor liquidity are all measured using different bases. This difference makes them difficult to evaluate in combination. In addition, portfolio liquidity and stress testing reporting fields require funds to make assumptions about asset liquidity that may not be consistent.

The FSOC in 2016 created an interagency working group to share and analyze regulatory information on hedge fund activities. The working group will assess the sufficiency and accuracy of Form PF and other existing data for evaluating risks to financial stability.

Figure 70. Differences in Portfolio Risks (percent)

In simulations of fund portfolios with identical Form PF data, market risk varied significantly, especially among funds that used options and were not constrained by Value-at-Risk (VaR)



Note: Figure depicts the average normalized range in risk for simulated equity market-neutral hedge fund portfolios with identical Form PF filings.

Source: Flood and Monin (2016)

The group will also consider how the existing data might be improved (see FSOC, 2016a).

Computing leverage for hedge funds is a long-running challenge. Comparing gross assets to net assets is the standard way to estimate on-balance-sheet financial leverage. But this ratio provides limited insight on the leverage hedge funds can achieve off-balance-sheet, particularly through derivatives. Gross notional exposure (GNE) is often used to measure total leverage. GNE is calculated as the summed absolute values of long and short notional positions, including both securities and derivatives. GNE has the benefit of incorporating both financial and synthetic leverage. However, it has notable shortcomings. First, simply summing long and short positions ignores offsetting positions, which hedge funds often take for hedging purposes. Second, notional values reflect different types of risk for different types of derivatives. Calculating more effective metrics to evaluate synthetic leverage may require identifying other data sources to supplement what is currently available on Form PF.

Mortgages

Regulators now collect origination data and loan performance data about much of the home mortgage market. However, they do not collect data about ownership of a mortgage between origination and final funding. Information on this short phase in the life of a loan is needed for a full picture of risks.

A mortgage loan may change hands several times or be used to raise money for more lending before it arrives at its long-term servicer and investor. Regulators do not collect data to monitor these activities. The Mortgage Call Report, started by state bank regulators in 2012, is the first data collection with high-level information on originators' lines of credit. But the report does not include the credit line terms or haircuts applied to the collateral. These data are needed to assess how credit would contract if the market faltered.

Regulators have data about mortgage originations and about the investors that eventually hold mortgages. Establishing a chain of ownership between those points still requires navigating a patchwork of local records and legally ambiguous central systems such as the Mortgage Electronic Registration Systems. More data about the chain of ownership could shed light on financing vulnerabilities and interconnections among financial institutions.

The data on commercial real estate loans have not improved as much as the data on home loans since the financial crisis. In some ways, commercial loans are more complex than residential mortgages. The mortgages within a single security or on a single balance sheet can vary in size by several orders

of magnitude. Unlike residential mortgages, the risks cannot be captured by a small number of uniform factors.

Loan-level data are available for commercial mortgages that are securitized into mortgage-backed securities with public offerings. Those data are collected and sold by private entities, and regulators may buy the data. Bank regulators also collect loan-level data on many multifamily loans and on loans from banks that take part in Federal Reserve stress testing. Insurers also report loan-level information to their regulator.

But loan-level data are not collected about other commercial mortgages, including whole loans held by real estate investment trusts and smaller banks not subject to stress testing. In recent years, the share of loans subject to loan-level collection has decreased as securitization markets have lost market share and credit risk has shifted to smaller banks.

Data Management Presents Evolving Challenges

Data management practices at individual firms can contribute to risks across the financial system. During the financial crisis, complex financial firms were unable to assess risks due to poor data quality and data management systems (see BIS, 2015). Data management practices may threaten finans cial stability when new interconnections create new and complex tasks of integrating data from many sources. Existing processes may also be overwhelmed by "big data."

Data management practices may threaten financial stability when new interconnections create new and complex tasks of integrating data from many sources. Existing processes may also be overwhelmed by "big data."

Interconnections and Interactions

Data management problems can hinder regulators' efforts to understand interconnections and interactions among companies.

Collecting Data for Living Wills. The Dodd-Frank Act mandates a new framework for planning for unwinding a failing financial institution. The Act requires systemically important banks, insurers, and other designated firms to submit a living will for orderly resolution in the event of failure.

Living wills introduce a novel set of data-related challenges. For example, the law requires systemically important institutions to maintain detailed records of qualified financial contracts (QFCs). QFCs generally include derivatives, repos, and securities lending agreement. Under the Treasury's final rule, firms have to be capable of providing their QFC records within 24 hours of request (see Treasury, 2016).

