World Economic and Financial Surveys

# Global Financial Stability Report

## A Bumpy Road Ahead

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World Economic and Financial Surveys

# Global Financial Stability Report

## April 2018

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## Editor's Note (May 11, 2018)

This online version of the GFSR has been updated to reflect the following changes to the print version:

- On page 6 (Figure 1.4), the data for Germany in panel 3 have been corrected and a note was added.
- On page 31 (Figure 1.17), the data in panel 3 have been corrected.
- On page 37 (Figure 1.21), the x-axis labels in panel 4 have been corrected.
- On page 49 (Figure 1.2.1), the second and third sentences in the note were added.



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# ASSUMPTIONS AND CONVENTIONS

The following conventions are used throughout the *Global Financial Stability Report* (GFSR):

. . . to indicate that data are not available or not applicable;

— to indicate that the figure is zero or less than half the final digit shown or that the item does not exist;

– between years or months (for example, 2016–17 or January–June) to indicate the years or months covered, including the beginning and ending years or months;

/ between years or months (for example, 2016/17) to indicate a fiscal or financial year.

"Billion" means a thousand million.

"Trillion" means a thousand billion.

"Basis points" refers to hundredths of 1 percentage point (for example, 25 basis points are equivalent to ¼ of 1 percentage point).

If no source is listed on tables and figures, data are based on IMF staff estimates or calculations.

Minor discrepancies between sums of constituent figures and totals shown reflect rounding.

As used in this report, the terms "country" and "economy" do not in all cases refer to a territorial entity that is a state as understood by international law and practice. As used here, the term also covers some territorial entities that are not states but for which statistical data are maintained on a separate and independent basis.

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## Corrections and Revisions

The data and analysis appearing in the *Global Financial Stability Report* are compiled by the IMF staff at the time of publication. Every effort is made to ensure their timeliness, accuracy, and completeness. When errors are discovered, corrections and revisions are incorporated into the digital editions available from the IMF website and on the IMF eLibrary (see below). All substantive changes are listed in the online tables of contents.

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# PREFACE

The *Global Financial Stability Report* (GFSR) assesses key risks facing the global financial system. In normal times, the report seeks to play a role in preventing crises by highlighting policies that may mitigate systemic risks, thereby contributing to global financial stability and the sustained economic growth of the IMF's member countries.

The analysis in this report has been coordinated by the Monetary and Capital Markets (MCM) Department under the general direction of Tobias Adrian, Director. The project has been directed by Fabio Natalucci and Dong He, both Deputy Directors, as well as by Claudio Raddatz and Anna Ilyina, both Division Chiefs. It has benefited from comments and suggestions from the senior staff in the MCM Department.

Individual contributors to the report are Ali Al-Eyd, Adrian Alter, Sergei Antoshin, Anil Ari, Magally Bernal, Christian Bogmans, Luis Brandão-Marques, Peter Breuer, Jeroen Brinkhoff, John Caparusso, Qianying Chen, Sally Chen, Yingyuan Chen, Kevin Chow, Fabio Cortes, Jane Dokko, Dimitris Drakopoulos, J. Benson Durham, Martin Edmonds, Alan Xiaochen Feng, Rohit Goel, Tryggvi Gudmundsson, Hideo Hashimoto, Sanjay Hazarika, Frank Hespeler, Henry Hoyle, Mohamed Jaber, David Jones, Mitsuru Katagiri, Will Kerry, Oksana Khadarina, Ashraf Khan, Divya Kirti, Robin Koepke, Romain Lafarguette, Jiaqi Li, Yang Li, Sheheryar Malik, Rebecca McCaughrin, Aditya Narain, Thomas Piontek, Jochen Schmittmann, Dulani Seneviratne, Juan Solé, Ilan Solot, Nour Tawk, Jérôme Vandenbussche, Jeffrey Williams, Peichu Xie, and Akihiko Yokoyama. Magally Bernal, Claudia Cohen, Breanne Rajkumar, and Han Zaw were responsible for word processing.

Gemma Diaz from the Communications Department led the editorial team and managed the report's production with support from Linda Kean and editorial assistance from Sherrie Brown, Lucy Scott Morales, Nancy Morrison, Katy Whipple, AGS, and Vector Talent Resources.

This particular issue of the GFSR draws in part on a series of discussions with banks, securities firms, asset management companies, hedge funds, standard setters, financial consultants, pension funds, central banks, national treasuries, and academic researchers.

This GFSR reflects information available as of March 30, 2018. The report benefited from comments and suggestions from staff in other IMF departments, as well as from Executive Directors following their discussion of the GFSR on April 2, 2018. However, the analysis and policy considerations are those of the IMF staff and should not be attributed to Executive Directors or their national authorities.



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# FOREWORD

Starting with this report, Chapter 1 of the *Global Financial Stability Report* (GFSR) will regularly provide a quantitative assessment of the degree to which future GDP growth faces downside risks from financial vulnerabilities, using a Growth-at-Risk (GaR) framework. The GaR approach links financial conditions to the distribution of future GDP growth outcomes and provides a framework for assessing the trade-off between supporting growth in the short term and putting financial stability and future growth at risk over the medium term. Our current assessment through the prism of GaR is that, over the past six months, short-term downside risks to global financial stability have increased somewhat, reflecting somewhat tighter financial conditions amid investors' concerns about newly announced trade measures. Even so, still-accommodative financial conditions continue to be supportive of economic growth. Taking a longer view, downside risks, as measured by GaR, remain large: easy financial conditions continue to fuel financial vulnerabilities, leaving the global economy exposed to the risk of a sharp tightening in financial conditions. Policymakers thus face the twin challenges of continuing to support growth in the short term by keeping monetary policy accommodative as well as reining in rising financial stability risks in the medium term by deploying micro- and macroprudential policy tools.

Managing the gradual process of monetary policy normalization will be tricky against this backdrop of elevated medium-term risks, and will require careful communication from central banks and policymakers to reduce the risks from a sharp tightening of financial conditions. The spike in volatility in global equity markets in early February has brought into focus the risk of abrupt, adverse feedback loops in a period of asset price adjustments. The recently increased trade tensions have led to investors' jitters, and a wider escalation of protectionist measures could ultimately take a toll on the global economy and on global financial stability. Many markets still have stretched valuations, and may experience bouts of volatility in the period ahead, in the context of continued monetary policy normalization in some advanced countries. Investors and policymakers should be cognizant of the risks associated with rising interest rates after years of very easy financial conditions and take active steps to reduce these risks. Asset price spillovers have important implications for the housing market. As explained in Chapter 3, house price correlations across countries and across major cities have been trending up during the past 30 years, suggesting that spillovers via the housing sector may play a prominent role in a future crisis.

A variety of indicators point to vulnerabilities from financial leverage, a deterioration in underwriting standards, and ever more pronounced reaching for yield behavior by investors in corporate and sovereign debt markets around the world. Chapter 2 presents an innovative gauge of the riskiness of credit allocation. The new metric computes the difference in vulnerability between the firms with the largest and smallest expansions in debt. This indicator exhibits strong forecasting power for downside risks to GDP growth, and is currently at medium to elevated levels in several countries. A host of more conventional metrics of corporate debt vulnerability around the world, including a deterioration in nonprice terms and underwriting standards in debt deals, suggest that market risks are rising, as easy financial conditions support high issuance and strong global capital flows. In low-income countries, the share of private and non–Paris Club creditors is increasing, and greater use of collateralized debt exposes borrowing countries to potentially costly debt restructurings in the future.

Over the past year, crypto assets trading has emerged as a new potential vulnerability. Price volatility of crypto assets has been much higher than that of commodities, currencies, or stocks. Financial stability risks could arise from leveraged positions taken by investors in this new asset class, infrastructure weaknesses of cryptocurrency exchanges, and fraud, in addition to elevated volatility. Regulators around the world are responding to the growing use of crypto assets through various measures, including enforcement actions, indirect interventions via the banking system, and outright bans. While crypto assets may generate new vulnerabilities, they also create opportunities and, indeed, a number of central banks around the world are considering the issuance of central bank digital currency.

Tobias Adrian
*Financial Counsellor*



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# EXECUTIVE SUMMARY

The global economic outlook has continued to improve, as discussed in the April 2018 *World Economic Outlook,* with the pace of economic growth picking up and the recovery becoming more synchronized around the world. While still supportive of economic growth, global financial conditions have tightened somewhat since the October 2017 *Global Financial Stability Report* (GFSR). Such a tightening reflects primarily the bout of equity volatility in early February and a decline in risky asset prices at the end of March following concerns about a wider escalation of protectionist measures.

Short-term risks to financial stability have increased somewhat relative to the previous GFSR, and medium-term risks continue to be elevated. Financial vulnerabilities, which have accumulated during years of extremely low rates and volatility, could make the road ahead bumpy and could put growth at risk. Indeed, Growth-at-Risk analysis (described in Chapter 3 of the October 2017 GFSR) shows that risks to medium-term economic growth, stemming from easy financial conditions, remain well above historical norms.

In advanced economies, stronger growth momentum and the firming of inflation have eased to some extent a key challenge facing central banks: maintaining the monetary accommodation required to support the economic recovery while addressing medium-term financial vulnerabilities. But the firming of inflation also brings risks. For example, inflation may pick up faster than currently anticipated, possibly propelled by significant fiscal expansion enacted in the United States. Central banks may respond to higher inflation more aggressively than currently expected, which could lead to a sharp tightening of financial conditions. This tightening could spill over to risky asset prices, bank dollar funding markets, and both emerging market economies and low-income countries, as discussed below. To minimize these risks, central banks should continue to normalize monetary policy gradually and communicate their decisions clearly to support the economic recovery.

Valuations of risky assets are still stretched, with some late-stage credit cycle dynamics emerging, reminiscent of the precrisis period. This makes markets exposed to a sharp tightening in financial conditions, which could lead to a sudden unwinding of risk premiums and a repricing of risky assets. Moreover, liquidity mismatches and the use of financial leverage to boost returns could amplify the impact of asset price moves on the financial system. Although no major disruptions were reported during the episode of volatility in early February, market participants should not take too much comfort. Investors and policymakers must remain attuned to the risks associated with higher interest rates and greater volatility. Policymakers should address financial vulnerabilities by using more actively the micro- and macroprudential tools at their disposal or by enhancing their toolkits as needed—for example, to address risks in the nonbank financial sector.

The banking sector has become more resilient since the global financial crisis. However, it is important to ensure that the postcrisis regulatory reform agenda is completed. In advanced economies some weaker banks still need to strengthen their balance sheets, and some institutions operating internationally run dollar liquidity mismatches. A sudden spell of turbulence in financial markets could expose these mismatches and crystallize dollar funding strains.

A number of emerging market economies have taken advantage of an extended period of benign external financial conditions to improve their fundamentals. However, they could be vulnerable to a sudden tightening of global financial conditions or spillovers from monetary policy normalization in advanced economies, resulting in an increase in risk aversion and capital flow reversals. The severity of such potential shocks will differ across countries, depending on economic fundamentals and the policy responses to those shocks. Although regulators in China have taken steps to address risks stemming from the interconnectedness of the banking and shadow banking sectors, vulnerabilities remain high. Further regulatory actions are crucial to continue reducing risks in the financial sector.



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The technology behind crypto assets has the potential to make the financial market infrastructure more efficient. However, crypto assets have been afflicted by fraud, security breaches, and operational failures, and have been associated with illicit activities. At present, crypto assets do not appear to pose financial stability risks, but they could do so should their use become more widespread without appropriate safeguards.

Chapter 2 takes a comprehensive look at the evolution of the riskiness of corporate credit allocation, given concerns that the continued search for higher yield may have led banks and investors to extend too much credit to risky borrowers. The chapter documents a pattern in which the firms obtaining more credit are relatively riskier during periods of strong credit expansion, especially when lending standards are loose or financial conditions are easy. An increase in the riskiness of credit allocation signals heightened downside risks to GDP growth and a higher probability of banking stress, in addition to the previously documented signals provided by credit growth. Country authorities can use the measures introduced in this chapter to monitor the buildup of vulnerabilities via risk taking in credit allocation. The chapter discusses policies that can mitigate the increase in credit riskiness during credit expansions.

Chapter 3 documents a striking increase in house price synchronization among 40 countries and 44 major cities in advanced and emerging market economies over the past several decades. The exposure of countries and cities to global financial conditions may help explain that increase. Rising housing valuations since the global financial crisis raise the specter of a simultaneous decline in house prices should financial conditions reverse. The chapter suggests that heightened synchronicity of house prices can signal a higher probability of adverse scenarios for the real economy, especially when credit is high or rapidly expanding.



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# IMF EXECUTIVE BOARD DISCUSSION SUMMARY

*The following remarks were made by the Chair at the conclusion of the Executive Board's discussion of the* Fiscal Monitor, Global Financial Stability Report, *and* World Economic Outlook *on April 2, 2018.*

Executive Directors broadly shared the key messages of the flagship reports and found the analytical chapters topical, relevant, and insightful. They welcomed the broadbased recovery of the global economy, supported by a pickup in investment and trade. Directors observed that global growth is expected to rise further in the near term. Meanwhile, inflation remains muted in many countries. Subdued labor productivity growth and population aging continue to hold back growth in advanced economies. While the recent commodity price increase has supported a recovery in commodity-dependent emerging market and developing economies, the ongoing adjustment processes continue to weigh on growth.

Directors agreed that risks around the short-term outlook are broadly balanced, but beyond the next several quarters, risks are tilted to the downside. On the upside, the cyclical pickup in advanced economy growth may prove stronger than expected as slack in labor markets may be larger than currently assessed. On the downside, a sharp tightening of global financial conditions could have negative repercussions for growth, while financial vulnerabilities accumulated over years of low interest rates could amplify the impact of asset price movements on the financial system, putting growth at risk in the medium term. Most Directors noted that the tax reform in the United States is procyclical and may trigger inflation pressure and a faster-than-anticipated withdrawal of monetary accommodation, as well as widen global imbalances, although the view was also expressed that the reform would boost investment and efficiency, and thus move the US economy to a higher, sustainable growth path. An abrupt tightening of global financial conditions, especially if accompanied by capital flow reversals, could be challenging for several emerging markets and low-income developing countries, notwithstanding improved resilience of their financial systems. Downside risks are particularly evident from escalating trade protectionism and inward-looking policies. Record-high levels of global debt, geopolitical tensions, and climate events also threaten global growth prospects.

Against this backdrop, Directors underscored that the cyclical upswing provides a golden opportunity to advance policies and reforms to strengthen medium-term prospects and reduce vulnerabilities. Priorities are to raise potential output, ensure the gains are widely shared, enhance economic and financial resilience, and safeguard debt sustainability. Directors stressed that a multilateral framework that is open, resilient, and adhered to by all can support growth and benefit the global economy. Enhanced commitment to multilateral cooperation is particularly needed to reduce trade barriers and distortionary trade practices, and to promote a rule-based multilateral trading system that works for all. Directors also called for multilateral cooperation to further reduce incentives for cross-border profit shifting and tax evasion, avoid tax competition, implement the postcrisis financial regulatory reform agenda, and address other shared challenges such as refugees, security threats, cyber risks, and climate change. Reducing excess external imbalances requires policy efforts to lift the contribution of domestic sources of growth above overall GDP growth in surplus countries and to boost potential output and saving in deficit countries.

Directors concurred that monetary accommodation should continue in advanced economies with inflation below target. Where output is close to potential and inflation is rising toward target, a gradual, data-dependent, and well-communicated withdrawal of monetary support is warranted. Directors supported the call for fiscal policy to start rebuilding buffers now, where appropriate, to create room for an eventual downturn and prevent fiscal vulnerabilities from becoming a source of stress. Fiscal adjustment is warranted in most countries, calibrated to avoid procyclicality and anchored on fiscal reforms that increase productivity and promote human and physical capital.



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In countries that have ample fiscal space and are operating at or close to capacity, fiscal policy should be used to facilitate growth-enhancing structural reforms. Directors also saw a role for fiscal policy in promoting equality, and for labor and immigration policies in boosting labor supply.

Directors agreed that digitalization presents both opportunities and risks. Digitalization can reduce tax compliance costs, improve spending efficiency, and enhance social protection. At the same time, it creates challenges for fiscal policy and the international tax system. Directors noted that mitigating risks from digitalization would require a comprehensive reform agenda, adequate resources, and a coordinated approach toward a long-term vision of the international tax architecture.

Directors welcomed the increased resilience of the banking system and stressed the importance of completing and implementing the postcrisis regulatory reform agenda. They encouraged policymakers to develop and deploy micro- and macroprudential tools to address financial vulnerabilities, and to closely monitor risks related to credit allocation and increasingly synchronized house prices across countries. The global implications of Brexit-related challenges also call for close cross-border cooperation. Directors concurred that, while crypto assets do not pose an immediate threat to financial stability, if widely used, they may raise issues about investor and consumer protection, money laundering, and tax evasion.

Directors agreed that enhancing the quality of credit intermediation, avoiding credit booms that lead to excessive risk taking, and, where feasible, permitting exchange rate flexibility can help emerging market and developing economies enhance their resilience to external shocks. Directors welcomed China's progress in reducing financial vulnerabilities and encouraged further efforts to strengthen its regulatory and supervisory frameworks, particularly in the shadow banking sector.

Directors noted that low-income developing countries face multiple challenges in their effort to progress toward the 2030 Sustainable Development Goals. They expressed concern over the broad-based increase in public debt burdens, the increasing number of countries at high risk of debt distress, and data gaps. These underscore the urgent need for fiscal prudence, improved debt management capacity, and greater debt transparency on the part of both debtors and creditors, as well as concerted efforts from the international community. Several countries need to make room in their budgets to accommodate higher spending on social services, such as health care and education, and public investment, by mobilizing domestic revenues and improving spending efficiency. Commodity exporters and those vulnerable to climate-related events face additional complex challenges of diversifying their economies. While country circumstances differ, common priorities for promoting economic diversification and employment include increasing access to credit, expanding vocational skills training, and improving the quality of infrastructure.

Directors expressed concern over the stalled progress in the catching-up process of emerging market and developing economies. They noted that, to facilitate income convergence, policies should aim to strengthen governance, improve educational and health outcomes, and lower entry barriers for new firms.



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CHAPTER 1

# A BUMPY ROAD AHEAD

## Outlook for Financial Stability

*Despite ongoing monetary policy normalization in some advanced economies and some signs of firming inflation, global financial conditions are still very accommodative relative to historical norms. Although supportive of near-term growth, easy financial conditions also continue to facilitate a buildup of financial fragilities, increasing risks to global financial stability and economic growth over the medium term.*

### Still-Easy Financial Conditions Continue to Support Economic Growth

With global economic recovery now stronger and more synchronized (as discussed in the April 2018 *World Economic Outlook* [WEO]), monetary policy authorities in advanced economies have started to, or are gearing up to, normalize their monetary policy stance (see "Monetary Policy Normalization in Advanced Economies"). Over the years since the global financial crisis, accommodative monetary policy has been crucial to ensuring a sustainable global economic recovery. But with inflation well below target and buoyant market sentiment, central banks in advanced economies have faced a difficult balancing act of keeping interest rates low to support the economy and addressing financial vulnerabilities that could put growth at risk in the medium term. The recent firming of inflation has provided policymakers with more leeway to address financial vulnerabilities, including by deploying and developing micro- and macroprudential tools.

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Global financial conditions have tightened somewhat, on balance, since the October 2017 *Global Financial Stability Report* (GFSR), reflecting the spike in equity market volatility in early February and investors' jitters in late March about a wider escalation of trade tensions (Figure 1.1, panel 1). Nonetheless, even as the US Federal Reserve has continued to normalize monetary policy, global financial conditions remain broadly accommodative relative to historical norms across both advanced and emerging market economies. Figure 1.1 (panels 1 and 2) shows global and regional financial conditions indices (FCIs), as well as their key components.

Although still-easy financial conditions support economic growth in the near term, they may also contribute to a buildup of financial imbalances, excessive risk taking, and mispricing of risks. The growth-at-risk (GaR) approach—which links financial conditions to the distribution of future GDP growth outcomes—provides a framework for assessing the intertemporal trade-off between supporting growth in the near term and putting financial stability and future growth at risk over the medium term.[1] The key steps in this approach are as follows: First, a model of output growth is estimated as a function of current economic and financial conditions. Second, this model is used to forecast conditional distributions of growth for different horizons. Finally, to gauge the impact of financial conditions on growth prospects, changes in the forecasted severely adverse growth outcomes (those that occur with a 5 percent probability, also called the "tail" of the distribution) for different horizons are compared with previous forecasts. Changes in financial conditions that result in a deterioration in severely adverse growth forecasts (that is, a leftward shift in the tail) can be interpreted as financial vulnerabilities potentially increasing toward macrocritical levels. This means that these vulnerabilities could magnify the severity of an eco-

[1]See Chapter 3 of the October 2017 GFSR for a description of the growth-at-risk methodology.



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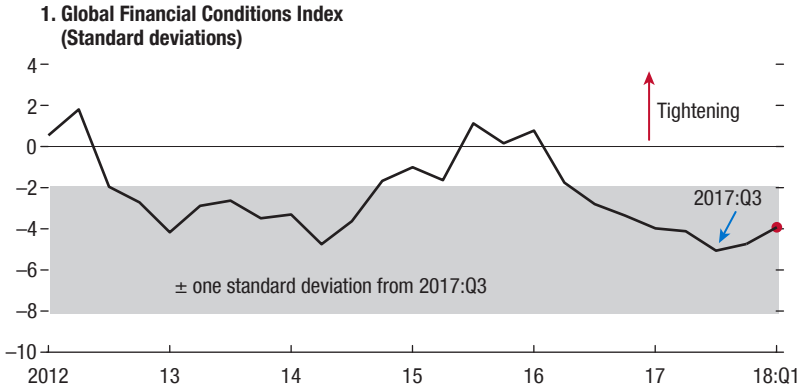
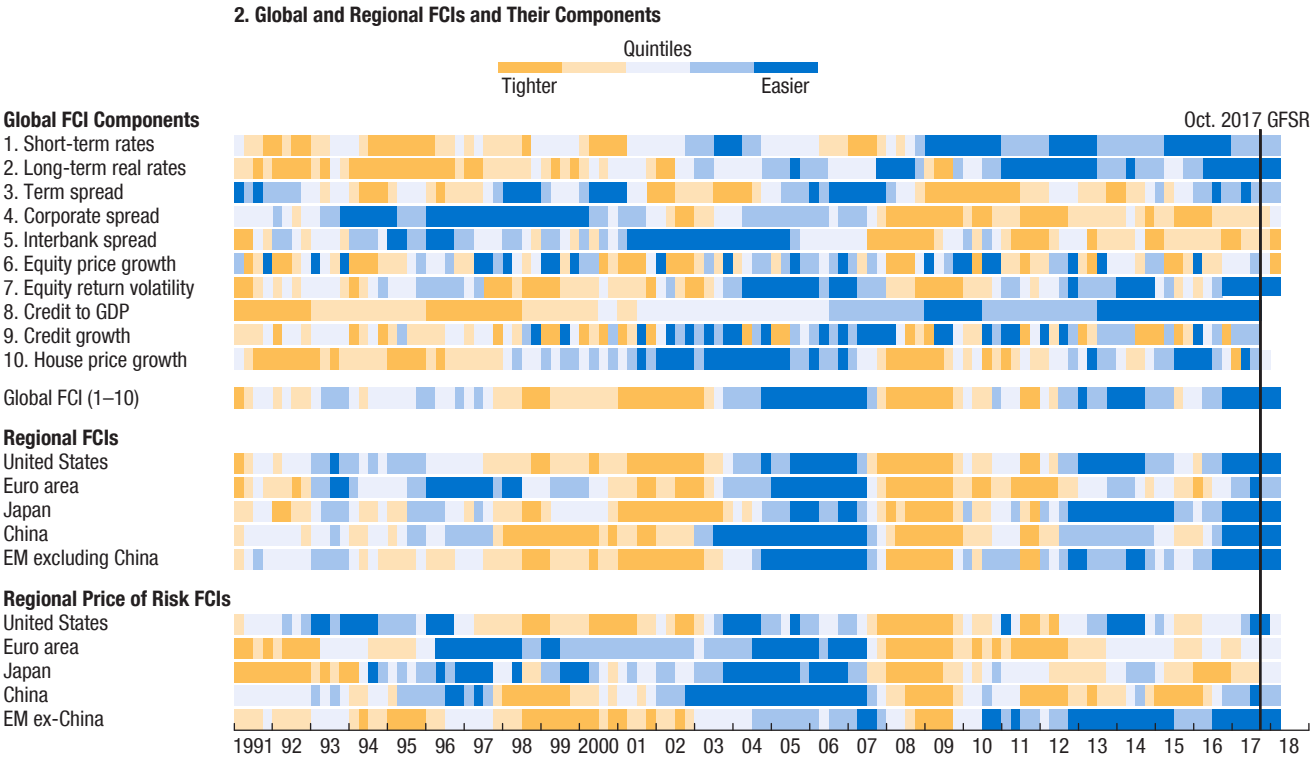
## Figure 1.1. Global Financial Conditions

Global financial conditions have tightened somewhat, but remain supportive of growth.




The price of risk is low, markets are buoyant, and leverage is high across both advanced and emerging market economies.




Sources: Bloomberg Finance L.P.; and IMF staff estimates.
Note: Panel 1 shows the Global (Financial Conditions Index) FCI. This was originally presented in GFSR October 2017 (Chapter 3). Higher values of FCIs indicate tighter conditions. The shaded area denotes ± one standard deviation changes relative to the level of Global FCI at 2017:Q3. Panel 2 shows quintiles of global and regional FCI series and components relative to their own history. Results are compared with a "Price of Risk" FCI, encompassing price-based information only (components 1–7). Easing of conditions is shown in blue and tightening in yellow. For FCI components, the shading is based on their contribution to the FCI index, e.g., a narrowing of credit spreads relative to historical norms would be contributing to the FCI easing, and hence, shown in blue. EM = emerging market; FCI = financial conditions index; GFSR = *Global Financial Stability Report*.



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nomic downturn in the future, even without necessarily leading to a systemic financial crisis.

### Short-Term Risks Have Increased Somewhat, while Medium-Term Vulnerabilities Remain Elevated

Against the backdrop of slightly tighter financial conditions, short-term financial stability risks have increased somewhat since the previous GFSR. Even so, the current broadly accommodative financial conditions appear to have dampened the near-term risks to growth relative to a few years ago. The GaR model forecasts that, under current financial conditions, the severely adverse outcome is for global growth to fall to about 3 percent or less over the following year (the red dot in Figure 1.2, panel 1). In comparison, in 2015 the predicted range of severely adverse growth outcomes was notably less favorable.[2]

This assessment, however, does not mean that the global financial system and the real economy are immune to macroeconomic, geopolitical, or policy shocks in the near-term:

- For example, inflation in the United States may rise faster than expected, possibly owing to the recent fiscal expansion. Central banks in response may tighten monetary policy more forcefully than currently anticipated. In such a scenario financial conditions could tighten sharply, generating adverse spillovers to other advanced (see "Monetary Policy Normalization in Advanced Economies" section) and emerging market economies (see "Vulnerabilities in Emerging Markets, Low-Income Countries, and China" section), as well as adversely affecting the internationally active banks that rely on dollar funding (see "Funding Challenges of Internationally Active Banks" section).
- Trade tensions and greater protectionism could affect financial stability via increased uncertainty and lower global growth. As discussed in the April 2018 WEO, a wider escalation of protectionist measures would take a toll on global output and welfare, both directly and indirectly by raising geopolitical tensions. This would shift the distribution of global growth outcomes to the left, with attendant negative implications for global financial stability. But even before any impact on trade, there may be a decline in confidence and a tightening in financial conditions, which could provide a separate and substantial headwind to growth.

At the same time, easy financial conditions risk fueling financial vulnerabilities that may put medium-term growth at risk. The estimated three-year-ahead growth distribution has a much fatter left tail compared with the one-year-ahead growth distribution (Figure 1.2, panel 2). Given current conditions, the GaR model forecasts that, under the severely adverse scenario, global growth will be negative three years from now. The downward slope of the curve (the dashed red line in Figure 1.2, panel 3) illustrates the intertemporal trade-off between the near-term and the medium-term growth prospects amid easy financial conditions. Continued easing of financial conditions over the past two years has tilted the curve, improving economic prospects in the near term while worsening the medium-term growth outlook. In contrast, the severely adverse medium-term growth forecast at the end of 2016 (the dashed blue line in Figure 1.2, panel 3), for example, was relatively less negative than the current forecast. Finally, a comparison of GaR severely adverse medium-term growth forecasts since the 1990s suggests that risks to medium-term growth stemming from the current easy financial conditions are well above historical norms (Figure 1.2, panel 4).

As central banks continue to normalize monetary policy, financial vulnerabilities foreshadow a bumpy road ahead. High leverage and other balance sheet mismatches tend to amplify the impact of shocks on the financial system and the broader economy. Leverage in the *nonfinancial sector* has been rising in many major economies, as discussed in the October 2017 GFSR, and remains high (Figure 1.1, panel 2, and Figure 1.3, panel 1), implying that aggregate debt-service ratios could deteriorate quickly once financial conditions tighten (see "Reach for Yield or Overreach in Risky Assets?" and "Vulnerabilities in Emerging Markets, Low-Income Countries, and China" sections). In addition, some economies with already-high nonfinancial sector debt are seeing faster growth in house prices (see gray dots in the upper right corner in Figure 1.3, panel 2). In contrast, *banks* have raised their capital and liquidity buffers since the global financial crisis, pointing to increased resilience, though they may still be vulnerable to funding shocks (see "Funding Challenges of Internationally Active Banks" section). At the same time, use of financial leverage *outside the banking sector* is on the rise as the

[2]As can be seen in Figure 1.1, global financial conditions have eased significantly since 2015–16.



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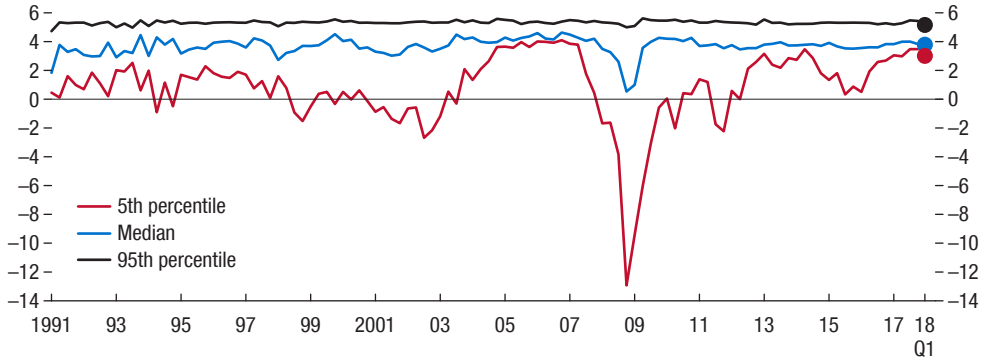
## Figure 1.2. Growth-at-Risk

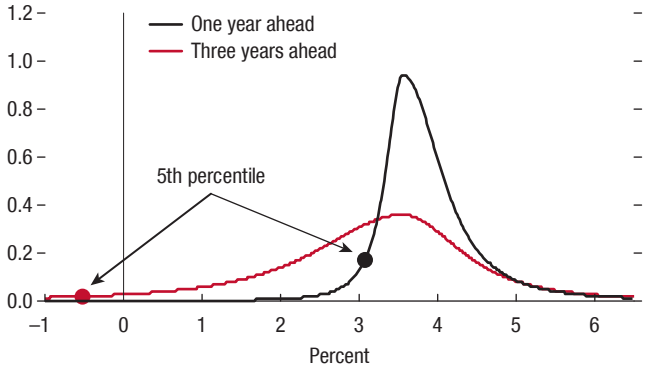
Supportive financial conditions tend to dampen the near-term risks, with growth-at-risk forecasting the severely adverse outcome (for example, with 5 percent probability) for global growth at about 3 percent or less one year ahead.

**1. Percentiles of One-Year-Ahead Growth Forecast Densities (Percent)**



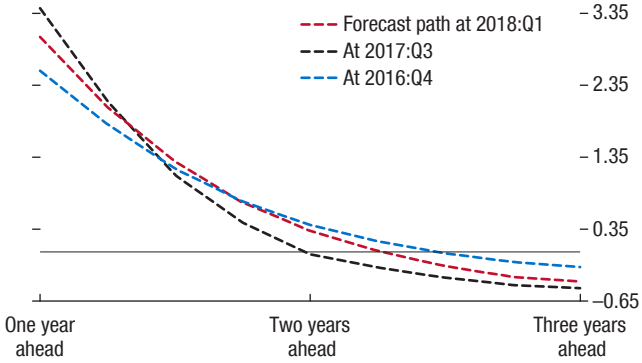

But easy financial conditions also raise the odds of adverse growth outcomes in the medium term—the three-year-ahead growth distribution has a much fatter left tail than the one-year-ahead growth distribution.

**2. Growth Forecast Densities at 2018:Q1 (Probability)**



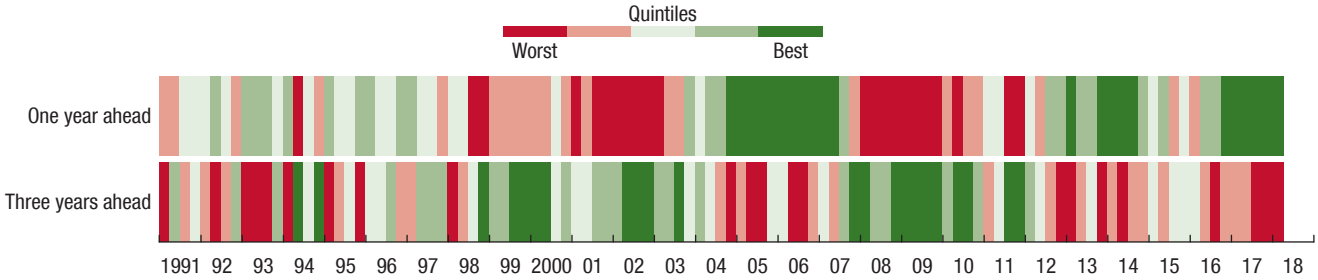

Medium-term risks to growth have increased in recent years ...

**3. Severely Adverse Growth Outcomes (5th Percentile) at Different Future Horizons (Percent)**




... and are well above historical norms, given the current financial conditions.

**4. GaR Forecasts of Severely Adverse Growth Outcomes: Percentile Ranks**




Sources: Bloomberg Finance L.P.; IMF, World Economic Outlook database; and IMF staff estimates.
Note: Growth-at-risk (GaR) refers to the set of outcomes that fall into the 5th percentile of (conditional) forecast densities of global growth. Panel 2 presents forecast densities for growth, one and three years ahead. In panel 4, the color shading depicts the percentile rank for the 5th percentile threshold of densities for one-year- and three-year-ahead growth. Red denotes lower growth outcomes.



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prolonged period of low interest rates has fueled search for yield and compressed market risk measures (see "Reach for Yield or Overreach in Risky Assets?" section).

Although the recent bout of volatility in global equity markets (Box 1.1) did not lead to any major dislocations, the episode underscores the need for investors and policymakers to remain attuned to the risks associated with rising interest rates after years of low rates and low volatility.

## Monetary Policy Normalization in Advanced Economies

*The buildup of financial vulnerabilities over the past few years has left financial markets exposed to the risk of a sharp tightening of financial conditions. In this context, central banks must strike a delicate balance of gradually withdrawing monetary policy accommodation while avoiding disruptive volatility in financial markets. This balancing act highlights the importance of continued clarity in central bank communications.*

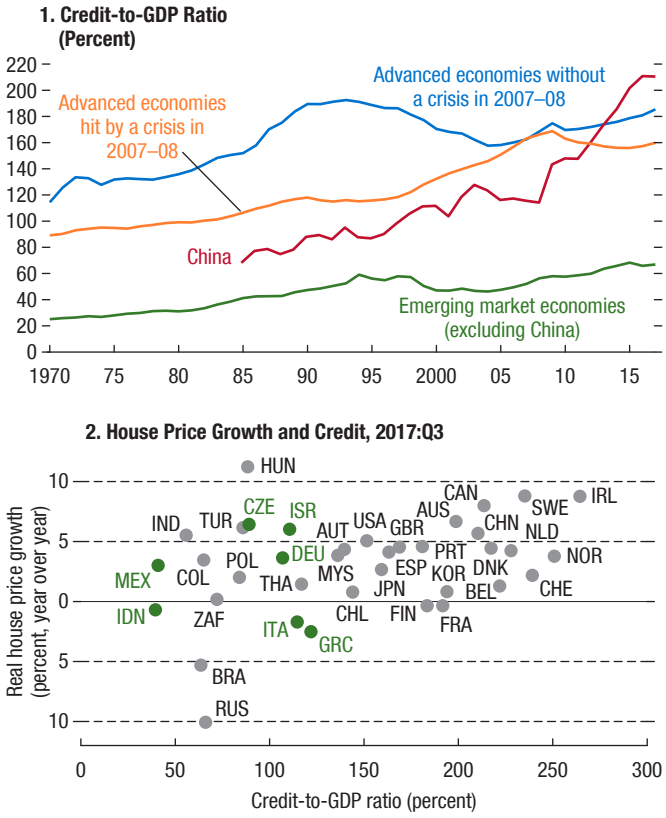
### The Global Economy Faces a Critical Transition as Monetary Policy Gradually Normalizes

Financial markets have thus far adjusted relatively smoothly to the gradual pace of monetary policy normalization, benefiting from clear central bank communications and historically large central bank asset holdings (Figure 1.4, panel 1). Indeed, although the expected path of policy interest rates in the United States points to a faster pace of tightening relative to other advanced economies, reflecting differences in the interest-rate-hiking cycle, it remains consistent with gradual removal of accommodation (Figure 1.4, panel 2).

But policymakers may face increasing challenges to ensuring a smooth normalization path. Substantial medium-term financial vulnerabilities have built up during the period of prolonged monetary accommodation. As central banks withdraw accommodation by raising short-term interest rates and shrinking their balance sheets, a decompression of term premiums (the compensation investors demand for holding bonds in excess of risk-free short-term interest rates) may cause an abrupt tightening of financial conditions.[3] This potential risk underscores the importance of a smooth process to avoid sudden, sharp volatility and disruptions in financial markets.

[3]Significant uncertainty surrounds the magnitude and size of the adjustments, as discussed in the October 2017 GFSR. Indeed, by letting asset holdings mature, central bank balance sheet normalization will increase net supply to the public, a development expected to put upward pressure on term premiums and broader risk premiums.

**Figure 1.3. Nonfinancial Private Sector Debt**




Sources: Bank for International Settlements (BIS); Haver Analytics; IMF, World Economic Outlook database; and IMF staff calculations.
Note: In panel 1, advanced economies hit by a crisis are those in the Laeven and Valencia (2012) database with a crisis starting in 2007 or 2008 that are also in the Bank for International Settlements credit database. Panel 2 shows data for 2017:Q3 or latest available figures, if earlier. House price growth is calculated over the past three years (annualized). Data for credit-to-GDP ratios are from the BIS. For some countries, these data include inter- and intra-company loans, which can be significant. Countries with gray dots have a credit-to-GDP ratio above the median historical ratio for advanced or emerging market economies. The median is calculated using annual data from 1970 (or first available date, if later) for a pooled sample of 27 advanced economies and 16 emerging market economies. Green dots are countries with a credit-to-GDP ratio below the median. Data labels in the panel use International Organization for Standardization (ISO) country codes.

### Why Have Term Premiums Remained Low in the United States Even as the Federal Reserve Has Started to Reduce Its Portfolio?

In the United States, the Federal Reserve has increased the federal funds rate six times since December 2015. Yet the term premium remains near historical lows, and financial conditions have continued to ease, in contrast



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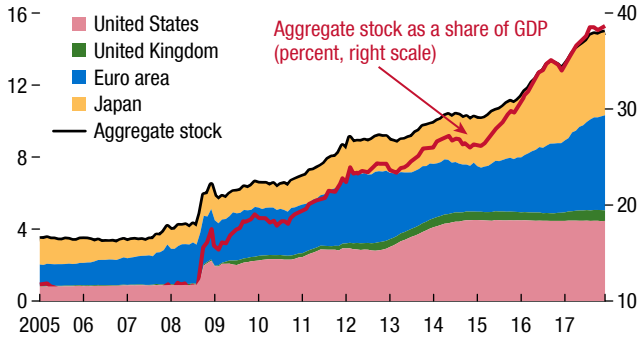
## Figure 1.4. Market Interest Rates, Central Bank Balance Sheets, and US Financial Indicators

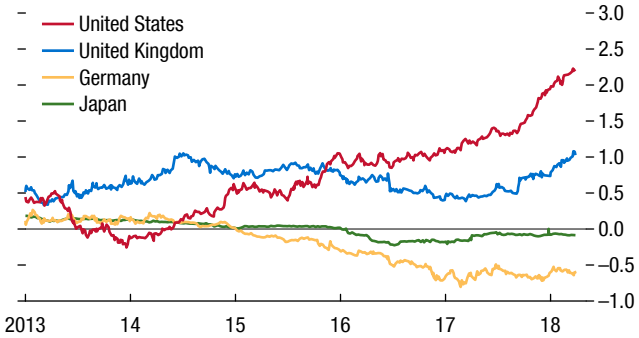
Easy global financial conditions are underpinned by advanced economy central banks' large asset holdings.

**1. Change in Central Banks' Balance Sheet Assets (Trillions of US dollars)**



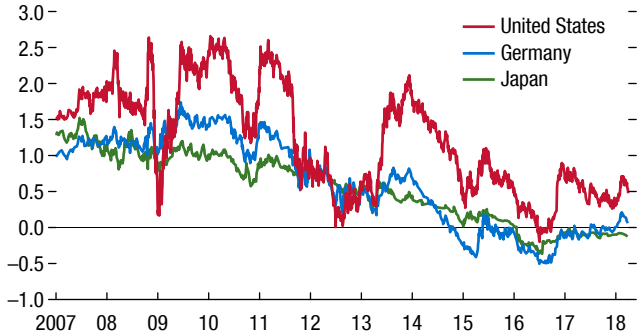

Policy rate expectations still point to gradual rate hikes.

**2. Estimated Average Short-Term Interest Rates through Two Years (Percent)**



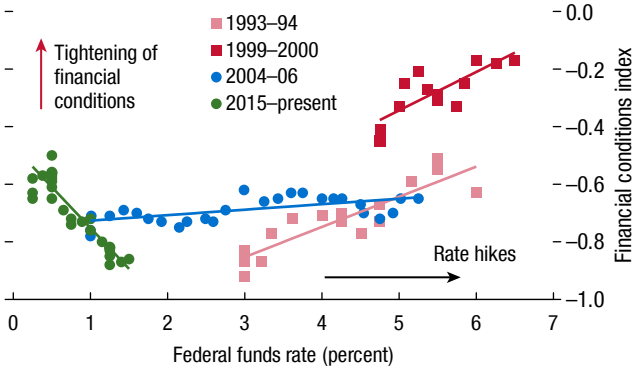

Term premiums have remained compressed in major economies and are near historic lows.

**3. Estimated 10-Year Term Premiums (Percent)**



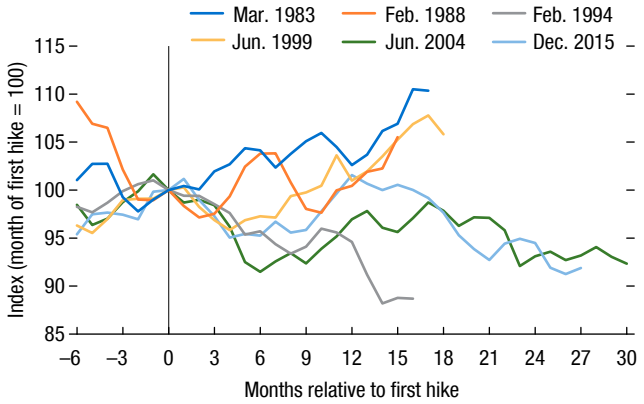

US financial conditions have continued to ease despite policy rate hikes ...

**4. Financial Conditions and US Federal Funds Rate**



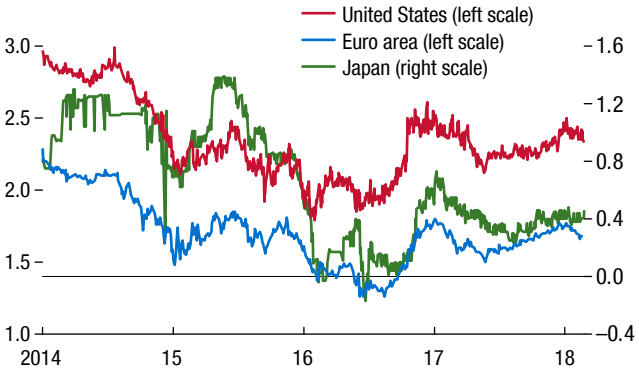

... while the US dollar has weakened ...

**5. US Real Effective Exchange during Federal Reserve Hiking Cycles (Index)**




... and measures of inflation compensation have remained relatively muted.

**6. Five-Year, Five-Year-Ahead Inflation Swaps (Percent)**




Sources: Bloomberg Finance L.P.; and IMF staff calculations.
Note: Panel 3 is based on IMF staff estimates of four-factor term structure models based on the Adrian, Crump and Moench (2013) model, using underlying Bloomberg fitted yield curve series from the early 1990s.



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to previous hiking cycles (Figure 1.4, panels 3 and 4). The tightening cycle so far has not offset the broader weakness of the dollar since the beginning of the normalization process in the United States (Figure 1.4, panel 5). Moreover, although measures of inflation compensation have moved a bit higher recently with the firming in inflation, they continue to be relatively low in the United States and other countries (Figure 1.4, panel 6).[4]

Several factors may help explain why the effects of the Federal Reserve's policy actions on term premiums (and thus financial conditions) have been somewhat muted to date, compared with the sizable decline following initial implementation of unconventional balance sheet policies:[5]

- *Liquidity considerations* point to likely asymmetric responses of term premiums to asset purchases, on the one hand, and shrinkage of balance sheets, on the other. For example, many studies find that the Federal Reserve's first asset purchase program had a larger effect than subsequent programs. One possible explanation is that the first rounds may have ameliorated illiquidity and extinguished potential fire sales of assets. By contrast, the initial withdrawal of unconventional accommodation seems unlikely to have had the concomitant and opposite effect of boosting liquidity premiums and therefore yields.
- *Central bank purchase programs* may have "structurally" lowered term premiums, especially in the current environment of lower equilibrium policy rates. Investors likely expect asset purchases to remain in the policy toolkit in the future, whether or not central banks reduce their asset holdings to near precrisis levels.[6] To commit credibly to abandoning these tools may prove difficult. Moreover, policymakers are presumably more likely than before to pull these levers, given new limits to conventional measures, because equilibrium or terminal policy interest rates (the rate that is consistent with full employment and capacity utilization and stable prices) may be lower today as a result of underlying structural factors in the economy that keep interest rates nearer their nominal lower bound.[7]
- *The signaling channel of balance sheet reduction* may be muted, especially compared with the significant signaling effects associated with implementation of asset purchases. This is because the Federal Reserve has mapped out the unwinding of its balance sheet into the future, with a "high hurdle" for revision. At least in the United States so far, the unwinding of balance sheet measures is less data dependent than the purchase program. Guidance around the initial balance sheet reduction contains much less information about the future path of the traditional tool compared with possible signaling effects of asset purchases. Indeed, at the nominal lower bound, unconventional policy tools supplement traditional levers. But when removing accommodation, policy rates have no upper bound.

## Are Term Premiums Too Low Given Economic Variables and Other Fundamentals?

Term premiums remain very low by historical standards. But are they "too low" relative to economic fundamentals? The answer to this question is central to determining the implications of the prolonged period of monetary policy accommodation for global financial markets. Even though a variety of shocks could push term premiums higher, the impact of these shocks on financial markets could be sudden and more pronounced if term premiums are too low given the stage of the economic cycle.

Model estimates suggest that term premiums are not too low. Analysis finds that term premiums are broadly in line with investors' expectations for growth, inflation, and the current stance of monetary policy. As shown in Box 1.2, the estimated term premium has remained near the lower bound of fitted model values over the past few years, in line with the large-scale monetary accommodation needed to support the economic recovery.[8] In addition, the gap between the estimated and the model-based weighted-average estimated term premiums has been closing recently, suggesting that term premiums are largely in line with investors' expectations for economic fundamentals. However, the model also suggests that term premiums are significantly vulnerable to any revisions in those expectations, particularly with

[4]Inflation compensation, typically referred to as breakeven inflation rates, is defined as the inflation rates that, if realized, would leave an investor indifferent between holding an inflation-protected Treasury security and a nominal Treasury security.

[5]As such, careful studies of the effects of unconventional policy measures (including Gagnon and others 2010) may be less relevant, if not somewhat misleading, to understanding the reversal of these measures.

[6]In addition, a possible sustained dearth of global risk-free assets could also durably lower the level of the term premium.

[7]These factors include demographic effects and changes in productivity, among others. See Chapter 2 of the April 2017 GFSR.

[8]Figure 1.2.1 in Box 1.2 shows the average and range of 900 model-fitted values for the Adrian, Crump, and Moench (2013) term premium estimate, conditional on various economic and financial factors, for the United States and Germany.



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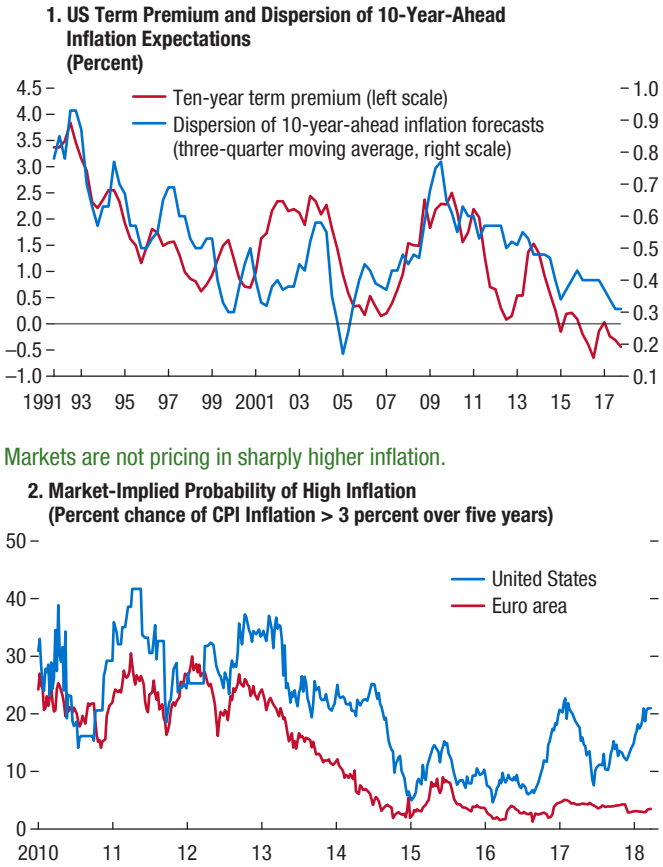
**Figure 1.5. US Inflation Expectations and Term Premium**

Term premiums have moved lower, and uncertainty about future inflation has declined.




Sources: Bloomberg Finance L.P.; Federal Reserve Bank of Minneapolis; and IMF staff estimates.
Note: In panel 2, euro area options are illiquid. CPI = consumer price index.

respect to uncertainty about the future path of inflation and growth, or the path for monetary policy.

## Financial Markets Remain Vulnerable to an Inflation Surprise

Although the expected path of policy rates has recently increased somewhat in some countries, markets continue to price in a gradual pace of monetary tightening. Uncertainty about future inflation outcomes has diminished in tandem with declining term premiums (Figure 1.5, panel 1). In addition, market participants are not currently pricing in a risk of sharply higher inflation over the next few years (Figure 1.5, panel 2).

An upside surprise to inflation could pose a challenge to investors and policymakers. For example, inflation in the United States may increase faster than expected, possibly as a result of the recent fiscal expansion at a late stage of the credit cycle. In response to the revision in the inflation outlook, the Federal Reserve may withdraw monetary policy accommodation at a faster pace than currently anticipated. In this scenario, term premiums could suddenly decompress, risk premiums could rise, and global financial conditions could tighten sharply, with possible adverse consequences for the global economy.

Emerging markets are vulnerable to spillovers from an abrupt tightening in global financial conditions. Gradual and well-telegraphed normalization of monetary policy in advanced economies has provided a period of favorable external conditions, and investor sentiment toward emerging markets has remained constructive. The favorable conditions have allowed weaker issuers to access markets, and the creditor base now includes investors more inclined to turn over their portfolios. If the tightening cycle is accompanied by a rise in investor risk aversion, portfolio flows to emerging markets could fall by at least one-quarter under realistic assumptions (see "Vulnerabilities in Emerging Markets, Low-Income Countries, and China" section). This drop would increase rollover risks and the cost of funding in these countries. Low-income, small, non-investment-grade borrowers are particularly exposed to such risks because they have seen a sharp rise in debt vulnerabilities over the past few years.

## Correlations among Global Term Premiums (and Expected Rates) Underscore Risks of International Spillovers

Rapid decompression of term premiums could quickly spill over to global financial markets. Key questions are the extent to which movements in term premiums are correlated across countries today, and thus primed for contagion, and the direction and intensity of such spillovers. Some evidence indicates that sovereign term premiums among major economies (Canada, Germany, Japan, United Kingdom, United States) move very closely together, even as investors' expectations for policy rate paths in these countries have diverged. This trend seems to have preceded the Federal Reserve's lift-off from the nominal lower bound in December 2015, and is in line with the view that asset purchases may be a stronger driver of spillovers than standard monetary policy via short interest rates (Figure 1.6, panel 1).

Moreover, model estimates indicate the impact of spillovers between G4 (Germany, Japan, United King-



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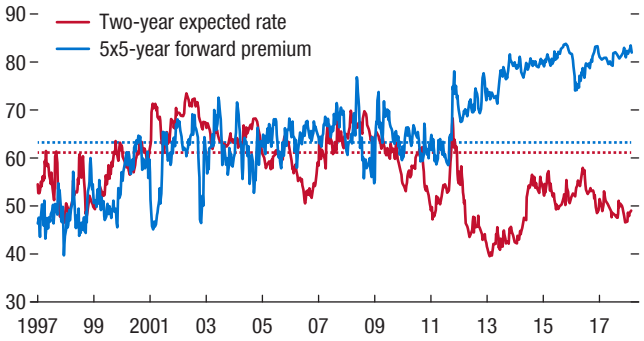
**Figure 1.6. Term Premium Correlations, Spillovers, and Exchange Rate Relationships**

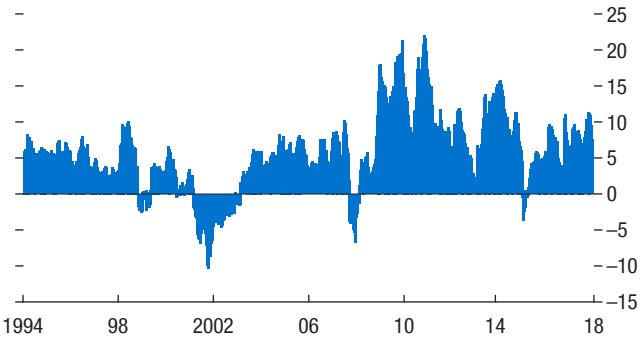
Term premiums in major advanced economies move very closely together even as market expectations of policy rate paths diverge.

**1. Term Premiums and Expected Rate Correlations (Percent explained by first principal component)**



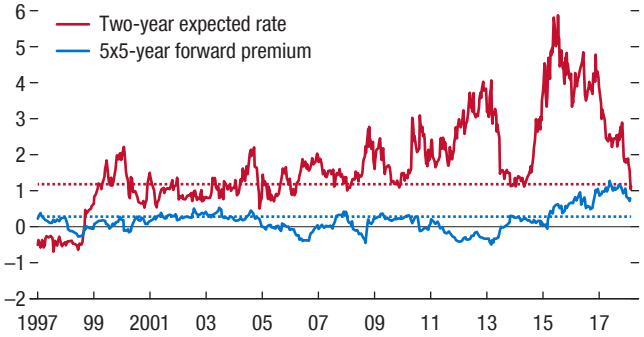

Spillovers between G4 term premiums are elevated, with the United States dominating the direction.

**2. Net Pairwise Spillovers between the US Term Premium and German, Japanese, and UK Premiums (Percent)**



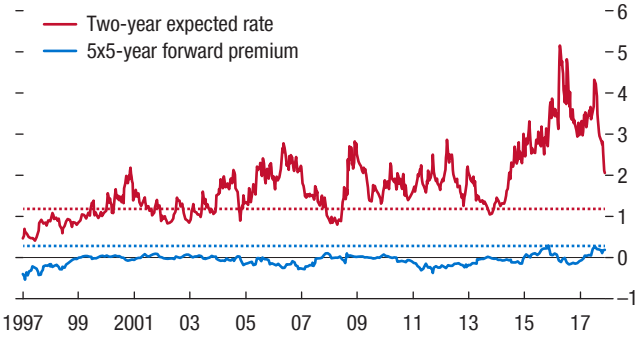

Short rates dominate movements in exchange rates between the euro-US dollar ...

**3. Spot US Dollar Exchange Rate Betas: Euro**




... and the sterling-US dollar cross rates.

**4. Spot US Dollar Exchange Rate Betas: British Pound**




Sources: Bloomberg Finance L.P.; and IMF staff estimates.
Note: The dotted horizontal lines denote unconditional sample estimates. In panel 2, a positive (negative) value indicates that the US term premium is a shock transmitter (receiver) to German, Japanese, and UK term premiums. G4 = Group of Four (Germany, Japan, United Kingdom, United States).

dom, United States) term premiums is elevated, with spillovers from the United States to the other countries mainly dominating (Figure 1.6, panel 2).[9] Although the net impact of such spillovers appears notably lower than at the height of the crisis, alongside higher correlations of term premiums this suggests considerable scope for a rapid rise in interest rates to be transmitted to global markets.

[9]The methodology, by Diebold and Yilmaz (2012), obtains a time-varying spillover index using rolling generalized forecast error variance decompositions in a generalized vector autoregression model. The framework measures directional spillovers by using the normalized elements of the variance decomposition matrix. The net pairwise spillovers are then calculated by taking the difference between the total spillovers transmitted from market *i* to all markets *j* and the spillovers transmitted from all markets *j* to market *i*.

In this environment, spillovers from a faster withdrawal of US Federal Reserve monetary policy accommodation in the wake of an inflation surprise and associated repricing of inflation risk and term premiums could rapidly tighten US and global financial conditions. This could challenge major central banks, such as the European Central Bank, that are not as far along in the normalization process, perhaps forcing them to respond through additional accommodation.

Although term premiums may be more correlated at present, perhaps because of global factors, central banks' strategies regarding conventional policy tools remain critical for communicating the stance of monetary policy. For example, term premium differentials do not appear to have dominated the transmission of monetary policy through exchange rates, at least



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among the G4.[10] In fact, the sensitivity of currencies to expected short rate differentials has remained elevated in recent years (Figure 1.6, panels 3 and 4). This finding holds both on average over the past 20 years and for estimates for the latest sensitivity.

### Continued Clear Monetary Policy Communication Is Essential to Avoid Market Disruptions

Gradual removal of monetary accommodation and clear communications will help anchor market expectations and prevent undue volatility. To support the recovery and ensure inflation objectives are met, monetary authorities should maintain accommodation, as needed. When normalizing policy, central banks should do so in a gradual and well-communicated manner. They should also provide guidance on prospective changes to policy frameworks if such changes are warranted. Gradualism and clear communications are crucial given the confluence of still relatively low inflation, easy global financial conditions, and rising financial vulnerabilities. To address the buildup in financial vulnerabilities and avoid putting growth at risk, policymakers should also deploy and develop appropriate micro- and macroprudential tools.

## Reach for Yield or Overreach in Risky Assets?

*Against a backdrop of mounting vulnerabilities, risky asset valuations appear overstretched, albeit to varying degrees across markets, ranging from global equities and credit markets, including leveraged loans, to rapidly expanding crypto assets (discussed in the next section). Moreover, the increasing use of financial leverage to boost returns and the growing influence of some passive investment vehicles, particularly exchange-traded funds (ETFs) in less liquid underlying markets, could amplify the impact of asset price moves on the financial system.*

### Financial Vulnerabilities Continue to Build amid Easy Financial Conditions

The unconventional monetary policies implemented since the global financial crisis, including both asset purchases and forward guidance, clearly and by design encouraged investors to reach for yield. But today's policy environment differs. Rather than encourage investors to take additional risk, some central banks around the globe have either been raising policy rates or preparing investors for an eventually less accommodative stance. And although the share of assets with negative yields remains sizable globally, this fraction has ticked down in recent months. So, rather than a reach for yield prompted by central bank accommodation, there may be outright speculative overreach in some risky assets.[11]

The key questions are the extent to which financial vulnerabilities have increased since the previous GFSR, how the constellation of current accommodative financial conditions and vulnerabilities compares with past episodes of financial stress, and whether asset valuations appear stretched, given current cyclical conditions. This final determination matters. If asset valuations are not judged to be significantly out of line with fundamentals, policymakers can continue to normalize monetary policy gradually and to implement macroprudential and other regulatory measures aimed at lessening financial stability risks. In contrast, if asset misalignments are significant and may put growth at risk in the future, a more forceful policy response may be needed.

To shed some light on rising financial vulnerabilities, this section focuses on *asset price valuations* in equity, corporate bond, and leveraged loan markets; on *financial leverage,* including that embedded in derivative products; and on *liquidity mismatches* related to the proliferation of certain types of investment funds and strategies (for example, exchange-traded funds).

### Equity Valuations Remain Expensive

The ongoing global economic recovery, strong corporate performance, and still-low interest rates have supported equity prices, on balance, since the previous GFSR (Figure 1.7, panel 1). In the United States, and through the spate of volatility beginning in early February, equity market capitalization has risen from 95 percent of GDP in 2011 to 155 percent of GDP in March 2018. Rising global equity prices have sup-

[10]Based on estimated dynamic correlations following Cappiello, Engle, and Shepphard (2006).

[11]"Reach for yield" may be a dated description of current investor behavior and financial asset price developments. Following Hanson and Stein (2015), the effects are transitory, and the lengths of these episodes depend on the capacity of so-called return-oriented arbitrageurs to take offsetting positions. Insofar as financial conditions are very accommodative (for example, the ability and willingness to take on leverage), any reach for yield should not have persisted.



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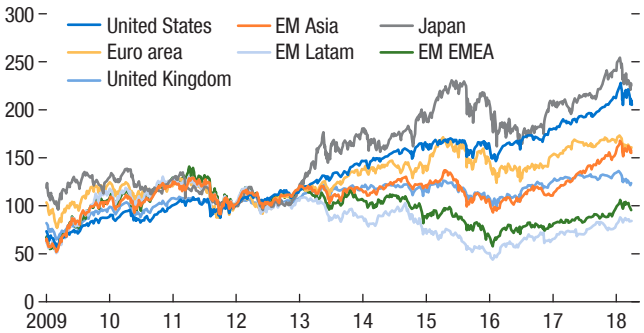
## Figure 1.7. Valuations of Global Equities

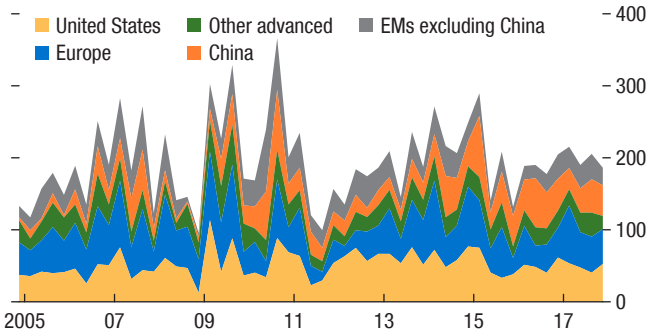
Global equities have extended their rally in recent months, on balance, since October ...

**1. MSCI Equity Indices (End-2011 = 100)**



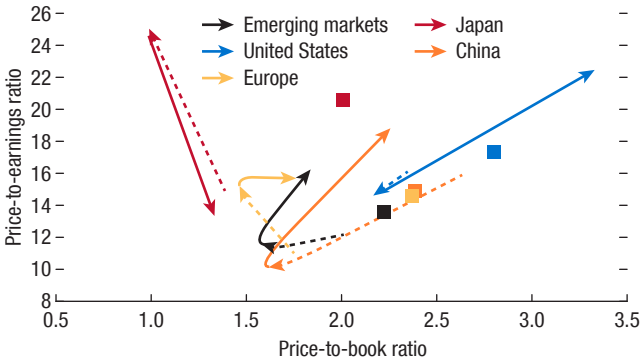

... supporting a rebound in equity issuance, especially in emerging markets.

**2. Gross Equity Issuance (Billions of US dollars, quarterly)**



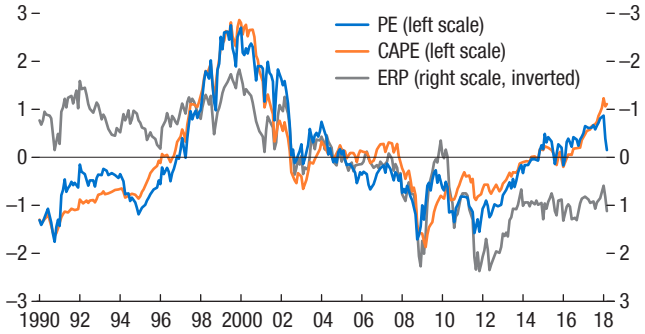

In the United States, valuations are high relative to their historical averages and pre-GFC peak, and to other countries.

**3. Valuation Metrics (Dotted arrows: 2008–12; solid arrows: 2012–18; squares: long-term average)**



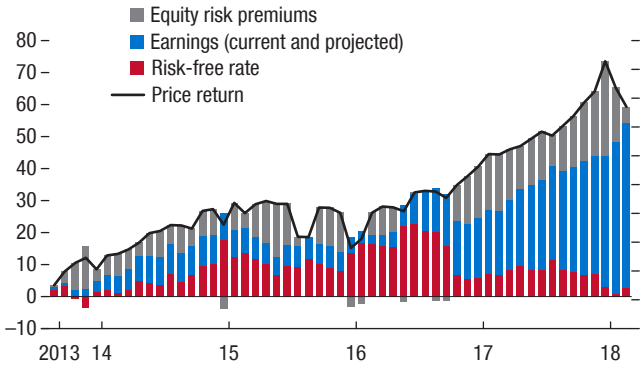

However, US equity valuations appear low relative to US Treasuries.

