Although finance is generally believed to contribute to long-term economic growth, recent studies have shown that the growth benefits start declining when aggregate leverage is high. At business cycle frequencies, new empirical studies—as well as the recent experience from the global financial crisis—have shown that increases in private sector credit, including household debt, may raise the likelihood of a financial crisis and could lead to lower growth.

Globally, household debt has continued to grow in the past decade. This chapter takes a comprehensive look at the relationship between household debt, growth, and financial stability across a sample of 80 advanced and emerging market economies. Besides aggregate macro-level analysis, the chapter also delves into micro-level data on individual household borrowing to shed additional light on how household indebtedness affects growth and stability at the aggregate level.

The chapter finds that there is a trade-off between the short-term benefits of rising household debt to growth and its medium-term costs to macroeconomic and financial stability. In the short term, an increase in the household debt-to-GDP ratio is typically associated with higher economic growth and lower unemployment, but the effects are reversed in three to five years. Moreover, higher growth in household debt is associated with a greater probability of banking crises. These adverse effects are stronger when household debt is higher and are therefore more pronounced for advanced than for emerging market economies, where household debt and credit market participation are lower.

However, country characteristics and institutions can mitigate the risks associated with rising household debt. Even in countries where household debt is high, the growth-stability trade-off can be significantly mitigated through a combination of sound institutions, regulations, and policies. For example, better financial regulation and supervision, less dependence on external financing, flexible exchange rates, and lower income inequality would attenuate the impact of rising household debt on risks to growth.

Overall, policymakers should carefully balance the benefits and risks of household debt over various time horizons while harnessing the benefits of financial inclusion and development.
**Introduction**

Considerable attention has been paid to household debt since the global financial crisis as it has continued to grow in a wide range of countries (Figure 2.1). The median household debt-to-GDP ratio among emerging market economies increased from 15 percent in 2008 to 21 percent in 2016, and among advanced economies it increased from 52 percent to 63 percent over the same period. At the same time, in the highest quartile, the household debt-to-GDP ratio fell only slightly from 88 percent to 86 percent in advanced economies and continued to rise from 28 percent to 32 percent in emerging market economies. While this increase reflects to some extent the intended effects of expansionary monetary policy, central banks in various advanced and emerging market economies have recently warned against the financial stability risks of high household debt and high debt-to-income ratios when inflation and wage growth are low (see, for example, Reserve Bank of Australia 2017, Bank of Canada 2017, Bank of England 2017, South African Reserve Bank 2017, and Banco Central de Chile 2017).

Household debt and access to credit can help boost demand and build personal wealth, but high indebtedness can also be a source of financial vulnerability. According to the permanent income hypothesis, higher debt indicates higher expected income. It also allows households to make large investments in housing and education and helps smooth consumption over time. In other words, debt allows households to acquire goods and services now and repay gradually, through higher (anticipated) income. In the long term, higher private sector credit supports economic growth (Beck, Levine, and Loayza 2000) although the precise link between growth and household debt is more elusive (Beck and others 2012). Nonetheless, even if positive in the long term, high household indebtedness can cause significant debt overhang problems when a country unexpectedly faces extreme negative shocks. The experience of the global financial crisis suggests that high household debt can be a source of financial vulnerability and lead to prolonged recessions (Mian and Sufi 2011). Broader cross-country studies also indicate that increases in household debt may predict lower future income growth and financial crises in the medium term (Mian, Sufi, and Verner, forthcoming; Jordà, Schularick, and Taylor 2016). As household borrowing increases the economy grows quickly in the short term but becomes highly leveraged. In this situation, a macroeconomic shock may increase unemployment and reduce output in the medium term because of financial disruptions or nominal rigidities (for example, downward wage rigidity, a zero lower bound on interest rates, or fixed exchange rates) that may prevent full adjustment to the shock.

The macroeconomic and financial risks arising from increasing household debt may not be equally important across countries at different stages of development and with different financial and institutional characteristics. Emerging market economies may be less prepared to deal with the consequences of a household deleveraging process because of limited institutional capacity. For exam-
ple, lack of effective personal bankruptcy regimes may prevent households and lenders from efficiently dealing with debt overhang. On the other hand, household debt is lower in emerging market economies than in advanced economies reflecting a higher prevalence of financial frictions that reduce households’ access to debt. The balance between more financially and institutionally developed economies’ ability to deal with the consequences of higher household debt and the higher debt resulting from those very characteristics will likely determine the effect of household debt on economic growth and financial stability immediately and over the medium term.

This chapter takes a comprehensive look at the relationship between household debt, macroeconomic performance, and financial stability across a broad sample of countries. It largely abstracts from the long-term considerations related to financial inclusion and financial access and focuses instead on the short- to medium-term consequences of household debt increases. It does so using a larger sample of advanced and emerging market economies than hitherto investigated to shed new light on the conditions under which household debt increases are more likely to predict subpar macroeconomic performance, large economic downturns, and financial crises.1

Furthermore, it also explores micro-level data based on national surveys for selected countries to document a series of stylized facts and the underlying mechanisms behind the aggregate results. Specifically, the chapter aims to answer the following questions:

- How strongly is household debt aligned with future GDP growth and consumption? Does the pattern differ between advanced and emerging market economies? Does the relationship depend on the institutional context, such as the terms of household debt contracts and various institutional factors?
- At the individual household level, what role do income differences play in household borrowing and consumption decisions? Is the household debt-to-income ratio very different across income groups and countries?
- How strongly is an increase in household debt associated with the probability of financial crises? Does household debt represent a neglected crash risk?
- What are the implications for macroprudential and other policies?


The main findings are as follows:

- **On average, an increase in household debt boosts growth in the short term but may give rise to macroeconomic and financial stability risks in the medium term.** Real GDP initially reacts positively to increases in household debt, as do consumption, employment, and house and bank equity prices. However, after one or two years, the dynamic relationship between debt, GDP, consumption, employment, housing, and bank equity prices turns negative. Higher household debt is associated with a greater probability of a banking crisis, especially when debt is already high, and with greater risk of declines in bank equity prices.

- **But the negative medium-term consequences of increases in household debt are more pronounced for advanced than for emerging market economies.** In the latter, the short-term positive relationships between household debt and GDP growth, consumption, and employment are stronger and the negative medium-term association with these variables is weaker. These relationships are explained by the lower average household debt and credit market participation in emerging markets, which may mean narrower and less costly deleveraging from a macro perspective. Or it may imply less room for overborrowing at the aggregate level in countries where other financial frictions constrain access to debt for a larger share of the population.

- **Country characteristics and the institutional setting play an important role.** These negative medium-term effects are reinforced when household debt is high in countries with more open capital accounts and fixed exchange rates, whose financial systems are less developed, and where transparency and consumer financial protection regulation is absent, quality of supervision is lower, and income inequality is larger. While these characteristics are more prevalent in emerging market economies, the lower initial levels of household debt in this group compensate for their amplifying effect for the average emerging market economy in the sample. Nonetheless, these results show that the overall consequences of household debt increases may vary importantly across countries and can be beneficial, even at high levels of debt, when the right mix of policies and institutions is in place.

- **Lower-income groups tend to be more vulnerable.** Household surveys confirm that, within countries, the share of lower-income households in total debt has grown. These households typically have higher
debt-to-income, higher debt-service-to-income, and higher debt-to-assets ratios, which makes them more vulnerable to adverse shocks than higher-income households.  
- **Macroundent tools are useful.** Macrounential tools that target credit demand, such as restrictions on loan-to-value and debt-to-income ratios, seem to help constrain the growth in household credit.