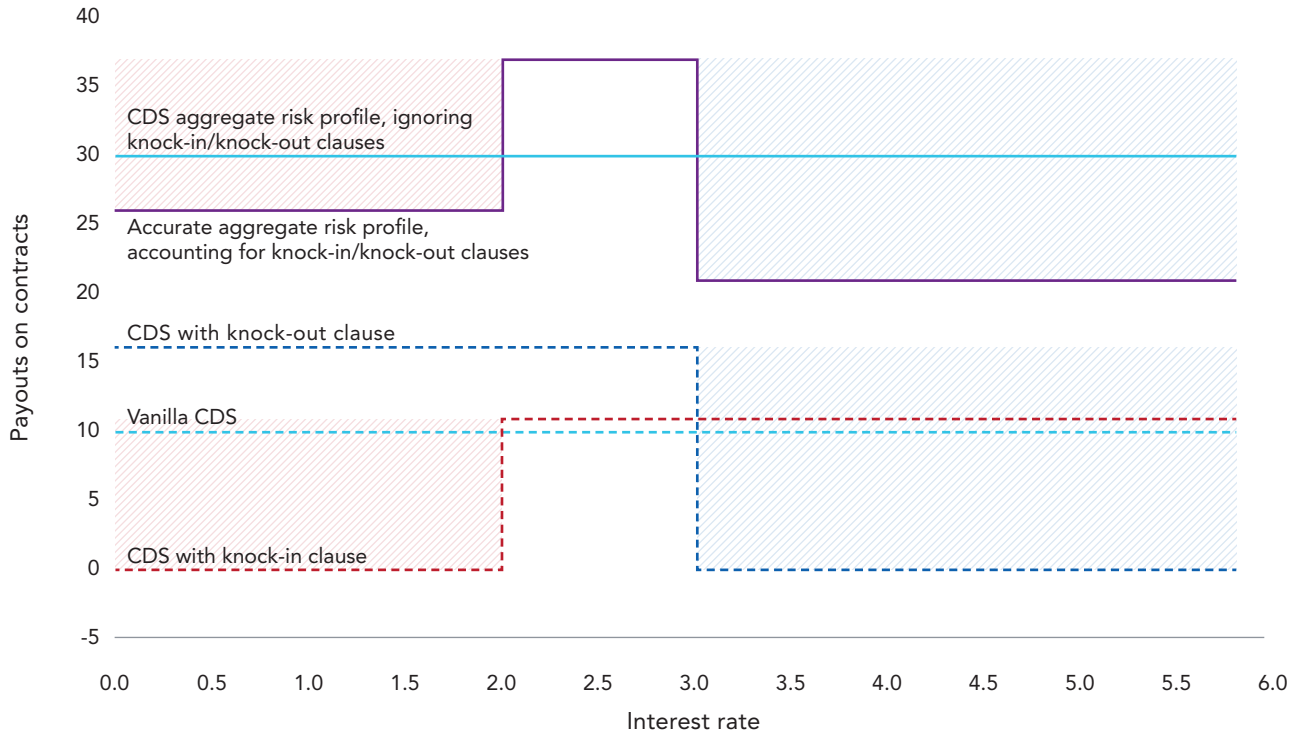
The wind down of a systemically important institution would require regulators to create unprecedented processes to take in and analyze large volumes of diverse data. Failures of large institutions are rare, but extricating a large company from the financial system must happen quickly — within a trading day or over a weekend. Fast, accurate identification of counterparties

and contracts would be crucial. The QFC 24-hour rule could become a natural framework for regulatory fire drills to test data management readiness. Firms subject to the new rules will be required to report their LEIs. Otherwise, given the volume and variety of data, rapid resolution could falter because of untested processes and insufficient data standards. Still, as of mid-2016, the Federal Deposit Insurance Corporation does not require firms to use the LEI.

Measuring Risk Concentrations. Risk concentrations in customized instruments — sometimes called bespoke instruments — can challenge supervisors. To evaluate risk concentrations, supervisors need to know if many firms all hold similar risk exposures at the same time or when a small aggregate exposure masks two extremely large, but offsetting, exposures at one firm. Risk concentrations tend to migrate to nonstandard contracts and novel venues where they are harder to measure.

Using standardized data to evaluate customized instruments is difficult, as shown in **Figure 71**. The horizontal axis shows the value of market interest rates and the vertical axis shows the payout on individual credit default swap (CDS) contracts as a function of those interest rates. The dotted lines show the payouts on three types of CDS contracts. The standardized, vanilla CDS

Figure 71. Customized Derivatives Can Mask Portfolio Risk



Source: OFR analysis

(blue dotted line) has a constant payoff that doesn't change with interest rates. The customized CDS contracts (red and dark blue dotted lines) have "knock-in" and "knock-out" clauses triggered by changes in interest rates. A credit event triggers CDS protection. Like a burglar alarm that goes off only when "armed," a knock-in clause (or knock-out clause) defines a second variable that controls whether the CDS's credit trigger is active (or inactive).

The solid lines show the aggregate payout on a contract that has both knock-in and knock-out clauses. The purple solid line shows the accurate payouts with information about those clauses, and the blue solid line shows what those payouts would look like without that information. Clearly, the existence of knock-in/knock-out contingencies is critical information. Unless regulators have a standardized way to collect contract terms about such clauses, these differences may be ignored. Without information about knock-in or knock-out clauses, regulators might be led to believe that aggregate market exposures to a specific change in interest rates are benign (blue line), when in fact those exposures are highly volatile (red line).