**4. Valuation Metrics (*Z*-scores)**



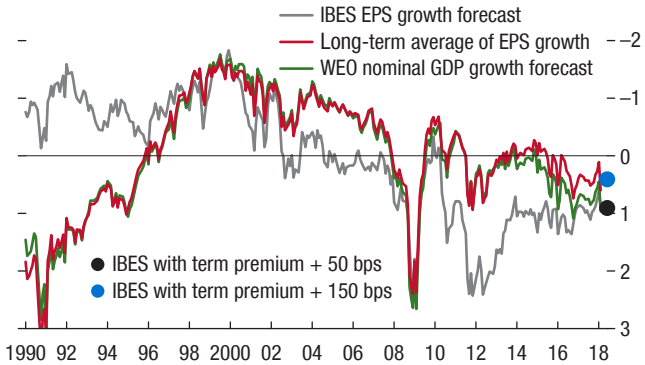

Equity valuations have been supported by historically low interest rates and robust earnings expectations.

**5. Decomposition of Equity Market Performance (Percent contributions to cumulative returns)**




The relative equity valuations are closer to their historical averages if more sustainable earnings are assumed.

**6. Equity Risk Premium under Different Assumptions (*Z*-scores; inverted scale)**




Sources: Bloomberg Finance L.P.; Citigroup Index LLC; ICE Bank of America Merrill Lynch; JPMorgan Chase & Co; IMF, World Economic Outlook (WEO) database; Morgan Stanley Capital International (MSCI); Standard & Poor's; Thomson Reuters IBES; and IMF staff calculations.
Note: bps = basis points; CAPE = cyclically adjusted price-to-earnings ratio; EM = emerging market; EMEA = Europe, Middle East, Africa; EPS = earnings per share; ERP = equity risk premium; GFC = global financial crisis; Latam = Latin America; PE = price-to-earnings ratio.



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ported a moderate rebound in new issuance, especially in emerging markets (Figure 1.7, panel 2).

These developments raise questions about valuations and potential investor excesses. Standard price-to-earnings and price-to-book valuation metrics remain elevated in most regions (Figure 1.7, panel 3). For the United States, these measures remain relatively high compared to both historical levels and current valuations in other countries. Indicators that incorporate longer-term averages of realized earnings to capture expectations, such as cyclically adjusted price-to-earnings, continue to support this assessment, even after the volatility spike in February and the slide in equity prices in March on concerns about trade tensions (Figure 1.7, panel 4).

Some measures of the US equity risk premium, in which equity valuations are conditional on the level of interest rates, suggest that shares have been closer to fair value. Indeed, strong near-term earnings expectations, as well as historically low interest rates, sustain comparatively wide equity risk premiums (Figure 1.7, panel 5). However, this approach is highly sensitive to profit forecasts as well as to different assumptions about the discount factor. Equity valuations deteriorate under alternative, less sanguine proxies for earnings, such as longer-term averages or nominal GDP growth. Also, higher projected paths for interest rates similarly narrow the equity premium and imply richer valuations (Figure 1.7, panel 6).

## Corporate Bond Valuations Are Stretched and Credit Quality Is Deteriorating in Risky Segments

With central banks in advanced economies continuing to lift policy rates from the nominal lower bound or signaling a not-too-distant commencement of the normalization process, the share of negative-yielding global bonds has dipped lower since the October 2017 GFSR. This ratio, however, remains significant (Figure 1.8, panel 1). Against a backdrop of low default rates, corporate spreads remain at very low levels, even in the riskiest segments (Figure 1.8, panel 2). Favorable financial conditions have boosted corporate bond issuances. Issuance of riskier bonds has surged, and the share of lower-grade bonds (BBB-rated) in the investment-grade universe has been rising (Figure 1.8, panel 3).

Strong economic growth and corporate restructuring efforts, particularly in the energy sector, have supported corporate profitability; and debt ratios—while still high—have edged lower, especially in China and other emerging markets (Figure 1.8, panel 4). Effective interest rates paid by the corporate sector moved higher, particularly outside the United States. As a result, interest coverage ratios have dipped everywhere except China and the United States (Figure 1.8, panel 5).

Recent US tax reform will have important implications for the corporate sector. As discussed in the April 2017 GFSR, most US companies will gain from the reform. However, historical experience in the United States in the 1980s and with the repatriation tax holiday in 2004 suggests that financial risk taking often follows tax policy changes, as evidenced by heightened purchases of financial assets, mergers and acquisitions, dividends, and share buybacks. The cap on the tax deductibility of interest expense will reduce incentives for debt financing, which tends to affect highly leveraged companies disproportionately (Figure 1.8, panel 6). These firms may face funding pressures because of higher interest expenses, more volatile earnings, and a more compressed schedule for adapting their funding structure to the new tax code.

## Signs of Overheating Are Evident in the Leveraged Loan Market

The leveraged loan market, consisting of commercial loans extended to borrowers who are non–investment grade or already have significant amounts of debt, is seen by market participants as a barometer for broader risk taking. Global credit markets have grown massively in recent years. Global leveraged loan issuance hit a record high in 2017 of $788 billion, surpassing the precrisis high of $762 billion in 2007. Most issuance occurred in the United States, amounting to $564 billion (Figure 1.9, panel 1). Since 2007, US institutional leveraged loans outstanding have doubled to almost $1 trillion, compared with $1.3 trillion in US high-yield bonds outstanding.[12] While refinancing volumes have been significant given the low-interest-rate environment, borrowing to fund mergers and acquisitions, leveraged buyouts, dividends, and share buybacks still accounts for half of total issuance amid improving global growth (Figure 1.9, panel 2).

[12]Institutional leveraged loans include term loans structured specifically for institutional investors, such as loan funds, collateralized loan obligations, real money investors, and hedge funds, though there are some banks that buy institutional term loans. These tranches include first- and second-lien loans.



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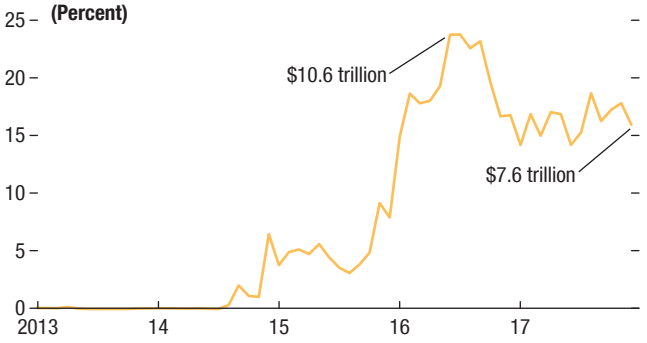
## Figure 1.8. Valuations of Corporate Bonds

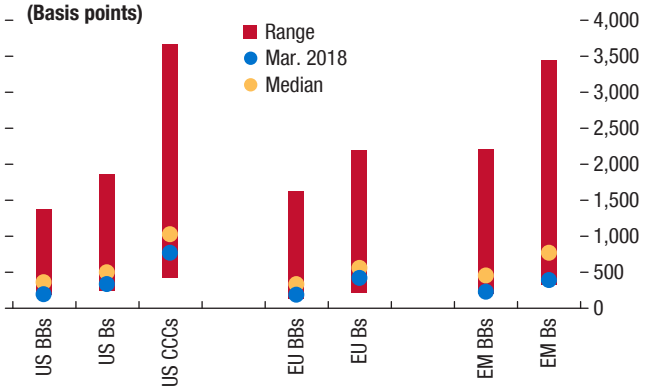
A still-high share of negative-yield assets ...

**1. Share of Negative Yielding Global Bonds (Percent)**



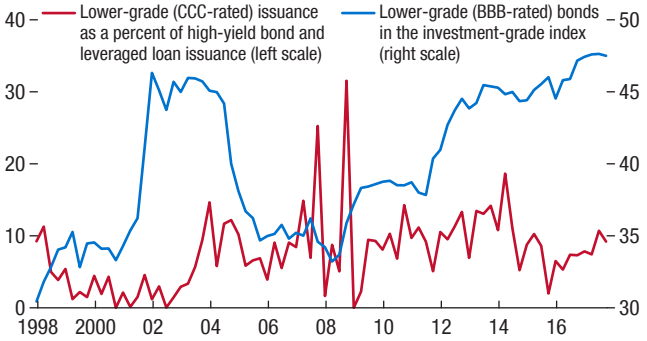

... has supported demand for risky assets and compressed credit spreads.

**2. Credit Spreads per Rating Bucket, 1999–2018 (Basis points)**



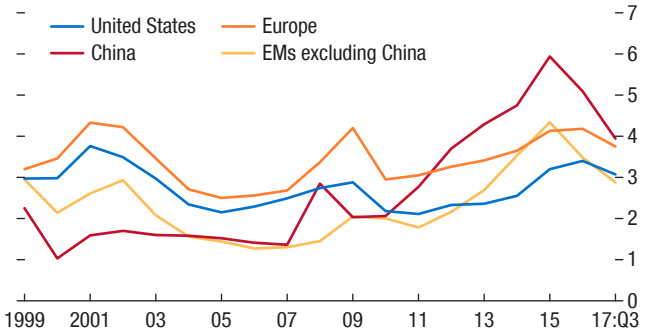

This has spurred the new issuance of risky bonds in lower-credit-quality buckets.

**3. Share of the Lowest Credit Bucket (Percent)**



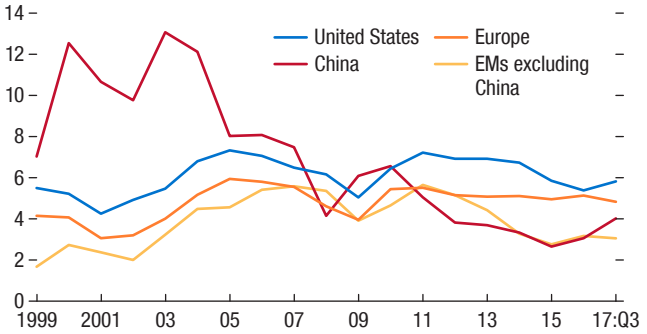

Profitability has helped reduce debt ratios.

**4. Debt Ratios (Net debt to EBITDA, percent)**



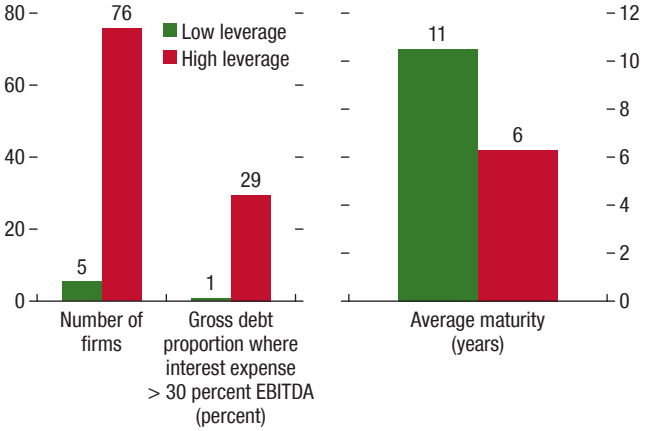

As a result, interest coverage ratios have dipped, except for the United States and China.

**5. Interest Coverage Ratios (EBIT to interest expense)**




Highly levered firms are more likely to be impacted by the US corporate tax reform.

**6. Comparison among High- and Low-Leveraged US Firms**




Sources: Bloomberg Finance L.P.; ICE Bank of America Merrill Lynch; JPMorgan Chase & Co; Standard & Poor's; and IMF staff calculations.
Note: In panel 2, the full sample is from 1999 to 2018. In panels 4 and 5, the full sample from 1999 to 2005 from the source is limited. In panel 6, high leveraged is defined as firms with net debt divided by EBITDA > four times. Real estate and utilities sectors are not included. EBIT = earnings before interest and taxes; EBITDA = earnings before interest, taxes, depreciation, and amortization; EM = emerging market.



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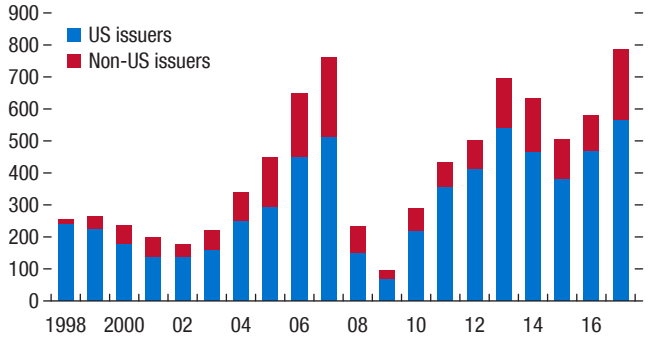
## Figure 1.9. Leveraged Loan Issuance, Quality, and Developments after Regulatory Guidance

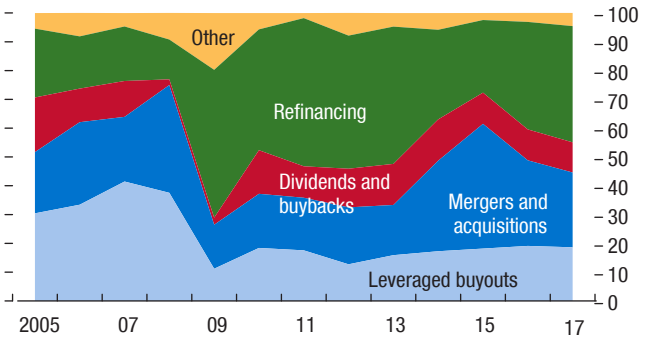
Loan issuance reached record highs in 2017 ...

**1. New Issue Global Leveraged Loan Volume (Billions of US dollars)**



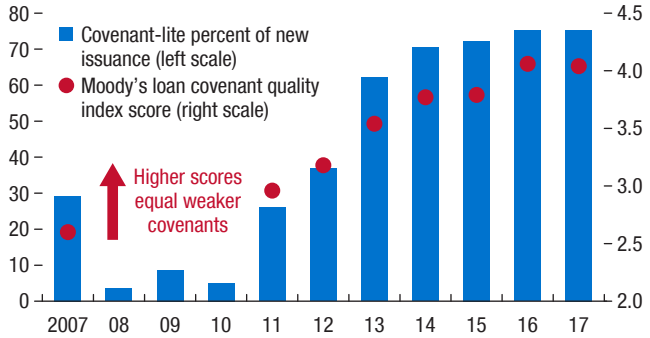

... with the share of proceeds used to fund acquisitions and shareholder enhancements still large.

**2. Global Leveraged Loan Issuance by Use of Proceeds (Percent)**



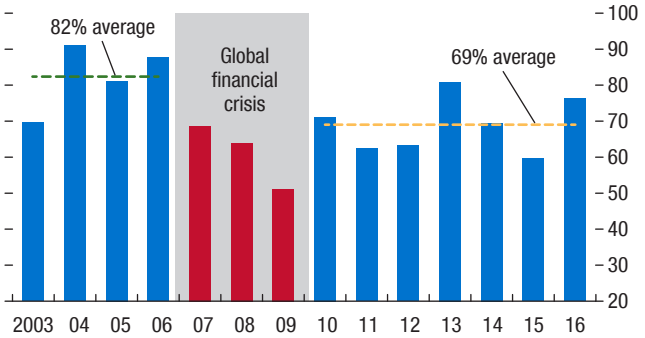

Covenant protections have weakened over time ...

**3. New Issue Covenant-Lite US Leveraged Loans and Covenant Quality Index**



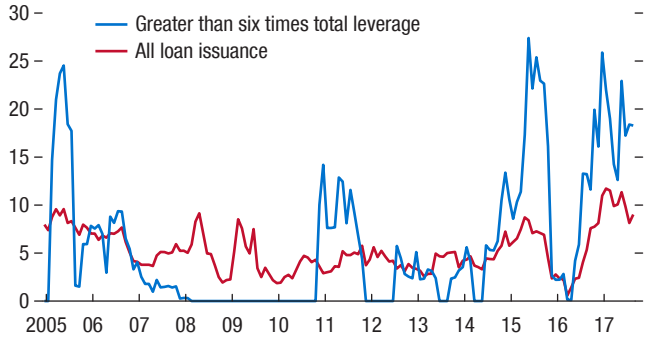

... leading to potentially lower recovery rates in the next default cycle.

**4. Average Annual First Lien US Loan Implied Recovery Rates (Percent)**



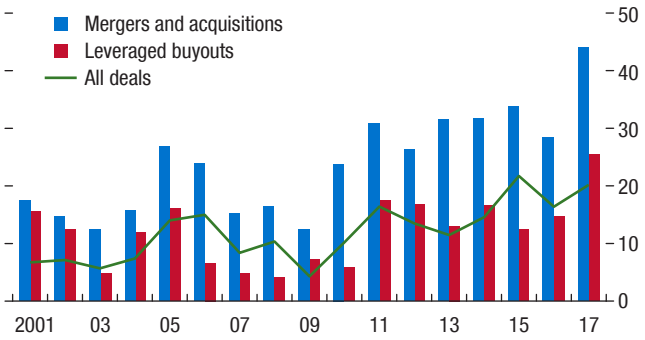

Highly leveraged loan deals have increasingly been arranged by nonbank lenders ...

**5. Fraction of US Deals with a Nonbank Entity as Lead Agent (Percent)**




... while adjustments to earnings expectations have led to less conservative leverage calculations.

**6. Percent of US Deals with EBITDA Adjustments**




Sources: Barclay's; Moody's Default and Recovery database; Standard & Poor's Leveraged Commentary and Data; and IMF staff calculations.
Note: In panel 3, the Moody's Loan Covenant Quality Index score is a yearly average; data are unavailable from 2008 to 2010 due to lack of rated leveraged loan issuance. A higher Covenant Quality Index score represents weaker covenant protections. In panel 4, implied recovery rates are based on loan prices one month after default. EBITDA = earnings before interest, taxes, depreciation, and amortization.



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The global leveraged loan market now offers an interesting example of the extent to which reach for yield has supported issuance and adversely affected price and nonprice terms, as well as credit quality, despite efforts by regulators to rein in risk taking.[13] Strong issuance and lofty valuations, including a weakening of nonprice terms such as investor protections, could exacerbate the next default cycle. A sharp rise in defaults following a tightening of financial conditions, or a shutdown of the market at the extreme, could have large negative implications for the real economy given the growing size of the loan market to date and the role it plays in channeling funding to corporations.

Signs of late credit cycle dynamics are already emerging in the leveraged loan market and, in some cases, are reminiscent of past episodes of investor excesses. Lower-quality companies continue to enjoy ample access to credit. Yet at the same time, ratings have deteriorated. In the United States, the percentage of new loan issuance rated single-B or lower increased from about 25 percent in 2007 to 65 percent in 2017, although this trend could partly reflect some changes in rating agencies since the crisis.[14] Meanwhile, new deals include fewer investor protections, such as looser covenants and thinner subordination in the capital structure. For example, covenant-lite loans have evolved from a specialty structured debt instrument before the financial crisis to the largest market segment today. Covenant-lite loans made up 75 percent of new institutional loan issuance in 2017. In addition, the quality of loan covenants has continued to deteriorate (Figure 1.9, panel 3).

To be fair, weaker covenants may reflect the loan market's changing investor base as loans mature into a widely accepted asset class in investors' portfolios. But looser provisions inherently provide fewer warning signals about a potential default and may thereby result in lower recovery rates. For example, in the recent past banks typically demanded a first-lien claim on collateral as well as sufficient loss-absorption capacity (usually in the form of corporate bonds) to protect loans in the event of a default. But the average debt cushion of first-lien covenant-lite loans is now only 15 percent, down from about 33 percent before the financial crisis. Although the number of defaults so far in this cycle has been limited, weakening investor protections and eroding debt cushions have coincided with lower average recovery rates for defaulted loans (69 percent), compared with the precrisis average of 82 percent (Figure 1.9, panel 4).

Regulators in the United States and Europe have taken actions aimed at curbing market excesses.[15] One unintended consequence of these actions appears to be a migration of activity away from banks toward institutional investors, such as collateralized loan obligations, bank loan mutual funds, private equity firms, and other private funds (Kim, Plosser, and Santos 2017). (See Box 1.3 for a discussion of the changing investor base in the US leveraged loan market.) As noted, institutional leveraged loans outstanding have grown rapidly in recent years, with institutional investors increasingly playing an important role in highly leveraged loan deals (Figure 1.9, panel 5). In addition, nonprice terms, which are more difficult to monitor, have been loosening. Weaker covenants have reportedly allowed borrowers to inflate projections of earnings before interest expenses, taxes, depreciation, and amortization (EBITDA) and to borrow more after the closing of the deal. New loans with EBITDA add-backs or adjustments that conceal deteriorated leverage metrics have reached new highs (Figure 1.9, panel 6).[16]

[13]There is no universal definition for leveraged loans, but the term usually refers to a speculative-grade loan for which the obligor's postfinancing leverage (as measured by debt-to-assets ratio, debt-to-equity ratio, cash-flow-to-total-debt ratio, or other such standards unique to particular industries) significantly exceeds industry norms. Leveraged borrowers typically have diminished ability to adjust to unexpected events and changes in business conditions because of their higher ratio of total liabilities to capital.

[14]Cohen and Manuszak (2013) find that increased competition among credit rating agencies from 2002 to 2007 led to lower subordination levels and less stringent ratings.

[15]For example, in March 2013 US federal banking agencies issued guidance to reduce risk in the leveraged loan market, both for loans retained on banks' balance sheets and for those repackaged for sale to other parties. More recently, in May 2017 the ECB issued supervisory guidance concerning expectations around leveraged transactions in Europe and the ongoing monitoring of the fundamental credit quality of leveraged exposures. In particular, US and European supervisors recommended that banks follow heightened risk management when a borrower's debt exceeds six times its earnings before interest expense, taxes, depreciation, and amortization.

[16]EBITDA add-backs generally consist of pro forma fees and expenses (expected to be eliminated following an acquisition deal) that increase the pro forma EBITDA during the loan syndication process. For additional debt after deal closing, most structures include a debt incurrence clause that allows the borrower to add debt subject to the satisfaction of certain financial ratios along with fixed-dollar debt baskets that generally permit the borrower to incur debt without reference to a maintenance covenant or other financial ratio.



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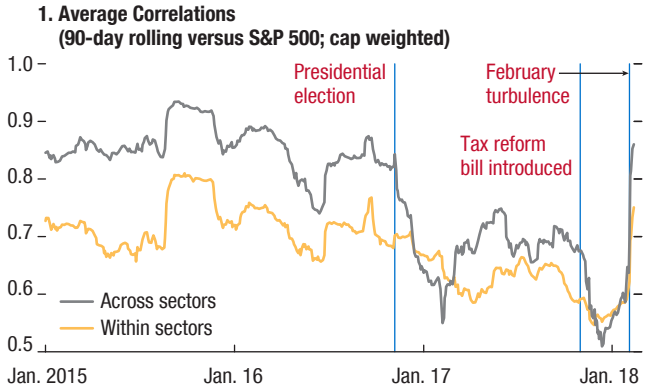
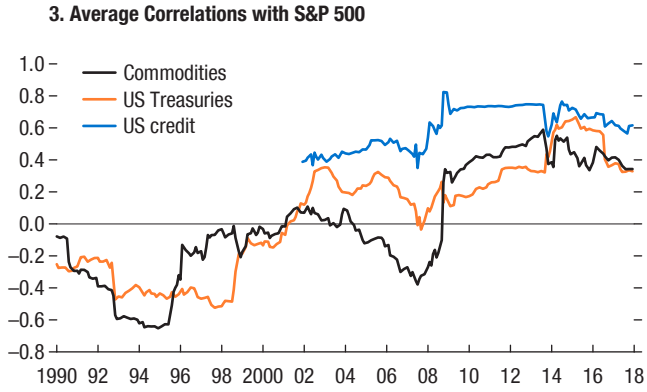
## Figure 1.10. Correlations and Interconnectedness

In the United States, correlations between individual stocks and across sectors have picked up.

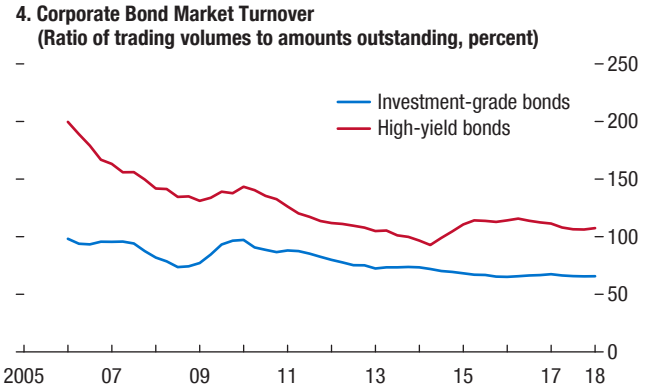



Within the global equity market, cross-country correlations have rebounded somewhat.

The average correlations across major asset classes have remained relatively high ...




... while market turnover has been relatively low.




Sources: Bloomberg Finance L.P.; Haver Analytics; Market Axess; and IMF staff estimates.
Note: In panel 4, data are as of end-February 2018. EM = emerging market. S&P = Standard & Poor's.

### The Price of Volatility Remains Low

Another critical issue is how much risk investors perceive around asset valuations. Indeed, valuations for options, on the one hand, and underlying securities, on the other, are distinct, strictly speaking. During the turmoil in global equity markets in early February, implied volatilities derived from equity options, which reflect information not only about investors' expectations for volatility but also the premium they require to bear volatility risk, spiked sharply from subdued levels. The VIX term structure, based on short- to longer-dated option expiration dates, not only shifted higher but also inverted briefly (see Online Annex 1.1 on implied volatility pricing).[17]

[17]See Online Annex 1.1 at www.imf.org/en/Publications/GFSR for more details.

But realized volatility and underlying forecasts of future volatility also increased. Both near- and longer-term equity options now appear close to, if not below, levels consistent with volatility forecasts. Therefore, the premium investors require to compensate for volatility risks was little changed, on net, which is ultimately consistent with persistently accommodative financial conditions, as well as a renewed willingness on the part of investors to sell volatility. A broadly similar picture arises across other asset classes, including US dollar swaptions.

Correlations within and across asset classes are also important indicators of financial conditions. Indeed, correlations among even typically unrelated assets tend to increase sharply during financial crises, making diversification difficult as investors' overall portfolio risk increases. Correlation measures have rebounded of late,



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albeit from subdued levels relative to historical norms. Within the US stock market, correlations between individual stocks and across sectors picked up somewhat after the completion of major tax legislation and increased further after the spike in volatility in February 2018 (Figure 1.10, panel 1). Global equity market correlations also rebounded in recent months, even before the drop in global share prices (Figure 1.10, panel 2). Finally, broader correlations across asset classes have increased, which suggests that global diversification has become somewhat more difficult (Figure 1.10, panel 3).

It should be noted, however, that trends in realized statistical correlations may understate the prospects of contagion risk. Indeed, both correlations and volatility tend to increase at precisely the most inopportune and unforeseeable times; namely, when prices of risky assets swoon. In addition, market turnover has been relatively low, especially for high-yield bonds, which may compound price discovery distortions and illiquidity in the future (Figure 1.10, panel 4).

Beyond asset price correlations and volatility, the ongoing structural changes in the investment management industry affect interconnectedness and the potential for spillovers across markets. For example, broker dealers' intermediation role has declined in recent years, leading to a greater role for the nonbank sector. Institutional investors include both firms dedicated to high-frequency trading across markets, which have become more prominent, and also other market participants, such as insurance companies and pension funds, which may be using less procyclical investment strategies. In any case, these new market structures have not been tested during a significant market downturn.

## Increasing Use of Financial Leverage May Amplify Risks

As the financial crisis illustrates, leverage can amplify negative shocks through pernicious feedback loops. Sharp price declines can lead to investor runs and fire sales of liquid and safe assets to cover redemptions and margin requirements.

There have been some noteworthy developments since the crisis. For example, lower volumes of *repurchase agreements (repos),* at least relative to market capitalization, may be reflective of less financial leverage. In the years before the global financial crisis, investors widely used repos and leverage to boost returns. But stricter regulations, as well as changes in bank business models, have significantly reduced repo activity.

However, other forms of financial leverage appear to be on the rise:

- *Synthetic collateralized debt obligations (CDOs):* Analysts estimate synthetic CDO issuance to have surged to between $80 billion and $100 billion in 2017—well below precrisis levels but up from about $20 billion a year in 2014–15 (Figure 1.11, panel 1). Some market participants also speculate that institutional investors are actively increasing leverage to boost yields using total return swaps and asset swaps, although little evidence is available at this point.
- *Margin debt:* The margin debt from stock borrowing stands at a record $580 billion in the United States, about 2 percent of overall market capitalization as of the end of 2017 (Figure 1.11, panel 2).[18] Although this share is below the peak in 2008, it is still quite elevated. Also worrisome, the current net exposure[19] of investors involved in stock margin borrowing is at record negative highs relative to overall market capitalization compared with the past 25 years (Figure 1.11, panel 3).
- *Use of financial leverage by investment funds:* Meanwhile, assets under management of large regulated bond investment funds that actively use derivatives have increased to more than $1.5 trillion, about 17 percent of the world's bond fund sector (Figure 1.11, panel 4). The use of embedded leverage through derivatives is increasing as fund managers seek to enhance low yields. The lack of sufficient data collection and oversight by regulators compounds the risks.[20] Gross notional exposure of bond funds to derivatives is worrisome. The average derivatives leverage (defined as gross notional exposure) of an asset-weighted sample of more than 200 US- and European-domiciled bond funds has risen from 215 percent to 268 percent of assets over the past four years (Figure 1.11, panel 5). The level of deriv-

[18]Stock margin borrowing data can also include fixed-income securities, but most transactions are related to stocks. The data include both retail and institutional investor transactions.

[19]Defined as the difference between debit balances and free credit balances in customers' security margin and cash accounts.

[20]No disclosure requirements for detailed leverage information for regulated investment funds are in place in the United States, and requirements are in place only on a selected basis in some European countries. Implementing comprehensive and globally consistent reporting standards across the asset management industry would give regulators better data with which to locate leverage risks. For example, reporting standards should include enough information on derivatives to show funds' sensitivity to large moves in underlying rate and credit markets.



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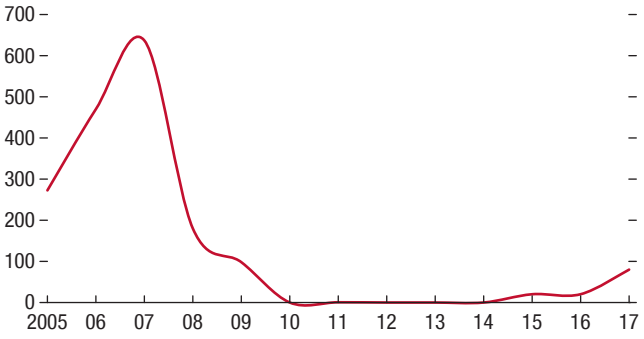
## Figure 1.11. Measures of Leverage and Investment Funds with Derivatives-Embedded Leverage

Although well below precrisis levels, synthetic CDO issuance is coming back ...

**1. Synthetic CDO Issuance (Billions of US dollars)**

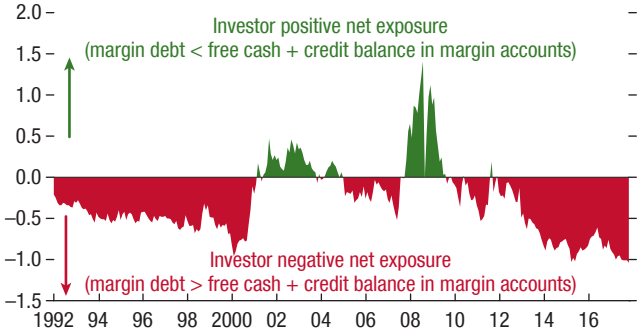



... with elevated stock borrowing by margin indicating greater leverage risk in US equity markets ...

**2. Margin Debt from Stock Borrowing**

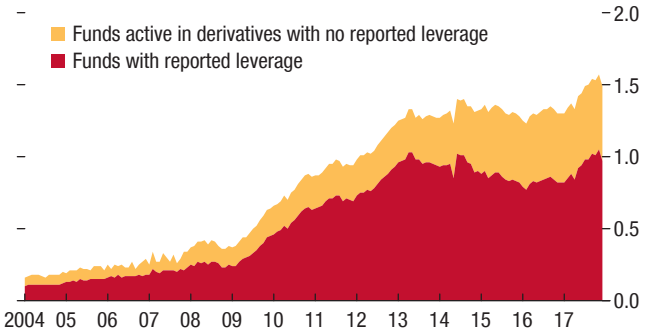
... and net exposures in margin accounting for stock borrowing reaching record negative levels.

**3. Net Exposure of Investors with Margin Debt (Percentage of market capitalization)**



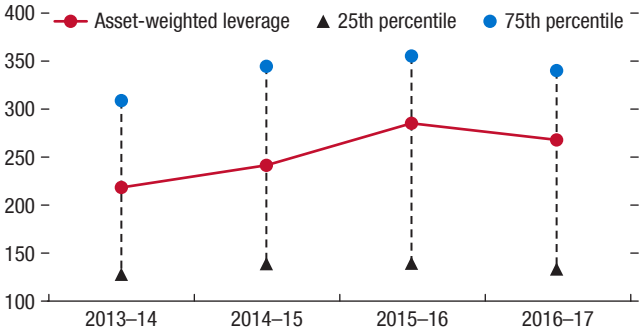

There is strong growth in the AUM of selected large regulated bond funds that use derivatives ...

**4. Assets under Management of Selected Bond Funds (Trillions of US dollars)**



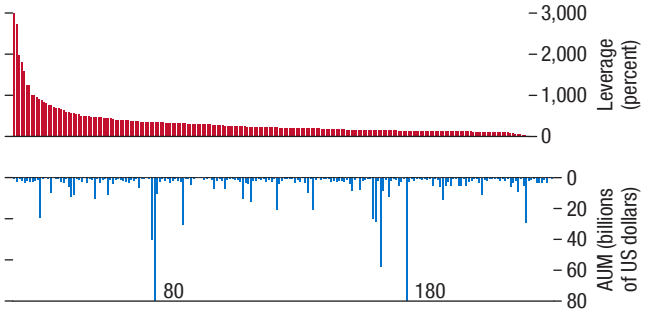

... with rising gross notional exposures ...

**5. Average Derivatives Leverage of Selected Bond Funds (Gross notional exposure as a percentage of net asset value)**




... that can exceed multiples of fund net asset values.

**6. Derivatives Leverage and AUM across the Different Funds (Gross notional exposure percentage; billions of US dollars)**




Sources: Annual reports of selected regulated investment funds; Bloomberg Finance L.P.; Federal Reserve; Financial Industry Regulatory Authority; ICE Bank of America Merrill Lynch; and IMF staff estimates.
Note: Selected EU-domiciled investment funds report a gross notional exposure of their derivative positions in their annual report. Funds with reported leverage in derivatives positions in the sample account for over $1 trillion of these assets, including the assets of the US-domiciled version of the same EU-domiciled funds that report leverage. Although these funds are separate investment vehicles, they share the same mandate and portfolio manager and therefore have closely matched portfolios, exhibiting a high correlation of returns. The remaining $500 billion of assets correspond to a group of selected funds that do not report leverage in derivatives positions but are known to be active in derivatives (the funds' latest annual reports list at least 15 derivatives positions). In panels 2 and 3, margin debt data may also include nonequity securities such as bonds. In panel 6, the data are as of the latest annual reports. AUM = assets under management; CDO = collateralized debt obligation.



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atives notional exposure in the sample ranges quite significantly: the bottom 25th percentile of funds has embedded derivatives leverage in the 100 to 150 percent range. But the top 25th percentile shows funds with average leverage between 300 and 2,800 percent (Figure 1.11, panel 6).[21] Some investors may enter derivatives contracts to hedge unwanted risk. However, others may do so to boost returns, which, in turn, can amplify shocks during periods of stress.[22]

## Growth in Less Liquid Bond ETFs May Raise Financial Stability Concerns

The assets under management of ETFs invested in less liquid assets—bank loans and high-yield and emerging market bonds—have risen rapidly to more than $140 billion (Figure 1.12, panel 1). Although the share of high-yield bond and emerging market bond ETF assets is still small (less than 5 percent of the total market value of underlying bond markets), it more than tripled from 2010 to 2017 (Figure 1.12, panel 2).[23]

ETFs offer several benefits to investors: they enhance price discovery, provide an alternative source of liquidity through exchange trading, facilitate hedging and diversification, and charge lower fees than other investment funds.[24] Indeed, ETFs can provide additional liquidity to less liquid bond markets: only about one-fifth of transactions in high-yield and emerging market bond ETFs prompt a corresponding transaction in the underlying market as a result of outflows from ETFs; that is, a destruction of ETF shares (Figure 1.12, panel 3).

However, the extension of ETFs to less liquid bond markets may pose risks related to liquidity mismatches between ETFs and underlying assets. Although there is no conclusive evidence about the broader impact of large outflows from less liquid bond ETFs on underlying markets,[25] the fast growth of these ETFs is worth monitoring, given their potential for increasing contagion risks:

- *Frequent trading:* Investors in ETFs appear to trade more actively than market participants in the underlying asset class, which may increase contagion risk. To start, unlike flows into retail mutual funds, ETF flows are very volatile (Figure 1.12, panel 4). Less liquid bond markets, such as high-yield bonds, lack the depth and breadth to accommodate large and frequent transactions.[26] Even during the financial crisis, outflows from high-yield bond investment funds were limited, with a maximum monthly outflow of 2.5 percent (of assets) in October 2008. Monthly ETF outflows now often exceed 3 percent (of assets), which may become more of a concern as the market share of ETFs rises.
- *Sensitivity to changes in risky asset prices:* As evidenced during the February episode of volatility in equity markets, the sensitivity of high-yield and emerging market bond ETFs to S&P 500 returns is higher than the sensitivity of their underlying indices to S&P 500 returns. This suggests that the rise in ETFs, particularly those investing in relatively illiquid assets, may increase contagion risk and possibly amplify price moves across asset markets during periods of stress. Greater investment in passive investment strategies, such as ETFs, may be related to the rise in cross-asset correlations during periods of stress, one of the main attributes of contagion. Benchmark-focused investors are more likely to be driven by common shocks than by the idiosyncratic fundamentals of assets they invest in.[27]

[21]While US and European regulated investment funds are subject to explicit leverage limits, derivatives exposures may mask implicit leverage since there is less explicit regulation on leverage, particularly in the United States. See Chapter 1 of the April 2015 GFSR for more detail.

[22]There are 14 funds in the sample (with about $25 billion in assets under management) that report both the gross notional exposure of their derivatives and a leverage exposure, adjusted for discretionary hedging and netting. About two-thirds of their gross derivatives notional exposure is not dedicated to hedging and netting, but to boosting returns and additional risk.

[23]Data on the share of the loan market are not included owing to lack of data availability.

[24]ETFs are generally index-tracking funds that are traded on exchanges and allow investors to gain exposure to several asset classes on a real-time basis at a relatively low cost compared with higher-fee regulated investment funds that do not offer intraday liquidity. ETFs thereby enhance price discovery and offer liquid and transparent investment and hedging alternatives.

[25]There is some evidence that the largest holdings of high-yield bond ETFs are increasingly and more systematically underperforming the broader market during days of large outflows. During these days (top 5th percentile of daily shares destroyed), the largest 10 bond holdings of US high-yield bond ETFs showed significantly greater underperformance to the market in the 2015–17 period as compared with the 2010–11 period, when their ownership of the underlying market was less than a quarter of what it is today. There is no evidence, however, of large redemptions from these ETFs having a significant impact on the pricing of the broader underlying market. This is not at all surprising given that their share of the underlying high-yield and emerging market bond markets is still less than 5 percent.

[26]This limitation is reflected in the lower trading volumes, smaller trading size, smaller share of large trades, and less frequent trading of the less liquid fixed-income markets. Some high-yield bonds do not even transact on a daily basis. See Chapter 1 of the October 2014 GFSR.

[27]See Chapter 1 of the April 2015 GFSR.



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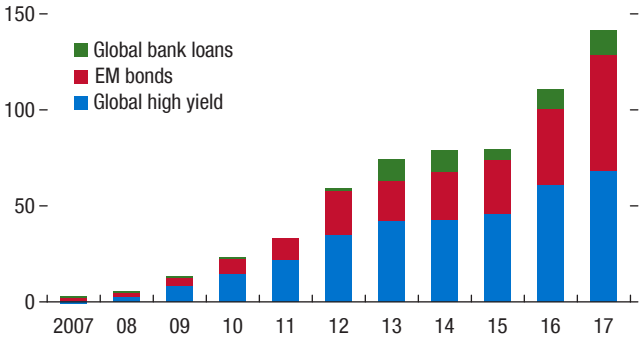
## Figure 1.12. Strong Inflows into Exchange-Traded Funds Pose Challenges for the Less Liquid Fixed-Income Markets

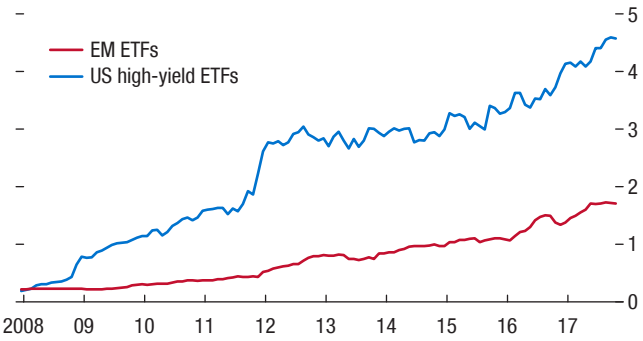
ETFs invested in less liquid bond markets are receiving strong inflows ...

**1. Assets under Management of ETFs Invested in Global High-Yield, Bank Loan, and Emerging Market Bonds (Billions of US dollars)**



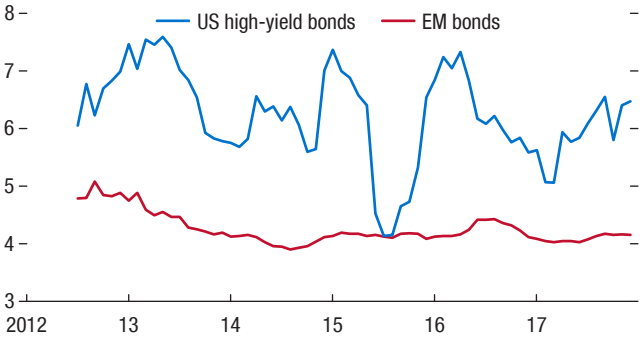

... and ETFs are owning a growing share of the underlying markets.

**2. Bond ETF Holdings as a Share of Total Market Value (Percent)**



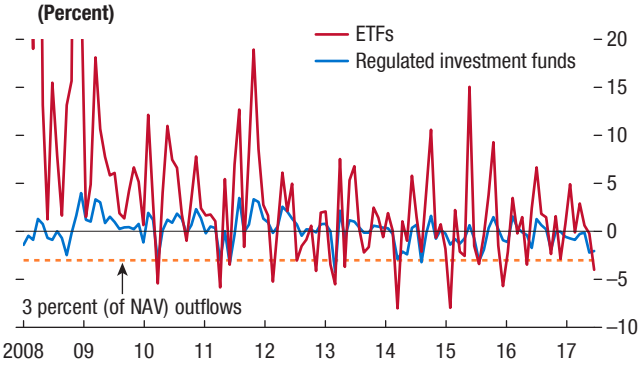

Although ETFs can provide additional liquidity to the less liquid bond markets ...

**3. Ratio of Average Trading Volume to Shares Destroyed or Created for US High-Yield and EM Bond ETFs (Six-month moving average)**



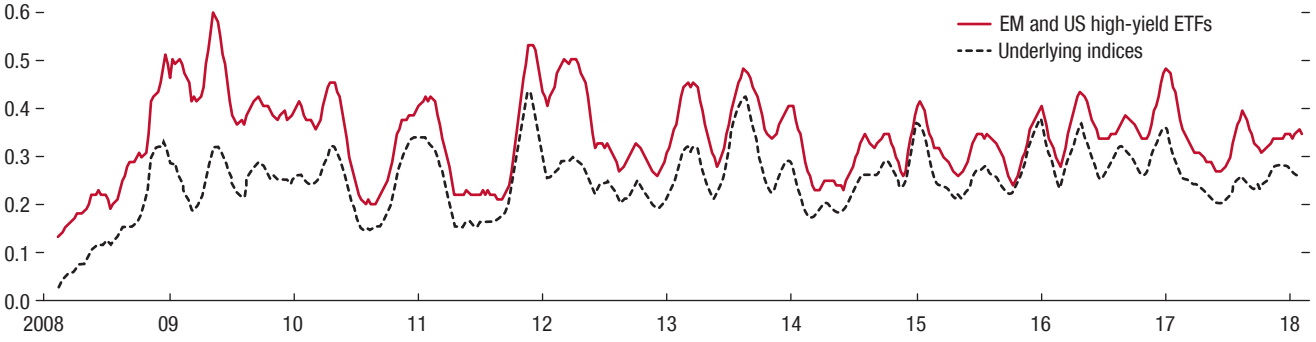

... their investor base is significantly more flight prone ...

**4. Flows as a Percentage of Net Asset Values for High-Yield Bond ETFs and Regulated Investment Funds (Percent)**




... and their greater sensitivity to major liquid markets increases contagion risks.

**5. Average Dynamic Conditional Betas with S&P 500**




Sources: Bloomberg Finance L.P.; EPFR Global; Haver Analytics; ICE Bank of America Merrill Lynch; and IMF staff estimates.
Note: The market value of underlying bonds in panel 2 is calculated using ICE Bank of America Merrill Lynch indices. EM = emerging market; ETF = exchange-traded fund; NAV = net asset value. S&P = Standard & Poor's.



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### Risks Arising from the Buildup of Financial Vulnerabilities Should Be Managed

Regulators and financial market participants should avoid complacency and be mindful of the risk of sudden bouts of extreme volatility. Although financial markets functioned well during the turbulence in early February, the episode was largely confined to global equity markets. Asset valuations remain stretched, and rising interest rates may be accompanied by a repricing of risky assets and further spikes in volatility. Regulators should, therefore, ensure that financial institutions maintain robust risk management standards, including through the close monitoring and assessment of exposures to asset classes deemed to be overvalued. Financial market participants should remain attuned to the risks associated with rising interest rates and monetary policy normalization.

Given signs of late-stage credit cycle dynamics, policymakers should use the macroprudential tools at their disposal more actively. In addition to deploying standard capital- and borrower-based macroprudential instruments, regulators should improve credit risk monitoring, also focusing on deterioration of nonprice terms and investor protection. Regulators should also be mindful of the unintended consequences of regulatory measures, including migration of activity toward more opaque segments of the financial system.

Finally, the macroprudential toolkit needs to be expanded to address risks in the nonbank financial sector. For example, regulators should do the following:

- *Endorse a clear and common definition of financial leverage in investment funds:* This definition would improve transparency, particularly for derivatives positions. Lack of progress on regulation covering the use of derivatives is also a concern that should be addressed.
- *Continue to strengthen supervisory frameworks for liquidity risk management in investment funds:* Although the International Organization of Securities Commissions' latest report on liquidity risk management for collective investment funds (IOSCO 2018) provides welcome guidance on this front, there is scope for the country authorities to monitor further the effectiveness of existing liquidity risk management tools used by fund managers. More broadly, it is important that the authorities across different jurisdictions agree on a harmonized and coherent macroprudential approach to the financial stability risks stemming from investment fund activities, including the possibility of conducting stress test exercises.

## Crypto Assets: New Coin on the Block, Reach for Yield, or Asset Price Bubble?

*Amid stretched valuations in many risky asset classes, crypto assets have erupted onto the financial landscape and their prices have skyrocketed. Some of the technological advances behind them have the potential to increase the efficiency of payment systems and the financial infrastructure. There has been a notable proliferation of crypto assets in recent years and major US exchanges have launched futures contracts. However, crypto assets have also been afflicted by notorious cases of fraud, security breaches, and operational failures and have been associated with illicit activities. At present, crypto assets do not appear to pose macrocritical financial stability risks. Policymakers, however, will need to be nimble, innovative, and cooperative to tackle potential financial stability challenges should crypto assets be used more widely.*

### Crypto Assets: A New Asset Class and Means of Payment?

Crypto assets have the potential to combine the benefits of traditional currencies and commodities.[28] Like fiat money, they can potentially be exchanged for other currencies, be used for payments, and store value.[29] As investment products, they may offer portfolio diversification, although their ability to do so is still limited by their short track record, regulatory uncertainty, and primitive market infrastructure.

The technology underlying crypto assets—distributed ledger technology (DLT)—could also lead to more efficient market infrastructure (IMF 2016a and CPMI 2017). This technology differs from traditional payment systems, which require a clearing entity, such as a central bank, that settles transactions and distributes funds between participants. DLT, in contrast, uses multiple copies of the central ledger, which are kept by individual entities. Blocks of transactions are subsequently validated and recorded, forming a historical chain—hence the name blockchain. New units of the major crypto assets are supplied by "miners" who solve a cryptographic puzzle as part of the validation process and receive a new coin in return. This procedure, however, is costly

[28]The term "crypto asset" is used here to refer to digital currencies that rely on encryption techniques to regulate the generation of units and verification of transfers. Digital currencies are often referred to as "cryptocurrencies" in the popular press. Although tokens and initial coin offerings (ICOs) are discussed at times in the section, the main focus is on crypto assets. ICOs are issuances of digital currencies sold via auction or investor subscription in return for crypto assets.

[29]Some jurisdictions, however, have forbidden the use of crypto assets as a medium of exchange for payments.



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in terms of both energy and time. The supply process differs somewhat across crypto assets and allows for some flexibility. For example, there is an upper limit on the eventual outstanding amount of Bitcoins. But crypto assets can be designed without such an upper limit, thus mimicking more closely the money supply dynamics in traditional fiat money systems.

Crypto assets have been touted as a new form of money. However, they are still far from fulfilling the three basic functions of money. While they may serve as a store of value, their use as a medium of exchange has been limited, and their elevated volatility has prevented them from becoming a reliable unit of account. These shortcomings could change with wider adoption and technological improvements, and some crypto assets may be able to perform the functions of money better, thus putting competitive pressure on fiat currencies (Box 1.4).

Even after accounting for recent price corrections, crypto assets have experienced spectacular appreciation over the past year, spurred by the global reach for yield. Nonetheless, they represent only a small share of the global financial system. Their total market value is less than 3 percent of the combined G4 central bank balance sheets (Figure 1.13, panel 1). Bitcoin alone accounts for 47 percent of crypto assets' market value, while the next two largest crypto assets, Ethereum and Ripple, account for 15 percent and 8 percent, respectively. As such, crypto assets currently pose limited challenges to fiat currencies or to the conduct of monetary policy. The dramatic growth in the sector, however, may pose risks to financial stability in the future and thus warrants vigilance by regulators.

Much attention has been devoted to the skyrocketing prices of crypto assets in 2017, which has invited comparisons with past speculative bubbles (Figure 1.13, panel 2). However, after accounting for price volatility, risk-adjusted returns have not dramatically exceeded those of mainstream assets over the medium term, though they have in the most recent year (Figure 1.13, panel 3).[30] For example, the Sharpe ratio of crypto assets was relatively close to the risk-reward ratio of the S&P 500 over the past three years, and it was below what investing in so-called FANG stocks (Facebook, Amazon, Netflix, Google) would yield (Figure 1.13, panel 4). However, crypto assets have not been correlated with other assets, and therefore could provide diversification benefits to investors, on balance.

The unconditional correlation between Bitcoin and other asset classes was close to zero between September 2015 and March 2018 (Bank of America Merrill Lynch 2017; Burniske and White 2017) (Table 1.1, panel 1).[31] Even during the most recent bout of volatility, the correlation of Bitcoin with most mainstream assets did not appear to change significantly. Pairwise correlations between different crypto assets are comparatively subdued, again despite tremendous variance in returns (Table 1.1, panel 2). Although these correlations are positive, they are somewhat lower than correlations with G4 sovereign yields and equities.[32] However, it is important to note that these correlations may change over time. So while some investors are beginning to investigate whether crypto assets could be an asset class in their own right, it is too early to draw clear conclusions.

Dedicated crypto-asset exchanges (CEs) provide liquidity, leverage, and custodial services. More than 180 CEs are transacting in thousands of different coins across jurisdictions, adding up to an average daily volume of $30 billion. Still, liquidity tends to be highly concentrated in a select few coins and exchanges. The top 14 CEs account for more than 80 percent of reported volume (Figure 1.14, panel 1), and the top 10 crypto assets account for 82 percent of the total reported volume (Figure 1.14, panel 2). Among currency pairs with fiat currency on one side, the US dollar dominates with 71 percent of volume, followed by the yen and the euro with about 14 percent and 11 percent, respectively (Figure 1.14, panel 3).

In December 2017, the Chicago Mercantile Exchange (CME) and Chicago Board Options Exchange (CBOE) introduced Bitcoin futures contracts. For now, however, futures volumes represent a small fraction of overall trading activity on the CME and CBOE and only 2.3 percent of reported trading in the Bitcoin cash market on CEs (Figure 1.14, panel 4).

However, CEs are a major source of risk for investors, given their opaque and often unregulated nature. Security breaches and exchange failures have led to periods—albeit short-lived—of high volatility and

[30]Admittedly, some of the volatility in crypto assets followed the consideration of regulatory measures in various countries.

[31]September 2015 is used as the starting point of the sample because of data availability limitations before then.

[32]To assess conditional correlations, another multivariate GARCH (asymmetric, generalized autoregressive conditional heteroscedasticity) model was estimated, which found no clear trend during the recent period of sharp crypto-asset appreciation.



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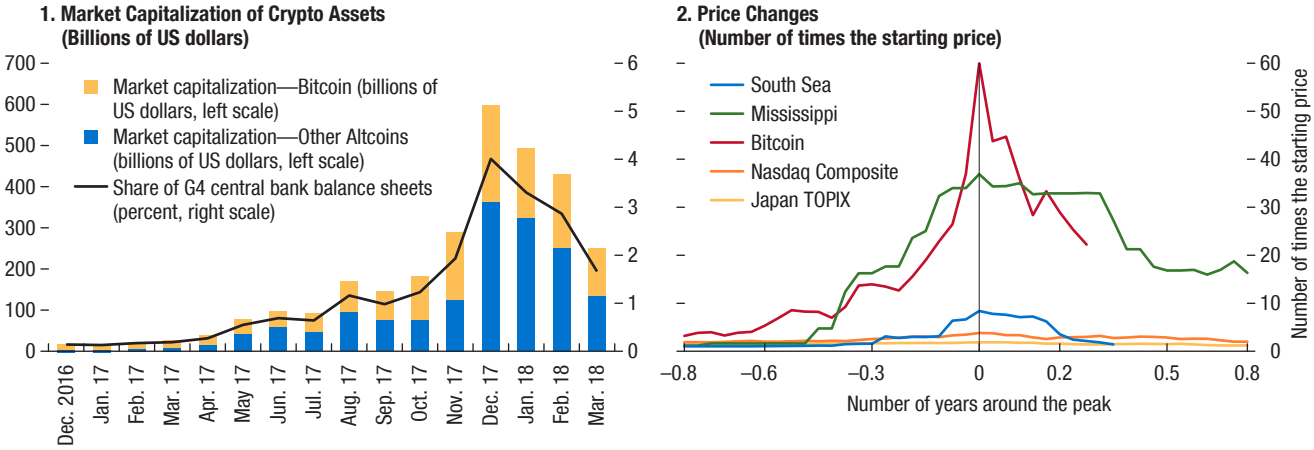
## Figure 1.13. Crypto Assets: Size, Price Appreciation, Realized Volatility, and Sharpe Ratio

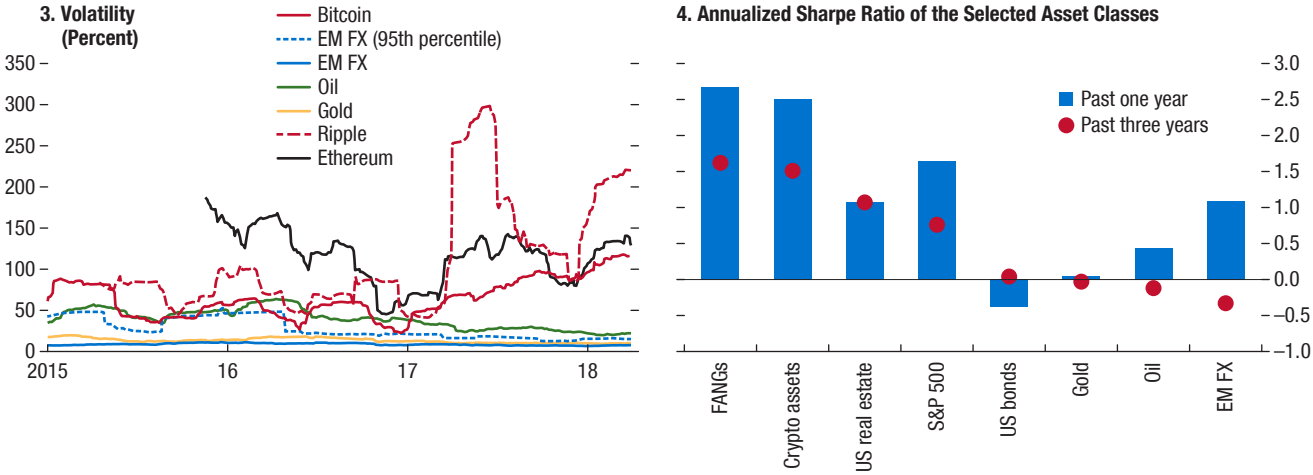
Crypto assets account for a small fraction of G4 central bank balance sheets.

Comparison with historical bubbles.




Bitcoin's realized volatility is much higher than that of other asset classes.

Risk-adjusted returns of crypto assets have not dramatically exceeded those of other mainstream assets.




Sources: Bloomberg Finance L.P.; CoinDance; CoinMetrics; European Central Bank; Haver Analytics; national central banks; Yale International Center for Finance; and IMF staff estimates.

Note: Panel 3 is based on 90-day realized volatility. In panel 4, crypto assets is an average across Bitcoin, Ethereum, Litecoin, and Ripple. The Sharpe ratio is the average return earned in excess of the risk-free rate per unit of total risk. EM = emerging market; FANGs = equal-weighted index of highly traded stocks of technology and tech-enabled companies such as Facebook, Amazon, Netflix, and Alphabet's Google; FX = foreign exchange; G4 = Group of Four (euro area, Japan, United Kingdom, United States); TOPIX = Tokyo Stock Price Index.



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### Table 1.1. Correlation of Bitcoin with Key Asset Classes and within Crypto Assets

The unconditional correlation between Bitcoin and other asset classes has been close to zero.

**1. Unconditional Covariance Matrix of Daily Returns within Selected Asset Classes**

| | Bitcoin | S&P 500 | Long US Treasury ETF | Euro | Chinese Renminbi | Gold |
|---|---|---|---|---|---|---|
| Bitcoin | 1.00 | 0.02 | 0.02 | –0.04 | 0.04 | 0.03 |
| Standard & Poor's 500 | 0.02 | 1.00 | –0.32 | –0.05 | –0.09 | –0.14 |
| Long US Treasury ETF | 0.02 | –0.32 | 1.00 | 0.11 | –0.07 | 0.39 |
| Euro | –0.04 | –0.05 | 0.11 | 1.00 | –0.37 | 0.42 |
| Chinese renminbi | 0.04 | –0.09 | –0.07 | –0.37 | 1.00 | –0.28 |
| Gold | 0.03 | –0.14 | 0.39 | 0.42 | –0.28 | 1.00 |

Pairwise correlations among the various crypto-asset pairs remain low.

**2. Unconditional Covariance Matrix of Daily Returns within Selected Crypto Assets**

| | Bitcoin | Monero | Ethereum | Ripple | Litecoin |
|---|---|---|---|---|---|
| Bitcoin | 1.00 | 0.36 | 0.35 | 0.28 | 0.49 |
| Monero | 0.36 | 1.00 | 0.40 | 0.23 | 0.29 |
| Ethereum | 0.35 | 0.40 | 1.00 | 0.22 | 0.30 |
| Ripple | 0.28 | 0.23 | 0.22 | 1.00 | 0.33 |
| Litecoin | 0.49 | 0.29 | 0.30 | 0.33 | 1.00 |

Sources: Bloomberg L.P.; and IMF staff estimates
Note: Correlations are calculated over September 2015–March 2018. ETF = exchange-traded fund.

severe losses. Data on trading volumes can be unreliable, especially since CEs operate under heterogeneous rules with different fee structures, investor bases, and levels of regulatory oversight.

## Financial Stability Risk Assessment

It is impossible to know the extent to which crypto assets may transform the financial infrastructure and whether most new crypto assets are likely to disappear as in past episodes of technological innovation (as many tech companies did during the boom of the late 1990s, for example). Before they can transform financial activity in a meaningful and lasting manner, crypto assets will first need to earn the confidence and support of consumers and financial authorities. The initial step in this process will involve coming to a consensus within the global regulatory community about what crypto assets are—for example, a security or a currency—and the role they can play in the financial system. Although Bitcoin was indeed created to circumvent a lack of trust among trading parties (Nakamoto 2008), a series of notorious fraud cases has undermined this goal, suggesting increased prudential regulation may be needed. At present, crypto assets do not appear to pose risks to financial stability. However, regulators should be vigilant to the potential for financial stability challenges that could arise should crypto assets be used more widely. A few aspects that deserve monitoring are highlighted below.

- *Leveraged trading:* CEs have set generous limits on leveraged positions, in some cases reportedly 15 times, 25 times, and even 100 times (Deutsche Bank 2017).[33] As in any exchange, sudden depreciations prompt margin calls and amplify price moves. Separately, concerns have also been raised about futures contracts traded on the CME and CBOE, given that clearing members in these exchanges bear the risk associated with these contracts through their obligation to the guarantee fund, even if they do not participate directly in the market.[34] Still, the combination of low asset return correlations discussed previously and crypto assets' small footprint within the financial system suggests that the risk of spillovers from idiosyncratic price moves in crypto assets to the wider market may be limited at this point.
- *Integration into mainstream financial products:* The proliferation of crypto-asset-related investment funds, ETFs, and futures contracts increases the opportu-

[33]Leverage limits have been reported at 15 times an investor's cash deposits in Japan's bitFlyer exchange ("Bitcoin feeding frenzy fuelled by 15 times leverage, says exchange," https://www.ft.com/content/7f02cdba-dbd6-11e7-a039-c64b1c09b482). Other exchanges offer even more extreme leverage opportunities of up to 100 times (see www.bitmex.com). In practice, however, industry contacts indicate that actual average leverage tends to be between 3 and 8 times.

[34]"Open letter to CFTC chairman Giancarlo regarding the listing of crypto-asset derivatives," from the US Futures Industry Association to the Commodity Futures Trading Commission regarding the introduction of futures contracts on crypto assets (https://fia.org/articles/open-letter-cftc-chairman-giancarlo-regarding-listing-crypto-asset-derivatives).



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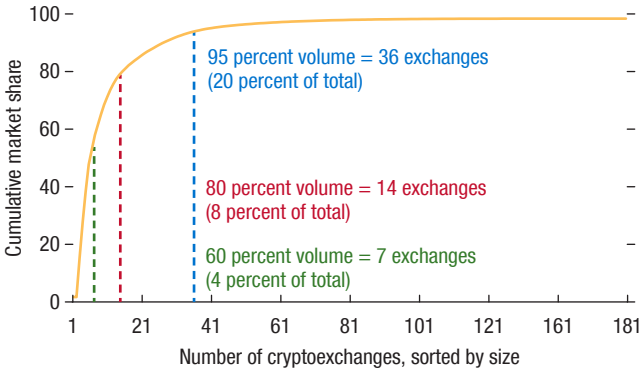
**Figure 1.14. Share of Trading Volumes across Exchanges, Crypto Assets, and Fiat Currencies**

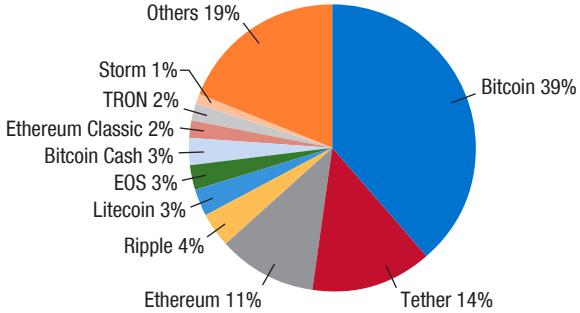
Trading volume is highly concentrated, with 80 percent of volume traded on just 14 exchanges.

**1. Cumulative Market Share across the Various Cryptoexchanges, March 2018 (Percent)**



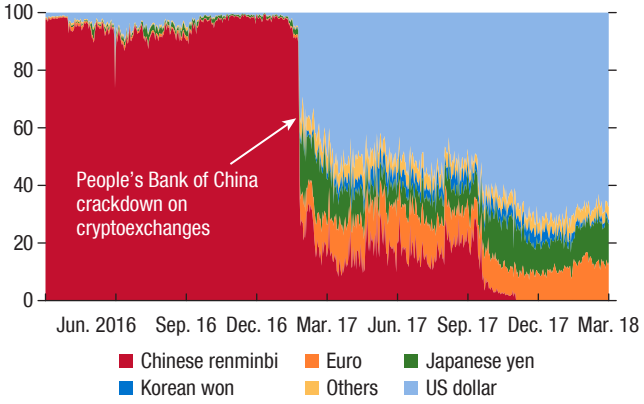

Volume share across crypto assets is led by Bitcoin, Ethereum, Ripple, and Tether.

**2. Reported Volumes by Cryptocurrency, March 2018 (Percent)**



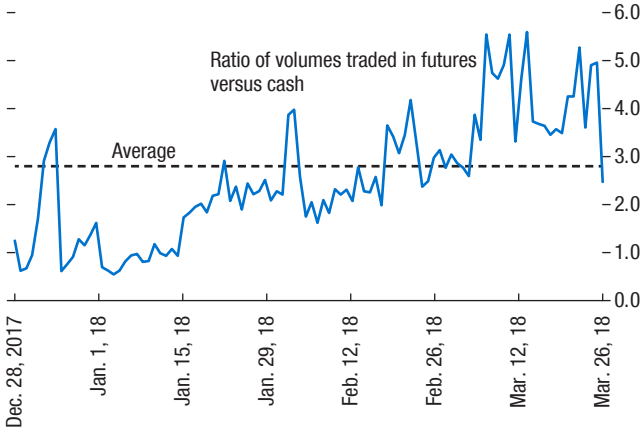

Composition of reported volumes has shifted away from the Chinese exchanges.

**3. Bitcoin: Reported Volumes by Fiat Currency (Percent)**




Bitcoin futures volumes remain low.

**4. Bitcoin Futures as a Proportion of Cash Volume (Percent)**




Sources: Bitcoinity; Bloomberg Finance L.P.; CoinMarketCap; and IMF staff estimates.

nities for mainstream investors to incorporate these assets into their portfolios. However, this broadening of the investor base could result in increased correlation between crypto assets and traditional assets over time, increasing the potential for transmission of shocks, especially during episodes of risk aversion.

- *Partial disintermediation of the banking system:* A large shift away from fiat money toward crypto assets could add challenges to banks' business models. Such a shift, if on a broad scale, would result in a more decentralized financial system in which banks would play a smaller role in traditional lending business and in payment systems. In such a decentralized system, financial stability risks may become more prominent because the critical prudential and safety-net functions of existing banking systems (for example, consumer protection, resolution regulations, and systemic liquidity management by the central bank) would safeguard a smaller segment of the financial system, and the ability of central banks to function as a lender of last resort may also be curtailed.
- *Cross-border considerations:* The lack of transparency in the markets and the rapid pace of growth could cause market disruptions. Those disruptions could be transmitted across national boundaries given the borderless nature of the underlying transaction mechanisms, a



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development that could be further facilitated by the differing national regulatory approaches.