The remainder of the chapter is organized as follows: The chapter first lays out a conceptual framework for household debt and macro-financial stability. It then describes some general developments in household debt, both from a macro and a micro (disaggregated) perspective. Next, it turns to empirical analysis of financial stability risks posed by household debt and the comovement between household debt, income, and consumption for both advanced and emerging market economies. The findings of the chapter lead to questions about the regulatory framework that influences household debt decisions and risk taking, which are addressed subsequently. The last section concludes and presents relevant policy implications.

**How Does Household Debt Affect Macroeconomic and Financial Stability?**

This section discusses some of the key models and mechanisms through which changes in household debt affect the macroeconomy and financial stability. First, it reviews some long-term relationships between household debt and growth. Next, it discusses the permanent income theory and some alternative models that yield different effects.

Higher financial inclusion and financial development can have positive effects on long-term growth, but the relationship between household debt and long-term growth is more elusive. Extensive literature has documented that financial development and the corresponding increase in private credit by both firms and households lead to higher growth (Levine 1998; Beck and Levine 2004, among others). However, the link between household debt and long-term growth has been more elusive, with earlier papers arguing that the growth consequences of household debt depend on the use of borrowed resources, and more recent evidence finding a weak relationship between household debt and GDP growth.\(^2\)

More recently, Arcand, Berkes, and Panizza (2015) and Sahay and others (2015b) find that when private sector debt reaches a certain level, the positive effects on per capita growth start to decline, which they relate to the diversion of resources from productive sectors and to rising financial stability risks when the economy becomes highly leveraged (see Box 2.1 for further discussion and a direct analysis of the long-term relationship between household debt and growth).

At the business cycle frequency, the permanent income theory argues that household debt has beneficial effects on the macroeconomy and on financial stability. Households that anticipate an increase in future income will increase their debt to smooth their consumption or make large investments in nonfinancial assets or education (Friedman 1957; Hall 1978).\(^3\) A smoother intertemporal consumption pattern improves household welfare and contributes to macroeconomic stability, while credit and asset markets accommodate the financing needs of households (Uribe and Schmitt-Grohé 2017). As such, household debt also enhances financial stability.

But newer theories and empirical evidence show that the relationship between household debt and macro-financial stability can also be negative. More recent consumption and debt theories relax some of the assumptions of the permanent income model and consider the consequences of borrowing constraints, negative externalities, and behavioral biases.\(^4\) These consider measures of household debt finding statistically insignificant relationships to long-term growth, see Beck and others 2012; Angeles 2015; and Sahay and others 2015a.

\(^2\)For the earlier papers on the conditional relationship between some proxies of household debt and growth, see Jappelli and Pagano 1994 and De Gregorio 1996. For recent analyses that directly

\(^3\)In this context, demographics and the distribution of income and debt matter. Younger households that anticipate future income growth would borrow more against their future income (Blundell, Browning, and Meghir 1994). Rajan (2010) and Kumhof, Rancière, and Winant (2015) have argued that increased income and wealth inequality led to the rapid growth of household debt in the United States and eventually to the financial crisis in 2008. Coibion and others (2017) find that, over the period 2001–12, income inequality may have indirectly operated as a screening device for banks, given that they lend less to low-income households in high-inequality regions in the United States.

\(^4\)Market incompleteness may also play a role in households’ borrowing and saving decisions. Sheedy (2014) argues that financial contracts are typically not contingent on all possible future events. Because households do not have access to insurance against future risks that could affect their ability to repay debt, the bundling together of borrowing and a transfer of risk are inefficient. In the same vein, Deaton (1991), Carroll (1992), and Aiyagari (1994) argue that households may maintain a “buffer stock” of precautionary savings to smooth out future consumption. This suggests that debt may have a more limited role for macro-financial stability.
Market imperfections may result in household debt becoming a source of vulnerability, with consequent risks for macro-financial stability. Some of the effects are illustrated in Figure 2.2. More specifically:

- **Borrowing constraints, leverage, and aggregate demand**: If aggregate demand determines the level of output, a contraction in demand by highly indebted households will not always be compensated for by an increase in demand by those that are less indebted, which may lead to a recession (Eggertsson and Krugman 2012; Korinek and Simsek 2016). In this type of model, adverse shocks to highly indebted households, such as a reduction in the value of collateral, trigger borrowing constraints that lead to a deleveraging process that may further reduce the value of collateral. The presence of nominal rigidities, such as a zero lower bound for nominal interest rates or nominal wages that cannot adjust downward, amplifies the consequences of these shocks. For instance, adverse shocks to house prices (or stock prices) reduce homeowners’ equity in their housing assets (or households’ net wealth, respectively). If sufficiently large, this reduction could trigger large debt defaults and impose further downward pressure on house prices (or stock prices, respectively), leading to a debt deflation spiral (Fisher 1933), as illustrated in Figure 2.2.

A broad set of macroeconomic models with financial frictions predict that high leverage reduces borrowing capacity and amplifies the impact of negative macroeconomic shocks (Kiyotaki and Moore 1997; Bernanke, Gertler, and Gilchrist 1999; Brunnermeier and Sannikov 2014, among others). Although these models focus on firms instead of household debt, the mechanism applies more broadly and is incorporated into newer studies described in this section.

Note, however, that household debt defaults can also facilitate adjustment to lower debt levels, because it increases the resources

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Figure 2.2. First- and Second-Round Effects of the Buildup of Household Debt on Financial Stability

1. **Balance Sheet View**

- **Household Sector**
  - **Assets**
    - Housing
    - Financial assets
    - Other assets
    - Human capital
  - **Liabilities**
    - Debt
      - Mortgages
      - Consumer credit
    - Other liabilities

- **Initial effect after a negative shock hits highly indebted households (for example, income shock, credit tightening)**
- **Second-round effects**

- **Downward price spirals due to collateral constraints**
- **Bank capitalization is impaired, banks reduce lending**
- **Fisher’s debt-deflation: declines in asset prices**
- **Worsened household balance sheets lead to more defaults, bankruptcies**

2. **Cash Flow View**

- **Household Sector**
  - **Income**
    - Labor income
    - Capital income
  - **Consumption**
    - Debt service
    - Other expenses
  - **Corporate investment and employment**
  - **Debt overhang**

- **Initial effect after a negative shock hits highly indebted households (for example, income shock, credit tightening)**
- **Second-round effects**

- **Declines in corporate investment and private employment**
- **Deleveraging reduces aggregate demand**
- **Declines in household income**
- **Households cut back consumption further due to lower income**

Source: IMF staff.

Note: This figure depicts the interactions between household debt, the financial sector, and the real economy. The balance sheet view (panel 1) shows assets and liabilities (debt) at the household level, whereas the cash flow view (panel 2) shows household income and expenses in the form of consumption and debt service. The two main channels through which household debt and consumption interact are deleveraging and debt overhang. Deleveraging may adversely affect aggregate demand through deleveraging or a crowding out of consumption by the debt service burden. Deleveraging can occur through forced or accelerated repayment of debt, reduction in new credit, and increased defaults or personal bankruptcies. From a legal standpoint, default follows from a situation in which assets and income are insufficient to cover debt-servicing costs, and bankruptcy from lack of sufficient assets and income to repay the debt. There may be second-round effects, such as Fisher-type debt-deflation dynamics, that may be caused by downward asset price spirals.
generates negative spillovers. It can cause stress to bank capital and balance sheets and thereby harm the rest of the economy and compromise financial stability. Since, when taking on debt, households do not internalize the potential impact of their decisions on aggregate demand and other households, they borrow too much from a social perspective. Hence, better outcomes could be achieved by ex ante policies that reduce the debt level, or constrain its increases (Korinek and Simsek 2016).