Scalability Challenges

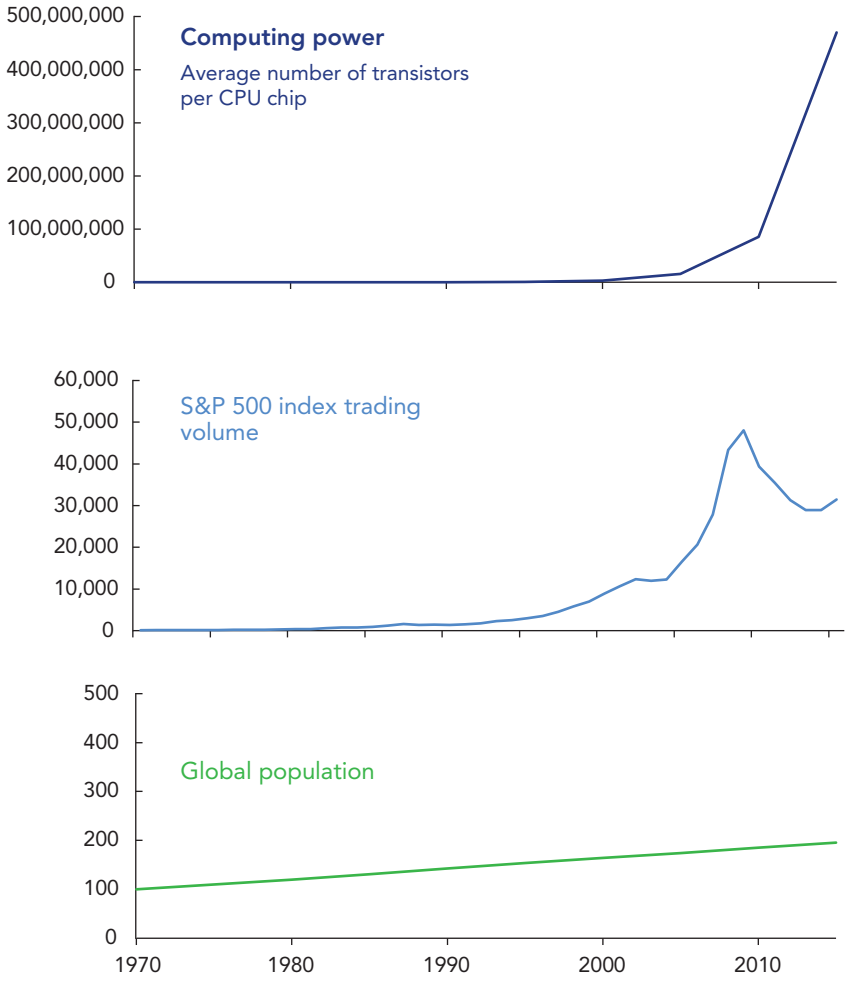
The abundance of data highlights the need for strong data management. Data management systems and practices are increasingly mismatched to the scale of the four Vs of "big data"—volume, velocity, variety, and veracity. Regulators risk being overwhelmed by the increasing volume, arrival rate (velocity), and variety of data. New data collections will introduce new challenges of data quality (veracity) (see Flood, Jagadish, and Raschid, 2016). New approaches to data management are needed to meet these challenges.

Data volumes have grown exponentially in recent decades (see **Figure 72**). Legacy processes cannot simply scale up to collect, clean, integrate, analyze, and share information by using bigger storage and faster processors. Rather, supervisors and firms need new processes to address the challenges of big data and to fully leverage the information big data can provide. Data processes designed for firm-level supervision will face scalability challenges as they are stretched to monitor the system as a whole.

One example is the need to accurately identify entities across different sources and data systems to allow supervisors to assemble a picture of the overall system. However, financial utilities, firms, and regulators use proprietary identification schemes requiring processes to align entity data across these systems. This situation is a big-data problem, because, without a coordination mechanism, the number of alignments to manage grows much faster than the number of identifier sets involved. Rather than continually scaling legacy processes to link different identification schemes, a different approach, such as the LEI, would better address the scalability challenge. The LEI defines each legal entity only once, facilitating data-quality management by eliminating different methods of referring to the same entity.

Figure 72. Scaling of Data Validation Requirements (index 100 = 1970)

Growth of trading volumes and computing power overwhelm traditional human diligence



Note: Data as of Dec. 31, 2015. Computing power is estimated as a linear regression of average number of transistors per central processing unit (CPU) chip (in logarithms) against year of introduction over the 1971-2004 period and extrapolated after that.

Sources: Census Bureau, Standard & Poor's, Intel Corporation, OFR analysis

If the LEI were adopted universally, proprietary identification schemes would become unnecessary, and legacy schemes would have to be mapped only to the LEI rather than to a continuing procession of separate schemes.

The SEC's proposed Consolidated Audit Trail (CAT) will create a central database with an unprecedented amount of information about each quote and order in listed securities (see SEC, 2016). The sheer volume of data, estimated at tens of billions of records daily, will challenge data management operations. Also, transactions recorded on the CAT will include high-frequency trading (HFT) in equities markets. However, the CAT may not include an LEI requirement.

The speed of trading is a data management challenge, one that also holds implications for financial stability and systemic monitoring. For example, the discussion in the Financial Industry Regulatory Authority's proposed rule 14-47 on clock synchronization highlights the challenges that time-stamp uncertainty creates for market surveillance. That includes the ability to evaluate whether customers are receiving best execution for their orders (see FINRA, 2014). Moreover, large order imbalances can cluster in time, with the potential to contribute to "flash-crash" price spikes and automated trading halts.