### Investor Protection and Anti-Money-Laundering Aspects

Crypto assets also present concerns for investor and consumer protection, as highlighted by the International Organization of Securities Commissions and in related forums. In this regard, securities regulators have drawn attention to the risks around ICOs, mostly on the back of the increasing targeting of ICOs to retail investors by parties located outside the investor's home jurisdiction, thus escaping the purview of the relevant securities regulator. Risks around ICOs include the heightened potential for fraud, cross-border distribution risks relating to heterogeneous regulatory regimes, information asymmetries, technological flaws, and liquidity risks partly caused by the lack of reliable market makers and opaque trading practices.[35]

By design, crypto-asset transactions entail a high degree of anonymity. This results in a potentially major new vehicle for money laundering and the financing of terrorism. Therefore, regulators and supervisors will have to be particularly vigilant regarding money laundering and the financing of terrorism when it comes to designing the appropriate environment for crypto assets (IMF 2016a). Preventive measures such as reporting requirements, customer due diligence, and transaction monitoring could be employed to ensure that crypto assets provide similar safeguards to traditional money against money laundering and the financing of terrorism.

### Policy Response

Ultimately, regulators need to decide what role crypto assets could play in the financial system. So far, views have varied widely, often within the same jurisdiction (see FATF 2015). In the United States, the Commodity Futures Trading Commission sees crypto assets as a commodity, whereas the Internal Revenue Service considers them property, and the Securities and Exchange Commission (SEC) has acted on a case-by-case basis, including by halting some ICOs.[36] Discrepancies also appear across countries. After hosting a large share of recent ICOs, the Swiss authorities have issued guidelines with the intent to regulate ICOs based on economic function and the purpose for which the token is issued, its tradability, and its transferability. In contrast, China, and Korea have cracked down on some trading activities.

Future policymaking will need to be nimble, innovative, and cooperative. The IMF can help advance the agenda on regulation of crypto assets by offering advice and by serving as a forum for discussion and international collaboration. National authorities and international standard setters are encouraged to intensify cooperation on the monitoring of crypto assets and on the consistency of the regulatory approach. Immediate action is needed to close data gaps that inhibit effective monitoring of potential risks and their links to the core financial system; support systemic risk assessment and timely policy responses; and underpin measures to protect consumers, investors, and market integrity. And given the borderless nature of crypto assets and risks of regulatory arbitrage, drawing out common elements of effective regulatory approaches to facilitate consistent international cooperation is essential. Such common elements could include good practices and regulatory requirements to promote the transparency and integrity of ICOs and to strengthen the risk management and robustness of crypto-asset exchanges.

## Vulnerabilities in Emerging Markets, Low-Income Countries, and China

*A number of emerging market economies have taken advantage of benign external financial conditions to address imbalances and build buffers; in others, however, vulnerabilities have continued to build. Monetary policy normalization in advanced economies could result in a tightening of global financial conditions and a reduction in capital flows, increasing rollover risk and adversely affecting productive investment. With weaker issuers increasingly able to access capital markets and with fickle investors playing a larger role in recent years, stress amplifiers have risen. In addition, a considerable number of low-income countries and other small non-investment-grade issuers have experienced a sharp deterioration in debt sustainability. Meanwhile, the creditor composition in these countries has become more complex, posing policy challenges for ongoing and prospective debt restructuring. In China, regulators have taken a number of steps to reduce risks in the financial system. Despite these efforts, however, vulnerabilities remain elevated. The use of leverage and liquidity transfor-*

[35]For details, see IOSCO (2017).

[36]For example, the SEC ruled last year that tokens issued by a virtual organization known as "The DAO" were securities, hence subject to federal regulation. More recently, the SEC halted some ICOs and launched a probe into several crypto assets. The SEC's chairman has promised increased scrutiny to prevent fraud in this area.



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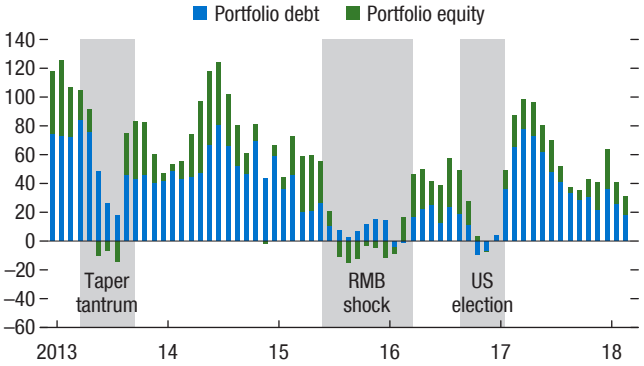
**Figure 1.15. Improving Fundamentals, Increased Foreign Currency Issuance**

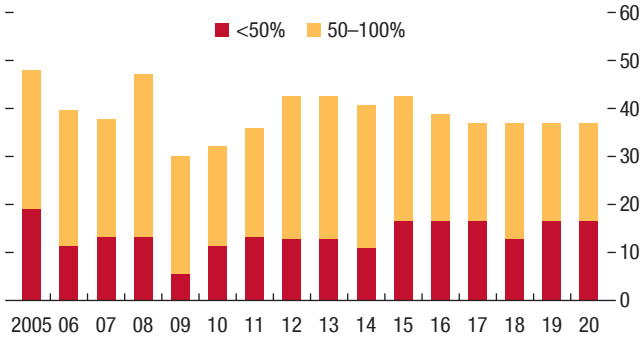
Portfolio flows have been robust.

**1. Nonresident Portfolio Flows to EMs (Three-month rolling sum in billions of US dollars)**



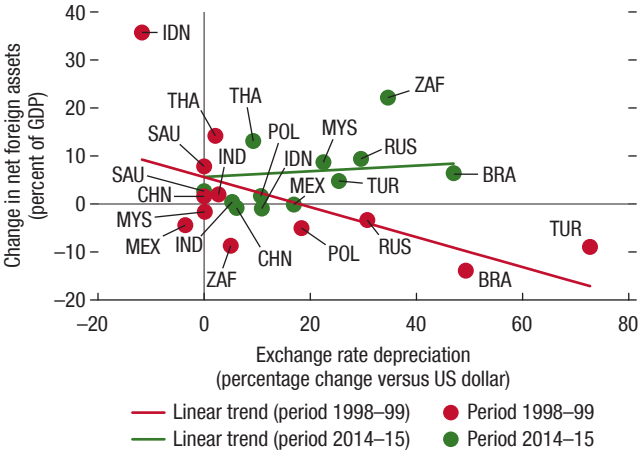

Reserve coverage has improved, but a tail of weak countries remains.

**2. Reserves as a Share of External Financing Needs (Percent of countries)**



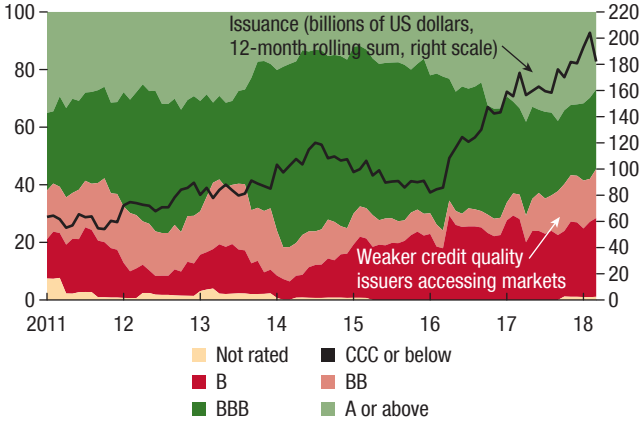

EMs were less vulnerable to dollar appreciation during 2014–15 than in the late 1990s.

**3. Change in Emerging Markets' Net Foreign Assets during Periods of Dollar Appreciation**




Sovereign issuers had a record year in 2017, and the share of non-investment-grade issuers is on the rise.

**4. Sovereign Issuance of International Bonds by Rating (Percent of total)**




Sources: Bloomberg Finance L.P.; Bond Radar; Lane and Milesi-Ferretti (2007); Institute of International Finance; IMF, World Economic Outlook database; and IMF staff estimates.
Note: Panel 2 sample includes 54 EM economies that are part of an external debt sovereign benchmark index. Data labels in panel 3 use International Organization for Standardization (ISO) country codes. EM = emerging market; RMB = renminbi.

*mation in risky investment products remains widespread, with risks residing in opaque corners of the financial system.*

## Has the Prolonged Search for Yield Made Emerging Market Economies More Vulnerable?

Investor sentiment toward emerging markets has remained favorable since the previous GFSR, underpinned by improving growth prospects and robust portfolio flows. Real GDP growth in emerging market economies is projected to reach 4.9 percent in 2018, the fastest pace since 2013 (see the April 2018 WEO). Nonresident portfolio flows to emerging market economies rose to an estimated $240 billion during 2017—twice the pace observed in the previous two years (Figure 1.15, panel 1). Although market interest rates in advanced economies have risen notably over the past six months, emerging market assets have generally performed well over the same period, even after accounting for the episode of volatility in global equity markets in early February.

The gradual and well-telegraphed normalization of monetary policy in advanced economies has pro-



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vided a window of opportunity for emerging market economies. Current account deficits have generally narrowed since 2013 but remain large in a number of emerging markets and are projected to widen, especially for commodity-importing countries (see the April 2018 WEO). Strong capital inflows have enabled some countries to strengthen reserve buffers, leaving a smaller tail of countries with low reserve adequacy (Figure 1.15, panel 2). Corporate fundamentals have also been improving (see "Reach for Yield or Overreach in Risky Assets?" section and Figure 1.8, panels 4 and 5). A strong recovery in earnings has improved interest coverage, and corporate debt levels have fallen somewhat recently but remain elevated in several countries (see October 2017 GFSR).

A sharp appreciation of the US dollar could pose challenges to some countries, even as external balance sheets at an aggregate level have become less vulnerable to exchange rate depreciations. Against the backdrop of an increase in foreign currency sovereign and corporate issuance, a stronger US dollar could put pressure on emerging markets. Borrowers that obtained credit in foreign currency would see the domestic currency value of their liabilities rise, making it more challenging to service and repay debt. A sudden episode of risk aversion could be accompanied by capital outflows, reduce productive investment, and put growth at risk in some emerging markets. However, many emerging market economies have continued to improve their net foreign currency positions, thus reducing their exposures to currency depreciations. Indeed, when the dollar appreciated in 2014–15, net foreign asset positions improved in most emerging markets, a reflection of increased foreign currency assets and higher reliance on both equity liabilities and domestic currency borrowing (Figure 1.15, panel 3; also see IMF 2016b).

Aggregate measures of net external balances may, however, mask vulnerabilities arising from offsetting gross positions and imbalances at a sectoral level. Indeed, gross issuance of foreign currency corporate and sovereign debt securities rose to new highs in 2017, allowing even weaker issuers to access markets (Figure 1.15, panel 4). The share of non-investment-grade issuance has risen to more than 40 percent over the past 12 months, boosted by the return to bond markets of issuers such as Egypt and smaller issuers in sub-Saharan Africa.

Furthermore, exposure to less committed, potentially "flighty," investors is growing, which makes countries more susceptible to a reversal in capital flows. The growing role of fickle investors is evidenced by an upward trend in the "investor base risk index" based on Arslanalp and Tsuda (2012) (Figure 1.16, panel 1).[37] Foreign investor participation helps deepen capital markets, but high shares of foreign ownership can also increase vulnerability to interest rate and rollover risks; for example, in the event of a risk aversion episode. Foreign ownership of sovereign bonds remains high among several emerging market economies (Figure 1.16, panel 2). Among nonbank investors, mutual funds and ETFs stand out as potential sources of volatility because they are associated with increased sensitivity of flows to global financial conditions (for example, Cerutti, Claessens, and Puy 2015; Converse, Levy-Yeyati, and Williams 2018). These investment funds now own nearly one-sixth of fixed-income assets included in emerging market benchmark indices, and more than a third in some countries (Figure 1.16, panel 3).

The reduction in portfolio flows to emerging markets expected to result from monetary policy normalization in the United States in the coming years could put countries with weak fundamentals at risk. Assuming the Federal Reserve's balance sheet normalization proceeds as announced and the federal funds rate is raised to 3.6 percent by early 2020, as projected in the April 2018 WEO, portfolio flows to emerging markets are estimated to be reduced by an average of $40 billion a year in 2018–19.[38] This estimate assumes a smooth normalization process in which there is no increase in investor risk aversion. If, instead, the policy tightening process were accompanied by a rise in risk aversion on the order of magnitude observed after the renminbi devaluation of August 2015, portfolio flows could be reduced by a total of $60 billion a year over the same period, equivalent to one-quarter of annual inflows

[37]The investor base risk index aims to capture the likelihood of sudden outflows, given the different types of investors that hold sovereign debt (Arslanalp and Tsuda 2012). The measure is calculated based on the historical relationship between changes in investor holdings of sovereign debt and sovereign bond yields. The index ranges from 0 to 100. The higher the score, the greater the likelihood of a sudden investor outflow. According to this measure, the most fickle investor type is foreign nonbanks, followed by foreign banks, foreign central banks, domestic nonbanks, domestic banks, and the domestic central bank.

[38]Estimates are based on an econometric model discussed in the October 2017 GFSR.



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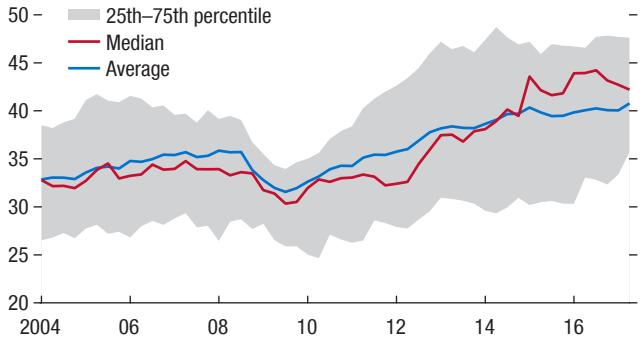
## Figure 1.16. Creditor Base and External Financing Vulnerabilities

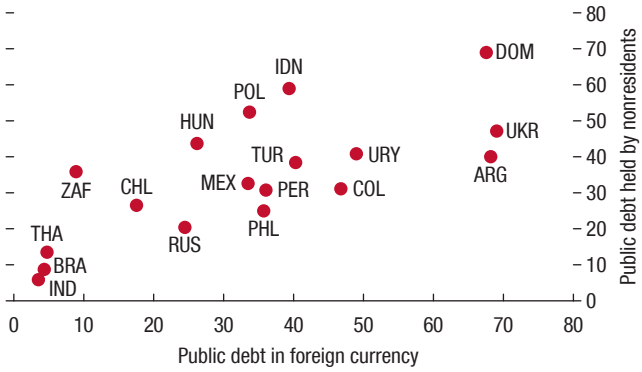
The investor base for EM sovereign debt has become more fickle in recent years.

**1. Investor Base Risk Index: Aggregates from 24 Emerging Market Economies**



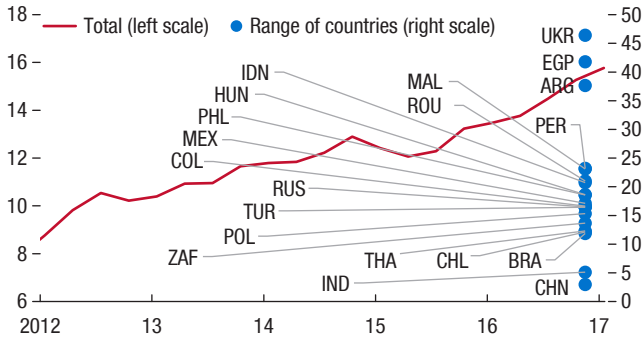

Vulnerabilities in public debt structure remain high for several countries.

**2. Public Debt Held by Nonresidents and Denominated in Foreign Currency (Share of total)**



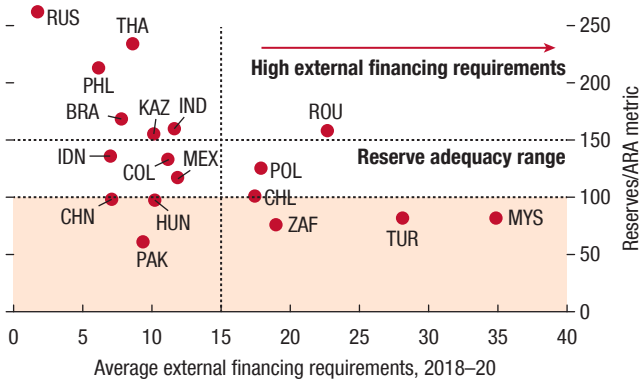

Fund investors account for a growing share of EM portfolio asset holdings.

**3. Exposure to Fund Investors (Share of bonds in EM benchmark indices owned by investment funds, percent)**




Countries with high financing needs could be vulnerable to a tightening of global financing conditions.

**4. Reserve Adequacy and External Financing Needs**




Sources: EPFR Global; JPMorgan Chase & Co.; and IMF staff estimates.
Note: Panel 1 uses the data set from Arslanalp and Tsuda (2012 updated). Panel 2 uses 2017 data or latest available. In panel 3, exposures to fund investors are measured as assets under management at investment funds (based on EPFR data) divided by the amount outstanding of bonds in EM local currency and hard currency benchmark indices (based on JPMorgan data). Panel 4 uses the IMF's Assessing Reserve Adequacy (ARA) metric estimates for 2017, not adjusted for capital controls. Data labels in the figure use International Organization for Standardization (ISO) country codes. EM = emerging market.

in 2010–17.[39] Countries that have not addressed vulnerabilities (such as low reserve adequacy) during the favorable period could be particularly at risk of a reversal in capital flows from rapid tightening of global financial conditions (Figure 1.16, panel 4). Moreover, countries with fixed exchange rates at different stages of the economic cycle face the risk that rising interest rates could weigh on growth and aggravate financial stability risks. Commodity producers could be further affected if monetary tightening is accompanied by weakening commodity prices (Husain and others 2015).

[39]Specifically, a 100-basis-point increase in the spread on US BBB-rated corporate bonds was assumed, which is on par with the increase observed from July 2015 to February 2016.

### Countries Should Prepare for Tighter Financial Conditions by Pursuing Adequate Policies

Policymakers in emerging markets should use current favorable conditions to prepare for a potential retrench-



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ment in capital flows that may be accelerated by monetary policy normalization in advanced economies and associated tightening in financial conditions. Vulnerable countries could be disproportionately affected and should strengthen fundamentals in preparation for less benign external financial conditions (Sahay and others 2014; Chen, Mancini-Griffoli, and Sahay 2014). To build resilience and reduce the likelihood of outflows, countries should maintain sound macroeconomic, structural, financial, and macroprudential policies, taking into account their cyclical position, balance sheet vulnerabilities, and macroeconomic policy space. Because capital outflow pressures can be driven by external rather than domestic factors, it is also necessary to build appropriate buffers that can be used during stress, possibly by taking advantage of low interest rates to borrow long term. Buffers include building international reserves to support exchange rate regimes in periods of stress or taking steps toward making the exchange rate regime more flexible where appropriate. Monitoring firms' foreign exchange exposures and ensuring their capacity to absorb exchange rate risks would also help emerging market economies cope with a reduction in capital inflows.

If external financial conditions deteriorate sharply, a rapid and appropriate macroeconomic and financial policy response to capital outflow pressures is particularly important (IMF 2012, 2015, 2016c). Exchange rates often serve as a critical shock absorber, but in countries with sufficient reserve buffers, foreign exchange intervention can be useful for preventing disorderly market conditions and allowing the economy to gradually adjust to a new equilibrium. In the context of outflow pressures, capital flow management measures should only be implemented in crisis situations or when a crisis is considered imminent, and should not substitute for any needed macroeconomic adjustment. When warranted, such measures should be transparent, temporary, and nondiscriminatory and should be lifted once crisis conditions abate.

## Rising Public Debt Vulnerabilities in Low-Income Countries and Small Non-Investment-Grade Sovereigns

Debt burdens have increased and affordability has deteriorated over the past few years among low-income borrowers and other small non-investment-grade issuers. Public and external debt burdens for many borrowers decreased from 2007 to 2014, especially in countries that benefited from debt relief efforts. In recent years, however, public debt vulnerabilities have increased because of revenue declines for commodity-exporting countries, exchange rate depreciations, consolidation of previously unaccounted for state-owned enterprise debt, and rising interest rate costs attributable to higher shares of nonconcessional debt.[40] More than 45 percent of low-income countries were at high risk of, or already in, debt distress as measured by debt sustainability ratings in 2017 (Figure 1.17, panel 1),[41] while several countries have debt-to-GDP levels close to what they were when debt relief was granted (see April 2018 *Fiscal Monitor*). In addition, vulnerabilities are on the rise not just in the current set of low-income countries but also in a wider set of small non-investment-grade issuers, which includes countries that have "graduated" from low-income country status (Figure 1.17, panel 2).

The increase in private and non–Paris Club creditors has led to a substantial change in creditor composition over the past decade. Among countries recently surveyed by the IMF, the combined share of external financing provided by commercial creditors increased from 7.5 percent to 15 percent (Figure 1.17, panel 3) between 2007 and 2016, and financing from non–Paris Club creditors has risen from 18.5 to 37 percent. Among non–Paris Club creditors, China has taken a key role in providing external financing. Since 2010, China has provided commitments of more than $100 billion a year, on average, in financing to emerging market economies,[42] over $30 billion of which has been to low-income countries. This change in debt composition has been more pronounced in several heavily indebted poor countries (HIPCs) that have received debt relief and are now in debt difficulty (Figure 1.17, panel 4).[43]

The shift to a more diverse composition of creditors can facilitate faster accumulation of debt and can also make debt resolution more complex. The involvement of new non–Paris Club official, as well as private, creditors remains relatively untested. There is less experience

[40]See IMF (2018) for some stylized facts on debt accumulation in recent years.

[41]The group of low-income countries refers to countries eligible for concessional financing through the Poverty Reduction Growth Trust. For a definition of low-income developing countries, see IMF 2018.

[42]According to estimates using data from AidData at the College of William & Mary (http://aiddata.org/data/chinese-global-official-finance-dataset).

[43]To date, 36 countries have received the full amount of debt relief for which they were eligible through the HIPC initiative and the Multilateral Debt Relief Initiative.



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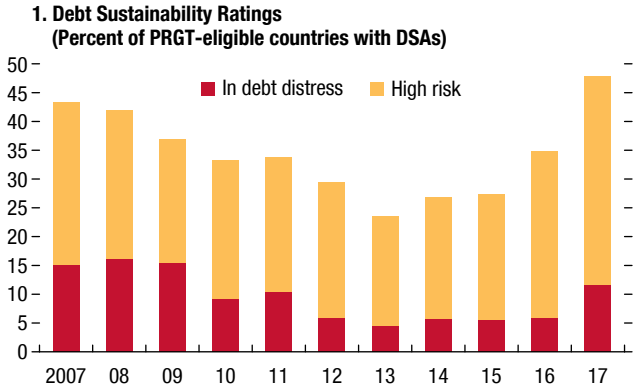
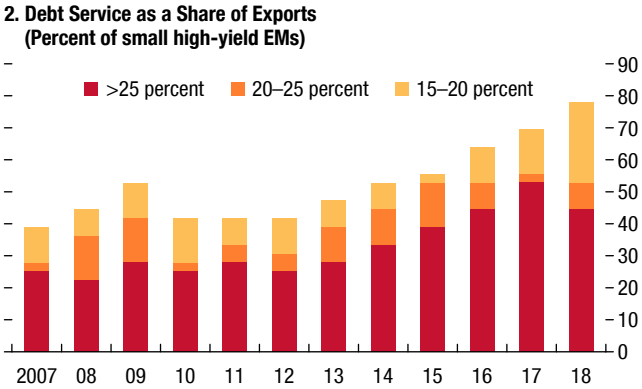
**Figure 1.17. Rising Vulnerabilities and More Complex Creditor Composition**

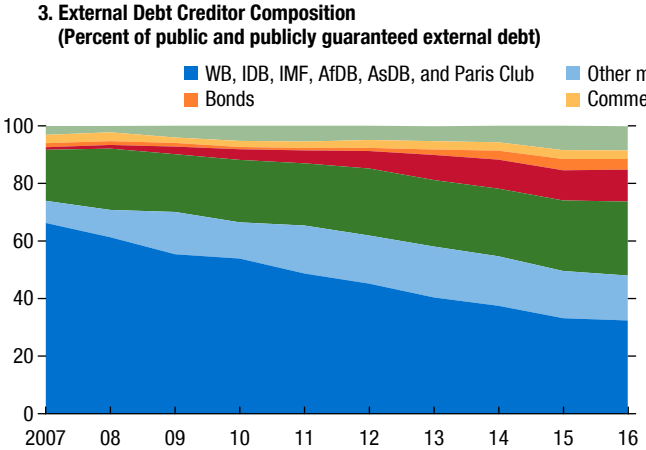
More than 45 percent of LICs are at high risk or in debt distress.



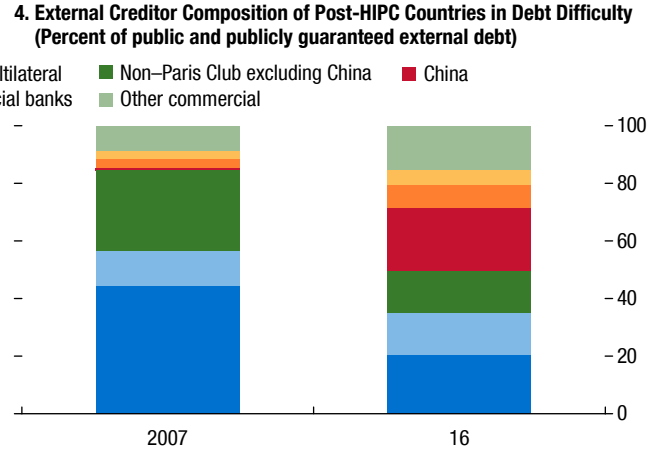

Debt-servicing costs have risen across small non-investment-grade EM issuers.




Composition of creditors of public debt has changed substantially ...




... particularly in several post-HIPC countries.




Sources: Bank for International Settlements; IMF-Organisation for Economic Co-operation and Development-WB Joint External Debt Statistics; 2017 survey of IMF country desks; World Bank International Debt Statistics; IMF, International Financial Statistics database; and various IMF staff reports.
Note: Panel 1 debt sustainability assessment ratings for LICs are based on the Debt Sustainability Framework for Low-Income Countries. Panel 2 sample includes 35 non-investment-grade relatively small issuers that are part of JP Morgan's EMBIG index. Each has a weight of less than 2 percent of the index. Panel 3 is based on 37 LIDCs where continuous data are available from 2007 to 2016. Panel 4 countries included are Cameroon, Chad, Republic of Congo, Ethiopia, Ghana, Mauritania, Mozambique, and Zambia. Figures are in simple averages and may be overly influenced by the experience of countries with very high levels of debt. Other commercial creditors include oil traders. AfDB = African Development Bank; AsDB = Asian Development Bank; DSA = Debt Sustainability Analysis; EM = emerging market; EMBIG = JPMorgan's Emerging Market Bond Index Global; HIPC = highly indebted poor country; IDB = Inter-American Development Bank; LIC = low-income country; LIDC = low-income developing country; PRGT = Poverty Reduction and Growth Trust; WB = World Bank.

with their engagement before and during debt distress than with traditional official lenders. Many of them have not been part of debt resolution in the past, but they could be called on to provide support in such cases.

The use of collateralized debt can further complicate debt resolution and lower recovery rates for creditors with unsecured claims. Some commodity-producing countries offer their exports as collateral; for example, by issuing senior loans through state-owned enterprises or by pledging commodity shipments that can be used to pay debt in lieu of cash. Both commercial and bilateral lenders have resorted to collateralized lending, as highlighted in recent debt distress cases (for example, Chad, Republic of Congo, Venezuela) that are yet to be resolved.[44] Apart from such cases, however, details on collateralized deals remain scant.[45] Given that sover-

[44]For details on recent debt distress cases in low-income developing countries, see IMF (2018).

[45]Bräutigam, Gallagher, and Hwang (2016) find that one-third of Chinese loans to Africa are secured by commodity exports,



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eigns have significant protections from seizure of assets, most creditors are reliant on good faith negotiations to secure recovery in distress.[46] The direct claim on an asset or a revenue stream, however, can grant holders of collateralized debt favorable treatment. Thus, collateralized claims could impair the ability of the sovereign to offer more generous terms in a renegotiation of its unsecured debt, and require a more significant haircut on remaining debt to ensure debt sustainability.

The higher share of private sector creditors could make low-income countries and other vulnerable emerging market borrowers more sensitive to a tightening of global financial conditions. The increase in the share of Eurobonds and commercial loans with shorter maturities can expose issuers to higher rollover and interest rate risk. These new avenues of financing are untested, and it is unclear whether they will remain available if financial conditions tighten significantly, particularly for first-time and low-rated issuers. Part of this new debt is held by investors who do not specialize in this sector and may choose to allocate their funds elsewhere if higher-yielding opportunities become more abundant in more traditional hard currency assets (for example, US high yield). In addition, the anticipation of complex debt resolutions and potentially lower recovery rates could trigger more rapid market repricing at the first sign of sovereign stress.

### Policies Should Address Rising Debt Vulnerabilities

To ensure a sustainable debt burden, policymakers should reduce vulnerabilities related to the structure of their debt and attract a stable investor base, including through local bond market development. Debt managers should minimize risks emanating from rollovers, potential foreign exchange mismatches, and collateralization. Countries should explore state contingent debt instruments that may offer some protection against unforeseen shocks such as natural disasters, assuming these instruments are priced at reasonable cost for the issuer by investors (IMF 2017b).

Official creditors, when needed, should emphasize timely resolution of debt distress cases to avoid potential spillovers and to minimize the costs for both the issuer and creditors. Transparent and broad creditor coordination should be encouraged, especially when the set of lenders is diverse. New official creditors should consider the benefits of adopting sustainable lending rules, such as those endorsed by the Group of 20. Finally, borrowers and official creditors should ensure transparency of the contractual terms for new debt, including debt that is issued by entities related to the sovereign.

### Shadow Banking Reform and Risk in China

The large-scale and opaque interconnections of the Chinese financial system continue to pose stability risks (Figure 1.18). China's RMB 250 trillion (300 percent of GDP) banking system is tightly linked to the shadow banking sector through its exposure to off-balance-sheet investment vehicles. These vehicles are largely funded through the issuance of investment products (RMB 75 trillion), with roughly half sold to multiple investors as high-yielding alternatives to bank deposits and half held by single investors, including banks.[47] They invest in various assets, such as bonds, bank deposits, and nonstandard credit assets, as well as in other investment products. Insurance companies also have considerable exposure to these vehicles because they invest in their products and use them as a source of funding. These little-regulated vehicles have played a critical role in facilitating China's historic credit boom and have helped create a complex web of exposure between financial institutions.

Banks are exposed to investment vehicles along many dimensions—as investors, creditors, borrowers, guarantors, and managers. These vehicles rely on banks' short-term financing to use leverage and manage their maturity mismatches. Banks, in turn, receive significant flows from these vehicles in the

and Bräutigam and Gallagher (2014) find that roughly half of the $132 billion in Chinese financing to Latin America and Africa is commodity backed.

[46]Sovereign states are typically granted immunity for noncommercial activities in international courts. The two jurisdictions most commonly used for international debt issuance formalize this immunity under the Foreign Sovereign Immunities Act (United States) and under the State Immunity Act (United Kingdom).

[47]Bank-issued non-principal-guaranteed wealth management products account for the majority of products sold to multiple investors. As used herein, investment products include asset management products issued by securities brokers, fund companies and their subsidiaries, trust companies, and insurers. Money market funds and other public mutual funds are more strictly regulated and not included. Other forms of nonbank credit activities also carry risks but are not considered in this section; for instance, money market funds, other public mutual funds, and exposures between firms.



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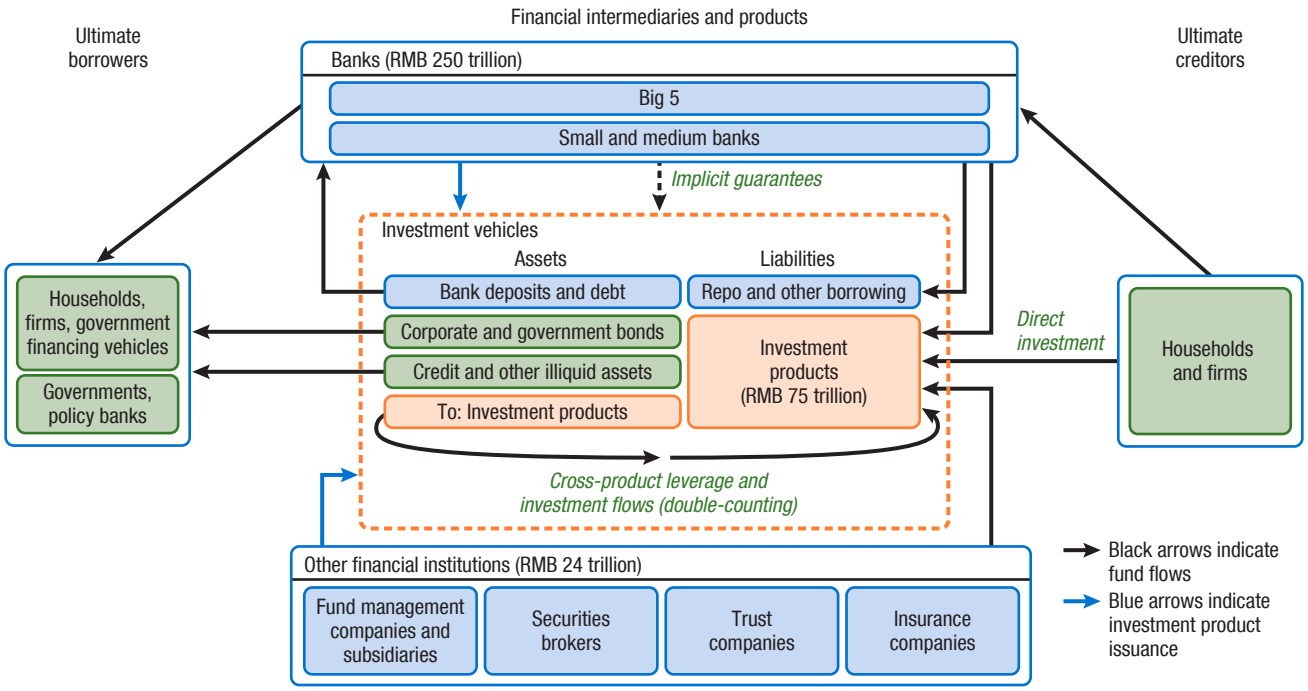
**Figure 1.18. Stylized Map of Linkages within China's Financial System**




Sources: Asset Management Association of China; CEIC; ChinaBond; People's Bank of China; and IMF staff estimates.
Note: Investment products include non-principal-guaranteed bank-issued wealth management products and asset management products issued by other financial institutions depicted. Numbers shown are total on-balance-sheet assets for banks and financial institutions, and total investment products outstanding as of end-2017 or latest available reporting period. Numbers for other financial institutions do not include fund management companies and their subsidiaries due to lack of data. See also Ehlers, Kong, and Zhu (2018). RMB = renminbi.

form of deposits and bond investments. Banks and other financial institutions are also direct investors in investment products. Small and medium-sized banking institutions and insurance companies are particularly exposed, with investment products accounting for one-fifth and one-third of their assets, respectively. About one-quarter of investment vehicle assets, in turn, are invested in other vehicles, leading to opaque cross-holding and leverage structures that are difficult for regulators and investors to monitor. Banks in particular are seen as implicitly guaranteeing the RMB 25 trillion in investment products they manage, which allows them to package high-risk credit investments as low-risk retail savings products. Investment vehicles managed by nonbank financial institutions are perceived to be higher risk, but in most cases banks still bear some risk as creditor, end investor, or guarantor.

The authorities have substantially tightened the regulatory framework to reduce risks related to investment vehicles and other borrowing between financial institutions. Since the summer of 2016, regulators have incorporated bank-sponsored investment vehicles in the macroprudential framework and have taken other steps to curb financial sector leverage and interconnectedness.[48] Proposed asset management rules would also overhaul the investment product market beginning in 2018. In addition to limits on investment vehicle leverage and complexity, banks would be gradually restricted from investing in these vehicles or providing them with financial support. This restriction would limit their ability to implicitly guarantee investment products' fixed-yield returns, effectively converting roughly half of the market from deposit-like products into mutual funds. In addition, the insurance regulator has clamped down on the sale of short-term investment products by life insurers.

[48]For more details on China's financial system stability assessment and associated policy recommendations, please refer to IMF (2017a).



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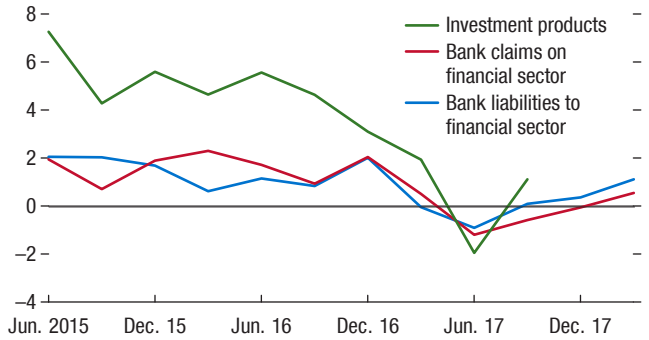
**Figure 1.19. Chinese Banking System and Financial Market Developments and Liabilities**

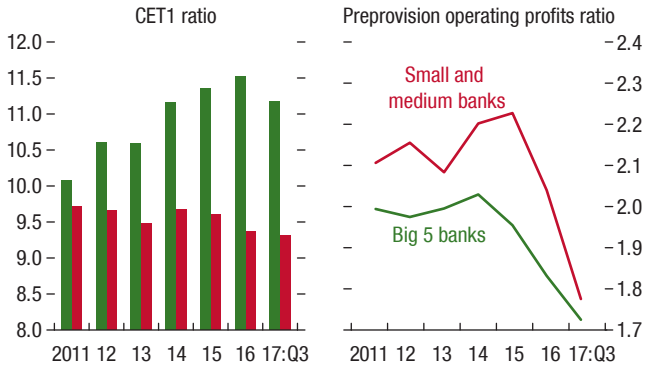
Regulatory tightening has stifled growth in financial sector leverage and in risky investment products ...

**1. China: Three-Month Changes in Investment Products Outstanding and Small and Medium Banks' Financial Sector Claims (Trillions of renminbi)**



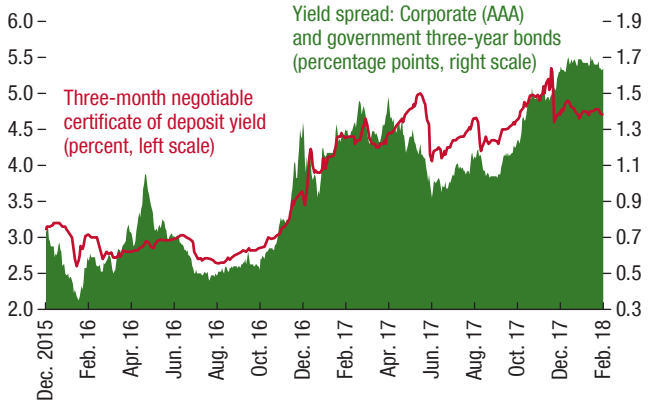

... but capital positions are becoming more stretched and underlying profitability continues to fall.

**2. Chinese Banks: Tier 1 Capital Ratio and Preprovision Operating Profits to Assets (Percent)**



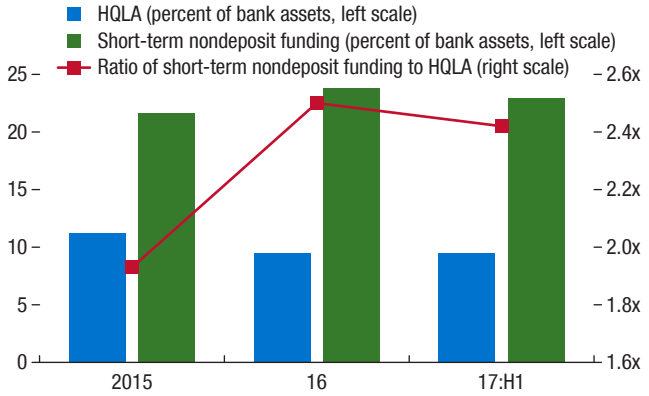

Bank vulnerabilities remain elevated as funding costs rise ...

**3. Chinese Bond Prices: Corporate Credit Spreads and Short-Term Unsecured Bank Funding Costs**




... and liquidity remains stretched.

**4. Chinese Small and Medium Banks: Short-Term Nondeposit Funding and High-Quality Liquid Assets**




Sources: Asset Management Association of China; Bloomberg Finance L.P.; CEIC; People's Bank of China; S&P Global Market Intelligence; and IMF staff calculations.
Note: Panel 4 is based on a sample of 10 banks that disclose HQLA and contractual maturities. Short-term is less than three-month contractual maturity or on demand. China's HQLA definition disallows required reserves held at the People's Bank of China. CET1 = common equity Tier 1; HQLA = high-quality liquid assets.

## Chinese Banks Have Made Progress in Deleveraging, but Risks Remain Elevated

Tighter regulations have lowered growth in banks' use of risky short-term funding and in investment products, slowing the buildup of bank vulnerabilities. Lending by small and medium-sized banks through investment vehicles has slowed, as has their use of wholesale short-term financing and the overall volume of investment products outstanding (Figure 1.19, panel 1). Notably, growth of banks' exposure to other financial institutions fell from about 80 percent on an annual basis in 2016 to less than 20 percent at the end of 2017, and banks' holdings of investment products issued by other banks has also declined sharply.

Financial stability risks nonetheless remain high, and smaller banks are particularly vulnerable. Bank buffers continue to thin at many of the country's commercial banks. In addition to still-elevated investment vehicle exposures, core Tier 1 capital ratios are declining and remain near minimum levels for many small and medium-sized banks, while preprovision profitability also continues to weaken (Figure 1.19, panel 2).



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Following tighter regulatory constraints, money market rates have risen sharply, leading to wider corporate bond spreads, particularly for weaker borrowers (Figure 1.19, panel 3). Highlighting liquidity risks faced by small and medium-sized banks, reliance on short-term nondeposit funding remains high, and short-term wholesale liabilities are still more than double the available liquidity buffers at smaller banks (Figure 1.19, panel 4).

### Reforming China's Investment Product Market—An Important Conduit for Shadow Credit—Poses Challenges to Financial Stability

A key challenge for the reform agenda will be phasing out implicit guarantees for investment vehicles. Because they primarily hold illiquid and long-term assets, such as corporate bonds and nonstandard credit assets, these vehicles rely on guarantees to borrow and to meet maturing short-term liabilities to product holders. As a result, investment vehicles are now the largest net borrower in China's repurchase market, driving overall market activity, often with relatively illiquid collateral (Figure 1.20, panel 1). Furthermore, direct lending by large banks to their sponsored vehicles amounts to about 10 percent of their investment product liabilities, on average.[49]

Without such financial support, investment vehicles would need to hold safer, more liquid asset portfolios to avoid rollover and refinancing risks. Yet allocations to such assets have recently decreased among bank-sponsored investment vehicles, falling to one-third in 2017, from about half in 2015 (Figure 1.20, panel 2). Rising use of illiquid assets and borrowing suggests dependence on implicit guarantees is still trending up, underscoring the difficulty of progress in this critical area.

Reducing risks in the investment product market will require further slowing credit growth in the near term, which is necessary to ensure financial stability and sustainable growth in the medium term. Investment vehicles have bought nearly all the net increase in corporate and financial bond issuance in the past three years and hold 70 percent of such bonds outstanding (Figure 1.20, panel 3). Without bank-guaranteed fixed yields on investment products, the generally risk-averse retail investor base is likely to shift toward less risky instruments, a development that would reduce net demand for already illiquid corporate bonds.[50] Banks will also need to gradually recognize some portion of the corporate credit exposure held through investment vehicles as loans or bonds, requiring capital and provisioning costs that will cut into loan growth capacity. For small and medium-sized banks, even absorbing half of these exposures over two years would reduce net new loan growth from 17 percent to 6 percent, unless banks raise new capital (Figure 1.20, panel 4) (see also the October 2017 GFSR).

### China's Insurance Sector Has Grown Rapidly, Increased Its Risk Profile, and Become Closely Linked with Other Parts of the Financial System

Chinese life insurers have grown rapidly, and their share prices have been volatile. Insurers' assets have more than tripled in size over the past seven years, growing in line with the rest of the Chinese financial system (Figure 1.21, panel 1). Growth has been fueled by "universal life insurance," flexible savings products (in 2015 and 2016), and more traditional life policies (in 2017) (Figure 1.21, panel 2). At the same time, insurers' share prices have risen sharply, accompanied by an increase in volatility reflecting perceived elevated risks (Figure 1.21, panel 3). Recently, the regulator took control of a large insurance group that had financed a rapid expansion into other business areas with short-term high-guarantee investment products.

The shift into riskier investments entails vulnerabilities for insurers and the system at large. To attain the high guaranteed returns of their long-term policies (4 percent, in many cases) amid the relatively small and illiquid corporate bond market, insurers have shifted their investments from bonds and deposits to equity, funds, and "other assets" (Figure 1.21, panel 4). These other assets include asset and wealth management products, debt and equity products, and participations in joint ventures (Figure 1.21, panel 5). These large investments in infrastructure, real estate, and loan portfolios concentrate credit risks, including for insurers with limited expertise in credit assessment.

[49]Eight banks (including four of the Big Five lenders) disclose active direct lending to their investment vehicles, which account for nearly half of the bank-managed investment product market (more than RMB 10 trillion in non-principal-guaranteed wealth management products). This lending was equivalent to 15 percent of these banks' core Tier 1 capital as of mid-2017.

[50]More than 80 percent of outstanding wealth management products are billed as low risk, rated as 1 or 2 on an industry group–defined scale to 5 (with 5 being riskiest).



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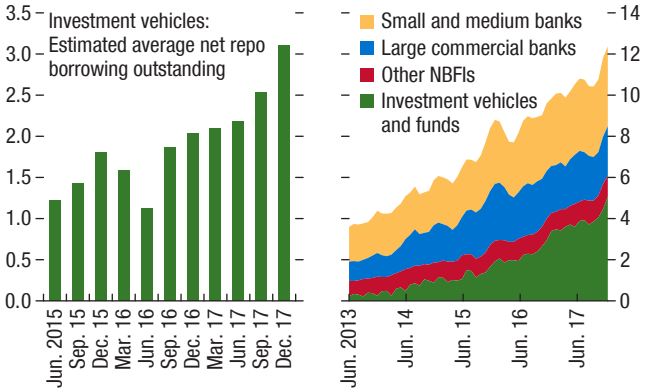
## Figure 1.20. Risks and Adjustment Challenges in Chinese Investment Products

Investment vehicles are borrowing more ...

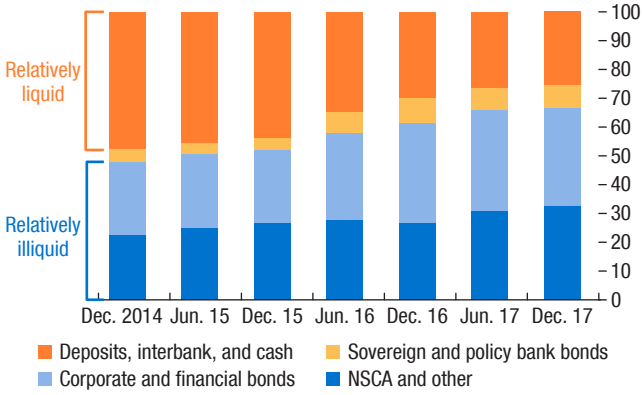
**1. Estimated Investment Vehicle Net Repo Borrowing and Interbank Gross Repo Position, by Institution Type (Trillions of renminbi)**




Sources: CEIC; China Central Clearing & Depository Corporation; National Interbank Funding Center; People's Bank of China; Shanghai Clearing House; WIND; and IMF staff calculations.
Note: Gross repo position includes the sum of outstanding month-end cash borrowing and lending positions. "Investment vehicles and funds" includes repo positions by mutual funds (which are net lenders) and other NBFIs not captured in the "Other NBFIs" category. Estimated average repo borrowing outstanding is the People's Bank of China—reported quarterly net repo borrowing volume for all funds, divided by the ratio of nonbank repo volume to month-end position, minus the reported net repo position of public mutual funds and other NBFIs. NBFI = nonbank financial institution.

... and holding more illiquid assets.

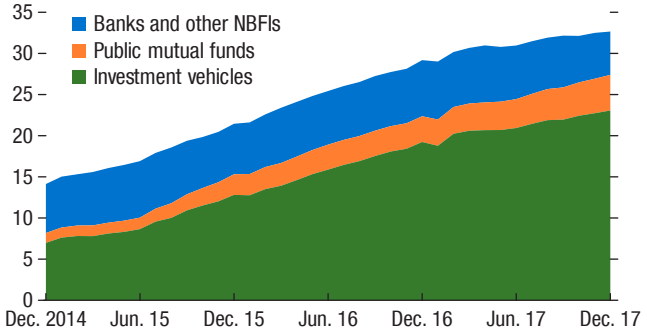
**2. Chinese Investment Vehicles: Bank-Issued Product Portfolio Allocation (Percent)**




Sources: Bank Wealth Management Registration and Trusteeship Center; and IMF staff calculations.
Note: Due to the lack of available data, data for June 2015 are the interpolation of December 2014 and December 2015 data. "NSCA and other" includes mostly illiquid credit assets but also has derivatives and investment fund shares. NSCA = nonstandard credit asset.

Reforming investment products will further slow credit growth by weakening demand for corporate and financial bond issuance ...

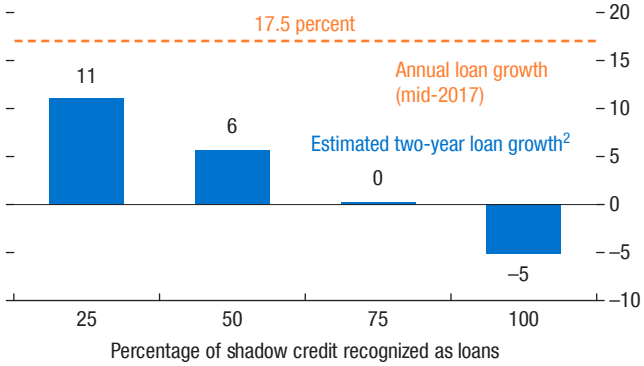
**3. China Bond Market: Corporate and Non-Policy-Bank Financial Bonds Outstanding, by Holder (Trillions of renminbi)**




Sources: China Clearing and Depository Corporation; National Interbank Funding Center; People's Bank of China; Shanghai Clearing House; WIND; and IMF staff calculations.
Note: Public mutual fund holdings shown are interpolated semi-annual data. NBFI = nonbank financial institution.

... and limiting small banks' ability to increase lending without fresh capital.

**4. Chinese Small and Medium Banks: Two-Year Estimated Loan Growth Capacity Given Shadow Credit Recognition Assumption[1] (Percent)**




Sources: Bank financial reports; S&P Global Market Intelligence; and IMF staff calculations.
[1]Shadow credit is defined as 100 percent of banks' investments in third-party unconsolidated structured products and 20 percent of their sponsored non-principal-guaranteed wealth management products. Based on a sample of 25 listed banks with available disclosures. Assumes banks receive no external capital and maintain static capital and profitability ratios. Shadow credit recognition entails raising risk weightings for selected assets to 100 percent from initial weightings of 25 and 0 percent for structured products and wealth management products, respectively.
[2]Growth rates shown are annualized. Negative number indicates loan book would need to shrink to initially accommodate existing shadow credit. Loan growth shown is net of loans converted from existing shadow credit.



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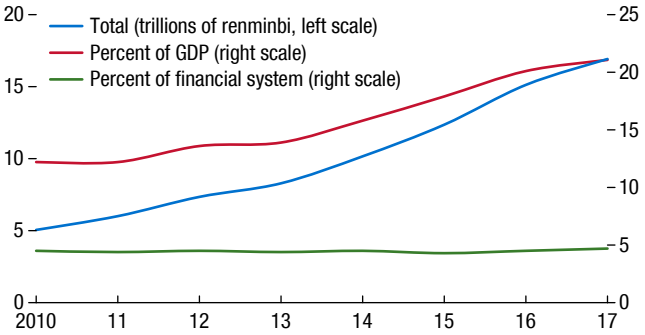
## Figure 1.21. Chinese Insurers

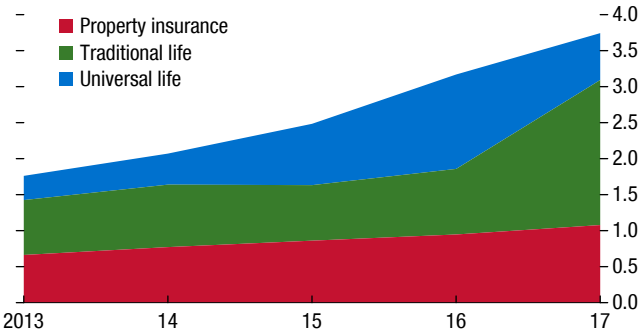
Chinese insurers have grown rapidly ...

**1. Insurance Sector Total Assets**



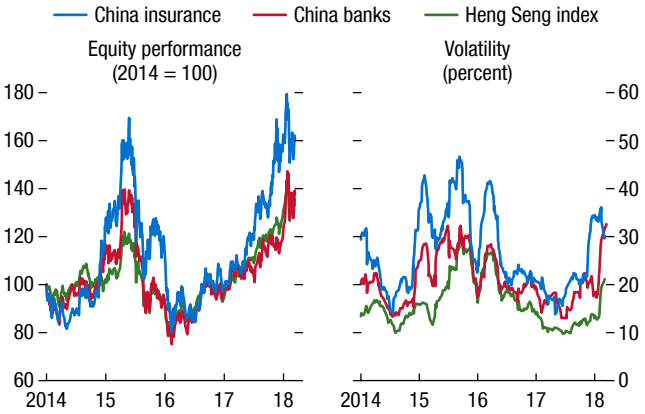

... fueled by life insurance sales.

**2. Annual Insurance Premiums (Trillions of renminbi)**



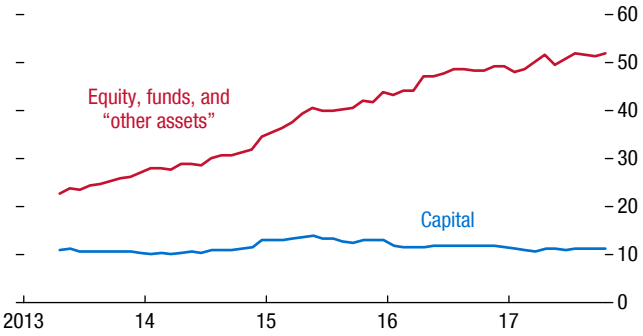

Insurers' shares have risen sharply, accompanied by high volatility.

**3. Equity Performance and Volatility**



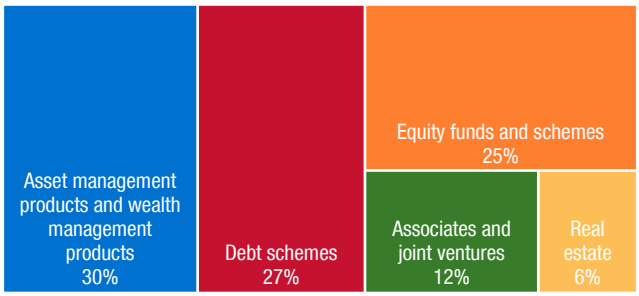

Increased revenues have been invested in higher-risk assets but capital has not been raised.

**4. Non-Fixed-Income Assets and Capital (Percent of total assets)**



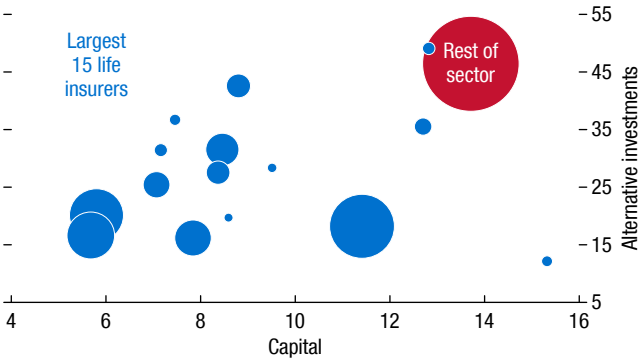

Other assets are mainly portfolios of infrastructure projects, real estate, and loans provided by asset managers.

**5. Decomposition of "Other Assets," 2016 (Percent of other assets)**




Variation of alternative investments and capital buffers within the sector is large.

**6. Capital and Alternative Investments, 2016 (Percent of assets)**




Sources: Annual reports; Bloomberg Finance L.P.; China Insurance Regulatory Commission; Morgan Stanley Capital International; and IMF staff calculations.
Note: In panel 3, volatility is calculated as the annualized standard deviation of the relative price change for the 60 most recent trading days' closing price. In panel 5, an associate is an entity in which the company/group has a long-term interest of generally not less than 20 percent of the equity voting rights and over which it is in a position to exercise significant influence. Panels 5 and 6 are based on annual reports of the 15 largest life insurers. These companies cover two-thirds of the total assets of the Chinese insurance sector. In panel 6, the size of the bubbles denotes total assets.



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Furthermore, the uncertain and volatile returns on these assets may not match the minimum yields promised to policyholders. Increased illiquid assets covered by deposit-like insurance products raise exposure to redemptions at short notice.[51] When faced with net cash outflows, insurers may need to sell off their illiquid assets, potentially adding to market volatility. In addition, insurers are in some instances part of financial conglomerates encompassing several sectors.[52] While these links give insurers the ability to sell their products within their own networks, they bring risks of spillovers across sectors.

Whether all insurers have sufficient resilience against these vulnerabilities is uncertain. Current regulations require relatively low capital charges for infrastructure investments, joint ventures, and real estate compared with, for instance, corporate bonds. Moreover, capital requirements for investments in funds are fixed and not based on the risks of the underlying assets.[53] Despite the elevated risks, capital levels have remained unchanged (Figure 1.21, panel 4). Medium-sized and smaller insurers have invested more heavily in alternative assets and have weaker capability to manage related risks (Figure 1.21, panel 6). In addition, risk assessments are clouded by complex and opaque company structures and uncertainty about the exact nature and credit quality of the underlying investments, including implicit guarantees.

### Authorities Should Continue to Reform the Investment Product Market and Enhance the Insurance Supervisory Regime

Addressing remaining financial risks is key to promoting financial stability in China. The proposed asset management reforms are a promising blueprint for gradually taming risks within the investment product sector. Regulators should, however, further limit leverage for lower-risk products and eventually require that implicitly guaranteed off-balance-sheet business carry the same capital and liquidity buffers as on-balance-sheet business. Careful sequencing of reforms is also critical. As recommended by the IMF's recent Financial Sector Stability Assessment (IMF 2017a), authorities should prioritize strengthening policy frameworks and financial institutions' liquidity and capital buffers to prevent the dismantling of implicit guarantees from inadvertently bringing forward stability risks. Equally important, authorities must address the wide range of nonregulatory factors that have driven the proliferation of risky investment products and excessive demand for credit more broadly; for instance, GDP growth targets.[54]

The insurance supervisory regime should continue to evolve toward a transparent, market- and risk-based regime that includes close cooperation with other authorities. The authorities have strengthened oversight of insurers by curtailing the sale of "universal life" policies and addressing duration mismatches. The introduction of a stronger prudential standard in the China Risk-Oriented Solvency System in 2016 was another important step. Nevertheless, the increase in insurers' "other assets" suggests further work is needed. Additional transparency on the nature, credit quality, and valuation of these investments, as well as a thorough review of prudential treatment to adequately reflect the risks of the underlying assets, are needed. The profile of liabilities—including duration and surrenders—should be closely monitored, and further action to curb unusual liquidity risks should be considered. Finally, the size, complexity, and interconnectedness of the largest life insurers require enhanced group supervision, strong cross-sector coordination, and a framework for recovery and resolution should one of them fail. The recently announced merger of the China Insurance Regulatory Commission and the China Banking Regulatory Commission should facilitate closer cooperation with respect to insurance and banking supervision.

## Funding Challenges of Internationally Active Banks

*Although banks have strengthened their consolidated balance sheets over the past decade, dollar balance sheet liquidity remains a source of vulnerability. International dollar lending continues to increase, dominated by non-US banks operating through international branch networks. Most rely heavily on short-term wholesale dollar funding and, at the margin, on volatile foreign*

[51]About one-fifth of life insurers' liabilities are deposits and policyholders' investments, which are presumed to be more easily withdrawn by policyholders than traditional life insurance products.

[52]One-third of the consolidated balance sheets of the five largest insurance groups consists of banking, asset management, or other activities.

[53]The risk factor applied to infrastructure equity plans is 12 percent, to real estate it is 8 to12 percent, and for 10-year AA-rated corporate bonds it is 15 percent. The risk factor applied to bond funds is 6 percent.

[54]For example, budget constraints at state-owned enterprises and local governments should be tightened, and the system's vulnerability to slower credit growth should be reduced via improvements to insolvency and debtor workout regimes.



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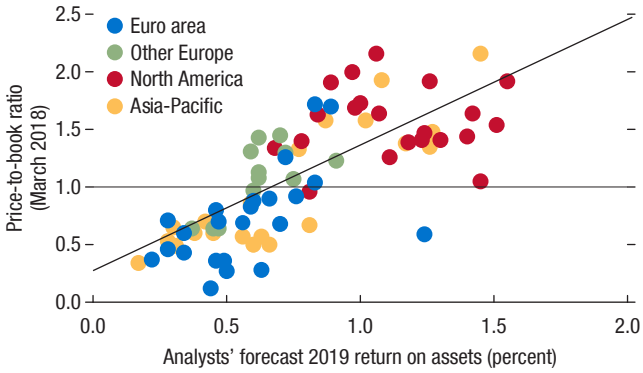
## Figure 1.22. Advanced Economy Bank Health

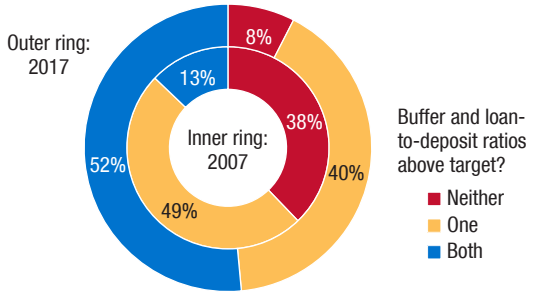
Equity market signals are mixed.

**1. Bank Price-to-Book Ratios and Profitability**




Bank balance sheet metrics have improved ...

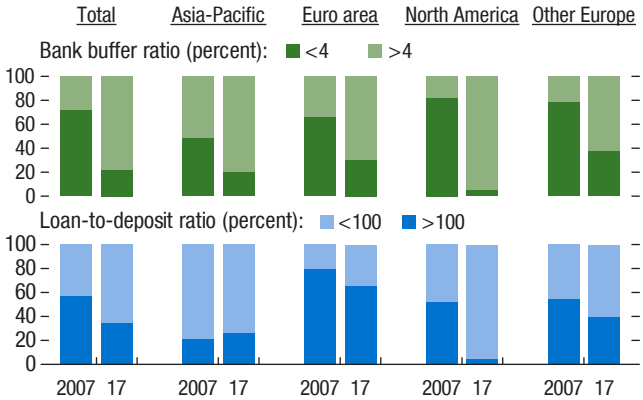
**2. Bank Balance Sheet Health (Percent of sample bank assets)**




Targets (percent): Buffer ratio = 4.0; loan-to-deposit ratio = 100

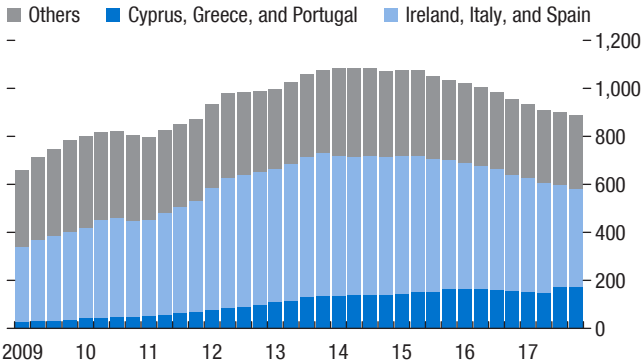
... including capital buffers and funding profiles.

**3. Buffer and Loan-to-Deposit Ratios (Percent of sample bank assets)**




But work to fortify balance sheets should continue.

**4. Euro Area Nonperforming Loans (Billions of euros)**




Sources: Bloomberg Finance L.P.; IMF, Financial Soundness Indicators database; S&P Global Market Intelligence; and IMF staff calculations.
Note: In panel 1, US bank assets have been adjusted for derivatives netting. Panels 2 and 3 are based on a sample of 691 banks headquartered in advanced economies. In panels 2 to 4, where 2017 data are unavailable, the latest published figures are used. Asia-Pacific = Australia, Japan, Korea, New Zealand, and Singapore; North America = Canada and the United States; Other Europe = Denmark, Iceland, Norway, Sweden, Switzerland, and the United Kingdom; Bank buffers = Tier 1 common capital plus loan loss provisions less 60 percent of nonperforming loans as a percentage of tangible assets (adjusted for derivatives netting at US banks). The 60 percent figure is an assumption used for this analysis and not a regulatory requirement.

*exchange swap markets. A sharp tightening of financial conditions could expose structurally vulnerable liquidity positions and trigger forced asset sales or even defaults, amplifying and transmitting market turbulence.*

### Banks Have Bolstered Their Balance Sheets, but These Efforts Need to Continue, Especially at Weaker Institutions

Markets are providing mixed signals about the health of the banking sector. Equity market price-to-book ratios vary across banks, likely reflecting investor concerns about the sustainability of some banks' business models, as discussed in previous GFSRs (Figure 1.22, panel 1).

But balance sheet metrics suggest that banks' consolidated financial positions have been fortified over the past decade.[55] In 2007 almost 40 percent of the sample, by assets, had weak buffers and high loan-to-deposit ratios, but this proportion is now less than 10 percent (Figure 1.22, panel 2). This improve-

[55]The October 2017 GFSR looked at global banks, but this analysis is based on a sample of almost 700 advanced economy banks. Also see BIS (2018) for a discussion on the enhanced resilience of banks.



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ment has been achieved by increasing capital and liquidity, raising provisions, and improving funding profiles in response to enhanced prudential standards, stricter supervision, better risk management practices at banks, and pressure from investors.

