



Annual Report to Congress

2018

FROM THE ACTING DIRECTOR



I am honored to submit this *2018 Annual Report to Congress*.

Fiscal 2018 has been a year of substantial change for the Office of Financial Research (OFR) and its workforce.

Like previous OFR annual reports, this report assesses the state of the U. S. financial system as required by the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010, including an analysis of threats to the financial stability of the United States, key findings from the OFR's research and analysis, and the status of the efforts of the OFR in meeting its mission.

But unlike previous reports, this seventh OFR annual report covers a year when the Office carried out a fundamental reexamination of its mission, culture, and structure — and sharpened its focus on primarily supporting the Financial Stability Oversight Council and its member organizations.

During the fiscal year, we tightened our bond with the Council, collaborating closely to tailor our data and research agendas to best support its work and analyze topics of concern to promote the stability of the financial system.

The OFR's first Director, Richard Berner, left at the end of 2017 and I became Acting Director on Jan. 1, 2018, in addition to my role as the Chief Risk Officer at the Department of the Treasury.

As part of our reexamination, we determined that we should undergo a "reshaping" project, retaining mission-critical functions, while paring support functions and the management structure. These efforts position the OFR as a data-driven organization with analytical capabilities serving the needs of its stakeholders.

While the reshaping project was underway, we continued our essential work to assess and support financial stability.

This report comes at a time when the economy is strong, unemployment is exceptionally low, growth remains healthy, and inflation is close to the Federal Reserve's target. We do, however, see risks in the outlook this year.

This report states that risks to financial stability remain in the medium range, reflecting a mix of high, moderate, and low risks in the financial system. Market risk is highest, reflected in historically high stock prices and the sensitivity of bond prices to changes in interest rates. Credit risk is moderate, with risk rising from leveraged lending, tempered somewhat by risks from consumer credit.

In contrast, risks remain mostly low from solvency and leverage (when a firm's resources are low related to its investment exposures), although some large banks, insurers, and hedge funds could be vulnerable to impacts of severe stress. Risks from funding and liquidity are also low overall.

In the coming year, we will continue to monitor and research these risks and other vulnerabilities; share what we learn; and strive to improve the scope, quality, and accessibility of financial data.

Fiscal 2018 has been a challenging year for OFR employees. They deserve tremendous credit — and my sincere thanks — for their diligence and commitment despite the change all around them.

As we embark on the course of a refocused OFR, I continue to value the great talent and dedication of every member of the OFR workforce, and look forward to their achievements in advancing the vital mission of the OFR.

A handwritten signature in black ink, appearing to read "Ken Phelan". The signature is fluid and cursive, with a large initial "K" and "P".

Ken Phelan
Acting Director, Office of Financial Research

FROM THE ACTING DIRECTOR

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OFR 2018 Annual Report to Congress

With this report, the Office of Financial Research (OFR) presents its assessment of the state of the U.S. financial system, as required by the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010. Our *2018 Annual Report to Congress* meets the requirement that the OFR submit a report to Congress within 120 days after the end of the fiscal year.

This report also reflects our duty to inform policymakers, regulators, market participants, and the American public about our work to monitor, investigate, and report on changes in systemwide risk levels and patterns. Our efforts support sound risk management for the entire financial system.

For fiscal year (FY) 2018, we have organized the report in two main parts:



1 Financial Stability Assessment and Key Findings



2 Status of the Efforts of the OFR in Meeting Its Mission



Financial Stability Assessment and Key Findings

This first part of the report combines our financial stability assessment with key findings from our research and analysis.

Risk Assessment

In this section, we find that risks to U.S. financial stability are still in a medium range overall. To reach this conclusion we look at the OFR's Financial System Vulnerabilities Monitor — a heat map of vulnerability indicators — to see what is changing. We also go beyond the heat map, an interactive tool on our website, to draw on our broader financial system surveillance, data analysis, and research to pinpoint the source of these changes and their implications for financial stability. In some cases, risks are higher or lower than the heat map indicates. Also, risks evolve with changes and innovations within the financial system.

We assess risks in several categories. Macroeconomic, market, and credit risks arise from the interplay between the financial sector and the rest of the economy. Solvency and leverage, funding and liquidity, and contagion risks are associated with the connections among the firms within the financial sector. Vulnerabilities in any of these areas can originate, amplify, or transmit shocks and stress.

Risk in several categories is moderate, including macroeconomic risk, credit risk, and contagion risk.

We continue to see relatively high market risk and cybersecurity risk. Market risk has been high the last few years and remains so. Stock market valuations, the U.S. Treasury term premium (a measure of compensation to long-term investors for taking the risk of rising interest rates), and bond duration (price sensitivity to interest rate changes) are signaling the most risk. Cybersecurity risks also persist. We first discussed the risks to financial stability from cybersecurity incidents in our inaugural *2012 Annual Report*. We have identified them every year since.

In contrast, risks from solvency and leverage remain low, for the most part, even though some large banks, insurers, and hedge funds could

be vulnerable to severe stress. Similarly, funding and liquidity risks are low overall, thanks to favorable borrowing conditions and high liquidity buffers for most banks.

Spotlight on Financial Markets

In this section, we look closely at volatility in the stock market and liquidity in the corporate bond market. Our research sheds light on how these two key aspects of markets affect the stability of the financial system.

For our discussion of volatility, we look at the pattern of U.S. stock market volatility going back nine decades, to before the Great Depression. We find that stock market volatility tends to be low most of the time and for very long periods. Very high spikes in volatility grab attention, but they are rare and brief. Those very high spikes are not always linked to obvious economic and financial conditions, making them hard to predict.

Based on our research, we conclude that if the economy remains healthy, market volatility will probably stay low. However, because some financial-market indicators are high from a historical standpoint, we cannot rule out a shift to very high volatility.

For our discussion of liquidity, we analyze confidential regulatory data on U.S. corporate bond trading. Liquid markets support trades being executed in a reasonable amount of time and at fair prices. This TRACE data — the Trade Reporting and Compliance Engine, from the Financial Industry Regulatory Authority — gives us a clearer view of liquidity in an often-opaque financial market. We examine trading patterns since before the financial crisis. We look at trade size, trade frequency, interdealer trading, and price implications.

We conclude that liquidity in corporate bond trading generally remains robust, with some exceptions.



Status of the Efforts of the OFR in Meeting Its Mission

Organization

In FY 2018, the OFR embarked on a process to reexamine its mission, culture, and structure.

This review — whose purpose was to ensure that the OFR can efficiently and effectively achieve its mission — began nearly seven years after the OFR was created.

We also hired Charles River Associates in 2017 to conduct an assessment of the OFR culture and treatment of employees. We released this report to the staff and the public in late 2017.

Through our self-assessment, consideration of the Charles River report, and discussions with Treasury Department officials, the OFR refocused its mission to primarily support the Financial Stability Oversight Council (FSOC) and its member agencies. This refocus resulted in an initiative to reshape the OFR workforce.

After the first OFR Director, Richard Berner, left the Office in December 2017, Treasury Chief Risk Officer Ken Phelan was appointed OFR Acting Director.

The OFR's current organizational structure retains its three centers to achieve the goals set by the Dodd-Frank Act:

1. Data Center,
2. Research and Analysis Center, and
3. Technology Center.

The OFR reshaping initiative streamlined the organization by scaling down its management structure and consolidating its support structure.

The OFR reduced its workforce during the fiscal year from 210 employee positions to 152. About 40 additional positions were eliminated by the end of the following month. The reduction took place through employee attrition, incentives for voluntary separation and

early retirement, and a reduction in force implemented during the fourth quarter of FY 2018.

The OFR obligated \$75.9 million in FY 2018 — 56 percent for labor and 44 percent for other expenses. A large portion of the nonlabor figure is due to significant OFR expenses for data acquisitions (\$6 million) and technology software and hardware (\$11 million) to support the OFR's unique mandates.

Data Initiatives

The OFR worked to fulfill its data-related mandates in FY 2018 through an array of data initiatives, including by issuing a proposed rule to collect data regarding transactions in the market for repurchase agreements, or repos, which provides more than \$3 trillion in funding every day to securities dealers and others.

The vulnerability of repos to runs and fire sales poses potential threats to financial stability. Data gaps persist regarding securities financing transactions, including repos and securities lending.

The repo collection will also help to meet the need for a viable alternative to the London Interbank Offered Rate, or LIBOR. LIBOR has been a widely used interest rate benchmark in global financial markets and the economy, but attempted manipulation of LIBOR during the financial crisis and ongoing doubts about LIBOR's reliability have led to efforts to devise a reliable, widely accepted, and transparent alternative.

The OFR worked closely with the Federal Reserve to design a set of three interest rate benchmarks based on data on overnight repos, which may form the basis of a future replacement for LIBOR.

The OFR also pursued several data standards initiatives during the fiscal year, including continued advances in adoption of the Legal Entity Identifier (LEI). During the year, regulators in the European Union began requiring companies to have an LEI before they can trade in stocks and bonds in European markets.

As a result, the number of LEIs issued increased from fewer than 500,000 to more than 1.2 million.

Collaboration

The OFR collaborated with numerous stakeholders during the fiscal year, including the FSOC and its member agencies, the OFR Financial Research Advisory Committee, and cosponsors of conferences related to financial stability.

The FSOC is the OFR's primary stakeholder and its needs are key in guiding the work of the office. The OFR supports FSOC and its member agencies by providing data, research, and analysis.

The OFR leads the FSOC Data Committee; collects, maintains, and shares supervisory and commercial datasets with the FSOC; is working to launch a system for secure data sharing among the FSOC, its member agencies, and the OFR; responds to requests for research and analysis from FSOC, which help the FSOC identify threats to financial stability; and works with FSOC member agencies on research and data projects. We also evaluate the effectiveness of regulatory policies.

The OFR Financial Research Advisory Committee, established in 2012, provides industry expertise to help the OFR fulfill its mission.

The committee met in February 2018, when members gave feedback on Treasury reports responding to the Presidential Executive Order on Core Principles for Regulating the United States Financial System.

[The committee meeting in July 2018 was the first one under a new format by which the OFR issued specific research requests to advisory committee members.](#)

The OFR also cosponsored two financial stability conferences during the fiscal year.

The OFR and the Federal Reserve Bank of Cleveland, along with the University of Maryland's Robert H. Smith School of Business, held their annual conference from Nov. 30 to Dec. 1, 2017, focusing on the financial stability implications of financial technology innovation, or fintech.

The OFR and the University of Michigan's Center on Finance, Law, and Policy held their third annual conference on November 16-17, 2017, exploring fintech innovation risks and opportunities from an interdisciplinary perspective.

Information Technology

The OFR maintained its robust information security infrastructure during FY 2018. The information technology (IT) security team achieved initial operating capability with three products in compliance with the Department of Homeland Security's continuous diagnostics and monitoring program. The team also updated security policies and procedures, and developed training materials to enhance the OFR's internal privacy training program.

A major IT priority for FY 2018 was our NextGen Initiative to move the OFR's IT systems from local servers to a network of remote servers hosted by private cloud providers to store, manage, and process data. Phase 1 of our migration is expected to be complete in late FY 2019.

This initiative will result in lower annual operating-and-maintenance expenses and a more flexible infrastructure that can adapt quickly to changing business models. It will also help avoid future hardware expenses, without any sacrifice of information security.



Financial Stability Assessment and Key Findings



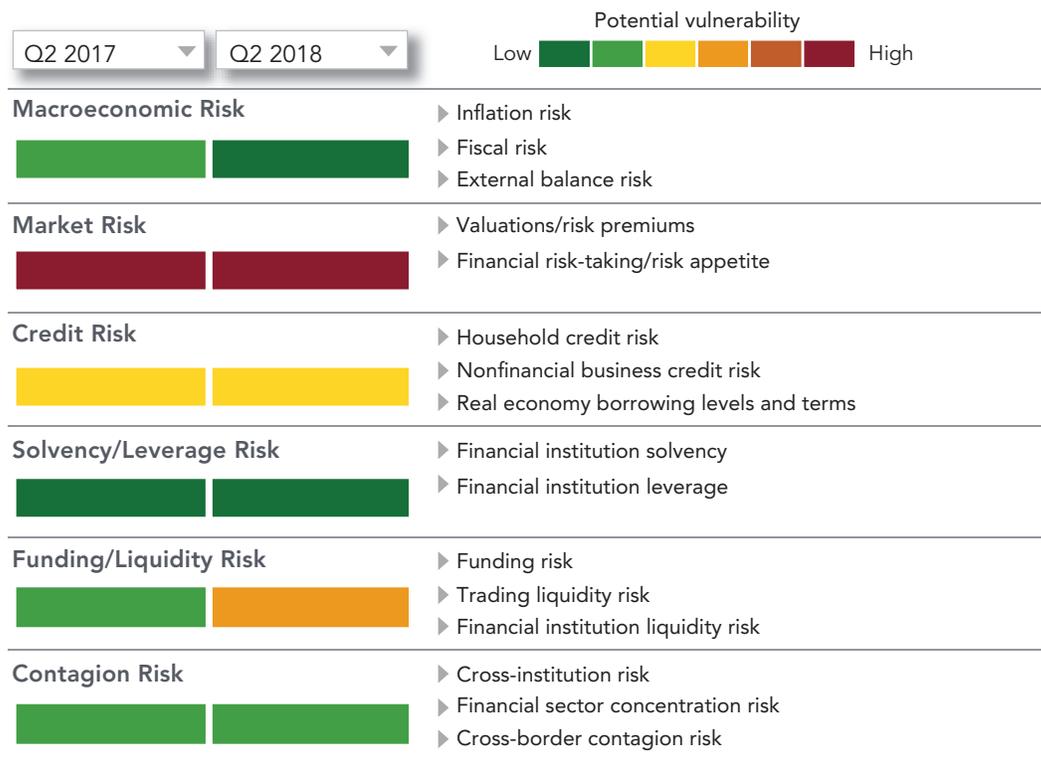
Risk Assessment

In our assessment, risks to U.S. financial stability remain in a medium range, as we have found for several years. Our assessment is informed by the OFR’s Financial System Vulnerabilities Monitor — a heat map of financial system vulnerability indicators — and by our broader financial system surveillance, data analysis, and research. These other sources of information and methods of analysis may imply more or less risk than depicted in the monitor.

The heat map reflects data available as of June 30, 2018 (see **Figure 1**). All other data cited in this report are as of September 30, 2018, unless otherwise noted.

Vulnerabilities are underlying weaknesses that can disrupt the financial system in the future. They can originate, amplify, or transmit shocks and stress. We analyze vulnerabilities to fulfill our statutory responsibility to monitor, investigate, and report on threats to the financial stability of the United States.

Figure 1. Financial System Vulnerabilities Monitor



Note: Figure is from the OFR Financial System Vulnerabilities Monitor. Technical information about the monitor is available at www.financialresearch.gov/financial-vulnerabilities.

Sources: Bloomberg Finance L.P., Compustat, Federal Financial Institutions Examination Council Call Reports, Federal Reserve Form Y-9C, Haver Analytics, Morningstar, SNL Financial LC, the Volatility Laboratory of the NYU Stern Volatility Institute (<https://vlab.stern.nyu.edu>), OFR analysis

Our assessment is based on our analysis of the six categories of risk in our Financial System Vulnerabilities Monitor (see McLaughlin and others, 2018), plus a seventh that captures risks that do not fit in any of those categories. The seven categories are: (1) macroeconomic, (2) market, (3) credit, (4) solvency and leverage, (5) funding and liquidity, (6) contagion, and (7) other risks.

At the OFR, our mandate is to monitor and research risks and share what we learn — our data and our findings — so that others can see what we see. In this way, our efforts support sound risk management for the entire financial system. The system is healthiest when all participants are monitoring risks, their own and those of others. In the following sections, we explain the details

supporting our finding that financial stability risks remain in a medium range.

Key Takeaways from the 2018 Assessment

- **We continue to see macroeconomic risks as moderate.** Unemployment is exceptionally low, growth remains healthy, and inflation is close to the Federal Reserve's target. However, we see more risks to the outlook this year than last. Key risks stem from interest rates potentially rising more quickly than expected, an unsustainable fiscal path of growing government debt, and substantial uncertainty surrounding trade tensions.
- **Market risks remain high.** Stock prices are historically high, while at the same time the macro outlook has more risks. Bond prices are more vulnerable to price declines than last year because of the possibility that interest rates could rise more quickly than market participants expect.
- **Credit risk is moderate.** Nonfinancial corporate credit growth is robust amid signs of weakening credit quality. Additionally this year, credit risk is rising with the growth in leveraged lending — lending to companies, often for the purposes of buyouts, acquisitions, or capital distributions, that can leave them highly indebted. Consumer credit remains a relatively lesser concern.
- **Solvency and leverage risks remain low under most conditions.** Large banks and insurers hold capital well above minimums required by regulators. However, under severely adverse conditions, a few U.S. global systemically important banks, or G-SIBs, could breach those minimums.
- **Funding and liquidity conditions are generally good.** Funding conditions from lenders and markets continue to support corporate borrowing. Given banks' special role in the financial system, we are primarily concerned with monitoring their funding and liquidity risks. For large banks, funding and liquidity risks appear to be low. These banks maintain ample liquidity buffers to survive at least 30 days of stress. Market liquidity risks also appear low, but these risks can change rapidly.
- **Contagion risks are moderate.** Risks to the financial system from the largest U.S. banks remain low. Derivatives exposures are still a source of contagion risk throughout the financial system. The contagion risk of derivatives exposures stems from interconnections among counterparties in financial transactions. These connections are why, for example, over-the-counter derivatives exposures are factored into the interconnectedness indicators the Federal Reserve uses in monitoring banks' systemic risk (see Board of Governors, 2016).
- **Other risks bear watching.** We think two risks that don't fall into the other categories are worth highlighting this year. Cybersecurity risks, which we have covered in previous years, remain a concern. The digital assets commonly known as cryptocurrencies, although not a concern at this point, are worth monitoring because their use is rapidly growing and evolving.

Macroeconomic Risks Inch Up on Uncertainty

We continue to view macroeconomic risks to U.S. financial stability as moderate, but we see possibly greater risk than a year ago (see Figure 2).

The economy continues to be strong. The U.S. economic expansion is the second longest on record since the 1850s. The economy is on track to grow about 3 percent in 2018, with support from the Tax Cuts and Jobs Act stimulus, regulatory reform efforts

across many sectors of the economy, and improved global growth. For 2019, growth is expected to move toward the economy's long-run potential growth rate, which is influenced by demographics and productivity trends.

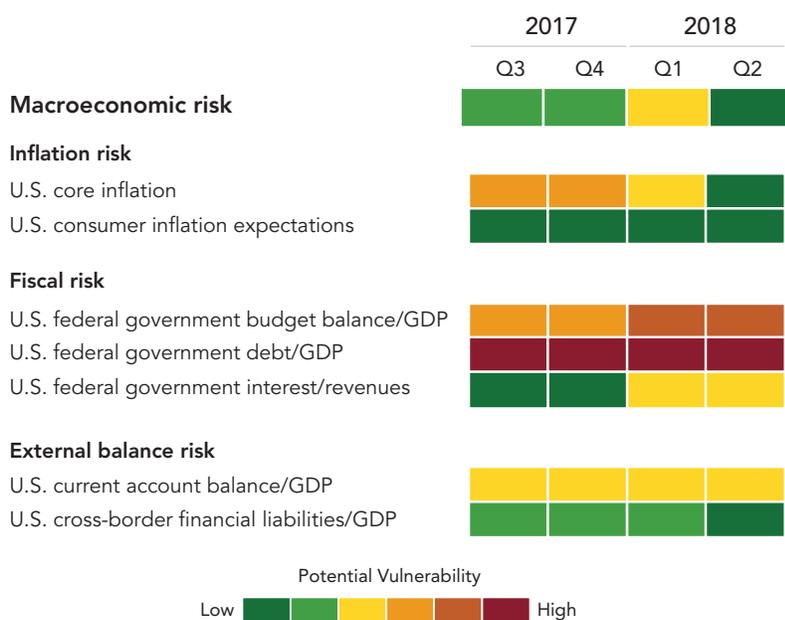
The Federal Open Market Committee (FOMC) is the monetary policymaking arm of the Federal Reserve System. U.S. inflation essentially hit the FOMC's target of 2 percent in March (see Figure 3). Except for periods in early 2012 and 2017, this instance was the first time since the 2007-09 financial crisis began that

the FOMC achieved its inflation goal. Meanwhile, labor markets remain tight. The unemployment rate hovers at lows rarely seen. Wage and benefits costs for private industry workers grew 2.9 percent for the 12 months ending in June 2018. Despite these sources of strength, when we look behind all these positive trends, we see some growing vulnerabilities.

One vulnerability is rooted in greater challenges facing the Federal Reserve. The fiscal stimulus from the tax cut package may boost demand more than supply, thereby pushing up inflation. In response, the FOMC might have to tighten credit conditions faster than markets now expect to achieve its objectives. Weighing in the opposite direction is the increased uncertainty associated with trade policy, which could have negative effects on business sentiment and investment spending.

Economic growth could turn out to be slower than expected. Financial markets could experience more volatility, and investors could lower their expectations for the economy. For now, market expectations are consistent with inflation

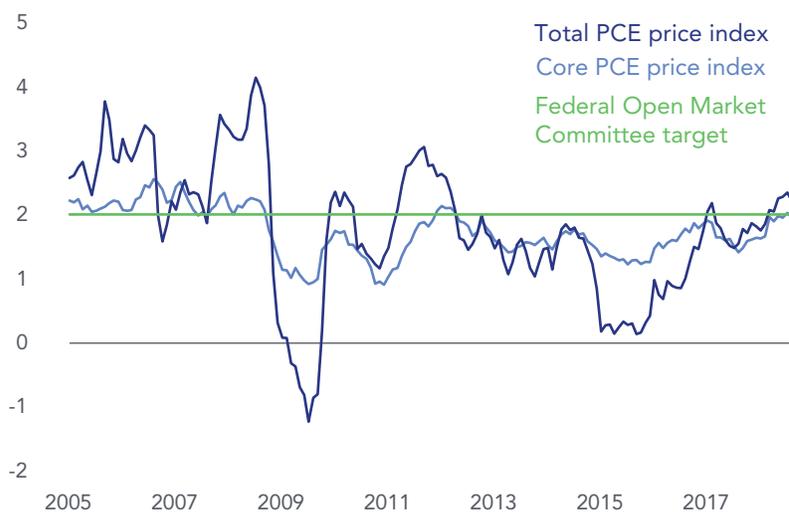
Figure 2. Financial System Vulnerabilities Monitor: Macroeconomic Risk



Note: GDP stands for gross domestic product. Figure is from the OFR Financial System Vulnerabilities Monitor. Technical information about the monitor is available at www.financialresearch.gov/financial-vulnerabilities.