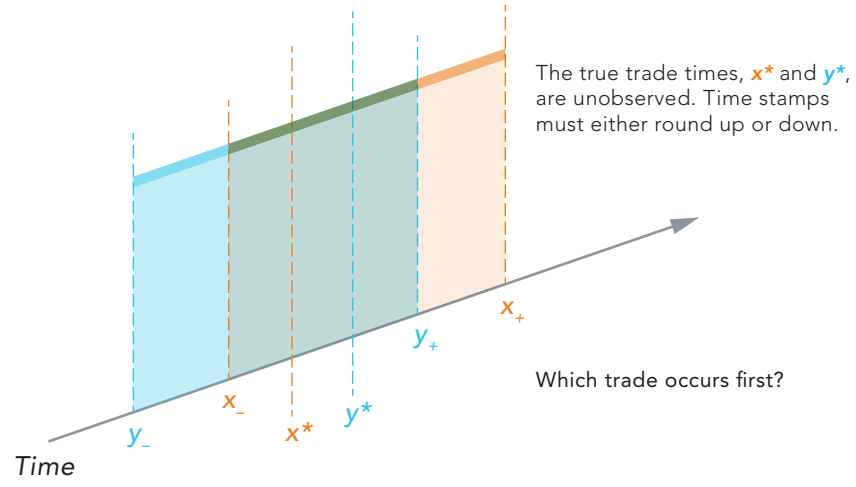
Increases in data velocity can also increase the difficulties of regulators monitoring the system. HFT operates in millisecond resolutions — one-thousandth of a second — and transactions within a single trading venue are often time stamped at this resolution. But comparison across venues is more difficult. The Financial Industry Regulatory Authority requires exchange clocks to be synchronized with precision only to the

nearest second. The CFTC similarly requires one-second resolution for its real-time reporting. The SEC recently narrowed the measurement window to 50 milliseconds for OTC equities and securities in the National Market System (NMS) (see CFTC, 2016a; FINRA, 2016a).

Securities markets typically give price-and-time priority to incoming transaction orders. Under the SEC's Regulation NMS, for example, transactions data must be shared with the securities information processors who supply the National Best Bid or Offer to market data vendors at least as timely as with HFT machines receiving a direct feed (see SEC, 2005). Yet under current rules, time stamps on two trades that come in milliseconds apart could be mismeasured in ways that mask which one should have priority (see **Figure 73**).

Technological limitations make it impossible to recover a true event time. For example, clock drift is the tendency of local clocks to run too slow or fast. Signal jitter is the unpredictable delay in a signal moving over long distances. Random disturbances like drift and jitter add unpredictable noise to the measured time stamp. In **Figure 73**, the true event time, x^*, precedes the true event time, y^*, but the recorded times (measured with error) might be as large as x_+ or as small as y_-, respectively. This combination of timestamps (x_+ and y_-) would create the misperception that y preceded x.

Figure 73. Measurement Uncertainty Confounds Time-Stamping of High-Frequency Trades



Source: OFR analysis

Conclusion: Data Require Continuing Attention

Risk management and financial stability assessment require data of sufficient scope, high quality, and proper accessibility. Much progress has been made to improve data since the crisis. But further improvement requires attention to the deficiencies that persist. The OFR has also seen that even though industry participants praise standards, they may not adopt them without mandates from regulators. The recent progress of the LEI provides an example (see Crowley, 2016).

Data management is often viewed as a firm-specific risk. However, it also presents possible systemic risks. Increasing complexity and interconnections present ever-evolving challenges.

Glossary

10-Year, 10-Year Forward Rate	The interest rate investors expect to receive on 10-year Treasury securities in 10 years.
Accommodation	Expansionary monetary policy in which a central bank seeks to lower borrowing costs for businesses and households to make credit more easily available.
Bail-in	The rescue of a failed or near-failed entity in which its creditors write down their claims to make the entity solvent, as opposed to the provision of government support.
Bank for International Settlements (BIS)	An international financial organization that serves central banks in their pursuit of monetary and financial stability, helps to foster international cooperation, and acts 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 under 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 forum for bank supervisors that aims to improve banking supervision worldwide. The BCBS develops guidelines and supervisory standards such as standards on capital adequacy, the core principles for effective banking supervision, and recommendations for cross-border banking supervision.
Basel III	A comprehensive set of global regulatory standards to strengthen the regulation, supervision and risk management of the banking sector. The reform measures include bank-level regulation and system-wide regulation to strengthen firms' capital, liquidity, risk management and public disclosures to reduce the banking system's vulnerability to shocks.
Brexit	An abbreviation for "British exit," which refers to the June 23, 2016, vote in the United Kingdom to exit the European Union.
Call Report	A quarterly report of a bank's financial condition and income that all federally insured U.S. depository institutions must file.
Capital Conservation Buffer	Additional capital banks are required to hold outside periods of financial stress, meant to be drawn down during times of stress. This buffer is meant to prevent breaches of minimum required capital ratios.