Although bank buffers have increased in aggregate (Figure 1.22, panel 3), there is a tail of weaker banks, representing about 20 percent of sample assets, with lower levels of capital and provisions against nonperforming loans (NPLs).[56] These banks are mainly concentrated in Europe (inside and outside the euro area) and would be more susceptible to shocks such as a sudden bout of market turmoil or an unexpected economic downturn. The combination of a pickup in economic growth, actions taken to reduce these NPLs, and policy measures by the European authorities have contributed to a decline in the stock of NPLs in recent quarters (Figure 1.22, panel 4), but NPL levels remain high at some banks.[57] So while the economic recovery will certainly help reduce NPLs, a comprehensive strategy—involving strict supervision, ambitious NPL reduction targets, modernizing insolvency and foreclosure frameworks, and further developing distressed debt markets—needs to be fully implemented to address the NPL problem at its root.

Banks have also improved their funding profiles; nonetheless, more could be done to bolster resilience against liquidity risks in some institutions.[58] About one-third of sample banks, by assets, still have loan-to-deposit ratios in excess of 100 percent (Figure 1.22, panel 3). This does not necessarily mean that these banks will fail to meet regulatory measures, such as the liquidity coverage ratio.[59] But these results do suggest that attention should continue to be paid to liquidity risks, particularly with respect to the dollar-funding profiles of banks operating internationally.

[56]The buffer ratio is Tier 1 common capital and provisions minus 60 percent of NPLs as a percentage of tangible assets (adjusted for derivatives netting at US banks). The 60 percent figure is an assumption used for this analysis rather than a regulatory requirement.

[57]In March, the European Commission and European Central Bank proposed new measures targeting NPLs.

[58]See also Chapter 3 of the October 2013 GFSR for a discussion of changes in bank funding structures over time.

[59]Data for the liquidity coverage ratio are not available over time for the full sample of banks.

## The International Dollar Banking System Faces a Structural Liquidity Mismatch

Demand for US dollar–denominated assets from outside the United States continues to grow rapidly. Demand remains robust, since the US dollar is often the default currency for commodities, energy, trade credit, and corporate borrowers (especially in emerging market economies). Banks and other institutional investors in low-interest-rate advanced economies also seek dollar assets to enhance yields. Although dollar bonds outstanding have increased rapidly, loans remain the largest form of credit (Figure 1.23, panel 1). Banks are central to this system through both lending and derivatives market activities.

Non-US banks occupy a dominant position in the provision of US dollar credit (Figure 1.23, panel 2). Banks intermediate dollars internationally through branches in the United States and elsewhere; these branches are relatively free to transfer funds across borders. Non-US banks' branches in the United States have been dollar borrowers from overseas, on net, since 2011, but the gross flows in each direction remain considerable (Figure 1.23, panel 3). By contrast, US subsidiaries of foreign banks gather retail dollar deposits but are limited in their flexibility to transfer funds intragroup across borders or legal entities, so they play little role in the international dollar system (Figure 1.23, panel 4) (McCauley, McGuire, and von Peter 2010; McCauley and von Peter 2012).

This section, therefore, assesses funding and liquidity across non-US banks' *international US dollar balance sheets*, defined to include non-US banks' dollar positions outside the United States plus their US branches, but excluding their US subsidiaries. The discussion focuses on country banking systems, and is based on top-down country aggregate balance sheet information combined with a bottom-up aggregate of non-US banks' branches in the United States (see Online Annex 1.2).[60]

Overall, non-US banks' international US dollar balance sheets rely more on short-term or wholesale dollar funding than do their consolidated balance sheets (Figure 1.24, panel 1). These short-term wholesale instruments—interbank deposits, commercial paper, and certificates of deposit—along with relatively unstable (corporate, nontransactional, and uninsured)

[60]See Online Annex 1.2 at www.imf.org/en/Publications/GFSR for more details.



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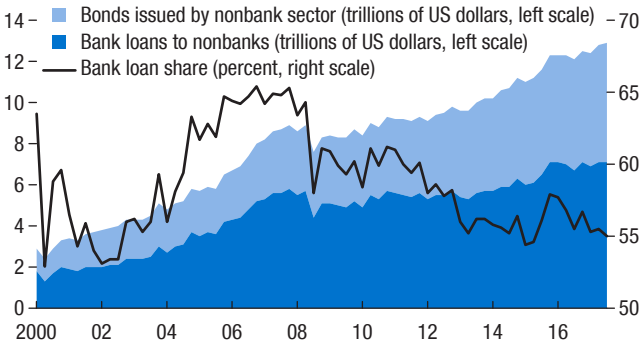
## Figure 1.23. US Dollar Credit Aggregates and Bank Intragroup Funding Structures

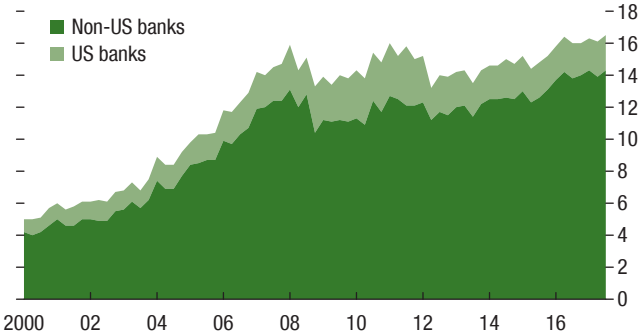
While dollar bonds outstanding have increased rapidly, loans remain the largest form of credit ...

**1. Dollar Credit Extension by Non-US Entities, by Instrument**



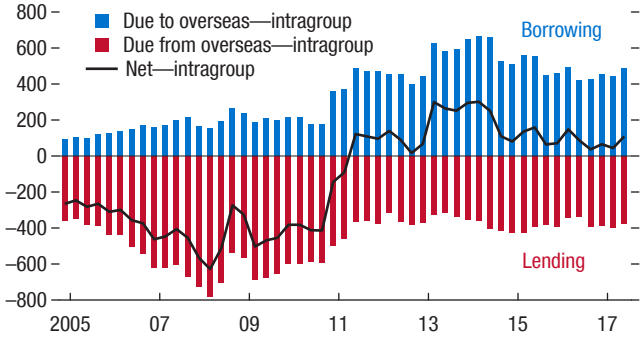

... dominated by non-US banks operating through international branch networks.

**2. Banks' US Dollar-Denominated Claims Outside the United States (Trillions of US dollars)**



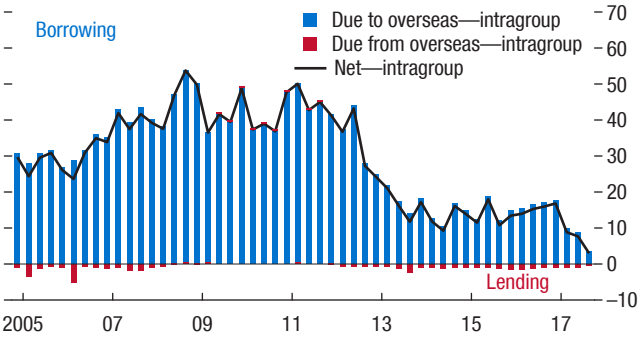

Non-US banks' international branches are key dollar intermediation channels ...

**3. US Branches of Non-US Banks: Intragroup Borrowing and Lending (Billions of US dollars)**




... while subsidiaries play a very limited role.

**4. US Subsidiaries of Non-US Banks: Intragroup Borrowing and Lending (Billions of US dollars)**




Sources: Bank for International Settlements; Federal Financial Institutions Examination Council; Federal Reserve call reports; and IMF staff calculations.

deposits are prone to outflows and can generate refinancing risk under stressed conditions.

This use of short-term funding makes international US dollar balance sheets structurally vulnerable to liquidity risks. This vulnerability can be assessed using two indicators—a liquidity ratio[61] that approximates the Basel Liquidity Coverage Ratio (LCR) and a stable funding ratio.[62] The aggregate stable funding ratio is lower for US dollar international balance sheets than for consolidated (aggregate position in all currencies) balance sheets, and the international US dollar liquidity ratio is lower than the reported LCRs for banks' consolidated positions (Figure 1.24, panel 2).[63] US dollar liquidity ratios vary widely between banking

[61]The liquidity ratio is estimated high-quality liquid assets divided by estimated funding outflows over a short stress period (see Online Annex 1.2 for more details). This mimics the Basel framework's liquidity coverage ratio but relies on more limited disclosure of assets (to measure high-quality liquid assets) and liabilities (to measure one-month stress outflow). Analysis of the sensitivity of the liquidity ratio to changes in the underlying assumptions (in Online Annex 1.2) suggests that the estimates shown here may be somewhat overstated; that is, dollar liquidity ratios as measured by the Bank for International Settlements Liquidity Coverage Ratio would probably be somewhat lower than shown here.

[62]The stable funding ratio is stable funding (total deposits plus long-term securities and swap funding) divided by loans (see Online Annex 1.2 for more details). This is intended to be broadly analogous to the Basel framework's net stable funding ratio but probably generates higher estimates since it does not apply available stable funding haircuts to wholesale deposits. For Japan, 70 percent of swap funding is greater than one year in duration and is therefore treated as stable, based on Bank of Japan data; for other countries, 50 percent of swap funding is included in stable funding.

[63]Global systemically important banks now meet the consolidated, Basel LCR.



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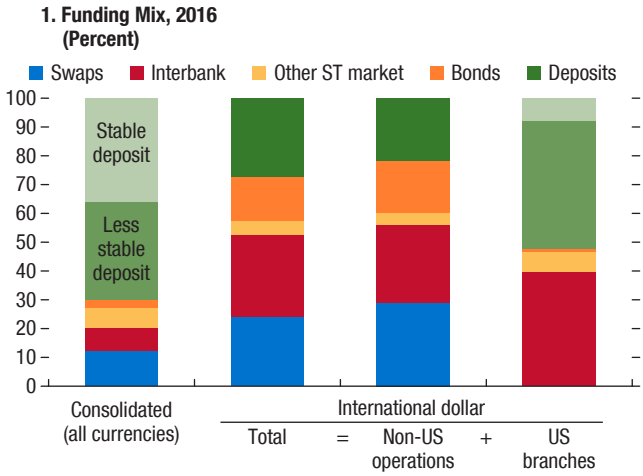
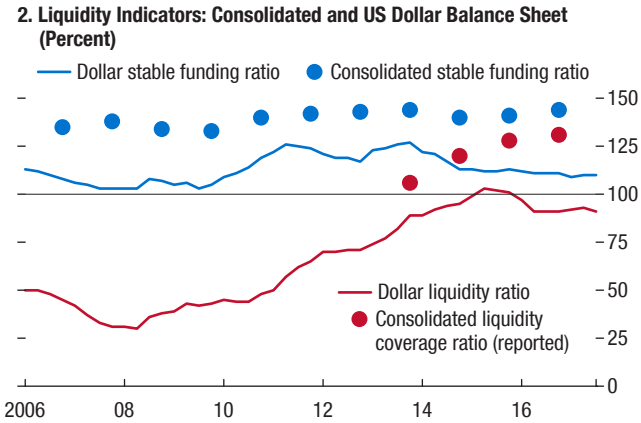
## Figure 1.24. Non-US Banks' International Dollar Balance Sheets

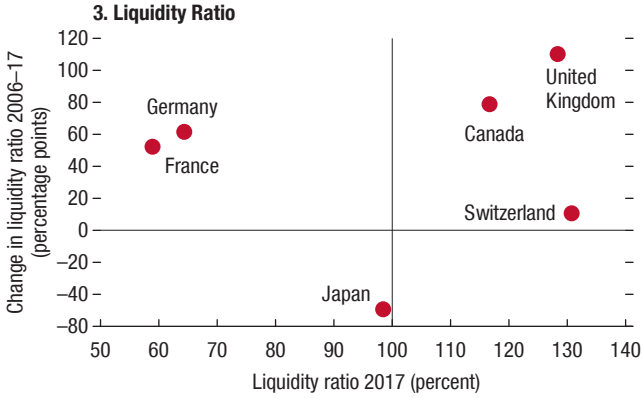
Non-US banks tend to rely on short-term or wholesale US dollar funding.

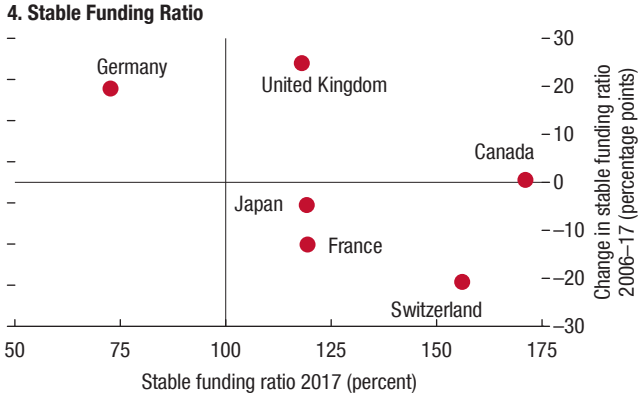



Their US dollar liquidity is usually weaker than their overall positions.




And US dollar funding ratios vary significantly between banking systems.




Sources: Bank for International Settlements; bank financial statements; Bank of Japan; Federal Financial Institutions Examination Council; S&P Global Market Intelligence; and IMF staff estimates and analysis.
Note: Measurement of the liquidity ratio and stable funding ratio is explained in the text and in more detail in Online Annex 1.2. International dollar = dollar claims/liabilities in non-US offices and in US branches of non-US banks. ST = short-term.

systems—the French and German aggregate liquidity ratios are somewhat lower than their peers', though they have been rising over the past few years, and the German banking system's stable funding ratio is below the levels in some other countries (Figure 1.24, panels 3 and 4).

Overall, US dollar liquidity ratios have improved since the global financial crisis. This improvement has largely been driven by large increases in High Quality Liquid Assets (HQLA, reserves at central banks and holdings of official sector bonds), probably in response to intensifying regulatory scrutiny of short-term liquidity positions (Figure 1.25, panel 1). Only the Japanese banking system's liquidity ratio declined over the same period, although it currently stands at about 100 percent (Figure 1.25, panel 3). This decline reflects a rise in interbank liabilities used to fund an increase in loans and securities (Figure 1.25, panel 5).

Aggregate US dollar stable funding ratios, however, are largely unchanged over 2006–17 (Figure 1.25, panel 2). Individual banking systems have shown little progress in strengthening stable funding ratios, and in some the ratio has actually fallen (Figure 1.25, panel 4). These declines reflect rapid growth in dollar loans—particularly in the Canadian, French, and Japa-



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nese banking systems—that has exceeded banks' ability or willingness to source deposits (Figure 1.25, panel 6). This situation is perhaps due to a reach for yield in banks looking to boost profitability by expanding lending across borders through an increased maturity mismatch. Systems whose stable funding ratios have improved (UK and German banking systems) accomplished this only by shrinking dollar loans (Figure 1.25, panel 6).

### Banks Use Foreign Exchange Swaps to Meet Short-Term Currency Funding Mismatches, but This Market May Not Be a Reliable Backstop in Periods of Stress

Non-US banks use foreign exchange swap markets to meet short-term currency needs. While some banks have lengthened the tenor of their swap positions, banks still plan to tap swap markets when liquidity is tight. Non-US banks' dependence on cross-currency swaps varies, but two facts stand out: their use has increased overall over the past decade, and Japanese banks rely relatively heavily on these instruments (Figure 1.26, panel 1). These developments are concerning, because cross-currency basis swap spreads have moved sharply in the past (Figure 1.26, panel 2) and because swap markets have been more volatile than other short-term funding sources such as repo and interbank markets (Figure 1.26, panel 3). This suggests that swap markets may not be a reliable backstop in periods of stress.

Furthermore, the yen-dollar market—a crucial source of bank funding—may have become more procyclical because of changes in market structure. As sovereign yields have fallen below policy guaranteed return targets, Asian life insurers have sought yield in dollar-denominated securities. The need to hedge currency risk has driven a surge in demand for swaps (Figure 1.26, panel 4). US banks' dollar swap supply has not kept up with this growing demand.[64] Nontraditional lenders, such as hedge funds and sovereign wealth funds, have stepped in to meet this demand and now account for about 70 percent of the supply of foreign currency derivatives to Japanese financial institutions (Figure 1.26, panel 5). But their appetite to supply dollars may be more procyclical than banks'. Because these new players place the yen they receive in swap transactions in Japanese government bills, their ability to provide dollar funding in the yen-dollar market may also be constrained by the scarcity of high-quality yen assets in the market; about 85 percent of short-term Japanese government bills are now held by non-Japanese investors and the Bank of Japan.

[64]The size of US banks' short-tenor dollar swap supply is estimated by their holdings of claims on the Japanese official sector, as non-Japanese investors receiving yen in swap transactions typically invest the yen in short-term Japanese government bills.

### Several Forces Are Tightening Dollar Funding Conditions

US dollar funding markets have begun to tighten. Market participants have pointed to a number of factors behind this, including an expected rise in Treasury bill issuance, US companies changing their investment patterns ahead of repatriating offshore assets, and continued central bank normalization. This tightening can be illustrated by the widening of the dollar LIBOR-OIS spread (the difference between the London interbank offered rate and the overnight indexed swap rate) in recent months (Figure 1.26, panel 6).

Moreover, country-specific liquidity regulations, while helping to strengthen national financial systems, may inadvertently introduce frictions in international funding markets. Some regulators have increased restrictions on or surveillance of cross-border intragroup liquidity flows in recent years and are extending the perimeter of their liquidity requirements to foreign banks operating in their country (Buch and Goldberg 2015; Gambacorta, van Rixtel, and Schiaffi 2017; Goldberg and Gupta 2013; Reinhardt and Riddiough 2014).

The combination of balance sheet vulnerabilities and market tightening could trigger funding problems in the event of market strains. Market turbulence may make it more difficult for banks to manage currency gaps in volatile swap markets, possibly rendering some banks unable to roll over short-term dollar funding. Banks could then act as an amplifier of market strains if funding pressures were to compel banks to sell assets in a turbulent market to pay their liabilities that are due. Funding pressure could also induce banks to shrink dollar lending to non-US borrowers, thus reducing credit availability. Ultimately, there is a risk that banks could default on their dollar obligations.



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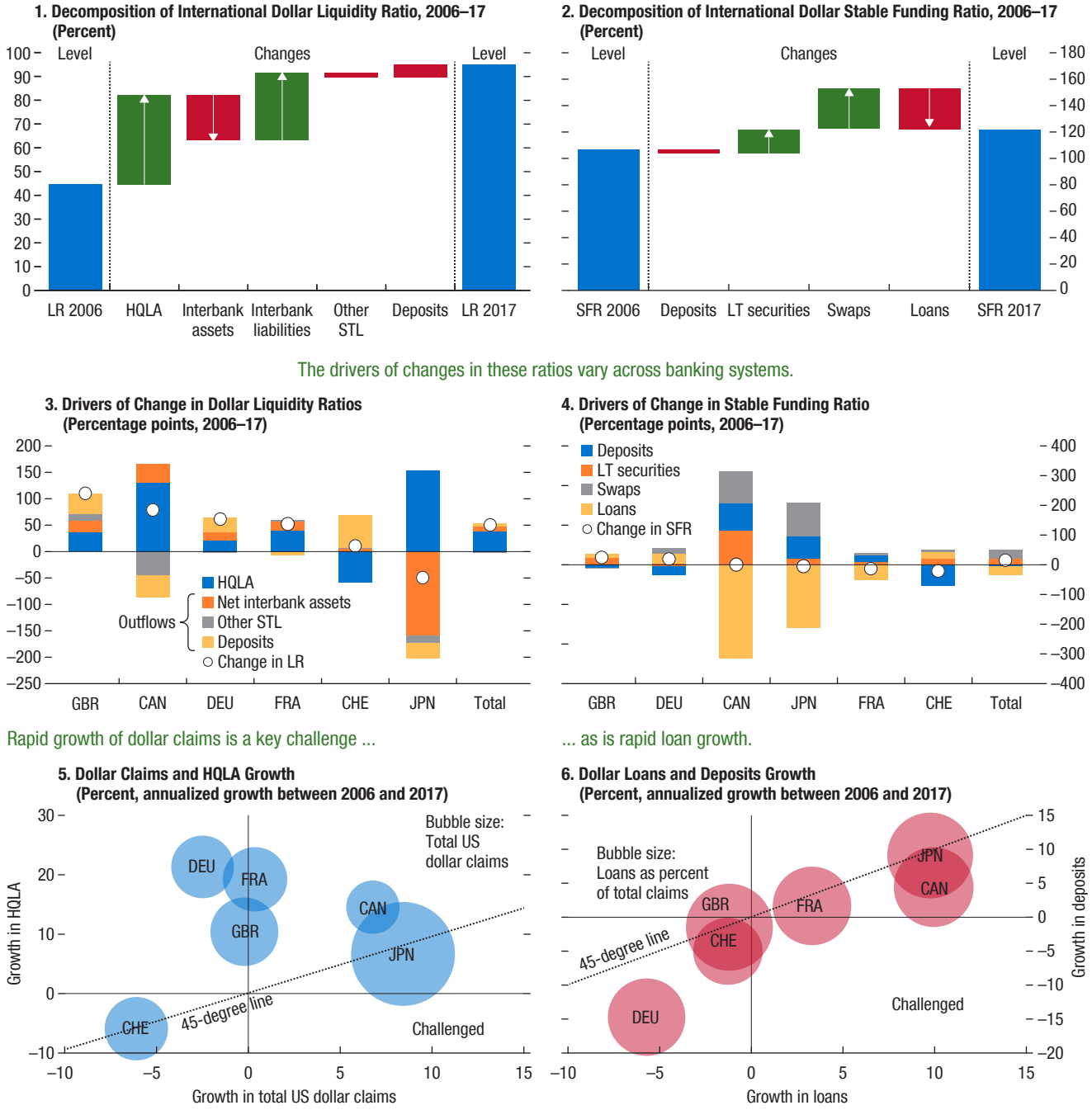
## Figure 1.25. Non-US Banks' International US Dollar Liquidity Ratios

The aggregate liquidity ratio has improved ...

... but the stable funding ratio is little changed.




Sources: Bank financial statements; Bank for International Settlements; Bank of Japan; Federal Financial Institutions Examination Council; S&P Global Market Intelligence; and IMF staff estimates and analysis.
Note: Dollar claims are loans and securities denominated in dollars. Data labels in the figure use International Organization for Standardization (ISO) country codes. HQLA = high-quality liquid assets; LR = liquidity ratio; LT = long-term; SFR = stable funding ratio; STL = short-term liabilities.



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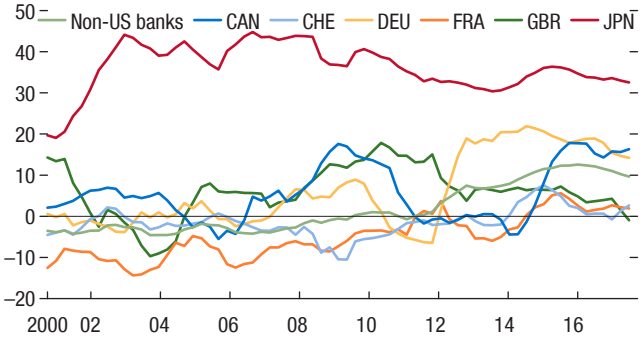
## Figure 1.26. Foreign Exchange Swap and Short-Term Bank Funding Markets

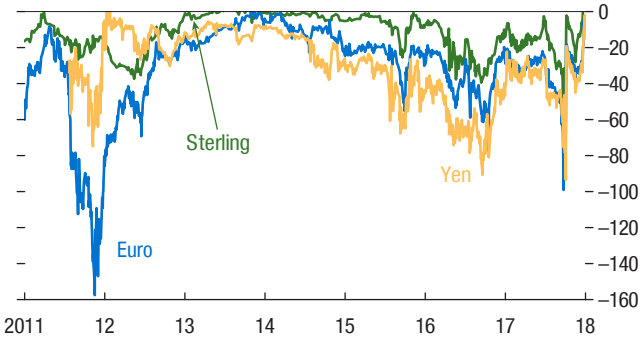
Some non-US banks are reliant on cross-currency funding via swaps.

**1. US Dollar Cross-Currency Funding Ratio**
**(Net cross-currency derivatives as percent of total assets)**



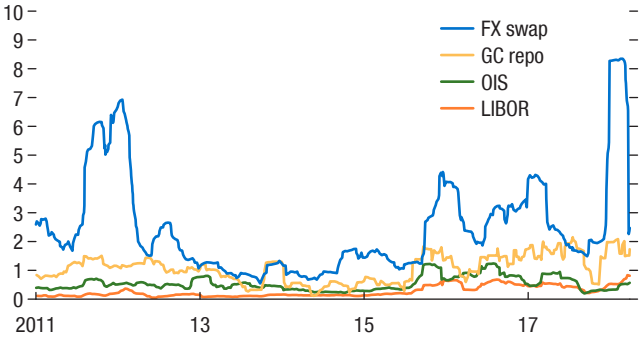

Cross-currency basis swap spreads have widened sharply in the past ...

**2. Three-Month Cross-Currency Basis Swaps**
**(Basis points)**



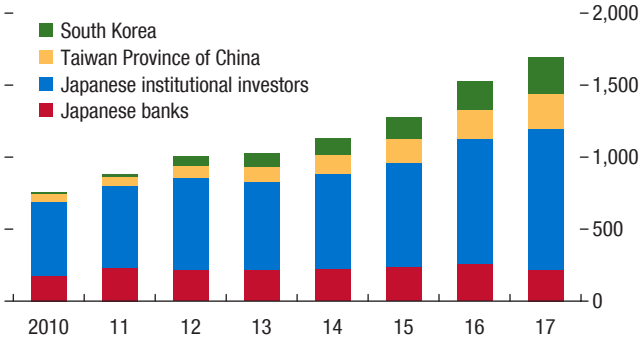

... and foreign exchange swaps are more volatile than other short-term funding sources.

**3. Sixty-Day Realized Volatility of Three-Month US Dollar Funding Rates**
**(Basis points a day)**



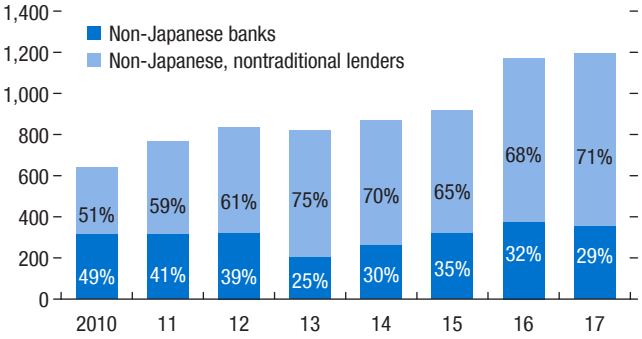

Demand to hedge foreign currencies by Asian financial institutions is increasing ...

**4. Demand for Foreign Exchange Derivatives by Asian Financial Institutions**
**(Billions of US dollars)**



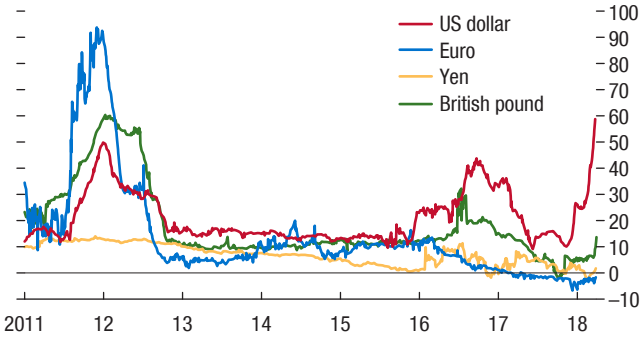

... while the supply is shifting from banks to nontraditional financial institutions.

**5. Supply of Foreign Exchange Derivatives to Japanese Financial Institutions**
**(Billions of US dollars)**




US dollar LIBOR-OIS spreads have widened recently.

**6. Three-Month LIBOR-OIS Spreads**
**(Basis points)**




Sources: Annual reports; Bank for International Settlements; Bank of Japan; Bloomberg Finance L.P.; Financial Supervisory Commission (Taiwan Province of China); the Korean Life Insurance Association; and IMF staff estimates.
Note: In panels 4 and 5, the latest data are as of September 2017. In panel 4, data for Korea life insurers and the National Pension Service are estimated assuming 100 percent hedging of their foreign investments. For Taiwan Province of China life insurers, the assumption is a 50 percent hedging of their foreign investments. Data labels in panel 1 use International Organization for Standardization (ISO) country codes. FX swap = foreign exchange swap (average of euro-dollar and yen-dollar); GC repo = general collateral repurchase agreement; LIBOR = London interbank offered rate; OIS = overnight indexed swaps.



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### Funding Market Risks Call for Disclosure as Well as Gradual and Coordinated Implementation of Regulations

The Basel liquidity framework, centered on the LCR, has significantly improved banks' consolidated balance sheet resilience against short-term funding shocks, and both capital and liquidity regulations have driven considerable improvement in banks' longer-term funding stability. But there is still a need to address risks from foreign currency liquidity mismatches.

- Banks should ensure that currency-specific mismatches within individual entities in their banking groups continue to be managed effectively to reduce the risk of funding strains.
- Consideration should be given to enhancing disclosure of foreign currency funding risks.[65] This would help investors and analysts better assess international liquidity and maturity mismatches.
- Regulators should develop or maintain currency-specific liquidity risk frameworks, including stress tests, emergency funding strategies, and resolution planning. Coordination and sharing of information among regulators are crucial to reduce any unintended cross-border spillovers from jurisdiction-specific liquidity requirements.
- Central bank swap lines should be retained to provide foreign exchange liquidity in periods of systemic stress. This should help prevent foreign currency funding difficulties from spilling over to other parts of the financial system.

Finally, while implementation of the Basel III package of reforms has helped strengthen the banking sector, there is still some ground to be covered, and completing the postcrisis reform agenda is vital (Box 1.5). Ensuring the independence of supervision will be crucial in this effort, as will be addressing the new challenges posed by technology.

[65]The Basel Committee's 2008 Principles for Sound Liquidity Risk Management and Supervision contained guidance on managing liquidity risk, including in different currencies. This guidance included a principle on the public disclosure of information on liquidity risk.



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## Box 1.1. The VIX Tantrum

Global equity markets experienced a bout of renewed volatility on February 5–6, 2018 (Figure 1.1.1). Equity losses were heavy, with a 7 percent cumulative drop in the S&P 500 over the first seven trading days of February. The Chicago Board Options Exchange Volatility Index (VIX) of implied equity volatility surged, jumping from below 15 at the open on February 5 to an intraday peak of 50 on February 6, the highest level since August 2015, when China devalued its currency.

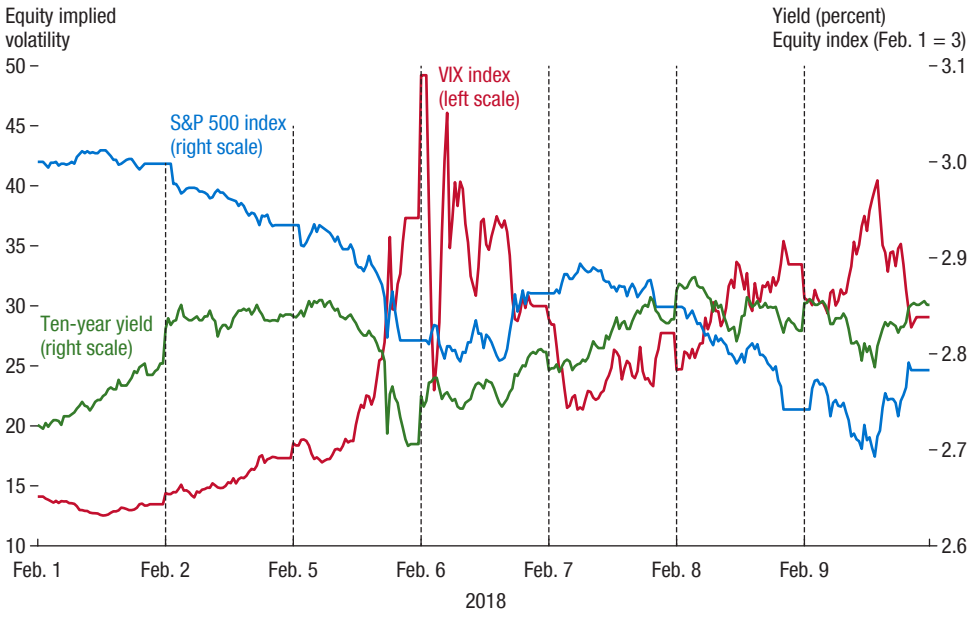
Market participants indicated that technical factors in options products and short-volatility strategies amplified market moves. For example, the implied volatility spike forced VIX-related exchange-traded products to buy large volumes of VIX futures to cover short VIX positions, creating a feedback loop that exacerbated the rise in the VIX. Some of these exchange-traded products closed with very heavy losses. In addition, the evidence to date is inconclusive, but debate persists among market participants about whether other investment strategies, based on momentum, risk parity, volatility targeting, or artificial intelligence, may have also exacerbated the initial volatility spike. But by the end of the episode, the VIX, which should reflect investors' expectations and attitudes toward equity risk, was about in line with forecasts of underlying stock market volatility (see Online Annex 1.1).[1]

Although technical factors may have exacerbated volatility at times, they do not seem to have triggered the initial shock. Mounting fears about higher inflation in preceding days reportedly soured investor sentiment. However, observed moves in market-based measures of inflation compensation, term premiums, and implied volatility derived from interest rate swaptions do not appear to be consistent with any concurrent, meaningful revision in inflation expectations or related risks precisely during the equity market swoon.

This box was prepared by J. Benson Durham and Will Kerry.

[1]See Online Annex 1.1 at www.imf.org/en/Publications/GFSR for more details.

**Figure 1.1.1. US Asset Prices**




Source: Bloomberg Finance L.P.
Note: VIX = Chicago Board Options Exchange Volatility Index.



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**Box 1.1** ***(continued)***

The fall in US equities spilled over to other equity markets, which fell by about 5–9 percent during February 1–9. Despite the large price moves, equity markets functioned well, with very high trading volumes; liquidity conditions were reportedly reasonable other than in futures markets; and there was no apparent disorderly portfolio unwinding. Declines in other risky assets were more modest than the fall in equities.

In the aftermath of the VIX tantrum, and after years of prolonged low interest rates, investors and central bankers are faced with increasing maturity and liquidity mismatches as well as rising leverage that may amplify market turbulence down the road. The extent of institutional investors' exposure to short volatility positions remains unclear. Yet estimates of the price of risk, based on volatility projections, are now very close to the levels observed before the episode, which broadly implies that investors' willingness to sell volatility remains robust today despite the tremors in early February. Moreover, valuations remained stretched, amid a sustained increase in correlations across asset classes since the episode (as discussed in "Reach for Yield or Overreach in Risky Assets?" section).



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## Box 1.2. An Econometric Lens on What Drives Term Premiums

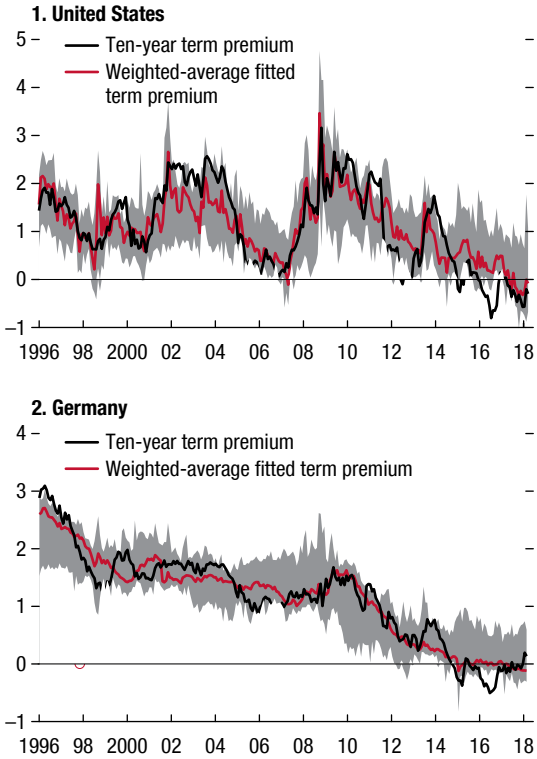
The term premium on a zero-coupon government bond is the extra compensation investors demand for holding government bonds in excess of risk-free short-term interest rates. Specifically, it is the difference between its yield and the average expected risk-free short rate over the maturity of the bond. Like equity risk premiums, term premiums are unobservable and must be estimated. Policymakers and investors routinely decompose bond yields into expected rates and term premiums to better understand the information embedded in the yield curve.

To determine what affects term premiums, researchers commonly estimate the econometric relationship between these estimates and observable macroeconomic and financial "factors" (Wright 2011; Li and Wei 2013). The return on a government bond should conceivably correlate with any variable that captures some component of either the quantity or the price of risk around the path of risk-free rates. Relevant factors include forecasts of economic growth and inflation, as well as measures of uncertainty around those projections; budget deficit forecasts and supply factors related to "special demand" for safe assets; estimates of the volatility of bond returns; estimated covariance of bond and stock returns, to assess hedging value; and broad measures of financial market stress, including the VIX (Chicago Board Options Exchange Volatility Index) or equity market volatility, to capture so-called flight-to-quality episodes.[1]

Rather than report the result from a single model and risk false precision, the estimates that follow average over hundreds of monthly regression models, based on alternative proxies for the underlying factors, to enhance robustness. In addition, the approach emphasizes weighted averages (based on the overall fit of the models) and ranges rather than a single point estimate of the fair value of term premiums; that is, the required returns statistically commensurate with underlying macroeconomic and financial variables. This method not only conveys warranted uncertainty around the estimates but also provides a sharper sense of which factors affect required returns, all else equal.

Importantly, the models generally track estimated 10-year term premiums for Canada, France, Germany, Japan, the United Kingdom, and the United States reasonably well over the sample from February 1996 through March 2018. For example, for the United States, the models largely capture the so-called conundrum period during the mid-2000s. Finally, considering the current environment, as referenced in the main text, the weighted-average estimate of the fair value of the 10-year term premium from these hundreds of monthly regression models was about –10 basis points, near its sample low, compared with the actual term premium estimate of –30 basis points. After closing a meaningful gap over the past year or so, the reported estimated term premium is largely within the range of all 900 models, and the latest reading is small by historical comparison (Figure 1.2.1, panel 1).

### Figure 1.2.1. Estimated Term Premiums




Sources: Bloomberg Finance L.P.; and IMF staff estimates.
Note: Ten-year term premium estimates follow the Adrian, Crump, and Moench (2013) model. The estimates for the US term premium follow a five-factor specification using underlying fitted yield data from June 1961 (for example, ACMTP10 Index). The estimates for Germany follow a four-factor specification using fitted yields from Bloomberg from October 1991. The weighted-average fair value estimate is the average of all estimated conditional term premium models. The shaded area denotes the range of fitted values from these models.

This box was prepared by J. Benson Durham.

[1]For a broader discussion of default risk premiums, see the April 2018 *Fiscal Monitor*.



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**Box 1.2 *(continued)***

Outside the United States, estimated term premiums on 10-year German bunds are close to historical lows. The latest fitted value, about –15 basis points, is less than the observed estimate, about 15 basis points, which strictly speaking suggests that required returns more than compensate for the current constellation of risks (Figure 1.2.1, panel 2). Finally, estimated term premiums are similarly close to their fitted values across Canada, France, Japan, and the United Kingdom.

Considering the coefficients of the models, as well as the current levels of the underlying factors, the most recent low fitted values of term premiums are owing to low survey-based uncertainty about near-term GDP growth and inflation, subdued volatility of US Treasury returns, and a persistently lower correlation between Treasury and risky asset returns. Notably, however, the models say nothing about the future direction of any of these underlying factors. Indeed, the estimates imply significant increases in term premiums should, say, investors become more uncertain about the outlooks for inflation, growth, and the path for monetary policy. Also, naturally this formal time-series approach has shortcomings. Other key variables are hard to capture with formal statistics, including some of the phenomena discussed in the main text and other regulatory restrictions that affect investors' demand for government paper or debt-management considerations.

Nonetheless, these statistical results are consistent with the view that the overall level of longer-dated yields is appropriate given the stance of monetary policy, which, in turn, should remain largely accommodative to support growth and to bring inflation closer to central banks' targets.



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## Box 1.3. The Changing Investor Base in the US Leveraged Loan Market

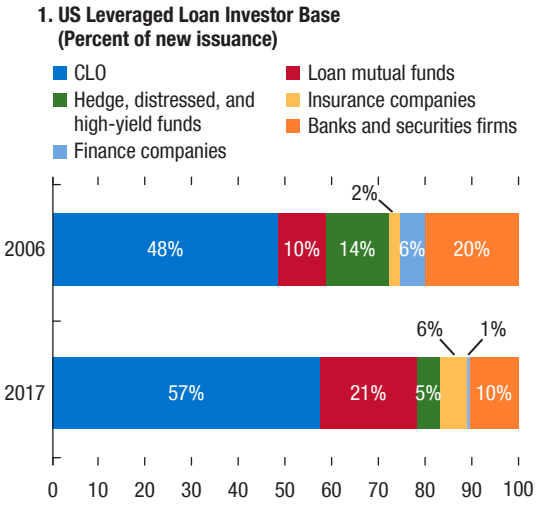
With the US leveraged loan market experiencing impressive growth over the past several years, the buyer base has shifted further toward institutional investors (Figure 1.3.1, panel 1). Similar to the precrisis period, structured financial products, such as collateralized loan obligations (CLOs), are an important source of demand for low-quality credit. Since 2014, CLOs have purchased more than half of total issuance of leveraged loans. US CLOs accounted for 57 percent of leveraged loans outstanding in 2017, with $495 billion in assets under management. CLO issuance (sale of CLO tranches to outside investors to fund purchases of loans) reached $118 billion in 2017, above precrisis levels. Loan mutual funds (including exchange-traded funds) are another important institutional investor class. They have grown from roughly $20 billion in 2007 to $170 billion in assets in 2017, and now account for more than 20 percent of the institutional loan market (Figure 1.3.1, panel 2).

Increased holdings of leveraged loans by institutional investors such as loan mutual funds and CLOs at the expense of banks may affect market dynamics during times of stress. The migration of loan assets to open-end loan mutual funds offering daily liquidity may exacerbate price moves in the event of large investor redemptions under distress (Braithwaite and others 2014). Furthermore, market participants cite an increase in demand for CLO tranches by asset managers, insurance companies, and pension funds, which now account for 45 percent of AAA CLO market share. In the years leading up to the financial crisis, AAA CLO tranches were routinely funded in the repurchase agreement (repo) market and through other means, essentially using financial leverage to boost meager AAA spreads. The unwinding of such leveraged positions reportedly amplified loan price moves when investors became uncertain about the safety and liquidity of higher-rated structured products. At this point, the use of financial leverage to fund CLO positions appears to be limited. Similarly, investors do not seem to be widely using total return swaps as a vehicle for gaining leveraged exposure to the loan market (another common instrument employed in 2006–07).

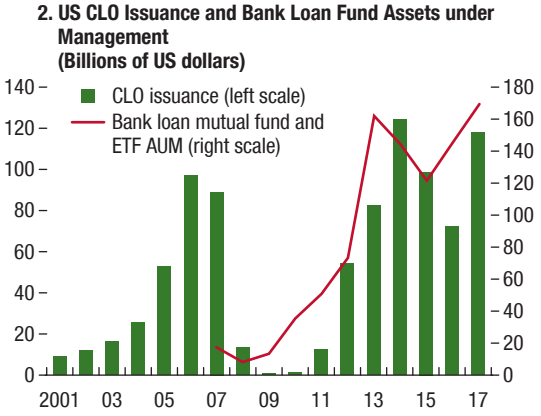
This box was prepared by Tom Piontek.

### Figure 1.3.1. Nonbanks Have Increased Their Credit Exposure in the US Leveraged Loan Market

The US leveraged loan investor base has shifted further toward CLOs and asset managers.




CLO formation and loan fund growth remain robust.




Sources: EPFR Global; S&P Leveraged Commentary and Data; and IMF staff calculations.
Note: AUM = assets under management; CLO = collateralized loan obligation; ETF = exchange-traded fund.



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## Box 1.4. Central Bank Digital Currencies

Crypto assets provide challenges and opportunities to central banks. As argued earlier, they are still far from fulfilling the three basic functions of money, and their underlying technology still has to develop further before it unequivocally offers the benefits it promises. Nonetheless, central banks can learn from the properties of cryptocoins and underlying technologies to make the use of fiat currencies more attractive. As a medium of exchange, cryptocoins have certain properties that central bank money in its current forms (cash and commercial bank reserves) does not have. Unlike reserve transfers, cryptocoin transactions can be cleared and settled instantaneously without an intermediary, and transacting parties can enjoy anonymity; unlike with cash, transacting parties do not need to be in the same place, and the technology offers more flexibility in designing the denomination structure of the cryptocoin. These properties make cryptocoins attractive for cross-border payments and micro payments in the new sharing, service-based digital economy.

Building on these developments, central banks such as the Bank of Canada, the People's Bank of China, the Monetary Authority of Singapore, and the Swedish Riksbank have started to explore a new form of central bank money: central bank digital currency (CBDC). Although approaches vary by institution, and a single definition is lacking, a CBDC could be defined as a digital form of central bank money that can be exchanged, peer to peer, in a decentralized manner. A CBDC would be a token representation of, or an addition to, cash in physical form (banknotes and coins) and/or electronic deposits. It could be issued by the central bank directly to commercial banks and other payment services providers or to individuals, and would be exchanged at par with the central bank's other monetary liabilities.

Payment system efficiency and stability seem to be important objectives in considering CBDCs. CBDCs could be used to counter the monopoly power that strong network externalities might confer on private payment networks or to address the inability to ensure the full stability and safety of private cryptocoins.

From a retail point of view, gradually replacing notes and coins with a CBDC could yield savings to the state for the costs of maintaining and replacing notes and coins. It may also reduce transaction costs for individuals and small enterprises that have little or costly access to banking services in some countries or regions, and it may facilitate financial inclusion. Central banks would also be able to tailor the level of anonymity of a CBDC, ensuring cash-like anonymity for small-value payments, yet allowing for more tailored regulatory compliance for larger-value payments.

From a monetary policy perspective, CBDCs could help maintain the demand for central bank money in the digital age. Central bank seigniorage would continue with CBDCs. This, in turn, would allow central banks to continue to finance their operations and distribute profits to government. CBDCs, along with the abolition of cash, might also allow central banks to overcome the zero lower bound, facilitating truly negative interest rates when necessary, though the benefit of enhanced monetary policy effectiveness may need to be traded off against a potential cost to financial stability. Making the CBDC a potential competitor to commercial bank deposits could, for instance, lead to volatility in fund flows between commercial banks and the central bank, potentially resulting in bank runs toward CBDCs and thereby hampering financial stability.

In summary, some central banks have expressed interest in exploring the idea of a CBDC.[1] Given the uncertainties described above, a gradual and cautious approach that builds on experience and takes into account evolving and maturing financial technologies seems warranted. Risks to financial stability could potentially be reduced if the design of the CBDC is such that it respects the current two-tier banking system (that is, the separation of commercial banking from central banking) and merely creates a digital form of cash.

This box was prepared by Dong He and Ashraf Khan.

[1]See CPMI (2018).



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## Box 1.5. Regulatory Reform—Tying Up the Loose Ends

The postcrisis regulatory reform agenda has been successful in enhancing the resilience of the major banks. This resilience has been achieved primarily through implementation of the Basel III package. However, the excessive variation in the output of internal models used by banks to compute regulatory capital led to concerns that these models were being gamed to reduce regulatory requirements without a corresponding reduction in risk exposures.

To address these concerns, the Basel Committee on Banking Supervision proposed a package of enhancements to Basel III in 2014, which was finally agreed to in December 2017, bringing closure to a critical piece of the regulatory reform agenda. These measures limit risk-weighted assets, based on the internal-ratings-based approach, to a minimum of 72.5 percent of the amount calculated using the simpler standardized approach.

These measures also aim to achieve a better balance between simplicity, risk sensitivity, and comparability. In this vein, the agreed-on implementation of the Fundamental Review of the Trading Book has been postponed to 2022, in response to practical challenges reported by countries, and the standardized approach to credit risk has been revised to make it more risk sensitive (for example, varying risk weights for real estate exposures using loan-to-value ratios).

Agreement on the Basel III enhancements has come at the cost of: a less conservative risk-weighted assets floor, from the 80 percent proposed initially; further extending the implementation timeline for these reforms to 2022–27, 20 years since the start of the crisis; an annual cap on any increase in risk-weighted assets resulting from the measures; and lowering some minimum risk weights in the standardized approach.

Despite these adjustments, the outcome has brought certainty to market participants. The focus of the international efforts can now move to full, timely, and consistent implementation, which has already been delayed and is lagging in important areas such as cross-border resolution frameworks for banks.

A major challenge for effective implementation is shortcomings in the operational independence of supervisors from political and market influence. IMF Financial Sector Assessment Programs have found that only a handful of the nearly 40 countries that have been assessed since the global financial crisis are in full compliance with the Basel Core Principles on independence and accountability. Policymakers must ensure that supervisors have the resources and power to take timely, preemptive, and corrective actions to address emerging threats.

What else remains on the agenda? The Financial Stability Board recommendations to transform shadow banking into resilient market-based finance are now being translated into operational guidance to facilitate consistent national implementation. Resolution efforts for nonbanks, including central counterparties, remain a work in progress, while the reform agenda for insurers has not kept pace with planned timelines. The issue of tackling incentives for excessive risk taking has moved away from regulating remuneration to reforming governance, addressing misconduct, seeking to reinforce individual accountability, and creating a supportive institutional culture. The difficult decision on better incorporating sovereign risks into the regulatory framework has been shelved for the time being.

All in all, even though much has been achieved through the regulatory reforms, there is still some ground to be covered. Given the backdrop of calls for rolling back the reforms, it is vital that the postcrisis agenda be completed and implemented to allow supervisors to focus on emerging challenges, including those from rapid developments in financial technology and the threats posed by cyberattacks.



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CHAPTER 2

# THE RISKINESS OF CREDIT ALLOCATION: A SOURCE OF FINANCIAL VULNERABILITY?

## Summary

The prolonged period of loose financial conditions in recent years has raised concerns that financial intermediaries and investors in search of yield may have extended too much credit to risky borrowers, potentially jeopardizing financial stability down the road. These concerns are related to recent evidence for selected countries that periods of low interest rates and easy financial conditions may lead to a decline in lending standards and increased risk taking.

Against this backdrop, this chapter takes a comprehensive look at the evolution of the riskiness of corporate credit allocation—that is, the extent to which riskier firms receive credit relative to less risky ones, its relationship to the strength of credit expansions, and its relevance to financial stability analysis for a large number of advanced and emerging market economies since 1991. The chapter focuses on the allocation of credit across firms rather than the aggregate volume of credit or credit growth.

The chapter finds that the riskiness of credit allocation rises during periods of fast credit expansion, especially when loose lending standards or easy financial conditions occur concurrently. Globally, the riskiness of credit allocation increased in the years preceding the global financial crisis and peaked shortly before its onset. It declined sharply after the crisis and rebounded to its historical average in 2016, the latest available year for globally comparable data. As financial conditions loosened in 2017, the riskiness of credit allocation might have risen further.

An increase in the riskiness of credit allocation signals heightened downside risks to GDP growth and a higher probability of banking crises and banking sector stress, over and above the previously documented signals provided by credit growth. Thus, a riskier allocation of corporate credit is an independent source of financial vulnerability.

The results highlight the importance of monitoring the riskiness of credit allocation as an integral part of macro-financial surveillance. The new measures constructed in this chapter are simple to compute, rely mostly on firm-level financial statement data that are available in many countries, and can be readily replicated for use in macro-financial surveillance. For this purpose, policymakers would benefit from collecting these data in a timely manner.

The chapter shows that various policy and institutional settings may help policymakers mitigate the increase in the riskiness of credit allocation that takes place during relatively fast credit expansions. A tightening of the macroprudential policy stance, greater independence of the supervisory authority from banks, a smaller government footprint in the corporate sector, and greater minority shareholder protection are all related to a smaller increase in the riskiness of corporate credit allocation during these episodes.



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## Introduction

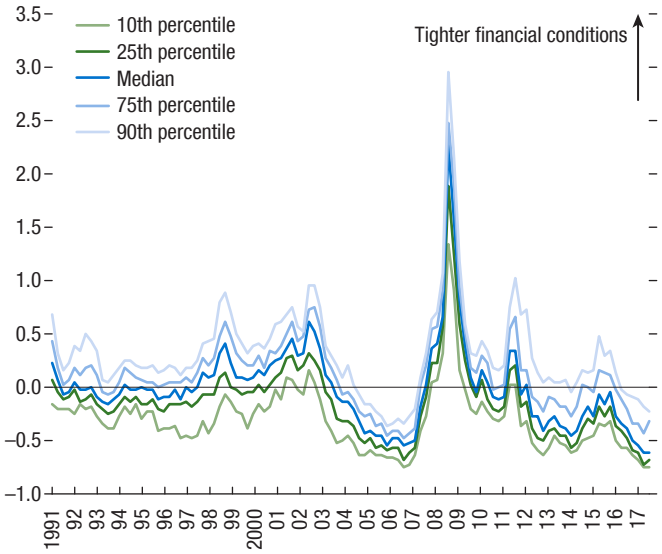
After years of accommodative monetary policy, financial conditions remain loose in most advanced and emerging market economies. Although withdrawal of monetary policy stimulus has begun in several advanced economies and is expected to keep proceeding at a gradual pace in the United States, and despite a recent rebound in financial market volatility, financial conditions have remained loose, and spreads (including corporate spreads) have remained compressed by historical standards in both advanced and emerging market economies (see Figure 2.1 and Chapter 1). Meanwhile, corporate credit-to-GDP ratios remain at or near their historical highs in both advanced economies and emerging markets.[1]

This environment has raised concerns among policymakers and market analysts that nonfinancial corporate credit might have been excessively allocated to risky firms, especially in advanced economies, jeopardizing financial stability down the road. As described in Chapter 1, persistently easy financial conditions may lead to a continued search for yield with too much money chasing too few yielding assets, pushing investors beyond their traditional risk tolerance into riskier investments. Indeed, the share of bond issuance by nonfinancial corporations with low ratings (high-yield and BBB-rated bonds) has rebounded from its crisis trough in the United States and is at or near an all-time high in the euro area and the United Kingdom (Figure 2.2). At the same time, the October 2017 *Global Financial Stability Report* (GFSR) highlighted that some indicators of nonfinancial corporate vulnerability had picked up in several major economies. Although greater risk taking by financial intermediaries could be part of a healthy economic recovery, it may breed vulnerabilities that could harm future growth if excessive.

Country-level studies have documented that the composition of corporate credit flows changes with financial conditions and that the riskiness of corporate credit allocation is procyclical. The riskiness of corporate credit allocation is the extent to which riskier firms receive credit relative to less risky firms. Empirical studies dating to the mid-1990s for the United States provide evidence that the riskiness of corporate credit allocation increases during economic expansions and declines during recessions (for example, Lang and Nakamura 1995; Bernanke, Gertler, and Gilchrist 1996).[2] More recently, Greenwood and Hanson (2013) offer further evidence of such behavior in the United States during the past few decades: the riskiness of corporate credit allocation rises when credit growth is stronger, the short-term Treasury bill yield is lower, the term spread is lower, or high-yield bond returns are higher. Corroborating evidence comes from Spain, where riskier firms had nearly the same access to the bank loan market as less risky firms in the years preceding the global financial crisis, but significantly less access during the crisis and early recovery period (Banco de España 2017). In the euro area, riskier firms increased their borrowing more than less risky firms following the rally in euro area sovereign bonds triggered by the European Central Bank's

**Figure 2.1. Financial Conditions Have Been Loose in Recent Years**

*(Financial conditions index; various percentiles of the cross-country distribution)*




Source: IMF staff estimates.
Note: A higher level of the financial conditions index (FCI) means financial conditions are tighter. The sample comprises 41 advanced and emerging market economies. For methodology and variables included in the FCI, refer to Annex 3.2 of the October 2017 *Global Financial Stability Report*.

Prepared by a staff team led by Jérôme Vandenbussche and composed of Luis Brandão-Marques, Qianying Chen, Oksana Khadarina, and Peichu Xie under the general guidance of Claudio Raddatz and Dong He. The chapter benefited from contributions by Divya Kirti and Jiaqi Li. Claudia Cohen and Breanne Rajkumar provided editorial assistance.

[1]See IMF (2016) and the October 2015 GFSR for recent analyses of the evolution of corporate debt across countries.

[2]A decline in the riskiness of credit allocation during recessions has sometimes been referred to as a "flight to quality."



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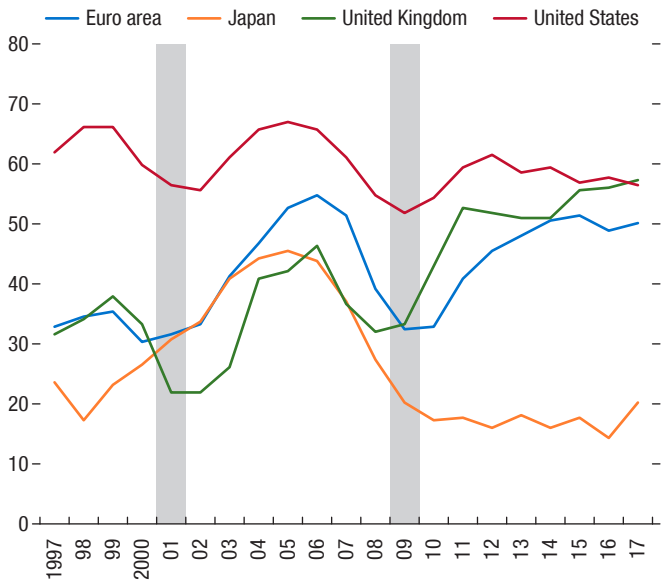
announcement in 2012 that it stood ready to conduct Outright Monetary Transactions (Acharya and others 2016). Analyses of granular data from Spain and the United States also reveal a positive association between low short-term interest rates and the probability of extending loans to risky borrowers (Jiménez and others 2014; Dell'Ariccia, Laeven, and Suarez 2017).

Against this backdrop, this chapter takes a comprehensive look at the evolution of the riskiness of corporate credit allocation, its relationship to the size of credit expansions, and its relevance to financial stability analysis.

- No cross-country measures are readily available that capture the riskiness of total credit flows across firms. To fill this gap, this chapter constructs several measures that map the flow of credit across firms to the distribution of various firm-level vulnerability indicators for 55 economies since 1991.[3] Existing methodologies for assessing firm-level vulnerability or default risk may be more or less suitable to different market and data environments. For this reason, the chapter discusses four options for measuring the riskiness of corporate credit allocation—henceforth, the "riskiness of credit allocation." In constructing these measures, this chapter provides the most comprehensive cross-country analysis of the riskiness of credit allocation to date.
- Financial stress and growth-at-risk models in the empirical literature have focused on changes in aggregate credit volumes as the key vulnerability measure.[4] Although it may seem intuitive that a measure capturing the extent to which credit is flowing to riskier firms can provide additional information on future macro-financial outcomes, this proposition has remained, at best, a matter of conjecture in the financial stability literature.[5] Furthermore, standard indicators of aggregate corporate vulnerability, which are discussed in most financial stability reports around the world, do not take firm-level credit flows into consideration.[6]

**Figure 2.2. Low-Rated Nonfinancial Corporate Bond Issuance Has Been High in Some Advanced Economies**
*(Percent of total nonfinancial corporate bond issuance)*




Sources: Dealogic; and IMF staff estimates.
Note: "Low-rated" refers to high-yield and BBB-rated bonds; the simple three-year moving average is shown. Shaded areas indicate periods during which global real GDP growth was less than 2.5 percent.

Following a conceptual discussion of the relationship between the riskiness of credit allocation and credit growth, this chapter addresses the following questions:

- How has the riskiness of credit allocation evolved in recent years across a broad spectrum of advanced economies and emerging markets?

[3]Some studies have relied on indirect measures such as bond issuance data by level of credit rating (for example, Kirti 2018). Others have focused on the share of credit flowing to distressed ("zombie") firms. The former measures ignore a significant source of credit (loans) and are not well suited to most emerging markets and advanced economies of relatively small size, where domestic bond market development is low. The latter are partial because they focus only on two categories of firms (distressed and nondistressed).

[4]See Schularick and Taylor (2012), Gourinchas and Obstfeld (2012), Dell'Ariccia and others (2016), Baron and Xiong (2017), and Chapters 2 and 3 of the October 2017 GFSR. Gourinchas and Obstfeld (2012) also emphasize the importance of external imbalances, especially in emerging markets. Jordà, Schularick, and Taylor (2016b) find that in advanced economies financial crises are not more likely when public debt is high. However, they show that high levels of public debt tend to exacerbate the effects of private sector deleveraging after financial crises, as does IMF (2016). Recent papers also suggest that credit spreads—the extra yield paid by bonds issued by firms with low credit ratings relative to firms with the best credit ratings—are particularly low before a financial crisis (Krishnamurthy and Muir 2017). López-Salido, Stein, and Zakrajšek (2017) provide evidence that low credit spreads by themselves forecast poor future economic performance in the United States.

[5]In the conclusion to their paper, Jiménez and others (2014) conjecture that the compositional change in the supply of credit with respect to risk is more important for financial stability than the volume of credit. Kirti (2018) shows that an increase in the share of high-yield bond issuance during a credit boom predicts lower future growth (see also Box 2.4).

[6]For a conceptual framework of financial stability monitoring, see Adrian, Covitz, and Liang (2015).



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- How does the riskiness of credit allocation relate to measures of financial conditions over time? Does it generally rise during periods of high credit growth? Is it more likely to increase when high credit growth is associated with strong risk appetite?
- To what extent does the riskiness of credit allocation help predict financial sector stress and downside risks to GDP growth? How far in advance can it predict these occurrences? Do the predictive properties of the riskiness of credit allocation reinforce those of credit growth documented in the existing literature?
- How is the dynamic of the riskiness of credit allocation affected by the regulatory, supervisory, and legal environments? What is the link between the cyclicality of the riskiness of credit allocation and common indicators of banking sector soundness?

The main findings of the chapter follow:

- Taking the riskiness of credit allocation into account helps better predict full-blown banking crises, financial sector stress, and downside risks to growth at horizons up to three years. Thus, the riskiness of credit allocation is an indicator of financial vulnerability.
- A period of high credit growth is more likely to be followed by a severe downturn over the medium term if it is accompanied by an increase in the riskiness of credit allocation. By contrast, when credit is stagnant or falling, the riskiness of credit allocation has a negligible effect on downside risks to GDP growth.
- The riskiness of credit allocation at the global level has followed a cyclical pattern over the past 25 years, has rebounded since its post-global-financial-crisis trough, and was slightly below its historical average at the end of 2016 (the latest data point).
- At the country level, the riskiness of credit allocation is more strongly associated with credit growth when lending standards are easier, when domestic financial conditions are looser, when credit spreads are lower, and when global risk appetite is higher.
- A period of credit expansion is less likely to be associated with a riskier credit allocation when macroprudential policy has been tightened, when the banking supervisor is more independent, when the government has a smaller footprint in the nonfinancial corporate sector, and when minority shareholder protection is greater.

The remainder of the chapter is organized as follows: The chapter first lays out a stylized conceptual framework for macro-financial shocks and the riskiness of credit allocation. It then describes the construction of the new measures, their evolution at the global level and in selected economies, their cyclical properties, and their relationship to various indicators of financial conditions. Next, the chapter turns to the empirical analysis of the relationship between the new indicators and future financial instability as well as downside risks to GDP growth. The last core section further explores determinants of the riskiness of credit allocation and its cyclicality, including macroprudential policies and aspects of the supervisory, legal, and institutional frameworks. The last section concludes and presents policy implications.

## The Riskiness of Credit Allocation: Conceptual Framework

The theoretical literature has identified various mechanisms through which the riskiness of credit allocation is related to financial conditions. Variations over time in the riskiness of credit allocation may happen for separate yet complementary reasons (see Figure 2.3 for a schematic representation of the main channels).

In the canonical view of the business cycle with financial frictions, the availability of credit to riskier, more vulnerable firms is procyclical, leading to a rise in the riskiness of credit allocation during economic expansions. A driver of fluctuations in the quantity and riskiness of credit is the time-varying effect of financing frictions attributable to changes in borrowers' net worth. Following a positive macroeconomic shock, or when interest rates fall, a firm's short-term prospects and its net worth—the difference between the economic value of its assets and its liabilities—increase, reducing the scope of problems related to asymmetries of information between lenders and borrowers, and allowing firms with high leverage easier access to credit markets. Conversely, following a negative shock, or when interest rates rise, firms with relatively weak balance sheets find it relatively harder to obtain credit (Bernanke and Gertler 1989; Kiyotaki and Moore 1997).[7]

[7]Various versions of this mechanism are described in the so-called financial accelerator literature. In this literature, the relaxation of the borrowing constraints applies to all firms, not only to riskier ones. However, borrowing constraints are binding only for the riskiest



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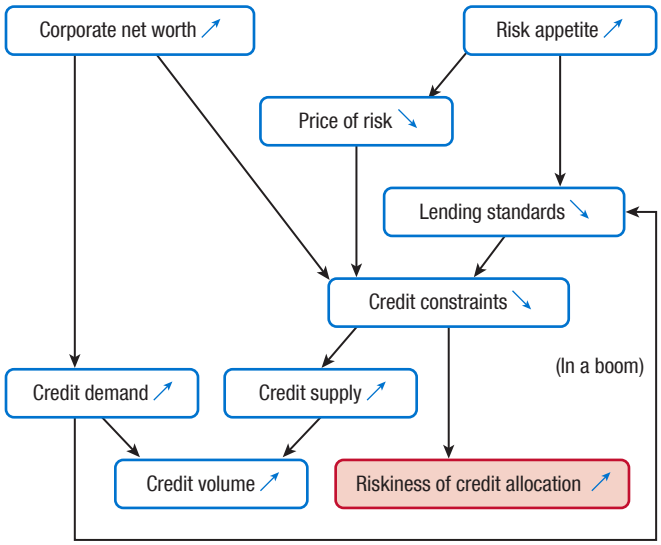
Fluctuations in credit quantity and the riskiness of credit allocation can also be driven by variations over time in investor beliefs, risk appetite, or perceptions of economic uncertainty, which directly affect credit spreads and expected volatility. In good times, those most optimistic about asset values can borrow extensively to acquire these assets, thereby pushing up asset prices. Following bad news, uncertainty and volatility rise, leading lenders to require higher margins, triggering deleveraging and fire sales (Geanakoplos 2010). To the extent that optimism is positively correlated with risk, this mechanism can also generate procyclical variations in the riskiness of credit allocation.[8] It is also possible that in good times investors form unduly optimistic beliefs about future economic prospects, leading them to extend credit to more vulnerable firms and allowing borrowers to increase their leverage excessively (Minsky 1977; Kindleberger 1978; Bordalo, Gennaioli, and Shleifer 2018). Finally, the risk appetite of financial intermediaries with long-term liabilities and short-term assets is likely to make them search for yield when monetary conditions are loose, resulting in riskier firms getting easier access to credit (Rajan 2006).