Sources: Haver Analytics, OFR analysis

Figure 3. Inflation Is Near the Federal Open Market Committee's Target (percent change)



Note: Measured as 12-month percent change. Data as of Aug. 31, 2018. PCE is personal consumption expenditures. Core PCE excludes food and energy.

Sources: U.S. Bureau of Economic Analysis via Haver Analytics, OFR analysis

near the FOMC's 2 percent target rate.

A second vulnerability is the risk of spillovers from the United Kingdom's exit from the European Union on March 29, 2019, which were discussed in the OFR's *2016 Financial Stability Report* (OFR, 2016) and *2016 Annual Report to Congress*. These risks could be realized well before the United Kingdom's departure because some financial contracts will need to be renegotiated.

A third vulnerability is the increased difficulty in forecasting the economy. Forecasting models are used in policymaking and throughout the financial

system as a basis for decision making. These models identify patterns in how economic indicators move together over time. The models project the future based on past patterns, so they produce less accurate forecasts when current and future conditions break significantly from the past.

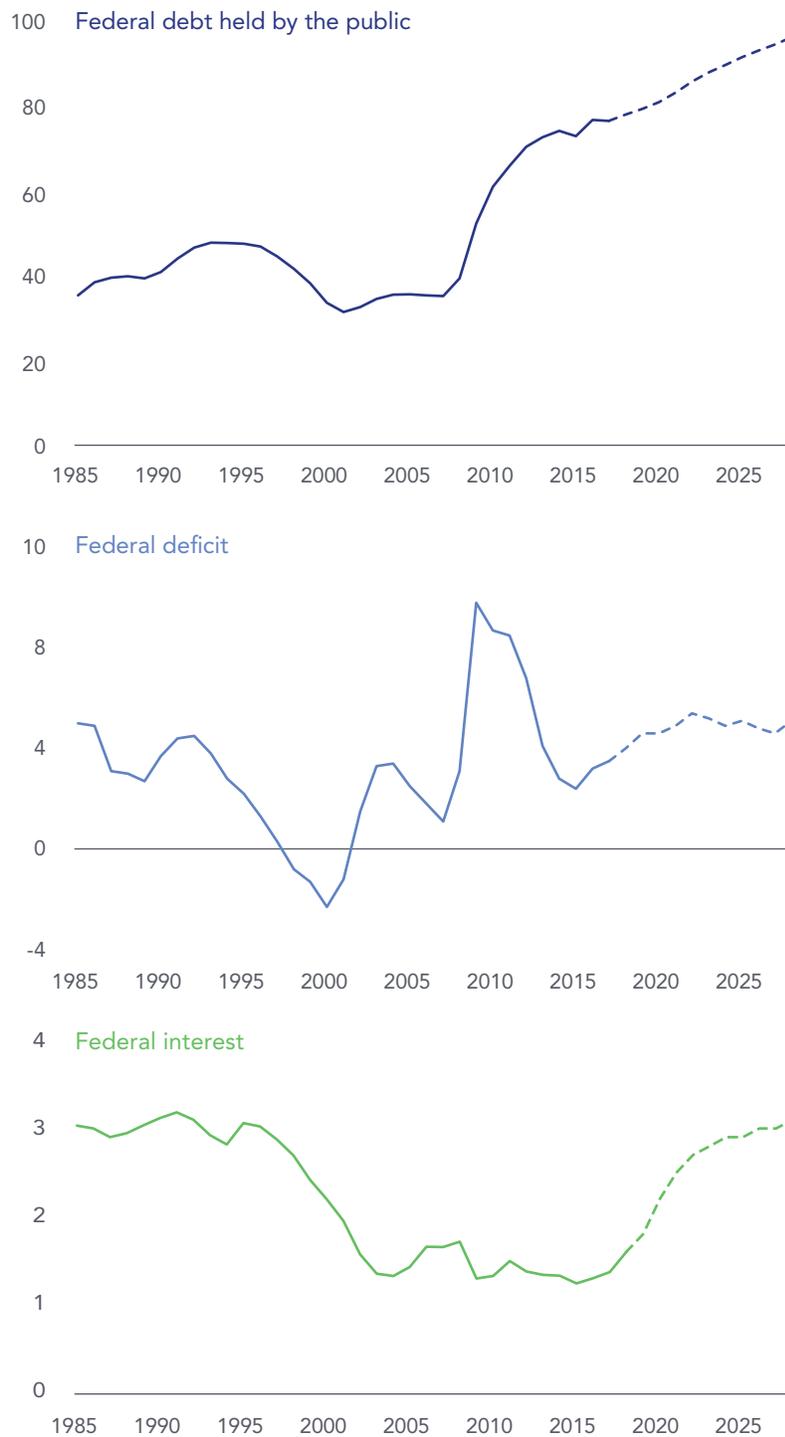
Such a break could be happening now. The data that feed forecasting models do not reflect fiscal stimulus so late in an economic expansion or higher tariffs in the United States and elsewhere. When forecasts are less reliable, risk assessments are clouded.

A fourth growing vulnerability is the trajectory of

the U.S. fiscal situation. Among the OFR macro-economic risk indicators in the heat map, risks from the government's debt are highest. Widening U.S. federal government deficits are lifting the ratio of the U.S. federal debt to gross domestic product (GDP) (see Figure 4). The Congressional Budget Office projects that federal government debt held by the public will reach 96 percent of GDP by 2028 (see CBO, 2018, 81). The Treasury projects that the debt-to-GDP ratio will reach 100 percent by 2037, be almost triple that amount by 2092, and continue to rise in later years (see Treasury, 2018, ii, 6, and 152).

We do not view the current fiscal path as posing a near-term risk to financial stability. Yet some related risks are a concern. One risk is that investors will have less confidence in the government's ability to repay its debt, resulting in the government having to refinance at sharply higher interest rates. Such a sell-off could spill over to negatively affect markets for repurchase agreements (repos) and other markets. Refinancing costs could rise even without a loss of investor confidence. The Treasury

Figure 4. Federal Debt, Deficit, and Interest Relative to Gross Domestic Product Continue to Rise (percent)



Note: Projections for 2018-28, indicated by dotted lines, are from the Congressional Budget Office (see CBO, 2018). Negative deficits represent surpluses.

Sources: Haver Analytics, OFR analysis

assumes an average annual interest rate of 5.1 percent in its long-run projections for the primary deficit, and that future interest rates would probably increase if the debt-to-GDP ratio rises as projected (see Treasury, 2018, 153-154).

Another risk related to government debt is that the government will have less room to use fiscal policy to mitigate a future economic downturn or financial crisis. The International Monetary Fund, European Central Bank, and others have noted these risks (see IMF, 2018, and ECB, 2018, 33).

The U.S. government's burden in paying interest owed on its debt is also a risk. These interest payments as a share of GDP have been rising slowly and remain low compared with the 1990s (see Figure 4). But as the Federal Reserve normalizes monetary policy in the next few years by pulling back its extraordinary support for the economy, interest rates could rise quickly, increasing the interest burden. The Congressional Budget Office projects that net interest payments will increase from 1.9 percent of GDP in 2018 to 2.5 percent in 2021. In 2017 dollars,

these payments amount to an extra \$155 billion in interest payments through 2021 — 40 percent more than in 2018.

Interest Rate Uncertainty and Rising Costs Drive Market Risk Higher

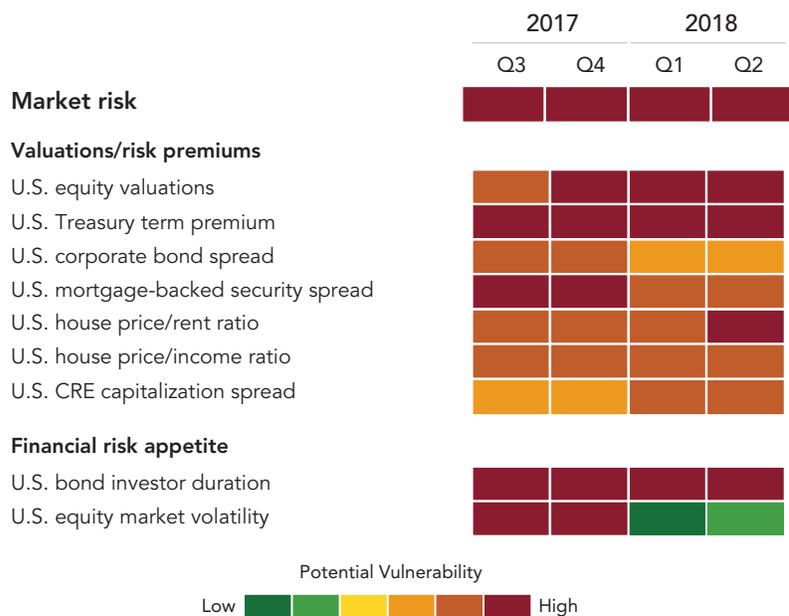
Market risk has been high during the last few years and remains so. Stock market valuations, the U.S. Treasury term premium (a measure of compensation to long-term investors for taking the risk of rising interest rates), house prices relative to rents, and bond duration (price sensitivity to interest rate changes) are signaling the most risk (see Figure 5). Stock prices can fall sharply in anticipation of a possible recession. Market corrections can trigger financial instability when key market participants take on too much debt or when uncertainty about their exposures is high.

Similar to last year, U.S. stock prices are high by historical standards. In 2018, stock prices faced potential headwinds from

trade tensions and other risks discussed in the previous section on macroeconomic risk. The Federal Reserve’s September 2018 Beige Book noted that “businesses generally remained optimistic about the near-term outlook, though most Districts noted concern and uncertainty about trade tensions — particularly though not only among manufacturers” (see Board of Governors, 2018c, 1). In real time, the OFR’s Financial Stress Index serves as an indicator of the market’s experiencing of stress (see **The OFR Financial Stress Index**).

The slope of the yield curve — typically the difference between the two-year and 10-year Treasury security yields — is usually upward when the economy is expected to expand. One reason is that people expect to be paid a premium for giving up access to their savings for a longer period. Another reason is that people may expect inflation and want the interest they earn in later years to offset the reduced purchasing power of those savings. A yield curve that slopes down (inverts) can be a sign that people expect slower

Figure 5. Financial System Vulnerabilities Monitor: Market Risk



Note: CRE stands for commercial real estate. Figure is from the OFR Financial System Vulnerabilities Monitor. Technical information about the monitor is available at www.financialresearch.gov/financial-vulnerabilities.

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

The OFR Financial Stress Index

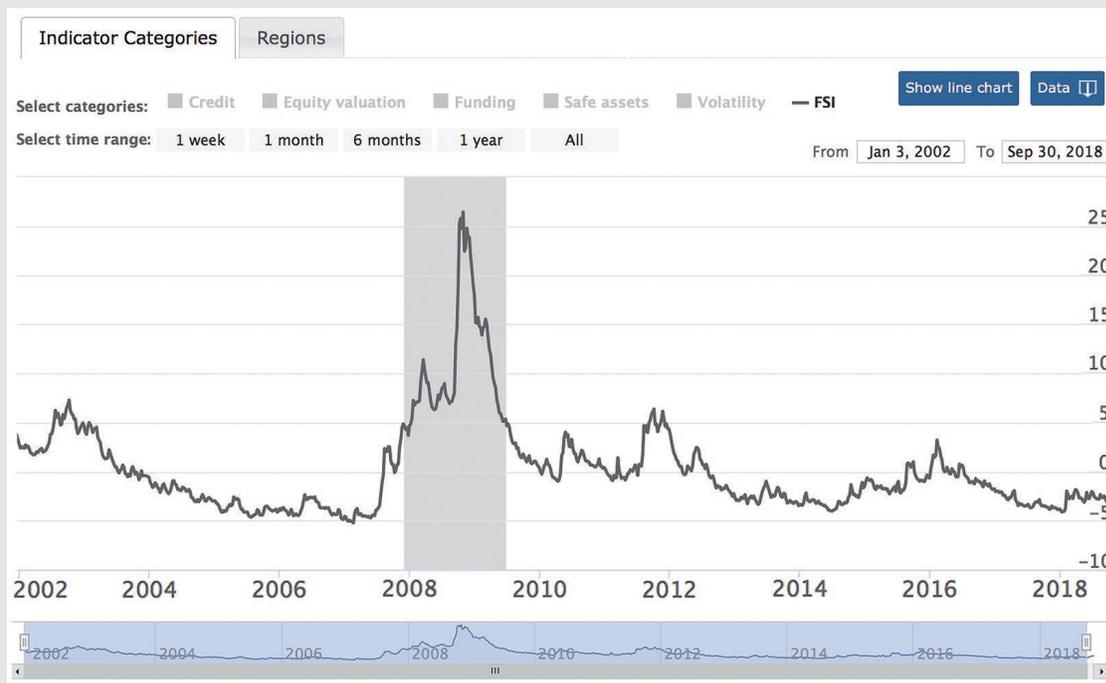
Our daily Financial Stress Index (FSI) supports our monitoring of stress in the financial system. Stress is a disruption in the normal functioning of the system. While vulnerabilities can signal future instability, stress measures disturbances as they occur.

The FSI is a daily market-based snapshot of stress in global financial markets. It is constructed from 33 financial market indicators. The indicators are organized into five categories: (1) credit, (2) equity valuation, (3) funding, (4) safe assets, and (5) volatility.

The index measures systemwide stress. It is positive (above zero) when stress levels are above average, and negative when stress levels are below average. Unlike financial stress indexes produced by others, the OFR's FSI can be decomposed into contributions from each of the five categories. It also can be broken down by the region generating the stress.

The FSI shows that financial market stress reached its post-crisis low in January 2018 (see Figure 6). The index has increased somewhat since then but remains below zero, indicating a below-average level of stress.

Figure 6. OFR Financial Stress Index



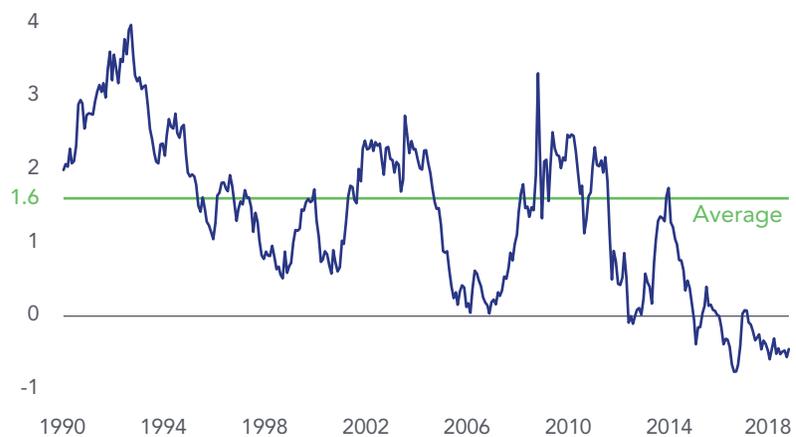
Note: Shaded areas are U.S. recessions. Technical information about this index is available at www.financialresearch.gov/financial-stress-index/.

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

economic growth and less inflation in the future.

The yield curve has inverted before many, but not all, recessions. Moreover, the time between inversion and recession has varied considerably. The yield curve has also inverted without being followed by a recession. A current concern is that the yield curve could invert because it is the flattest it has been since mid-2007. Some researchers and industry observers argue that an inverted yield curve today could be a false signal of a near-term recession (see, for example, Engstrom and Sharpe, 2018). Supply and demand for U.S. Treasuries, not fear of recession, could be driving the flattening. Yields for 10-year Treasury notes have been held down by global quantitative easing, in which central banks bought longer-dated government securities, driving up the price and lowering yields, as well as by demand from investors for longer-dated bonds. The term premium — the difference in return between buying longer-term Treasury debt and simply rolling over shorter-term debt — has been negative for a while (see Figure 7).

Figure 7. 10-year Treasury Term Premium Near Record Low (percent)

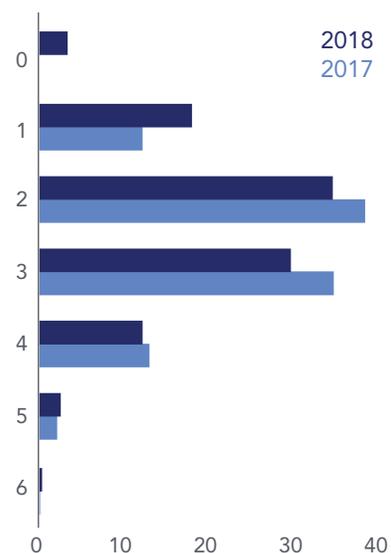


Note: The term premium is based on Adrian, Crump, and Moench (2013) estimates. Average is based on 1961 to present.

Sources: Bloomberg Finance L.P., OFR analysis

Bond duration — a measure of bonds' price sensitivity to interest rate changes — remains near its all-time high. The duration of the Barclays U.S. Aggregate Bond Index is just above six years. Its average since 1990 is 4.8 years. Market risk rises as duration increases. With duration at six years, a 1 percentage point increase in interest rates would lead to a \$1.2 trillion decline in the value of the Barclays Index. Financial markets widely expect another two or three 25-basis-point increases in the FOMC's policy interest rate during the next 12 months (see Figure 8). Duration poses more risk if market participants are incorrectly pricing the probability of rate hikes.

Figure 8. Market Expectations for the Number of Federal Reserve Policy Rate Increases (percent)



Note: Data as of Sept. 28, 2018. Each bar represents Bloomberg's estimated cumulative probability for the total number of 0.25 percent rate hikes for Federal Open Market Committee meetings in the next 12 months.

Sources: Bloomberg Finance L.P., OFR analysis

Stock market volatility is the one market-risk indicator showing marked improvement. Market volatility was very low in 2017. In the OFR's *2017 Financial Stability Report*, we noted that investors may react to low volatility by taking on more risk and leverage. Volatility spiked in February 2018. In the aftermath, volatility returned to more typical levels, suggesting that market participants might be less complacent and more focused on managing their riskier exposures. We delve deeper into this issue in the Spotlight on Financial Markets section, where we discuss findings from our recent research on volatility risks.

Credit Risk Rises on Leveraged Lending

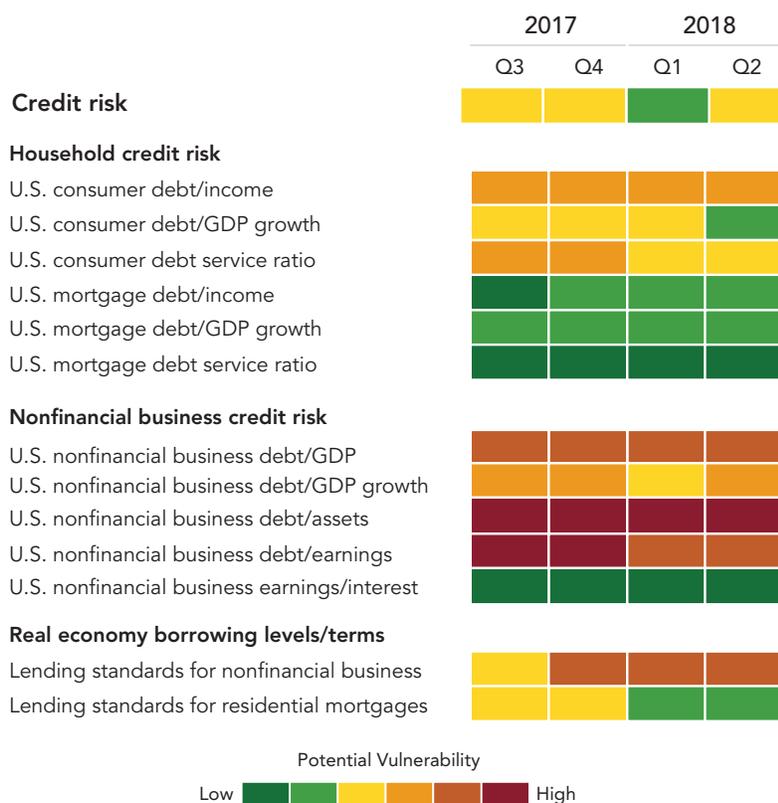
Credit risk — the risk of borrowers or counterparties not meeting their financial obligations — is moderate overall. U.S. nonfinancial corporate credit risk is elevated (see **Figure 9**). Leveraged lending — often lending to companies for buyouts, acquisitions, or capital distributions — is

one reason. For households, delinquencies in nonmortgage consumer loans are rising. On the positive side, consumer debt service ratios and debt levels relative to GDP have improved.