- **Behavioral biases**: Short-sighted households may strongly prefer current consumption over future consumption, or neglect crash risk. Households that value too much current consumption (hyperbolic discounting) tend to postpone saving decisions indefinitely and to contract an excessive amount of revolving debt (Laibson 1997). Overoptimism may also lead households to borrow too much, resulting, for instance, in higher credit card debt (Meier and Sprenger 2010). Consistent with the idea of overoptimism, not only among households but also among market participants, recent evidence shows that credit expansions forecast equity crashes (Baron and Xiong 2017). Households that base their expectations solely on extrapolations from past events, when house prices have been growing, may increase their borrowing during housing booms because they expect their home equity to continue growing (Fuster, Laibson, and Mendel 2010; Shiller 2005). Alternatively, households may neglect certain low-probability risks, such as potentially large defaults on mortgages affecting AAA-rated securities exposed to these defaults (Gennaioli, Shleifer, and Vishny 2012). Or they may vary in their optimism about returns on risky assets (Geanakoplos 2010), with optimistic agents borrowing from pessimistic ones to purchase assets that serve as collateral. This process may amplify asset prices and leverage cycles and impair financial stability. Finally, tax treatment (interest deductibility) may also play a role in explaining a bias toward debt financing for households, much as it does for firms (IMF 2016b).

To summarize, the exact nature of the relationship between household debt and future growth and financial stability may depend on several factors. The relationship may be positive if agents behave in a rational, forward-looking manner and contract debt solely with an eye on future income growth and returns to capital in the absence of financial frictions and binding borrowing constraints. However, the relationship between household debt and macro-financial stability may turn negative for the reasons described above. The negative relationship may be more likely when households borrow primarily for nonproductive purposes or experience inadequate returns on their investment. High debt may bring about sharp adjustments in their consumption pattern—through deleveraging—and affect other parts of the economy. Depending on how well a country can absorb macro-financial stress or on the policies and institutions in place—such as the monetary stance, fiscal space, quality of regulation and supervision, capital account openness, and the degree of foreign-currency-denominated loans—some episodes of debt overhang and deleveraging may be absorbed more easily than others, in response to exogenous shocks affecting households.

### Developments in Household Debt around the World

This section shows that household debt levels are higher in advanced economies than in emerging market economies and mainly comprise mortgage debt, while household debt has grown substantially in emerging market economies. Micro-level evidence indicates that lower-income households are less likely to borrow, but those that do tend to have riskier borrowing profiles.

Household debt to GDP is higher in advanced economies than in emerging market economies, but there is considerable heterogeneity within each group. On average, in 2016, the household debt-to-GDP ratio reached 63 percent in advanced economies and 21 percent in emerging market economies, reflecting differences in financial depth and inclusion across these groups of countries. But even in advanced economies, it ranges from about 30 percent of GDP in Latvia to more than 100 percent of GDP in Australia, Cyprus, Denmark, Switzerland, and the Netherlands (Figure 2.3, panel 1). In some emerging market economies, house-

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7Cheng, Raina, and Xiong (2014) find that even real estate professionals (midlevel managers in securitized finance) had overly optimistic beliefs about house prices.

8In this chapter, household debt comprises loans by households from banks and other financial institutions. In some countries, this also includes nonprofit institutions serving households.
Household debt remained very low, at less than 10 percent of GDP in 2016, in Argentina, Bangladesh, Egypt, Ghana, Pakistan, the Philippines, and Ukraine, while in others, such as Malaysia, South Africa, and Thailand, it exceeded 50 percent of GDP. More broadly, the cross-country distribution of the household debt-to-GDP ratio is positively correlated with differences in financial development (Figure 2.3, panel 2).

Mortgage debt makes up the bulk of household debt in advanced economies, but less so in emerging market economies. It accounts for more than 50 percent of total household debt in most advanced economies, whereas among emerging market economies it captures one-third or less of total household debt (Figure 2.3, panel 3). Indeed, differences in mortgage debt explain a large fraction of the difference in household debt between emerging market and advanced economies. Although the characteristics of mortgages vary widely across countries and jurisdictions, a survey of IMF country desks finds that most mortgages are recourse loans: after a default the lender can try to seize additional household assets to cover the debt if the market value of the house is insufficient (see Annex Figure 2.1.1). Other debt consists primarily of consumer credit, which is typically used to smooth out short-term fluctuations in consumption and income but can also be used to finance microenterprises.9

Household debt has grown substantially in many countries over the past decade and has kept growing in recent years, especially among emerging market economies. Household debt-to-GDP levels fell in the United States and the United Kingdom after the global financial crisis of 2007–08 and in various European countries—most notably, Iceland, Ireland, Portugal, Spain, and the Baltics—in the wake of the European sovereign debt crisis (Figure 2.3, panel 1). In Germany, household debt has fallen as a percentage of GDP since 2000. Notwithstanding these recent declines, the level of household debt to GDP remains high by historical standards in most of these countries and has kept growing in other advanced economies, such as Australia and Canada (Figure 2.3, panel 5). In a number of emerging market economies—most notably Chile, China, Malaysia, Thailand, Paraguay, Poland, and some central and southeastern European countries, household debt to GDP expanded rapidly over a short time, from as low as 10 percent of GDP in 2005 to more than 60 percent of GDP in some cases. This is also reflected in the rapid rise of median household debt-to-GDP ratios in emerging market regions: from between 5 percent and 10 percent in 2000 to between 17 percent and 22 percent in 2016 (Figure 2.3, panels 5 and 6).

Changes in household debt ratios are driven mainly by debt increases rather than low or negative income growth. In theory, the household debt-to-GDP ratio may go up if debt increases more, or declines less, than GDP does. The rapid rise in the household debt-to-GDP ratio from 1990 to 2007 is due mainly to rapid increases in inflation-adjusted household debt, in both advanced and emerging market economies, amounting to 6.7 percent and 13.4 percent a year, respectively—far exceeding the growth of real GDP and real disposable income (Figure 2.3, panel 4). This rise was facilitated by the sharp decline in interest rates and easier and more widespread access to credit. Hence, debt servicing may not have risen that much. During this period, net wealth also rose on account of strong real house price increases. After 2008, the growth in household debt slowed to 2 percent a year in advanced economies, reflecting a retrenchment of households in the wake of the global financial crisis, and to 6.6 percent a year in emerging market economies. In both cases, debt continued to exceed the rate of GDP growth, leading to increases in the ratio of household debt to GDP.

The overall trend in household debt to GDP is very similar to that of the debt-to-assets ratio. For a subsample of 18 Organisation for Economic Co-operation and Development countries, increases in household debt to assets are highly correlated with household debt-to-GDP ratios (Figure 2.4, panel 6). Thus, increases in debt are usually accompanied by rising leverage, meaning that a focus on net wealth may mask underlying vulnerabilities that arise from procyclical asset values. The trend is most notable for mortgage debt—which constitutes the bulk of household debt in many countries—for which there is large comovement with the housing market cycle. As a result, households are less able to tap into their housing wealth to smooth consumption after a shock. Therefore, following the recent empirical literature and without losing much generality, the rest of the empirical analysis focuses on the debt-to-GDP ratio.10

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9 For instance, urban Indian households report about one-fifth of their debt to be for business-related purposes. In addition, rural households use two-fifths of their debt for productive purposes, with the highest share among the wealthier households (see Badarinza, Balasubramaniam, and Ramadorai 2016).