Banks' capacity and incentives to screen borrowers are likely to deteriorate in periods of significant credit expansions, reinforcing the procyclical nature of lending standards and of lending to relatively more vulnerable firms. The longer a credit expansion lasts, the lower the screening ability of the pool of loan officers becomes because of a loss of institutional memory about bad credit risks (Berger and Udell 2004). In addition, faced with the need to intermediate larger volumes of credit than usual during a credit boom, financial intermediaries do not find it profitable to properly screen borrowers or maintain lending standards (Dell'Ariccia and Marquez 2006).

Bank capital can also play an important role in determining the riskiness of credit allocation and its cyclicality through several channels. Banks gather and generate information about the creditworthiness of potential borrowers and thus can provide credit to firms that are too risky to tap financial markets directly. But banks' ability to raise funds to perform this role also depends on their own capital levels. Thus, through this channel, an increase in bank capital may lead to an expansion of credit to firms with poorer fundamentals (Holmstrom and Tirole 1997).[9] Yet the relationship between short-term interest rates, bank leverage, and bank risk taking is ambiguous in theory, because it is the result of the combination of several effects that work in opposite directions (see Dell'Ariccia, Laeven, and Marquez 2014; Dell'Ariccia, Laeven, and Suarez 2017).[10]

The balance of these mechanisms will also determine how the riskiness of credit allocation relates to future

**Figure 2.3. Key Drivers of the Riskiness of Credit Allocation**




Source: IMF staff.
Note: The diagram abstracts from the role of bank capital and leverage, feedback loops, and possible heterogeneity in credit demand.

firms. Thus, relatively riskier firms benefit disproportionately from the cyclical relaxation of these constraints in good times.

[8]Caballero and Simsek (2017) argue that the degree of optimism is a critical state variable in the economy, not only because optimism has a direct impact on asset valuations, but also because it weakens the dynamic feedback between asset prices, aggregate demand, and growth.

[9]Such an increase can, at least in the short term, be the result of a positive macroeconomic or financial shock, which strengthens the asset side of banks' balance sheets. Adrian and Shin (2014) show that the Holmstrom and Tirole (1997) model translates into a model of procyclicality.

[10]Traditional portfolio allocation models predict that a higher interest rate on safe assets leads to a reallocation from riskier securities toward safe assets (Fishburn and Porter 1976). In contrast, risk-shifting models of monetary policy predict that an increase in the interest rate that banks must pay on deposits exacerbates the agency problem associated with limited liability and increases bank risk taking, especially for poorly capitalized banks (Matutes and Vives 2000). Finally, banks may be induced to switch to riskier assets with higher expected yields when monetary easing compresses their margins by lowering the yield on their short-term assets relative to that on their long-term liabilities, especially if they are poorly capitalized (Dell'Ariccia, Laeven, and Suarez 2017).



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macro-financial stability. Directing an increased share of lending to riskier firms may be fully rational and profitable and reflect the normal functioning of a healthy financial system in some phases of the business and credit cycles, or it may reflect improvements in intermediaries' risk-management technologies. Alternatively, it may reflect poorer screening of borrowers, excessive risk taking (or neglect of risk), and misallocation of financial resources and may therefore have widespread detrimental consequences on the soundness of financial intermediaries and the economic performance of the economy down the road.[11] Furthermore, in the latter case, higher riskiness is much more a reflection of compositional shifts in lending toward riskier firms than a reflection of an aggregate buildup of leverage.

## The Riskiness of Credit Allocation and Its Evolution across Countries

A first step in the chapter's analysis is the construction of new measures capturing the riskiness of corporate credit allocation.

- The riskiness of credit allocation cannot be assessed from aggregate macroeconomic or financial data because they do not reflect the heterogeneity of firms. The chapter builds on work by Greenwood and Hanson (2013) to construct such new measures based on various indicators of firm vulnerability for a set of 55 economies (26 advanced economies and 29 emerging market economies) over the 1991–2016 period using data for listed firms.[12]
- Four firm-level vulnerability indicators are considered to construct the measures. Methodologies for assessing default risk generally rely on accounting information or on a combination of accounting and market information.[13] In the chapter, several common accounting-based ratios are used to capture borrower vulnerability: the leverage ratio, the interest coverage ratio (ICR), and the debt-to-profit ratio (or debt overhang). All three ratios have a strong monotonic relationship with credit ratings (Moody's 2006). The ICR is also sometimes used as a proxy for a credit rating (for example, Damodaran 2014). A market-based indicator of credit risk, the expected default frequency (EDF), is also used.[14]
- Starting from information on a firm-level vulnerability indicator, a raw measure is computed as the average of this indicator among firms whose debt (the sum of loans and bonds) increases the most minus the average computed among firms whose debt increases the least—or declines the most. This raw measure is then transformed into the final measure by subtracting its country-specific mean to remove any influence of the country-specific sectoral composition and to ensure both cross-country and cross-measure comparability. An increase in the measure signals that the vulnerability of firms getting relatively more credit has risen relative to the vulnerability of firms getting relatively less credit. A positive (negative) value of the measure indicates that the riskiness of credit allocation is above (below) its country sample average. Box 2.1 provides a detailed explanation of how the measure is constructed and how to interpret its magnitude.[15]

The evolution of the riskiness of credit allocation across countries suggests clear global patterns (Figure 2.4). Its dynamic at the global level is broadly the same across the four borrower vulnerability indicators used. Starting from elevated levels in the late 1990s, it fell in 2000–04 in the aftermath of the Asian and Russian crises and of the burst of the dot.com equity bubble, reached its historical low in 2004, rose steeply during 2004–08, and hit a peak at the onset

[11]In addition, excessive borrowing is a source of negative externalities (see Farhi and Werning 2016 and references therein).

[12]Data are sourced from the Worldscope database, which provides a rich set of annual financial variables for listed firms. Annex 2.1 provides details on the sample and explanations on the data cleaning process.

[13]Scoring methods are based on a small set of accounting ratios. These include the *Z*-score (Altman 1968, 2013) and the *O*-score (Ohlson 1980). Other methods add market-based variables and use more advanced statistical techniques to compute relative weights (Shumway 2001; Campbell, Hilscher, and Szilagyi 2011). Other approaches have instead focused on using Merton's (1974) option pricing formula as the basis for modeling to construct measures of expected default frequency (such as Moody's KMV model). Credit rating agencies have designed sophisticated rating methodologies that also incorporate judgment (for example, Standard and Poor's 2013).

[14]In their study of credit quality in the United States, Greenwood and Hanson (2013) focus the core of their analysis on the EDF and demonstrate the robustness of their result when using leverage or the ICR. Acharya and others (2016) measure riskiness using the ICR. Banco de España (2017) includes leverage and the ICR in its small set of indicators aimed at capturing financial soundness. See Annex 2.1 for a precise definition of the firm-level indicators used in the chapter.

[15]While it is challenging to establish a "neutral" level for the riskiness of credit allocation, its average over an extended period could be a good proxy.



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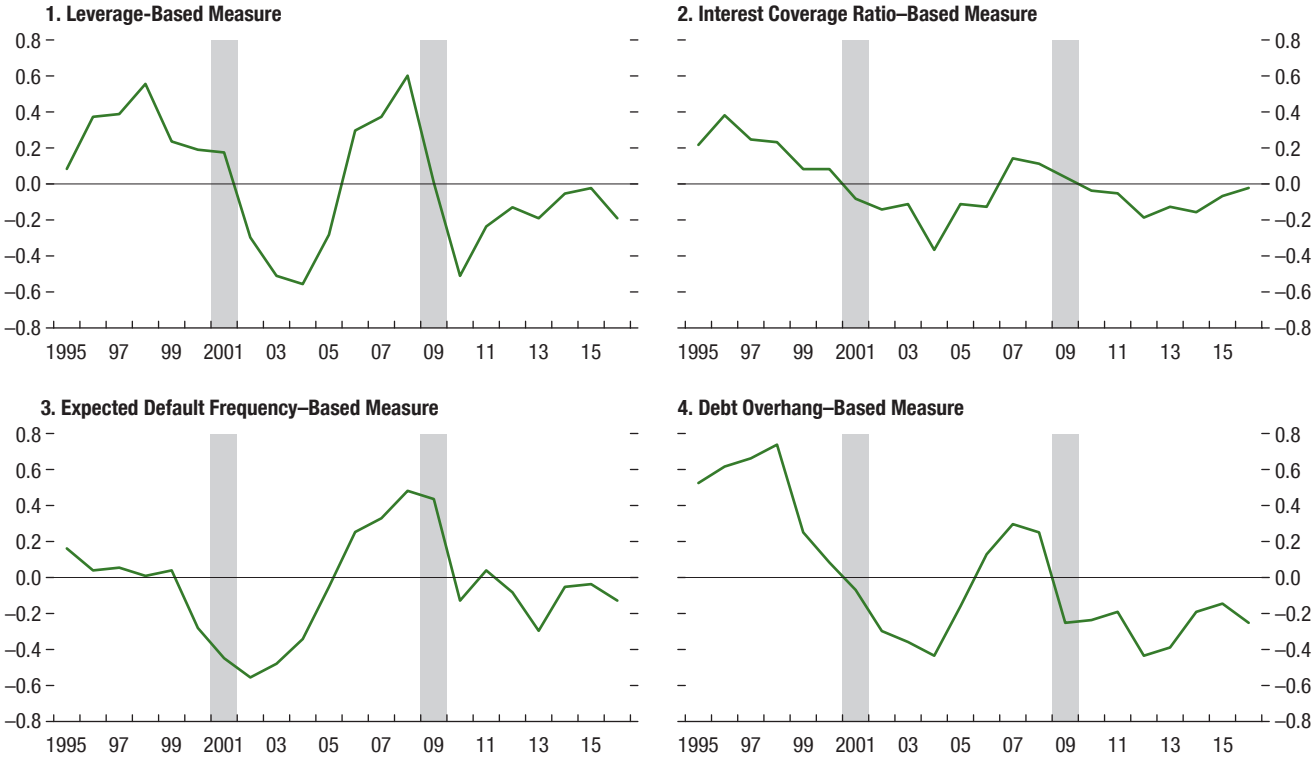
**Figure 2.4. The Riskiness of Credit Allocation Is Cyclical at the Global Level**
*(Index; global median)*




Sources: Worldscope; and IMF staff estimates.
Note: The panels show the simple two-year moving average of the median economy in the unbalanced subsample. Shaded areas indicate periods during which global real GDP growth was less than 2.5 percent. See Annex 2.1 for the list of economies included in the analysis.

of the global financial crisis. It then declined sharply over the next two years and was slightly below its precrisis level at the end of 2016, the latest available data point.

This global dynamic is reflected at the country level, with some country-specific nuances. Figure 2.5 shows the evolution of the riskiness of credit allocation in eight major economies using the leverage-based measure and the EDF-based measure during 1995–2016. The two measures display similar patterns in the first six countries, but sometimes provide contrasting signals in the last two countries, documenting a degree of complementarity across measures in some countries or periods:[16]

- The dynamics in the United States (Figure 2.5, panel 1) and Japan (Figure 2.5, panel 2) are very similar in both cyclicality and magnitude.[17] The most recent period (2014–16), however, suggests a divergence: the riskiness of credit allocation decreased in the United States to a relatively low level, while in Japan it remained at a level that is relatively high in historical perspective.[18]
- Figure 2.5, panels 3 and 4, show contrasting developments in two of the largest euro area countries. Spain (Figure 2.5, panel 3) had a credit boom

[16]While the correlation of the four measures is generally high, it is the smallest between the leverage-based and the EDF-based measures.

[17]The pattern in the United States closely resembles that in Greenwood and Hanson (2013). The decline in Japan in the first half of the 2000s is consistent with the findings of Fukuda and Nakamura (2011) in their study of zombie lending.

[18]In the United States, corporate leverage increased across the board during 2010–16. Since increases are similar across groups of firms, the relative comparisons between groups used in this chapter to track the distribution of credit allocation may not rise over this period (see Box 2.1).



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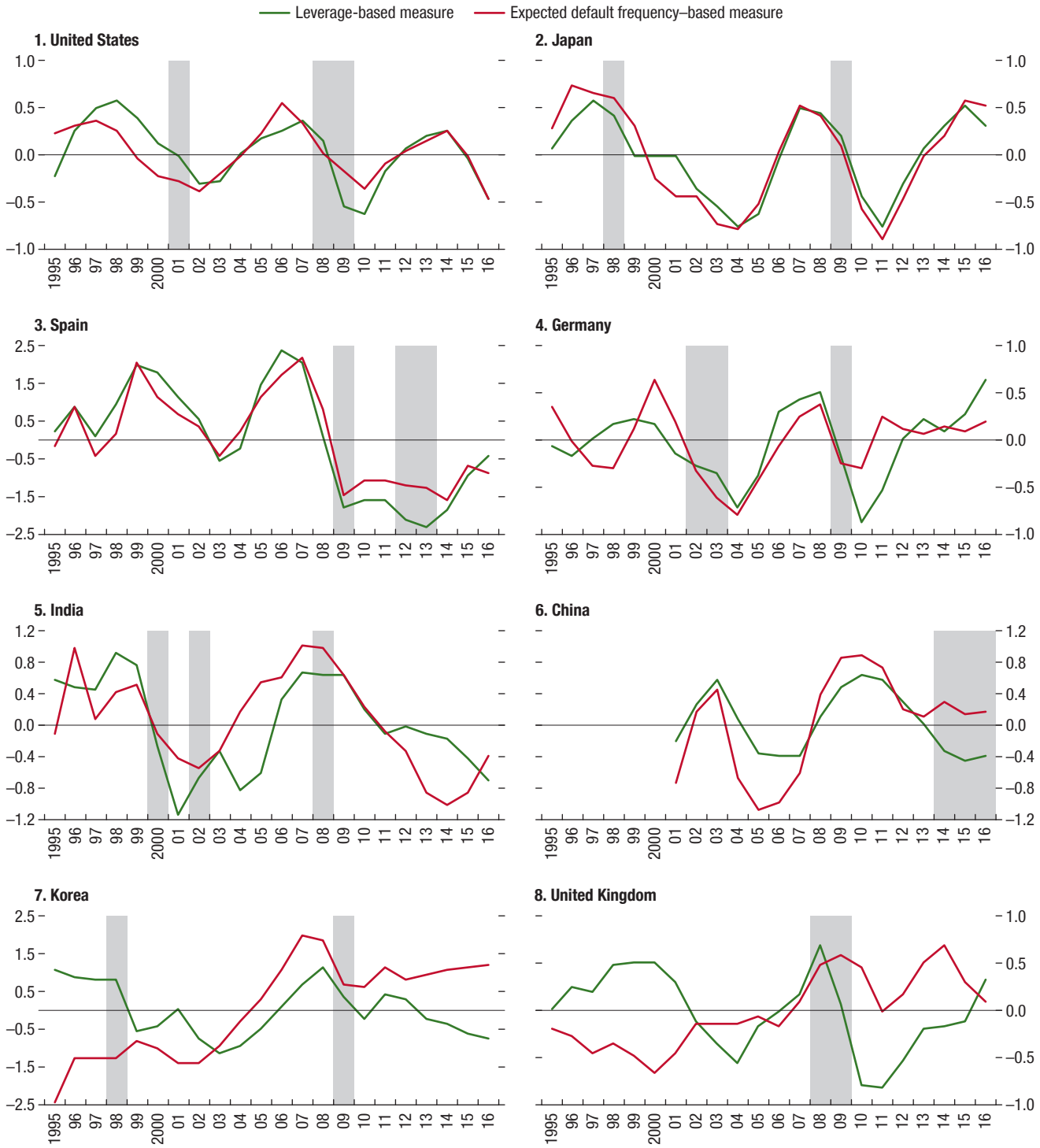
**Figure 2.5. Selected Economies: Riskiness of Credit Allocation, 1995–2016**
*(Index)*




Sources: Worldscope; and IMF staff estimates.
Note: The panels show the simple two-year moving average. Shaded areas indicate periods of growth below the 15th percentile of the growth distribution. See Box 2.1 for details on the construction of the measures.



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from the late 1990s to the mid-2000s, which was followed by a deep recession during the global financial crisis and the euro area sovereign debt crisis. Measures of the riskiness of credit allocation for this country reflect these developments quite well: a steep rise in riskiness took place in the mid- to late 1990s, leading to very high levels of riskiness until the crisis of 2008, which triggered a sudden and large fall of the indicator. This pattern is consistent with the findings of Banco de España (2017) mentioned in the introduction to the chapter. By contrast, variations in the riskiness of credit allocation in Germany (Figure 2.5, panel 4), a country that did not have a credit boom during the 20-year period, have remained within the same narrower range as the United States and Japan, and the measure has moved into positive territory in recent years, suggesting a higher level of risk taking.

- The evolution of the riskiness of credit allocation in India (Figure 2.5, panel 5) has broadly followed global patterns, and the measure was at a relatively low level in 2016. The synchronization of China (Figure 2.5, panel 6) with global developments is weaker—peaks and troughs appear to occur with a two- to three-year lag. The finding of a peak in 2009–10 is consistent with recent evidence that the implementation of a large stimulus plan beginning at the end of 2008 led to a misallocation of credit (Cong and others 2017). Most of the recent literature on credit allocation in China has focused on the link between credit and firm-level productivity of capital (or profitability) rather than firm-level credit risk. Using China as an example, Box 2.2 illustrates how a set of new profitability-based indicators, constructed similarly to the new vulnerability indicators discussed in the core of this chapter, can provide additional insights into the quality of credit allocation.
- Developments in Korea (Figure 2.5, panel 7) highlight that only the accounting-based measure indicated high riskiness before this country's crisis in the late 1990s. The EDF-based measure, constructed using equity market information, does not signal any potential problem related to the riskiness of credit allocation at that time, suggesting that equity market investors were too optimistic and that accounting-based measures better reflected fundamentals. Also, the two measures point in different directions in recent years, with the leverage-based measure at a low level at the end of 2016. As in Korea, there is a disconnect between the dynamics of the two measures for the United Kingdom (Figure 2.5, panel 8) during the 1990s and the 2010s. This disconnect could be due to the effect of the volatility of firm-level equity prices on the EDF-based measure but is a little puzzling given the depth of financial markets in that country. Nonetheless, the two measures point to rising riskiness of credit allocation before the global financial crisis in Korea and the United Kingdom.

These patterns raise several questions regarding the cyclicality of the riskiness of credit allocation. Does it systematically rise when GDP growth and credit growth are strong? If so, does this increase depend on other measures of financial conditions that can signal expansions in credit supply, such as credit spreads or a broad financial conditions index? To shed light on these questions, the econometric analysis that follows focuses on the relationship between the riskiness of credit allocation, the state of the business cycle, and financial conditions using standard cross-country panel regressions (see Annex 2.1 for data sources and Annex 2.2 for details on methodology).

Periods of faster economic and credit expansion are associated with riskier credit allocations. Regression analysis indicates that the riskiness of credit allocation is procyclical: it increases when GDP growth or changes in the domestic credit-to-GDP ratio are stronger. The first finding is consistent with standard financial accelerator mechanisms, and the second points to mechanisms in which credit supply shocks affect macro-financial outcomes through a risk-taking channel. The association of credit expansion with greater riskiness of credit allocation is statistically significant for all four measures. A one standard deviation increase in the change of the credit-to-GDP ratio (equivalent to an increase of 5.5 percentage points) is associated with an increase in the riskiness of credit allocation of 0.12–0.25 standard deviation, depending on the exact measure (Figure 2.6). Results are similar for advanced and emerging market economies, although the dispersion of the estimated relationship is larger in the latter, most likely because of their smaller sample size.

The association between larger credit expansions and riskier allocations is stronger when financial con-



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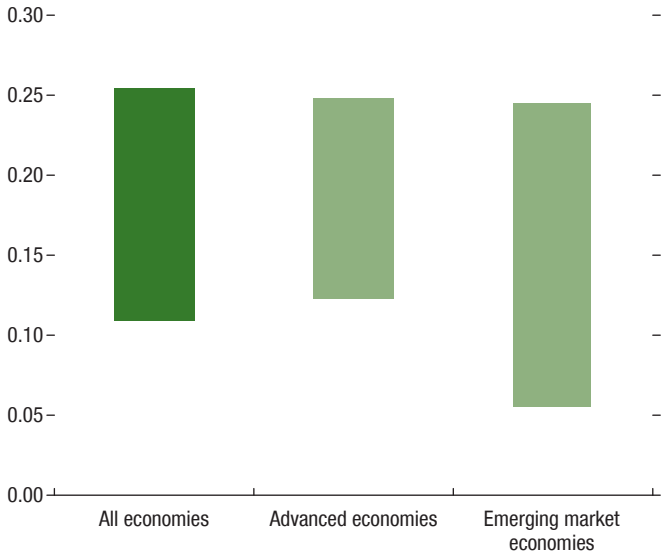
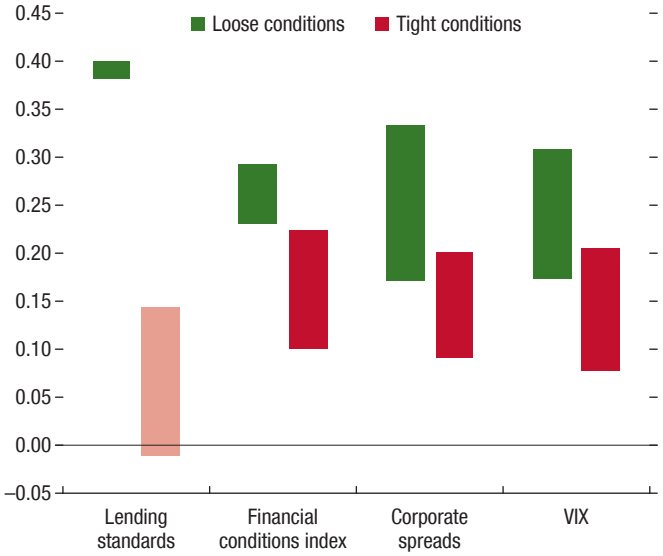
**Figure 2.6. The Riskiness of Credit Allocation Rises When a Credit Expansion Is Stronger**
*(Standard deviations of the riskiness of credit allocation)*




Sources: Worldscope; and IMF staff estimates.
Note: The figure shows the range of impact of a contemporaneous increase in the change in the credit-to-GDP ratio by one standard deviation on the four (leverage-, interest coverage ratio–, debt overhang–, and expected default frequency–based) measures of the riskiness of credit allocation. Dark-colored (light-colored) bars indicate that the effects are statistically significant at the 10 percent level or higher for four (three) measures out of four. See Annex 2.2 for details on methodology.

**Figure 2.7. The Association between the Size of a Credit Expansion and the Riskiness of Credit Allocation Is Greater When Lending Standards and Financial Conditions Are Looser**
*(Standard deviations of the riskiness of credit allocation)*




Sources: Worldscope; and IMF staff estimates.
Note: The figure shows the range of impact of a contemporaneous increase in the change in the credit-to-GDP ratio by one standard deviation on the four (leverage-, interest coverage ratio–, debt overhang–, and expected default frequency–based) measures of the riskiness of credit allocation when lending standards or financial conditions (financial conditions index, corporate spreads, and VIX) are "loose" or "tight." The level of a variable is defined as loose (tight) when it is equal to the 25th percentile (75th percentile) of its distribution. Dark-colored (light-colored) bars indicate that the effects are statistically significant at the 10 percent level or higher for four (one) measures out of four. See Annex 2.2 for details on methodology. VIX = Chicago Board Options Exchange Volatility Index.

ditions are loose. A credit expansion accompanied by loose financial conditions or loose lending standards is more likely to be driven by shifts in credit supply and higher risk appetite of financial intermediaries. Regression analysis provides evidence of such a channel: both variables amplify the cyclicality of the riskiness of credit allocation. Specific components of financial conditions appear to matter more than others. In particular, low corporate credit spreads (or high global risk appetite, proxied by the Chicago Board Options Exchange Volatility Index [VIX]) during credit expansions result in allocations that are riskier than those observed when the expansions are accompanied by high credit spreads (or low global risk appetite) (Figure 2.7). Furthermore, a higher stock market price-to-book ratio is associated with a higher level of the riskiness of credit allocation. Additional analysis studying the joint dynamics of the riskiness of credit allocation, financial conditions, credit expansions, and economic growth using a panel vector autoregression confirms these findings and shows a significant effect of financial conditions on the riskiness of credit allocation (Box 2.3).[19]

These trends and properties of the riskiness of credit allocation are generally confirmed when using a different sample that covers both listed and unlisted firms. The robustness of the results discussed above is checked by constructing similar measures using data that cover a wider universe of firms (both listed and unlisted), but for a smaller set of countries and over fewer years.[20] The similarity is very reassuring considering the significant differences in the cross-sectional coverage of the two databases.

[19]Measurement of these effects assumes that the financial conditions index responds contemporaneously to all other variables, while the riskiness of credit allocation responds with a lag.

[20]This robustness analysis is based on the Orbis database and covers only 50 economies from 2000. See Annex 2.1 for details.



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**Figure 2.8. The Riskiness of Credit Allocation Rises to a High Level before a Financial Crisis, and Falls to a Low Level Thereafter**
*(Index; median across all crisis episodes; 11-year window)*

Sources: Laeven and Valencia (forthcoming); Worldscope; and IMF staff estimates.
Note: Systemic banking crises are defined as in Laeven and Valencia (forthcoming). The crisis occurs at time 0. Data are demeaned at the country level. The panels show the median across all crisis countries in a balanced panel. The riskiness measures are constructed as explained in Box 2.1. Median leverage (EDF) refers to the median of the firm-level leverage (EDF) variable. Median ICR refers to the negative of the median of the firm-level ICR. Median debt overhang refers to the negative of the median of the EBITDA-to-debt ratio. EBITDA = earnings before interest payments, taxes, depreciation, and amortization; EDF = expected default frequency; ICR = interest coverage ratio.

## The Riskiness of Credit Allocation and Macro-Financial Stability

Does the riskiness of credit allocation help predict episodes of financial instability and downside risks to growth? To answer these questions, the econometric analysis builds on the existing empirical literature on the determinants of risks to the financial sector and real activity, and augments the literature's specifications with the riskiness of credit allocation. Specifically, using cross-country regressions, this section analyzes whether this new measure constitutes an early warning indicator of a systemic financial crisis and of banking sector stress, and whether it is a predictor of low realizations of future GDP growth.[21] Information on the econometric framework is provided in Annex 2.3.

The riskiness of credit allocation has a very clear inverted-U shape around systemic financial crisis episodes. The dynamic of the riskiness of credit allocation in the period at the start of a crisis is unambiguous: it rises gradually during the five years preceding the crisis, reaches a relatively high level, and then falls following the onset of the crisis. This is true regardless of the firm-level indicator chosen to construct the riskiness measure (Figure 2.8). Interestingly, the riskiness of credit allocation signals a forthcoming crisis much better than

[21]The results described in this section are robust to the inclusion of standard corporate vulnerability indicators, such as median firm leverage, and to the inclusion of a measure of the high-yield share of bond issuance. The results, however, are weaker if the post-2008 period is excluded from the sample. The analysis of predictive performance is in-sample (all available observations are used to estimate the models).



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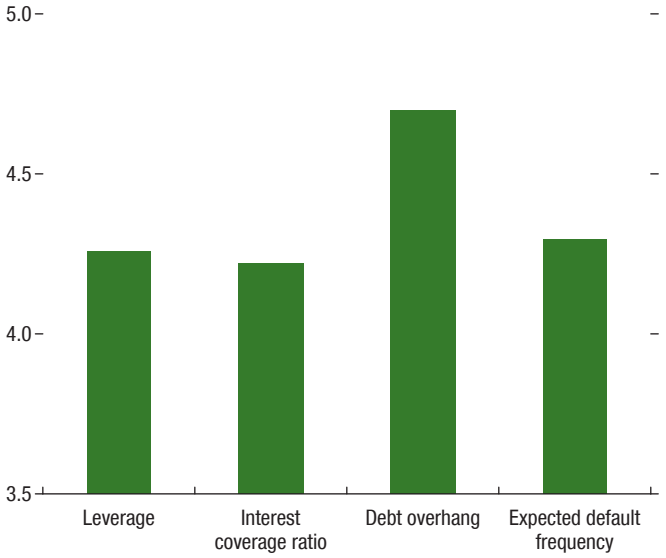
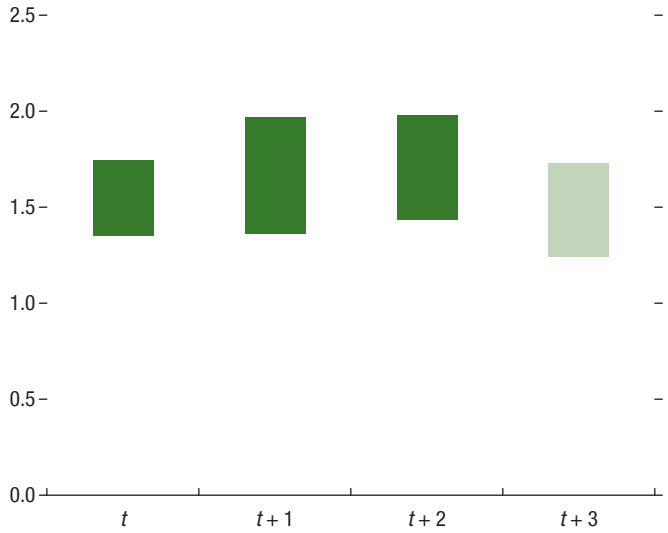
**Figure 2.9. Higher Riskiness of Credit Allocation Signals Greater Risk of a Systemic Banking Crisis**
*(Proportional increase in the odds of a banking crisis)*




Source: IMF staff estimates.
Note: The figure shows the multiplicative effect of a one standard deviation increase in the riskiness of credit allocation on the odds of a systemic banking crisis, as defined in Laeven and Valencia (forthcoming). See Annex 2.3 for methodology.

**Figure 2.10. Higher Riskiness of Credit Allocation Signals Greater Risk of Banking Sector Stress**
*(Proportional increase in the odds of banking sector stress)*




Source: IMF staff estimates.
Note: The figure shows the multiplicative effect of a one standard deviation increase of the riskiness of credit allocation on the odds of bank equity stress in a time window from $t$ to $t + h$, in which $h = 0, 1, 2, 3$. Bank equity stress is defined as annual bank equity excess return over the short-term government bond yield that is lower than the country-specific mean by at least one standard deviation. Each bar shows the minimum and maximum effects across the four (leverage-, interest coverage ratio–, debt overhang–, and expected default frequency–based) measures. Dark-colored (light-colored) bars indicate that the effects are statistically significant at the 10 percent level or higher for four (two) measures out of four. See Annex 2.3 for methodology.

the underlying conventional corporate vulnerability indicators when considered individually (see the blue lines in Figure 2.8): these more traditional indicators pick up significantly only when the crisis has already struck.

Regression analysis confirms that a greater riskiness of credit allocation increases the odds of a future systemic banking crisis (Figure 2.9). The effect in the crisis model is measured in addition to the effect of the change in credit volumes, which has been emphasized in the literature, and the effect of financial conditions. Thus, for a given size of credit expansion, a greater riskiness of credit allocation implies a higher probability of a financial crisis. A one standard deviation increase in the riskiness measure increases the odds of a crisis by a factor of about four.[22] The gain in explanatory power when adding the riskiness variable, between 11 and 25 percentage points, is also reasonably large.

The riskiness of credit allocation also helps forecast banking sector equity stress up to three years in advance. Because the identification and timing of the occurrence of a systemic financial crisis are somewhat subjective and crises are rare events, it is useful to seek confirmation of the results obtained in a crisis model by using a banking sector equity stress model for which the number of events is larger and the timing is completely objective.[23] Regression analysis shows that the riskiness of credit allocation adds predictive power to such a model for any horizon from zero to three years (Figure 2.10). A one standard deviation increase in the riskiness of credit allocation increases the odds by a factor of 1.3 to 2, making banking sector stress up

[22]The odds of a crisis refer to the ratio of the probability of observing a crisis to the probability of not observing it. For instance, in the sample used in the estimation, the probability of observing a crisis is about 5 percent. Thus, the probability of not observing a crisis is about 95 percent, and the odds of a crisis are 5.3 percent (100*5/95). A fourfold increase from this level would raise the odds to 21 percent.

[23]A banking sector equity stress episode occurs when the annual excess equity return of the banking sector is lower than the country-specific mean by at least one standard deviation. Such episodes are relevant for macro-financial stability because they are typically followed by significant negative credit supply shocks, which, in turn, can translate into declines in economic activity and employment.



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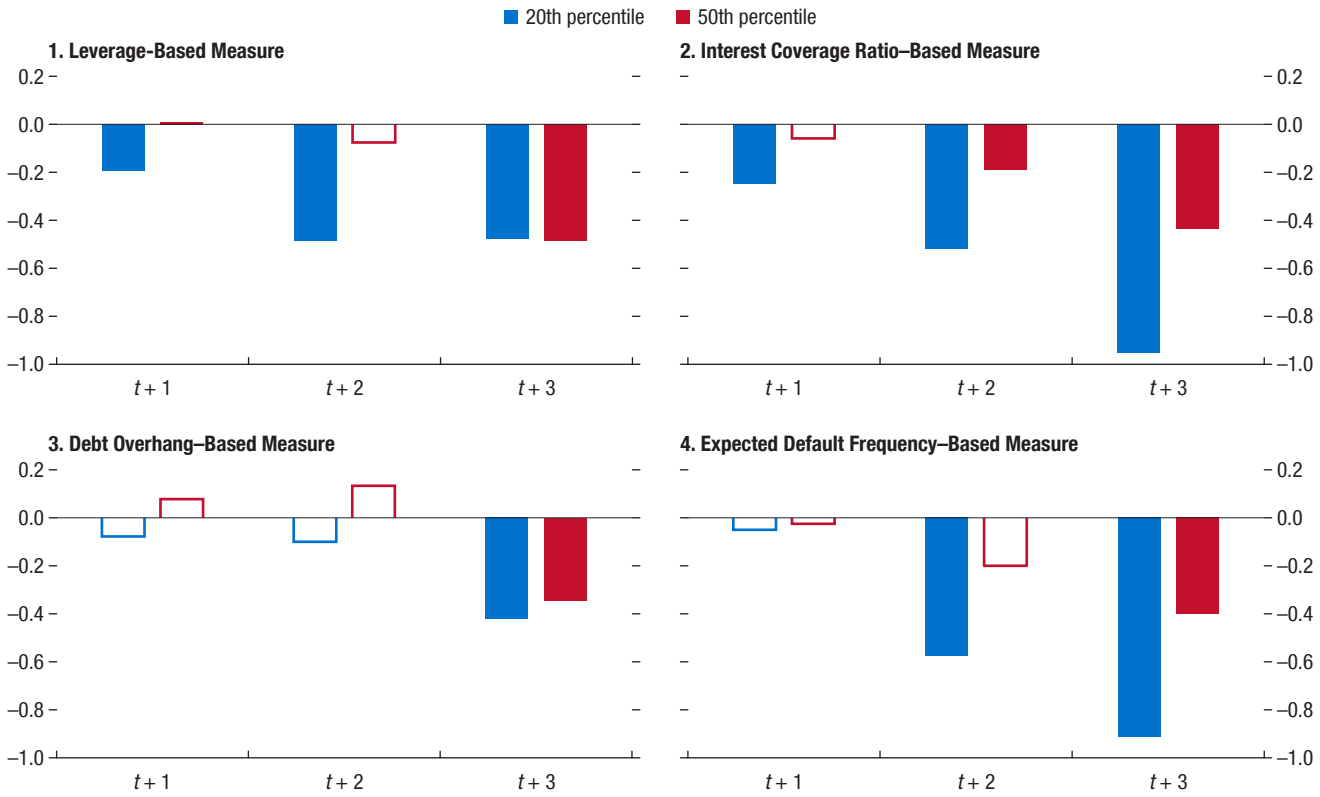
**Figure 2.11. Higher Riskiness of Credit Allocation Signals Higher Downside Risks to GDP Growth**
*(Percentage points of GDP growth)*




Source: IMF staff estimates.
Note: The panels show the impact of a one unit increase in the riskiness of credit allocation on the 20th and 50th percentiles of the distribution of future cumulative GDP growth from year $t$ to year $t + h$, with $h = 1, 2, 3$. Solid colored bars indicate that the effects are statistically significant at the 10 percent level or higher. An empty bar indicates absence of statistical significance. See Annex 2.3 for methodology.

to two times more likely, depending on the measure and the horizon.

A riskier credit allocation signals downside risks to growth in the short to medium term. The analysis examines the predictive power of the riskiness of credit allocation on two percentiles (20th and 50th) of cumulative real GDP growth one to three years into the future.[24] The riskiness of credit allocation is strongly related to the median and left tail of the growth distribution over all horizons. In line with the findings described previously on banking sector stress risk, the new measure provides information on downside risks to growth over the short to medium term (Figure 2.11). These effects are in addition to those of changes in the credit-to-GDP ratio and financial conditions. The effect on the downside risks to growth is significant when measures of the riskiness of credit allocation are constructed based on a sample that covers unlisted as well as listed firms.

The effects of a riskier credit allocation complement those of credit expansions on growth-at-risk over the medium term. One might expect that credit booms that are accompanied by a rise in the riskiness of credit allocation pose stronger downside risks to growth than those that are not. The analysis indicates that they do. This simultaneous rise in credit volumes and riskiness signals elevated risks to growth two and three years ahead. This finding is consistent with recent evidence showing that an increase in the high-yield share of bond issuance in advanced economies during credit booms is associated with lower future mean GDP growth (see Box 2.4 and Kirti 2018).

[24]The approach builds on Adrian, Boyarchenko, and Giannone (2016) and Chapter 3 of the October 2017 GFSR.



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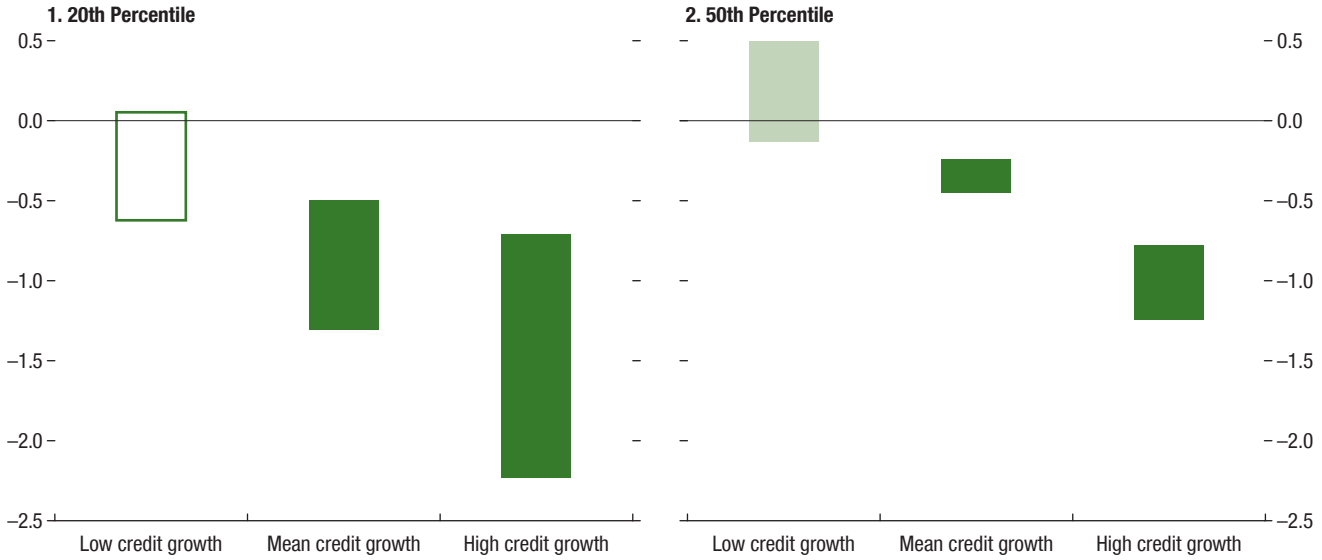
**Figure 2.12. The Association of the Riskiness of Credit Allocation with Downside Risks to GDP Growth Depends on the Size of Credit Expansion**
*(Percentage points of GDP growth)*




Source: IMF staff estimates.
Note: The panels show the range of impact of a one unit increase in the riskiness of credit allocation on the 20th and 50th percentiles of the distribution of future cumulative GDP growth from year *t* to year *t* + 3 across the four (leverage-, interest coverage ratio–, debt overhang–, and expected default frequency–based) measures. The impact is conditional on high, mean, and low credit growth. High (low) credit growth is defined as one standard deviation above (below) mean credit growth. Dark-colored (light-colored) bars indicate that the effects are statistically significant at the 10 percent level or higher for four (two) out of four measures. An empty bar indicates no statistically significant impact of any of the four measures. Further details on the methodology are in Annex 2.3.

Conversely, during credit contractions or relatively soft credit expansions, a higher riskiness of credit allocation does not increase downside risks to future GDP growth. When the change in the credit-to-GDP ratio is well below its historical average—for example, in the aftermath of a recession or a creditless recovery—the association between higher riskiness of credit allocation and downside risks to GDP growth is weaker, and its sign can reverse if the credit expansion is sufficiently weak. Figure 2.12 shows that at a three-year horizon, when the change in the credit-to-GDP ratio is low by historical standards, an increase in risk taking has no significant impact on downside risks to growth. This finding indicates that a rise in the riskiness of credit allocation is harmless in some phases of the cycle.

## The Role of Policy and Structural Factors

Having established that the riskiness of credit allocation is a vulnerability indicator, the chapter now turns to an analysis of more structural determinants of its level and cyclicality. Three sets of variables—banking sector soundness, macroprudential policies, and selected aspects of the supervisory, legal, and institutional frameworks—come into play. The determinants of the level and credit cyclicality of the riskiness of credit allocation vary somewhat depending on which underlying firm-level vulnerability indicator is used. The analysis that follows focuses on determinants whose robustness is apparent across all four measures.[25] The quantitative effects of these structural determinants on the cyclicality of the riskiness of credit allocation are summarized in Figure 2.13.

Bank capital appears to have little significant effect on the cyclicality of the riskiness of credit allocation. Recent empirical studies on how bank capital

[25]The effect on the credit cyclicality of the riskiness of credit allocation is estimated through an interactive term between the policy or institutional variable and the change in the credit-to-GDP ratio. Variables capturing financial sector depth and financial openness are not found to have any robust effect across measures and are therefore omitted from the discussion. A finding is defined as robust when the regression coefficient is significant for at least two of the four measures and when the sign is identical across all four measures. Consistency of the signs of the effects in level and in interaction is also required. See Annex 2.1 for definitions of the variables and Annex 2.2 for methodology.



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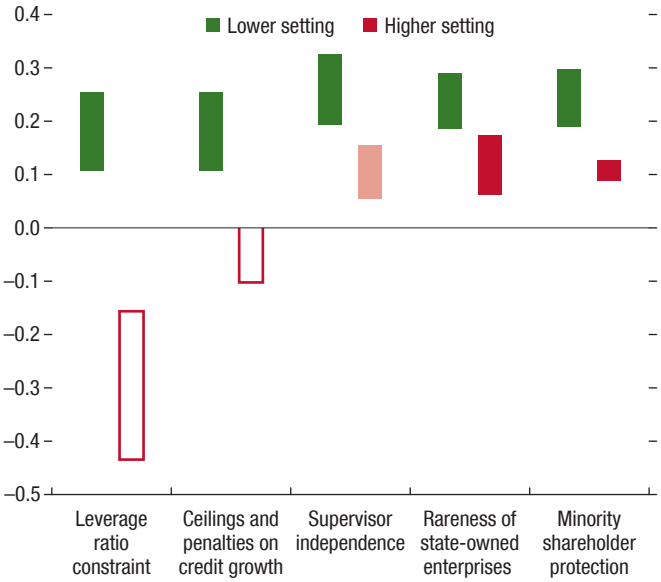
affects the relationship between financial conditions and credit flows to risky firms provide contrasting results.[26] This literature indicates that the link between credit conditions, firm riskiness, and bank risk taking is likely to depend on country circumstances. Therefore, it may not be surprising that only suggestive evidence is found that conventional measures of banking system capitalization or leverage matter for the cyclicality of the riskiness of credit allocation: greater buffers are generally associated with greater cyclicality of the riskiness of credit allocation, but not in a robust manner.

However, macroprudential policy tightening reduces the cyclicality of the new vulnerability measure. An increase in regulatory capital requirements curtails domestic banks' risk-bearing capacity by reducing the availability of free capital that banks can use to provide loans. Regression analysis confirms that tightening of the macroprudential policy stance dampens the increase in the riskiness of credit allocation associated with faster credit growth. The result holds for changes in minimum leverage ratio and changes in ceilings and penalties related to credit growth.[27] Increases in capital conservation buffers also reduce the level of the riskiness of credit allocation. The capital conservation buffer and the minimum leverage ratio are policy instruments that were introduced as part of the regulatory changes following the global financial crisis. The findings of the chapter thus suggest that postcrisis regulatory tightening has had an impact on the evolution of the riskiness of credit allocation and has played a role in limiting the size of the rebound in the measure documented in Figure 2.4.[28]

Greater supervisory independence is associated with reduced cyclicality of the riskiness of credit allocation. A more independent supervisor is likely to be more empowered to exert its oversight throughout the financial cycle. Accordingly, when the supervisory authority enjoys greater legal protection from the banking industry, the quality of credit allocation is less sensitive to domestic credit growth.

**Figure 2.13. The Association of a Credit Expansion with the Riskiness of Credit Allocation Depends on Policy and Institutional Settings**
*(Standard deviations of the riskiness of credit allocation)*




Sources: Worldscope; and IMF staff estimates.
Note: The figure shows the range of impact of a contemporaneous increase in the change in the credit-to-GDP ratio by one standard deviation on the four (leverage-, interest coverage ratio–, debt overhang–, and expected default frequency–based) measures of the riskiness of credit allocation when policy and institutional settings (leverage ratio constraint, ceiling and penalties on bank credit growth, independence of supervisory authority from banks, rareness of state-owned enterprises, and minority shareholder protection) are at a "lower" setting or a "higher" setting. A lower (higher) setting for macroprudential policy means no policy change (one tightening action during the year). A lower (higher) setting for the other variables means a level equal to the 25th percentile (75th percentile) of their distribution. Dark-colored (light-colored) bars indicate that the effects are statistically significant at the 10 percent level or higher for four (three) measures out of four. Empty bars indicate that the effects are statistically insignificant at the 10 percent level for the four measures. See Annex 2.2 for details on the methodology.

[26]On the one hand, Jiménez and others (2014) show that in Spain during 2002–08 a lower overnight interest rate induced relatively less capitalized banks to grant more loan applications and to commit larger loan volumes to risky firms. Acharya and others (2016) find that, in contrast with relatively highly capitalized banks, relatively less capitalized banks in the euro area increased their lending to very risky firms following the European Central Bank's announcement in 2012 that it stood ready to conduct Outright Monetary Transactions. On the other hand, Dell'Ariccia, Laeven, and Suarez (2017) find evidence consistent with traditional risk shifting by less capitalized banks, while Schivardi, Sette, and Tabellini (2017) find that undercapitalized banks were less likely to cut credit to zombie firms during the recent crisis years in Italy.

[27]Tightening of minimum capital requirements is found to be associated with a nonrobust increase in the riskiness of credit allocation, suggesting reverse causality. Loan provisioning requirements are not found to have any significant effects, either in level or when interacted with the change in the credit-to-GDP ratio. Jiménez and others (2017) and Uluc and Wieladek (2017) provide evidence that tightening capital or provisioning requirements can result in greater risk taking by banks.

[28]Only one change in minimum leverage requirements was implemented before the global financial crisis in the sample. Changes to ceilings and penalties related to credit growth occur in only four countries in the sample.



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The sensitivity of the riskiness of credit allocation to domestic credit growth also responds to some aspects of the institutional and legal environments. A smaller government footprint in the nonfinancial corporate sector reduces the cyclicality of the new measure. Greater protection of minority shareholders has an effect in the same direction. This latter finding highlights the importance of sound corporate governance frameworks for financial stability, as documented in Chapter 3 of the October 2016 GFSR.

## Conclusions and Policy Implications

A riskier credit allocation is a source of vulnerability that may threaten financial stability. Policymakers and supervisors should pay close attention to its evolution. Both the volume and allocation of credit matter for financial stability. A period of high credit growth is more likely to be followed by a severe downturn or financial sector stress over the medium term if it is accompanied by an increase in the riskiness of credit allocation. Thus, while policymakers should be alert to periods of rapid credit expansion or increasing riskiness of credit allocation, they should pay special attention when they take place together. Supervisors should monitor credit origination standards and the riskiness of credit allocation on a continuous basis, intensify supervisory scrutiny during episodes of large credit expansion and loose financial conditions, and require corrective action if needed.[29]

The riskiness of credit allocation can be measured using firm-level financial statement data that are available in many countries and used for financial surveillance. The measures of the riskiness of credit allocation constructed for this chapter exploit cross-sectional information on firm-level net debt issuance and firm-level vulnerability. Several firm-level indicators of vulnerability (including leverage, interest coverage ratio, debt overhang, and expected default frequency) can be used to construct a measure. Each is suitable to specific country and data environments. The measures are simple to compute and can be readily used for macro-financial surveillance. Of course, the usefulness of these indicators for surveillance purposes will depend on the speed with which the underlying data become available. It is important, therefore, that policymakers engage in efforts to collect these granular data as swiftly as possible.[30]

Various institutional and policy settings may help policymakers tame the increase in the riskiness of credit allocation that occurs during large credit expansions. A more independent banking supervisor can better exert control over lending and origination standards during good times, when risks appear contained. Sounder corporate governance standards—which may reduce the ability of vulnerable firms' managers to "gamble for resurrection" or engage in pet projects—should be promoted. And several macroprudential policies, such as the tightening of some regulatory capital requirements, may reduce the ability or willingness of banks to lend to vulnerable firms.[31] Furthermore, policymakers could also address the potential consequences of an increase in the riskiness of credit allocation during a period of strong credit growth through increased provisioning requirements and thicker countercyclical capital buffers. The calibration of capital buffers should arguably consider the riskiness of credit allocation.[32] Finally, policies aimed at directing credit to certain firms or sectors of the economy without due consideration of underlying credit risk should be discouraged in periods of strong credit growth.

The riskiness of credit allocation at the global level has rebounded since its post-global-financial-crisis trough and was back to its historical average at the end of 2016. The relatively mild credit expansion in recent years, combined with postcrisis regulatory tightening, contributed to a softer rebound in the riskiness of credit allocation than might be expected given the very loose financial conditions. However, global patterns hide relevant country-level heterogeneity, and the rise of the riskiness of credit allocation in certain

[29]In periods when credit is stagnant or falling, a higher riskiness of credit allocation is less of a vulnerability.

[30]Financial statement data for domestically listed firms is often available to policymakers quarterly or semiannually. Therefore, policymakers in many countries should be able to easily construct the measures introduced in the chapter for their own country with shorter lags and at higher frequency than those reported in the chapter based on internationally comparable data.

[31]The evidence provided in the chapter is tentative. Further research needs to be performed to better understand the effect of macroprudential policy on the riskiness of credit allocation.

[32]Exploring issues related to calibration and timing of macroprudential policy actions as well as associated GDP growth trade-offs are, of course, essential and should be concrete next steps in the analysis. In particular, delving into the role thicker capital buffers could play in improving macro-financial outcomes following a rise in the riskiness of credit allocation to a high level would seem warranted.



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countries has been more pronounced. As financial conditions loosened further in 2017, the riskiness of credit allocation might have continued to rise, which warrants close monitoring and heightened vigilance. Furthermore, relatively low credit allocation riskiness is not inconsistent with a large increase in conventional corporate vulnerability indicators, such as average leverage, as has been observed in some major economies in recent years. Finally, while this chapter focuses on the corporate sector, the riskiness of credit allocation to households may also be relevant and may not necessarily follow the same patterns. Monitoring this dimension of credit allocation is difficult, especially for a broad set of countries, but evidence from selected household surveys reported in the October 2017 GFSR suggests that the indebtedness of lower-income, more vulnerable households has increased in recent years in various countries.



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## Box 2.1. Measuring the Riskiness of Credit Allocation

The chapter measures the riskiness of credit allocation using the approach proposed by Greenwood and Hanson (2013). The measure is constructed for four different firm-level vulnerability indicators—leverage (total debt to total assets), debt overhang (total debt to earnings before interest, taxes, depreciation, and amortization [EBITDA]), interest coverage ratio (ICR; EBITDA to interest expenses), and expected default frequency.

For each firm-level vulnerability indicator, the measure is built as follows: first, for every year each firm is assigned the value (from 1 to 10) of its decile in the distribution of the indicator in the country where it is located. A higher decile represents a larger value of the underlying vulnerability. Second, firms are similarly sorted by the changes in net debt to lagged total assets into five equal-size bins. Firms in the bin with the largest increases in debt are called "top issuers," and firms in the bin with the largest decreases in debt are the "bottom issuers." Finally, the measure is computed as the difference between the average vulnerability decile for the top issuers and the corresponding average for the bottom issuers.

Changes in the measure over time help answer the following question: what is the evolution of the vulnerability profile of firms that are accumulating debt the fastest relative to that of firms that are reducing debt the fastest? The sign of the measure for some indicators is adjusted so that it rises when the vulnerability of firms whose total debt issuance is the largest is increasing.[1] Figure 2.1.1 summarizes this computation process graphically.

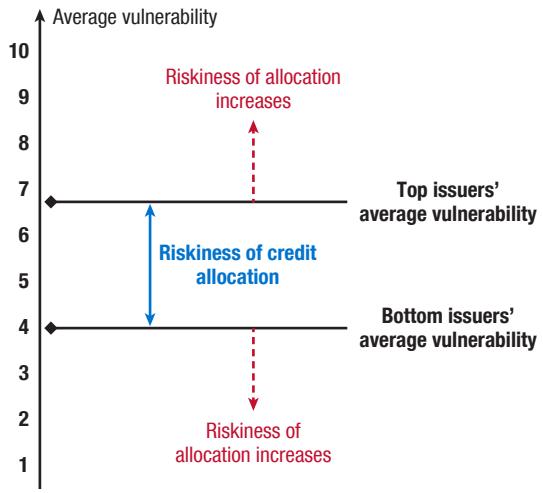
An example might be useful to provide a better understanding of the measure. Suppose that firm leverage increases by 5 percentage points for all firms and that firm-level issuance increases in equal proportion. Mean leverage will increase by 5 percentage points, but the measure of allocation riskiness will not change. Conversely, if leverage increases by 5 percentage points for top issuers, decreases by 5 percentage points for bottom issuers and remains unchanged for all other firms, mean leverage will not change, but the measure of allocation riskiness will rise.

Because it abstracts from changes in the mean and shape of the distribution of the vulnerability indicator, only the ranking of a firm in the distribution of that indicator matters. The measure is computed for all country-year pairs that meet minimum sample size requirements (see Annex 2.1). It reflects the broadest possible measure of debt (notably, it includes both loan and bond financing) and is therefore not affected by secular shifts in the relative size of bond and loan markets. It also reflects the continuous nature of firm vulnerability and default risk.

Using deciles rather than the raw values of a vulnerability indicator provides several advantages: it minimizes the influence of outliers, avoids the possibility of picking up secular trends, makes the comparison across measures based on different indicators straightforward, and provides a way to normalize the measure across countries. A downside of transforming into deciles is that information about changes in the cross-sectional dispersion of the indicator is lost.

Figure 2.1.2 presents information on the distribution of the four measures, which helps give a sense of their magnitude in the sample. Because the focus of the chapter is on the dynamics of the riskiness of credit allocation within countries and not on its variation across countries, the measures are demeaned at

### Figure 2.1.1. Measuring the Riskiness of Credit Allocation




Source: IMF staff.
Note: Top (bottom) issuers are firms in the top (bottom) quintile of the distribution of the ratio of change in net debt to lagged total assets. A firm's vulnerability is measured by its decile in the distribution of a vulnerability indicator (for example, expected default frequency).

This box was prepared by Jérôme Vandenbussche.

[1]For debt overhang, the deciles of EBITDA to debt (instead of debt to EBITDA) are used to avoid classifying firms with negative earnings as low-vulnerability firms.



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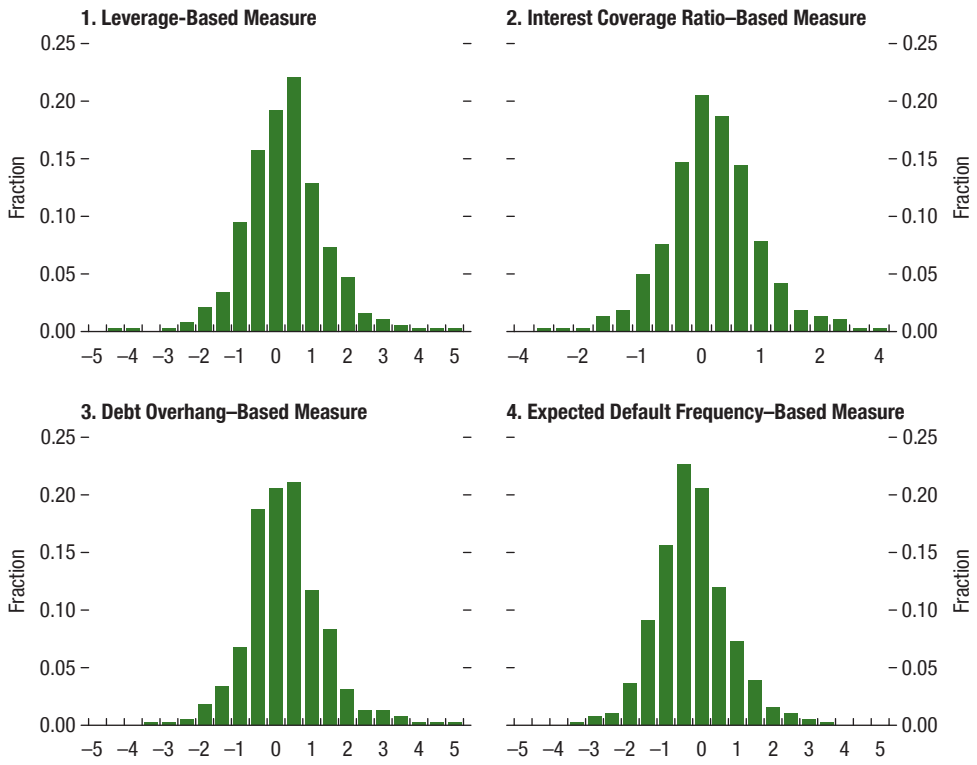
## Box 2.1 *(continued)*

**Figure 2.1.2. Histograms of Measures of the Riskiness of Credit Allocation**




Sources: Worldscope; and IMF staff estimates.
Note: The panel covers 55 economies for the period 1991–2016. Data are demeaned at the country level. The value of the riskiness of credit allocation is shown on the *x*-axis.

the country level to construct the histograms shown in the figure and in the analysis. Differences in the average value of the indicator across countries may reflect differences in the industrial composition of their corporate sectors, so these differences cannot be interpreted to mean that some countries have riskier credit allocations.[2] Their distributions have the shape of a bell curve and have a standard deviation of about one.

[2]The long-term average of the measure in each country could also be interpreted as representing the neutral allocation of credit in the absence of cyclical fluctuations.



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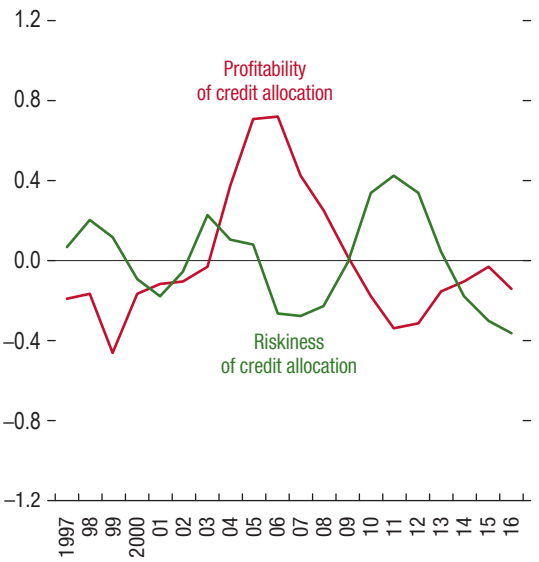
## Box 2.2. Credit Allocation in China: Is Credit Flowing to the Most Profitable Firms?

Because nonfinancial corporate debt in China has continued to expand at a brisk pace, understanding how credit has been allocated may help assess the extent to which vulnerabilities are building.[1] Concerns regarding credit allocation and related medium-term macro-financial risks in China have recently focused on productivity and profitability rather than on credit risk because of the strong presence of the state in the corporate and financial sectors and the associated risk transfers to the sovereign (Song and Xiong 2018; Cong and others 2017). This box constructs a new measure of credit allocation quality that compares the profitability of firms whose credit is growing the fastest to the profitability of firms whose credit is growing the slowest—henceforth, the profitability of credit allocation—in the same way as described in Box 2.1 to evaluate these concerns.[2,3]

Although the riskiness of credit allocation has markedly declined in China since 2012, the profitability of credit allocation has experienced only a mild recovery and remained relatively low at the end of 2016 (Figure 2.2.1). The profitability of credit allocation rose significantly in the early 2000s following the reforms to state-owned enterprises (SOEs) in the 1990s, but it started declining just before the global financial crisis along with an acceleration in the credit-to-GDP ratio. This indicator continued declining during and after the global financial crisis as a large stimulus plan was put in place in 2009–10. The riskiness of credit allocation also started climbing in that period, but declined significantly after 2011–12, while the profitability of credit allocation experienced only a mild recovery and remains low by historical standards.

The decline in the profitability of credit allocation over the past decade has been stronger among SOEs and firms in traditional sectors. SOEs have drawn attention for their relatively high share of credit flows in recent years (IMF 2017a), their role as policy tools for achieving growth targets and development goals (Maliszewski and others 2016; Song and Xiong 2018), and their low relative profitability (Dollar and Wei 2007). From 2007 to 2011, the decline in the profitability of credit allocation took place both within the universe of SOEs and within the universe of private firms. However, while the decline has continued since then within the group of SOEs, the profitability of credit allocation has improved among private firms (Figure 2.2.2, panel 1). Furthermore, within some sectors considered to be the new engines of Chinese growth (IMF 2017b) the profitability of credit allocation has stabilized or improved over the past 10 years. This is in contrast with more traditional sectors in which a sharp fall has taken place. These sectors used to play a key role as China's drivers of economic growth and have the most severe overcapacity issues and contain a large share of distressed, or

**Figure 2.2.1. China: Profitability of Credit Allocation, 1997–2016**
*(Index)*




Sources: WIND data; and IMF staff estimates.
Note: Data are demeaned and shown as simple three-year moving averages. The riskiness of credit allocation is based on leverage data. See Annex 2.1 for definition of the variables.

This box was prepared by Qianying Chen and Peichu Xie, with assistance from Juno Xinze Yao.

[1]For concerns about the expansion of credit in China, see IMF (2017a, 2017b). The outstanding stock of corporate debt in China reached about 163 percent of GDP at the end of 2017.

[2]The credit risk dimension of the quality of credit allocation in China may also have more implications for medium-term growth and the fiscal sector than for short-term financial stability (Song and Xiong 2018). The literature is typically focused on the share of credit to firms with public ownership or with relatively poor fundamentals in total credit (Lam and others 2017).

[3]See Annex 2.1 for details on data sources.



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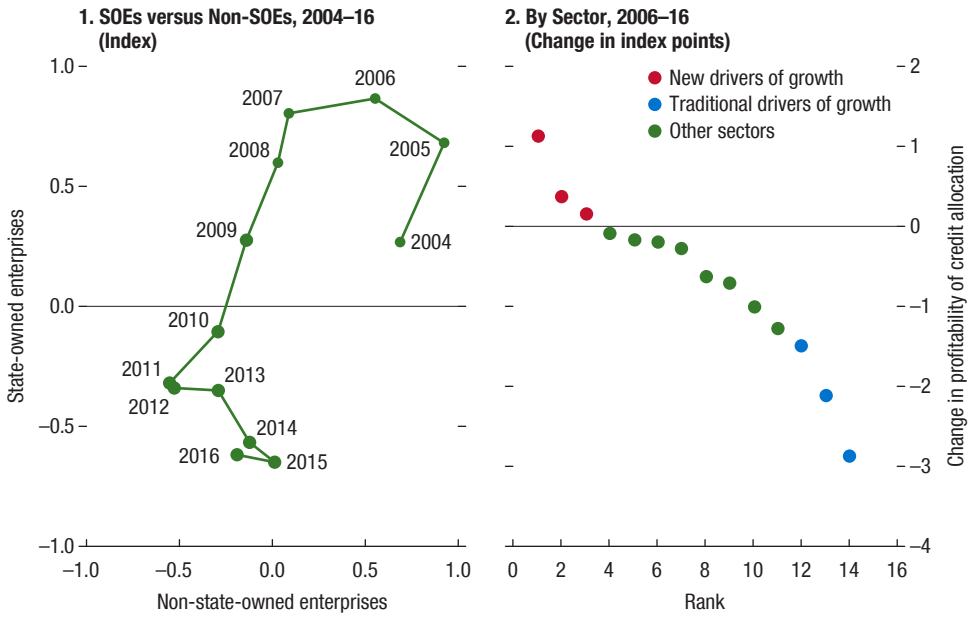
## Box 2.2 *(continued)*

**Figure 2.2.2. China: Profitability of Credit Allocation, by Ownership and Sector**




Sources: WIND data; and IMF staff estimates.
Note: Data are demeaned and shown as a simple three-year moving average. "New drivers" refer to sectors identified as the new drivers of growth (IMF 2017a). These sectors are information and communication technology (ICT), technology hardware and equipment, health care equipment and services, pharmaceuticals, biotechnology, and life sciences. Traditional drivers are automobiles and components, energy, and materials. Other sectors are transportation, retail, capital goods, media, software and services, consumer goods and services, real estate, and utilities. The simple three-year moving average of the indicator is used to compute the change between 2006 and 2016. To have at least 40 firms for each industry in 2006, the one-year moving average is used for the ICT sector, and the two-year moving average is used for the energy, media, and software and services sectors. See Annex 2.1 for variable definitions. SOEs = state-owned enterprises.

"zombie" firms (Lam and others 2017). The quality of credit allocation within other industries has also declined since 2006, but to a much lesser extent (Figure 2.2.2, panel 2). These findings complement and are consistent with those of Lam and others (2017) and call for a sectoral approach to the analysis of financial vulnerabilities and associated medium-term financial stability risks in China.