Nonfinancial corporate credit

Leverage typically rises as an expansion progresses (see **Figure 10**). Nonfinancial corporate leverage is high across multiple industries, including energy, consumer

Figure 9. Financial System Vulnerabilities Monitor: Credit Risk



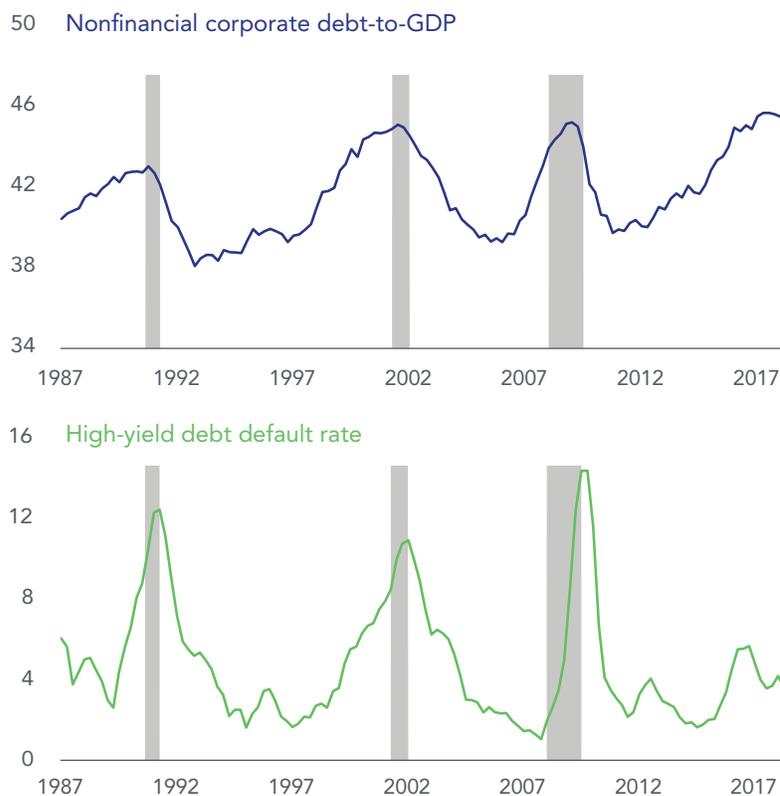
Note: GDP stands for gross domestic product. Figure is from the OFR Financial System Vulnerabilities Monitor. Technical information about the monitor is available at www.financialresearch.gov/financial-vulnerabilities.

Sources: Compustat, Haver Analytics, OFR analysis

staples, and healthcare. This elevated leverage means losses from an increase in defaults could be more widespread than in 2015-16, when defaults spiked at energy and materials firms. Rates of default in high-yield debt, which remain low today, reflect risks in the most vulnerable segment of the corporate credit market from a downturn in the economy (see Figure 10). This debt provides investors with a higher yield as compensation for the additional risk associated with a rating that is below investment grade.

An interest-coverage ratio below one means a firm's earnings before interest and taxes are less than the firm's interest expense. As of the second quarter of 2018, one-third of nonfinancial corporations that were either rated high yield or are not rated had interest coverage ratios below one. Since 1990, an average of 28 percent of these firms have had such low interest coverage ratios. These firms represented 21 percent of outstanding debt for high yield and not rated companies.

Figure 10. High U.S. Nonfinancial Corporate Debt Precedes High Defaults (percent)



Note: Default rate data as of Sept. 30, 2018, and debt-to-GDP data as of June 30, 2018. Shaded areas indicate U.S. recessions.

Sources: Haver Analytics, Moody's Investors Service, OFR analysis

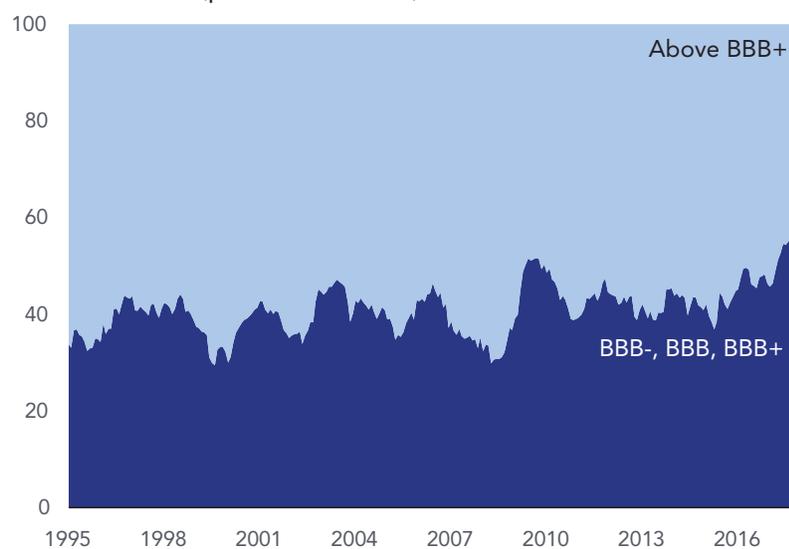
A sharp rise in the issuance of debt rated BBB (including BBB+, BBB, and BBB-) is another sign of worsening credit quality. BBB-rated debt is the lowest rating category for debt to be considered investment grade. (Investment-grade securities carry low-to-medium credit risk.) BBB-rated issuance was a record 56 percent of all U.S. investment-grade issuance during the 12 months ending September 2018, well above levels before the financial crisis (see **Figure 11**). Many investment management strategies require an investment-grade rating. If there were widespread

downgrades of bonds to non-investment-grade ratings, institutional investors with mandates to hold investment-grade assets would be pressed to sell their downgraded securities. Although investors in these non-investment-grade — or high-yield — securities could be buyers, it is not certain they could absorb all the supply. Market liquidity could be significantly reduced, amplifying a drop in bond prices in a likely already-stressed market. Such events have been documented before for insurers (see Ellul, Jotiskasthira, and Lundblad, 2011).

Leveraged lending

Rapid growth in leveraged lending is a concern. These commercial loans, often used by borrowers with credit ratings below investment grade for buyouts, acquisitions, or capital distributions, can leave borrowers highly indebted. Strong investor demand for these higher-yielding loans is behind the rapid growth. Less creditworthy corporations took advantage of that demand by seeking more funding in leveraged loan markets. As a result, more than \$1 trillion of leveraged loans are outstanding. That is more than 11 percent of all U.S. nonfinancial debt — a record high.

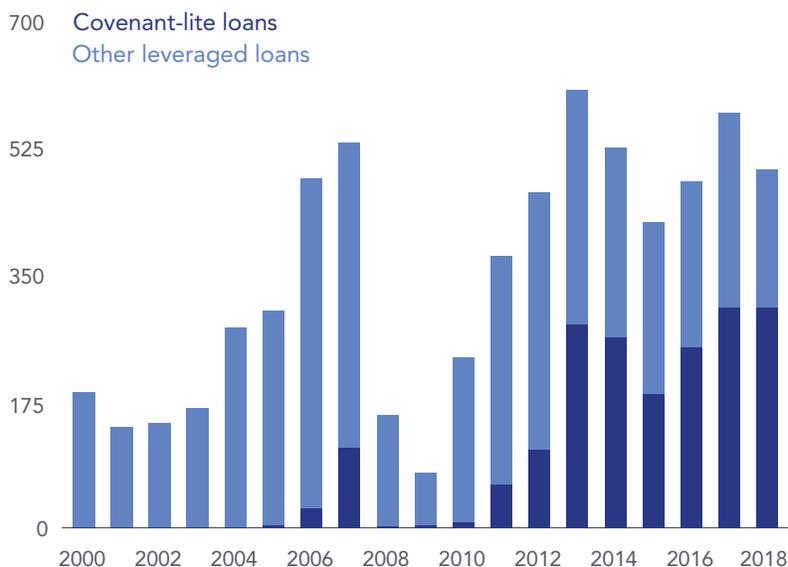
Figure 11. Majority of New Investment-grade Bonds Are Lowest-rated (percent of total)



Note: Based on trailing 12-month totals.
Sources: Dealogic, OFR analysis

With the growth in leveraged lending has come a deterioration in the credit quality of newly issued loans. One sign of this decline is the high share of covenant-lite loans (see **Figure 12**). Covenants are restrictions placed on debt-issuing firms meant to increase the likelihood of payment. Another sign of deterioration in underwriting quality is that more than half of all leveraged loans issued are rated B+ or lower (that is, highly speculative).

Figure 12. Majority of Leveraged Loan Issuance Is Covenant-lite (\$ billions)



Note: Covenant-lite loans carry limited restrictions compared with other loans.

Sources: Standard & Poor's LCD, OFR analysis

Household credit risks

Overall, household credit risks are moderate. Residential mortgage debt is two-thirds of total household debt, and risks from mortgage debt are also moderate. However, a recent trend toward easier mortgage lending standards is likely to increase risks. Mortgage defaults typically arise from a combination of borrowers being both unable to make mortgage payments and unable to sell their homes for more than the value of their mortgage debt.

Most outstanding mortgages were originated at low fixed rates. As a result,

mortgage debt service ratios are low and the average borrower is likely to be able to continue making mortgage payments. However, more loans are being made today with higher debt-to-income ratios and higher loan-to-value ratios, somewhat inhibiting the ability to repay. Similarly, higher loan-to-value ratios probably mean that more borrowers will not be able to sell their homes for more than the value of their mortgage debt if house prices decline.

Risks are somewhat higher for nonmortgage consumer debt, which rose to a record 19.3 percent of GDP in the fourth quarter of 2017. The

increase came mostly from auto and student loans. Since then, growth in this loan category has been essentially constant. Student loans are mostly guaranteed by the federal government, limiting the direct risks they pose to the financial system, but their effect on the financial burdens of consumers may increase default risks in other types of loans. Nonmortgage consumer credit quality weakened during the past few years, but is unchanged recently. For example, the median credit score for buyers taking out loans to purchase new cars has been steady and relatively good at around 700. However, auto loan delinquencies have been rising since 2015, with 4.3 percent delinquent 90-plus days as of the first quarter of 2018. This share remains below the post-crisis peak of 5.3 percent in fourth quarter of 2010. Credit card balances have continued to inch up as they approach 2008 peak levels. Delinquency rates in commercial banks' consumer loan portfolios have been rising since 2015.

Solvency and Leverage Risks Are Low Under Most Conditions

For several years, solvency and leverage risks have been low. We continue to view them that way. Nevertheless, some large banks, insurers, and hedge funds could be vulnerable to severe stress situations.

Banks

Banks hold capital to cover unexpected losses and remain solvent. The heat

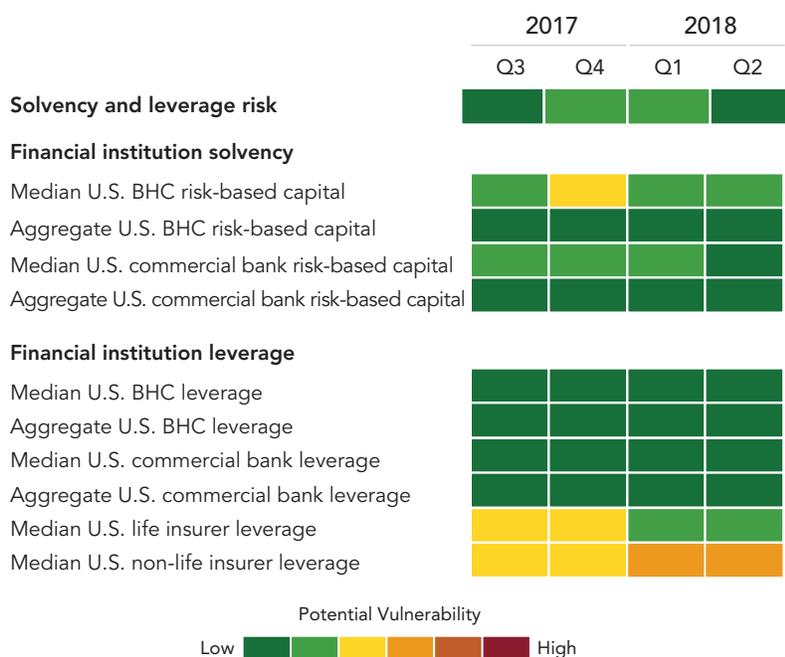
map (see Figure 13) shows that the amount of capital banks and bank holding companies maintain generally meets or exceeds regulatory requirements. For the largest U.S. bank holding companies, the level and quality of capital has improved. Common equity capital for those companies has more than doubled since 2009.

Regulatory capital requirements aim to ensure a bank’s solvency. But even the more stringent capital requirements put in place

after the financial crisis do not protect banks against all possible stress scenarios. The Federal Reserve’s Comprehensive Capital Analysis and Review (CCAR) for 2018 showed that the capital ratios of three of the eight U.S. G-SIBs could fall below at least one of their regulatory minimums under the severely adverse conditions applied in the review (see Board of Governors, 2018b).

The Federal Reserve does not approve a bank’s capital plan; rather, it objects or does not object to plans, sometimes with conditions. State Street, a global systemically important bank, received a “conditional non-objection” on its submitted capital plan in the 2018 review. The condition of the State Street non-objection is that the bank must take certain steps in managing and analyzing its counterparty exposures under stress. Goldman Sachs and Morgan Stanley also received conditional non-objections. The post-stress capital ratios of these two firms were affected by U.S. tax reform and other factors.

Figure 13. Financial System Vulnerabilities Monitor: Solvency and Leverage Risk



Note: BHC stands for bank holding company. Figure is from the OFR Financial System Vulnerabilities Monitor. Technical information about the monitor is available at www.financialresearch.gov/financial-vulnerabilities.

Sources: Bloomberg Finance L.P., Federal Financial Institutions Examination Council Call Reports, Federal Reserve Form Y-9C, Haver Analytics, OFR analysis

capital requirements with stress tests (see **Proposed Changes to Large Bank Holding Company Capital Regulation**). Today, large bank holding companies must comply with 24 regulatory capital rules. The proposed changes would reduce the number of rules to 14. The Federal Reserve and the Office of the Comptroller of the Currency (OCC), the regulator of national banks, also proposed changes to the enhanced supplementary leverage ratio for G-SIBs. The Federal Reserve and the OCC have stated that these changes are expected to free up capital at the G-SIBs as a whole and increase their leverage to a moderate degree.

Insurance companies

Median leverage among U.S. life insurance companies is largely unchanged from 2017. The heat map captures leverage, but does not reflect how changes in life insurers' liabilities affect these firms' risks. Life insurers' liabilities have expanded beyond traditional life insurance policies. Annuities — a type of contract in which a policyholder makes an initial payment to an insurer in return for the option to

Proposed Changes to Large Bank Holding Company Capital Regulation

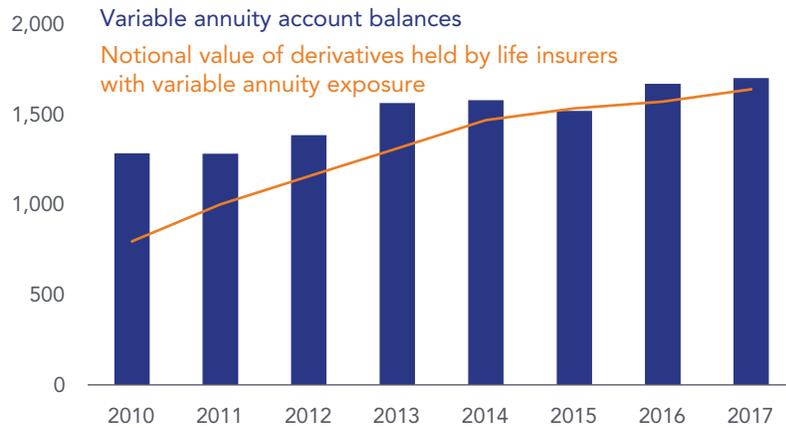
The Federal Reserve has proposed changes to the capital ratios required of bank holding companies subject to its Comprehensive Capital Analysis and Review. The Federal Reserve would create a new stress capital buffer to replace the fixed 2.5 percent capital conservation buffer now in place. The new buffer would be tailored to each company. It would be the higher of a bank holding company's worst-quarter Federal Reserve stress test result or 2.5 percent (see Board of Governors, 2018a). The new buffer would also include an amount equal to four quarters of planned dividends. This requirement is intended to address concerns that many large bank holding companies continued to pay dividends during the financial crisis despite the stress on the banking system. A company that breaches the new ratios during non-stress times would have to limit the dividends it pays, much as it now does under the capital conservation buffer.

Regulators also propose changing the enhanced supplementary leverage ratio rule that applies to G-SIBs (see OCC, Treasury, and Board of Governors, 2018). Currently the rule requires G-SIB bank holding companies to hold the equivalent of 5 percent of their total leverage exposures in Tier 1 capital. (Tier 1 capital consists primarily of common stock and retained earnings. Total leverage exposures includes assets and some off-balance-sheet items.) Of that 5 percent, 3 percent is for the supplementary leverage ratio, and 2 percent is for the G-SIB surcharge. The proposal would replace the 2 percent G-SIB surcharge with a surcharge equal to 50 percent of each individual G-SIB's risk-based surcharge.

request regular future disbursements in return, often for retirement-funding purposes — now make up more than half of the

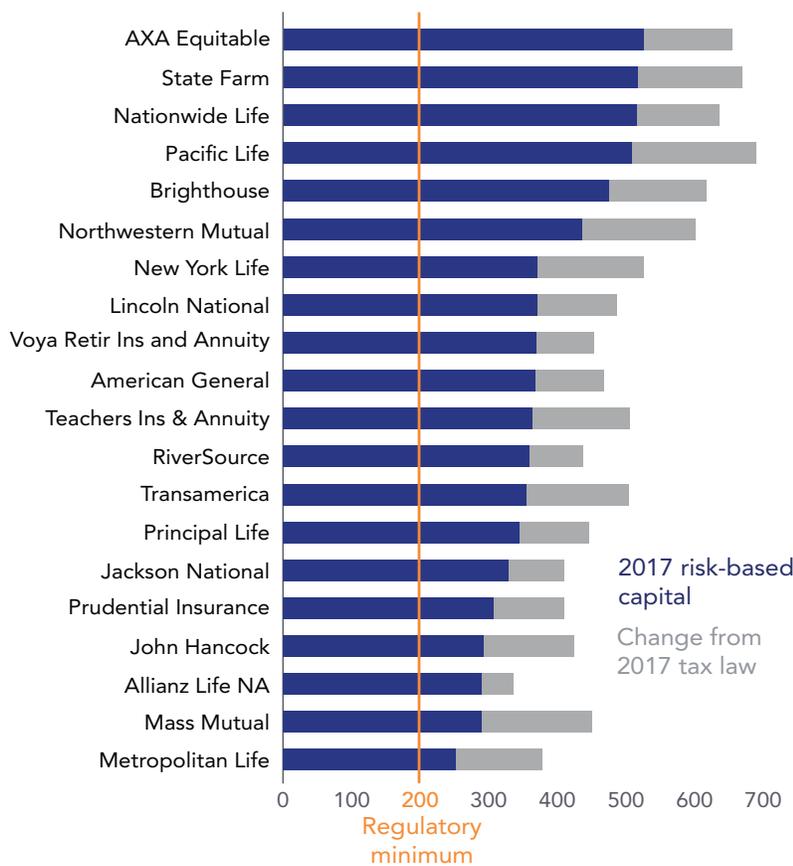
industry's total liabilities (see ACLI, 2017, 26). This shift in liabilities implies different risks than in the past. For example, certain large

Figure 14. Insurers' Derivatives Use Grows with Variable Annuity Account Balances (\$ billions)



Sources: Insurers' Statutory Annual Statements via S&P Global Market Intelligence, OFR analysis

Figure 15. Tax Law Lowers Life Insurers' Risk-based Capital Ratio



Note: Blue bar is hypothetical 2017 risk-based capital ratio incorporating change from the 2017 tax law.

Sources: Insurers' Statutory Annual Statements via S&P Global Market Intelligence, OFR analysis

life insurers are exposed to stock market risk through exposure to benefits guaranteed on variable annuity products. As equity prices have risen, account values have increased. Higher account values can mean higher guaranteed benefits for some variable annuity products. To hedge this risk, life insurers have increased their use of derivatives (see Figure 14). This hedging has its own risks. As with banks, derivatives increase life insurers' interconnectedness with other large financial institutions. Large banks must report their net over-the-counter derivatives exposures quarterly to the Federal Reserve as a measure of interconnectedness in their Banking Organization Systemic Risk Report. U.S. insurance operating companies report their derivatives quarterly through their state statutory filings.

The 2017 tax law affects the regulatory capital of U.S. life insurers, as it does for banks. Insurers' risk-based capital appears to remain above the regulatory minimum, but not by as much as in the past (see Figure 15). Lower capital buffers make insurers potentially more vulnerable to insolvency risk in times of stress.

Median leverage has risen for other types of insurers too, but does not signal higher risk. Most of these firms sell property and casualty insurance. The increase in leverage mostly reflects large storm losses at property and casualty specialists from the 2017 hurricanes. Much of the storm exposure was reinsured (see **Insurance Industry Risks Stemming from Natural Disasters**). As these insurers pay policyholder claims and await repayment from the reinsurers, their reported leverage temporarily increases.

Hedge funds

Banks and insurers are not the only financial institutions that use leverage. Since the failure of the large hedge fund Long-Term Capital Management in 1998, regulators and financial market participants have been aware of the potential systemic risk from excessive leverage in hedge funds. Vulnerabilities from leverage do not arise only from a single large fund.

Balance-sheet leverage can grow through repurchase agreements or from borrowing through funds' prime brokers. Such leverage increases risks to financial stability in three ways. First, it creates more connections

Insurance Industry Risks Stemming from Natural Disasters

Natural disasters usually do not pose much risk to financial stability, though their humanitarian and economic costs can be enormous. The 2017 natural disasters were a case in point. For decades, the U.S. population has been migrating to southern coastal areas. As a result, a larger share of the U.S. population is exposed to hurricanes. For example, between 2000 and 2010, the most recent decade for which census data are available, the population of counties susceptible to hurricane damage grew 22 percent faster than the overall U.S. population (see CBO, 2016, 4). With more construction in coastal areas and rising property values, the potential economic damage from hurricanes has grown.