10 In the ensuing analysis, using the debt-to-assets ratio instead of the debt-to-GDP ratio for a subset of 26 Organisation for Economic Co-operation and Development countries for which such data are available yields qualitatively the same results (see Figure 2.6, panel 2).
Figure 2.3. Growth and Composition of Household Debt by Region (Percent)


4. Decomposition of Annual Changes in Household Debt Ratio

5. Advanced Economies and Central and Eastern European Countries: Median Household Debt-to-GDP Ratio

6. Emerging Market Economies in Asia, Africa, the Middle East, and Latin America: Median Household Debt-to-GDP Ratio

Sources: Bank for International Settlements; CEIC Data Co. Ltd.; Economic Cycle Research Institute; Haver Analytics; IMF, International Financial Statistics, Monetary and Financial Statistics, and World Economic Outlook databases; Jordà-Schularick-Taylor Macrohistory Database; Svirydzenka 2016; Thomson Reuters Datastream; and IMF staff calculations.

Note: For countries included in regional breakdowns, see Annex 2.1. In panel 2, financial development is the index taken from Svirydzenka 2016. Panel 4 reports median annual growth rates for each country group and period for real GDP, real disposable household income, real household debt (RHDD), and household debt-to-GDP ratio (HHD/GDP). Dashed line in panel 1 denotes the 45-degree line. AEs = advanced economies; CEEC = Central and Eastern European countries; EMEs = emerging market economies; income = real disposable household income.
Figure 2.4. Household Debt: Evidence from Cross-Country Panel Data
(Percent, unless noted otherwise)

1. Loan Participation Rate, 2010

2. Debt-to-Income Ratio, 2010

3. Loan Participation versus per Capita GDP, 2013
   (X axis = US dollars purchasing power parity)

4. Mortgage Participation Rate and Overall Participation Rate, 2013


6. Household Debt-to-GDP Ratio and Debt-to-Assets Ratio

Sources: Bank for International Settlements; country panel surveys; Euro Area Housing Finance Network; Luxembourg Wealth Study; Organisation for Economic Co-operation and Development (OECD); US Survey of Consumer Finance; and IMF staff calculations.

Note: Panels 1 and 2 show the cross-country dispersion across income quintiles, evaluated at the median for mortgage borrowers (quintile 1 to quintile 5, from lowest to highest income). Dashed lines in panels 4 and 5 denote the 45-degree line. For country coverage, see Annex 2.1. Panel 6 shows debt, asset, and wealth ratios for a subsample of 18 OECD countries for which such data are available since 1995. AEs = advanced economies; EMEs = emerging market economies.
Lower-income groups typically participate less in credit markets, and their credit profiles are weaker. Household survey data from 25 countries show that households in the lowest income quintiles participate much less in mortgage (and overall) credit markets (Figure 2.4, panel 1). Those that do, however, have, on average, higher risk profiles, with higher debt-to-assets and debt-to-income ratios as well as higher debt service ratios (defined as total debt repayment as a percentage of total income) (Figure 2.4, panel 2). This suggests that lower-income households are most vulnerable to cyclical fluctuations in income and are less likely to benefit from positive wealth effects, given their relatively low net asset holdings. From a bank’s perspective, these customers generally represent a higher credit risk, which, in turn, may explain the relatively low participation rate, indicating the presence of credit constraints.

Differences in participation across countries explain part of the differences in debt ratios between advanced and emerging market economies. As with other measures of financial inclusion, household credit participation increases with economic development, as measured by real GDP per capita (Figure 2.4, panel 3). As credit participation increases, it initially covers mainly high-income families and then moves more aggressively toward easing access for lower-income families, as reflected by the curvature of the respective income groups’ lines (Figure 2.4, panel 4). Thus, high credit participation by low-income families is mainly an advanced economy phenomenon; lower-income countries grant access to credit mainly to higher-income households. Since not all households have debt and since debt-to-income ratios vary significantly across households, macro-level measures of household debt (such as debt-to-GDP and debt-to-net-wealth ratios) underestimate the true burden of indebted households (Figure 2.4, panel 5). This underestimation could be especially relevant for emerging market economies where participation rates are low and where low macro-level indebtedness may coexist with significant micro-level household indebtedness (see Box 2.2 for an analysis of Chinese households).

The dynamics of household debt are linked to the evolution of house prices. For example, household debt in Canada and the United States evolved very similarly until the global financial crisis (Box 2.3). After the crisis, household debt continued to rise in Canada but fell in the United States as house prices followed different paths: declining in the United States while continuing to appreciate in Canada. As a result, US households’ leverage for mortgage holders, reflected in the debt-to-income ratio, remained broadly constant, while Canadian mortgage borrowers’ debt to income increased across all income groups and is now much higher than for US households. These patterns suggest that household debt and housing prices have common dynamics (Box 2.4). Similarly, in China, where house prices rose by 16 percent in real terms, the debt-to-income ratio increased across most income groups between 2011 and 2015, and especially for lower-income households (Box 2.2).

**Financial Stability Risks of Household Debt: Empirical Analysis**

Increases in household debt have a positive short-term but a negative medium-term relationship to macroeconomic aggregates such as GDP growth, consumption, and employment. They also predict downside risks to GDP growth and a higher probability of a banking crisis. However, the strength of the negative association depends on the level of household debt to GDP, getting stronger when this level exceeds certain thresholds. The short-term positive effects are generally stronger and the medium-term negative effects are consistently weaker for emerging market economies.

**Household Debt and Growth, Consumption, and Employment**

When household debt increases, future GDP growth and consumption decline and unemployment rises relative to their average values. Changes in household debt have a positive contemporaneous relationship to real GDP growth and a negative association with future real GDP growth, in line with various recent empirical studies. Specifically, a 5 percent increase in household debt to GDP over a three-year period forecasts a 1¼ percent decline in real GDP growth three years ahead (Figure 2.5, panel 1). These results do not seem to be

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11See also Demirgüç-Kunt and Klapper (2012), who find that account penetration is higher in economies with higher national income, as measured by GDP per capita.

12The aggregate measures of household indebtedness correspond to an income-weighted average of individual household debt ratios. Households with no debt but positive income, as well as differences in indebtedness across households, lead to differences between aggregate and micro-level measures.


14The empirical model includes country fixed effects, so that all variables can be interpreted as deviations from their sample averages.
driven by potential endogeneity concerns. A further breakdown shows that household debt is correlated with future declines in private consumption (Figure 2.5, panel 2) but less so with government consumption and investment. It is also negatively correlated with the current account deficit. These findings suggest that household debt booms finance consumption expansions, often through current account deficits that revert later when consumption and GDP growth also decline. Increases in household debt are also associated with significantly higher unemployment up to four years in the future (Figure 2.5, panel 3).

The short-term positive association between changes in household debt and GDP growth is stronger and the medium-term negative relationship weaker for emerging market economies than for advanced economies (Figure 2.5, panel 1). On the other hand, consumption expands less in the short term and declines less in the medium term after household debt increases in emerging market economies (Figure 2.5, panel 2), while the results for unemployment follow a similar pattern as those for GDP (Figure 2.5, panel 3). This suggests that the trade-off between the benefits of increased household participation in credit markets and the risks to macroeconomic stability is less striking for these countries, most likely because of lower average household debt, although institutions and policies may also play an important role, as discussed later. Moreover, the evidence on long-term growth reviewed in Box 2.1 suggests that, in the long term, increases in household debt appear positively related to growth up to a certain level.