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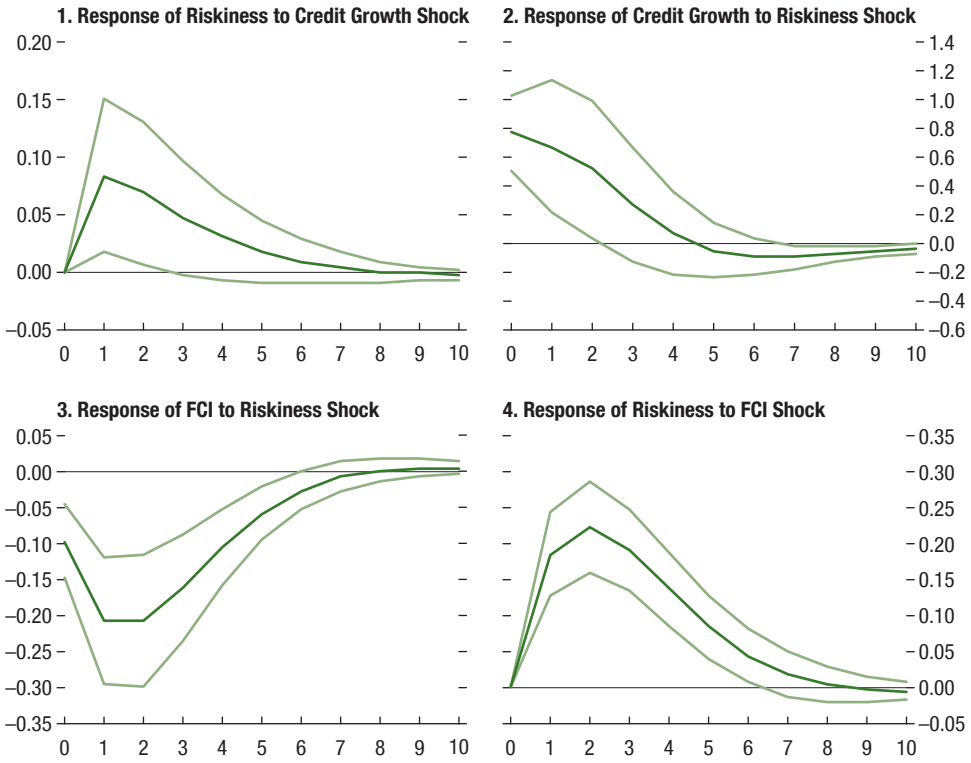
## Box 2.3. The Joint Dynamics of the Riskiness of Credit Allocation, Financial Conditions, Credit Expansions, and GDP Growth

This box analyzes the joint dynamics of the leverage-based measure of riskiness of credit allocation, financial conditions, credit growth, and the business cycle. The results of a panel vector autoregression (VAR) using annual data for 41 countries from 1991 to 2016 suggest that loosening financial conditions leads to riskier credit allocation over a two- to three-year horizon, as well as to credit expansion and higher GDP growth (Figure 2.3.1).[1] The response of the riskiness of

This box was prepared by Luis Brandão-Marques.

[1]The panel VAR includes the financial conditions index (FCI), GDP growth, change in credit to the private sector to GDP, and the leverage-based measure of the riskiness of credit allocation, as well as country fixed effects, and uses one lag. The VAR is estimated using Abrigo and Love's (2016) generalized method of moments package for Stata (pvar), which in this case is warranted because of the relatively short time series available

### Figure 2.3.1. The Riskiness of Credit Allocation and Financial Conditions




Source: IMF staff.
Note: The figure shows the responses of a given variable to an orthogonal shock to another variable. The responses are estimated using a panel vector autoregression (VAR) of the financial conditions index (FCI), GDP growth, credit growth, and the leverage-based measure of riskiness of credit allocation, using yearly data (1991–2016) for 41 countries. The VAR includes country fixed effects and one lag. The responses of the FCI (panel 3) and the riskiness of credit allocation (panels 1 and 4) are in standard deviations. The responses of credit growth (panel 2) are in percent of GDP. A rise in the FCI means a loosening of financial conditions. The *x*-axis in all panels is years after the shock. The dark-green lines are the average response, and the light-green lines are confidence bands at the 90 percent level.



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## Box 2.3 *(continued)*

credit allocation to shocks to credit and GDP growth are like those documented in the chapter and corroborate the chapter's findings about the cyclicality of this measure. Importantly, an increase in the riskiness of credit allocation is followed by a tightening (decline) in financial conditions. The results of the panel VAR also show that credit growth increases significantly after an increase in the riskiness of credit allocation. This response is likely caused by an unobserved loosening of credit standards that also leads to a more immediate deterioration in credit quality.[2] Results from a similar panel VAR augmented to include lending standards (not shown), albeit with a much smaller sample size, seem to support this hypothesis.[3]

(on average, 19 years per country). The responses of each variable in the VAR to orthogonal shocks to the variables are measured using a simple Cholesky decomposition. The ordering is such that the riskiness of credit allocation comes first, followed by credit growth and GDP growth, and the FCI is last. Although economic theory does not provide clear guidance for which variables should come first, these results assume that the FCI responds contemporaneously to all other variables. In addition, the analysis assumes that the riskiness of credit allocation does not respond contemporaneously to credit growth, GDP growth, or financial conditions; it responds only with a lag. Changing the ordering of the other variables or including more lags in the specification does not materially affect results.

[2]Looser lending standards imply that lenders increase credit to previously credit-constrained firms with low creditworthiness. Therefore, the perceived increase in the riskiness of the allocation of credit across firms is followed by higher credit growth.

[3]The panel VAR augmented with lending standards also shows that GDP first rises, but then declines after an increase in the riskiness of credit allocation. This could be consistent with the higher riskiness of credit allocation feeding the trade-off between current economic and financial conditions and future financial vulnerabilities (Adrian and Liang 2018). However, higher-frequency data are probably needed to tease out all effects.



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## Box 2.4. The High-Yield Share during a Credit Boom and Output Growth

This box focuses on an alternative measure of the riskiness of credit allocation, the high-yield (HY) share of bond issuance (see Kirti 2018 for details). The HY share is based solely on information from bond markets. It provides a simple, complementary approach to the main metrics used in this chapter. The HY share can be constructed for a sample of 38 countries, with coverage for some starting in 1980. Greenwood and Hanson (2013) construct the HY share for the United States and show its relevance for predicting excess bond returns; López-Salido, Stein, and Zakrajšek (2017) also show that it has macroeconomic relevance for the United States.

For the analysis in this box, the HY share is based on issuance by nonfinancial corporations and governments. It is procyclical: it rises when recent economic performance has been good and falls when recent economic performance has been bad. A procyclical HY share suggests extrapolative dynamics, consistent with the narratives of Minsky (1977, 1986) and Kindleberger (1978). The HY share also moves in line with survey measures of bank lending standards.

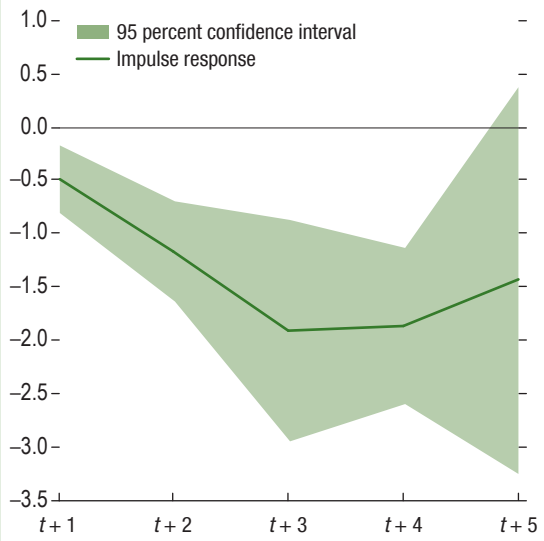
Focusing on a set of 25 advanced economies, this box examines whether credit booms with a rising HY share are followed by lower GDP growth in subsequent years. Credit booms are defined here as episodes in which the change in the credit-to-GDP ratio over the previous five years is high relative to recent international experience. To examine the role of the HY share, local projection specifications that interact dummies for credit booms with the average change in the HY share over the course of the boom are used.

Credit booms with a rising HY share are followed by lower growth over the subsequent three to four years. Figure 2.4.1 shows the impulse response for an increase in the HY share over the course of the boom. A one standard deviation increase in the HY share during a credit boom lowers cumulative GDP growth over the next three years by 2 percentage points. The HY share also helps separate good from bad credit booms: the probability of growth being low following a credit boom is very low given a "good" HY indicator and substantially higher given a "bad" HY indicator.

These results suggest that issuance quality (using the HY share as a proxy) during a credit boom contains information about growth out to three or four years and that credit booms with a rising HY share merit special attention from policymakers.

This box was prepared by Divya Kirti.

**Figure 2.4.1. Impulse Response of Cumulative Real GDP Growth to a High-Yield Share Shock Given a Credit Boom**
*(Percent)*




Sources: Bank for International Settlements; Dealogic; IMF, World Economic Outlook database; and IMF staff calculations.
Note: The sample comprises 25 advanced economies. Time periods are shown on the *x*-axis.



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## Annex 2.1. Description and Definition of Variables

The core of this chapter uses firm-level data from the Worldscope database, which covers the universe of listed firms in many economies around the world. The sample is first cleaned by dropping financial sector firms (except those in the real estate sector). Second, observations are dropped if their values are incompatible with the economic content of the data; for example, when market capitalization, total assets, total debt, total liability, or interest expenses are strictly negative or when the operating profit margin or the ratio of short-term debt to total debt exceeds 100 percent. Third, observations are kept only if full information on net debt issuance; leverage; earnings before interest, taxes, depreciation, and amortization (EBITDA); and market capitalization is available. Then, only economy-year pairs with no fewer than 40 firms and available information on aggregate credit to the private sector are kept.[33] After all cleaning, about 500,000 nonfinancial firm-year observations from 55 economies during 1991 to 2016 are left in the sample.

The Orbis database is used for the robustness analysis. It covers both listed and unlisted firms. The data are cleaned following the guidance in Kalemli-Özcan and others (2015). In addition, only observations with full information on net debt issuance, leverage, earnings before interest and taxes (EBIT), loans, and long-term debt are kept. Then, only economy-year pairs with at least 50 nonfinancial (including real estate) firms are kept. In the end, the Orbis sample covers 50 economies. Data availability in several economies is relatively poor for the 1990s, and panels are very unbalanced in most economies before 2005. A balance is struck by choosing 2000 as the start date for the Orbis-based analysis.

[33]For the construction of the interest coverage ratio–based indicator, a minimum of 40 observations for interest expenses is also required. An exception is made for one borderline case (Ireland), for which some years have only 38 or 39 observations. For the construction of the debt overhang–based indicator, a minimum of 40 observations for non-zero debt is also required. For the construction of the expected default frequency–based indicator, a minimum of 40 observations for expected default frequency is also required.

The WIND database, which covers listed Chinese firms, is used for the analysis in Box 2.2. The advantage of using WIND over Worldscope is that it provides annual information on ownership. Observations are dropped if (1) key financial variables (net debt issuance, total assets, leverage, EBITDA, interest expenses, and market capitalization) are missing; (2) values are incompatible with the economic content of the data (such as negative values of total assets, total liabilities, market capitalization, or interest expenses); (3) values deviate from accounting identities (for example, the sum of total liability and equity book value is greater than total assets by 5 percent or more); or (4) the inception date is missing or invalid. In addition, only one observation a year is kept for firms listed on several stock markets. Only years with at least 50 nonfinancial (including real estate) firms are kept. In the end, about 37,000 firm-year pairs from 1995 to 2016 are used in the analysis. Ownership information is available for most firms only from 2004.

The leverage ratio is defined as the ratio of total debt to total assets. The interest coverage ratio (ICR) is defined as the ratio of interest expenses to EBITDA. The debt overhang measure is defined as the ratio of total debt to EBITDA. The expected default frequency (EDF) is computed using the Black-Scholes-Merton model as in Vassalou and Xing (2004). The ingredients in the model are the value of equity, the sum of short-term debt and half of long-term debt and interest payments, expected returns, the risk-free rate, and the volatility of the price of equity. The return on assets (used in Box 2.2) is defined as the ratio of EBITDA to total assets. Because availability of EBITDA is poor for some countries in the Orbis database, EBIT is used instead to compute the debt overhang indicator. Availability of data on interest expenses is also poor for several countries in Orbis, so the ICR is not used in this robustness exercise. Computing the EDF requires firm-level equity market information and therefore cannot be done for unlisted firms.

The list of economies included in the analysis is provided in Annex Table 2.1.1. Other data sources, definitions, and transformations used in this chapter's analysis are summarized in Annex Table 2.1.2.



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### Annex Table 2.1.1. Riskiness of Credit Allocation: Economies Included in the Analysis

| | Start Year | |
|---|---|---|
| | Worldscope | Orbis |
| **Advanced Economies** | | |
| Australia* | 1991 | 2000 |
| Austria* | 1991 | 2002 |
| Belgium* | 1991 | 2000 |
| Canada* | 1991 | 2000 |
| Czech Republic* | 1997 | 2000 |
| Denmark* | 1991 | 2000 |
| Estonia | n.a. | 2000 |
| Finland* | 1991 | 2000 |
| France* | 1991 | 2000 |
| Germany* | 1991 | 2000 |
| Greece* | 1994 | 2000 |
| Hong Kong SAR | 1991 | 2002 |
| Iceland | n.a. | 2000 |
| Ireland* | 1999 | 2000 |
| Israel* | 2000 | 2002 |
| Italy* | 1991 | 2000 |
| Japan* | 1991 | 2000 |
| Korea* | 1993 | 2000 |
| Netherlands* | 1991 | 2000 |
| New Zealand* | 1999 | n.a. |
| Norway* | 1991 | n.a. |
| Portugal* | 1996 | 2000 |
| Singapore | 1991 | 2000 |
| Slovak Republic | n.a. | 2000 |
| Spain* | 1991 | 2000 |
| Sweden* | 1991 | 2000 |
| Switzerland* | 1991 | 2000 |
| United Kingdom* | 1991 | 2000 |
| United States* | 1991 | 2000 |

| | Start Year | |
|---|---|---|
| | Worldscope | Orbis |
| **Emerging Market Economies** | | |
| Argentina* | 2000 | n.a. |
| Brazil* | 1992 | 2000 |
| Bulgaria* | 2006 | 2000 |
| Chile* | 1995 | 2000 |
| China* | 2000 | 2000 |
| Croatia | 2006 | 2000 |
| Egypt | 2006 | n.a. |
| Hungary* | n.a. | 2000 |
| India* | 1993 | 2002 |
| Indonesia* | 1992 | 2002 |
| Jordan | 2006 | n.a. |
| Kuwait | 2006 | 2009 |
| Malaysia* | 1991 | 2000 |
| Mexico* | 1995 | 2000 |
| Morocco | 2009 | n.a. |
| Oman | 2006 | n.a. |
| Pakistan | 1995 | 2000 |
| Peru* | 2001 | 2002 |
| Philippines* | 1996 | 2002 |
| Poland* | 2000 | 2000 |
| Romania | 2006 | 2000 |
| Russia* | 2005 | 2000 |
| Saudi Arabia | 2006 | n.a. |
| Serbia | 2010 | 2000 |
| South Africa* | 1991 | 2000 |
| Sri Lanka | 2006 | 2006 |
| Thailand* | 1993 | 2000 |
| Turkey* | 1997 | n.a. |
| Ukraine | 2008 | 2000 |
| Vietnam* | 2007 | 2005 |

Source: IMF staff.
Note: End year for Worldscope is 2016; for Orbis, 2015. n.a. = data not available.
* The financial conditions index is available (see the October 2017 *Global Financial Stability Report* for the methodology).

## Annex 2.2. The Determinants of the Riskiness of Credit Allocation

This annex provides a general overview of the empirical methodologies used in this chapter to analyze the cyclical determinants of the riskiness of credit allocation and its relationship to institutional and policy variables. A finding is defined as robust across measures when the regression coefficient is significant for at least two of the four measures and when the sign is identical across all four measures. Consistency of the signs of the effects in level and in interaction is also required.

The results are robust to using alternative data sources for credit, including credit data compiled by the Bank for International Settlements (both for total credit to the nonfinancial private sector and for credit to the nonfinancial corporate sector), to using different ways to capture the business cycle (output gap) and credit cycle (real credit growth), and to estimating two-way clustered standard errors at country and year levels.

### Cyclicality of the Riskiness of Credit Allocation

The empirical specification is as follows:

$$Riskiness_{i,t}^{X} = \alpha_i^X + \gamma_t^X + \beta_1^X \Delta\, Credit_{i,t} + \beta_2^X \Delta GDP_{i,t} + \beta_3^X Appreciation_{i,t} + \varepsilon_{i,t}^X, \qquad \text{(A2.2.1)}$$

in which $X \in \{leverage, interest\ coverage\ ratio, debt\ overhang, expected\ default\ frequency\}$ represents a borrower vulnerability or credit risk indicator and, correspondingly, $Riskiness_{i,t}^X$ measures the riskiness of credit allocation based on that indicator for country $i$ at time $t$. $\Delta Credit$ is the change in the ratio of bank credit to the nonfinancial private sector to nominal GDP, and



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## Annex Table 2.1.2. Country-Level Data Sources and Transformations

| Variable | Description | Source | Transformation |
|---|---|---|---|
| **Macroeconomic Variables** | | | |
| Real GDP | Gross domestic product, constant prices in national currency | IMF, World Economic Outlook database | |
| Current Account | Current account balance, in US dollars | IMF, World Economic Outlook database | |
| Exchange Rate | National currency per US dollar | IMF, International Financial Statistics and World Economic Outlook databases | |
| **Macro-Financial Variables** | | | |
| Lending Standards | Cumulative net percentage balance (or diffusion index) of the weighted percentage of surveyed financial institutions reporting tightened credit standards minus the weighted percentage reporting eased credit standards. An increase in this index implies a net tightening. | Haver Analytics; IMF staff estimates | *Z*-Score at country level |
| Financial Conditions Index (FCI) | For methodology and variables included in the FCI, refer to Annex 3.2 of the October 2017 *Global Financial Stability Report*. Positive values of the FCI indicate tighter-than-average financial conditions. | IMF staff estimates | *Z*-Score at country level |
| Corporate Spreads | Corporate yield of the country minus sovereign yield of the benchmark country; JPMorgan Corporate Emerging Markets Bond Index Broad is used for emerging market economies where available. | Bloomberg Finance L.P.; Thomson Reuters Datastream | *Z*-Score at country level |
| Private Credit-to-GDP Ratio | The credit provided to the private sector by domestic money banks as a share of GDP | IMF, International Financial Statistics and World Economic Outlook databases | Demeaned at country level |
| Stock Price-to-Book Ratio | Yearly averages of price-to-book ratios | Thomson Reuters Datastream | *Z*-Score at country level |
| VIX | Chicago Board Options Exchange Volatility Index | Bloomberg Finance L.P. | Logarithm; demeaned across time |
| **Financial Stress Variables** | | | |
| Systemic Banking Crisis | Dummy for systemic banking crisis start | Laeven and Valencia (forthcoming) | |
| Banking Sector Equity Stress | Dummy variable for banking sector stress is equal to 1 when the annual excess equity return of the banking sector (relative to a zero-coupon government bond yield with short maturity) is below the country-specific mean by at least one standard deviation in any year within the time frame. Equity return is defined as the change in the logarithm of the equity price index of the banking sector (or financial sector if a banking sector price index is not available). Money market rate or interbank lending rate is substituted for government bond yield if not available. | Thomson Reuters Datastream; Bloomberg Finance L.P.; IMF, International Financial Statistics database | |
| **Banking Sector Characteristics** | | | |
| Buffers from Banking Default | The buffer of a country's banking system (capitalization and returns) relative to the volatility of returns. It is defined as (ROA+(Equity/Assets))/sd(ROA), where ROA is return on assets. sd(ROA) is the standard deviation of ROA. ROA, Equity, and Assets are country-level aggregate figures. | World Bank, Global Financial Development Database (2017) | Demeaned at country level |
| **Policy and Institutional Variables** | | | |
| Independence of Supervisory Authority from Banks | The degree to which the supervisory authority is protected by the legal system from the banking industry. Higher values indicate greater independence. | Barth, Caprio, and Levine (2013) | Country average across years |
| Rareness of State-Owned Enterprises (SOEs) | The negative of the scope of state-owned enterprises (SOEs), which is the pervasiveness of state ownership across 30 business sectors measured as the share of sectors in which the state controls at least one firm. | Organisation for Economic Co-operation and Development, Economy-wide Product Market Regulation Database | Country average across years |
| Minority Shareholder Protection Index | Minority Shareholder Rights Protection Index | Guillén and Capron (2016) | Country average across years |
| Net Tightening Capital Conservation Buffers | Net tightening of macroprudential instrument regarding capital conservation buffers | Alam and others (forthcoming) | Demeaned at country level |
| Net Tightening Ceilings and Penalties on Bank Credit Growth | Net tightening of macroprudential instrument regarding ceilings and penalties on overall bank credit growth | Alam and others (forthcoming) | Demeaned at country level |
| Net Tightening Minimum Leverage Ratio | Net tightening of macroprudential instrument regarding leverage ratio | Alam and others (forthcoming) | Demeaned at country level |

Source: IMF staff.



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### Annex Table 2.2.1. Cyclicality of the Riskiness of Credit Allocation

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | | | | Robustness | |
| Variables | Dependent Variable: Riskiness of Credit Allocation Based on Leverage | | | Sign | Significance |
| Change in Credit-to-GDP Ratio | 0.05*** | 0.04*** | 0.06*** | 4 | 4 |
| | (0.01) | (0.01) | (0.01) | | |
| Real GDP Growth | 0.08*** | 0.12*** | 0.05* | 4 | 4 |
| | (0.02) | (0.02) | (0.03) | | |
| Appreciation against the US Dollar | –0.04*** | –0.02* | –0.05*** | | |
| | (0.01) | (0.01) | (0.01) | | |
| Country Group | All | AE | EM | | |
| Country Cluster | Yes | Yes | Yes | | |
| Country Fixed Effect | Yes | Yes | Yes | | |
| Year Fixed Effect | Yes | Yes | Yes | | |
| Observations | 986 | 563 | 423 | | |
| Number of Countries | 55 | 26 | 29 | | |
| $R^2$ | 0.31 | 0.34 | 0.37 | | |

Source: IMF staff estimates.
Note: Dependent variable = riskiness of credit allocation based on leverage for columns (1)–(3). For robustness, the cyclicality of the other three measures of the riskiness of credit quality (based on interest coverage ratio, debt overhang, and expected default frequency) is investigated in the full sample. The number of measures (out of four) that have the same sign and that are significant at the 10 percent level or higher is reported in columns (4) and (5). See Annex Table 2.1.1 for countries and years in the sample. See Annex Table 2.1.2 for definitions and source of all variables. In all specifications, standard errors are clustered at the country level. Standard errors are in parentheses. AE = advanced economies; EM = emerging market economies.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

$\Delta GDP$ is real GDP growth. Domestic currency appreciation against the US dollar is included to control for a potential mechanical valuation effect on the riskiness of credit allocation from debt denominated in foreign currency. Both country ($\alpha_i^X$) and year ($\gamma_t^X$) fixed effects are included. The standard errors are clustered at the country level for all specifications.

Results are provided in Annex Table 2.2.1. The results also hold if the fiscal position is controlled for through the general government structural balance. In addition, the results are robust (and coefficients quantitatively very similar) when instrumenting GDP growth and the change in the credit-to-GDP ratio by their lagged values to account for their potential endogeneity.

## Financial Conditions, Lending Standards, and the Riskiness of Credit Allocation

The following equation is estimated:

$$Riskiness_{i,t}^X = \alpha_i^X + \gamma_t^X + \beta^X Controls_{i,t} + \delta^X FC_{i,t} + \theta^X \times FC_{i,t} \times \Delta Credit_{i,t} + \varepsilon_{i,t}^X, \quad \text{(A2.2.2)}$$

in which $Controls_{i,t}$ is a vector of control variables including change in the credit-to-GDP ratio, real GDP growth, and domestic currency appreciation as discussed in the previous section. The standard errors are clustered at the country level, as before. The term $FC_{i,t}$ represents a financial conditions index (FCI), financial variables representing specific components of the broad index, or a measure of lending standards. Both $\Delta Credit$ and $FC$ are demeaned at the country level. The estimated coefficient $\hat{\delta}^X$ measures the level effect of $FC_{i,t}$ on the riskiness of credit allocation when demeaned $\Delta Credit$ is 0. The estimated coefficient $\hat{\theta}^X$ captures the marginal effect on the credit cyclicality of the riskiness of credit allocation caused by a change in the FCI, financial variables, or lending standards.

The results for lending standards, FCI, corporate spreads, stock market price-to-book ratio, and log VIX (Chicago Board Options Exchange Volatility Index) are shown in Annex Table 2.2.2. Columns (1)–(5) show the results obtained when each financial variable enters the regression individually. The impact of other financial variables, such as stock market volatility, a credit boom dummy (as defined in Dell'Ariccia and others 2016), length of credit boom, a dummy to capture different phases of a credit boom, cross-border bank-flows-to-GDP ratio, and housing price inflation is also investigated. However, none of these variables has a robust significant impact on the riskiness of credit allocation, so they are not included in the table.



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**Annex Table 2.2.2. Impact of Financial Conditions and Lending Standards on the Riskiness of Credit Allocation**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | | | | | | Robustness | |
| Variables | Dependent Variable: Riskiness of Credit Allocation Based on Leverage | | | | | Sign | Significance |
| Change in Credit-to-GDP Ratio | 0.05*** | 0.05*** | 0.05*** | 0.05*** | 0.05*** | | |
| | (0.02) | (0.01) | (0.01) | (0.01) | (0.01) | | |
| Bank Lending Standards | –0.10 | | | | | 4 | 1 |
| | (0.07) | | | | | | |
| Change in Credit-to-GDP Ratio × Bank Lending Standards | –0.03* | | | | | 4 | 4 |
| | (0.02) | | | | | | |
| Financial Conditions Index (FCI) | | –0.05 | | | | 3 | 0 |
| | | (0.07) | | | | | |
| Change in Credit-to-GDP Ratio × FCI | | –0.01** | | | | 4 | 4 |
| | | (0.00) | | | | | |
| Corporate Credit Spreads | | | –0.07 | | | 4 | 0 |
| | | | (0.06) | | | | |
| Change in Credit-to-GDP Ratio × Corporate Credit Spreads | | | –0.02** | | | 4 | 2 |
| | | | (0.01) | | | | |
| Stock Price-to-Book Ratio | | | | 0.20*** | | 4 | 4 |
| | | | | (0.06) | | | |
| Change in Credit-to-GDP Ratio × Stock Price-to-Book Ratio | | | | 0.01 | | 4 | 0 |
| | | | | (0.01) | | | |
| Change in Credit-to-GDP Ratio × Log (VIX) | | | | | –0.04** | 4 | 3 |
| | | | | | (0.02) | | |
| Controls | Yes | Yes | Yes | Yes | Yes | | |
| Country Cluster | Yes | Yes | Yes | Yes | Yes | | |
| Country Fixed Effect | Yes | Yes | Yes | Yes | Yes | | |
| Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | | |
| Observations | 266 | 824 | 663 | 949 | 986 | | |
| Number of Countries | 21 | 41 | 37 | 51 | 55 | | |
| $R^2$ | 0.39 | 0.34 | 0.33 | 0.33 | 0.31 | | |

Source: IMF staff estimates.
Note: Real GDP growth and domestic currency appreciation against the US dollar are controlled for in all regressions. Increase in bank lending standards means stricter bank lending standards. Increase in financial conditions index means tighter financial conditions. Dependent variable = riskiness of credit allocation based on leverage for columns (1)–(5). For robustness, the cyclicality of the other three measures of the riskiness of credit allocation (based on interest coverage ratio, debt overhang, and expected default frequency) is investigated in the full sample. The number of measures (out of four) that have the same sign and that are significant at the 10 percent level or higher is reported in columns (6) and (7). See Annex Table 2.1.1 for countries and years in the sample. See Annex Table 2.1.2 for definitions and source of all variables. In all specifications, standard errors are clustered at the country level. Standard errors are in parentheses. VIX = Chicago Board Options Exchange Volatility Index.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

## Policy and Institutional Settings and the Riskiness of Credit Allocation

This analysis investigates the role played by financial market depth, banking system soundness, macroprudential policy, selected aspects of the legal and institutional framework, and banking supervision quality on the riskiness of credit allocation. The following equation is estimated:

$$Riskiness^X_{i,t} = \alpha^X_i + \gamma^X_t + \beta^X Controls_{i,t} + \rho^X Z_{i,t} + \varphi^X \times Z_{i,t} \times \Delta Credit_{i,t} + \varepsilon^X_{i,t}, \quad \text{(A2.2.3)}$$

in which $Controls_{i,t}$ is the same set of control variables as in the previous section. The standard errors are clustered at the country level. The term $Z_{i,t}$ represents different measures of financial market depth, banking system soundness, macroprudential policy, the legal and institutional framework, and banking supervision quality. All financial development and financial soundness variables enter the regression in the form of a one-year lag to eliminate potential endogeneity concerns. The estimated coefficient $\hat{\rho}^X$ measures the level effect of $Z_{i,t}$ on the riskiness of credit allocation when demeaned $\Delta Credit$ is 0. The estimated coefficient $\hat{\varphi}^X$ captures the marginal effect on the credit cyclicality of the riskiness of credit allocation with respect to a change in each of the $Z_{i,t}$ variables. Because of lack of sufficient time series variation, data



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## Annex Table 2.2.3. Impact of Policy and Institutional Settings on the Riskiness of Credit Allocation

| | Dependent Variable: Riskiness of Credit Allocation Based on Leverage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| | | | | | | | Legal and Institution Aspects | | Robustness | |
| Variables | Financial Soundness | Macroprudential Policy | | | | Supervision Quality | | | Sign | Significance |
| Change in Credit-to-GDP Ratio | 0.05*** | 0.05*** | 0.05*** | 0.05*** | 0.05*** | 0.12*** | –0.00 | 0.15*** | | |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.02) | (0.02) | (0.03) | | |
| Lag Buffers from Banking Default | 0.01 | | | | | | | | 3 | 0 |
| | (0.01) | | | | | | | | | |
| Change in Credit-to-GDP Ratio × Lag Buffers from Banking Default | 0.005** | | | | | | | | 3 | 2 |
| | (0.002) | | | | | | | | | |
| Net Tightening of Capital Conservation Buffers | | –0.45** | | | | | | | 4 | 3 |
| | | (0.21) | | | | | | | | |
| Change in Credit-to-GDP Ratio × Net Tightening of Capital Conservation Buffers | | –0.09*** | | | | | | | 4 | 1 |
| | | (0.03) | | | | | | | | |
| Net Tightening of Minimum Leverage Ratio | | | –0.29 | | –0.30 | | | | 4 | 0 |
| | | | (0.20) | | (0.20) | | | | | |
| Change in Credit-to-GDP Ratio × Net Tightening of Minimum Leverage Ratio | | | –0.09* | | –0.09* | | | | 4 | 2 |
| | | | (0.05) | | (0.05) | | | | | |
| Net Tightening on Ceilings and Penalties on Bank Credit Growth | | | | –0.57 | –0.57 | | | | 4 | 2 |
| | | | | (0.54) | (0.54) | | | | | |
| Change in Credit-to-GDP Ratio × Net Tightening on Ceilings and Penalties on Bank Credit Growth | | | | –0.07** | –0.07** | | | | 4 | 4 |
| | | | | (0.03) | (0.03) | | | | | |
| Change in Credit-to-GDP Ratio × Independence of Supervisory Authority from Bank | | | | | | –0.09*** | | | 4 | 3 |
| | | | | | | (0.02) | | | | |
| Change in Credit-to-GDP Ratio × Rareness of State-Owned Enterprises | | | | | | | –0.01* | | 4 | 4 |
| | | | | | | | (0.01) | | | |
| Change in Credit-to-GDP Ratio × Minority Shareholder Protection Index | | | | | | | | –0.02*** | 4 | 3 |
| | | | | | | | | (0.01) | | |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | |
| Country Cluster | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | |
| Country Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | |
| Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | |
| Observations | 861 | 976 | 976 | 976 | 976 | 929 | 739 | 898 | | |
| Number of Countries | 55 | 54 | 54 | 54 | 54 | 52 | 37 | 46 | | |
| $R^2$ | 0.33 | 0.31 | 0.31 | 0.31 | 0.32 | 0.32 | 0.34 | 0.34 | | |

Source: IMF staff estimates.

Note: Dependent variable = riskiness of credit allocation based on leverage. Real GDP growth and domestic currency appreciation vis-à-vis the US dollar are controlled for in all regressions. Column (4) is a horse race between different macroprudential policies. The number of measures (out of four) that have the same sign and that are significant at the 10 percent level or higher is reported in columns (9) and (10). For the macroprudential policies, the robustness information is based on the horse race. See Annex Table 2.1.1 for countries and years in the sample. See Annex Table 2.1.2 for definitions and sources of all variables. In all specifications, standard errors are clustered at the country level. Standard errors are in parentheses.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

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for all variables related to the legal and institutional framework and supervisory quality are averaged at the country level and enter the regression only as an interaction term.

The results are shown in Annex Table 2.2.3. Columns (1)–(3) and (5)–(7) show the results obtained when each variable found to be robustly significant enters the regression individually.[34] Column (4) presents the results of a horse race between the macroprudential measures that are significant when entering individually.

## Annex 2.3. The Riskiness of Credit Allocation and Macro-Financial Outcomes

This annex discusses the empirical methodologies used to analyze how the riskiness of credit allocation affects the occurrence of systemic banking crises, banking sector stress, and downside risks to GDP growth. The results are robust to using alternative data sources for credit, including credit data compiled by the Bank for International Settlements (for both total credit to the nonfinancial private sector and credit to the nonfinancial corporate sector). The results are also robust to the inclusion of corporate spreads, median firm leverage (or median interest coverage ratio), and share of high-yield bond issuance as an additional control variable.

[34]This analysis also investigates (1) measures of financial depth, including the ratios of private credit to GDP, bank assets to GDP, bank credit to deposits, and external loans and deposits to domestic deposits; and capital account openness; (2) other measures of banking sector soundness, including bank concentration; probability of default of the banking sector; and the ratios of bank capital to total assets, bank regulatory capital to risk-weighted assets, and bank return on equity; (3) an additional 11 types of macroprudential instruments, including countercyclical capital buffers and minimum capital requirements; (4) other measures of supervisory quality, such as a dummy for high supervisory quality based on Basel Core Principles assessments, restructuring power of the supervisory authority, and the degree of independence of the supervisory authority from political influence; and (5) other legal and institutional indicators, such as anti-self-dealing (Djankov and others 2008), burden of proof and disclosure index (La Porta, Lopez-de-Silanes, and Shleifer 2006), corruption index (La Porta, Lopez-de-Silanes, and Shleifer 2006), and the corporate governance opacity index (Brandão-Marques, Gelos, and Melgar 2013). None of these are found to have a robust significant impact on the riskiness of credit allocation.

### The Impact of the Riskiness of Credit Allocation on Systemic Banking Crisis Risk

The logarithm of the odds ratio of the start of a systemic banking crisis is analyzed using the following panel logit model:

$$log\frac{P\left[Crisisstart_t = 1\middle|X_{i,t-1}\right]}{P\left[Crisisstart_t = 0\middle|X_{i,t-1}\right]} = \alpha_i + \beta\,\Delta Credit^{mv3}_{i,t-1} + \gamma Riskiness^{mv3}_{i,t-1} + \delta\, Controls^{mv3}_{i,t-1} + u_{i,t}, \qquad \text{(A2.3.1)}$$

in which *Crisisstart* is a dummy variable equal to 1 at the start of a systemic banking crisis, as defined in Laeven and Valencia (forthcoming) and equal to 0 otherwise. $X$ refers to the vector of explanatory variables. $\alpha_i$ is a country fixed effect. $\Delta$*Credit* is the change in the ratio of bank credit to the nonfinancial private sector to nominal GDP.[35] *Riskiness* is the riskiness of credit allocation, based on the leverage indicator, the interest coverage ratio indicator, the debt overhang indicator, or the expected default frequency indicator. *Controls* include controls for the macroeconomic and financial environment; that is, the change in the current-account-balance-to-GDP ratio, real GDP growth, and a financial conditions index. All explanatory variables enter the equation as the lag of their simple three-year moving average and are demeaned at the country level. The selection of macroeconomic variables follows the specification of Jordà, Schularick, and Taylor (2016a).[36] An extended version of this exercise includes interaction terms between the change in the credit-to-GDP ratio and the riskiness of credit allocation. The results, presented in Annex Table 2.3.1, are robust to using alternative estimators for the panel logit model (including two-way-clustered standard errors of the coefficients).

### The Effect of the Riskiness of Credit Allocation on Banking Sector Equity Stress Risk

The importance of the riskiness of credit allocation for financial stability is explored in a further dimen-

[35]The change in the credit-to-GDP ratio is winsorized at the 1 percent level to reduce the influence of outliers.

[36]This specification differs from Jordà, Schularick, and Taylor (2016a) in that it uses real GDP growth instead of real GDP growth per capita. The results are robust to using real GDP growth per capita.



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**Annex Table 2.3.1. Panel Logit Analysis: Probability of the Occurrence of a Systemic Banking Crisis**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Variables** | **Dependent Variable: Start of a Systemic Banking Crisis** | | | | | |
| Change in Credit-to-GDP Ratio | 0.202*** | 0.141* | 0.0565 | 0.0745 | 0.0808 | –0.0902 |
| | (0.0699) | (0.0737) | (0.0849) | (0.100) | (0.108) | (0.131) |
| Financial Conditions Index | | –1.742** | –2.536*** | –2.686*** | –2.907*** | –4.441*** |
| | | (0.682) | (0.611) | (0.604) | (0.724) | (0.854) |
| Riskiness_Leverage | | | 1.924*** | | | |
| | | | (0.674) | | | |
| Riskiness_Interest Coverage Ratio | | | | 2.533*** | | |
| | | | | (0.861) | | |
| Riskiness_Debt Overhang | | | | | 2.087*** | |
| | | | | | (0.461) | |
| Riskiness_Expected Default Frequency | | | | | | 2.113*** |
| | | | | | | (0.734) |
| Observations | 443 | 443 | 443 | 443 | 431 | 361 |
| Number of Countries | 21 | 21 | 21 | 21 | 20 | 17 |
| Country Cluster | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo $R^2$ | 0.243 | 0.353 | 0.465 | 0.487 | 0.515 | 0.606 |

Source: IMF staff estimates.
Note: Standard errors are in parentheses. Explanatory variables enter the regression as the lag of their simple three-year moving average and are demeaned at the country level; the change in credit-to-GDP ratio is winsorized at 1 percent. Controls include the change in current-account-to-GDP ratio and the real GDP growth rate.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

sion: the risk of a banking sector equity price stress event. This risk is examined using the following framework, as in Baron and Xiong (2017):

$$log\frac{P\left[stress_{t,t+h} = 1 \middle| X_{i,t-1}\right]}{P\left[stress_{t,t+h} = 0 \middle| X_{i,t-1}\right]} = \alpha_i + \beta\,\Delta Credit_{i,t-1}^{mv3} + \gamma Riskiness_{i,t-1}^{mv3} + \delta\, Controls_{i,t-1}^{mv3} + u_{i,t+h}, \quad \text{(A2.3.2)}$$

in which *stress* is a dummy variable equal to 1, if there is a stress event of banking sector equity prices in the time window from $t$ to $t + h$, $h = 0,...,3$. A stress event is defined as an episode in which the annual excess equity return on the banking sector (relative to a zero-coupon government bond yield of short maturity) is below the country-specific mean by more than one standard deviation. The other variables are defined in the same way as in the crisis model described previously. Controls include a financial conditions index. An extended version of this exercise includes interaction terms between the change in the credit-to-GDP ratio and the riskiness of credit allocation. Annex Table 2.3.2 presents the results. The results are robust to using alternative estimators for the panel logit model (including two-way-clustered standard errors of the coefficients).

## The Impact of the Riskiness of Credit Allocation on Downside Risks to GDP Growth

The following equation is estimated:

$$\Delta y_{i,t,t+h} = \beta\,\Delta Credit_{i,t-1}^{mv3} + \gamma Riskiness_{i,t-1}^{mv3} + \delta\,\Delta Credit_{i,t-1}^{mv3} \times Riskiness_{i,t-1}^{mv3} + \rho\, Controls_{i,t-1}^{mv3} + u_{i,t}, \quad \text{(A2.3.3)}$$

in which $\Delta y_{i,t,t+h}$ is the cumulative real GDP growth rate over the future $h$ years (from $t$ to $t + h$), in which $h = 1,...,3$. Riskiness and the change in the credit-to-GDP ratio are defined as in the previously described analyses. Controls include real GDP growth and a financial conditions index. The financial conditions index includes the sovereign spread, which partially captures the impact of fiscal policies.[37] All explanatory variables enter the equation as the lag of their simple three-year moving average and are demeaned at the country level. The model is esti-

[37]Fiscal policies are found to affect economic recoveries in a different empirical framework by IMF (2016).



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### Annex Table 2.3.2. Panel Logit Analysis: Banking Sector Equity Stress Risk

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| **Variables** | **Dependent Variable: Bank Equity Crash between *t* and *t* + *h* (*h* = 1,3)** | | | | | | | |
| | *t* + 1 | *t* + 3 | *t* + 1 | *t* + 3 | *t* + 1 | *t* + 3 | *t* + 1 | *t* + 3 |
| Change in Credit-to-GDP Ratio | –0.000975 | 0.0129 | 0.0294 | 0.0306 | 0.0316 | 0.0317 | 0.0345 | 0.0253 |
| | (0.0381) | (0.0433) | (0.0309) | (0.0357) | (0.0365) | (0.0427) | (0.0437) | (0.0464) |
| Riskiness_Leverage | 0.898*** | 0.727*** | | | | | | |
| | (0.246) | (0.246) | | | | | | |
| Riskiness_Interest Coverage Ratio | | | 0.690*** | 0.717** | | | | |
| | | | (0.256) | (0.320) | | | | |
| Riskiness_Debt Overhang | | | | | 0.569** | 0.440 | | |
| | | | | | (0.223) | (0.271) | | |
| Riskiness_Expected Default Frequency | | | | | | | 0.451* | 0.321 |
| | | | | | | | (0.274) | (0.296) |
| Observations | 573 | 573 | 573 | 573 | 552 | 552 | 505 | 505 |
| Number of Countries | 36 | 36 | 36 | 36 | 34 | 34 | 33 | 33 |
| Country Cluster | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo $R^2$ | 0.0882 | 0.130 | 0.0495 | 0.115 | 0.0517 | 0.102 | 0.0388 | 0.0950 |

Source: IMF staff estimates.
Note: Standard errors are in parentheses. Explanatory variables enter the regression as the lag of their simple three-year moving average, and are demeaned at the country level; the change in credit-to-GDP ratio is winsorized at 1 percent. Each estimation controls for financial conditions.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

mated using quantile regressions with nonadditive fixed effects to examine the relationship between the riskiness of credit allocation and the 20th and 50th percentiles of the future growth distribution. Regressions with and without the interaction between the change in the credit-to-GDP ratio and riskiness are both estimated. The results are shown in Annex Table 2.3.3. Similar results are obtained for the leverage-based measure using Orbis data. The impact of the riskiness of credit allocation on growth is also examined using a logit regression with a low-growth outturn dummy as the dependent variable. In that exercise, low-growth outturn is equal to 1 when the cumulative real GDP growth rate over the future *h* years (from *t* to *t* + *h*) is below the 20th percentile of its country-specific distribution and equal to zero otherwise. The findings confirm those obtained in the quantile regression framework.



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## Annex Table 2.3.3. Impact of the Riskiness of Credit Allocation on Downside Risks to Growth *(20th and 50th percentiles of growth distribution)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | **20 pt** | **50 pt** | **20 pt** | **50 pt** | **20 pt** | **50 pt** | **20 pt** | **50 pt** | **20 pt** | **50 pt** | **20 pt** | **50 pt** | **20 pt** | **50 pt** | **20 pt** | **50 pt** |
| | Cumulative Real GDP Growth Rate over Future Three Years ($t$, $t$ + 3) | | | | | | | | | | | | | | | |
| Change in Credit-to-GDP Ratio | –0.232*** | –0.268*** | –0.239*** | –0.254*** | –0.228*** | –0.291*** | –0.172*** | –0.231*** | –0.224*** | –0.268*** | –0.192*** | –0.207*** | –0.219*** | –0.272*** | –0.213*** | –0.128*** |
| | (0.0335) | (0.0358) | (0.0364) | (0.0471) | (0.0278) | (0.0260) | (0.0274) | (0.0380) | (0.0349) | (0.0367) | (0.0233) | (0.0472) | (0.0294) | (0.0315) | (0.0369) | (0.0328) |
| Riskiness_Leverage | –0.468*** | –0.480*** | –0.494*** | –0.444*** | | | | | | | | | | | | |
| | (0.144) | (0.107) | (0.159) | (0.127) | | | | | | | | | | | | |
| Change in Credit-to-GDP Ratio × Riskiness_Leverage | | | –0.0549** | –0.0820*** | | | | | | | | | | | | |
| | | | (0.0253) | (0.0288) | | | | | | | | | | | | |
| Riskiness_Interest Coverage Ratio (ICR) | | | | | –0.927*** | –0.421*** | –1.306*** | –0.391*** | | | | | | | | |
| | | | | | (0.207) | (0.118) | (0.237) | (0.0948) | | | | | | | | |
| Change in Credit-to-GDP Ratio × Riskiness_ICR | | | | | | | –0.237*** | –0.217*** | | | | | | | | |
| | | | | | | | (0.0467) | (0.0360) | | | | | | | | |
| Riskiness_Debt Overhang | | | | | | | | | –0.406* | –0.328** | –0.522*** | –0.229* | | | | |
| | | | | | | | | | (0.237) | (0.140) | (0.161) | (0.132) | | | | |
| Change in Credit-to-GDP Ratio × Riskiness_Debt Overhang | | | | | | | | | | | –0.146*** | –0.204*** | | | | |
| | | | | | | | | | | | (0.0297) | (0.0277) | | | | |
| Riskiness_Expected Default Frequency | | | | | | | | | | | | | –0.879*** | –0.383** | –0.942*** | –0.397** |
| | | | | | | | | | | | | | (0.243) | (0.161) | (0.233) | (0.190) |
| Change in Credit-to-GDP Ratio × Riskiness_Expected Default Frequency | | | | | | | | | | | | | | | –0.0798 | –0.171*** |
| | | | | | | | | | | | | | | | (0.0749) | (0.0199) |
| Observations | 602 | 602 | 602 | 602 | 602 | 602 | 602 | 602 | 592 | 592 | 592 | 592 | 532 | 532 | 532 | 532 |
| Number of Countries | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 39 | 39 | 39 | 39 |

Source: IMF staff estimates.
Note: Standard errors are in parentheses. Explanatory variables enter the regressions as the lag of their simple three-year moving average and are demeaned at the country level; the change in credit-to-GDP ratio is winsorized at 1 percent. Controls include real GDP growth and a financial conditions index. pt = percentile.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

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CHAPTER 3

# HOUSE PRICE SYNCHRONIZATION: WHAT ROLE FOR FINANCIAL FACTORS?

## Summary

Rising house prices have been a feature of the economic recovery in many countries since the global financial crisis. But recent increases have also been occurring in an accommodative monetary policy environment in many advanced economies, raising the specter of financial instability should financial conditions reverse and simultaneously lead to a decline in house prices.

This chapter analyzes whether and how house prices move in tandem across countries and major global cities; that is, the *synchronicity* of global house prices. On the one hand, higher house price synchronization and deeper global links in housing markets may be beneficial. On the other hand, higher synchronization may be the result of global financial conditions influencing local house price dynamics and housing markets, thereby propagating local economic and financial shocks. The analysis in this chapter aims to inform the views that policymakers ought to take on the synchronicity in house prices.

Strikingly, the chapter finds an increase in house price synchronization, on balance, for 40 countries and 44 major cities in advanced and emerging market economies. The chapter's analysis suggests that countries' and cities' exposure to global financial conditions may provide an explanation for the increase in house price synchronization. Moreover, cities in advanced economies may be particularly exposed to global financial conditions, perhaps owing to their integration with global financial markets or to their attractiveness for global investors searching for yield or safe assets.

Thus, policymakers cannot ignore the possibility that shocks to house prices elsewhere may affect domestic markets. While house price synchronization in and of itself may not warrant policy intervention, the evidence presented in this chapter suggests that heightened synchronicity of house prices can signal a downside tail risk to real economic activity, especially when taking place in a buoyant credit environment. The chapter finds that macroprudential policies seem to retain some ability to influence local house price developments even in countries with highly synchronized housing markets, and that macroprudential policy measures put in place to tame rising vulnerabilities in a country's financial sector may have the additional effect of reducing a country's house price synchronization with the rest of the world. These unintended effects are worth considering when evaluating the trade-offs of implementing macroprudential and other policies.



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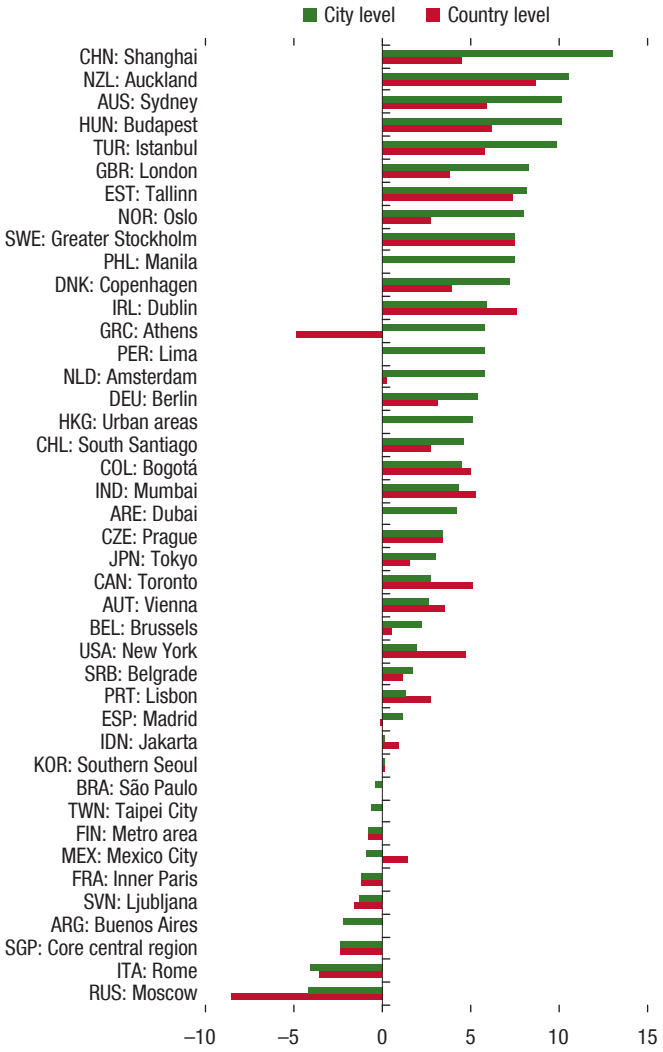
## Introduction

Rising house prices have been a feature of the economic recovery in many countries since the global financial crisis (Figure 3.1). House price gains have been widespread and, in some markets, brisk. Indeed, in recent years, the simultaneous growth in house prices in many countries and cities located in advanced and emerging market economies parallels the coordinated run-up seen before the crisis (Figure 3.2).

House prices may comove across countries and cities because economic activity has picked up at similar times. During 2017, there was a pickup in growth in 120 economies, accounting for three-quarters of world GDP, which was the broadest synchronized global growth upsurge since 2010 (IMF 2018a). The widespread boost to economic growth may support additional housing demand across many countries, leading to upward pressure on house prices.

Global financial conditions—that is, those prevailing in major financial centers—and cross-border capital flows may also explain the comovement in house prices (see Rey 2015 and Chapter 3 of the April 2017 *Global Financial Stability Report* [GFSR]).[1] Recent increases in house prices have been occurring in an environment of easy financial conditions in major advanced economies characterized by low policy rates, compressed spreads, and low volatility that has spread globally (Figure 3.2). Moreover, in some housing markets, the motives of global and institutional investors searching for yield in a low-interest-rate environment have emerged as a potential explanation for the brisk and synchronized increases in house prices. In the past several years, real estate investments—including in residential real estate—by private equity firms, real estate investment trusts (REITs), and institutional investors appear to have grown (Figure 3.3), and anecdotes point to increasing investor participation in select housing markets, such as Amsterdam, Melbourne, Sydney, Toronto,

**Figure 3.1. House Price Gains in Selected Cities and Countries Have Been Widespread**
*(Average annual real house price growth, 2013–17, percent)*




Sources: Bank for International Settlements; CEIC Data Co. Ltd; Emerging Markets Economic Data Ltd; Global Financial Data Solutions; Haver Analytics; IMF, Research Department house price data set; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Data used in this figure comes from the sources listed above, and therefore they could differ from data published by national authorities. Nominal house prices are deflated by consumer price inflation, when real house prices are not readily available in the sources above. Cities selected are the largest cities in each economy in the sample based on population owing to data availability, and overlap with the top 50 cities for global investors identified by Cushman & Wakefield (2017). Labels in the figure use International Organization for Standardization (ISO) codes. Latest available data as of 2017:Q2 for most economies; fewer than 15 economies have data through 2017:Q3.

Prepared by a staff team consisting of Jane Dokko (team leader), Adrian Alter, Mitsuru Katagiri, Romain Lafarguette, and Dulani Seneviratne, with contributions from Anil Ari, Christian Bogmans, and Alan Xiaochen Feng, under the general guidance of Claudio Raddatz and Dong He. Claudia Cohen and Breanne Rajkumar provided editorial assistance.

[1]Moreover, global financial conditions may affect the comovement in commercial real estate prices, but the chapter does not analyze the synchronicity in commercial real estate prices because high-quality, cross-country comparable data are limited to fewer than 10 countries.



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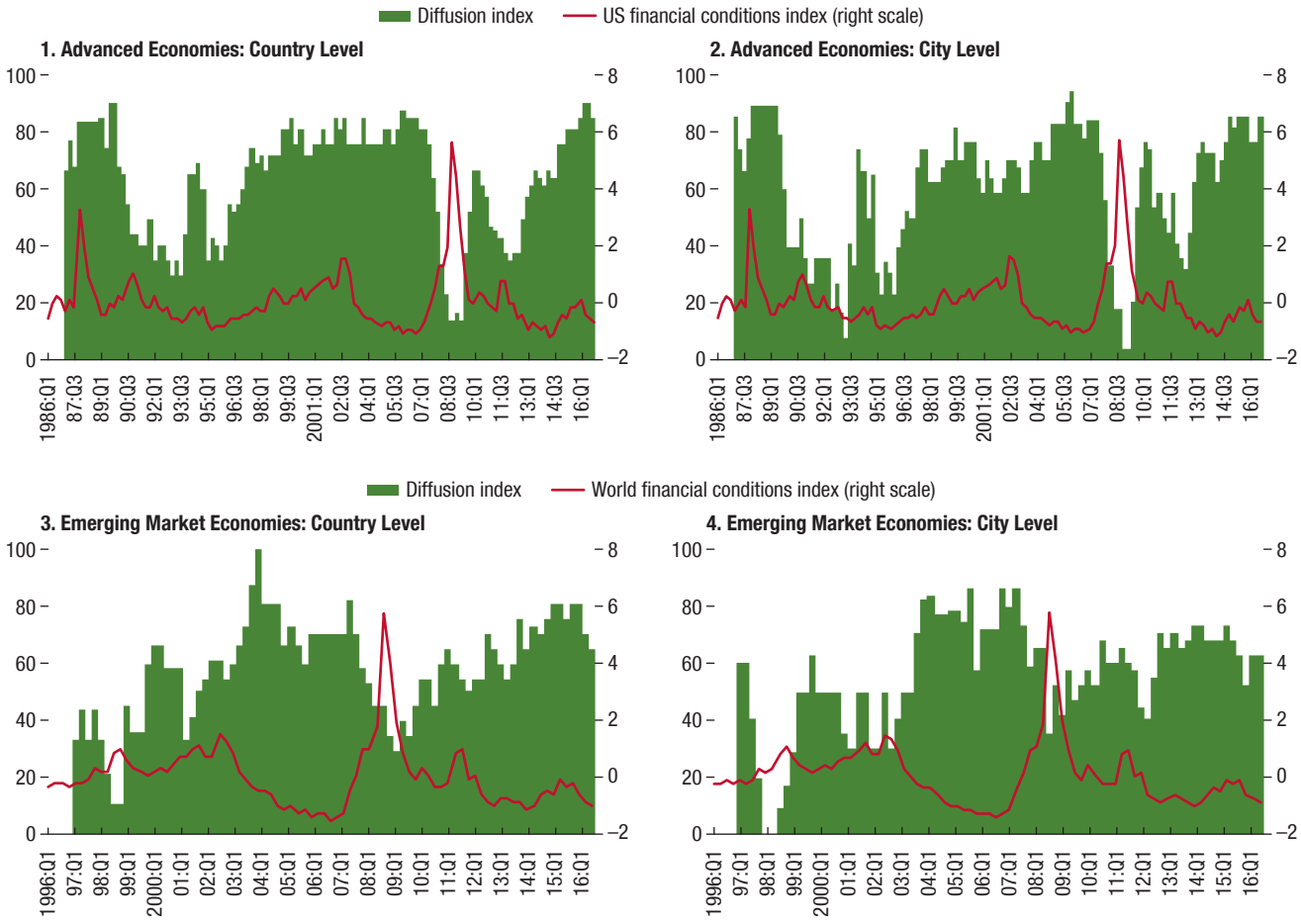
**Figure 3.2. Widespread House Price Gains Have Accompanied Accommodative Financial Conditions (Diffusion Index of House Price Growth and Global Financial Conditions)**
*(Left scale = percent; right scale = standard deviations)*




Source: IMF staff calculations.
Note: Diffusion index is based on year-over-year growth rates of real house prices. This index measures the share of positive house price growth observations in each quarter.

and Vancouver (Zillow Research 2017; Bloomberg News 2018).[2]

Synchronicity, or the correlation, in house prices should concern policymakers because it may signal stronger transmission of external shocks to local housing markets. The global integration of housing markets may contribute to house price synchronization, as well as to more liquidity in housing and mortgage markets, higher capital flows from abroad, and enhanced risk-sharing opportunities for households and lenders.

[2]Other factors, such as illicit capital flows, motives for tax evasion, or the legal environment, may contribute to cross-border real estate purchases, but analyzing these issues is beyond the scope of this chapter.

At the same time, however, the links across housing markets may transmit or amplify financial and macroeconomic shocks, increasing the exposure of local housing markets to global financial conditions or to shocks affecting foreign investors active in local markets. As a result, policymakers' ability to address imbalances in the housing market through national or local policies may be constrained, particularly if house prices across many countries decline at once. In this case, a decline in external demand may exacerbate the challenges of stabilizing household balance sheets, financial markets, and economic activity. In this sense, a sharp reversal of the prevailing accommodative global financial conditions could challenge how policymakers



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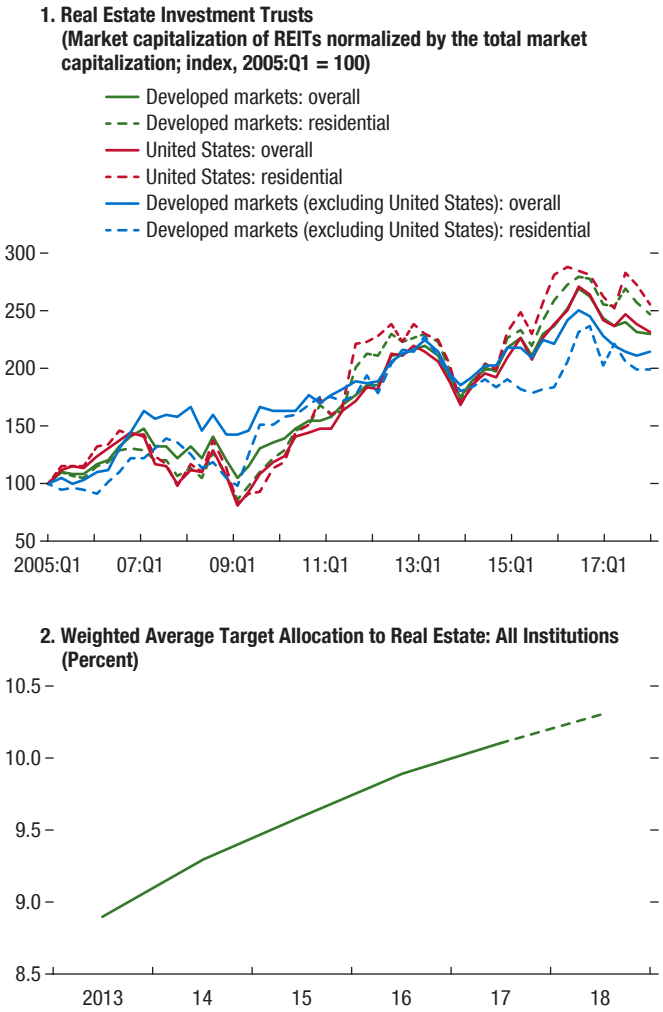
**Figure 3.3. Institutional Investor Participation Has Been on the Rise**




Sources: Jones and Weill (2017); Thomson Reuters Datastream; and IMF staff calculations.
Note: Developed markets correspond to the aggregate REITs series compiled by Thomson Reuters Datastream for developed markets in line with the country classifications from Morgan Stanley Capital International and Dow Jones.
REITs = real estate investment trusts.

address financial and macroeconomic instability should a simultaneous decline in house prices occur.

This chapter analyzes whether and how house prices move in tandem across countries and major global cities; that is, the synchronicity in global house prices and its determinants. Using quarterly data on house prices for countries and major cities (see Annex 3.1), the chapter addresses the following questions:

- What are the trends in the synchronization of house prices across countries and across major cities? Has synchronization increased in recent years? Did it increase before the global financial crisis?
- What factors contribute to or dampen synchronicity? Is there a role for financial factors, or is house price synchronization related mainly to the comovement in economic activity? Do bilateral or two-way links between country or city pairs matter for synchronicity or do only global factors matter?
- Should policymakers pay attention to house price synchronicity to gain a better understanding of financial vulnerabilities and risks?

The chapter's focus on house price synchronization should not detract from the important task of monitoring house prices in individual markets. In fact, the analysis in the chapter seeks to complement bilateral surveillance efforts and country-level analysis that can explore house price valuation and dynamics using sophisticated models and rich data.

The main findings are as follows:

- On balance, synchronization in house prices across countries and major cities has increased over the past several decades in advanced and emerging market economies. This trend follows the rise in the comovement of financial asset prices documented elsewhere (see Chapter 2 of the April 2016 GFSR).
- The short-term comovement in house prices sharply increases around the time of global recessions in advanced economies. These spikes are much larger among major cities than at the country level, suggesting that the ramifications of the global financial cycle for cities may be particularly notable.
- Global financial conditions contribute to synchronization in house prices across pairs of countries and cities even after accounting for the comovement in economic activity and other fixed and time-varying fundamentals. Their contribution is particularly strong in major cities in advanced economies that are usually more integrated with global financial markets but also where local supply constraints may be more binding. The presence of global investors searching for yield or safe assets in major cities may also be an explanation.
- The dynamics of house prices are similar to those of other financial assets. For example, the expected return to investing in housing varies over time and is predictable in the long term. In the financial literature, this pattern is usually associated with variations in the risk premium demanded by investors,



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indicating that the demand for housing may also be influenced by investors.

- Higher house price synchronization corresponds to increased downside risks to growth at horizons of up to one year, controlling for other financial and macroeconomic conditions. This finding suggests that the comovement in house prices can help predict the tail risk of an economic downturn.

The policy discussion for this chapter centers around the following sets of issues:

- Policymakers may wish to monitor the synchronization of house prices with respect to other countries, in addition to the over- or undervaluation of house prices within a country. To that end, increasing the granularity, timeliness, and coverage of data on house prices within countries would help provide richer indicators for bilateral and multilateral surveillance. In addition, more comprehensive data on the participation of global and institutional investors in housing markets would strengthen surveillance efforts.
- Macroprudential policies seem to retain some ability to influence local house price developments in countries with highly synchronized housing markets, albeit to a lesser extent than in those that are less synchronized. Consistently, macroprudential policy measures put in place to tame rising vulnerabilities in a country's financial sector are followed by a decline in a country's house price synchronization, suggesting that some of the drivers of synchronization operate through local financial intermediaries. Fiscal-based policies, such as ad valorem and buyers' stamp duty taxes, may also lower house price synchronization, but less so than other measures, such as limits on loan-to-value ratios. These unintended effects are an aspect to consider when evaluating the trade-offs of implementing macroprudential and other policies (IMF 2013).
- Other policies that enhance resilience to global financial shocks may also dampen house price synchronicity. This chapter presents evidence that exchange rate flexibility plays a role, but policies that deepen domestic real estate markets—or consumer financial protections that discourage excessive or predatory lending to households—may also help.

The rest of this chapter covers four areas. First, the next section provides a conceptual framework for analyzing house price synchronization. Second, stylized facts are presented to document trends and heterogeneity in house price synchronization across advanced and emerging market economies. Third, potential contributors to house price synchronization are analyzed, as is the importance of this measure for economic growth. The final section concludes with a policy discussion.

## House Price Synchronicity: A Conceptual Framework

House prices may move in tandem across countries and major cities because of synchronous supply and demand factors (Figure 3.4).[3] Supply-side considerations include the costs of construction and land acquisition. On the demand side, demographics, tax and other policy considerations, and depreciation and maintenance play a role. Financial factors, such as the mortgage interest rate, the risk premium on assets with similar risk characteristics as housing, household leverage, and the expected nominal house price appreciation rate, also matter.[4]

The comovement in economic fundamentals may be a source of house price synchronization. Several of these factors, such as construction costs, taxes, and demographics, tend to be slow moving and may lead to synchronization only over long horizons. However, other economic fundamentals, such as rent, income, and inflation, may lead to comovement in housing prices at shorter terms.[5] Indeed, the coincidence of recessions and housing downturns is well-documented, with trade and financial links between countries possibly playing a contributing role (Claessens, Kose, and Terrones 2011; Kose, Otrok, and Prasad 2012; Kalemli-Özcan, Papaioannou, and Peydró 2013; Leamer 2015).

Simultaneous changes to financial factors can also lead to greater house price synchronization. Changing interest rates, risk premiums, or expected capital gains

[3]For an example of an asset pricing model that decomposes supply and demand factors for housing, see Poterba (1984) and Poterba, Weil, and Shiller (1991).

[4]Together, these nonfinancial and financial demand-side factors determine the annual cost of homeownership, which is a function of the user cost of housing. See US Department of Housing and Urban Development (2000) for the precise details of how user costs are calculated in the United States, and Poterba (1984) and Poterba, Weil, and Shiller (1991) for a more general discussion.

[5]See the October 2013 *World Economic Outlook* (WEO) for a discussion of the factors contributing to the synchronization in business cycles.