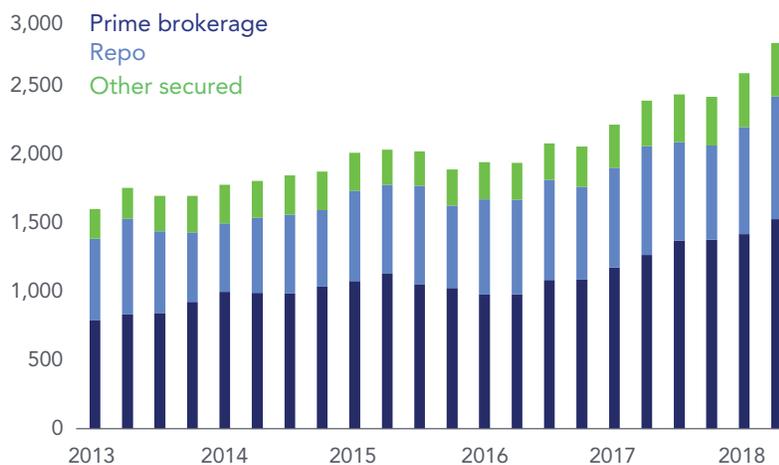
Insurers that operate in multiple states and nationally face risks that are diversified across regions. They generally also have enough capital and liquidity to handle claims from disasters that hit a limited geographic area. But these insurers are starting to do less business in some coastal states, leaving small local insurers to play bigger roles (see A.M. Best, 2017). Over time, these trends can increase the financial fragility of private insurance markets and increase insurers' dependence on reinsurance. Insurers may find that reinsurance for coastal natural disasters becomes more expensive or less available because of reinsurers' concerns about regionally concentrated risks.

to other financial institutions. Second, it may make the value of assets used as collateral more volatile. And third, it may increase the likelihood and potential impact of stress in the hedge fund industry being transmitted to the funds' counterparties.

The amount of total hedge fund borrowing is one measure of the potential systemic risk from leverage in hedge funds. Total hedge fund borrowing increased from \$1.9 trillion at the end of 2015 to more than \$2.8 trillion by June 2018 (see **Figure 16**). During this time, hedge funds' net assets increased from \$2.7 trillion to \$3.1 trillion.

Data also indicate that the total amount of hedge fund borrowing is significant, has grown recently, and is largely concentrated among a few borrowers. The 10 largest hedge fund borrowers account for nearly 40 percent of all hedge fund borrowing. The top 50 account for more than 60 percent.

Figure 16. Hedge Fund Secured Borrowing Has Grown (\$ billions)



Note: Data as of June 30, 2018, based on Form PF question 43. Data include only qualifying hedge funds.

Sources: SEC Form PF, OFR analysis

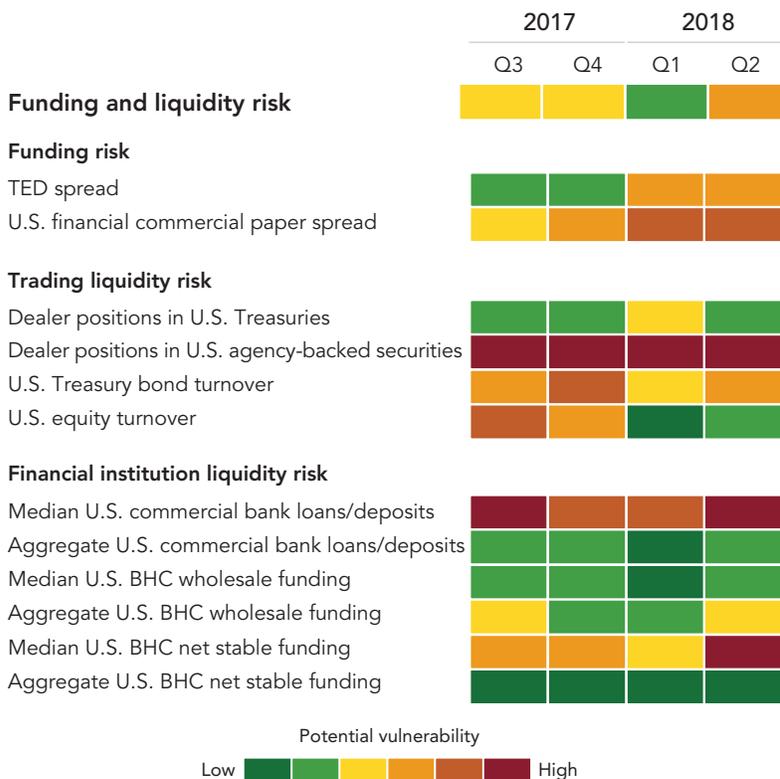
Funding and Liquidity Conditions Are Generally Good

Funding and liquidity risks are inherent when companies maintain enough credit and cash on hand to meet their payment obligations (see Figure 17). We consider these risks to be low overall thanks to favorable market conditions for borrowing and historically high liquidity buffers for most banks. Market liquidity reflects the ability of a market participant to buy or sell an asset in a timely manner at relatively low cost. Market liquidity is generally strong, but liquidity can change quickly and always warrants close monitoring.

Funding risk

Financial conditions continue to support corporate borrowing, whether the funds are coming from banks or nonbank lenders. The spread between the three-month LIBOR and Treasury bill rate widened during the first half of 2018, but trended back down during the third quarter (see Figure 18). This spread, known as the TED spread, reflects the credit risk that large international banks

Figure 17. Financial System Vulnerabilities Monitor: Funding and Liquidity Risk



Note: BHC stands for bank holding company. The TED spread is the difference between the three-month U.S. dollar LIBOR and Treasury bill rates. Figure is from the OFR Financial System Vulnerabilities Monitor. Technical information about the monitor is available at www.financialresearch.gov/financial-vulnerabilities.

Sources: Bloomberg Finance L.P., Federal Financial Institutions Examination Council Call Reports, Federal Reserve Form Y-9C, Haver Analytics, OFR analysis

Figure 18. Funding Spreads Remain Narrow (percent)



Note: The commercial paper spread is the difference between the three-month U.S. financial commercial paper and Treasury bill rates. The TED spread is the difference between the three-month U.S. dollar LIBOR and Treasury bill rates.

Sources: Bloomberg Finance L.P., OFR analysis

assume when they lend money among themselves. LIBOR, in turn, affects the interest rate paid on floating-rate bank loans taken out by corporate borrowers. The spread between the three-month financial commercial paper rate (the rate on unsecured short-term promissory notes) and the corresponding Treasury bill rate also rose during the first half of 2018, but subsequently fell during the third quarter to the year-ago level. This spread reflects the market's collective view of the credit risk of providing short-term funding to financial firms.

Amid favorable funding conditions, we have not seen a buildup of vulnerabilities so far. For example, the amount of commercial paper outstanding remains low after falling markedly during and after the crisis. The banking system's reliance on short-term wholesale funding is also low compared with historical averages.

Liquidity risk

For financial institutions, managing liquidity risk involves having enough cash-like financial instruments on hand to meet upcoming obligations. Large banks' liquidity risks are low.

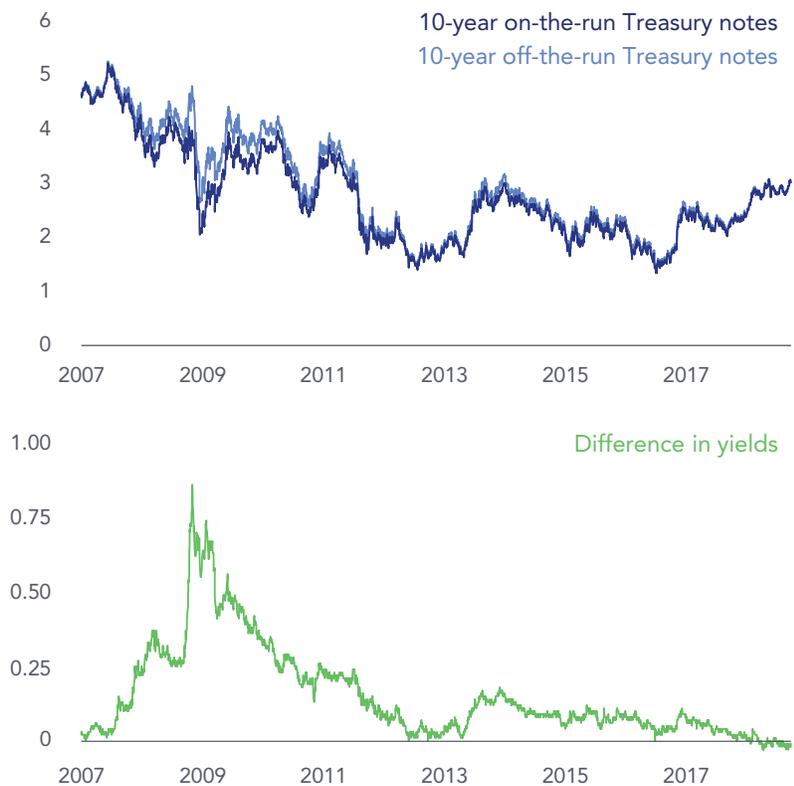
The largest bank holding companies have liquidity buffers well in excess of regulatory requirements put in place after the crisis. These requirements are set to ensure a bank's liquidity over a 30-day stress event.

For markets, liquidity risk involves an inability to rapidly buy or sell a sizable volume of securities at a low cost and with a limited price impact. Liquidity risks for stock and corporate bond markets appear low at present. Turnover is the ratio of

securities traded to those outstanding. Turnover in equities is relatively high, a sign of more-liquid markets. The corporate bond market's liquidity is also strong, with some possible exceptions and vulnerabilities, which we will delve into in the Spotlights on Markets section, where we spotlight liquidity.

Turnover in U.S. Treasuries is on the lower end of moderate, as reflected in the heat map. However, liquidity risk for these

Figure 19. Illiquidity Premium for Treasuries Is Declining (percent)



Note: Data as of Sept. 28, 2018. Spread is daily 10-year on-the-run minus off-the-run constant-maturity yield spread, U.S. Treasuries.

Sources: Federal Reserve FRED, Gurkaynak and others (2007), OFR analysis

securities varies by market segment. Recently issued, or on-the-run, Treasuries are the more-liquid segment of the market. There is a risk of reduced liquidity for Treasuries that are not recently issued, known as off-the-run securities. The spread between the yields for off-the-run and on-the-run Treasuries has declined to near zero (see Figure 19). This convergence in yields between the two market segments indicates that off-the-run securities are vulnerable to liquidity risk. Some analysts think this tightening reflects increased demand for less-liquid securities. Others think it results from the increase in the supply of on-the-run Treasury securities. Regardless of the cause, the market is not assigning a premium for the less-liquid off-the-run securities. This situation increases the chances that the spread surges if a flight to more-liquid securities occurs. The financial stability implication is that these less-liquid securities could provide less cash to sellers than expected, potentially worsening their liquidity positions. Sellers could find themselves with less liquidity than they expected.

Contagion Risk Is Moderate, But Hard to Measure

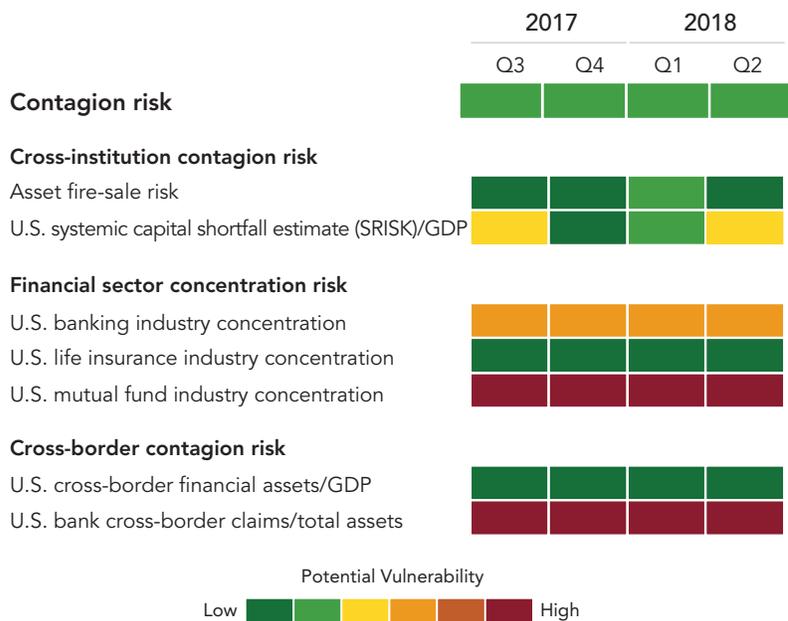
Contagion is the risk that stress at one financial institution or market spills over to others. It can arise from asset or liability exposures, or from disruptions to financial markets or infrastructure. The heat map indicates that contagion risk has changed little in the past year and is low (see Figure 20). But for contagion risk, the heat map gives only a glimpse of the risk. Overall,

we view contagion risk as being moderate, but remain mindful that contagion is among the hardest of the financial stability risks to measure.

Systemically important banks

A key component of contagion risk is risk from the U.S. global systemically important banks. For the six largest G-SIBs, three key systemic risk measures that reflect contagion risk were at or near post-crisis lows in the fourth quarter of 2017 (see Figure 21). Still, the results

Figure 20. Financial System Vulnerabilities Monitor: Contagion Risk



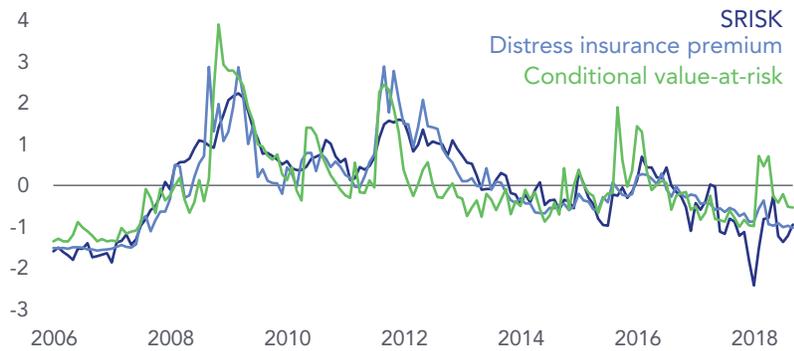
Note: BHC stands for bank holding company. Figure is from the OFR Financial System Vulnerabilities Monitor. Technical information about the monitor is available at www.financialresearch.gov/financial-vulnerabilities.

Sources: Bloomberg Finance L.P., Federal Financial Institutions Examination Council Call Reports, Federal Reserve Form Y-9C, Haver Analytics, OFR analysis

of the Federal Reserve’s 2018 Comprehensive Capital Analysis and Review suggest a need to watch for potential risks to large U.S. banks from the impact of defaulting counterparties. Losses resulting from stressed counterparties caused State Street to breach its minimum regulatory capital requirements under the severely adverse test scenario.

The OFR contagion index lets us zero in on risk posed by individual banks (see Glasserman and Young, 2013). From 2016 to 2018, contagion risk rose for three of the eight U.S. G-SIBs (see Figure 22). For two of the three — Bank of New York Mellon and State Street — contagion risk rose above its 2014 level. At the same time, the level of contagion risk posed by these two banks is small compared with the largest U.S. G-SIBs. The index is designed to capture potential spillovers to the rest of the financial system if a bank defaults. It combines measures of a bank’s leverage, size, and connectivity. Connectivity is measured as the share of a bank’s liabilities that other financial institutions hold. It does not capture connections that result from

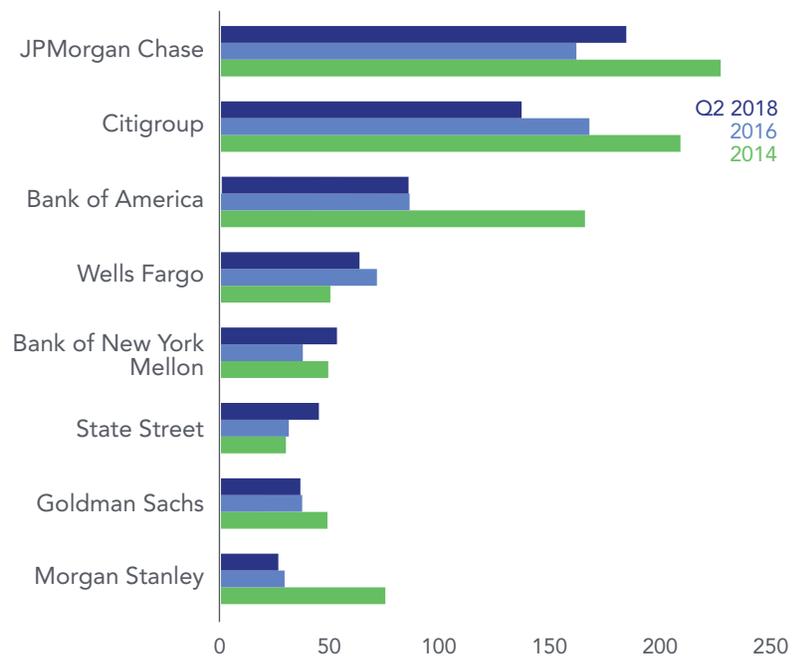
Figure 21. Systemic Risk for the Largest U.S. Bank Holding Companies Is Low (z-scores)



Note: Equal-weighted average. The six 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 Finance L.P., the Volatility Laboratory of the NYU Stern Volatility Institute (<https://vlab.stern.nyu.edu>), OFR analysis

Figure 22. OFR Contagion Index Declined for Most of the Largest U.S. Bank Holding Companies During Second Quarter 2018



Note: The values reported for 2014 and 2016 are based on year-end data. The values reported for 2018 are based on data for the quarter ending June 30, 2018. G-SIB stands for global systemically important bank. The OFR Contagion Index is a measure of financial connectivity that, together with size and leverage, measures a financial institution’s potential contribution to financial contagion. The index does not rely on data on network structure.

Sources: Federal Reserve Form Y-15, OFR analysis

a bank's provision of critical services to other banks.

Derivatives exposures

Exposures among counterparties in derivatives trades remain a source of contagion risk because they contribute to the interconnectivity among large financial firms. This risk has evolved over time. When the hedge fund Long-Term Capital Management faltered in 1998, the Federal Reserve organized a private consortium of the fund's creditors to buy and manage the wind-down of its derivatives holdings. A key concern was the potential for spillovers from a default of the fund to its derivatives counterparties (see Morrison and Edwards, 2005).

This concern contributed to the broadening in 2005 of the exemption of qualified financial contracts from the bankruptcy law's automatic stay on contract executions. Qualified financial contracts include derivatives, securities lending, and short-term funding transactions such as repurchase agreements. With the exemption, derivatives counterparties no longer face the possibility that the court would prevent them from closing

out their contracts with a bankrupt firm. Since the change, the exemption has applied to almost all derivatives contracts (see Roe, 2011, and Simkovic, 2009). The exemption is meant to reduce the risk of runs by counterparties before a firm's bankruptcy.

The expanded exemption soon gave rise to another risk from runs by a firm's derivatives counterparties when the firm files for bankruptcy. This run risk was realized when Lehman Brothers filed for bankruptcy in September 2008. Derivatives did not cause Lehman's failure. Lehman's counterparties terminated contracts with the firm, which caused losses on Lehman's derivatives book and magnified the impact of the firm's failure on the financial system.

Since Lehman's bankruptcy, tools have been developed to mitigate contagion risks between G-SIBs and the broader financial system, as discussed in our *2017 Financial Stability Report* (see OFR, 2017). However, the potential remains for a disorderly unwind of a large financial firm's derivatives portfolio in bankruptcy. A disorderly unwind can create uncertainty about the

impact on, and hence the solvency of, a failing firm's counterparties. This risk of spillovers to a failing firm's counterparties that could spark a broader financial crisis is defined as contagion risk.

Recent OFR research used credit default swap data to study the price impacts from the disorderly unwinding of a large financial firm's derivatives positions. It found that the price impacts could be similar to those from Lehman's bankruptcy (see **Effects of a Failed Financial Firm's Derivatives Exposures**).

A related goal of OFR research is to identify ways of managing counterparty risk exposures after a firm's failure. Our research shows that the most efficient ways involve netting counterparty exposures when possible. Netting involves the termination or cancellation of reciprocal payment obligations, the valuation of the terminated obligations, and the replacement of these multiple payment obligations with a single one. When a firm fails, surviving firms may be able to assume its counterparty exposures because in the process they reduce (net down) their own exposures

Effects of a Failed Financial Firm's Derivatives Exposures

Recent OFR research looked at the effects of the disorderly unwind of a failed financial firm's portfolio. Using transactions data, we considered the impact of such a scenario in the credit default swap (CDS) market, which is the market for credit default insurance (see Eisfeldt, Herskovic, Siriwardane, and Rajan, 2018). Our data cover market prices and exposures of firms trading uncleared CDS bilaterally from 2010 through 2013.

Our findings indicate that if a large net writer (seller) of credit protection fails, prices of default insurance can rise by as much as 40 percent. This estimate is similar to the price effects seen around the failure of Lehman Brothers. In our research and the Lehman episode, price increases resulted from fears by market participants of each other's failure in times of stress. Central clearing, a post-crisis reform, may diminish the impact of price swings related to counterparty risk. In central clearing, swaps transactions are cleared through central counterparties rather than conducted through two-way, or bilateral, transactions. Central clearing reduces the risk to each party in the transaction from the other party defaulting, but it also concentrates risk in the central counterparty itself.

Other OFR research examined how counterparty exposures may be managed following a firm's failure. To avert adverse price impacts, can a failing firm's exposures be assigned, or transferred, to other firms? Can this be done in some optimal way within a short time period? Like the other research, this analysis used confidential data on CDS exposures from the Depository Trust Clearing Corporation, but for 2010 through 2016. We made several assumptions to conduct the analysis. First, we assumed that after a firm's failure, but before the assignment of CDS exposures, surviving firms agreed to share risks. Second, these agreements were designed to net counterparty exposures. This approach works best for the failure of a firm that is similar to its survivors in the types of counterparties and its distribution of counterparty exposures. Central clearing may reduce these risks through risk management practices, but if they fail, can also impose obligations on clearing member firms that do not exist in bilateral uncleared markets.

to those counterparties. This approach might reduce counterparty risk arising from a firm's failure.

Counterparty risk could still rise for surviving firms in two ways. First, if the failed firm had unique counterparties, surviving firms

would take on new risk through the assumption of the failed firm's counterparty exposures. Second, the failed firm's counterparty risk exposures could be so large that excess risk remains even after surviving firms net down their

corresponding counterparty risk exposures as much as possible. The inability to fully net down counterparty risk could contribute to sizable price swings in times of stress.

Other Risks Bear Watching

Not all risks to financial stability fit neatly within the framework of our heat map. Operational risks are one example. Risks associated with financial technology innovations are another.