Capital Requirement	The amount of capital a bank must hold to act as a cushion to absorb unanticipated losses and declines in asset values that could otherwise cause a bank to fail. U.S. banking regulators require banks to hold more high-quality, or Tier 1, capital against total risk-weighted assets under the Basel III international accord. Banks are classified as well capitalized, adequately capitalized, undercapitalized, significantly undercapitalized, or critically undercapitalized based on regulators' capital and leverage calculations.
Central Clearing	A settlement system in which securities or derivatives of a specific type are cleared by one entity that guarantees the trades, such as a clearinghouse or central counterparty. Central clearing is an alternative to bilateral or over-the-counter trading (see Over-the-Counter Derivatives).
Central Counterparty (CCP)	An entity that interposes itself between counterparties to contracts traded in one or more financial markets. A CCP becomes the buyer to every seller and the seller to every buyer to help ensure the performance of open contracts.
Clearing Bank	A commercial bank that facilitates payment and settlement of financial transactions, such as check clearing or matching trades between the sellers and buyers of securities and other financial instruments or contracts.
Clearing Member	A member of, or a direct participant in, a central counterparty that is entitled to enter into a transaction with the CCP (see **Central Counterparty**).
Clearing	A system that facilitates the transfer of ownership of securities after they are traded.
Collateral	Any asset pledged by a borrower to guarantee payment of a debt.
Commercial Mortgage-Backed Securities	Securities collateralized by commercial mortgages.
Commercial Paper	Short-term (maturity of up to 270 days), unsecured corporate debt.
Committee on Payments and Market Infrastructures (CPMI)	A standing committee of the BIS. Representatives are senior officials of member central banks. The CPMI promotes safety and efficiency of payment, clearing, settlement, and related activities, and it serves as a global standard setting body in this area.
Comprehensive Capital Analysis and Review (CCAR)	The Federal Reserve's annual exercise to ensure that the largest U.S. bank holding companies have robust, forward-looking capital planning processes that account for their unique risks and sufficient capital for times of financial and economic stress. The CCAR exercise also evaluates the banks' individual plans to make capital distributions such as dividend payments or stock repurchases.
Concentration Risk	Any single exposure or group of exposures with the potential to produce losses large enough to threaten a financial institution's ability to maintain its core operations.

Conditional Value-at-Risk (CoVaR)	CoVaR indicates an institution's contribution to systemic risk, calculated as the difference between Value-at-Risk (VaR) of the financial system when the firm is under distress and the VaR of the system when the firm is in its regular, median state.
Contingent Convertible (CoCo) Bonds	Hybrid capital securities that absorb losses in accordance with their contractual terms when the capital of the issuing bank falls below a certain level. Due to their loss-absorbing capacity, CoCos can be used to satisfy regulatory capital requirements.
Countercyclical Capital Buffer	A component of Basel III requiring banks to build capital buffers during favorable economic periods. The buffers can be used to absorb losses in unfavorable periods.
Counterparty Risk	The risk that the party on the other side of a contract, trade, or investment will default.
Covenant-Lite Loans	Loans that do not include typical covenants to protect lenders, such as requiring the borrower to deliver annual reports or restricting loan-to-value ratios.
Credit Default Swap (CDS)	A bilateral contract protecting against the risk of default by a borrower. The buyer of CDS protection makes periodic payments to the seller and in return receives a payoff if the borrower defaults, similar to an insurance contract. The protection buyer does not need to own the loan covered by the swap.
Credit Default Swap Spreads	The premium paid by the buyer of CDS protection to the seller.
Credit Gap	A metric in which the ratio of debt-to-GDP is measured against its statistically estimated long-run trend.
Credit Risk	The risk that a borrower may default on its obligations.
Cybersecurity Assessment Tool	A tool designed to complement the National Institute of Standards and Technology Cybersecurity Framework. The Federal Financial Institutions Examination Council (FFIEC) developed the tool to help financial institutions identify and address cybersecurity risks and determine their level of cybersecurity maturity in addressing those risks.
Default Waterfall	The financial safeguards available to a CCP to cover losses arising from the default of one or more clearing members.
Defined-Benefit Pension Plan	A plan where members' pension benefits are determined by formula, usually tied to years of service and earnings during service; contrasts with a defined-contribution plan such as a 401-K, where benefits are determined by returns on a portfolio of investments.
Derivative	A financial contract whose value is derived from the performance of underlying assets or market factors such as interest rates, currency exchange rates, and commodity, credit, and equity prices. Derivative transactions include structured debt obligations, swaps, futures, options, caps, floors, collars, and forwards.

Distress Insurance Premium	A systemic risk indicator that measures the hypothetical contribution a financial institution would make to an insurance premium that would protect the whole financial system from distress.
Dodd-Frank Act	Short name for the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010, the most comprehensive financial reform legislation in the United States since the Great Depression. The Dodd-Frank Act seeks to promote financial stability by improving accountability in the financial system, adding transparency about over-the-counter (OTC) derivatives markets, and protecting consumers from abusive financial services practices.
Duration Risk	The risk associated with the sensitivity of the prices of bonds and other fixed-income securities to changes in the level of interest rates.
Emerging Markets	Developing countries where investments are often associated with both higher returns and higher risk. Emerging market countries fall between developed markets such as the United States and more speculative frontier markets.
Eurozone	A group of 19 European Union countries that have adopted the euro as their currency.
Exchange-Traded Fund (ETF)	An investment fund whose shares are traded on an exchange. Because ETFs are exchange-traded products, their shares are continuously priced, 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 banking supervision. Members include the Federal Reserve, Federal Deposit Insurance Corporation, National Credit Union Administration, Office of the Comptroller of the Currency, Consumer Financial Protection Bureau, and a representative of state financial supervisors.
Financial Contagion	A scenario in which financial or economic shocks initially affect only a few financial market participants and then spread to other parts of the financial system and countries in a manner similar to the transmission of an epidemic. Financial contagion can happen at both the international level and the domestic level.
Financial Stability Oversight Council (FSOC)	Created by the Dodd-Frank Act, a collaborative U.S. governmental body with a statutory mandate that creates collective accountability for identifying risks and responding to emerging threats to financial stability. Chaired by the Secretary of the U.S. Treasury, the Council consists of 10 voting members and 5 nonvoting members, including the OFR Director.
Financial Stability Board (FSB)	An international coordinating body that monitors financial system developments on behalf of the G-20 nations. The FSB was established in 2009 and is the successor to the Financial Stability Forum.