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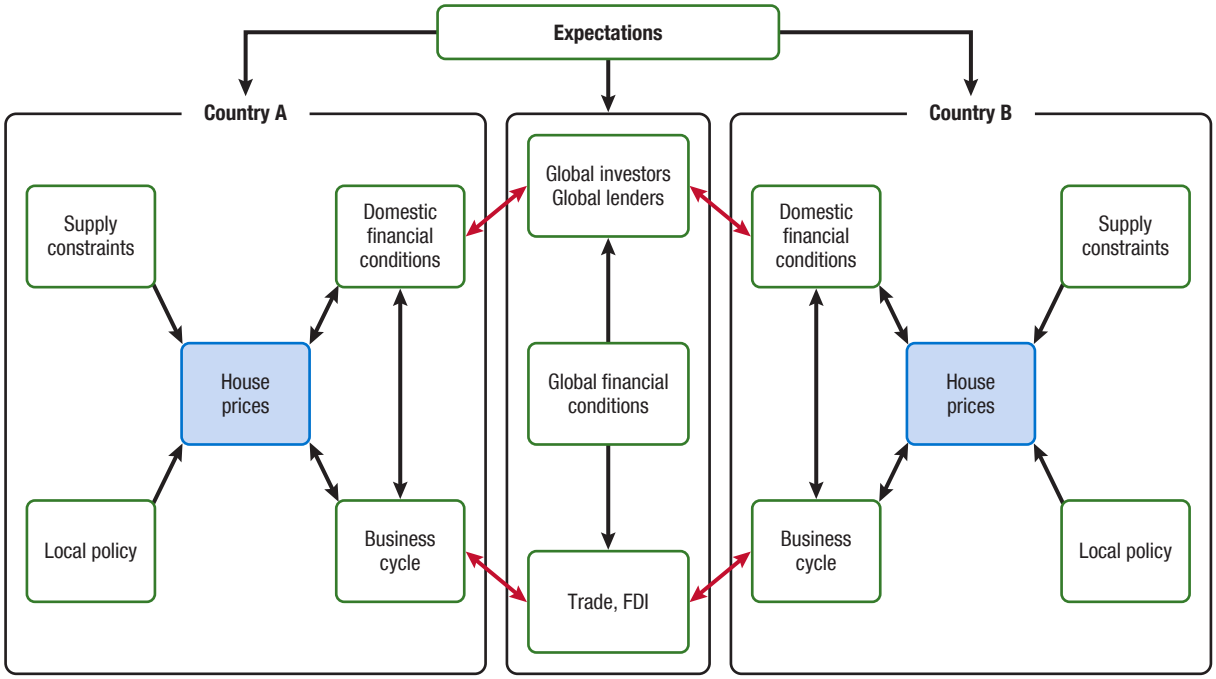
**Figure 3.4. Global Financial Conditions, Portfolio Channels, and Expectations Contribute to House Price Synchronization, as Do Supply Constraints and Local Policy**




Source: IMF staff.
Note: FDI = foreign direct investment.

may increase the comovement in house prices through the following mechanisms (Figure 3.4):[6]

- *Changes in global financial conditions:* The international transmission of financial conditions, such as those occurring because of a change in monetary policy in one large country, usually occurs through capital flows (Chapter 3 of the April 2017 GFSR).[7] These flows do not need to go directly into housing investments as long as they affect credit availability and mortgage rates in the receiving country. In addition, an increase in the global demand for safe assets may compress the rates of sovereign bonds considered as low risk, thereby holding down mortgage rates and supporting booming house prices across many countries at once (Bernanke and others 2011).
- *Portfolio channels:* The presence of common lenders or investors allows for the interdependence in house prices in both crisis and normal times for reasons potentially unrelated to economic fundamentals.[8] For example, a shock in one country may lead global financial institutions to pull back on mortgage lending in many countries, perhaps to maintain capital requirements (Allen and Gale 2000; Cetorelli and Goldberg 2011). Alternatively, investors experiencing distress in one market may liquidate leveraged housing investments in other countries, possibly to meet margin calls or in anticipation of future redemptions, or may rebalance their portfolios to follow predetermined investment mandates (Kodres and Pritsker 2002). Or shocks in one country can result in changes to investors' risk appetite and lead them to increase or withdraw their housing investments from many countries at once (Acharya and Pedersen 2005). In the housing market, recent

[6]The user cost may also shift simultaneously across countries if there is a coordinated tax reform that similarly changes tax rates or aligns the tax deductibility of mortgage interest, but this chapter does not focus on these issues.

[7]Hirata and others (2012) find a role for a broader range of global shocks, such as those to interest rates, productivity, credit, and uncertainty.

[8]See Chapter 2 of the April 2016 GFSR for a discussion of the sources of financial market spillovers.



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developments point to the growing contribution of global and institutional investors to house price dynamics in select major cities (Hekwolter of Hekhuis, Nijskens, and Heeringa 2017). Though they are limited in number in the aggregate, the geographic concentration of investors in certain cities may make house price synchronization more apparent among cities than among countries. These channels may also contribute to house price synchronization in normal times through arbitrage and mortgage rates.

- *Changes in expected capital gains:* A coordinated change in households' or investors' views of future house prices across many countries can also result in synchronicity. These changes in expectations can be driven by rational views regarding future fundamentals (Himmelberg, Mayer, and Sinai 2005), but also by bouts of overoptimism, psychological factors, and speculation (Shiller 2015). Rational or irrational beliefs about house prices can propagate through social networks, word of mouth, and other interpersonal links (Bailey and others 2016). If a wake-up call leads to reassessment of these beliefs, perhaps in response to a shock in one country, a widespread realignment of house prices with fundamentals could occur (Goldstein 1998). There could even be a systematic overcorrection if house prices exhibit momentum and excess variance relative to fundamentals (Case and Shiller 1990; Glaeser, Ponzetto, and Shleifer 2016).

As with many financial assets, institutional characteristics may influence whether financial factors lead to simultaneous changes in house prices across countries. For example, financial integration can expose mortgage markets to global financial conditions and expose local financial markets to sudden stops in capital flows (Chapter 3 of the April 2017 GFSR). Moreover, a country's financial integration may create a favorable environment for global investors to purchase housing directly, allowing global factors to influence local house prices and local shocks to spread more widely through a variety of mechanisms (see earlier discussion).[9] In contrast, greater exchange rate flexibility may dampen the impact of global financial conditions because monetary policies may have more bite under such circumstances.

Fluctuations in home values pose risks to households and financial institutions even if they occur in only one country at a time. In a booming house price environment, households may engage in excessive risk taking (Mian and Sufi 2009; Bhutta and Keys 2016), financial institutions may relax lending standards (Demyanyk and Van Hemert 2009; Dell'Ariccia, Igan, and Laeven 2012; Chapter 2 of the April 2018 GFSR), and there may be overbuilding (Haughwout and others 2011). Thus, once the boom ends, a decline in house prices may result in risks to macroeconomic and financial stability. Consumption may fall given that housing is often the largest component of household wealth in many countries, and household deleveraging may be a further drag on growth (Chapter 2 of the October 2017 GFSR; Mian and Sufi 2009). Furthermore, banks' exposures to house prices can cause them financial difficulties and may lead them to curtail many forms of lending, which, in turn, can lower employment (Berrospide, Black, and Keeton 2016; Glancy 2017). Moreover, housing is a physical asset that requires maintenance and cannot be moved, so fire sales are often associated with blight and crime, which are destabilizing at the local level, because distressed homes often sit vacant before they are sold (Campbell, Giglio, and Pathak 2011; Anenberg and Kung 2014). These costs are borne not just by the households living in neighborhoods with distressed sales but also by financial institutions if the legal system is such that the ownership of foreclosed properties is transferred to them.

The challenges to macro-financial stability posed by a house price decline in a given country can be larger if the decline is synchronized with declines in other countries. In this case, the pullback in consumption and investment driven by balance sheet deleveraging would coincide with a decline in external demand,

[9]See Forbes (2012); Bekaert, Lundblad, and Siegel (2011); Bekaert and Harvey (2000); Burger, Warnock, and Cacdac Warnock (2012); and Miyajima, Mohanty, and Chan (2015) on equity and bond market integration. Theoretically, greater financial integration may also correspond to less house price synchronization given that housing purchases are tied to business cycles. This relationship may arise through the specialization of production or because of how financially integrated banks differentially increase lending to countries experiencing productivity shocks and contribute to divergent output growth (Kalemli-Özcan, Papaioannou, and Peydró 2013). Finally, greater participation of foreign investors, especially those with long horizons, may be able to stabilize asset prices, including housing, if they behave countercyclically and take advantage of fire sale opportunities. This would lead to a dampening of other drivers of synchronicity, although evidence on this countercyclical behavior may be limited (Chapter 2 of the April 2014 GFSR).



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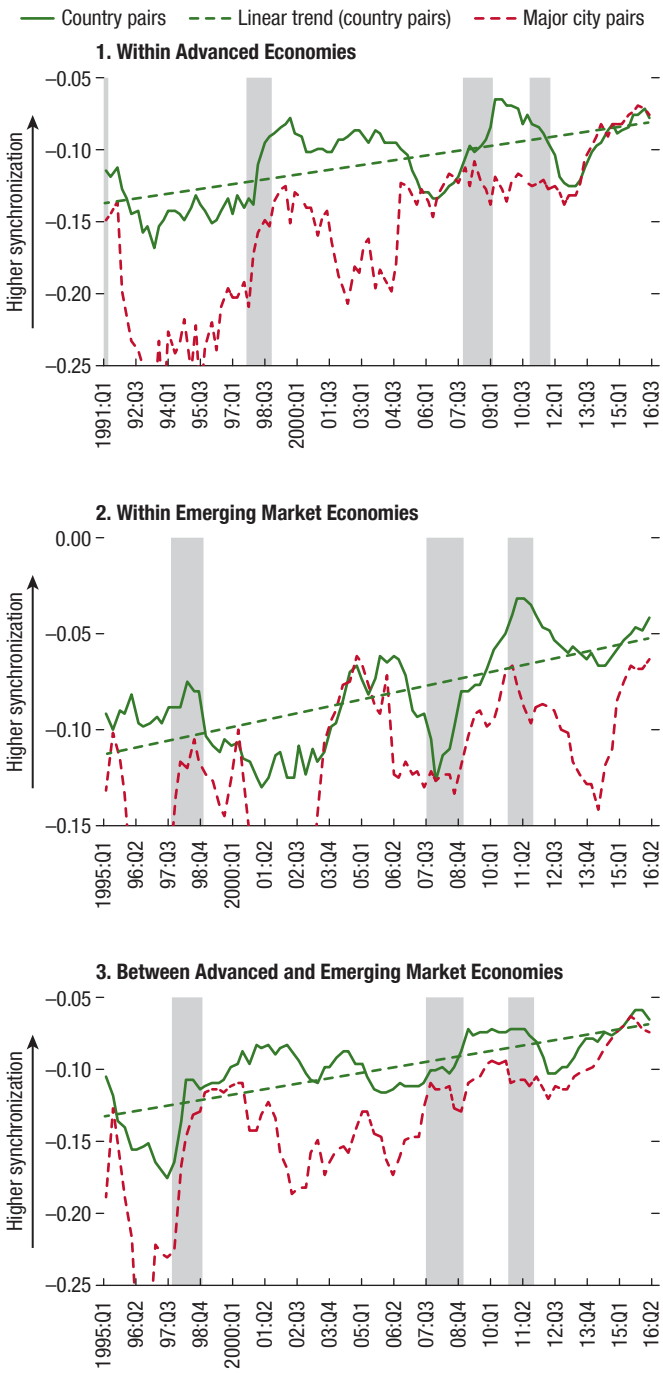
**Figure 3.5. Synchronization Has Steadily Increased across Countries and Cities**
*(Median synchronization; closer to zero denotes higher synchronization)*




Source: IMF staff estimates.
Note: The Synch1 measure capturing the negative of the absolute difference between two countries' house price gaps is used. See Annex 3.2 for methodology. Shaded areas correspond to US recessions.

leaving little room for the current account to offset the contraction in domestic demand. Indeed, in the past, large and widespread house price swings have been associated with periods of financial instability across many countries at once (Claessens, Kose, and Terrones 2008, 2011; Reinhart and Rogoff 2008). These risks would be compounded if a pullback among global investors were to lead to fire sales across asset classes, capital flight, and tighter mortgage market conditions (Kaminsky and Reinhart 2000; Campbell, Giglio, and Pathak 2011; Bekaert and others 2014; Chinco and Mayer 2015).[10]

## House Price Synchronization in Countries and Cities

Different measures of house price synchronization capture distinct dimensions of this phenomenon. Synchronization can be measured in different ways and at different frequencies. To capture these distinctions, this chapter uses a broad set of measures applied to the comovement in house prices across countries and cities. All measures focus on either the cyclical component of real house prices—henceforth, the house price gap—or the quarterly growth rate in real house prices. The former removes the medium-term trend in these prices and allows for comparisons of housing markets with different medium-term cycles. The latter provides a higher-frequency measure of house price growth that can be analyzed at long horizons. Annex 3.2 provides details of these measures.

Synchronicity in housing markets has markedly increased over time.

- On balance, the house price gap has become more synchronized in countries and cities in advanced and emerging market economies (Figure 3.5).[11] The synchronization in the house price gap reflects medium-term changes to how shocks propagate

[10]More specifically, such a pullback could directly cause or accompany instability. Previous GFSR research analyzing the financial stability implications of rising equity and bond price correlations has found that financial factors explain cross-country spillovers and investor retrenchment during crises (see Chapter 3 of the April 2014 GFSR and Chapter 2 of the April 2016 GFSR). Moreover, as with financial assets, at times of fire sales, global investors may base their decision to sell on how liquid a particular housing market is rather than on the fundamentals of the housing market.

[11]The period for which data are available for each group starts in 1973 for advanced economies and 1995 for emerging market economies.



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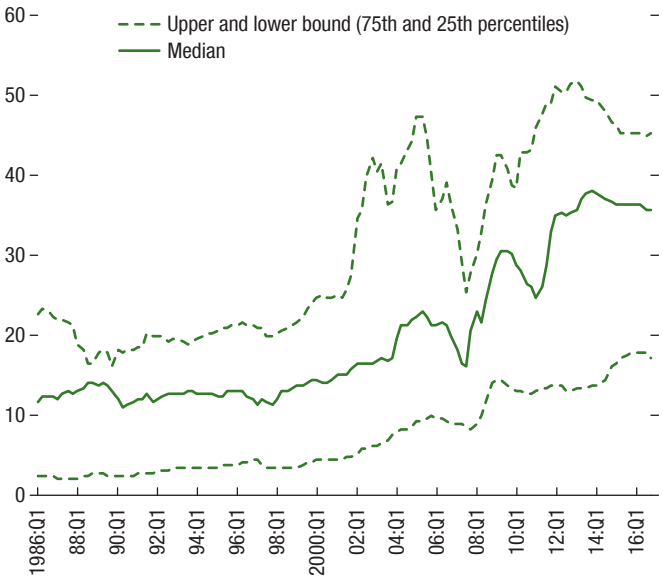
across countries or cities (see Annexes 3.2 and 3.3).[12] Between 1991 and 2016, synchronicity is lower among major cities in advanced economies than among the countries where they are located, but it has gradually moved closer to country-level synchronicity. This pattern is intriguing because synchronicity should be lower among cities that are affected by idiosyncratic shocks that average out at the country level, and it indicates that the factors driving house price synchronicity have become disproportionately more important for cities. This finding motivates a closer look at the house price dynamics of major cities. Among emerging markets, synchronicity between countries and between major cities is similar, perhaps for purely statistical reasons (the major city often represents the bulk of the national house price index) or because of more integrated internal housing markets.

- In many advanced economies, moreover, the increase in synchronization is evident in the rising share of the variation in house price growth explained by a common global factor (Figure 3.6). A dynamic factor model estimates that the share of the variance explained by the estimated global factor increases from about 10 percent to 30 percent over the period from 1971 to 2016.[13] This common global factor summarizes the long-term contribution of many sources of house price synchronicity, including the role of global financial developments and the tightening of financial links, among others (see Annex 3.3).

The short-term comovement in house prices increases sharply around the time of global recessions in advanced economies. This can be seen in Figure 3.7, which depicts the instantaneous quasi correlation, a measure of short-term comovement, in house price gaps. The sharp increases around global economic downturns are noticeable and may reflect common shocks affecting housing markets in many advanced economies.[14] For example, the housing boom of the 2000s extended to many advanced economies, and simultaneous declines in house prices triggered large financial sector losses worldwide during the global financial crisis. Common shocks appear to affect emerging market economies differently, as evidenced by the fact that the comovement in house prices is less likely to shoot up around the time of global recessions. Among advanced economies, the increase in short-term synchronicity before recessions is much larger between major cities than between countries. This again suggests that the factors driving this synchronous movement may particularly affect major cities in advanced economies.

Countries and cities differ in how synchronized they are. Their exposure to the common global factor varies, with a larger contribution of this factor to house prices in countries and cities in Europe than in other regions (Figure 3.8). In addition, advanced economies are more exposed than emerging market

**Figure 3.6. The Relative Contribution of the Global Factor Has Grown**
*(Window = 15 years; percent)*




Source: IMF staff estimates.
Note: The figure shows the rolling estimation with a 15-year window for the share of the variation in house price growth explained by a common global factor in the dynamic factor model. See Annex 3.3.

[12]A similar pattern is found when using seven-year rolling correlations in house price gaps.

[13]The factor loadings and vector autoregression parameters are simultaneously estimated by the two-step procedure proposed in Koop and Korobilis (2013) using data for 19 advanced economies from the second quarter of 1971 to the fourth quarter of 2016. This procedure requires long time series, so it cannot be adequately applied to most emerging market economies.

[14]The instantaneous quasi correlation is constructed not to have a trend (see Annexes 3.2 and 3.3).



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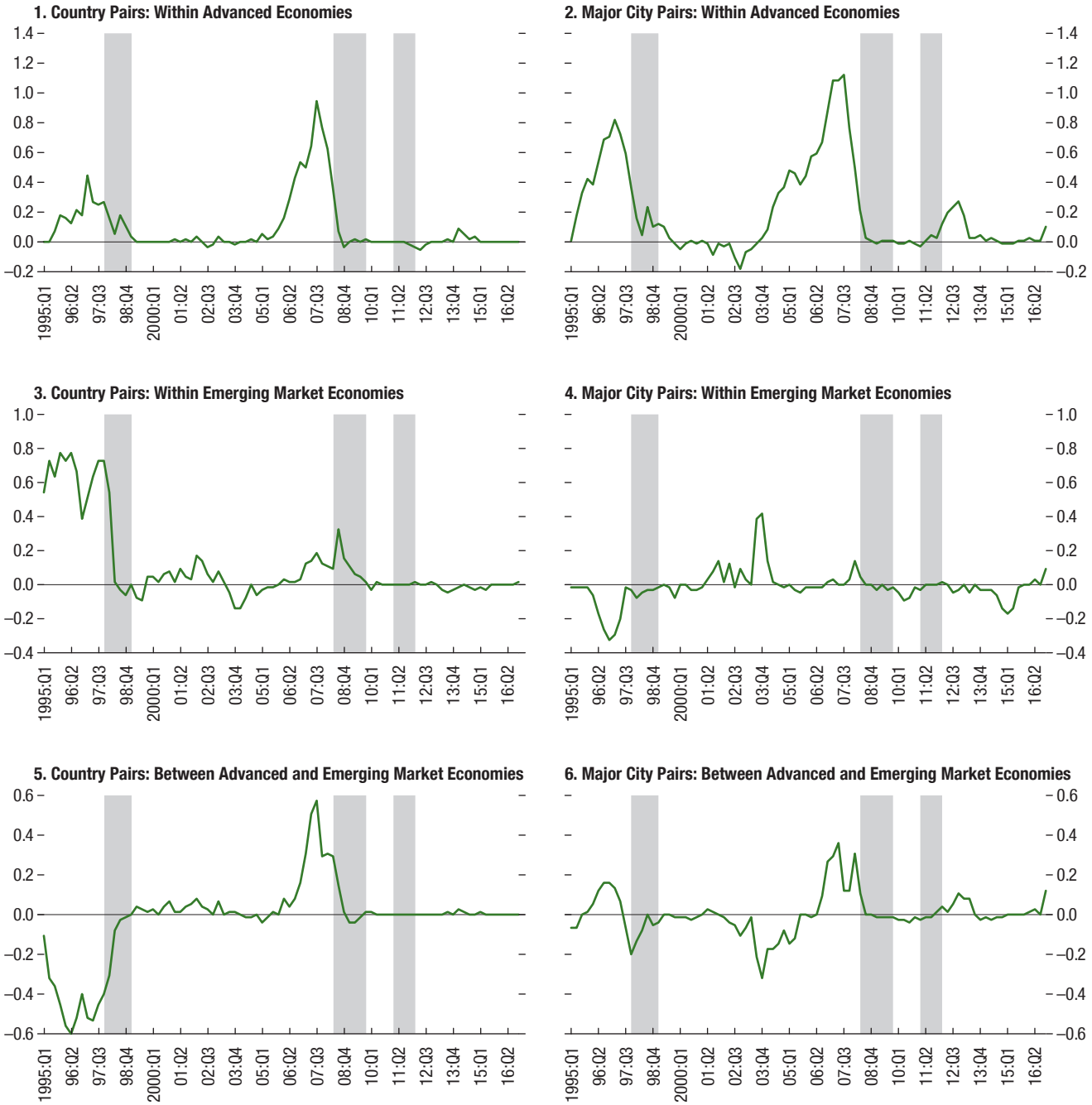
**Figure 3.7. Instantaneous Quasi Correlation of House Price Gaps Shows Financial Cycle Properties (Median Shown)**




Source: IMF staff estimates.
Note: Higher quasi correlation values imply that the house price gaps of both countries (cities) are simultaneously above or below their respective historical averages. See Annex 3.2 for methodology for quasi-correlation computation. Shaded areas correspond to US recessions.



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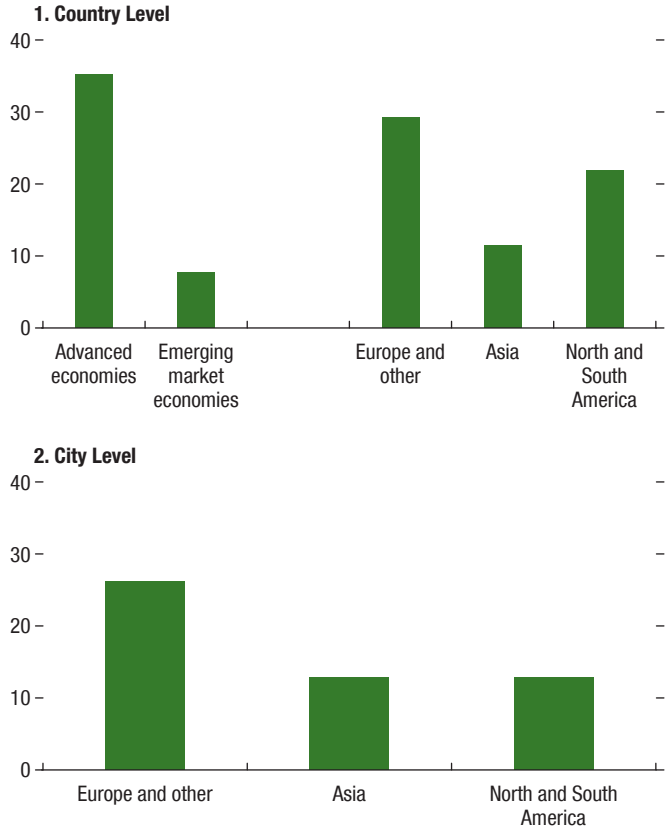
economies to global factors. Over time, the relative importance of the global factor has increased, but not uniformly across advanced economies.[15]

Countries and cities also differ in how interconnected they are. The approach in Diebold and Yilmaz (2014) offers one way to measure the interconnectedness in housing markets via an examination of quarterly house price growth correlations.[16] This approach shows that, after controlling for various global factors, countries' housing markets account differentially for house price developments in other countries. Moreover, countries differ in the degree to which their house prices can be attributed to other countries' house prices. For example, many large advanced economies' housing markets are closely interconnected, as suggested by their central location and proximity to other economies in a network map representing the links in housing markets (Figure 3.9). In contrast, many emerging market economies show weaker connectivity with other countries.

Cities may have housing markets that are highly interconnected even if their countries do not have strong connectivity (Figure 3.10). Some cities lie more at the core of the network, possibly reflecting the deviation of house price dynamics in these cities from the rest of their respective countries' experiences. For instance, while at the country level Japan is on the periphery of the network, at the city level, Tokyo is more centrally located, closer to cities such as London and Stockholm, perhaps reflecting the relative attractiveness of Tokyo to global investors over other cities in Japan. Moreover, looking at cities, it is apparent that many financial centers are more centrally positioned and influential, suggesting that city-level house price dynamics may also be transmitted across borders.

The interconnectedness of housing markets has also increased over time (Figure 3.11). Consistent with the rising trend in synchronicity discussed earlier, the network analysis shows that, on average, the share of the house price variance in a country that can be accounted for by changes in another *single* country—henceforth, "spillovers"—increased from 1.4 percent in 1990–2006 to 2.1 percent in 2007–16, which is a notable increase and comparable to that seen for equities (see Chapter 2 of the April 2016 GFSR).[17] Spillovers are particularly strong among advanced economies, but the proportional increase is the largest for spillovers from advanced economies to emerging market economies and then from emerging market economies to advanced economies, with average interconnectedness increasing by about 60 percent and 40 percent, respectively.

**Figure 3.8. Relative Contribution of the Global Factor Varies across Regions**
*(Percent)*




Source: IMF staff estimates.
Note: The figure shows the share of the variation in house price growth from 2002 to 2016 explained by a common global factor in the dynamic factor model. "Europe and other" category comprises European countries, South Africa, and Israel. See Annexes 3.2 and 3.3 for methodology.

[15]These results are available on request.

[16]Chapter 2 of the April 2016 GFSR explains the Diebold and Yilmaz (2014) methodology that is applied here.

[17]Data limitations preclude omitting the global financial crisis period in this comparison.



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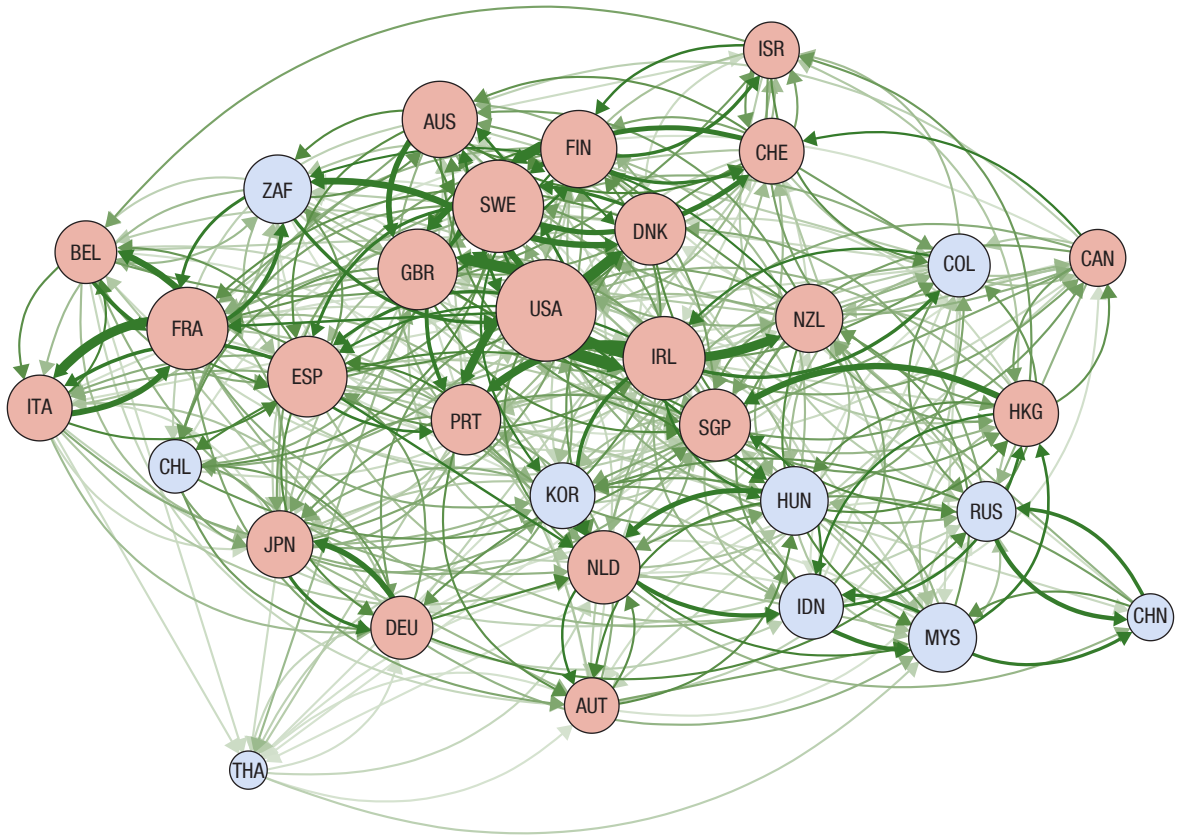
**Figure 3.9. Economies Differ in Their House Price Interconnectedness**




Source: IMF staff estimates.
Note: The figure is based on a vector autoregression of house price growth rates (quarter over quarter), controlling for global factors, from a sample covering 1990:Q1 to 2016:Q4. For methodology details, see Chapter 2 of the April 2016 *Global Financial Stability Report*. Node size is based on an economy's total outward spillovers. Pink nodes represent advanced economies, and blue nodes represent emerging market economies. Arrow thickness is based on link distribution. Only links above the 50th percentile are considered. The figure layout is based on the algorithm by Fruchterman and Reingold (1991) and plotted using the "qgraph" R package. Node labels used in the figure are International Organization for Standardization (ISO) codes. Following Morgan Stanley Capital International markets classification criteria and the IMF's *World Economic Outlook* country classification in 1990, the beginning of our sample, Korea is classified as an emerging market economy.

## Analyzing Contributors to House Price Synchronization

What are the factors behind house price synchronization? What is the role of financial factors? As discussed earlier, the comovement in house prices may arise from synchronous business cycles or other nonfinancial economic fundamentals. To distinguish among potential factors, the econometric framework analyzes house price synchronization within country and city pairs over time.[18]

Countries with deeper financial links, as captured by their bilateral banking linkages, exhibit more synchronization (Figure 3.12). This result, which is independent of the comovement in output and other economic fundamentals, is consistent with financial factors propagating local economic or financial developments between

[18]The bilateral panel data approach removes hard-to-observe country characteristics influencing synchronicity in house prices across countries or cities, such as strong cultural ties, similar mortgage market design, or similar tax treatment of housing capital gains. Thus, the results discussed in this section are less likely to be confounded by these issues. The analyses are performed at the country-pair level using quarterly data from 1990 through 2016 for 40 countries (as well as for major city pairs) using two synchronicity measures: (1) negative value of the absolute difference in house price gaps (synch1), in which a value closer to zero suggests that the differences in house price gaps between two countries have declined; and (2) instantaneous quasi correlation of house price gaps (QCORR), in which a higher value implies that the house price gaps of both countries are simultaneously above or below their respective historical averages. See Annex 3.2 for a technical discussion of the econometric model.



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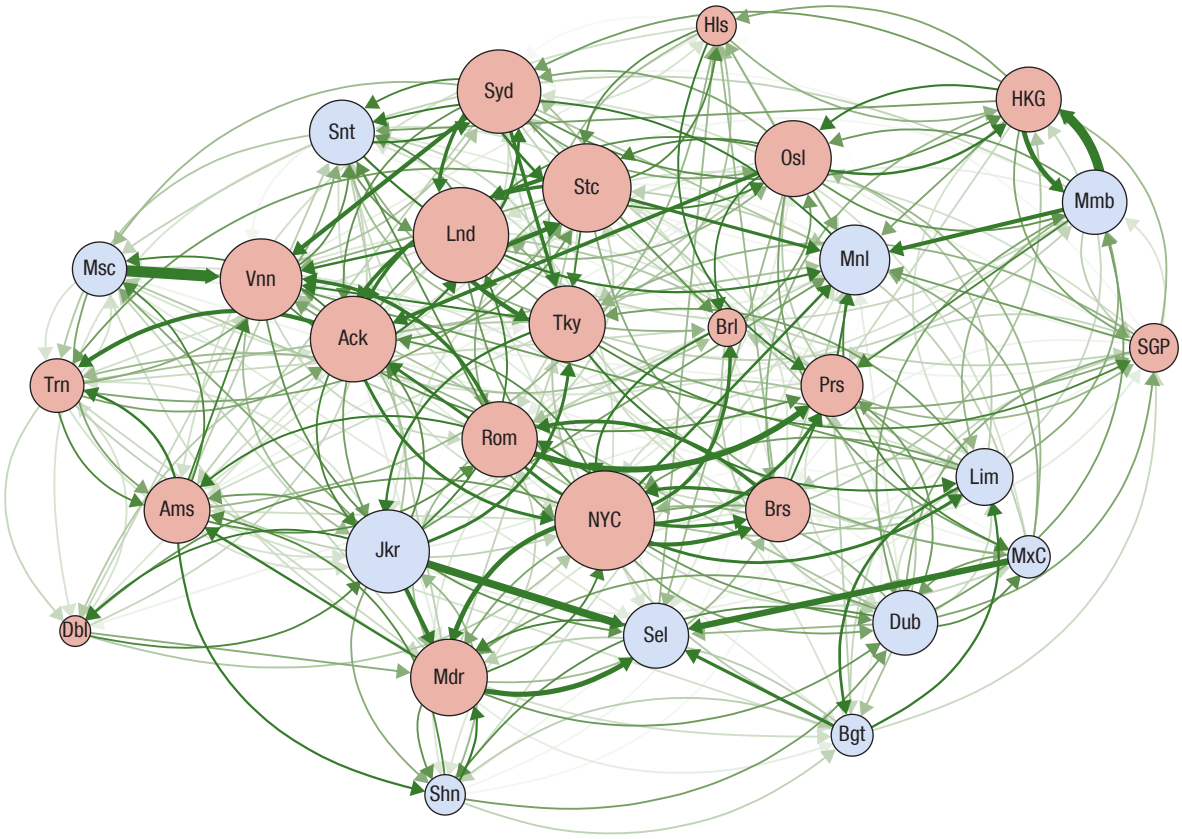
**Figure 3.10. Interconnectedness among Cities' House Prices Varies**




Source: IMF staff estimates.
Note: The figure is based on a vector autoregression of city-level house price growth rates (quarter over quarter), controlling for global factors, spanning 2004:Q1 to 2017:Q2. For methodology details, see Chapter 2 of the April 2016 *Global Financial Stability Report*. See Annex Table 3.1.2, note 1, for city selection criteria, conditional on data availability. Node size is based on the city's total outward spillovers. Pink nodes represent advanced economies, and blue nodes represent emerging market economies. Arrow thickness is based on link distribution. Only links above the 66th percentile are considered. The figure layout is based on the algorithm by Fruchterman and Reingold (1991) and plotted using the "qgraph" R package. Ack = Auckland; Ams = Amsterdam; Bgt = Bogotá; Brl = Berlin; Brs = Brussels; Dbl = Dublin; Dub = Dubai; HKG = Hong Kong SAR; Hls = Helsinki; Jkr = Jakarta; Lim = Lima; Lnd = London; Mdr = Madrid; Mmb = Mumbai; Mnl = Manila; Msc = Moscow; MxC = Mexico City; NYC = New York City; Osl = Oslo; Prs = Paris; Rom = Rome; Sel = Seoul; SGP = Singapore; Shn = Shanghai; Snt = Santiago; Stc = Stockholm; Syd = Sydney; Tky = Tokyo; Trn = Toronto; Vnn = Vienna. Following Morgan Stanley Capital International markets classification criteria and the IMF's *World Economic Outlook* country classification in 1990, the beginning of our sample, Korea (and thus Seoul) is classified as an emerging market economy.

two countries.[19] Moreover, the magnitude of the relationship is nearly as large as that between business cycle synchronization and house price synchronization, suggesting that financial frictions, such as contagion and sudden capital flow stops, may play an important role in transmitting shocks across countries (for example, see Allen and Gale 2000; Calvo and Mendoza 2000; Perri and Quadrini 2011). For instance, when a negative shock affects a country (or a set of countries), banks may retrench from activity abroad, triggering a credit crunch in other countries, which might lead to deeper recessions and lower asset prices.[20]

[19]These conclusions are robust to the inclusion of monetary policy synchronization and bilateral trade linkages as controls. While a causal link from bilateral banking linkages to house price synchronicity cannot be directly established from this analysis, the inclusion of country-pair fixed effects and multiple time-varying bilateral determinants reduces the possibility of confounding factors. Also, reverse causality, in which house price synchronicity increases bilateral banking linkages, is difficult since diversification motives should lead to a negative correlation between these two variables.

[20]For example, during the global financial crisis, subsidiaries of foreign banks had to reduce their operations in eastern Europe because of the subprime crisis and the new regulatory environment (Chapter 2 of the April 2015 GFSR). However, the results discussed here and in the literature are limited in identifying the mechanisms by which bank retrenchment may occur, as data on bilateral banking flows do not differentiate by their intended use.



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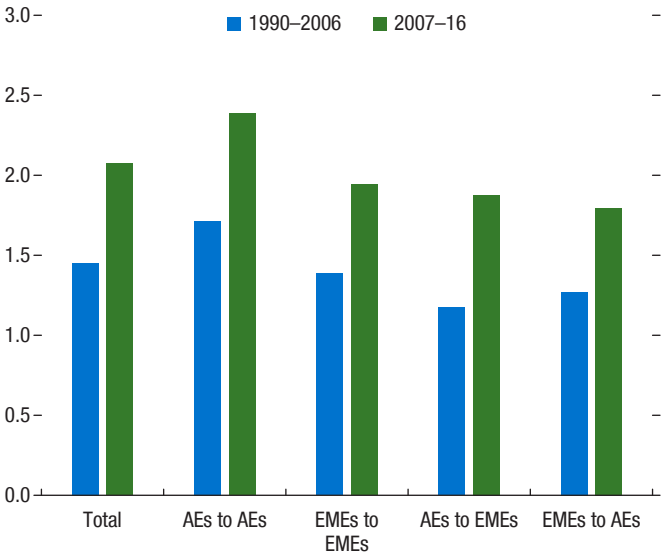
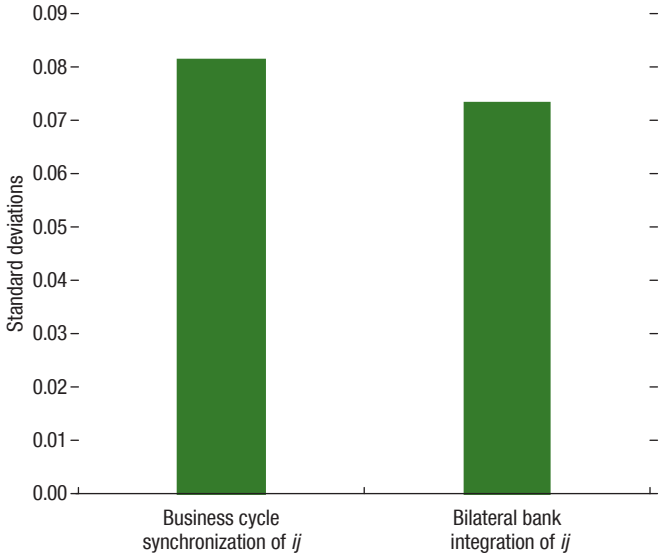
**Figure 3.11. Average Country-Level Housing Market Spillovers Have Increased**
*(Percentage points)*




Source: IMF staff estimates.
Note: The figure is based on a vector autoregression of country-level house price growth rates (quarter over quarter), controlling for global factors, for two sample periods (1990–2006 and 2007–16). Spillovers are defined as the share of the house price variance in a country that can be accounted for by changes in another single country. For methodology, see Chapter 2 of the April 2016 *Global Financial Stability Report*. AEs = advanced economies; EMEs = emerging market economies.

**Figure 3.12. Bilateral Links between Countries Are Associated with House Price Synchronization**




Source: IMF staff estimates.
Note: Synchronicity is measured by the synch1 of gaps measure; see Annex 3.2 for computation methodology. Figure shows statistically significant standardized coefficients that are calculated using the coefficients in specification 4 in Annex Table 3.2.1 and their respective standard deviations, and presented in terms of standard deviations of the dependent variable; this specification also controls for global financial conditions (proxied through global liquidity) in addition to country-pair fixed effects and quadratic and linear time trends (standard errors are clustered at multiway at time, country *i*, and country *j*). The standard deviation for business cycle synchronization is 0.0124 and 1.040 for bilateral bank integration. See Country-Pair Analysis section of Annex 3.2 for further details. *i* = country 1 and *j* = country 2 in the country pair.

A country's financial openness contributes to house price synchronicity. Among advanced and emerging market economies, countries with greater capital account openness, as proxied by the Chinn-Ito index, are more exposed to global factors (Figure 3.13). Moreover, among the advanced economies that can be observed for a longer period, the rise in exposure to the global factor is observed in parallel with the increase in the comovement in equities documented here, in previous GFSRs, and elsewhere (Figure 3.14; Jordà and others 2017). Taken together, these results suggest that house price synchronization can be understood in the broad context of the asset price synchronization spurred by the evolution of financial openness.

Past increases in global liquidity, as well as good market sentiment and loose global financial conditions, are strongly associated with a higher short-term comovement in house prices. These relationships apply to the instantaneous quasi correlation in house price gaps when looking within country pairs in advanced and emerging market economies (Figure 3.15). Moreover, global financial factors play a role even after accounting for the comovement in business cycles, which points to an independent role for global factors in accounting for house price synchronization.

Greater exchange rate flexibility appears to dampen the importance of global financial conditions (Figure 3.15). The impact of global liquidity is lower in countries with high exchange rate flexibility, perhaps because countries with this feature may have tools for dealing with imbalances resulting from exposure to global financial conditions (Obstfeld, Ostry, and Qureshi 2017).[21] For instance, in countries where local currency loans prevail and exchange rates are flexible, central banks may have a stronger

[21]Nominal rigidities may be less relevant in countries with exchange rate flexibility, dampening the role for global financial conditions.



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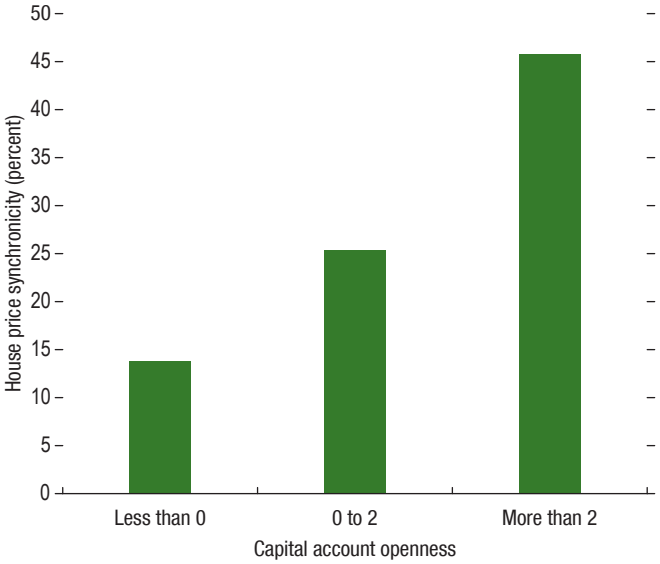
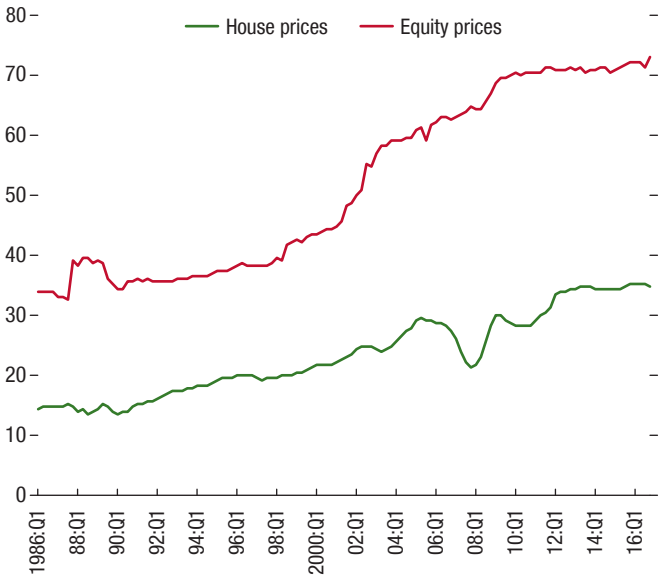
**Figure 3.13. Greater Financial Openness Is Associated with Higher House Price Synchronization**




Sources: Chinn and Ito (2006); and IMF staff estimates.
Note: Synchronicity is measured by the share of the variation in house price growth from 2002 to 2016 explained by a common global factor in the dynamic factor model. See Annexes 3.2 and 3.3 for more details on methodologies.

**Figure 3.14. On Average, the Global Factor for House Prices Has Increased along with That for Equities**
*(Window = 15 years; percent)*




Source: IMF staff estimates.
Note: The figure shows the rolling estimation with a 15-year window for the share of the variation in house and equity price growth explained by a common global factor in the dynamic factor model. See Annexes 3.2 and 3.3 for methodology.

influence on short-term interest rates and thus on financing conditions.[22]

The contribution of global financial conditions to house price synchronization in cities is somewhat larger than for countries (Figure 3.15). If large cities attract global investors, house price comovement in cities may be particularly responsive to global financial conditions. This seems to be the case. Notably, cities in advanced economies show greater responsiveness to global financial conditions, using global liquidity as a proxy. These cities are, on average, more exposed to the global factor (Figure 3.8), but also may face constrained housing supply such that changes in housing demand driven by global liquidity conditions may have a more pronounced and coordinated impact.

Indeed, city-level house price dynamics may reflect demand from global investors searching for yield or safe assets in residential real estate (Box 3.1). Granular analysis of housing market segments within the United States suggests that higher-priced homes are more responsive to changes in house prices of non-US cities. In particular, house prices in non-US cities characterized as destinations for global investors (such as London) exert more influence on higher-priced homes in the largest US cities, as would be the case if demand from global investors were exerting upward pressure on house prices in US and non-US markets.

The participation of global investors in local real estate markets may contribute to the behavior of housing returns, in addition to contributing to synchronized house prices across countries. As Box 3.2 discusses, as with many other financial assets, the expected return on housing assets varies over the investment horizon and is predictable in the long term. Moreover, this predictability is greater in countries with high capital account openness, suggesting that the risk sentiment of global investors is more likely to contribute to house price dynamics when capital account openness is high.

Global investors may also participate in the widespread acquisition of farmland, exposing remote devel-

[22]However, recent literature has also found that long-term rates tend to be strongly influenced by global factors (Goodhart and Turner 2014; Obstfeld 2015), which might have a more important role in domestic real outcomes and asset prices. In addition, flexible exchange rates can amplify boom-bust cycles instead of acting as a shock absorber, because of leverage effects (especially when liabilities are mainly in foreign currency).



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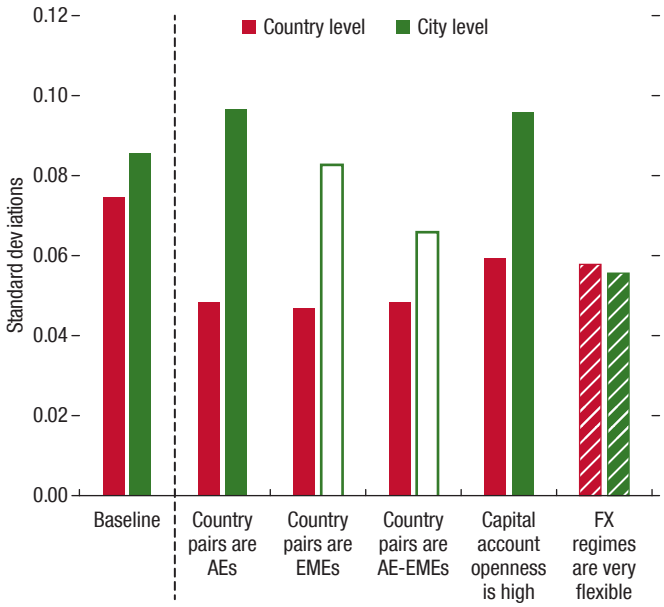
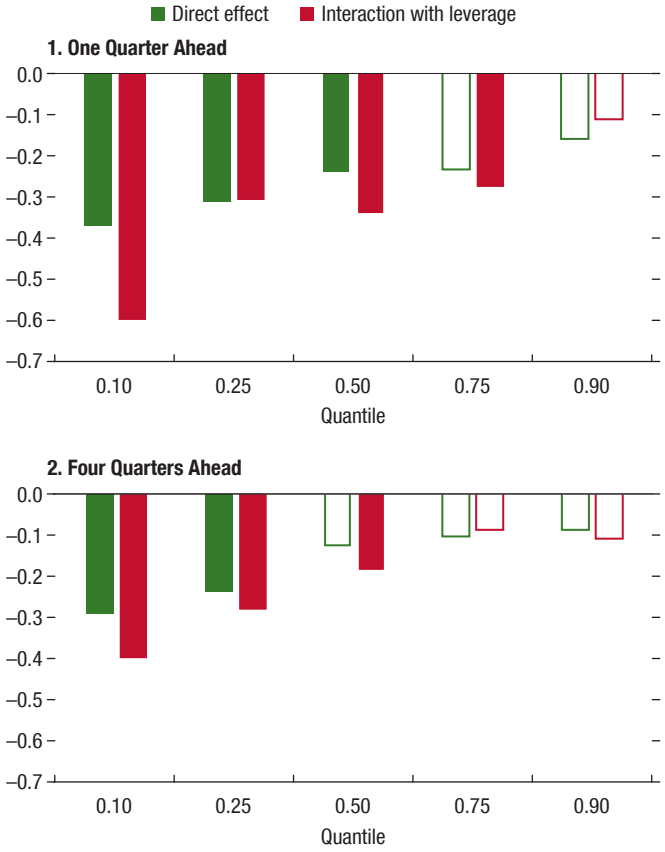
**Figure 3.15. Global Financial Conditions, as Proxied by Global Liquidity, Have Different Associations with House Price Synchronization across Countries and Cities**




Source: IMF staff estimates.
Note: Synchronicity is measured by the quasi correlation of gaps. Solid bars denote joint significance of the *F*-test at or above 90 percent. Patterned bars denote interaction terms that are statistically significant. Coefficients are standardized. For city level, 4th, 6th, and 8th bars correspond to city pairs that reside either in country pairs that are AEs, country pairs that are EMEs, or country pairs that are AE-EMEs, respectively. Standard deviation of the country-level dependent variable is approximately 0.85, and standard deviation of the city-level dependent variable is approximately 0.97. See Annex 3.2 for methodology and Annex Table 3.2.2 for detailed results. AEs = advanced economies; EMEs = emerging market economies; FX = foreign exchange rate.

**Figure 3.16. House Price Synchronization Predicts a Downside Risk to Economic Growth at Short Horizons**
*(Quantile regression coefficients, percentage points of GDP)*




Source: IMF staff estimates.
Note: Solid bars denote statistically significant quantile regression coefficients at a 10 percent confidence interval.

oping economies to global financial conditions. As explained in Box 3.3, private investors and food corporations turned to farmland as a new source of profit in the aftermath of the global financial crisis, motivated by low interest rates and diminished risk appetite.

## House Price Synchronization and Risks to Growth

Higher house price synchronization corresponds to increased downside risks to growth at horizons of up to one year (Figure 3.16). In a standard growth-at-risk model, house price synchronization—as measured by the instantaneous quasi correlation between a country's house price growth and the global factor—appears to negatively affect the lower tail of the growth distribution, over and above the risks associated with the price of risk, leverage, and external conditions (Chapter 3 of the October 2017 GFSR). This means that a decline in one country's house prices, coinciding with those taking place in other countries, signals additional risks to growth.

In addition, at short horizons, the relationship between house price synchronization and risks to future growth is amplified when leverage is high (Figure 3.16). The negative impact of house price synchronicity is about twice as large when leverage is higher. The potential for a synchronized decline in house prices heightens the vulnerabilities associated with a highly leveraged economy.[23] When leverage

[23]While the relationship between downside risks to growth and house price synchronization may capture the influence of underlying financial and nonfinancial drivers of synchronization, these results are qualitatively unchanged when controlling for the role of business cycle synchronization.



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is high, the magnitude of the relationship between house price synchronization and future growth is about two-thirds that of financial conditions, which measure the price of risk.

## Policy Discussion

Increasingly, house prices have become determined at the global level. Local factors, such as land-use regulations, tax policy, and demographics, still account for most of the variation in house prices, but during the past three decades, house prices have become increasingly synchronized across countries, especially among major cities. Thus, policymakers cannot ignore the possibility that shocks to house prices elsewhere may affect domestic markets. The evidence presented in this chapter suggests that this trend is associated with the process of global financial integration, which, despite the many benefits, may have contributed to the "financialization" of housing (Box 3.2). The behavior of housing as a financial asset is particularly notable in light of housing's physical immobility. If synchronization leads to contagion during crises, the ramifications for housing markets may be more damaging for the real economy than in the case of financial assets (Dornbusch, Park, and Claessens 2000). This is because households hold most of their assets and liabilities in housing and mortgages, respectively, and because of financial institutions' outsized exposure to house prices.

Monitoring synchronization in addition to the over- or undervaluation of house prices may help policymakers understand the trade-offs associated with greater global links in housing markets. House prices may comove because business cycles are synchronized or because of financial factors such as global financial conditions, portfolio channels, or expected capital gains. While house price synchronization in and of itself may not warrant policy intervention, it points to the scope for global financial conditions and global investors to influence local house price dynamics. Moreover, the evidence presented in this chapter suggests that heightened synchronicity of house prices can signal a downside tail risk to real economic activity, especially in an environment with buoyant credit and high leverage. Thus, increasing the granularity, timeliness, and coverage of data on house prices may help provide richer indicators for bilateral and multilateral surveillance. Also, more comprehensive data on the participation of global investors in housing markets would strengthen surveillance efforts.

The effectiveness of demand-side macroprudential policy measures may vary with the degree of house price synchronicity (Box 3.4). For instance, the introduction of demand-side macroprudential policy measures, such as loan-to-value limits, is typically followed by a decline in house price growth, but this decline is larger and more persistent in countries with low house price synchronicity. Policymakers may thus have additional control over house price dynamics in countries where house price synchronicity is low and global investors may have a less prominent role. Nonetheless, the decline in house prices observed after the introduction of macroprudential policy measures in high-synchronicity countries suggests that the drivers of synchronicity operate at least partially through the local financial intermediaries that are usually targeted by these measures. Macroprudential policy measures aimed at dampening the accumulation of domestic financial vulnerabilities may have the additional consequence of reducing a country's house price synchronization (Box 3.4). Fiscal-based measures, such as ad valorem and buyers' stamp duty taxes, may also lower house price synchronization, but to a lesser extent than demand-based measures, such as loan-to-value limits. This does not mean that such policy tools should target the reduction of synchronicity. Rather, to the extent that they are able to tame excesses in domestic housing markets, macroprudential policy measures can also reduce the comovement between domestic and foreign house prices and potentially mitigate the influence of global financial conditions. This unintended effect is an aspect to consider when evaluating the consequences of macroprudential policy measures (IMF 2013).

Policymakers wishing to deter foreign buyers of real estate for the purpose of alleviating valuation pressures will likely face a number of challenges. For one, systematically identifying the impact of foreign buyers on housing affordability is difficult because of data limitations. And without a conclusive evidence base on their impact, there may be uncertainty in the appropriate timing and method of intervention in the housing market (Bank of Canada 2017).[24] A range of policy instruments, including tax policy, land-use regulation,

[24]For example, in Hong Kong SAR, a buyers' stamp duty tax affecting foreign buyers has faced limited success in taming house price appreciation, though other housing market policies have had a moderating effect on prices (IMF 2018b). In Canada, foreign buyer taxes in Vancouver and Toronto are expected to mitigate housing market imbalances, but authorities are aware of the uncertainty and scope for spillovers to other areas (Bank of Canada 2017).



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and macroprudential policy measures, may be contemplated to address affordability concerns in residential real estate markets, but the effectiveness of these tools is far from certain. Moreover, some policies may be circumvented, leading to implementation challenges. Last, limiting house purchases in one city or country may steer foreign buyers elsewhere, leaving a role for national or international policy coordination.

More generally, policies that enhance resilience to global financial shocks may also dampen house price synchronicity. In the context of housing markets, exchange rate flexibility seems to play an important role, likely by giving more flexibility to monetary authorities to influence their domestic conditions (Chapter 3 of the April 2017 GFSR). Others may include policies that deepen domestic real estate markets or consumer financial protections to limit excessive or predatory lending to households. While this chapter does not explore the impact of these policies, existing research suggests that such abuses can accelerate during and reinforce housing booms (Bond, Musto, and Yilmaz 2009), and when financial shocks occur, consumer protections may help both insulate households' balance sheets and limit the fallout from household deleveraging, particularly among households with high marginal propensities to consume (Campbell and others 2011; Mian, Rao, and Sufi 2013; Chapter 2 of the October 2017 GFSR).



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## Box 3.1. Global Investors, House Price Dispersion, and Synchronicity

*House price dispersion can be used as a proxy for demand from high-net-worth foreign investors with a preference for luxury housing. Using granular data from the US housing market, this box finds that house price dispersion in the United States has increased sharply over recent decades, and it increases when house prices in alternative investment destinations outside the United States rise. Both findings point to global investors contributing to house price synchronicity across cities and countries.*

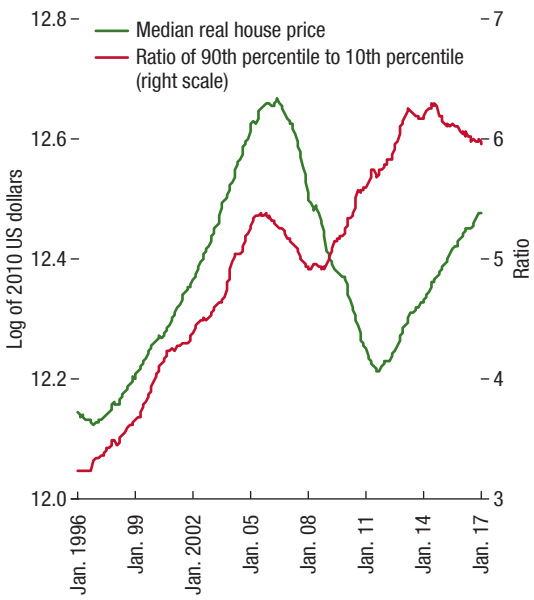
Housing serves a dual purpose: it is a residential good for the local population and an investment good for investors across the globe (Bernanke 2005, 2010; Sá, Wieladek, and Towbin 2014; Badarinza and Ramadorai 2016; Sá 2016). In its capacity as an asset for investment, housing is substitutable geographically and may attract significant amounts of funds from global investors. If this is the case, shocks to demand from global investors may be a source of synchronicity in house prices across cities and countries.

This possibility can be tested by looking at the behavior of house price dispersion, which can capture global investor demand. Global investors may prefer high-end properties in major cities for several reasons. First, information asymmetries may be less severe for high-end properties situated in recognizable areas. Second, investors with anonymity concerns may wish to minimize the number of properties they own. Third, the possibility of future migration may lead them to prefer these markets. To the extent that global investors prefer high-end houses, their prices will rise disproportionately in response to an increase in global investor demand. In other words, an increase in house prices in a global city like London should lead to a larger increase in high-end US house prices than in the median house price, bringing about a rise in house price dispersion.

A measure of house price dispersion in the 40 largest US cities can be constructed by taking the ratio of the top and bottom deciles of house prices.[1] Consistent with rising demand from global investors, house price dispersion has increased sharply in recent decades (Figure 3.1.1).[2] Moreover, there is substantial

This box was prepared by Anil Ari.

**Figure 3.1.1. Real House Prices in 40 Largest US Cities by Population**




Sources: US Census Bureau; Zillow Group; and IMF staff calculations.

[1]This is equivalent to the interpercentile range at log scale. The percentiles are determined by pooling house price estimates from Zillow at the granularity of individual ZIP codes. Cities are ranked according to 2015 population estimates from the US Census Bureau.

[2]An alternative interpretation is that luxury houses are located in areas with tighter constraints on housing supply and therefore experience greater price rises in response to a common rise in demand. However, this interpretation cannot account for the positive significant relationship between house price dispersion and house prices in foreign cities despite controlling for domestic determinants of housing demand (see Annex Table 3.3.2).



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**Box 3.1 *(continued)***

comovement between real house prices and house price dispersion.

Beyond these trends, regression analysis confirms the presence of a statistically significant relationship between US house price dispersion and house prices in alternative investment destinations outside the United States. House prices in major cities outside the United States—Beijing, Dublin, Hong Kong SAR, London, Seoul, Shanghai, Singapore, Tokyo, Toronto, and Vancouver—are positively associated with US house price dispersion. The coefficient associated with the foreign city index is positive and significant in all specifications considered, including those that control for potential domestic determinants of house prices. These findings indicate that common shocks to global investor demand may contribute to house price synchronicity.[3]

[3]An advantage of this approach is that using a measure of house price dispersion eliminates any confounding factors that have a uniform impact across the distribution of US house prices. Regression results are reported in Annex Table 3.3.2. These cities were selected based on the criteria of Cushman & Wakefield (2017) and data availability. The control variables include the unemployment rate as a proxy for economic fundamentals; the Chicago Board Options Exchange Volatility Index (VIX) as a proxy for risk appetite; and the effective federal funds rate, 30-year fixed-rate average mortgage interest rates, and the mortgage-backed security holdings of large domestically chartered commercial banks (excluding mortgage-backed securities with government guarantees) as proxies for ease of access to financing. Specifications with a time trend and a dummy variable for the global financial crisis are also considered.



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## Box 3.2. Housing as a Financial Asset

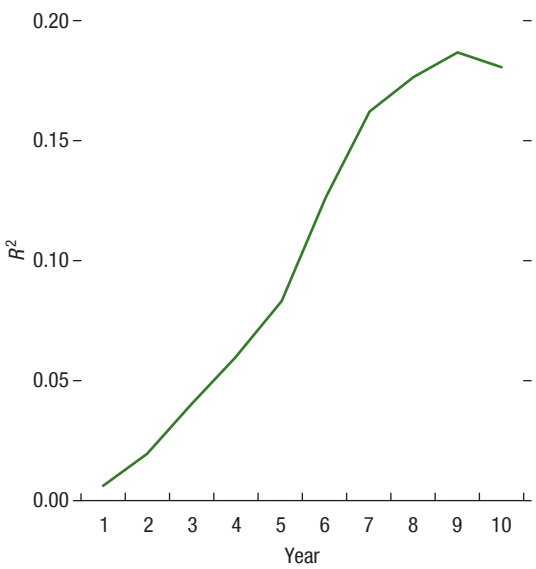
Housing is an important asset class for households and investors. In a typical economy, housing wealth, on average, accounts for roughly one-half of total national wealth and can fluctuate considerably over time (Piketty 2014). Real estate investors often borrow to purchase housing assets, making mortgage payments and receiving rental income and potential capital gains. Publicly traded real estate investment trusts have become available in many countries, allowing investors to invest indirectly in the real estate market. In addition, institutional investors have been increasing their direct exposure to residential real estate in recent years (see Figure 3.3 in the main text).

Investing in housing assets can yield considerable returns in the long term, but is subject to significant variation over time. In many advanced economies, the average annual real return on housing assets between 1950 and 2015 lies between 5 percent and 8 percent, comparable in magnitude to that of equity investment but with a lower standard deviation (Jordà and others 2017). In the shorter term, however, the expected returns on housing assets can vary significantly over time and are affected by the risk appetite of financial market investors as well as other behavioral factors (for example, Cheng, Raina, and Xiong 2014; Brunnermeier and Julliard 2008).

### *Time-Varying Expected Returns on Housing Assets*

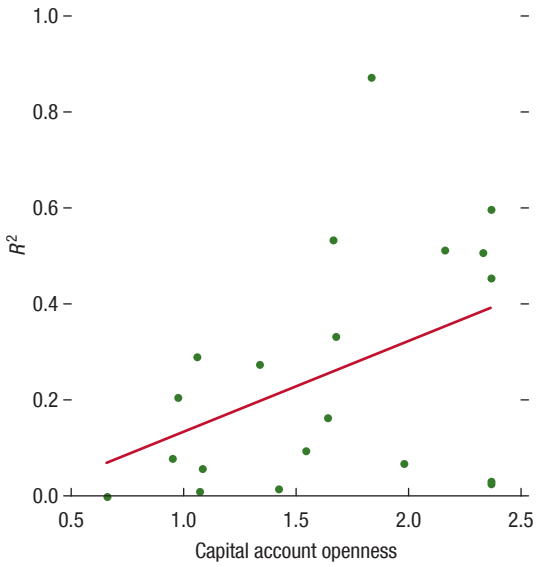
The expected return on housing assets varies over time and is predictable in the medium and long term, a typical feature of financial assets. A high current house-price-to-rent ratio strongly predicts low housing return in the future and vice versa. Moreover, the predictive power increases with the forecasting horizon (Figure 3.2.1), a property similar to many other financial assets, such as stocks (Fama and French

**Figure 3.2.1. Housing Return Predictability**




Source: IMF staff estimates.
Note: The forecasting equation uses the current price-to-rent ratio to predict future capital gains in housing assets. The *y*-axis in this figure shows the $R^2$ from the forecasting equation, that is, the proportion of variance in the future housing return explained by the current price-to-rent ratio. The forecasting horizon ranges from 1 year to 10 years. The median $R^2$ among countries in the sample is plotted in this figure.

**Figure 3.2.2. Predictability of Returns on Housing and Capital Account Openness**




Sources: Chinn and Ito (2006); and IMF staff estimates.
Note: The *y*-axis shows the $R^2$ from the housing return forecasting equation, which measures the proportion of variance in the future housing return nine years ahead explained by the current price-to-rent ratio.

This box was prepared by Alan Xiaochen Feng.



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**Box 3.2 *(continued)***

1988), bonds (Fama and Bliss 1987; Campbell and Shiller 1991), and foreign exchange rates (Hansen and Hodrick 1980). Such a high degree of housing return predictability indicates that house price variation is driven mostly by time-varying risk premiums on housing assets as opposed to shocks to rental income growth. As a result, volatility of house prices is generally much higher than suggested by the volatility of rent growth.

Empirical evidence suggests that housing return predictability is particularly strong in countries with high capital account openness (Figure 3.2.2). In an integrated global financial system, global financial conditions can significantly affect domestic house price variation because domestic prices are more likely to be affected by the risk sentiment of global investors. Consequently, house prices in these countries are more prone to temporary deviations from their domestic rental market fundamentals and are likely to exhibit excess volatility.[1]

[1]The analysis is based on a sample of 20 advanced economies that have long time series for the price-to-rent ratio. The estimated relationships may or may not be the same when emerging market economies are also considered.