Operational risk is the risk of loss from internal inadequacies or failures — problems from lapses by people, processes, or systems — or from external events. Physical disasters, fraud, software and hardware failures, and maintenance lapses are examples of such operational risks. Risk managers need to consider these risks at a company-specific level. Regulators foster this behavior, for example, by requiring financial institutions to have in place and routinely test disaster recovery plans.

Sound risk management in the financial sector also requires viewing operational risks at a systemic level. Within the financial system, firms are connected in formal and informal networks. Operational incidents in one firm or network can spread through contagion. With this broader view, for example, regulators require financial institutions

to conduct due diligence on third-party service providers. Federal banking regulators also have conducted a review of interconnection risks and mitigants at the highest-risk service providers.

Cybersecurity risks are high-profile operational risks that warrant independent attention. We first discussed the risks to financial stability from cybersecurity incidents in our inaugural *2012 Annual Report* and have raised them every year since. In our 2016 report, we described the channels through which cybersecurity incidents could pose risks to financial stability. In 2017, we explored the link between cyber and operational risks. Without an operational failure, an attempted cyber incident generally would not succeed. Even if a firm's defenses are breached, other defenses, such as those designed to identify system intrusions, typically also would have to fail for a cybersecurity incident to do harm. To spread damage to other firms, the incident would also have to reach a transmission channel.

Recent OFR research shows how network analysis could help firms, markets, and regulators build stronger

defenses. Detailed data about the many links firms have to each other would support the use of network analysis to get a clearer picture of cybersecurity risks and other risks (see Schreft and Zhang, 2018).

Tabletop exercises are now common to better understand the effects across firms of a cyber incident. In a tabletop exercise, participants consider a hypothetical scenario, the risks posed to the financial system, and potential mitigants. Participants typically come from a range of institutions to achieve a systemic perspective. For instance, the U.S. Treasury led the Hamilton Series, tabletops that included participants from the government and private sector.

The financial industry runs other cooperative projects to encourage operational resilience, especially to cyber risks. The Financial Systemic Analysis & Resilience Center and the Financial Services Information Sharing and Analysis Center are examples.

In recent years, new digital financial assets have emerged that rely on cryptographic distributed ledger, or blockchain,

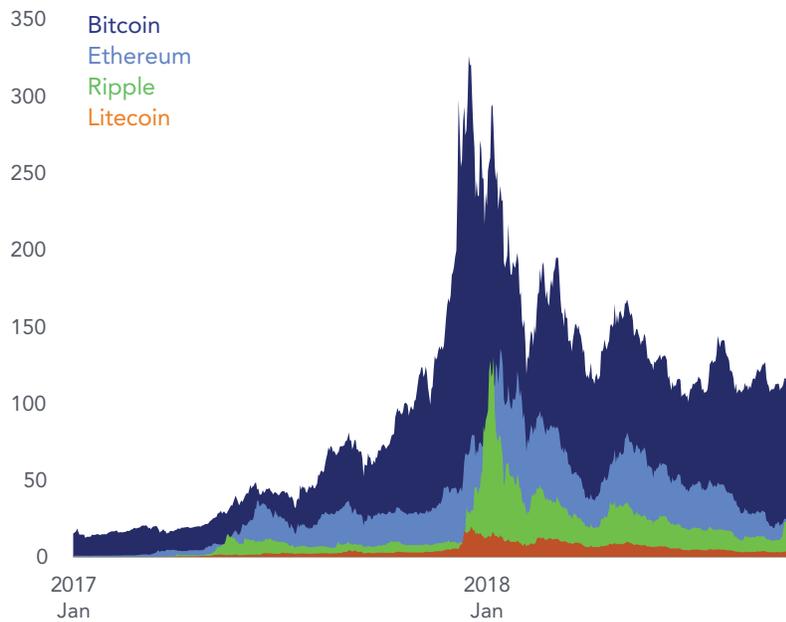
technology. Digital assets, also known as cryptoassets, include what are popularly known as cryptocurrencies, such as Bitcoin, as well as tokens and initial coin offerings. These assets have the potential to transform the financial sector — and to bring new risks.

In July, the international Financial Stability Board published a framework for monitoring the financial stability implications of cryptoassets (see FSB, 2018). The board does not consider these assets as posing a material risk to global financial stability at this time.

Our view is that cryptoasset markets are evolving rapidly and warrant monitoring to protect investors and maintain market integrity. We focus our attention on the largest subset of the market for cryptoassets — the cryptocurrency market. Most cryptocurrencies lack features to make them true currencies, but nevertheless are popularly called cryptocurrencies and aim to be currency substitutes. The estimated market capitalization of the most widely traded cryptocurrency, Bitcoin, rose in 2017 from \$16 billion to \$327 billion, but dropped to \$115 billion by late 2018 (see Figure 23).

For comparison, the U.S. money supply, including currency in circulation and short-term deposits, was about \$14 trillion in June 2018. Although we do not consider the narrow market for cryptocurrencies a current threat to financial stability, we examined it for its impact on financial system vulnerabilities and resilience. We concluded that it could be amplifying some types of financial stability risks, particularly market and liquidity risks (see **Markets for Cryptocurrencies: Some Risks, but Not a Current Threat to Stability**).

Figure 23. Market Capitalization of Blockchain-based Currencies Peaked in Late 2017 (\$ billions)



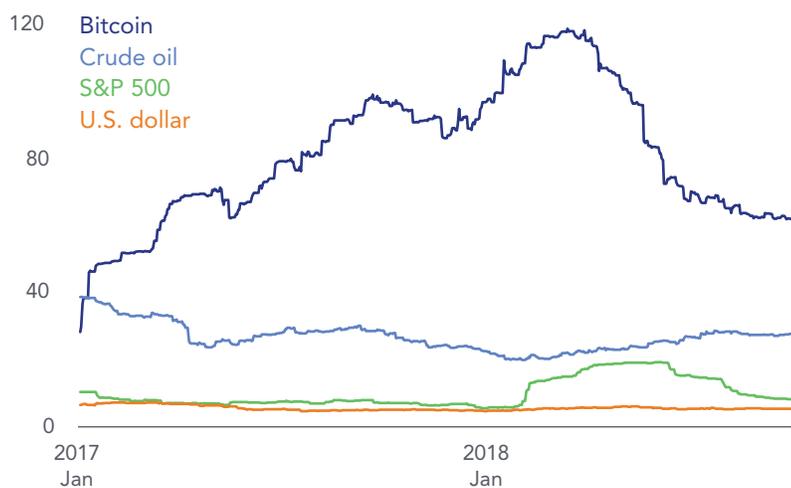
Sources: Coinmarketcap.com, OFR analysis

Markets for Cryptocurrencies: Some Risks, but Not a Current Threat to Stability

To assess the risks to financial stability from cryptocurrencies — Bitcoin and its competitors — we use the framework of our Financial System Vulnerabilities Monitor.

- Macroeconomic risk posed by the cryptocurrency market is negligible. The market is small enough that it is unlikely to affect household wealth or GDP in a way that would pose much risk to the U.S. economy. Likewise, the market currently is of little risk to the Federal Reserve’s ability to control the money supply to stabilize the economy.
- Market risk from trading in the assets is elevated. The price of Bitcoin and its counterparts is volatile relative to prices for other asset types (see Figure 24). These blockchain-based currencies typically have no intrinsic value, generate no cash flow, and have no backing to guarantee their value. The lack of foundation and potential lack of liquidity contribute to price volatility and manipulation risk.

Figure 24. Bitcoin Is a Highly Volatile Asset



Note: Volatilities are realized 90-day standard deviation of daily returns. Standard deviations set equal to 100 on Oct. 1, 2017.

Sources: Bloomberg Financial L.P., OFR analysis

- The limited statistics available on lending involving cryptocurrencies suggest little credit risk at this time. Only a few companies offer loans collateralized by these assets. Those loans are subject to the risk of a collateral shortfall because of the currencies’ volatility.

continued on next page

Markets for Cryptocurrencies, continued

- Solvency and leverage risk from financial institutions' exposures appears low. A credit card issuer could be exposed to higher losses if customers used their credit cards to buy cryptocurrencies. Most banks ban such purchases. Some exchanges for these assets allow trading on margin, meaning that a buyer borrows part of the funds needed to trade. For example, Hong Kong-based Bitfinex allows trades with up to 3.3 times leverage. U.S.-based Kraken allows up to 5 times leverage.
- Bitcoin and its counterparts could add liquidity risk to the financial system if they were more widely adopted. The risk arises through their design features. For example, Bitcoin transactions usually are lumped into blocks of a fixed size, and blocks are processed every 10 minutes. Between 3.3 and 7 transactions can be processed per second, according to analysts (see Coindesk, 2018). By comparison, Visa claims it executes up to 56,000 credit and debit card transactions per second (see Visa, 2018). Such limitations could stoke fire sales if investors tried to liquidate their holdings in times of stress.
- Contracts tied to cryptocurrencies and traded on exchanges could introduce contagion risk through exchanges that are highly interconnected. But the trading volumes of Bitcoin futures contracts, which began trading in 2017 at two major U.S. exchanges, are too low in total value for now to pose a financial stability risk. The development of derivatives markets in cryptocurrencies could help promote market liquidity and price formation by broadening trading opportunities. But the exposure of organized exchanges and their members to a highly volatile, untested asset class would entail added risks and require fine-tuning of risk management practices.

The regulatory framework in the United States subjects many cryptocurrency and, more generally, cryptoasset operators to oversight by their state regulators as money transmission businesses. Some data about these operators are available to regulators through reports that registered money services businesses file. However, not all states have adopted licensing and reporting requirements for these businesses. Available regulatory data show that reported U.S. trading volumes are notably below the volume of activity tracked by private data providers. The lack of comprehensive regulatory data about U.S. and global markets in all cryptoassets hinders regulators' ability to monitor the sector (see FSB, 2018).

Spotlight on Financial Markets: Volatility and Liquidity

U.S. financial markets provide capital to companies producing goods and services. More than in other countries, these markets are an important alternative to bank lending. They are large, liquid, and efficient, and as a result, generally resilient to shocks.

Part of what we do at the OFR is monitor and improve our understanding of market changes that can create or amplify risks to financial stability. Every year in our annual report, we spotlight some findings from these research efforts. This year, we focus on our work delving into some key features of financial markets.

Markets work best when their volatility reflects a healthy diversity of investor opinions about prices. Evidence indicates that markets can be more volatile than fundamentals warrant (see, for example, Campbell and Shiller, 1987). We discussed two prominent views about what drives low-volatility environments in our *2017 Financial Stability Report* (see OFR, 2017, 34-35). Low volatility can imply low uncertainty about underlying fundamentals, but low volatility can also encourage risk-taking that makes the financial system more fragile.

Markets also work best when they are liquid enough for investors to

have confidence they can execute trades in a reasonable amount of time and at fair prices. During times of market stress, illiquid markets can instill panic and accelerate fire sales that magnify losses to investors and the economy because of the lack of information about actual value.

In this section, we take a close look at volatility in the stock market and liquidity in the corporate bond market. We discuss what key measures tell us about how volatility and liquidity have changed and what they imply for U.S. financial stability.

Developments in financial markets in the past year make this research especially timely.

In the *2017 Financial Stability Report* and *2017 Annual Report to Congress*, we expressed concern that prolonged low volatility could lead investors to be complacent and take on too much risk. That risk was realized when market volatility returned in February 2018. It

exposed vulnerabilities from the use of trading strategies that needed continued low volatility to be profitable. In this year's analysis, we discuss findings from our recent research aimed at understanding shifts in volatility and the factors driving them.

The corporate bond market is growing in size and importance as a source of capital for nonfinancial firms. It has undergone structural changes since the 2007-09 crisis. We describe findings from our research using confidential regulatory data to better understand liquidity in this market. We conclude that liquidity remains robust generally — and more akin to pre-crisis levels — but has increasingly become constrained for very large trades. Our findings point to vulnerabilities that could reduce liquidity if the market entered a period of stress.

With these spotlight discussions, we aim to tie together our research on these two key topics for market stability.

Has Financial Market Volatility Returned?

The OFR has written often about the potential risks from the long period of low market volatility that began in 2012 (see OFR, 2017). During periods of calm, vulnerabilities can build. Investors may increase their leverage or reduce hedges against market price changes. These activities can magnify losses when volatility returns. Add in uncertainty about key firms' exposures, and you have a recipe for financial instability.

A modest spike in stock market volatility in February 2018 aimed a spotlight on the vulnerabilities we and others have previously discussed. This year, we analyze past shifts in stock market volatility (see **Market Volatility Key Takeaways**).

An important limitation to keep in mind is that market volatility can also be influenced by sentiment among market participants. Events with even a nebulous link to economic and financial conditions can influence volatility. Measures of market sentiment are not precise enough to include in our analysis.

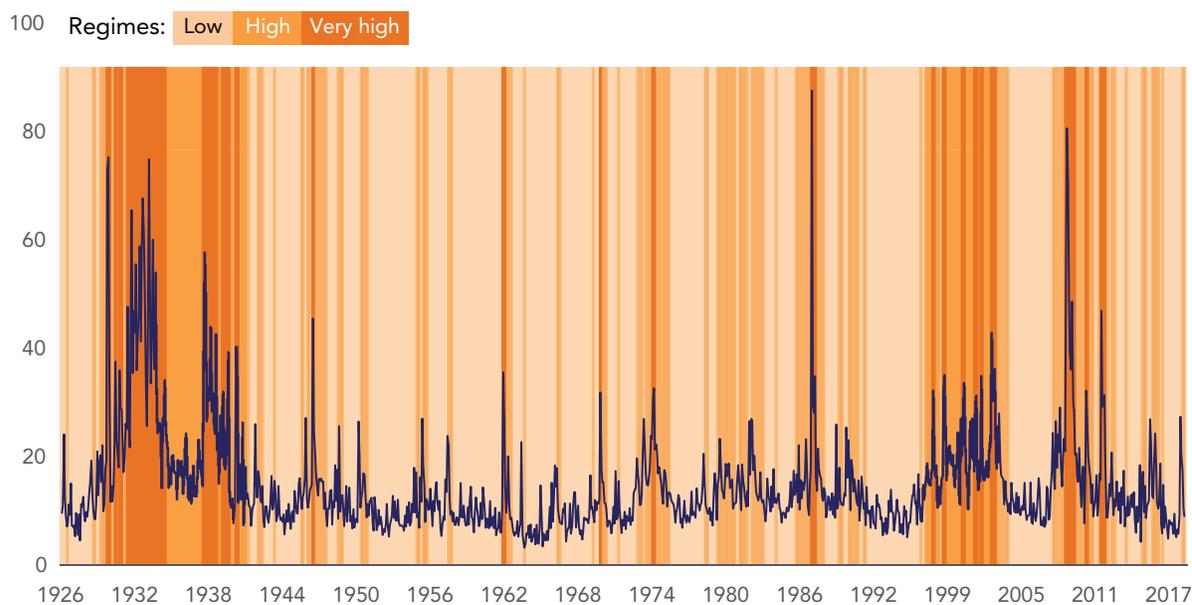
Measuring Shifts in Market Volatility

Historically, stock market volatility spikes are large — in some cases, very large — but otherwise volatility appears to fluctuate within a fairly narrow and much lower range (see **Figure 25**). This pattern suggests that a feasible approach is to classify time periods according to higher or lower volatility. We do so rigorously, and discuss how long periods of higher or lower volatility tend to last, and what shifts look like. We conclude with

Market Volatility Key Takeaways

- Low volatility historically has lasted longer than high volatility
- Spikes of very high volatility are rare and short
- Very high volatility is often, but not always, linked to certain economic and financial conditions
- Most of the time, macroeconomic conditions affect volatility more than financial ones

Figure 25. Stock Market Volatility Model Shows Very High Spikes Are Rare (annualized percent)



Note: Data as of June 2018. The dark blue line is realized volatility and is the monthly standard deviation of daily returns for a stock market index that includes all U.S.-listed firms weighted by their market capitalizations. Median realized volatility is 11.8 percent from January 1926 through June 2018.

Sources: Calculated based on data from the Center for Research in Security Prices ©2018 Center for Research in Security Prices (CRSP®), the University of Chicago Booth School of Business; OFR analysis

a closer look at the drivers of very high spikes in volatility.

We use a version of a “Markov switching model” to assign stock market volatility to a category, or regime. The model has three regimes — low, high, or very high volatility — from January 1926 through June 2018. We measure volatility as the variation in daily stock market returns within each month. By “stock market,” we mean an index that includes all U.S.-listed firms weighted by their market capitalization.

The categories of low, high, and very high do a good job of capturing the historical pattern of stock market volatility (see Figure 25). The model yields estimates of how long we stay in each regime and how likely we are to switch from one regime to another. This pattern is why it’s called a switching model.

The takeaways from our analysis are:

- The very-high-volatility regime occurs least often (9 percent of the time) and for the shortest period (an

average of four months). A very-high-volatility regime has never shifted directly to a low one in the next month.

- The high-volatility regime occurs more frequently (33 percent of the time). It lasts an average of six months. A high-volatility regime is much more likely to transition to a low one than to a very high one.
- The low-volatility regime occurs most often (58 percent of the time). It also lasts the longest (an average of 15 months).

A low-volatility regime rarely shifts directly to a very high one.

Shifts in regimes reflect abrupt changes in volatility. When volatility shifts from low to high, it increases by eight percentage points on average. When volatility shifts from high to very high, it increases by an average of 23 points. Shifts into very-high regimes appear to coincide with extreme market stress. Shifts from low to high regimes are not as sharp, but are more frequent.

Our analysis classifies the month of February 2018 as a high volatility period, but not a very high one. Volatility fell after that spike and settled into a low regime. As of June 2018, stock market volatility remained low, but not exceptionally so.

The European Central Bank (ECB) conducts a similar analysis in its *2018 Financial Stability Review*. The ECB uses a specialized version of our model, categorizes the regimes differently, and uses a different market index (see ECB, 2018). It reaches a similar conclusion — that low volatility lasts much longer than high volatility. However, the ECB's results

differ slightly because some of what they classify as moderate volatility is low or high in our model. The ECB finds market volatility to be moderate in February and April 2018.

Drivers of Very High Market Volatility

Because economic and financial conditions can drive shifts in market volatility, determining the set of factors that captures these effects is a key challenge. We evaluate several factors associated with these conditions by constructing a model, similar to one by Londono and Wilson (2018).

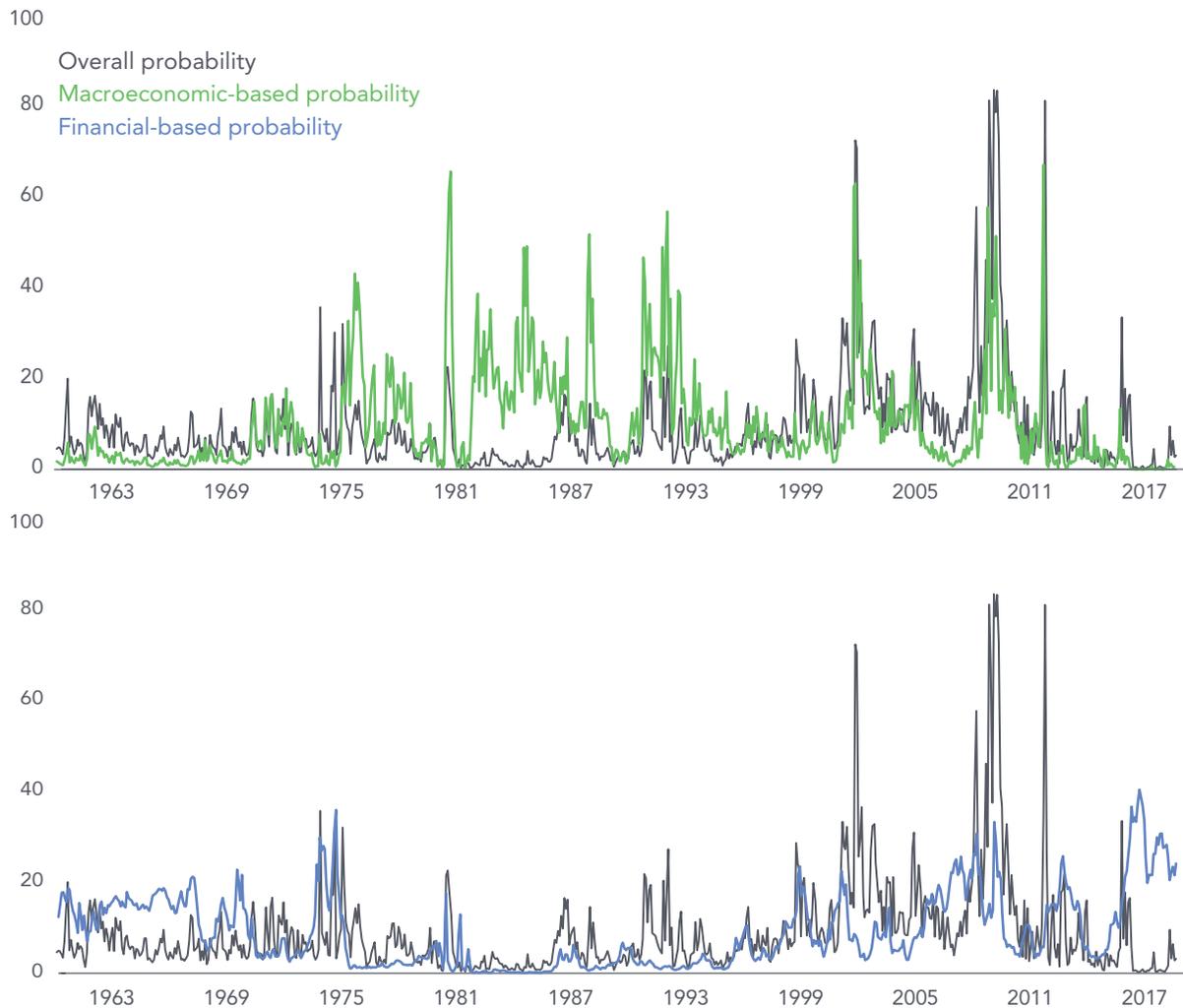
We use seven factors that represent macroeconomic conditions. The factors include inflation, industrial production, unemployment, recession odds, and policy uncertainty. Additionally, we use three factors that reflect short-term and long-term interest rates, and premiums for credit, which influence financial market conditions. Based on the values of these factors for a given month, we estimate the probability of a very-high-volatility regime occurring during the following three months. We use a logistic regression model, common for this type of analysis. We are

limited to using data from January 1960 through June 2018 because many data series do not start earlier.