Increases in household debt are associated with heightened downside risks to future GDP growth for all countries, but in emerging market economies they also predict higher upside risks. Quantile regression results show that changes in household debt have important implications for movements in the distribution of future GDP growth (Figure 2.5, panel 4). Initially, household debt is associated with strong positive output growth (the right tail of the distribution), especially among emerging market economies. But three to five years ahead, increases in household debt seem to have a clearer association with below-average movements of future growth (the left tail of the distribution of future real GDP growth). This pattern is consistent with the deleveraging and aggregate demand externalities that arise after a period of rapid growth in household debt, resulting in a volume of borrowing above the socially optimal level that leads to important corrections after a shock. It is interesting to note that, among emerging market economies, increases in household debt are associated with worse negative and stronger positive future growth outcomes compared with advanced economies. This finding may reflect the more extreme historical experiences in this group of countries; they benefit more from financial development and improved access to finance but also suffer more strongly during episodes of debt overhang and financial crises.

Supply-driven increases in household debt are more damaging to future growth. Using changes in financial conditions to identify supply- and demand-driven increases in household debt, similar to Mian, Sufi, and Verner, forthcoming, shows that the supply-driven component of household debt has a stronger impact on future GDP growth than the demand component (Figure 2.5, panel 5). Similarly, a monetary policy loosening (negative Taylor rule residuals) reinforces the negative relationship between household debt and future economic activity.

The negative medium-term association between GDP growth and growing household debt is largely absent at low levels of debt to GDP. At very low levels of household debt to GDP, below 10 percent, the association between increases in debt and future real GDP growth is positive; it turns negative when household indebtedness exceeds 30 percent of GDP (Figure 2.5, panel 6). Beyond that point, the correlation declines slightly, but it maintains its negative sign. The presence of this nonlinearity is consistent with recent findings of a bell-shaped
Sources: Bank for International Settlements; CEIC Data Co. Ltd.; Economic Cycle Research Institute; Haver Analytics; IMF, World Economic Outlook database; Jordà-Schularick-Taylor Macrohistory Database; Penn World Table; and IMF staff calculations.

Note: Panels 1, 2, and 3 are from panel regressions of rolling three-year real GDP growth (consumption and unemployment, respectively) up to six years ahead, on lagged changes in household and corporate debt-to-GDP ratios (over a three-year period), controlling for lags of the dependent variable, and country and time fixed effects. Panel 4 shows quantile regression coefficient estimates for changes in the household debt ratio, using the same specification as the panel regression model. Panel 5 breaks down changes in household debt-to-GDP ratios into supply and demand factors, where local financial conditions are assumed to signal supply-side factors, and the residual to reflect other (demand) factors. Panel 6 shows coefficient estimates from a panel regression estimation, conditioning the effect on changes in household debt, and interacted with various debt thresholds. Colored bars indicate that the effects are statistically significant at the 10 percent level or higher. See Annex 2.2 for details of the estimation methodology. AEs = advanced economies; EMEs = emerging market economies.
relationship between financial deepening and long-term growth (Sahay and others 2015b) and studies relating this to increased financial risks (see also Box 2.1). While the threshold above which increases in household debt more strongly signal risks to real activity is low, it is generally above the levels reached by emerging markets in this sample. This finding may partly explain the milder association estimated for this group of countries.

The relationship between future GDP growth and household debt is driven mostly by mortgage debt. The finding that the mortgage debt component is statistically significant and the nonmortgage component is not (Figure 2.6, panel 1) goes somewhat against the argument that increases in debt accompanied by a simultaneous accumulation of assets are less risky, because households may be able to tap into these assets when facing shocks. This could be due to the procyclicality of home equity lines or—more generally—to wealth effects that lead households to cut consumption when the value of their housing assets decline. Further evidence confirms that the accumulation of assets does not dampen the consequences of increased indebtedness. Changes in the household debt-to-total-assets ratio are associated with growth declines only at horizons beyond five years ahead, with increases in household debt to GDP remaining significant at shorter horizons (Figure 2.6, panel 2). These results suggest that, at business cycle frequencies, it is primarily households’ debt service capacity, approximated by a higher debt-to-GDP ratio, that signals vulnerabilities rather than their solvency position.

Similar results are found in micro-level data: high debt-to-income ratios make households more vulnerable to income shocks. Micro longitudinal data for five euro area countries show that high household indebtedness in 2010, right before the European sovereign debt crisis, caused a significant reduction in consumption between 2010 and 2014 (Figure 2.7, panel 1). Furthermore, consumption declined more for the most indebted

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18Boom-bust cycles in housing prices that accompany increases in household debt could be driving the results reported above, but further analysis shows that lagged house price growth is not very significant in growth forecasting regressions. Additional evidence from dynamic panel vector autoregression techniques shows that house price shocks are associated with a gradual rise in household debt, whereas household debt shocks lead to significant increases in house prices in the short term, up to two to three years, but are followed by a fall in house prices afterward (Box 2.5).

19The macroeconomic and unexpected nature of the shock makes it unlikely that the results are driven by the reverse causality argument that individual households borrowed preemptively to hoard liquidity and smooth consumption.
households (Figure 2.7, panel 2), which also perceived themselves to be the most financially constrained (Figure 2.7, panel 3). The larger reduction in consumption by highly indebted households at the micro level and the corresponding decline in aggregate consumption observed in macro data are consistent with the effects of aggregate demand externalities arising from deleveraging. Evidence for China also shows that consumption of households with high debt-to-income ratios responds more strongly to income shocks (Figure 2.7, panel 4 and Box 2.2). Hence, highly indebted households’ higher marginal propensity to consume may amplify the effect of negative income or credit shocks on China’s economy, in line with evidence in advanced economies (for example, Mian, Rao, and Sufi 2013). Similar results are found for advanced economies, such as Australia, although they are less pronounced.

Financial Stability Risks and Neglected Crash Risk

Increases in household debt are also good early warning indicators for banking crises.20 A simple look at the data shows that increases in household debt peak about three years before the onset of a banking crisis (Figure 2.8, panel 1). Formal evidence from a logit

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20Previous research documenting similar findings includes Gourinchas and Obstfeld 2012; Drehmann and Tsatsaronis 2014; and Jordà, Schularick, and Taylor 2016.
panel data model shows that a rise in the household debt-to-GDP ratio contributes to a greater probability of banking crises three years ahead (Figure 2.8, panel 2). The marginal effect, at about 1 percent, is economically significant, since the unconditional crisis probability is about 3.5 percent for the countries under examination.

The relationship between increasing household debt and financial crises is more pronounced when household debt is high (65 percent of GDP). This is broadly consistent with the nonlinear effects found for the relationship between household debt and GDP growth, with the higher threshold resulting from the extreme nature of crises as compared with episodes of growth declines. The existence of nonlinear effects suggests that debt increases in already highly indebted households may be hard to sustain when facing a negative income shock, leading them to drastically reduce consumption and default on their debts.

Increases in the household debt ratio predict negative equity excess returns (over the risk-free rate), especially for the banking sector. Such predictability is present for both the banking sector and the overall stock market index (Figure 2.9, panel 1). This negative correlation may reflect investor overoptimism and a systematic neglect of the risk of equity crashes (so-called neglected crash risk) during periods of high growth in household debt (Figure 2.9, panel 2). Further analysis with quantile regressions shows that the negative association between increases in household debt and future equity returns is stronger in the lower tail of the return distribution than in the upper tail, confirming that investors appear to systematically neglect the risk of equity crashes.

Although the neglected crash risk affects all sectors, predictability is stronger for bank stock returns, suggesting that rising household debt is often associated with neglected banking sector vulnerabilities. As discussed later in the chapter and shown earlier, these vulnerabilities may arise both from the ensuing decline in growth associated with the deleveraging process or from higher debt defaults from overindebted households.