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## Box 3.3. The Globalization of Farmland

### *What Is Farmland Globalization?*

Over the past decade there has been an unprecedented increase in the amount of farmland, primarily in low- and middle-income countries, that has been sold or leased through large-scale land acquisitions to international commercial investors. These acquisitions imply the potential conversion of land from, for example, smallholder production or local community use to commercial use. In other words, farmland has become increasingly commodity-like.

Between 2000 and 2016 commercial investors negotiated more than 2,100 large-scale land acquisitions in 88 countries worldwide, with a cumulative size of almost 59 million hectares, roughly equal to 15 percent of the remaining global stock of unused and unforested arable land.[1] Sub-Saharan Africa (about 900 deals) and east Asia (about 600 deals) have been the most important target regions, followed by Latin America (about 350 deals).

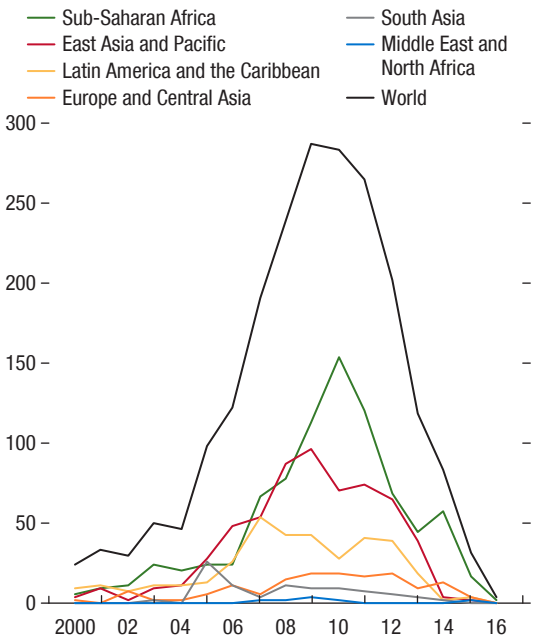
### *What Are the Implications for Farmland Prices?*

Until recently, foreign interest in land in developing economies has been relatively limited. Not surprisingly, agricultural land rent in developing economies has been low compared with that in developed economies. For example, rent on land in Africa has been in the range of $3–$12 a hectare, compared with €100–€240 in the European Union and $200 in the United States (see Collier and Venables 2012). With most land deals now taking place in regions where land rent is currently relatively low, rent on farmland across different regions of the world could converge. To date, however, only 49 percent of the land deals has been cultivated to some extent. These and other facts suggest the convergence process is likely to be very slow.

### *What Drives the Globalization of Farmland?*

Figure 3.3.1 depicts the evolution of the number of land deals over time by target region.[2] It shows how demand for farmland increased in tandem in sub-Saharan Africa and east Asia and the Pacific in the run-up to the 2007–08 global financial crisis and peaked shortly thereafter.

**Figure 3.3.1. Large-Scale Land Acquisitions over Time by Target Region**
*(Number of deals)*




Sources: The Land Matrix Global Observatory; and IMF staff calculations.

### *What Explains the Synchronization of Farmland Demand across Different Regions in the World?*

In the aftermath of the global financial crisis, conventional stocks and assets became riskier, interest rates fell, and biofuel subsidies and prices of agricultural commodities soared. Private investors and food corporations turned to farmland as a new source of profit. In addition to these business cycle factors, the long-term demand for food and hence for farmland has been steadily increasing because of growing populations and rising incomes around the world.

### *What Is the Role of Global Investors?*

Recent research indicates that much of the investment in land by international investors has been directed at remote developing economies that until recently participated little in global agricultural trade

This box was prepared by Christian Bogmans.

[1]See the Land Matrix (www.landmatrix.org), an online database of large-scale land acquisitions that are verified by nongovernmental organizations. The Land Matrix incorporates those deals that lead to a transfer of land rights from one party to another by means of sale, concession, or lease with a size of 200 hectares or more.

[2]The fact that investment has fallen sharply in recent years should not be interpreted as evidence that the interest in farmland has disappeared, because there is a lag in data collection. In addition, many investors may have become less transparent about their operations in developing economies.



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**Box 3.3 *(continued)***

(Arezki, Bogmans, and Selod, forthcoming). Hence, all else equal, more distant locations are preferred to more central locations. As such, these investments signal that capital, technology, and agronomic knowledge in the agricultural sector is flowing to countries that need them the most. By promoting these flows, global investors could be instrumental in driving convergence of global farmland prices.

### *What Are the Policy Implications?*

Attracted by the potential for large future capital gains (from increasing land value), much of the land that has been acquired by financial investors has been held idle for speculative purposes. Depending on whether the land was initially used for small-scale farming or something else, the domestic opportunity costs of these investor strategies are potentially high. This problem has parallels to housing: purchases of housing assets by private and institutional investors in major cities around the world may limit the affordability and availability of housing for the local population. In addition, much land has been acquired in countries where the land rights of existing land users are weak (Arezki, Deininger, and Selod 2013), supposedly because investors can obtain land at a lower cost. Host-country governments can remedy the risks by investing in monitoring capacity to ensure that land is leased to responsible investors and by setting strict rules for compensation to displaced land users (Glaeser, Ponzetto, and Shleifer 2016).



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## Box 3.4. House Price Gap Synchronicity and Macroprudential Policies

*This box analyzes the relationship between macroprudential policies and house price synchronicity. Macroprudential policies targeted at dampening the accumulation of domestic vulnerabilities in the financial and housing sectors may have the indirect effect of reducing the correlation of house price cycles, thereby leaving room for policymakers to regain control over local house price dynamics. Tighter macroprudential tools targeting bank capital and credit conditions are found to be associated with lower house price synchronicity.*

Macroprudential tools, which have been used more actively since the global financial crisis (Alam and others, forthcoming), aim to curb leverage and reduce financial vulnerabilities for the purpose of decreasing the likelihood of domestic asset bubbles and financial crises. Macroprudential policies are usually domestically targeted, with a large share of measures focused on domestic credit and housing market conditions. However, in countries experiencing deeper financial integration, where business cycles are more intertwined at the regional and global levels, house prices are, in part, driven by other factors, such as capital flows from global investors and by global financial conditions.[1] Thus, the relationship between macroprudential tools and house price synchronicity might be ambiguous because it may be offset by other factors.[2]

House price growth seems to evolve differently after the adoption of demand-side macroprudential policies, such as loan-to-value limits, depending on the level of synchronicity (Figure 3.4.1, panel 1). Before the adoption of these policies, house prices grow similarly in countries with high or low house price synchronicity. After they are adopted, house price growth declines in both groups of countries, but the decline is stronger and more sustained in low-synchronicity countries. These simple patterns suggest that policymakers may have more control over the dynamics of the housing market in these countries. At the same time, they suggest that a high degree of synchronicity does not render macroprudential policies ineffective. This could be the case if the financial factors behind house price synchronization operate at least partially through local financial intermediaries.

Macroprudential tools are also associated with a reduction in house price synchronicity (Figure 3.4.1, panel 2).[3] Since these tools mostly affect local financial intermediaries and domestic demand, this finding also suggests that factors driving house price comovement operate, at least partially, through these channels. The relationship between capital-based measures, which include countercyclical capital buffers, and house price synchronicity seems the most negative. Likewise, loan-targeted measures, including loan-to-value limits, and supply-side loan-targeted tools, such as limits on foreign currency loans, are found to lessen correlations with the global house price cycle.[4] The adoption of fiscal-based measures, such as ad valorem and buyers' stamp duty taxes, that could potentially deter global investors from engaging in speculative real estate purchases is also associated with a decline in synchronicity, but to a lesser extent than other macroprudential policies.[5]

This box was prepared by Adrian Alter and Dulani Seneviratne.

[1]House price synchronicity with the global cycle is heterogeneous across regions, potentially reflecting deeper intraregional financial and trade integration.

[2]Recent empirical literature (Cerutti, Claessens, and Laeven 2015; Cerutti, Dagher, and Dell'Ariccia 2017; Vandenbussche, Vogel, and Detragiache 2015) suggests that the role of macroprudential policies in mitigating house price imbalances is less consistent than when household credit is considered. For instance, loan-targeted measures (Akinci and Olmstead-Rumsey 2017) and those that complement monetary policy (Bruno, Shim, and Shin 2017) seem to be most effective in mitigating house price growth. In contrast, there is no robust evidence for the effectiveness of policies such as risk weighting and provisioning requirements (Kuttner and Shim 2016).

[3]The relative magnitude of the effect of macroprudential measures averages about one-half of the effect of global factors and about one-third of the effect of bilateral financial integration. Consistent with Figure 3.15, both global factors and financial integration are positively associated with house price synchronicity.

[4]When only periods with credit booms are considered, the results are both qualitatively and quantitatively similar, although the relationships are slightly less significant.

[5]In some instances, fiscal-based measures target speculative investments, including by foreign buyers (see IMF 2018b).



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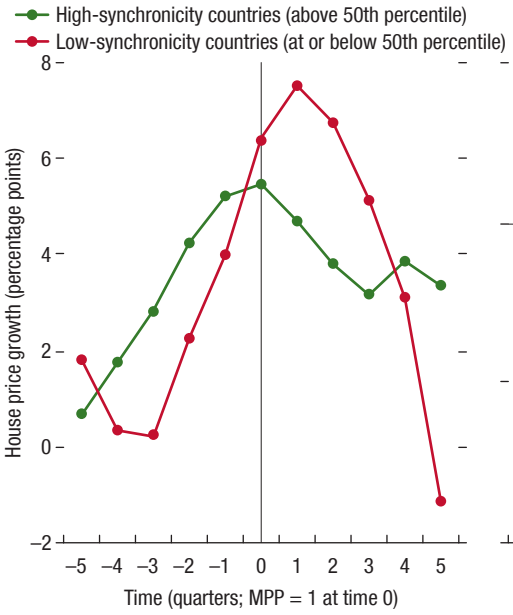
## Box 3.4 *(continued)*

### Figure 3.4.1. Macroprudential Tools Indirectly Reduce House Price Synchronicity

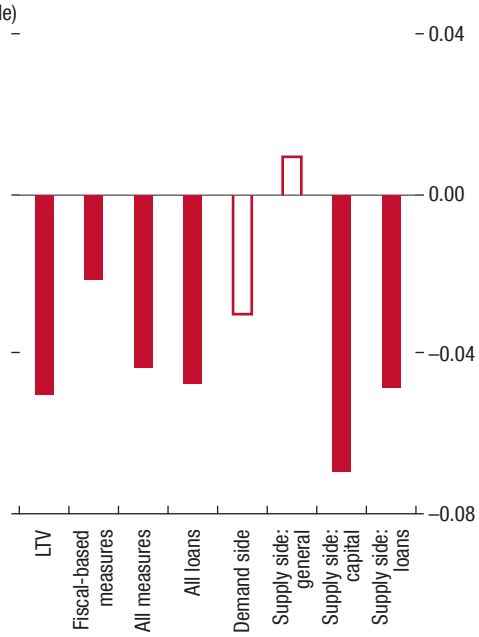
On average, house prices are affected more by demand-side macroprudential policies in low-synchronicity countries.

Supply-side measures targeting bank capital and loan-specific measures, including loan-to-value limits, seem effective in reducing synchronicity with the global cycle.

**1. Average House Price Growth and Demand-Side Macroprudential Policies**




**2. Impact of Macroprudential Measures on House Price Synchronicity (Standard deviations)**




Source: IMF staff estimates.
Note: Panel 1 depicts the average year-over-year house price growth for high-synchronicity and low-synchronicity countries within a period of plus or minus five quarters around the tightening of demand-side macroprudential policies (MPPs). Demand-side MPPs include limits on debt-service-to-income and loan-to-value (LTV) ratios. The total number of demand-side events is 47, and $t = 0$ is identified as the first quarter in which demand-side MPPs were implemented within the plus-or-minus-five-quarter window. Synchronicity is based on the quasi correlation of house price gaps with the global cycle. A country is classified in the high-synchronicity group when its average synchronicity (over the sample period) with the global cycle is above the 50th percentile in the sample, and vice versa. Panel 2 depicts estimated average effects of macroprudential tools on house price synchronicity with the global cycle (refers to through-the-cycle regressions). Solid bars in panel 2 show statistically significant standardized coefficients at the 10 percent confidence level. Estimated panel regressions use data for 41 countries spanning the period 1990:Q2–2016:Q4. Regressions control for business cycle synchronicity, financial integration, and global financial conditions. All regressors are lagged one quarter. Supply side (loans) consists of limits on credit growth, loan loss provisions, loan restrictions, and limits on foreign currency loans. Supply side (capital) consists of capital requirements, conservation buffers, the leverage ratio, and the countercyclical capital buffer. Supply side (general) consists of reserve requirements, liquidity requirements, and limits on foreign exchange positions. Demand side consists of limits to debt-service-to-income and LTV ratios. All loan measures include demand side and supply side (loans). Fiscal-based measures include taxes such as ad valorem, sellers' and buyers' stamp duty, or other taxes. For more details about the macroprudential tools database and estimation details, see Annex 3.3 on the methodology for Box 3.4.



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## Annex 3.1. Data Sources and Country Coverage

### Annex Table 3.1.1. Data Sources

| Variable | Description | Source |
|---|---|---|
| **Country-Level Variables** | | |
| Real House Price Indices | Residential real property prices (seasonally adjusted) at country level (also at city level) | Bank for International Settlements; CEIC Data Co. Ltd; Emerging Markets Economic Data Ltd; Global Financial Data Solutions; Global Property Guide; Haver Analytics; IMF, Research Department house price data set; Organisation for Economic Co-operation and Development; Thomson Reuters Datastream; IMF staff calculations |
| Real House Price Indices (long historical) | Annual nominal house prices starting 1870 for 17 advanced economies, adjusted for inflation | Jordà-Schularick-Taylor Macrohistory database; IMF staff calculations |
| Real GDP | GDP at constant prices, seasonally adjusted | Haver Analytics; Organisation for Economic Co-operation and Development; IMF, Global Data Source database; IMF, World Economic Outlook database |
| Real GDP (long historical) | Annual real GDP starting 1870 for 17 advanced economies | Jordà-Schularick-Taylor Macrohistory database |
| Nominal GDP | GDP at current prices, seasonally adjusted (in both national currency and US dollars) | Haver Analytics; Organisation for Economic Co-operation and Development; IMF, Global Data Source database; IMF, World Economic Outlook database |
| Claims on Private Sector | Depository corporations' claims on private sector, in nominal and real terms (adjusted for inflation), both as nonseasonally adjusted and seasonally adjusted series | Bank for International Settlements; Haver Analytics; IMF, Global Data Source database; IMF staff calculations |
| Equity Returns | Log difference of the equity indices | Bloomberg Finance L.P.; Thomson Reuters Datastream; IMF staff calculations |
| Real Estate Investment Trust Index | Market capitalization of overall and residential real estate trust indices, normalized by the total market capitalization and rebased to 2005:Q1 = 100 | Thomson Reuters Datastream; IMF staff calculations |
| Weighted Average Target Allocations to Real Estate | Based on all institutions, as reported | Jones and Weill (2017) |
| Short-Term Nominal Interest Rate | Three-month Treasury bill or interbank rate | Bloomberg Finance L.P.; Haver Analytics; Thomson Reuters Datastream; IMF staff calculations |
| Real Effective Exchange Rate | Trade-weighted exchange rate vis-à-vis trade partners (adjusted for inflation) | IMF, International Financial Statistics database |
| Bilateral Exchange Rate | National currency per US dollar | IMF, International Financial Statistics database |
| Inflation | Percent change in the consumer price index | Haver Analytics; IMF, Global Data Source database; IMF staff calculations |
| Inflation (long historical) | Percent change in the consumer price index for 17 advanced economies starting 1870 | Jordà-Schularick-Taylor Macrohistory database |
| Trade Openness | Exports plus imports vis-à-vis the world, in percent of GDP | IMF, Direction of Trade database; IMF staff calculations |
| Total Bank Claims and Liabilities | Total locational assets and liabilities vis-à-vis the world in percent of GDP | Bank for International Settlements; IMF staff calculations |
| Financial Openness | Foreign assets plus foreign liabilities in percent of GDP | Lane and Milesi-Ferretti (2007) data set (updated) |
| Financial Development | Domestic credit to private sector in percent of GDP | Bank for International Settlements; Haver Analytics; IMF staff calculations |
| Capital Account Openness | Chinn-Ito index, measuring a country's degree of capital account openness | Chinn and Ito (2006) data set (updated) |
| Exchange Rate Regime | De facto exchange rate regime of a country (variables based on 15 categories and 6 categories are used) | Ilzetzki, Reinhart, and Rogoff (2017) data set |
| Macroprudential Policies | Macroprudential policy tools at quarterly frequency | Alam and others (forthcoming) |
| Large-Scale Land Acquisitions | Number of deals | The Land Matrix Global Observatory |
| Term Spreads | Yield on 10-year government bonds minus yield on three-month Treasury bills | Bloomberg Finance L.P.; Haver Analytics; IMF staff calculations |
| Interbank Spreads | Interbank interest rate minus yield on three-month Treasury bills | Bloomberg Finance L.P.; Haver Analytics; IMF staff calculations |

*(continued)*



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### Annex Table 3.1.1. Data Sources *(continued)*

| Variable | Description | Source |
|---|---|---|
| Change in Long-Term Real Interest Rate | Percentage point change in the 10-year government bond yield, adjusted for inflation | Bloomberg Finance L.P.; Haver Analytics; IMF staff |
| Corporate Spreads | Corporate yield of the country minus yield of the benchmark country. JPMorgan CEMBI Broad is used for emerging market economies where available. | Bloomberg Finance L.P.; Thomson Reuters Datastream |
| Equity Return Volatility | Exponential weighted moving average of equity price returns | Bloomberg Finance L.P.; IMF staff |
| Change in Financial Sector Share | Log difference of the market capitalization of the financial sector to total market capitalization | Bloomberg Finance L.P. |
| Credit Growth | Percent change in the depository corporations' claims on private sector | Bank for International Settlements; Haver Analytics; IMF, International Financial Statistics database |
| Change in Credit to GDP | Change in credit provided by domestic banks, all other sectors of the economy, and nonresidents (in percent of GDP) | Bank for International Settlements; Haver Analytics; IMF staff |
| Sovereign Spreads | Yield on 10-year government bonds minus the benchmark country's yield on 10-year government bonds | Bloomberg Finance L.P.; Haver Analytics; IMF staff |
| Banking Sector Vulnerability | Expected default frequency of the banking sector | Moody's Analytics, CreditEdge; IMF staff |
| Domestic Commodity Price Inflation | A country-specific commodity export price index constructed following Gruss 2014, which combines international commodity prices and country-level data on exports and imports for individual commodities. Change in the estimated country-specific commodity export price index is used. | Bloomberg Finance L.P.; IMF, Global Data Source database; United Nations, COMTRADE database; IMF staff |
| Trading Volume (equities) | Equity markets' trading volume, calculated as level to 12-month moving average | Bloomberg Finance L.P. |
| Market Capitalization (equities) | Market capitalization of the equity markets, calculated as level to 12-month moving average | Bloomberg Finance L.P.; Thomson Reuters Datastream |
| Market Capitalization (bonds) | Bonds outstanding, calculated as level to 12-month moving average | Dealogic; IMF staff |
| **Bilateral-Level Variables** | | |
| Bilateral Bank Claims vis-à-vis Counterparty Economies | Bilateral locational cross-border claims on residency basis | Bank for International Settlements, International Banking Statistics confidential databases |
| Bilateral Gross Trade vis-à-vis Counterparty Economies | Gross exports vis-à-vis counterparty economies | IMF, Direction of Trade database; IMF staff calculations |
| **Global-Level Variables** | | |
| Global Liquidity | Total claims of all Bank for International Settlements reporters vis-à-vis the world, in percent of world GDP | Bank for International Settlements; Haver Analytics |
| US Financial Conditions Index | Positive values of the FCI indicate tighter-than-average financial conditions. For methodology and variables included in the FCI, refer to Annex 3.2 of the October 2017 *Global Financial Stability Report*. | IMF, October 2017 *Global Financial Stability Report* (Chapter 3) |
| Global Financial Conditions Index | Based on a PCA of all FCIs estimated; positive values of the FCI indicate tighter-than-average financial conditions. For methodology and variables included in the FCI, refer to Annex 3.2 of the October 2017 *Global Financial Stability Report*. | IMF, October 2017 *Global Financial Stability Report* (Chapter 3) |
| VIX | Chicago Board Options Exchange Volatility Index | Haver Analytics |
| MOVE | Merrill Lynch Option Volatility Estimate Index | Bloomberg Finance L.P. |
| US Shadow Interest Rates | Wu-Xia and Krippner shadow federal funds rates | Bloomberg Finance L.P.; Haver Analytics |
| Global Oil Prices | Petroleum prices, US dollar a barrel | Bloomberg Finance L.P.; IMF, Global Data Source database |
| Global Commodity Prices | Commodity prices: all primary commodities | IMF, Global Data Source database |

Source: IMF staff.
Note: CEMBI = Corporate Emerging Markets Bond Index; FCI = financial conditions index; MOVE = Merrill Lynch Option Volatility Estimate Index; PCA = principal component analysis; VIX = Chicago Board Options Exchange Volatility Index.



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### Annex Table 3.1.2. Economies and Cities Included in the Analyses

| Economies Included in the Analyses | | | |
|---|---|---|---|
| Australia | Euro area | Italy | Singapore |
| Austria | Finland | Japan | Slovenia |
| Belgium | France | Korea | South Africa |
| Canada | Germany | Malaysia | Spain |
| Chile | Greece | Mexico | Sweden |
| China | Hong Kong SAR | Netherlands | Switzerland |
| Colombia | Hungary | New Zealand | Taiwan Province of China |
| Cyprus | India | Norway | Thailand |
| Czech Republic | Indonesia | Portugal | Turkey |
| Denmark | Ireland | Russia | United Kingdom |
| Estonia | Israel | Serbia | United States |
| **Cities Included in the Analyses[1]** | | | |
| Amsterdam | Dublin | Madrid | South Santiago |
| Athens | Finland metro area | Manila | Southern Seoul |
| Auckland | Greater Stockholm | Mexico City | Sydney |
| Bangkok | Hong Kong SAR (urban areas) | Moscow | Taipei City |
| Belgrade | Inner Paris | Mumbai | Tallinn |
| Berlin | Istanbul | New York City | Tokyo |
| Bogotá | Jakarta | Oslo | Toronto |
| Brussels | Kuala Lumpur | Prague | Vienna |
| Budapest | Lima | Rome | Zurich |
| Buenos Aires | Lisbon | São Paulo | |
| Copenhagen | Ljubljana | Singapore (core central region) | |
| Dubai | London | Shanghai | |

Source: IMF staff.
[1]Cities selected are the largest cities based on population owing to data availability, and overlap with the top 50 cities for global investors identified by Cushman & Wakefield (2017). An additional sample comprising 76 cities based on the top 30 cities for global investors in Cushman & Wakefield's (2017) Global Capital Markets 2017 report's economic scale, financial center, technology hub, and innovation pillars is also used in robustness checks. In the latter data set, if none of the cities in an economy (where data are available) are chosen based on the four pillars stated above, the largest city by population owing to data availability is used.

## Annex 3.2. Measuring Synchronization and Country-Pair Analysis

### Measuring Synchronization

First, the instantaneous quasi correlation (Morgan, Rime, and Strahan 2004; Kalemli-Özcan, Papaioannou, and Perri 2013; Kalemli-Özcan, Papaioannou, and Peydró 2013; Duval and others 2016) in house price gaps[25] is defined as follows:

$$HPsynch_{ijt} = QCORR_{ijt} = \frac{\left(HPgap_{it} - \overline{HPgap_i}\right)\left(HPgap_{jt} - \overline{HPgap_j}\right)}{\sigma_i^{gap}\sigma_j^{gap}}, \quad \text{(A3.2.1)}$$

in which $HPgap_{it}$ and $HPgap_{jt}$ stand for house price gaps of countries $i$ and $j$, respectively, at quarter $t$, and the gaps are measured as explained in note 25. $\overline{HPgap_i}$ and $\overline{HPgap_j}$ are the average house price gaps of countries $i$ and $j$, respectively, and $\sigma_i^{gap}$ and $\sigma_j^{gap}$ are the standard deviations of house price gaps of countries $i$ and $j$, respectively.

Second, the negative of the absolute difference of house price gaps in countries $i$ and $j$ at quarter $t$ is calculated as follows:

$$HPsynch_{ijt} = Synch1_{ijt} = -\left|HPgap_{it} - HPgap_{jt}\right|. \quad \text{(A3.2.2)}$$

Third, based on a dynamic factor model (Kose, Otrok, and Prasad 2012; Kose, Prasad, and Terrones 2003; Del Negro and Otrok 2007), the synchronization measure for house prices for country $i$, $synch_{L,i,t}$, is defined as:

$$synch_{L,i,t} = \frac{var_L\left(\lambda_{i,t}g_t\right) + var_L\left(\lambda_{r,i}r_{k,t}\right)}{var_L\left(h_{i,t}\right)} \text{ or}$$

$$synch_{L,i,t} = \frac{var_L\left(\lambda_{i,t}g_t\right)}{var_L\left(h_{i,t}\right)}, \quad \text{(A3.2.3)}$$

[25]House price gaps are measured by extracting the cyclical component of real house prices using the band-pass filter of Christiano and Fitzgerald (2003), with a maximum length of 20 years to capture medium-term financial cycles. The cyclical components of house prices are then taken as a ratio of house price levels to obtain house price gaps. As a robustness check, house price gaps are also constructed using a Hodrick and Prescott (1997) filter with a lambda of 400,000, which is commonly used as the lambda relevant for financial cycles. House price gaps broadly consistent with those of the Christiano and Fitzgerald (CF) filter are obtained. The CF filter is chosen for the analysis because it computes the cyclical component for all observations without being prone to tail bias.



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in which $var_L(\cdot)$ is the realized variance from period $t - L$ to $t$, $\lambda_{i,t}$, and $\lambda_{r,i}$ are the factor loadings to the global, $g_t$, and regional, $r_{k,t}$, factors. In the model, the quarterly growth rate of house prices for country $i$ in period $t$, $h_{i,t}$ consists of the global factor, $g_t$, the regional factor for region $k$ ($k$ = *Europe, Asia,* and *the Americas*), $r_{k,t}$, and the country-specific idiosyncratic component, $c_{i,t}$. See Annex 3.3 for more details on the dynamic factor models and related analyses.

## Country-Pair Analysis[26]

This analysis uses bilateral country-pair panel data to estimate the impact of business cycle synchronization, bilateral financial links, and global factors on house price synchronization. The baseline econometric specification presented below is estimated at quarterly frequency spanning the period 1990–2016, for 40 countries:[27]

$$\begin{aligned} HPsynch_{ijt} = {} & \alpha_{ij} + \beta_1 BCS_{ijt-1} + \beta_2 FININT_{ijt-1} \\ & + \beta_3 GLOBAL_{t-1} \\ & + \beta_4 INST_{ijt-1} \times GLOBAL_{t-1} \\ & + \beta_5 OTHER_{ijt-1} + tr + \varepsilon_{ijt}, \end{aligned} \qquad \text{(A3.2.4)}$$

in which $HPsynch_{ijt}$ is the synchronization of house price gaps between country-pairs $i$ and $j$ at quarter $t$. $BCS_{ij}$ denotes business cycle synchronization between countries $i$ and $j$.[28] $FININT_{ij}$ refers to bilateral financial integration between countries $i$ and $j$.[29] $GLOBAL_t$ is the global factor proxied by changes in global liquidity (see Annex Table 3.1.1 for descriptions of variable).

$INST_{ij}$ denotes dummies that equal 1 if both countries have a high level of an institutional characteristic (that is, economic development level, capital account openness, exchange rate flexibility, or financial development).[30] $OTHER_{ij}$ includes other controls (for example, institutional factors). All regressors are lagged by one quarter. In addition, linear and quadratic time trends ($tr$) are included. The term $\alpha_{ij}$ is the country-pair fixed effects capturing unobservable time-invariant idiosyncratic factors common to country-pairs $i$ and $j$, such as geographic proximity. The error term is $\varepsilon_{ijt}$.[31] Importantly, country-pair fixed effects capture how time-invariant supply-side and regulatory considerations influence house price synchronicity between two countries. Results are presented in Annex Tables 3.2.1 and 3.2.2.[32]

### *Robustness Checks*

In addition to the results in Annex Tables 3.2.1 and 3.2.2, various robustness checks are performed, with the main findings broadly unchanged. For instance, alternative proxies for global liquidity include the US financial conditions index (FCI), global FCI, Chicago Board Options Exchange Volatility Index (VIX), US shadow interest rates (in the spirit of Wu and Xia 2016; and Krippner 2013).[33] The specifications above were also estimated by replacing business cycle synchronization with interest rate synchronization to investigate the contribution of synchronized monetary policies to house price synchronization. Interest rate synchronization is found to be a statistically significant driver of house price synchronization on its own when either synchronicity measure is used (either Synch1 or quasi correlation). However, the statistical significance of interest rate synchronicity above and beyond other financial factors, such as global liquidity and bilateral banking links, is robust only to a less stringent manner

[26]Prepared by Adrian Alter and Dulani Seneviratne.

[27]Although the house price time series in this analysis, particularly for advanced economies, start several decades before 1990, the econometric analysis is restricted to series beginning in 1990 because the availability of data on bilateral banking links significantly improves that year. Four emerging markets out of the sample of 44 countries in the econometric analysis are excluded because of the short length of their house price time series.

[28]Business cycle synchronization measures are calculated similarly to house price synchronicity.

[29]Financial integration is measured using bilateral locational banking statistics on residency basis obtained from Bank for International Settlements International Banking Statistics confidential databases. Bilateral banking integration is measured as the logarithm of the sum of bilateral claims of country $i$ vis-à-vis country $j$ and bilateral claims of country $j$ vis-à-vis country $i$ as a ratio of the sum of the GDPs of countries $i$ and $j$. Additional forms of bilateral financial integration measures, such as bilateral portfolio links and bilateral direct investment links, are not used in the analysis because of their lower frequency and much shorter time span.

[30]High level is defined based on the top fifth of the distribution of institutional characteristics at any time. In addition, robustness checks were performed by defining the institutional factors as high if both countries are at or above the 75th or 66th percentiles instead of the 80th percentile.

[31]To account for serial correlation, following Cameron, Gelbach, and Miller (2011), standard errors are multiway clustered (at country $i$, country $j$, and time level, where appropriate).

[32]Similar analyses for city-level house prices were performed, in which the dependent variable is city-level house price gap synchronization, and the explanatory variables are the same as the variables presented in this annex (see Figure 3.15 for city-level results).

[33]Although results are robust to these alternative proxies for the global factor, when some proxies are combined with the most stringent manner of standard error clustering, the level of statistical significance declines.



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## Annex Table 3.2.1. House Price Gap Synchronization at Country Level and Bilateral Linkages

| **Dependent Variable: House Price Gap Synchronization of Country Pair *i* and *j* (Synch1)** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** |
|---|---|---|---|---|---|---|---|---|---|---|
| Business Cycle Synchronization of *ij* | 0.766*** | 0.675** | 0.733*** | 0.657** | 0.658** | 0.746*** | 0.725*** | 0.725*** | 0.675** | 0.706** |
| | (0.254) | (0.293) | (0.243) | (0.254) | (0.253) | (0.262) | (0.261) | (0.262) | (0.253) | (0.337) |
| Bilateral Bank Integration of *ij* | | | 0.006* | 0.007** | 0.012 | 0.009* | 0.007** | 0.007* | 0.007** | 0.004 |
| | | | (0.003) | (0.003) | (0.007) | (0.004) | (0.003) | (0.004) | (0.003) | (0.005) |
| Global Factor (global liquidity) | | | | –0.001 | –0.001 | –0.001 | –0.001 | –0.001 | –0.001 | 0.001 |
| | | | | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Bilateral Bank Integration Interacted with: | | | | | | | | | | |
| × EMEs-EMEs Dummy | | | | | –0.016* | | | | | |
| | | | | | (0.009) | | | | | |
| × EMEs-AEs Dummy | | | | | –0.009 | | | | | |
| | | | | | (0.010) | | | | | |
| × High Capital Account Openness with the World | | | | | | –0.005 | | | | |
| | | | | | | (0.003) | | | | |
| × High Exchange Rate Regime (*ij*) (15 categories; high = more flexible) | | | | | | | –0.005 | | | |
| | | | | | | | (0.004) | | | |
| × High Exchange Rate Regime (*ij*) (6 categories; high = more flexible) | | | | | | | | –0.001 | | |
| | | | | | | | | (0.004) | | |
| × High Financial Openness with the World (*ij*) | | | | | | | | | –0.019*** | |
| | | | | | | | | | (0.004) | |
| GFC Period Dummy Interacted with: | | | | | | | | | | |
| × Business Cycle Synchronization of *ij* | | | | | | | | | | –0.080 |
| | | | | | | | | | | (0.516) |
| × Bilateral Bank Integration of *ij* | | | | | | | | | | 0.008** |
| | | | | | | | | | | (0.004) |
| × Global Factor | | | | | | | | | | 0.001 |
| | | | | | | | | | | (0.001) |
| Post-GFC Period Dummy Interacted with: | | | | | | | | | | |
| × Business Cycle Synchronization of *ij* | | | | | | | | | | 0.380 |
| | | | | | | | | | | (0.456) |
| × Bilateral Bank Integration of *ij* | | | | | | | | | | 0.007 |
| | | | | | | | | | | (0.005) |
| × Global Factor | | | | | | | | | | 0.004 |
| | | | | | | | | | | (0.003) |
| GFC Dummy | | | | | | | | | | 0.048*** |
| | | | | | | | | | | (0.011) |
| Post-GFC Dummy | | | | | | | | | | 0.042*** |
| | | | | | | | | | | (0.009) |
| Observations | 65,450 | 65,343 | 49,384 | 49,384 | 49,384 | 43,871 | 46,708 | 46,708 | 47,353 | 49,384 |
| $R^2$ | 0.353 | 0.498 | 0.386 | 0.356 | 0.356 | 0.361 | 0.356 | 0.356 | 0.360 | 0.360 |
| Multiway Clustering | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Two-way |
| Time FE and Country-Pair FE | Yes | | Yes | | | | | | | |
| Time FE, Country-Pair FE, and country*time FE | | Yes | | | | | | | | |
| Quadratic Trend and Country-Pair FE | | | | Yes | Yes | Yes | Yes | Yes | Yes | |
| Country-Pair FE | | | | | | | | | | Yes |

Source: IMF staff estimates.

Note: GFC Period Dummy = a dummy variable that equals 1 during 2008–09 and zero otherwise. Post-GFC Period Dummy = a dummy variable that equals 1 during 2010–16 and zero otherwise. All regressors are lagged by one quarter. Institutional characteristics dummies are included in specifications 5 through 9, but are not shown above (specifically, dummy variables for EMEs-EMEs, EMEs-AEs, high capital account openness, high exchange rate regime, and high financial openness are included in specifications 5 through 9, but not shown). High = a dummy variable that equals 1 when both countries are in the top fifth of the institutional characteristic. Standard errors (in parentheses) are three-way clustered (at country *i*, country *j*, and date), with the exception of regression 10, in which errors are two-way clustered (at country *i*, country *j*). The standard deviation for business cycle synchronization is 0.0124 and 1.040 for bilateral bank integration. AEs = advanced economies; EMEs = emerging market economies; FE = fixed effects; GFC = global financial crisis; Synch1 = synchronization measure introduced in the text of this annex.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.



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## Annex Table 3.2.2. House Price Gap Synchronization at Country Level and Global Factors

| **Dependent Variable: House Price Gap Synchronization of Country Pair *i* and *j* (Quasi correlation)** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** |
|---|---|---|---|---|---|---|---|---|---|---|
| Business Cycle Synchronization of *ij* | 0.025* | 0.030** | 0.022 | 0.026* | 0.026* | 0.025* | 0.026* | 0.026* | 0.026** | 0.042 |
| | (0.013) | (0.014) | (0.014) | (0.013) | (0.013) | (0.015) | (0.014) | (0.014) | (0.013) | (0.033) |
| Bilateral Bank Integration of *ij* | | | –0.011 | 0.012 | 0.012 | 0.011 | 0.022 | 0.022 | 0.012 | –0.016 |
| | | | (0.033) | (0.031) | (0.031) | (0.036) | (0.036) | (0.035) | (0.032) | (0.034) |
| Global Factor (global liquidity) | | | | 0.016** | 0.016** | 0.020** | 0.019*** | 0.019** | 0.018** | 0.022* |
| | | | | (0.006) | (0.008) | (0.008) | (0.007) | (0.007) | (0.007) | (0.013) |
| Global Factor Interacted with: | | | | | | | | | | |
| × EMEs-EMEs Dummy | | | | | –0.001 | | | | | |
| | | | | | (0.009) | | | | | |
| × EMEs-AEs Dummy | | | | | 0.000 | | | | | |
| | | | | | (0.006) | | | | | |
| × High Capital Account Openness with the World | | | | | | –0.002 | | | | |
| | | | | | | (0.005) | | | | |
| × High Exchange Rate Regime (*ij*) | | | | | | | –0.023*** | | | |
| (15 categories; high = more flexible) | | | | | | | (0.008) | | | |
| × High Exchange Rate Regime (*ij*) | | | | | | | | –0.009 | | |
| (6 categories; high = more flexible) | | | | | | | | (0.007) | | |
| × High Financial Openness with the World (*ij*) | | | | | | | | | 0.003 | |
| | | | | | | | | | (0.006) | |
| GFC Period Dummy Interacted with: | | | | | | | | | | |
| × Business Cycle Synchronization of *ij* | | | | | | | | | | –0.032 |
| | | | | | | | | | | (0.038) |
| × Bilateral Bank Integration of *ij* | | | | | | | | | | –0.022 |
| | | | | | | | | | | (0.035) |
| × Global Factor | | | | | | | | | | –0.025* |
| | | | | | | | | | | (0.012) |
| Post-GFC Period Dummy Interacted with: | | | | | | | | | | |
| × Business Cycle Synchronization of *ij* | | | | | | | | | | –0.039 |
| | | | | | | | | | | (0.035) |
| × Bilateral Bank Integration of *ij* | | | | | | | | | | 0.010 |
| | | | | | | | | | | (0.033) |
| × Global Factor | | | | | | | | | | –0.029 |
| | | | | | | | | | | (0.018) |
| GFC Dummy | | | | | | | | | | –0.137** |
| | | | | | | | | | | (0.060) |
| Post-GFC Dummy | | | | | | | | | | –0.044 |
| | | | | | | | | | | (0.052) |
| Observations | 65,450 | 65,343 | 49,384 | 49,384 | 49,384 | 43,871 | 46,708 | 46,708 | 47,353 | 49,384 |
| $R^2$ | 0.227 | 0.354 | 0.251 | 0.230 | 0.230 | 0.233 | 0.224 | 0.223 | 0.241 | 0.232 |
| Multiway Clustering | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Two-way |
| Time FE and Country-Pair FE | Yes | | Yes | | | | | | | |
| Time FE, Country-Pair FE, and country*time FE | | Yes | | | | | | | | |
| Quadratic Trend and Country-Pair FE | | | | Yes | Yes | Yes | Yes | Yes | Yes | |
| Country-Pair FE | | | | | | | | | | Yes |

Source: IMF staff estimates.

Note: GFC Period Dummy = a dummy variable that equals 1 during 2008–09, and zero otherwise. Post-GFC Period Dummy = a dummy variable that equals 1 during 2010–16, and zero otherwise. All regressors are lagged by one quarter. Institutional characteristics dummies are included in specifications 5 through 9, but are not shown above (specifically, dummy variables for EMEs-EMEs, EMEs-AEs, high capital account openness, high exchange rate regime, and high financial openness are included in specifications 5 through 9, but not shown). High = a dummy variable that equals 1 when both countries are in the top fifth of the institutional characteristic. Standard errors (in parentheses) are three-way clustered (at country *i*, country *j*, and date), with the exception of regression 10, in which errors are two-way clustered (at country *i*, country *j*). AEs = advanced economies; EMEs = emerging market economies; FE = fixed effects; GFC = global financial crisis.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.



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of standard error clustering (for instance, clustering at the country-pair and time dimension or computing robust standard errors instead of the multiway clustering of standard errors used in the main analyses). Moreover, trade integration was included as an additional control, but found not to be statistically significant. When equity price synchronization is included as an additional control, the results presented in Annex Tables 3.2.1 and 3.2.2 remain broadly unchanged. However, equity price synchronization itself does not consistently have a statistically significant relationship with house price synchronization.

Various clustering alternatives were used (clustering at country-pair level, two-way at country *i* and country *j*, two-way at country-pair and time levels, and without clustering, robust), and as expected, the level of significance improves under less restrictive clustering options. Additional time controls, such as year fixed effects and linear time trends, were also analyzed with little change to the main conclusions. Additional robustness checks were performed by dropping one country pair at a time.

In a separate exercise, regressions were run using a panel of three nonoverlapping seven-year periods in which house price and business cycle synchronization is captured by the bilateral Pearson correlation coefficients for the period. Explanatory variables apart from business cycle synchronization are the average values for the period. Further robustness checks in this exercise were explored by collapsing the other explanatory variables using the last value of the previous period instead. The interaction term of the global factor and foreign exchange regime is still found to be statistically significant, in addition to the global factor itself.

The relationship between house price gap synchronicity and business cycle synchronization is found to be positive and statistically significant when using the Jordà, Schularick, and Taylor (2017) data set, which starts in 1870 for 17 advanced economies at annual frequency. Additional analysis was limited by data availability.

## Annex 3.3. Technical Annex

### Measuring Synchronicity: Conceptual Issues[34]

Measuring whether house prices move in tandem can take many approaches; this chapter focuses on three commonly used techniques to take advantage of each method's strengths (for example, see Hirata and others 2012; Del Negro and Otrok 2007; Jara and Romero 2016; and Landier, Sraer, and Thesmar 2017). For simplicity, assume the economy consists of two countries, *i* and *j*. Based on the framework in Doyle and Faust (2005), house prices in each country, $h_i$ and $h_j$, can be decomposed into a common factor, $\varepsilon_c$, and an idiosyncratic factor for each country, $\varepsilon_i$ and $\varepsilon_j$:

$$h_i = \varepsilon_c + \varepsilon_i + \gamma h_j, \text{ and } h_j = \varepsilon_c + \varepsilon_j + \gamma h_i . \quad \text{(A3.3.1)}$$

Here, $0 \le \gamma < 1$ represents the interconnectedness of house prices between the two countries. Simple arithmetic yields the following:

$$h_i = \frac{1}{1-\gamma^2}\left[\varepsilon_i + \gamma\varepsilon_j + (1+\gamma)\varepsilon_c\right], \text{ and}$$

$$h_j = \frac{1}{1-\gamma^2}\left[\varepsilon_j + \gamma\varepsilon_i + (1+\gamma)\varepsilon_c\right] . \quad \text{(A3.3.2)}$$

Without loss of generality, we assume that the size of the variance of the idiosyncratic shock is the same between the two countries (that is, $\sigma_i = \sigma_j$), all shocks are independent of each other (that is, $\sigma_{ij} = \sigma_{ic} = \sigma_{jc} = 0$), and house prices in each country have a mean of zero. In what follows, we define the three measures of synchronization used in the main text based on this framework and explain how we interpret those measures.

First, the instantaneous quasi correlation ($qc_{ijt}$) is defined in this framework as follows:

$$\begin{aligned} qc_{ijt} &= h_{it}h_{jt}/\sigma_{h_i}\sigma_{h_j} \\ &= \frac{1}{(1-\gamma^2)^2\sigma_{h_i}\sigma_{h_j}}\Big[\gamma\left(\varepsilon_{it}^2+\varepsilon_{jt}^2\right) + (1+\gamma)\varepsilon_{it}\varepsilon_{jt} \\ &\quad + (1+\gamma)\left(\varepsilon_{it}\varepsilon_{ct}+\varepsilon_{ct}\varepsilon_{jt}+\varepsilon_{ct}^2\right)\Big]. \end{aligned} \quad \text{(A3.3.3)}$$

When $\gamma$ is not very large, the squared terms for idiosyncratic shocks, $\varepsilon_{it}^2 + \varepsilon_{jt}^2$, do not have large effects on this measure. In addition, since the interaction terms, $\varepsilon_i\varepsilon_j$, $\varepsilon_i\varepsilon_c$, and $\varepsilon_c\varepsilon_j$, fluctuate around zero, systematic movements of $qc_{ijt}$ are driven by the square term of the common shock $(1+\gamma)\varepsilon_c^2$. Hence, this measure is suitable for identifying short-term comovement of house prices that is caused by the common shock and, indeed, as seen in Figure 3.7, sharp movements in the instantaneous quasi correlation are observed around global recessions in advanced economies, which, in this framework, points to a role for a common rather than an idiosyncratic shock driving the spike.

Second, the bilateral absolute difference in house prices between two countries ($ad_{ijt}$) is defined in this framework as follows:

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$$ad_{ijt} = -\left|h_{it} - h_{jt}\right| = -\frac{1}{1+\gamma}\left|\varepsilon_{it} - \varepsilon_{jt}\right|. \qquad \text{(A3.3.4)}$$

In contrast to the instantaneous quasi correlation, this measure is independent of the common shock because it cancels out. Given that idiosyncratic shocks are independent of one another and that their absolute difference moves almost randomly, this measure is suitable for assessing a long-term trend in synchronicity driven by changes in $\gamma$ (the interconnectedness of house prices). Hence, the increasing trend in $ad_{ijt}$, as is observed in both advanced and emerging market economies, implies that the interconnectedness of housing markets across countries represented by $\gamma$ has been increasing over the long term.

Third, the relative contribution of the global factor in country $i$ ($rc_i$) is defined in this framework as follows:

$$rc_i = \frac{var\left(\frac{1+\gamma}{1-\gamma^2}\varepsilon_c\right)}{var(h_i)} = \frac{\sigma_c^2}{\frac{1+\gamma^2}{(1+\gamma)^2}\sigma_i^2 + \sigma_c^2}. \qquad \text{(A3.3.5)}$$

As long as we estimate these variances using a relatively long-term window (for example, 15 years), this measure is suitable for identifying a long-term trend in synchronization. An observed increasing trend in $rc_i$, as is the case in advanced economies in the past two decades, could include any or all of three possibilities: (1) the size of common shocks has become larger ($\sigma_c$ has risen); (2) the size of idiosyncratic shocks has become smaller ($\sigma_i$ has declined); and (3) the interconnectedness has become tighter ($\gamma$ has risen). Hence, this measure is a comprehensive measure for house price synchronicity, but it is empirically difficult to separately identify the above three cases using this measure.

## Estimation of a Dynamic Factor Model[35]

House price dynamics are decomposed into the common and idiosyncratic factors by a dynamic factor model with time-varying parameters. In the model, the quarterly growth rate of house prices for country $i$ in period $t$, $h_{i,t}$, consists of the global factor, $g_t$, the regional factor for region $k$ ($k$ =*Europe, Asia,* and *the Americas*), $r_{k,t}$, and the country-specific idiosyncratic component, $c_{i,t}$:

$$h_{i,t} = \lambda_{g,i}g_t + \lambda_{r,i}r_{k,t} + c_{i,t}, \qquad \text{(A3.3.6)}$$

in which $\lambda_{g,i}$ and $\lambda_{r,i}$ are the factor loadings on the global and regional factors. The regional factor is extracted by region from the residuals after extracting the global factor. The global and regional factors are assumed to follow the vector autoregression jointly with global output, global inflation, and the global interest rate, which are the first principal components of each sequence across countries, and the time-varying factor loadings and the vector autoregression parameters are simultaneously estimated by the two-step procedure proposed in Koop and Korobilis (2013).

The relationship between house price synchronization and financial and trade openness is examined by the panel regression using the synchronization measured by estimating a dynamic factor model ($synch_{L,i,t}$):

$$synch_{L,i,t} = \alpha_i + \delta_t + \beta_1 kaopen_{i,t} + \beta_2 tr_{i,t} + \gamma Z_{i,t} + \varepsilon_{i,t}, \qquad \text{(A3.3.7)}$$

in which $\alpha_i$ is a country fixed effect and $\delta_t$ is a time dummy. Here, financial openness is measured by capital account openness as represented by the Chinn-Ito index (Chinn and Ito 2006), $kaopen_{i,t}$, and trade openness is measured by the ratio of gross trade volume to GDP, $tr_{i,t}$. A vector of control variables, $Z_{i,t}$, includes the level of real GDP and consumer price index inflation. We use 15 years for the length of the fixed window for $synch_{L,i,t}$ for the baseline results and present results for 20 years as a robustness check. Also, for the measures of financial and trade openness, $kaopen_{i,t}$ and $tr_{i,t}$, the weighted average over the length of the window $\left(\text{that is, } \frac{1}{\sum_{l=0}^{L}(l+1)}\sum_{l=0}^{L-1}(l+1)x_{i,t-l}\right)$ is used. The weighted average assigns greater weight to the periods close to the beginning of the window because financial and trade openness may take some time to have effects on synchronization.

For house price synchronization, Annex Table 3.3.1 shows that $\beta_1$ and $\beta_2$ are positive and statistically significant. This result implies that, among 19 advanced economies that can be observed for a longer period, increases in financial and trade openness over time partly account for the rise in exposure to the global factor. Financial openness also explains the increase in the comovement in equities. Taken together, those results suggest that house price synchronization can be understood as part of asset price synchronization induced by the progress of financial openness more generally.

## Growth at Risk[36]

### *Data Partitioning*

To avoid parameter inflation and to reduce noise in financial time series, financial data are aggregated

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[36]Prepared by Romain Lafarguette.



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### Annex Table 3.3.1. Capital Account Openness and Synchronicity

| | House Price Synchronicity | | Equity Price Synchronicity | |
|---|---|---|---|---|
| | 15 years | 20 years | 15 years | 20 years |
| Chinn-Ito Index | 0.06691** | 0.06220*** | 0.13516** | 0.12603*** |
| | (0.02387) | (0.01585) | (0.04697) | (0.02585) |
| Exports plus Imports (over GDP) | 0.00911** | 0.01096*** | –0.00160 | –0.00715* |
| | (0.00394) | (0.00351) | (0.00416) | (0.00346) |
| Log of Output | 0.22121 | 0.27416** | 0.80820* | 0.86895*** |
| | (0.13475) | (0.11590) | (0.43479) | (0.21138) |
| Inflation | 0.02439 | 0.00052 | 0.02031 | 0.01830** |
| | (0.02069) | (0.00643) | (0.02969) | (0.00775) |
| Observations | 1,861 | 1,645 | 1,296 | 1,140 |
| $R^2$ | 0.38823 | 0.47414 | 0.71709 | 0.88296 |
| Number of Countries | 19 | 19 | 12 | 12 |

Source: IMF staff estimates.
Note: 15 years and 20 years correspond to the window for variance decomposition. Robust standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

between three ad hoc groups of variables representing, respectively, price of risk, leverage, and external factors.[37] The data-reduction technique used is linear discriminant analysis (LDA); the goal of LDA is to project a data set onto a lower-dimensional space while ensuring adequate separation of data into categories. LDA is similar to principal components analysis (PCA) in the sense that it maximizes the common variance among a set of variables, but it diverges from PCA in also ensuring that the linear combination of the variables discriminates across the classes of another categorical variable of interest. In the framework of the chapter, this categorical variable is a dummy variable, defined at the country level, equaling 1 when future GDP growth at a one-year horizon is below the 20th percentile of historical outcomes and equaling zero otherwise. Consequently, the loading on each individual financial indicator in the LDA is determined in a way that maximizes its contribution to discriminating between periods of low GDP growth and periods of normal GDP growth. This is convenient from the chapter's perspective because it allows for a link between financial indicators and GDP growth in the data-reduction process. By contrast, the PCA approach only aggregates information about the common trend among financial indicators.[38]

[37]The tables in Annex 3.2 in Chapter 3 of the October 2017 *Global Financial Stability Report* describe the specific financial indicators used.

[38]LDA assumes independence of normally distributed data and homoscedastic variance among each class, although LDA is considered robust when these assumptions are violated. See Duda, Hart, and Stork (2001). See Izenman (2009) for a thorough exposition of the LDA technique.

### *Quantile Regressions*

The complex interplay between financial variables, house price synchronicity, and GDP growth is captured through a simple nonlinear framework using panel quantile regressions.[39] The model investigates the relative significance of asset prices, credit aggregates, foreign factors, and house price synchronicity in signaling risks to GDP growth ($y$), $h$ quarters ahead.

The estimation is performed over different quantiles, spanning the full GDP growth distribution at different horizons (near, medium, and long term):

$$y_{t+h,q} = \alpha_q^h p_t + \beta_q^h Agg_t + \gamma_q^h y_t + \phi_q^h f_t + \theta_q^h HP_t + \epsilon_{t,q}^h, \quad \text{(A3.3.8)}$$

in which $p$, $Agg$, $f$, and $HP$ correspond to the aggregated data of the price of risk (asset prices and risk spreads), credit aggregates (leverage), global and foreign variables (commodity prices, exchange rates, and global risk sentiment), and house price synchronicity.

[39]For an introduction to quantile regression, see Koenker (2005). As discussed in Komunjer (2013), quantile regressions rely on specific functional form assumptions and have some important advantages in forecasting the conditional distribution of the variable of interest. These advantages include the optimality of the conditional quantile estimator as a predictor of the true future quantile; robustness of the estimation to extreme outliers and violations of normality and homoscedasticity of the errors; flexibility, in terms of allowing for time-varying structural parameters and the optimal weighting of predictors depending on country, horizon, and the part of the distribution that is of interest; and the ability to avoid overfitting (compared with more complex models such as copulas and extreme value theory). Panel quantile regressions are estimated using the methodology proposed by Koenker (2004).



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The role of house price synchronicity in signaling downside and upside risks to future growth can also function through amplification effects, particularly in conjunction with higher leverage or tighter financial conditions. To investigate this amplification mechanism, an augmented specification is considered:

$$y_{t+h,q} = \alpha_q^h p_t + \beta_q^h Agg_t + \gamma_q^h y_t + \phi_q^h f_t + \theta_q^h HP_t + \varsigma_q^h HP_t \times Agg_t(or\, p_t) + \epsilon_{t,q}^h. \quad \text{(A3.3.9)}$$

The coefficient $\varsigma_q^h$ represents the amplification effect of the impact of house price synchronicity when leverage increases or when financial conditions tighten. Overall, this approach disentangles the contribution of changes in house price synchronicity from the evolving price of risk, credit aggregates, and shocks to the external environment to forecasting risks to GDP growth. It thereby provides insights into which variables signal growth tail risks over different time horizons. This can help policymakers and others design a surveillance framework that seeks to embed information flowing in at different frequencies.

## Methodology for Boxes

### Methodology: Box 3.1

Four alternative regression specifications are considered to analyze the role of global investors. The main specification can be written parsimoniously as:

$$HPD_t = \beta_0 + \beta_1 FC_t + \beta_2 X_t + \beta_3 \gamma_t + \beta_4 GFC_t + \varepsilon_t, \quad \text{(A3.3.10)}$$

in which the dependent variable $HPD_t$ is the ratio of the 90th percentile of house prices to the 10th percentile in the 40 largest US cities by population. The independent variable of interest, $FC_t$, is an unweighted real US$ average of house prices in non-US destinations for global investors. $X_t$ is a vector of domestic control variables that includes the unemployment rate as a proxy for economic fundamentals, the Chicago Board Options Exchange Volatility Index (VIX) as a proxy for risk appetite, and the effective federal funds rate, 30-year fixed-rate average mortgage interest rates, and the mortgage-backed security holdings of large domestically chartered commercial banks (excluding mortgage-backed securities with government guarantees) as proxies for ease of access to financing. $\gamma_t$ is a time trend, and $GFC_t$ is a dummy variable for the global financial crisis.[40] Specification (1) regresses $HPD_t$ on $FC_t$ and a time trend; (2) includes the control variables. Specifications (3) and (4) use the first difference of the dependent variable to eliminate potential common trends. Specification (4) also includes the global financial crisis dummy $GFC_t$. See Annex Table 3.3.2.

### Methodology: Box 3.4

The analysis in Box 3.4 gauges the effectiveness of macroprudential tools in reducing house price synchronicity across 41 countries from 1990:Q2–2016:Q4. More specifically, the following panel regression specification is estimated, with $i$ denoting the country and $t$ representing the quarter:

$$HPS_{i,t} = \rho BCS_{i,t-1} + \beta MPP_{i,t-1} + \gamma X_{i,t-1} + \alpha_i + \epsilon_{i,t}, \quad \text{(A3.3.11)}$$

in which $\alpha_i$ denotes country fixed effects. The dependent variable *HPS* refers to house price cycle synchronicity (instantaneous quasi correlation) with the global cycle. *BCS* is business cycle synchronicity with the rest of the world. *X* is a vector of controls (including a global factor, financial integration with the world, and institutional characteristics). *MPP* is a macroprudential tool (such as limits on loan-to-value ratios or debt-to-income ratios or fiscal-based measures that include sellers' and buyers' stamp duty taxes) or a macroprudential group index (such as loan-targeted, supply-side [capital, general, loans], or demand-side tools).[41]

[40] $GFC_t$ equals 1 during 2008 and 2009.

[41] For more details regarding the macroprudential tools database, see Alam and others (forthcoming).



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## Annex Table 3.3.2. Global Investors, House Price Dispersion, and Synchronicity: Regression Results

| Dependent Variable: Ratio of 90th Percentile of House Prices to the 10th Percentile in the 40 Largest US Cities by Population | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Levels | | Differences | |
| Foreign City House Price Index ($FC_t$) | 0.600*** | 0.339** | 0.019** | 0.019** |
| | (0.000) | (0.031) | (0.039) | (0.039) |
| VIX Index | | –0.002** | 0.000** | 0.000** |
| | | (0.041) | (0.021) | (0.022) |
| Federal Funds Rate (effective) | | 0.002 | 0.007*** | 0.007*** |
| | | (0.952) | (0.009) | (0.009) |
| Mortgage Interest Rates | | –0.011 | 0.005** | 0.005** |
| | | (0.654) | (0.017) | (0.017) |
| Bank MBS Holdings | | 0.434* | –0.002 | –0.002 |
| | | (0.053) | (0.883) | (0.881) |
| Unemployment Rate | | 0.012 | –0.003 | –0.003 |
| | | (0.652) | (0.145) | (0.148) |
| Time Trend | 0.025*** | 0.024*** | | |
| | (0.000) | (0.000) | | |
| Financial Crisis Dummy ($GFC_t$) | | | | –0.000 |
| | | | | (0.528) |
| Constant | 0.188* | 0.287** | –0.001 | –0.001 |
| | (0.073) | (0.016) | (0.618) | (0.619) |
| Observations | 256 | 250 | 250 | 250 |
| Adjusted $R^2$ | 0.904 | 0.911 | 0.060 | 0.083 |

Sources: Board of Governors of the Federal Reserve; Haver Analytics; Zillow Group; and IMF staff calculations.
Note: Monthly data from 1996:Q4 to 2017:Q9. Robust (Newey-West, 12 lags) *p*-values in parentheses. Dependent variables are lagged one month. All variables other than the foreign city real house price index pertain to the United States. Bank MBS holdings refer to MBS without government guarantees held by large domestically chartered commercial banks, and mortgage interest rates reflect the 30-year fixed-rate average. The dependent variable, foreign city house prices, and bank MBS holdings are in log scale. All variables are in first differences except the VIX, bank MBS holdings, and the dependent variable in (1)–(3), which are stationary in levels according to unit root tests. FC = foreign city house price index; GFC = global financial crisis; MBS = mortgage-backed securities; VIX = Chicago Board Options Exchange Volatility Index.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.



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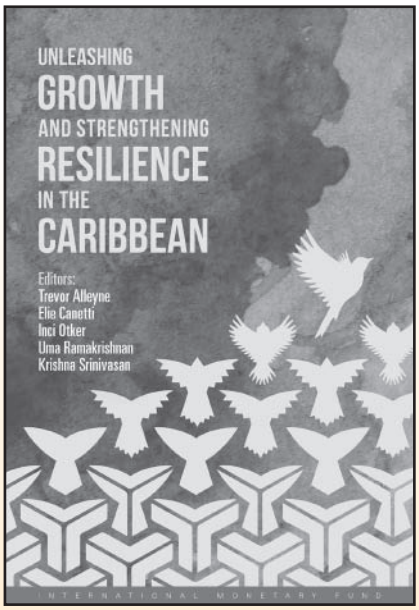


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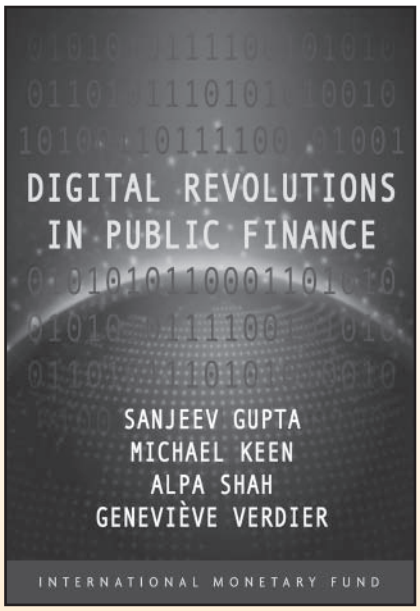


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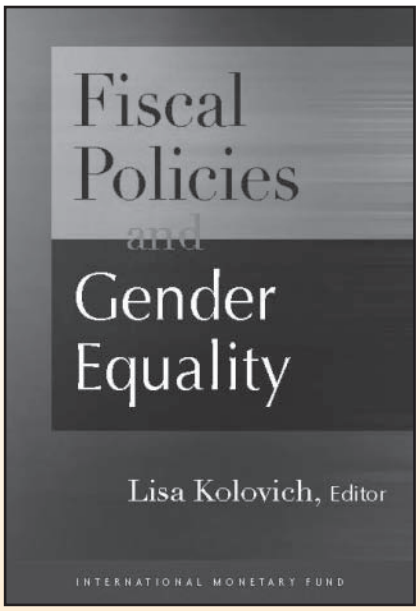


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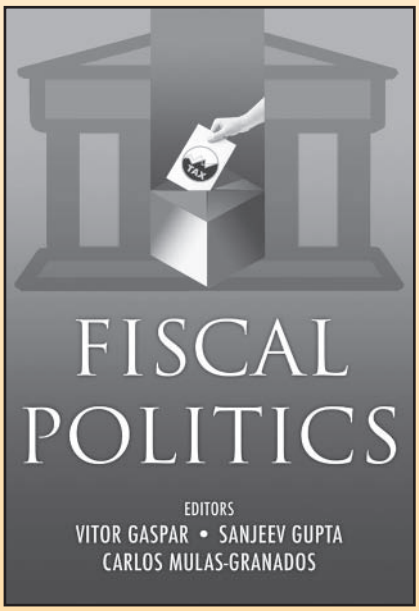


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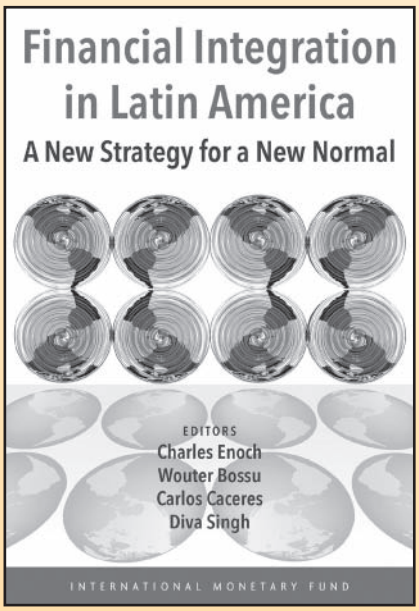


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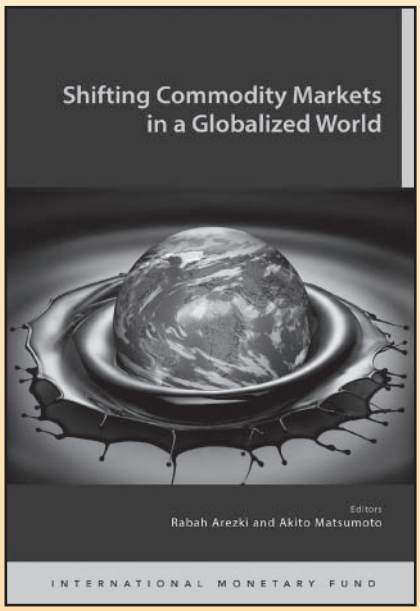


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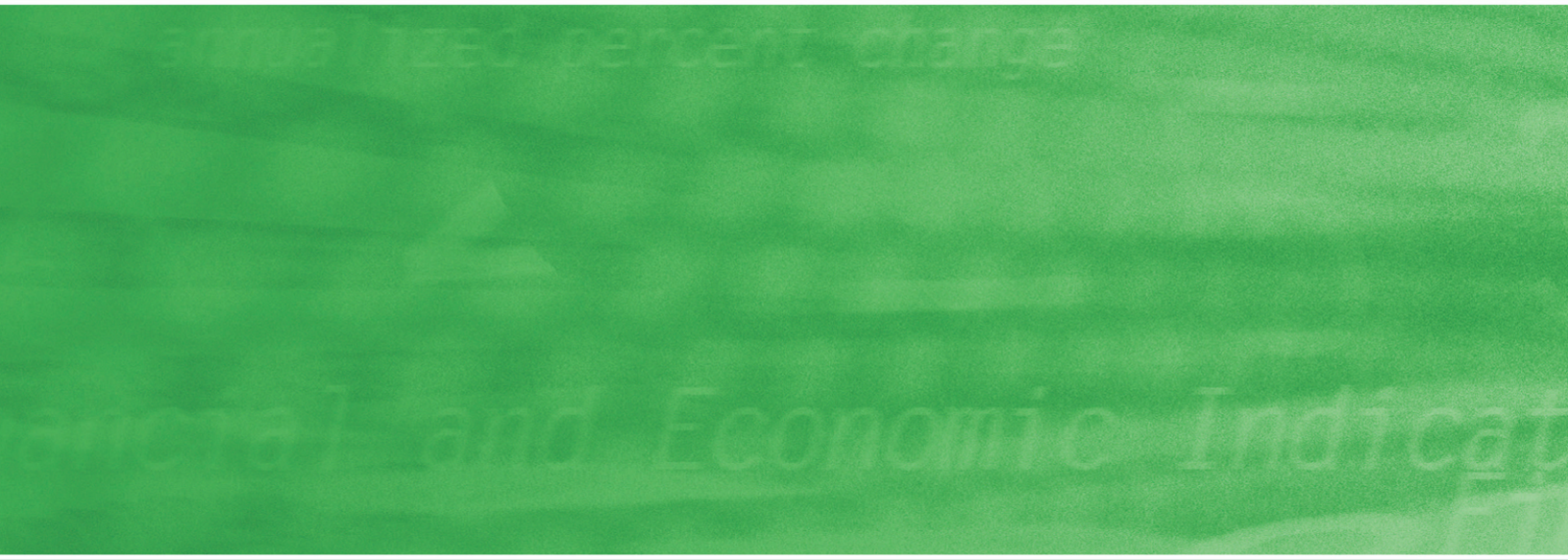

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