We find that very high volatility can occur even when macroeconomic and financial conditions appear to be sound (see **Figure 26**). This finding suggests that factors not directly related to economic or financial market conditions can also drive very high volatility. For example, these other factors may be affecting market or economic sentiment more than activity.

We also look at macroeconomic and financial factors separately as drivers of very high volatility. We find that economic conditions usually contribute more to the odds of very high volatility than financial ones (see **Figure 26**). There are exceptions. During the 1960s and mid-1970s, for example, financial factors were more significant than economic ones. The same was true during the last few years, when probabilities based on financial factors were historically high. However, in both periods, the likelihood of a very-high-volatility regime remained low overall based on strong economic indicators. This finding is consistent with the view that the

Figure 26. Very High Volatility Is Driven More by Economic than Financial Factors (percent)



Note: Data as of June 2018. A logistic regression model is used to estimate the probability of a very-high-volatility regime based on macroeconomic and financial factors measured three months prior. The macroeconomic factors include the rate of inflation, U.S. industrial production, the unemployment rate, forecasted recession probabilities in the United States and the United Kingdom, and policy uncertainty indices for the United States and the United Kingdom. The financial factors include the 10-year Treasury security yield, the spread between investment grade and non-investment grade corporate bond yields, and the federal funds rate. We use the actual federal funds rate when it is above zero, and the shadow federal funds rate when the zero lower bound is binding, as calculated by Wu and Xia (2016).

Sources: Bloomberg Finance L.P.; calculated based on data from the Center for Research in Security Prices ©2018 Center for Research in Security Prices (CRSP®), the University of Chicago Booth School of Business; OFR analysis

robust economy supported low volatility during these periods.

In some instances, conflicting economic and financial indicators have preceded very-high-volatility spikes. These incidents suggest that such periods may be associated with heightened financial market vulnerabilities.

Conclusions

Historically, stock market volatility tends to be low most of the time and for long periods. High volatility can persist, but is more likely to be replaced by low volatility than very high volatility. Very high spikes in volatility are rare and brief.

The evidence shows that very high spikes in volatility

are not always associated with obvious economic and financial conditions. That makes them hard to predict. When those factors do matter, macroeconomic factors are more likely to drive very high volatility than financial ones. Still, financial factors are sometimes the prime driver, so those factors should not be ignored.

This analysis suggests that, if economic conditions remain robust, market volatility will likely stay low rather than shift to a very high regime. However, historically high financial market indicators keep us from ruling out the possibility of a shift to very high volatility. Conflicting indicators of this kind have preceded some volatility spikes in the past.

Corporate Bond Market Liquidity: Takeaways from TRACE Data

The corporate bond market is a large and important source of capital for nonfinancial firms. Its liquidity is commonly measured by the extent to which market participants can rapidly buy or sell a sizable volume of bonds at a low cost and with a limited price impact. Some market participants feel the market is less liquid than before the crisis. As evidence, they cite declines in the number of very large trades and in dealers' bond inventories. They also point to structural changes in the market since the global financial crisis as a possible driver of reduced liquidity. These structural changes include post-crisis regulations, changes in dealers' risk appetite, changes in investor behavior, and a large increase in the supply of outstanding bonds.

To better understand liquidity in secondary markets for corporate bonds, where previously issued investments are resold, we analyze measures of liquidity using confidential regulatory TRACE data. TRACE

— the Trade Reporting and Compliance Engine operated by the Financial Industry Regulatory Authority — captures information on corporate bond trades in the United States. We compare measures of corporate bond market liquidity based on TRACE information before and after the financial crisis. The evidence is consistent with the view that liquidity remains robust generally — and more akin to pre-crisis levels — with some exceptions (see **Market Liquidity Key Takeaways**).

An important caveat to our analysis is that market

liquidity can change rapidly and by a lot. The period after the crisis has been characterized by generally low market volatility, low interest rates, and declining spreads between long-term rates and short-term rates. We view our findings, particularly for interdealer trading, as turning a spotlight on vulnerabilities that could reduce liquidity if the market enters a period of stress.

Assessing Corporate Bond Market Liquidity

Trading volume affects liquidity because with more opportunities to buy and sell at a given price,

the odds of being able to sell if needed are higher. Larger volumes are generally associated with a more liquid market. However, we need to put volume into perspective to assess corporate bond market liquidity. Are we talking about small trades or large ones? All bond issues or only the most frequently traded ones? Clients or dealers? These market segmentations matter.

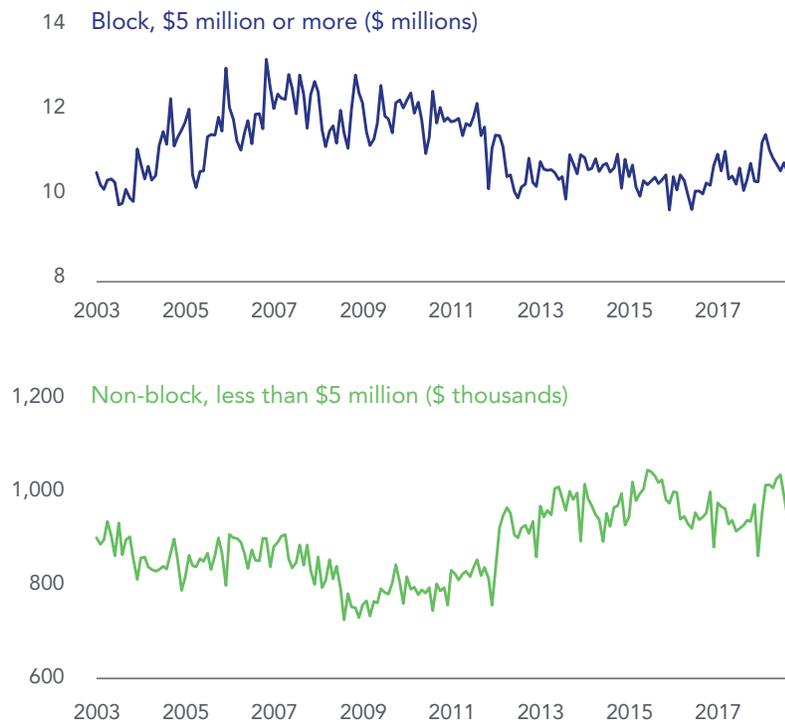
TRADE SIZE

Trade size tells us how much in dollars is transacted in a single trade. Average trade size is calculated as total trading volume in dollars divided by total number of trades. A larger average trade size generally reflects higher liquidity. For example, if the average trade size for a given market is \$1 million, then a trader needing to sell \$10 million of a particular security could sell through a series of 10 trades. In contrast, if the average trade size is only \$100,000, the trader would need to make many more trades over a longer period of time. This requirement exposes the trader to more market risk — the risk that market prices move against the trader before the series of trades is completed.

Market Liquidity Key Takeaways

- Very large trades are a smaller share of the market, which could mean less liquidity for these trades.
- A smaller share of trading volume in the top 1,000 bonds has mixed implications for corporate bond market liquidity.
- Interdealer trades — trades between two dealers on behalf of their firms rather than on behalf of clients — are a smaller share of the market, which could mean less liquidity for these trades.
- Estimated bid-ask spreads (the difference between the price a dealer is willing to pay to buy a bond and the price the dealer is willing to accept to sell a bond) are tighter, suggesting higher liquidity for the corporate bond market as a whole.

Figure 27. Average Non-block Trade Size for Investment-grade Corporate Bonds Is Larger than Before Crisis

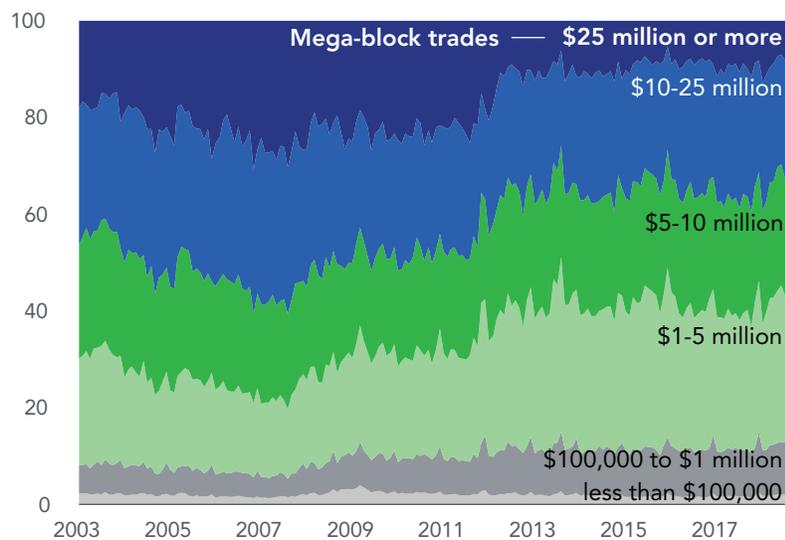


Corporate bond trades fall into two major categories by size. For investment-grade bonds, block trades are each at least \$5 million. Smaller trades are referred to as non-block trades. A large increase in the average size of non-block trades during 2011-12 has persisted, suggesting higher liquidity in that segment of the market (see Figure 27). For block trades, average trade size has declined modestly since the crisis.

By further segmenting our analysis, we can see that liquidity has not declined for all block trades. “Mega-block” trades, each of \$25 million or more for investment-grade bonds, are the source of the decline (see Figure 28). Mega-block trades are now a much smaller share of total bond trading volume. However, liquidity remains robust for other large trades as indicated by their steady shares of the market.

We find similar trends for high-yield bonds. However, market conditions for high-yield bonds and investment-grade bonds differ considerably. High-yield bonds trade less frequently, and fewer are outstanding compared with

Figure 28. A Smaller Share of Investment-grade Corporate Bonds Is Traded in Mega-blocks (percent of total)



Note (both figures): Includes dealer-to-client and dealer-to-affiliate trades; excludes convertible bonds. Figure 27 excludes trades sizes of less than \$100,000. Sources (both figures): FINRA TRACE, OFR analysis

investment-grade bonds. For high-yield bonds, block trades are each at least \$1 million in size. In the high-yield universe, block-trade size declined modestly after the crisis, while average non-block trade size increased markedly (see Figure 29).

We define mega-block trades for high-yield bonds as each being \$10 million or more in size. Most of the decline in mega-block trades involves trades of \$25 million and up (see Figure 30).

The decline in mega-block trading for all corporate bonds may be a result of the low-interest-rate, low-volatility environment. In such an environment, a trader has the luxury of breaking up a larger trade into smaller ones to get the best price. The larger the trade, the more likely that the bond's price will move against the trader. However, if market conditions were to change, investors could reverse their priorities and seek to trade more quickly, rather than breaking up trades. This situation could be problematic if the market were in distress and dealers became reluctant to take the other side of client trades. The

Figure 29. Average Non-block Trade Size for High-yield Corporate Bonds Is Larger than Before Crisis

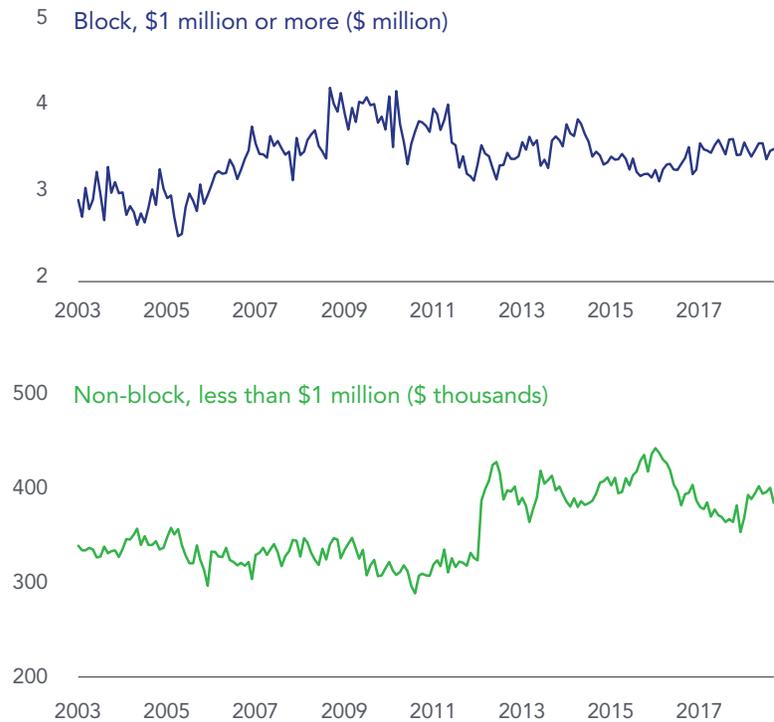
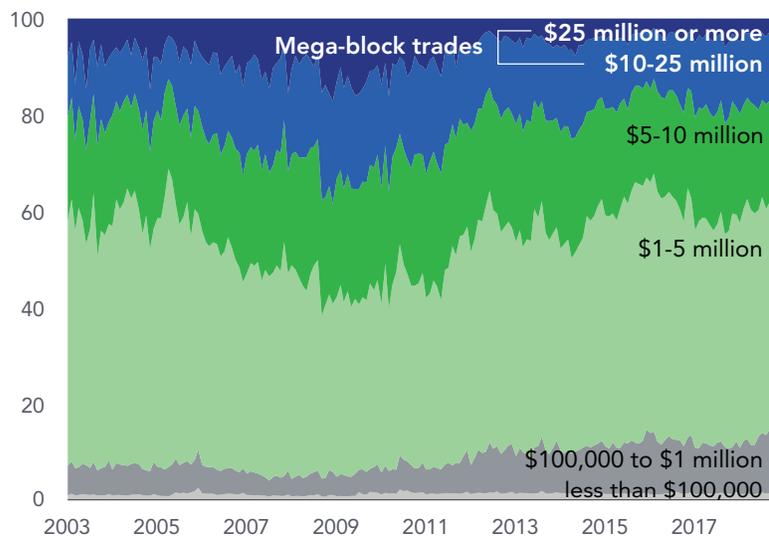


Figure 30. A Smaller Share of High-yield Corporate Bonds Is Traded in Mega-blocks (percent of total)



Note (both figures): Includes dealer-to-client and dealer-to-affiliate trades; excludes convertible bonds. Figure 29 excludes trades sizes of less than \$100,000. Sources (both figures): FINRA TRACE, OFR analysis

market would then be more likely to have more sellers than buyers. To maintain market liquidity under such conditions, dealers have to be willing to make a market.

TRADE FREQUENCY

Trade frequency refers to how often bonds trade. If a bond trades infrequently, the odds of being able to sell it are lower. The greater the frequency, the more liquid the market. Most corporate bonds trade infrequently. In fact, more than one-third of bonds never trade each year. Recently issued bonds generally are more actively traded than seasoned bonds.

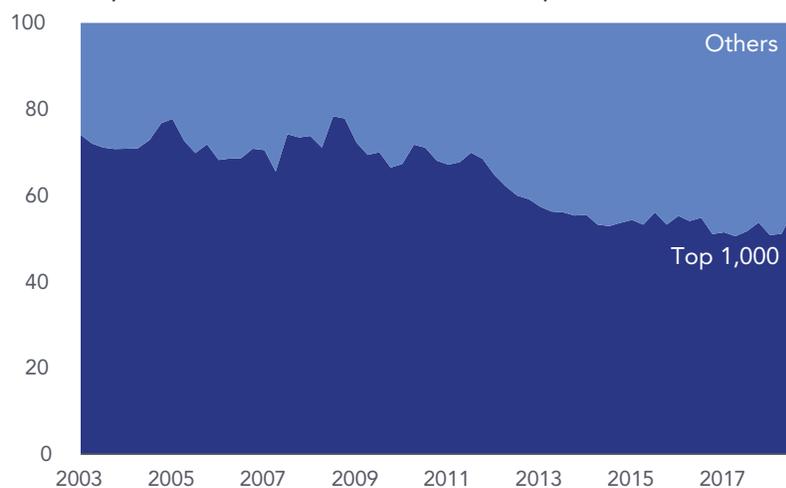
In discussions about market liquidity, we are primarily talking about actively

traded bonds. Trading is now divided among a larger pool of bonds after a big increase in the number of companies issuing bonds during the past decade. The top 1,000 most-traded investment-grade bonds account for 56 percent of trading volume, down from 78 percent during the crisis (see **Figure 31**).

The smaller share of trades for the top 1,000 bonds traded has mixed implications for bond liquidity. On one hand, more firms' debt is actively traded. On the other hand, with a larger number of bonds outstanding that may need to be traded, finding someone to take the other side of specific trades could be more difficult. Also, dealers potentially need to quote

prices for a larger universe of bonds for their clients who are looking to trade. This extra work comes at a cost to the dealer — for analyzing a larger number of issues related to the broader scope of bonds. All-to-all trading platforms, in which investors and dealers can trade directly with one another anonymously through an intermediary, might be somewhat helpful in facilitating trading for this larger pool of bonds (see **Effects of All-to-All Trading Platforms on Market Liquidity**).

Figure 31. Top 1,000 Investment-grade Corporate Bonds Make Up a Smaller Share of the Market (percent of total)



Note: Includes dealer-to-client and dealer-to-affiliate trades; excludes convertible bonds. Calculations are based on quarterly trading volume.

Sources: FINRA TRACE, OFR analysis

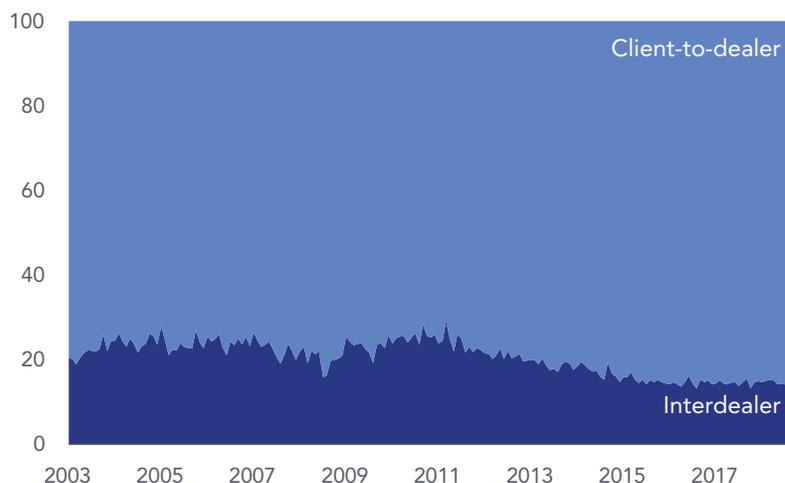
Effects of All-to-All Trading Platforms on Market Liquidity

Dealers have long been the main liquidity providers for investors trading corporate bonds. However, this feature of the market is evolving with technological advances that affect liquidity. Both new and existing electronic trading platforms allow for all-to-all trading protocols. Participants, both investors and dealers, can trade directly with one another anonymously through an intermediary.

Before the emergence of all-to-all trading, dealers served the role of price makers, while investors were price takers. A price taker submits a request for quotes to a network of dealers and accepts the best quote. This process remains the primary way corporate bonds are traded today. But with all-to-all trading, the investor is able to act as a price maker by responding to quote requests with bids or asks that effectively are the market clearing price. This activity can lower transaction costs and create a more diverse universe of liquidity suppliers. As a result, some trades may occur that otherwise would not.

Price making is not the same as market making. Investors are not providing the traditional intermediation services that dealers offer, such as on-demand liquidity for a fee and responding to bid and ask inquiries for a wide range of bonds.

Figure 32. Interdealer Share of Total Trading Volume Has Declined (percent of total)



Sources: FINRA TRACE, OFR analysis

INTERDEALER TRADING

Interdealer trading helps a dealer manage the market risk of holding bonds in inventory to meet client demands for immediacy. The share of interdealer trading volume has fallen by 10 percentage points in the last seven years (see **Figure 32**). This trend is not surprising given the greater emphasis on matching clients' buy and sell orders, and given the reduction in dealers' inventories of corporate bonds after the crisis. When dealers match offsetting client trades, there is less need for the dealers to offset their own

What Is Riskless Principal Trading?

Dealers are central to providing liquidity in the corporate bond market. There are two main trading models for corporate bonds. Each model emphasizes a particular way to provide liquidity to clients.

Dealers make markets for bonds. They hold bonds in their inventories to trade with clients on demand. They reduce their inventory risk by trading with other dealers in the interdealer market. This principal trading model provides clients with liquidity in the form of immediacy, but at the cost of a higher spread between prices at which clients can buy and sell bonds.

Riskless principal trading involves a dealer matching one client selling a bond with another client that wants to buy the same bond. There is little to no need for the dealer to take inventory risk. Bid-ask spreads are tighter for this type of trade because the dealer has less inventory and market risk that would be passed onto the client as a cost. Historically, tighter bid-ask spreads are perceived as a sign of better liquidity. But riskless principal trading comes at a cost to the client — namely, a lack of immediacy.

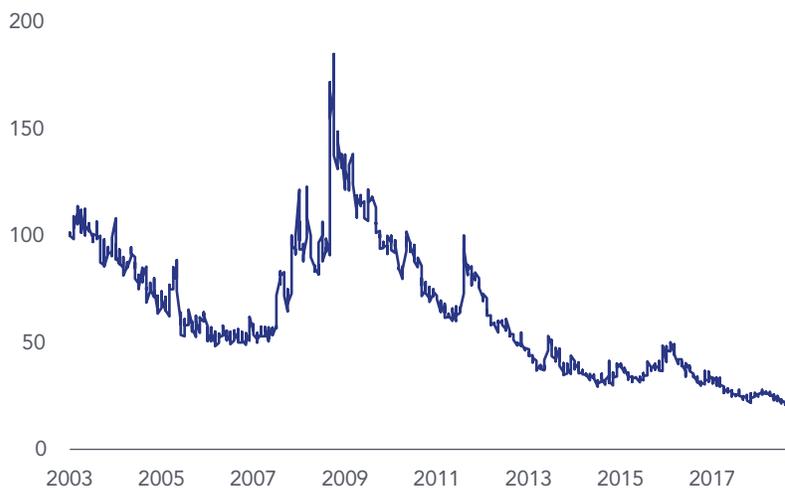
residual risk from trading with clients by trading in the interdealer market (see **What Is Riskless Principal Trading?**). Dealers generally incur more costs trading in the interdealer market than offsetting trades within their own client network.