The predicted decline in overall stock market returns suggests that growth contractions explain part of these results. But consistent with a simultaneous role for

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21Risk-adjusted abnormal returns of the banking sector are computed to measure the performance of bank stocks relative to market returns. Abnormal returns are defined as the capital asset pricing model regression residuals with quarterly data. For each country, the coefficient on market excess return, that is, the market beta, is estimated in each year based on past return data to avoid using future information that is unknown in that year.
rising defaults, increases in the household debt ratio are often associated with higher growth of nonperforming loans in the country’s banking sector three years later, confirming that rapid growth in household debt is associated with greater banking stress in the future.

**When Is Household Debt More Likely to Predict Low GDP Growth?**

The consequences of an increase in household debt for future growth differ substantially across countries. The estimated debt-to-GDP-growth relationship exhibits substantial heterogeneity within both advanced and emerging market economies (Figure 2.10, panel 1). The median coefficient for the three-year-ahead impact of an increase in debt on GDP growth is \(-0.5\) for advanced economies and \(-0.13\) for emerging market economies. Within each group of countries, the dispersion of the estimated coefficients is large, although more so for emerging market economies, which also have a larger share of positive country-level coefficients. This dispersion suggests that, in addition to the initial level of household debt documented earlier, country-specific and institutional factors may play a role in mediating the relationship between rising household debt and future economic activity. To investigate the role of various leading factors, separate panel regressions add interactions between household debt and a number of institutional and country-specific characteristics to the panel regression between changes in household debt and three-year-ahead GDP growth (Figure 2.10, panel 2).\(^{22}\)

Having an open capital account and a fixed exchange rate regime increases the risks associated with rising household debt. An open capital account has multiple benefits for financial integration and access to foreign capital (Mussa and others 1998; Stulz 1999), but it also exposes countries experiencing large capital inflows to sudden stops (Calvo and Reinhart 2000). In this sample, a more open capital account results in a stronger negative association between increases in household debt and future GDP growth.\(^{23}\) This result might arise from the accumulation of foreign-currency-denominated debt, similar to findings by Mian, Sufi, and Verner (forthcoming). As noted in the literature, capital flows that sustain episodes of foreign debt accumulation are frequently followed by sudden stops that force strong corrections in consumption, particularly in emerging markets. This pattern is consistent with a larger differential effect of capital account openness in this group of economies. Along similar lines, having a fixed exchange rate regime reduces an economy’s flexibility to accommodate external shocks, resulting in a larger contraction in aggregate demand, especially in the presence of nominal wage rigidities (Schmitt-Grohé and Uribe 2016). Interestingly,

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\(^{22}\)Additional analysis also attempted to relate the effect of household debt on banking crises documented earlier to institutional and country-specific variables, but no significant interaction effects were detected, probably because of the relatively smaller coverage, over time, and number of countries and crises observations, relative to the panel data growth regression analysis.

\(^{23}\)In this analysis, capital account openness is measured as de jure openness. The results do not change when using de facto measures such as capital flows as a percentage of GDP.
this analysis shows that it is the combination of a fixed exchange rate regime and capital account openness that magnifies the risks associated with increasing household debt. This finding is consistent with the limitations that such a regime poses for accommodating the consequences of large changes in capital inflows (IMF 2016a).

Financial development and the quality of bank supervision seem to mitigate the medium-term negative relationship between increases in household debt and GDP growth. Credit expansion in a more financially developed environment entails lower risks because the financial system is better able to assess credit risk and allocate credit and is better prepared to deal with their consequences. Moreover, countries where banking supervision is more stringent and capital requirements are stricter appear able to reduce the negative effect of household debt on GDP growth. The same effect is found for banking systems that have higher capital ratios or a larger distance to default. All these measures directly or indirectly reflect the quality and conservatism of the banking supervision—supervisors may stop banks from paying out high dividends to shareholders and instead require them to retain higher capital buffers, thereby limiting, to some extent, the bank lending channel.

Among institutional variables, the existence of credit registries significantly reduces the risks signaled by rising household debt. Having access to broad information on individuals’ levels of debt and payment histories (both positive and negative) reduces the possibility of overborrowing, improves origination standards, and reduces borrowing costs for good creditors. In addition, characteristics of the debt frameworks—such as protection against predatory lending—temper the negative association with future GDP growth, but are not robustly significant. Other aspects of the institutional framework, such as various characteristics of the household credit market obtained through a survey of country desks, do not appear to have a significant effect in reducing the risks signaled by household credit expansion.24

The effect of household debt on GDP is somewhat larger in more unequal societies. The role of inequality is not obvious because of two countervailing forces (Figure 2.10). On one hand, richer households tend to have lower debt-to-income (DTI) ratios and higher participation (Figure 2.4). A higher level of inequality

24 For the list of housing market characteristics see Annex Figure 2.1.1. The lack of significance for several of these and other institutional measures may result from the reduced samples for which they are available or the limited time variation of the data (some being available for a single year).
means that the share of income of the richest households increases and the macro-level DTI ratio declines. The macro-level DTI is the weighted average of household-level DTIs, with weights by income share.

26However, the significance of this effect varies, depending on the exact model specification.

27Along these lines, Rajan (2010) argues that household debt among lower-income households was encouraged by the political system in the United States as an easier (but riskier) way to deal with income inequality.

28While capital openness may also strengthen the association between household debt and future growth decelerations, it does so mainly in combination with less flexible exchange rate regimes.

On the other hand, higher-income households may decide to borrow more as a response to their relatively higher income, leading to an increase in macro-level DTI. Thus, the relationship between macro-level household debt and inequality is ambiguous. In this sample, higher inequality is associated with a slightly higher impact of changes in household debt on future growth. Other explanations center on behavior, arguing that higher inequality results in more people with less financial education who are more vulnerable to over-lending and predatory practices.

These results suggest that the level of household debt at which further increases are detrimental is country specific and higher for countries with better institutions. The negative effects of increases in the household debt-to-GDP ratio on future GDP growth differ by country and depend on the initial level of indebtedness and country characteristics, as outlined earlier. This means that countries can attenuate the negative effects of increased household debt that arise at high initial levels of indebtedness if they are more financially developed and have higher standards of financial information transparency (credit registries) and consumer finance protection, better regulation and supervision, less inequality, and more flexible exchange rate regimes. In effect, the impact on growth of a rising household debt-to-GDP ratio appears to be positive in the medium term when institutions and policies are the most effective, and appears to be negative when institutions and policies are the least effective, regardless of the initial level of household debt.

Conclusions and Policy Implications

The econometric analysis clearly shows that household debt has different effects on economic growth and financial stability depending on the horizon. At business cycle frequency, high growth in household lending appears to foster above-average growth and employ-

- ment at first, but tends to be followed by a period of instability and subpar GDP growth and employment. This finding is consistent with the presence of a policy trade-off between short-term and medium-term growth and financial instability. While this forecasting trade-off is a robust pattern of the data, it is stronger for advanced economies than for emerging market economies, with increases in household debt consistently signaling higher risks when initial debt levels are already high. Nonetheless, the results indicate that the threshold levels for household debt increases being associated with negative macro outcomes start relatively low, at about 30 percent of GDP. Therefore, although emerging market economies have some space to take advantage of the positive effects of expanding households’ access to credit—in both the short and long term—with low medium-term risks, such space may be limited. Furthermore, even in countries with low macro levels of household debt, a rapid expansion in credit may lead to an increasing fraction of highly leveraged households that may be vulnerable to shocks. Finally, existing studies suggest that household debt appears positive for growth across medium- to long-term horizons, although the relationship weakens at high levels of indebtedness.