Fire Sale	The disorderly liquidation of assets to meet margin requirements or other urgent cash needs. Such a sudden sell-off can drive prices below their fair value. The quantities sold are large relative to the typical volume of transactions.
Form N-MFP	A monthly disclosure of portfolio holdings submitted by money market funds to the SEC, which makes the information publicly available. SEC Rule 30b1-7 established the technical and legal details of N-MFP filings.
Form PF	A periodic report of portfolio holdings, leverage, and risk management submitted by hedge funds, private equity funds, and related entities. The report is filed with the SEC and CFTC, which keep the information confidential. The Dodd-Frank Act mandated the reporting to help the FSOC monitor financial stability risks.
Funding Liquidity	The availability of credit to finance the purchase of financial assets.
Generally Accepted Accounting Principles (GAAP)	Accounting rules published in the United States by the Financial Accounting Standards Board.
Global Systemically Important Banks (G-SIBs)	Banks annually designated by the Basel Committee on Banking Supervision for having the potential to disrupt international financial markets. The designations are based on banks' size, interconnectedness, complexity, dominance in certain businesses, and global scope.
Global Systemically Important Insurers (G-SIIs)	Insurance companies annually designated by the FSB for having the potential to disrupt international financial markets because of their size, market position, and global interconnectedness.
Gross Notional Exposure (GNE)	A measure of total portfolio leverage, for example in a hedge fund. GNE is calculated as the summed absolute values of long and short notional positions, including both securities and derivatives.
Haircut	The discount at which an asset is pledged as collateral. For example, a $1 million bond with a 5 percent haircut would collateralize a $950,000 loan.
Hedge Fund	A pooled investment vehicle available to accredited investors such as wealthy individuals, banks, insurance companies, and trusts. Hedge funds can charge a performance fee on unrealized gains, borrow more than one half of their net asset value, short sell assets they expect to fall in value, and trade complex derivative instruments that cannot be traded by mutual funds.
Hedging	An investment strategy to offset the risk of a potential change in the value of assets, liabilities, or services. An example of hedging is buying an offsetting futures position in a stock, interest rate, or foreign currency.
High-Frequency Trading	The use of computerized securities trading platforms to make large numbers of transactions at high speeds.

High-Quality Liquid Assets (HQLA)	Assets such as central bank reserves, government bonds, and corporate debt that can be quickly and easily converted to cash during a stress period. U.S. banking regulators require large banks to hold HQLA to comply with the Liquidity Coverage Ratio.
High-Yield Bonds	Instruments rated below investment grade that pay a higher interest rate than investment-grade securities because of the perceived credit risk.
Initial Margin	A percentage of the total market value of securities an investor must pay to purchase securities with borrowed funds.
Interest Rate Swap	A swap in which two parties swap interest rate cash flows, typically between a fixed rate and a floating rate (see **Swap**).
Intermediation	Any financial service in which a third party or 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.
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 of Securities Commissions (IOSCO)	IOSCO is the international body for securities regulators, and is the recognized standard setting organization for the securities industry. IOSCO works closely with the G-20 forum of nations and the Financial Stability Board on global financial regulatory reforms.
Investment-Grade Debt	Securities that credit rating agencies determine carry less credit risk. Noninvestment-grade securities, also called speculative-grade debt, have lower ratings and a greater risk of default.
Legal Entity Identifier	A unique 20-digit alphanumeric code to identify each legal entity within a company that participates in global financial markets.
Leverage	Leverage is created when an entity enters into borrowings, derivatives, or other transactions resulting in investment exposures that exceed equity capital.
Leverage Ratio	The Tier 1 (highest quality) capital of a bank divided by its total exposure to derivatives, securities financing transactions, and on- and off-balance-sheet exposures.
Liquidity Coverage Ratio	A Basel III standard to ensure that a bank maintains enough high-quality liquid assets to meet its anticipated liquidity needs for a 30-day stress period. The ratio applies to banks with $250 billion or more in total consolidated assets or $10 billion or more in on-balance-sheet foreign exposure. A less-strict ratio is required of banks with $50 billion or more in total assets (see **High-Quality Liquid Assets**).