PRICE IMPLICATIONS

The bid-ask spread is the difference in the prices at which market participants are willing to buy and sell a bond. Narrower bid-ask spreads are associated with higher market liquidity. The corporate bond market is an over-the-counter market where institutional clients trade directly with dealers.

We cannot observe pre-trade prices for corporate bonds, so instead we estimate bid-ask spreads using post-trade transactions reported to TRACE. The estimated bid-ask spread is the average price change per executed trade (see Thompson and Waller, 1987, 141-163). The logic behind this method is that among a sufficient number of trades within a short time, bond prices change primarily because of differences between bid and ask prices, not because of changes in fundamental factors such as credit risk and interest rates.

Figure 33. Estimated Bid-ask Spread for Investment-grade Bonds Has Fallen Below Pre-Crisis Low (basis points)



Note: A basis point is one-hundredth of a percentage point. Spreads shown are the median of the estimated spreads across bonds that trade each week. Estimated spreads are the weekly average of the within-day average of price changes for each bond (not including zeroes in calculating the averages). Average daily spreads require at least two client trades in the same bond that day.

Sources: FINRA TRACE, OFR analysis

The average estimated bid-ask spread spiked in 2008, but returned to pre-crisis lows in 2013 and returned below that point again after 2015 (see Figure 33). Generally speaking, spreads widen when volatility increases and market uncertainty is high. Market volatility mostly has been exceptionally low since 2012. Not surprisingly, estimated bid-ask spreads have narrowed. As of September

2018, the estimated bid-ask spread for investment grade bonds averaged about 21 basis points, or about 21 cents for each \$100 transacted.

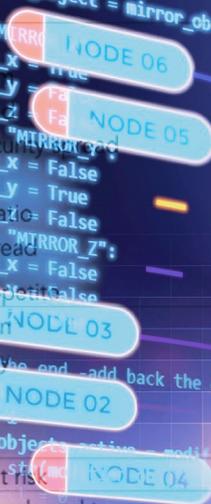
Estimated bid-ask spreads may understate trading costs in a liquidity crisis. For example, if the only bonds that trade are the ones for which buyers and sellers can get the best prices, the bid-ask spreads implied by trading data may be a poor

proxy for the spreads that would exist if traders were forced to quickly or unexpectedly sell a less-liquid bond.

Conclusions

Corporate bond market liquidity generally appears to be robust for most bonds. More companies are issuing bonds, and bid-ask spreads are low. There are possible exceptions. Trades of \$25 million or more make up a smaller share of the market, which could be an indication of lower liquidity for these large trades. Some individual bond issues may also be less liquid, and interdealer trading may have declined. The latter could be because dealers have less need to trade with each other. In a time of market stress, this combination means that trading is more likely to emphasize immediacy over cost. Spreads could widen. Under such conditions, the willingness of dealers to make markets for corporate bonds would determine whether or not liquidity evaporates.

Market Risk
Valuations/risk premiums
U.S. equity value
U.S. Treasury term
U.S. corporate
U.S. mortgage-backed security
U.S. house price/rent
U.S. house price/income ratio
U.S. CRE cap rate
Financial risk
U.S. bond investor duration
U.S. equity market volatility
Credit Risk
Household credit risk
Nonfinancial business credit risk
Real economy borrowing levels and terms
Solvency/Leverage Risk
Financial institution solvency
Financial institution leverage
Median U.S. BHC leverage



Status of the Efforts of the OFR in Meeting Its Mission



Organization

The year after the Dodd-Frank Act of 2010 established the Office of Financial Research, a small group of Treasury Department employees began to create a new federal organization to fulfill the OFR's mandates. They and subsequent OFR employees stood up the OFR, forming the organizational structure of the Office, setting initial priorities, writing policies and procedures, constructing a technical infrastructure, and expanding the OFR workforce.

Nearly seven years later — in FY 2018 — the OFR embarked on an effort to review its operations to ensure that the Office can efficiently and effectively achieve its mission.

The OFR also hired Charles River Associates to conduct an assessment of the OFR culture and treatment of employees. We released this report to the staff and the public in late 2017 and the then-Director testified before Congress on the report and the stability of the financial system.

Through self-assessment, consideration of the Charles River report, and discussions with Treasury Department officials, the OFR refocused its mission to primarily support the Financial Stability Oversight Council (FSOC) and its member agencies. This refocus resulted in an initiative to reshape the OFR workforce. The new structure positions the OFR as a data-driven organization with analytical capabilities serving the needs of its stakeholders. It also reflects additional emphasis on leveraging the support services of Treasury Departmental Offices, reducing management layers, and avoiding redundancy.

The first OFR Director, Richard Berner, was confirmed by the Senate in January 2013 and left the Office in December 2017. Ken Phelan, Chief Risk Officer at the Treasury Department, was appointed OFR Acting Director, effective Jan. 1, 2018. Since then, Phelan has served a dual role, continuing his work at Treasury while leading the effort to streamline the OFR to better support the FSOC. The initiative to reshape the OFR's organizational structure received

input from outside experts, the OFR leadership team, the Treasury Department's Office of Human Resources, and the Office of Personnel Management.

The OFR's current organizational structure retains its three centers to achieve the goals set by the Dodd-Frank Act (see **Figure 34**):

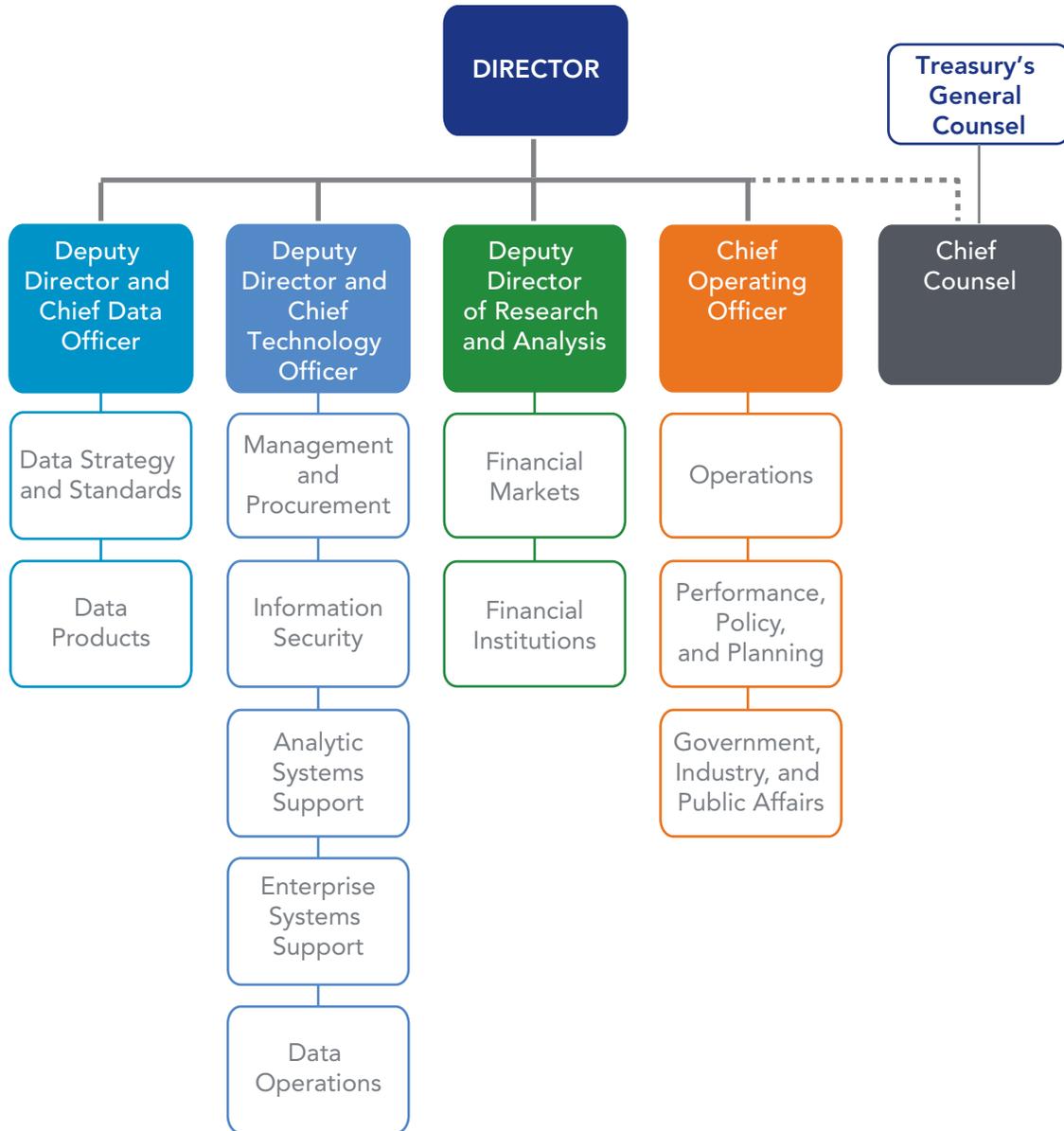
1. **The Data Center** leads and supports global efforts to develop and improve data standards for efficiencies in reporting and analyzing financial data. The Data Center also develops data products and promotes appropriate data sharing to meet stakeholder needs.
2. **The Research and Analysis Center** conducts applied and essential long-term research and analysis to support the stability of the U.S. financial system. The center produces financial stability monitors, research and briefings for the FSOC and other stakeholders, and evaluations of financial stability policies. Much of the center's work on longer-term research is published on the OFR website.

3. **The Technology Center** oversees OFR information technology systems and system security, including an information technology platform to support analysis with large-scale datasets. The Technology Center also acquires commercial, nonpublic, and proprietary data through procurements, provider agreements, and the OFR's own collection activities.

The OFR reshaping initiative streamlined three support divisions (Operations, External Affairs, and Office of the Chief Counsel) and combined them into two divisions:

1. **The Operations Division** provides expertise, implementation, policy, and oversight for organizational strategy and performance, budgeting, OFR publications, travel, human resources, procurement, and facilities. The division also maintains relationships and communicates with a broad array of stakeholders, including Congress, industry, the news media, and the OFR workforce. These support functions were managed in FY 2018 by

Figure 34. OFR Organizational Chart (as of October 12, 2018)



the OFR Director's Front Office, the Operations Division, and the External Affairs Division.

2. **The Office of the Chief Counsel**, which reports to the Treasury Department's Office of General Counsel, gives legal guidance on research and analysis, data acquisition and usage, policy initiatives, procurements, and agreements with other organizations. It also coordinates the Office's responses to oversight bodies, such as auditors and Congress.

The reshaping initiative included a shift away from the OFR's programmatic approach to its work, while retaining the important underlying projects related to financial stability research and data.

Workforce

In FY 2018, the OFR reduced its workforce from 210 employees to 152. About 40 additional positions were eliminated by the end of the following month. The reduction took place through employee attrition, use of incentives for voluntary separation and early retirement, and a reduction in force implemented during the fourth quarter of FY 2018.

The reshaping initiative scaled down the OFR management structure by abolishing or consolidating a number of senior roles. Overall, the number of senior managers and associate directors declined by 36 percent. The current OFR organizational structure has six senior managers: Director, three deputy directors, and two chiefs supervising 12 associate directors. The positions of OFR Director, Chief Operating Officer, and five associate directors are vacancies to be filled in FY 2019. Only the OFR Director position is a political appointment; a nomination for that position was referred to the Senate in June 2018.

The reshaping initiative aimed at reducing support positions and functions, while retaining functions related to the core OFR mission. Support functions were consolidated under the Chief Operating Officer and several separate business and procurement offices were abolished. The offices of the Chief of Staff; External Affairs; Strategy, Governance, and Performance; and Project Management were eliminated. Administrative support positions and human resources functions were also consolidated under the Chief Operating Officer.

Budget

The OFR obligated \$75.9 million in FY 2018 — 56 percent for labor and 44 percent for other expenses (see **Figure 35**). A large portion of the nonlabor figure is due to significant OFR expenses for data acquisitions (\$6 million) and technology software and hardware (\$11 million) to support the OFR’s unique mandates.

The OFR is an office within the U.S. Department of the Treasury, overseen by Congress and government auditors. Since its establishment, the OFR has responded to four audit engagements from the Government Accountability Office, and interviewed for another five; seven audits by the Treasury Inspector General; one audit by the Council of Inspectors General on Financial Oversight, and interviewed

for another one. OFR leaders have testified before Congress on five occasions: former Director Richard Berner testified four times as Director, and a former Chief Operating Officer testified once before the former Director’s confirmation.

Though part of the Treasury Department, the OFR is not funded by annual Congressional appropriations, but by semiannual assessments from bank holding companies with total consolidated assets of \$100 billion or more each, and nonbank financial companies supervised by the Board of Governors of the Federal Reserve System.

The OFR pays the Treasury Department nearly \$10 million per year for support for OFR human resources, budget, travel, and acquisitions activities. In addition, the Office pays Treasury more than \$6 million annually for information technology circuits; payroll services; and agency-wide systems for training, performance management, and human resources management. The OFR Director (currently Acting Director) must consult with the Treasury Secretary in establishing the OFR budget and workforce.

Figure 35. OFR Funds Obligated in Fiscal Years, 2014-18 (\$ thousands)

	2014	2015	2016	2017	2018
Compensation	24,168	29,036	32,485	37,379	31,991
Benefits	7,968	9,507	11,322	13,054	10,932
Labor Total	32,136	38,543	43,807	50,434	42,923
Travel	296	453	556	447	147
Communication and Utilities	5,332	3,811	62	179	131
Printing and Reproduction	27	31	26	22	8
Other Services	23,558	25,033	35,794	31,823	26,353
Supplies and Materials	4,947	8,060	8,312	6,508	5,649
Equipment	16,970	8,785	5,997	3,459	679
Grants			320		
Nonlabor Total	51,130	46,173	51,067	42,439	32,967
TOTAL	83,266	84,716	94,874	92,873	75,890

Note: Other services include rent and administrative support for human resources, conferences and events, facilities, and procurement.

Source: OFR analysis

Data Initiatives

LIBOR Alternative and Repo Data

The U.S. market for repurchase agreements, or repos, provides more than \$3 trillion in funding every day to securities dealers and others. But its vulnerability to runs and fire sales poses potential threats to financial stability. Data gaps persist in securities financing transactions, including repo agreements and securities lending. In particular, comprehensive and detailed data are scant for about half of the U.S. repo market — bilateral repo transactions.

The OFR is proposing to collect data on cleared bilateral repos. We are also exploring ways to learn more about uncleared bilateral repos.

In a repo transaction, a security owner sells a security to raise cash. The agreement requires the seller of the security to repurchase it on a specific date for a prearranged price.

For more than three decades, the London Interbank Offered Rate, commonly known as LIBOR, was the interest rate benchmark in global financial markets and the economy. U.S. dollar LIBOR has been used to set interest rates on trillions of dollars of retail mortgages, private student loans, corporate loans, derivatives, and other financial products. The rate is now known as Intercontinental Exchange LIBOR, or ICE LIBOR.

However, attempted manipulation of LIBOR during the financial crisis and ongoing doubts about LIBOR's reliability prompted the OFR and Federal Reserve to work with other agencies and market participants to devise a reliable, widely accepted, and transparent alternative.

To meet the need for a viable alternative rate, the OFR worked closely with the Federal Reserve to design a set of three interest rate benchmarks based on data on overnight repos.

The Alternative Reference Rates Committee, an industry group convened by the Federal Reserve Board and Federal Reserve Bank of New York, later named one of these rates — the Secured Overnight Financing Rate, or SOFR — as its preferred alternative to U.S. dollar LIBOR.

The Federal Reserve Bank of New York, in cooperation with the OFR, began publishing the three interest rate benchmarks in April 2018. The OFR is continuing to work closely with the Federal Reserve Bank of New York to oversee the production of the new rates and ensure they accurately represent what they are intended to measure. The SOFR currently relies on a set of repo transactions data provided voluntarily. The SOFR and other rates comply with the applicable sections of the International Organization of Securities Commissions "Principles for Financial Benchmarks," which sets standards for benchmark governance and accountability and the

quality of the methodology and benchmarks.

The successful launch of SOFR laid the groundwork for progress on alternative rates. Building on this progress, cleared futures referencing the SOFR launched in May 2018, and swaps referencing the SOFR launched in July 2018, achieving important steps in the reference rate committee's Paced Transition Plan, ahead of schedule.

In fiscal 2018, we issued a proposed rule covering the collection of data on cleared repo trades. This collection will produce critical data for monitoring financial stability, expand the source of data for input into the calculation and oversight of

the SOFR, and help ensure the continued availability of reliable data as markets evolve. When we released this report, we were evaluating comments on the proposed rule and developing next steps, including making the rule final and securing agreements with the Federal Reserve System to collect the data as our agent and then receive our collected data for use on the SOFR.

Data Standards

In FY 2018, the OFR continued its work to advance the Legal Entity Identifier (LEI) and other data standards, including for international reporting on derivatives market activities.

Legal Entity Identifier

Previous OFR annual reports cited advances in adoption of the LEI, the benefits of obtaining a sufficient volume of LEIs, and the costs and benefits associated with using regulatory mandates to foster adoption. In FY 2018, the LEI system moved from a start-up to an operational stage. The Global LEI Foundation took on virtually all operational activities and the Regulatory Oversight Committee performed more traditional activities in overseeing the foundation, while the role of the public sector remained important.

During the fiscal year, European Union regulators determined that, given the complexities of their 27-nation union, the benefits of requiring an LEI for stock-and-bond trades in Europe outweigh the approximately \$65-\$100 annual cost of maintaining an individual LEI. Companies are now required to have an LEI before they can trade in European markets.

The result has been dramatic. The number of LEIs issued increased in less than a year from fewer than 500,000 to more than 1.2 million (see Figure 36). Based on this growth, we

31896

Proposed Rules Federal Register
Vol. 83, No. 132
Tuesday, July 10, 2018

This section of the FEDERAL REGISTER contains notices to the public of the proposed issuance of rules and regulations. The purpose of these notices is to give interested persons an opportunity to participate in the rule making prior to the adoption of the final rules.

DEPARTMENT OF THE TREASURY
Office of Financial Research
12 CFR Part 1610
RIN 1505-AC58

Ongoing Data Collection of Centrally Cleared Transactions in the U.S. Repurchase Agreement Market

AGENCY: Office of Financial Research, Treasury.
ACTION: Proposed rule.

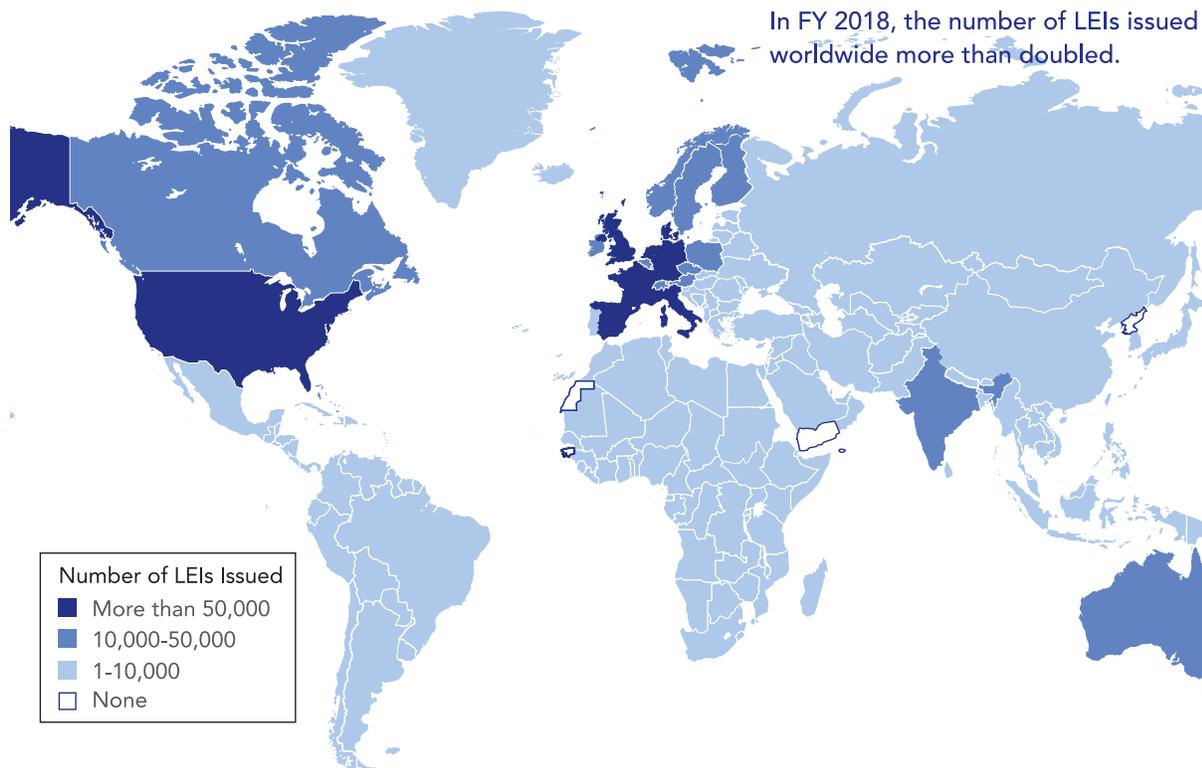
without change to <http://www.regulations.gov>, including any personal information provided.
For access to the docket to read background documents or comments received, go to <http://www.regulations.gov>.