A country’s characteristics, institutions, and policies can mitigate the risks associated with increasing household debt. The negative effects are weaker in countries with less external financing and floating exchange rates, that are financially more developed, that have better financial sector regulations and policies, and that have lower income inequality. Thus, even in countries where the level of household debt to GDP is high, the stability-growth trade-off can be attenuated by a combination of good policies, institutions, and regulations. On the other hand, in countries where the low initial level of household debt mitigates some of the risks, the wrong combination of institutional characteristics and policies may offset the effect of a low debt level. This indicates that the point at which further increases in household debt pose risks to future economic performance is country specific; various factors should be evaluated by country authorities to assess vulnerabilities arising from household leverage.

Policy action will need to calibrate the short-, medium-, and long-term benefits and risks. Policies need to carefully balance minimizing the medium-term risks of growth in household credit for financial stability without harming the potential long-term benefits of inclusion and development. Moreover, policy
action must overcome the inaction bias and political pressure generated by the very short-term positive impact of household credit on GDP growth versus the medium-term negative impact.

In any event, certain policy changes can help reduce the impact of aggregate demand externalities and behavioral biases. Some of the drag household debt places on GDP can be reduced by moving away from fixed exchange rates; introducing financial sector policies that promote financial institutions and market depth, access, and efficiency; and advancing policies that help reduce income inequality. For the most part, these policy changes may also have long-term positive effects on growth. For example, as noted by Coibion and others (2017), lower inequality may enhance lower-income households’ access to credit and their ability to smooth consumption and make long-term investments (for example, sending children to college and retraining for different careers) that benefit society. Furthermore, the reliance on foreign debt and the role of capital flows may need further attention because they expose countries to sudden stops or destabilizing capital outflows (see also IMF 2014).

Macroprudential policy can help curb household leverage. Macroprudential policies can help internalize the externality that the borrowing by each household imposes on the rest of the financial system, given that large increases in household debt are associated with a greater likelihood of financial crises and recessions. The design of targeted macroprudential measures may need to take distributional aspects into account, since certain characteristics of households are associated with a greater misalignment of debt and future income. Detailed panel regression analysis shows that various macroprudential measures can significantly reduce real household credit growth, both in advanced economies and in emerging market economies (Box 2.5). Demand-side measures, such as limits on the debt-service-to-income ratio and loan-to-value ratio, seem highly effective. Supply-side measures targeted at loans, such as limits on bank credit growth, loan contract restrictions, and loan loss provisions, are equally effective. However, these policies would require careful calibration to maintain the balance between the short-, medium-, and long-term effects discussed.

There is also a role for policymakers to further strengthen the protection of consumer finance. The empirical analysis found that credit registries reduce the negative effects on growth in the medium term. The development of credit registries will help improve the welfare of households vulnerable to overborrowing. Consumer financial protection not only helps unsophisticated consumers make wiser finance decisions, it also helps enhance overall financial stability, as shown in the empirical analysis. Measures could include increasing the transparency of financial contracts, financial education, prohibition of predatory lending, and regulation of certain financial innovation products.

Similarly, good microprudential supervision can mitigate the negative effects of household debt. As amply demonstrated during the global financial crisis, differences in the quality and depth of banking supervision helped explain why some countries escaped the negative externalities associated with the large increase in household debt during the preceding decade. This may reflect stronger supervisory powers or more stringent capital regulation frameworks that allowed supervisors to diminish the negative effect of household debt increases on future GDP.

Market solutions may also help mitigate the economic consequences of household debt in financial recessions. For example, risk sharing between mortgage lenders and borrowers could be increased, which is the aim of the shared appreciation design of mortgage contracts advocated by Shiller (2014) and Mian and Sufi (2014). In this more equity-like design of mortgage contracts, the principal is automatically written down if the local house price index falls below a specified threshold; increases in property value are shared between the homeowner and the lender. This type of mortgage loan can help price in the associated crash risk before lenders extend credit and reduce the debt overhang problem of households when house prices fall. In theory, this approach would reduce the blow to the macroeconomy of housing busts during episodes of household deleveraging. It would thus enhance financial stability much as nonfinancial firms or banks benefit from bail-in debt with loss-absorbing capacity vis-à-vis bondholders (see Chapter 3 of the October 2013 Global Financial Stability Report). However, more work is needed on the conditions and pricing that would entice banks to offer such contracts and to get a full understanding of the potential effects on financial stability (including banks’ ability to absorb associated losses).
In the long term, higher levels of credit to GDP are generally associated with higher economic growth. Financial development, including better institutions and easier access to credit by households, has been shown to be beneficial to economic growth in the long term (Levine 1998; Beck and Levine 2004). As the financial sector develops, growth-enhancing investments can be more easily financed. Nonetheless, the relationship between household debt and growth is more elusive (Jappelli and Pagano 1994; De Gregorio 1996; Beck and others 2012; Sahay and others 2015a). Recent studies have found that economies may reach a point of “too much finance.” Arcand, Berkes, and Panizza (2015) and Sahay and others (2015b) found that financial depth begins to dampen output growth when credit to the private sector reaches between 80 percent and 100 percent of GDP. Too much finance may increase the frequency of booms and busts because of greater risk taking and leverage, and may leave countries ultimately worse off and with lower real GDP growth. Another argument is that too much finance leads to a diversion of talent and human capital away from productive sectors and toward the financial sector (Shiller 2005).

A more detailed analysis with household credit suggests the existence of a tipping point. An empirical exercise conducted for the countries covered in the chapter finds that household debt increases long-term real GDP per capita growth, but the effects weaken at higher levels of household debt and eventually become negative. The maximum positive impact in this exercise is found when household debt is between 36 percent and 70 percent of GDP (Figure 2.1.1, panel 1). In addition, there does not appear to be an effect specific to emerging market economies, but a financial crisis seems to result in permanently lower per capita GDP growth (Figure 2.1.1, panel 2).

**Box 2.1. Long-Term Growth and Household Debt**

In the long term, higher levels of credit to GDP are generally associated with higher economic growth. Financial development, including better institutions and easier access to credit by households, has been shown to be beneficial to economic growth in the long term (Levine 1998; Beck and Levine 2004). As the financial sector develops, growth-enhancing investments can be more easily financed. Nonetheless, the relationship between household debt and growth is more elusive (Jappelli and Pagano 1994; De Gregorio 1996; Beck and others 2012; Sahay and others 2015a). Recent studies have found that economies may reach a point of “too much finance.” Arcand, Berkes, and Panizza (2015) and Sahay and others (2015b) found that financial depth begins to dampen output growth when credit to the private sector reaches between 80 percent and 100 percent of GDP. Too much finance may increase the frequency of booms and busts because of greater risk taking and leverage, and may leave countries ultimately worse off and with lower real GDP growth. Another argument is that too much finance leads to a diversion of talent and human capital away from productive sectors and toward the financial sector (Shiller 2005).