Liquidity Risk	The risk that a firm will not be able to meet its current and future cash flow and collateral needs, expected and unexpected, without materially affecting its daily operations or overall financial condition.
Liquidity Transformation	Funding illiquid assets with liquid and demandable liabilities.
Living Wills	Annual resolution plans required of U.S. banks with $50 billion or more in total consolidated assets and nonbank financial companies designated by the Financial Stability Oversight Council for supervision by the Federal Reserve. Each living will must describe how the company could be dismantled in a rapid, orderly way in the event of failure.
Macroeconomic Risk	Risk from changes in the economy or macroeconomic policy.
Macroprudential Supervision	Supervision to promote the stability of the financial system as a whole (see **Microprudential Supervision**).
Margin Call	A requirement by a broker that a borrower increase the collateral pledged against a loan in response to changes in the collateral's value.
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 Liquidity	The ability of market participants to sell large positions with limited price impact and low transaction costs.
Market Risk	The risk that an asset's value will change due to unanticipated movements in market prices.
Market-Making	The process in which an individual or firm stands ready to buy and sell a particular stock, security, or other asset on a regular and continuous basis at a publicly quoted price. Market-makers usually hold inventories of the securities in which they make markets. Market-making helps to keep financial markets efficient.
Maturity Transformation	Funding long-term assets with short-term liabilities; this practice creates a maturity mismatch that can pose risks when short-term funding markets are constrained.
Metadata	Data about data; metadata include information about the structure, format, or organization of other data.
Metadata Catalog	An organized way to present metadata for discovery, exploration, and use of the related data.
Microprudential Supervision	Supervision of the activities of a bank, financial firm, or other components of a financial system (see **Macroprudential Supervision**).
Money Market Fund	A fund that typically invests in government securities, certificates of deposit, commercial paper, or other highly liquid and low-risk securities.

Mortgage Call Report	A quarterly report of mortgage activity and company information created by state regulators and administered electronically through the Nationwide Mortgage Licensing System & Registry (NMLS).
Mutual Fund	A pooled investment vehicle that can invest in stocks, bonds, money market instruments, other securities, or cash; regulated by the SEC.
National Association of Insurance Commissioners (NAIC)	An organization that represents U.S. state insurance regulators. Through the NAIC, regulators establish accreditation standards and practices, conduct peer review, and coordinate their regulatory oversights of insurance companies.
National Institute of Standards and Technology Cybersecurity Framework	Voluntary guidance, based on existing standards, guidelines, and practices, for critical infrastructure organizations to better manage and reduce cybersecurity risk. The framework focuses on using business drivers to guide cybersecurity activities and considering cybersecurity risks as part of an organization's risk management process.
Net Asset Value (NAV)	The value of an entity's assets minus its liabilities. For example, a mutual fund calculates its NAV daily by dividing the fund's net value by the number of outstanding shares.
Network	A model consisting of a set of nodes, or financial institutions, and a set of payment obligations linking them, to show how financial interconnections can amplify market movements.
Notional Derivatives Exposure	The reference amount from which contractual payments will be derived on a derivatives contract; generally not an amount at risk.
Operational Risk	Risks occurring during the normal operation of a business, including, for example, failed internal processes, legal risk, and environmental risk.
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. For example, an equity call option provides the right, but not the obligation, for a fixed period to buy a block of shares at a fixed price.
Originate	To extend credit after processing a loan application. Banks, for example, originate mortgage loans and either hold them until maturity or distribute them to other financial market participants. The distribution can include a direct sale or a securitization of a portion of the credit at the time of origination or later.
Over-the-Counter (OTC) Derivatives	Deals negotiated privately between two parties rather than traded on a formal securities exchange. Unlike standard exchange-traded products, OTC derivatives can be tailored to fit specific needs, such as the effect of a foreign exchange rate or commodity price over a given period.
Own Risk and Solvency Assessment (ORSA)	An internal process undertaken by an insurer or insurance group to assess the adequacy of its risk management and current and prospective solvency positions under normal and severe stress scenarios.

Pension Funded Ratio	The ratio of a pension plan's assets to the present value of its obligations.
Pension Risk Transfer	The transfer of pension risk from a pension plan to another party, usually through insurance or annuity contracts, longevity swaps, or other contractual arrangements.
Price Discovery	The process of determining the prices of assets in the market place through the interactions of buyers and sellers.
Primary Dealer	Banks and securities broker-dealers designated by the Federal Reserve Bank of New York to serve as trading counterparties when it carries out U.S. monetary policy. Among other things, primary dealers are required to participate in all auctions of U.S. government debt and to make markets for the FRBNY when it transacts on behalf of its foreign official accountholders. A primary dealer buys government securities directly and can sell them to other market participants.
Regulation SCI	An SEC regulation regarding technology infrastructure; it applies to entities that directly support six key securities market functions: (1) trading, (2) clearance and settlement, (3) order routing, (4) market data, (5) market regulation, and (6) market surveillance. The rules in Regulation SCI are designed to reduce the occurrence of systems issues, improve resiliency when systems problems occur, and enhance SEC oversight and enforcement of securities market technology infrastructure.
Reinsurance	The risk management practice of insurers to transfer some of their policy risk to other insurers. A second insurer, for example, could assume the portion of liability in return for a proportional amount of the premium income.
Repurchase Agreement (Repo)	A transaction in which one party sells a security to another party and agrees to repurchase it at a certain date in the future at an agreed price. Banks often do this on an overnight basis as a form of liquidity that is similar to a collateralized loan.
Resolution Plans	See **Living Wills**.
Risk Assets	Assets that carry risk, usually risk of price changes. Such assets include equities, bonds, commodities, and most other investment vehicles, in contrast with U.S. Treasury securities, which are generally considered safe.
Risk-Based Capital	Amount of capital a financial institution holds to protect against losses; based on the risk weighting of different asset categories.
Risk Management	The business and regulatory practice of identifying and measuring risks and developing strategies and procedures to limit them. Categories of risk include credit, market, liquidity, operations, model, and regulatory.
Risk Retention	Under the Dodd-Frank Act, a requirement that issuers of asset-backed securities must retain at least 5 percent of the credit risk of the assets collateralizing the securities. The regulation also prohibits a securitizer from directly or indirectly hedging the credit risk.