FOR FURTHER INFORMATION CONTACT
Patrick Bittner, Senior Counsel, (202) 927-0035, patrick.bittner@ofr.treasury.gov; Matthew McCormick, Research Economist, (202) 927-8211, matthew.mccormick@ofr.treasury.gov

SUPPLEMENTARY INFORMATION:

- I. Executive Summary
- II. Repurchase Agreement Market Background
 - a. Importance of Repurchase Agreement Markets and Associated Vulnerability
 - i. Low-Risk Option for Cash Investment Deposit Substitute
 - ii. Monetizing Liquid Assets
 - iii. Transformation of Collateral

Figure 36. Number of Legal Entity Identifiers Issued Has Increased Worldwide



Source: Global Legal Entity Identifier Foundation

believe a more operational phase of the Global LEI System is beginning.

The increase — spurred by regulation — illustrates the benefit of a targeted approach to drive LEI adoption. The OFR’s proposed repo rule would require all counterparties and intermediaries to obtain LEIs. This requirement will improve regulators’ ability to aggregate total exposures for risk monitoring and net-out affiliate transactions for calculation of rates, such as the SOFR alternative to U.S. dollar LIBOR as an interest rate benchmark.

LEI regulation also encourages continued private sector adoption because market participants increasingly recognize that the LEI is accepted all over the world. The Global LEI Foundation commissioned a study by McKinsey and Company that found financial firms could save nearly \$700 million by using the LEI to help with simple tasks, such as bringing on clients and processing letters of credit.

The foundation has consistently produced high-quality reference data about the firms that have an LEI.

In addition, the foundation offers “challenge facilities,” metrics, rigorous accreditation standards, and technical support to improve data quality. The foundation also is rolling out information about corporate lineage — if an entity has a direct or ultimate parent with an LEI, those connections will be public.

In addition, the foundation hosts workshops to help market participants and vendors reap LEI benefits. For example, the foundation convenes a “Vendor Relationship Group” of financial data vendors,

works with vendors to map the LEI to other data standards such as the Business Identification Code, and convened a workshop in 2018 in San Francisco on digital identity management. Some banks are now voluntarily adopting the LEI.

The global foundation does its work under the supervision of the Regulatory Oversight Committee, a group of more than 60 authorities from around the globe including seven U.S. regulators. The OFR serves on its Executive Committee and the OFR Chief Counsel served as its inaugural chair. The current chair is from Bundesbank in Germany, and is supported by a vice chair from the Federal Reserve Bank of Dallas. The OFR also leads or participates in several policy work streams. We will continue to provide strong, consistent leadership on the LEI

among our fellow regulators in the United States.

Data Standards for Instruments in Derivatives and Repo Markets

During FY 2018, the OFR continued to make progress on key instrument standards. In the past we supported other agencies' development of the mortgage identifier and standards for the collection of derivatives data. During FY 2018, the OFR continued to serve on the Working Group for Harmonization of Over-the-Counter Derivatives Data Elements of the Committee on Payments and Market Infrastructures-International Organization of Securities Commissions (CPMI-IOSCO).

The OFR has been a core participant of the working group since it was established in 2014, and our participation was key to

developing and publishing the final technical guidance on the unique transaction identifier, unique product identifier, and the 101 critical data elements in 2018. The subgroup working on the critical data elements published a consultation document in August 2018 to seek feedback from the public and industry on the data elements framework.

In parallel with the CPMI-IOSCO work, the OFR continued to serve on the Financial Stability Board's Working Group on Unique Transaction Identifier and Unique Product Identifier Governance. We worked with representatives from the CFTC, SEC, and Federal Reserve Board on the working group, which met throughout the year.

The governance working group aims to recommend designation of one or more unique product identifier

FY 2018 CPMI-IOSCO Working Group's Focus

1. Developing a unique transaction identifier to identify individual over-the-counter derivatives transactions in reports to trade repositories.
2. Developing a unique product identifier to identify each product in a particular over-the-counter derivatives transaction that would be submitted to a trade repository.
3. Developing global guidance for defining, formatting, and using other critical data elements that are reported to trade repositories.

service providers that will manage issuing these identifiers and will offer recommendations for putting the identifier system in place and governing it in the long term. In April 2018, the governance working group published its second consultation paper on governance arrangements for the unique product identifier and in July 2018, published a provider self-assessment questionnaire.

The governance model is aimed at establishing an effective maintenance and governance framework for critical data elements. The model should ensure that definitions, formats, and allowable values of the data elements remain up-to-date and evolve to reflect and support market practices and authorities' needs.

The OFR's proposed rulemaking to collect repo data will also advance our data-standards agenda. In addition to proposing that a number of repo market participants use the LEI, the rulemaking would set a series of critical data standards for these instruments. If we expand this collection to other aspects of the repo markets, we would align the data standards for those instruments also.

Data Gathering

Our efforts to gather data from noncommercial sources in FY 2018 focused on our needs for assessing financial stability. The efforts span the public and private sectors, and continue to strengthen our data analytics and our data-sharing relationships with our stakeholders.

In January 2018, the OFR began collecting data for the FSOC's 2018 reevaluation of systemically important financial institutions. The FSOC uses these data to evaluate these institutions' exposures, asset liquidations, and risk transmission channels.

We recently obtained permission from the SEC to receive its Financial and Operational Combined Uniform Single Report, or FOCUS, the most comprehensive source of information on U.S. broker-dealers. The data will enable us to assess potential vulnerabilities in these complex institutions or in the markets they serve. We are also close to completing acquisition of other critical datasets.

Data Management

We recognized during the fiscal year that we needed to improve our data

management to continue providing timely, relevant, and accurate data for our researchers and the FSOC. In response, we developed a standard operating procedure for data management and a roadmap for improving our data management practices over the next three years.

Our focus in FY 2018 was to standardize and automate newly developed data management processes and procedures. We launched new software and developed operational processes to ingest newly acquired data more efficiently. We also redesigned our internal knowledge catalog to create a system that manages the full data lifecycle. This tool is now the central repository for cataloging all data-related information.

The system enhancements allowed for improved identification and cleansing of data, as well as better tracking and visibility of the users who access the data.

The internal Data Management Working Group, established to identify and resolve data governance issues, created an enhanced review process to improve the quality and shorten the delivery time for new data products. The

group also addressed the challenge of defining and improving the tracking of derived data (data derived from other data) and other characteristics about our use of data, so we are able to make more informed decisions about whether to continue to invest in existing datasets.

In addition, we have started a data quality pilot with a focus on data profiling. Data profiling will allow the OFR to better identify data anomalies when we take in new datasets and monitor data quality trends. Once these standards are implemented for all our datasets, we will identify data quality rules specific to individual datasets or elements.

Interagency Data Inventory Upgrades and Metadata Repository

The FSOC Interagency Data Inventory of the FSOC Data Committee is a catalog of the data collections of FSOC member agencies and other government organizations. The inventory does not contain data; it holds the metadata about each collection. Metadata is data about data.

These metadata are all publicly available but are sometimes hard to find. The

inventory can be used to search for data collections more easily and analyze gaps and overlaps in data collections. Each FSOC member organization determines which of its data collections to include in the inventory.

In 2018, we added the metadata for data collections by other governmental agencies that could be useful for financial stability analysis and research.

The interagency inventory contains a brief description of each data collection and basic information such as the collecting organization, the name and number of the form used to collect the data, and the type of collection such as financial or supervisory. In FY 2018, FSOC expanded the inventory so its member organizations could include additional information, such as the frequency of the collection, the website address and link to instructions and forms, and the website where the underlying data are found if the data are publicly available.

This year, we also created a new Web interface for the inventory and a new system to categorize the data in the collections. Examples

of data categories include accounting, consumer, and risk and vulnerability information. The new interface allows users to filter the collections by key word, organization, collection type, or data category.

The OFR is also working to build on the success of the Interagency Data Inventory with a metadata repository to provide a more connected and complete view of the data necessary for financial stability decision making and to overcome the barriers that hinder data sharing. We have completed an internal pilot of the metadata repository and developed plans to engage FSOC agencies in metadata collaboration.

Ultimately, we plan to serve as the knowledge center for financial data and financial data standards, with a focus on the data and data standards critical to financial stability. The metadata repository will contain metadata describing financial data, data standards, and links to organizations such as domestic and international regulatory bodies, standards organizations, and private-sector organizations.



Collaboration

Support of FSOC and its Members

FSOC is the OFR's primary stakeholder and its needs are key in guiding the work of the office. The OFR supports FSOC and its member agencies by providing data, research, and analysis. The OFR collects data from nonbank financial institutions at the request of FSOC. The Director of the OFR is a nonvoting member of FSOC.

To focus the OFR's research and data agendas, the OFR and FSOC collaborate to ensure that proposed research and data topics, projects, and publications are consistent with the OFR's mission.

The OFR leads the FSOC Data Committee, which shares information and coordinates action on data-related topics. The development of the Interagency Data Inventory is overseen by the committee.

We also collect, maintain, and share supervisory and commercial datasets with

the FSOC. The OFR has provided FSOC with more than 65 datasets and is currently working to launch a system that will allow secure data sharing among the FSOC, its member agencies, and the OFR.

The OFR also responds to requests for research and analysis from FSOC, which

help the FSOC identify threats to financial stability.

The OFR works with FSOC member agencies on research and data projects. We also evaluate the effectiveness of regulatory policies.

In FY 2018, the OFR worked with the Federal Reserve to collect and analyze data as

2018 OFR Support to FSOC and Its Member Agencies

- Collect data at FSOC's request.
- Provide support and expertise to FSOC committees.
- Contribute to the production of the FSOC's annual report.
- Supply data and analysis regularly on market trends.
- Conduct research at the request of FSOC.
- Present insights from our data monitoring products — Financial System Vulnerabilities Monitor, Financial Stress Index, U.S. Money Market Fund Monitor, and G-SIB (global systemically important banks) Scores Interactive Chart — to FSOC.
- Provide data and analysis for the nonbank designation process.

part of a project to develop an alternative to LIBOR, an interest rate benchmark known as the London Interbank Offer Rate. In July 2018, the OFR posted a request for comment on the proposed data collection for the alternative reference rate.

The OFR continued during the year to update our suite of financial stability monitoring products, including the U.S. Money Market Fund Monitor, which tracks the investment portfolios of money market funds. Users of the monitor can see trends and developments across the money market fund industry. The OFR updates the monitor with data from the SEC and

presents the data in a visual format.

Financial Research Advisory Committee

The OFR Financial Research Advisory Committee, established in 2012, provides industry expertise to help the OFR fulfill its mission. This guidance helps focus and inform the OFR's work on relevant issues related to financial stability. The advisory committee is made up of members who are experts in business, economics, finance, data science, risk management, and information technology.

The committee meets twice each year and is governed according to the Federal Advisory Committee Act. The agenda and minutes of each meeting are available on the OFR's public website.

The July 2018 meeting was the first time the OFR issued specific charges, or research requests, to advisory committee members. The OFR asked for feedback on three topics: central counterparty resolution, metrics to monitor market liquidity, and examples of duplicative or inconsistent regulatory reporting requirements. Advisory committee members and the OFR discussed how to best approach this research and deliver findings.

2018 Financial Research Advisory Committee Meetings

February 15, 2018 • Department of the Treasury

This meeting included feedback on Treasury reports responding to the Presidential Executive Order on Core Principles for Regulating the United States Financial System. Topics of discussion related to the reports included nonbank designations, an activities-based approach to financial regulation, the Volcker Rule, and central counterparty resolution. The OFR received updates from the committee's Financial Services Risk Management subcommittee, the Data Technology Standards subcommittee, the Research subcommittee, and the Financial Innovations working group.

July 26, 2018 • Federal Reserve Bank of New York

This meeting was the first held under a new topic-based format. The central counterparty resolution working group, the market liquidity working group, and the regulatory reporting working group all led discussions with the committee. The OFR provided updates on the notice of proposed rulemaking, and the legal entity identifier.

OFR Cosponsored Conferences

The OFR and the Federal Reserve Bank of Cleveland, along with the University of Maryland's Robert H. Smith School of Business, held their annual financial stability conference in Washington, D.C., from Nov. 30 to Dec. 1, 2017. Policymakers, industry representatives, and academic experts focused on the financial stability implications of financial technology innovation, or fintech, on U.S. macroprudential policy and regulation.

The conference included keynote speeches by Federal Reserve Board Governor Randal Quarles and New York University professor David Yermack, as well as sessions and panel discussions. Topics included:

- How is fintech shaping competition and regulation in the financial sector?
- What challenges and opportunities does fintech represent for firms and upstarts?
- How should regulators distinguish between — and respond to

— beneficial innovation and circumventing of regulation?

- What frictions may be affecting the influence of fintech? Is big data helping to fill existing gaps, or is it creating new gaps?
- Will regulatory technology reduce data collection burdens or become a compliance headache?
- How can regulators protect growing supervisory datasets from cyber threats, and mitigate the potential abuse of big data analytics and algorithms in systemic monitoring?

The OFR and the University of Michigan's Center on Finance, Law, and Policy hosted their third annual Financial Stability Conference on November 16-17, 2017, at the University of Michigan Law School. The conference explored fintech innovation risks and opportunities from an interdisciplinary perspective. It focused on how fintech continues to disrupt and evolve, not only in how financial products and services are delivered, but in who delivers them. Regulators and market participants face challenges

in understanding and balancing the benefits of fintech against its potential risks.

Lael Brainard of the Federal Reserve Board of Governors and Gillian Tett, U.S. Managing Editor of the Financial Times, delivered keynote remarks.

Panels discussed topics including:

- regulation of fintech firms and the Office of the Comptroller of the Currency's fintech charter;
- market innovations in high-frequency trading, machine learning, and artificial intelligence, including explorations of market efficiency, fairness, investor protection, and systemic issues;
- ways that technological innovation in lending, derivatives clearinghouses, and payments systems may contribute to, or help overcome, systemic risk;
- cybersecurity, and positive and negative network disruptions that can occur with innovation;
- how fintech might help expand access

to financial products and services for low- and moderate-income people throughout the world;

- how regulators can encourage innovation and use technology to improve data collection, analytics, and regulation; and
- trade-offs between policies to promote innovation and competition, and policies to maintain stability and protect consumers.

Participation in Events and Working Groups

- An OFR researcher presented the OFR working paper, "Contagion in the Credit Default Swap Market," at the Federal Reserve Bank of Boston's 2017 Stress Testing Research Conference. (Oct. 3, 2017)
- OFR researchers gave a press demonstration for the launch of the OFR's Financial System Vulnerabilities Map and Financial Stress Index. (Oct. 24-25, 2017)
- The OFR chaired periodic meetings of the FSOC Data Committee, providing presentations of its metadata repository, interagency data inventory, the LEI, and other matters. (October 2017, February 2018, June 2018)
- An OFR researcher served as a panelist in a session on data availability in repo markets at the Finadium Rates and Repo Conference. (Nov. 1, 2017)
- An OFR staff member gave a presentation on cross-market surveillance analysis at the Commodity Futures Trading Commission. (Nov. 2, 2017)
- An OFR researcher presented the OFR working paper, "The Market-implied Probability of European Government Intervention in Distressed Banks," at the Federal Reserve Bank of Atlanta's conference, "Financial Regulation: Fit for the Future?" (Nov. 2-3, 2017)
- An OFR researcher served as a panelist in a session on methods of secure data sharing in the financial services industry at the Massachusetts Institute of Technology's Internet Policy Research Cybersecurity Workshop. (Nov. 8, 2017)

[continued on next page](#)

Participation in Events and Working Groups, continued

- Members of the OFR staff moderated or delivered presentations at conferences the OFR cosponsored with the University of Michigan's Center on Finance, Law, and Policy (Nov. 16-17, 2017) and with the Federal Reserve Bank of Cleveland, along with the University of Maryland's Robert H. Smith School of Business. (Nov. 30 to Dec. 1, 2017)
- OFR staff members participated in sessions at Columbia University conference, "Ten Years After the Financial Crisis." (Dec. 7, 2017)
- An OFR researcher presented the OFR working paper, "How Safe are Central Counterparties in Derivatives Markets?" at the Commodity Futures Trading Commission. (Jan.3, 2018)
- An OFR staff member presented, "Credit Default Swap Market Structure, Before and After the Volcker Rule," at the Federal Reserve Board of Governors. (Jan. 8, 2018)
- An OFR staff member presented, "Credit Default Swap Market Structure, Before and After the Volcker Rule," at the Commodity Futures Trading Commission. (Jan. 9, 2018)
- An OFR researcher presented, "Networks: Games, Contagion, and Control" to a class at Columbia University on financial networks. (Feb. 8, 2018)
- An OFR researcher was a panelist at a session on financial network measurement at the Columbia University conference, "Financial Networks: Big Risks, Macroeconomic Externalities, and Policy Commitment Devices." (Feb. 23, 2018)
- An OFR staff member presented research on estimating agent-based models at the Eastern Economic Association conference. (March 1, 2018)
- An OFR researcher presented the OFR working paper, "Contagion in Credit Default Swap Markets," at the International Monetary Fund. (March 1, 2018)
- OFR staff members demonstrated the Financial System Vulnerabilities Monitor and served as panelists at the Global Association of Risk Professionals convention. (March 6-7, 2018)
- An OFR staff member moderated a panel on Digital Identification and the LEI in San Francisco. (March 2018)
- OFR staff members presented on the importance and usefulness of ontologies in managing metadata at the Enterprise Data World conference. (April 2018)

[continued on next page](#)

Participation in Events and Working Groups, continued

- An OFR researcher served as a panelist at the Financial Information Management Association 2018 conference. (May 3, 2018)
- An OFR staff member moderated a panel, "Machines Learning Regulation," at the Federal Reserve Bank of Atlanta's 23rd annual Financial Markets Conference, "Machines Learning Finance: Will They Change the Game?" (May 6, 2018)
- An OFR staff member demonstrated the Financial System Vulnerabilities Monitor and Financial Stress Index at the Columbia University School of International Public Affairs second workshop on Cyber Risk and Financial Stability. (May 10, 2018)
- An OFR researcher presented, "Measuring Risks in Hedge Funds: Evaluation and Usefulness of Exposure Data in Form PF," at the Federal Reserve Board. (June 5)
- OFR researchers presented an OFR discussion paper, "An Ontology of Ownership and Control Relations for Bank Holding Companies," at the Data Science for Macro-Modeling with Financial and Economic Datasets workshop. (June 15, 2018)
- An OFR staff member discussed research on run risk in depository institutions at the Western Finance Association meetings. (June 19, 2018)
- An OFR staff member served on a panel about emerging uses of the LEI outside the financial sector. (June 2018)
- An OFR researcher presented the OFR working paper, "How Safe are Central Counterparties in Derivatives Markets?" at the Society for Economic Dynamics Annual Meeting. (June 28, 2018)

Information Technology

Major Initiatives

Following significant investment in hardware platforms to stand up the OFR's information technology (IT) services, the Office was faced with a decision to replace aging hardware or consider an alternative approach. OFR leaders decided to begin moving the OFR's core IT systems to third-party cloud offerings — moving IT systems from local servers to a network of remote servers hosted by private cloud providers to store, manage, and process data. Moving the OFR's IT systems to the cloud will result in lower annual operating-and-maintenance expenses and a more flexible infrastructure that can adapt quickly to changing business models. It will also help avoid future hardware expenses, without any sacrifice to information security.

Our initiative to move the OFR's IT systems to the cloud is called the NextGen Initiative and was a major IT priority for FY 2018. Phase 1 of our migration to the

cloud is expected to be complete in late FY 2019 and will reduce operating and maintenance expenses by about \$2 million per year.

Information Security

The OFR brings large amounts of data into its information systems. The security of that information is a top priority. The OFR's information security program is operated in compliance with guidance from the National Institute of Standards and Technology, which includes performing risk assessments for all new or changed IT capabilities. Throughout FY 2018, the information security team applied necessary patches to bolster security and ensure OFR systems are protected from newly identified threats.

The OFR's IT security team ensures that all systems are in compliance with established policies, guidance, and best practices. During FY 2018, the team achieved initial operating

capability with three products mandated by the Department of Homeland Security's continuous diagnostics and monitoring program. Internal and external penetration tests of the OFR's systems were performed by an independent third party. These tests yielded no significant findings of concern.

In FY 2018, the IT security team updated security policies and procedures, and developed specialized training material to enhance the OFR's internal privacy training program. This training will be mandatory for OFR staff members who perform certain privacy-related roles within the Office.

Throughout the fiscal year, the information security team conducted security risk assessments for:

- the NextGen Initiative,
- connectivity for Apple Macintosh computers,
- an emergency mass notification system,

The NextGen Initiative

- **Website relocation.** We migrated the OFR's public website, financialresearch.gov, from one cloud provider to another. The migration resulted in an annual savings of \$800,000 and gave us a platform to accommodate new business requirements. We completed this step in FY 2018.
 - **Migrating analytic systems.** Moving the OFR's analytic systems to the cloud will provide more flexibility to accommodate shifting systems requirements and result in cost savings. Work began in FY 2018 and is expected to be complete in FY 2019.
 - **Migrating backup and archival systems.** This migration will eliminate the need for a costly expansion to in-house systems. Work to migrate the OFR's backup and archival systems to the cloud began in FY 2018.
 - **Migrating the OFR's e-mail system.** The analysis, design, and engineering work for migrating the OFR's e-mail system to the cloud began in FY 2018.
 - **Migrating the OFR's Internet service.** The OFR's dedicated Internet service will be migrated to the Treasury Shared Service provided by Treasury's Bureau of Fiscal Services. By using this system, the OFR will be able to use the advanced security features that the Bureau of Fiscal Services plans to deploy. Work on this migration began in FY 2018.
 - **Reengineering the OFR's telecommunications network.** To accommodate the cloud migration initiatives, we will need to reengineer much of the OFR's telecommunications network. This work began in the fourth quarter of FY 2018 and will continue through FY 2019.
- a financial network analysis tool and its associated infrastructure,
 - an electronic authentication feature on the OFR's public website,
 - reconfiguration of the OFR's internal wireless network,
 - the triparty repo data collection for the alternative reference rate project, and
 - an upgrade to the new version of the Linux operating system.

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