Risk-Weighted Assets	Bank assets or off-balance-sheet exposures weighted according to risk. This asset measure is used to determine a bank's regulatory capital requirements.
Run Risk	The risk that investors lose confidence in a market participant because of concerns about counterparties, collateral, solvency, or related issues and respond by pulling back their funding or demanding more margin or collateral.
Search for Yield (Reach for Yield)	The practice of accepting greater risks in hopes of earning higher than average returns.
Securities Financing	The transfer or lending of securities from one party to another. A borrower of securities puts up collateral in the form of shares, bonds, or cash, and is obliged to return the securities on demand. These transactions provide liquidity in the market.
Securities Lending/ Borrowing	The temporary transfer of securities from one party to another for a specified fee and time period in exchange for collateral in the form of cash or securities.
Settlement	The process of transferring securities and settling by book entry according to a set of exchange rules. Some settlement systems can include institutional arrangements for confirmation, clearance, and settlement of securities trades and safekeeping of securities.
Shadow Banking	The extension of credit by nonbank companies, or credit funded by liabilities that are susceptible to runs because they are payable on demand and lack any government backstop.
Skin in the Game	Term coined to indicate incurring monetary risk using an individual's or organization's own money. For example, a CCP has skin in the game because it contributes to its default waterfall.
Speculative-Grade Debt	Loans and debt securities for businesses that debt rating firms consider riskier than those businesses whose debt is rated investment grade. Speculative-grade debt is generally defined as a debt rating of BB+ or below.
Spread	The difference in yields between private debt instruments and government securities of comparable maturity. The spread can be used as one of many indicators of financial stability.
SRISK	A systemic risk indicator based on the capital that a firm is expected to need if there is another financial crisis; short for "systemic risk."
Stable Net Asset Value	A characteristic of some money market funds in which the value of a single share remains the same, usually $1, even when the value of the underlying assets shifts.

Stress Test	An exercise that shocks asset prices by a prespecified amount, sometimes along with other financial and economic variables, to observe the effect on financial institutions or markets. Under the Dodd-Frank Act, banking regulators run annual stress tests of the biggest U.S. bank holding companies.
Supplemental Leverage Ratio	Under Basel III, the ratio of a bank's Tier 1 (high quality) capital to its total leverage exposure, which includes all on-balance-sheet assets and many off-balance-sheet exposures. U.S. regulators require a 3 percent ratio for most banks with $250 billion or more in consolidated assets or $10 billion or more in foreign exposures. The eight large U.S. banks designated as global systemically important banks by the Financial Stability Board must maintain a ratio of 5 percent
Swap	An exchange of cash flows agreed by two parties with defined terms over a fixed period.
Swap Data Repository (SDR)	A central recordkeeping facility that collects and maintains a database of swap transaction terms, conditions, and other information. In some countries, SDRs are referred to as trade repositories
Swap Execution Facility	Under the Dodd-Frank Act, a trading platform market participants use to execute and trade swaps by accepting bids and offers made by other participants.
SWIFT	The Society for Worldwide Interbank Financial Telecommunications (SWIFT) provides messaging services and interface software between wholesale financial institutions. SWIFT is organized as a cooperative owned by its members.
Systemic Risk Indicators	Cross-sectional measures of the risks financial firms may pose to the financial system.
Tail Risk	The low-probability risk of an extreme event moving an asset price.
Tier 1 Capital Ratio and Tier 1 Common Capital Ratio	Two measurements comparing a bank's capital to its risk-weighted assets to show its ability to absorb unexpected losses. Tier 1 capital includes common stock, preferred stock, and retained earnings. Tier 1 common capital excludes preferred stock.
Total Loss Absorbing Capacity (TLAC)	A mix of long-term debt and equity that global systemically important bank holding companies would be required under recent proposals to hold sufficient to absorb losses and implement an orderly resolution without resorting to taxpayer-funded bailouts or extraordinary government measures.
Triparty Repo	A repurchase agreement in which a third party, such as a clearing bank, acts as an intermediary for the exchange of cash and collateral between two counterparties. In addition to providing operational services to participants, agents in the U.S. triparty repo market extend intraday credit to facilitate settlement of triparty repos.

Value-at-Risk (VaR)	A 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 Annuity	A tax-deferred insurance company contract where the owner can choose investment options whose values fluctuate with the underlying securities, much like mutual funds. Variable annuities may also include minimum guarantees, which may exceed the value of the investment accounts.
Variation Margin	Payment made by clearing members to the clearinghouse based on price movements of the contracts these members hold.

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