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Housing assets and mortgages are important components of the balance sheets of Chinese households. High levels of ownership (about 90 percent of the population own a property) make housing the largest asset of Chinese households: more than two-thirds of their total assets (Figure 2.2.1, panels 1 and 2). On the liability side, urban households in China have increased their borrowing. Mortgage loans from banks account for the largest share of their debt. Consistent with the life-cycle theory of debt, participation rates among urban Chinese households across age groups follow a hump shape and are highest for younger

Box 2.2. Distributional Aspects of Household Debt in China

Figure 2.2.1. Characteristics of China’s Household Debt

1. Housing-to-Assets and Mortgage-to-Debt Ratios, and Homeownership
2. Mortgage Participation Rate
3. Debt-to-Income and Debt-Service-to-Income Ratio
4. Loan Balance-to-Value Ratio
5. Distribution of Household Debt by Debt-to-Income Groups
6. Response of Consumption to Income Shocks

Sources: IMF staff calculations, based on China Household Finance Survey; see Gan and others 2013 for details.
Note: Data shown are mainly for urban households from different income quintiles (Q1 to Q5, lowest to highest). The housing-to-assets ratio is defined as the ratio of housing assets to total assets. The mortgage-to-debt ratio is defined as the ratio of mortgage debt to total debt. The mortgage debt participation rate is computed across age groups. Debt-to-income (multiple) and debt-service-to-income (percentage) ratios by income quintiles are scaled by the share of each household quintile in total debt. The response of consumption-to-income shocks is the coefficient in the cross-sectional regressions of the percentage change in consumption on the percentage change in income between 2013 and 2015 among households that were tracked in the survey. In panel 2, “age” refers to the age of the head of household. For panel 5, a ratio above 4 indicates a highly indebted household.
Households. Household debt has become an increasingly important component of credit in China. As the household debt-to-GDP ratio rose from 18.7 percent to about 38 percent from 2007 to 2016, loans to households as a percentage of total loans issued by financial institutions increased from 19.4 percent to 31.3 percent over the same period.

The debt burden of mortgage borrowers in urban areas has increased in recent years, although mortgage participation rates are still relatively low compared with advanced economies. The debt-to-income ratio increased across most income groups, especially for lower-income households. The debt service ratio, defined as total debt repayment as a percentage of total income, also increased for all income groups but especially for lower-income households (Figure 2.2.1, panel 3). The loan balance-to-value ratio, defined as the remaining loan balance as a percentage of self-reported housing value, also increased over time (Figure 2.2.1, panel 4). On the other hand, mortgage loan participation rates, especially for low-income households, are still low, which is consistent with China’s economic and financial development level.

The increased household debt could amplify the macroeconomic consequences of negative shocks. Although household debt is about 38 percent of GDP in China, more than one-third of it is held by highly indebted households, defined as those with a debt-to-income ratio greater than 4 (Figure 2.2.1, panel 5). This means that deterioration in the balance sheets of these households could have an amplified negative impact on the banking sector as well as on the macroeconomy, even though loans to households, including home mortgages, in China are still a smaller fraction of banks’ total assets than in advanced economies. In addition, empirical evidence based on tracked samples of Chinese households between 2013 and 2015 shows that consumption of households with high debt to income responds more strongly to income shocks (Figure 2.2.1, panel 6). This suggests that negative shocks to household balance sheets may amplify the effect on China’s economy because of highly indebted households’ higher marginal propensity to consume—a pattern consistent with evidence in advanced economies (for example, Mian, Rao, and Sufi 2013).

Box prepared by Alan Xiaochen Feng, in collaboration with Feng Li and Xiaomeng Lu from the Survey and Research Center for China Household Finance at Southwestern University of Finance and Economics.

1Note that not many households of those ages 45–59 borrow for mortgages because a large share of today’s housing stock still originates from the planned-economy period during which the government or state-owned enterprises distributed housing.

2Only domestic-currency (renminbi) loans are included. Data on total loans and loans to households are based on Sources and Uses of Funds of Financial Institutions published by the People’s Bank of China.
Box 2.3. A Comparison of US and Canadian Household Debt

Until the global financial crisis, household debt levels evolved very similarly in the United States and Canada. US household debt increased from 56 percent in 1995 to nearly 100 percent of GDP in the first quarter of 2008 and from 62 percent to 80 percent in Canada (Figure 2.3.1, panel 1). Afterward, US household debt fell to below 80 percent by early 2017, whereas in Canada, it continued to rise to more than 100 percent. This reflects different house price and unemployment trends, as well as difference in the evolution of net wealth, which left Canadian households relatively better off than their US counterparts.

The composition of household debt has changed in both countries. In response to continuously rising house prices, Canadian household debt became more tilted toward mortgage debt, which increased from 61 percent of total debt in 2005 to 66 percent of total debt in 2016 (Figure 2.3.1, panel 2). In the United States, where house prices fell by 40 percent from their peak in 2008, households’ share of mortgage debt decreased, while consumer debt increased substantially, mainly because of increased student loan debt.

Leverage is very different across households. US households’ leverage (as given by the debt-to-income ratio) remained broadly constant, except for the poorest income group, whose leverage increased slightly. In Canada, on the other hand, debt-to-income

Box prepared by Adrian Alter, Alan Xiaochen Feng, and Nico Valckx.

Figure 2.3.1. US and Canadian Household Debt Developments and Characteristics

1. Household Debt-to-GDP Ratio and House Prices
   - Canadian debt (left scale)
   - Canadian real house price (right scale)
   - US debt (left scale)
   - US real house price (right scale)

2. Composition of Household Debt (Percent)
   - Mortgage
   - Consumer
   - Other
   - Canada 2005, 2016

3. United States: Debt-to-Income Ratio Distribution (Percent)
   - 2004, 2013

4. Canada: Debt-to-Income Ratio Distribution (Percent)
   - 2005, 2012

Note: Panels 3 and 4 refer to the median debt-to-income levels by income quintiles for mortgage borrowers.
Box 2.3 (continued)

ratios increased across all income groups, resulting in an average ratio almost 50 percent higher than in the United States (Figure 2.3.1, panels 3 and 4). Moreover, highly indebted households (those with debt-to-income ratios above 350 percent) held more than Can$400 billion, or 21 percent of the total household debt in Canada at the end of 2014, up from 13 percent before the crisis (Bank of Canada 2015).

High leverage may expose households to potentially adverse income shocks. The past recession in the United States showed that highly indebted households substantially reduced spending, which contributed to a significant decline in aggregate demand (Mian and Sufi 2011). Results reported in this chapter are in line with analysis by the Bank of Canada, which in its latest Financial System Review highlighted high household indebtedness and imbalances in the Canadian housing market as its two most important vulnerabilities; accordingly, it has implemented several macroprudential measures to mitigate these problems (IMF 2017).
Household debt leads to higher house prices and more debt in the future, likely through reinforcing feedback effects. Dynamic panel vector autoregression analysis confirms that household debt has a short-term positive effect on real house prices and output. A one standard deviation shock to household debt initially leads to higher real house prices and output, but over the medium term (after about three to five years) results in a decline (Figure 2.4.1, panels 1 and 3). Higher house prices are positively associated with output in the short and medium term, but negatively in the long term (Figure 2.4.2). In response to a positive shock to house prices, household debt increases steadily over the short and medium term, while reverting to its long-term mean thereafter (Figure 2.4.1, panel 4).

These findings are consistent with Lombardi, Mohanty, and Shim 2017. See also Mian, Sufi, and Verner, forthcoming; Calza, Monacelli, and Stracca 2013; and Brunnermeier and others 2017.

Figure 2.4.1. Panel Vector Autoregression Dynamic Analysis
(Percentage points)

1. Shocks to Household Debt Ratio: Effect on Real Output

2. Shocks to House Prices: Effect on Real Output

3. Shocks to Household Debt Ratio: Effect on House Prices

4. Shocks to House Prices: Effect on Household Debt Ratio

Source: IMF staff calculations.
Note: The figure presents impulse responses from a five-variable recursive panel vector autoregression with eight lags using quarterly data from 1998:Q1 to 2015:Q4, which includes country and time fixed effects. Shocks are identified using a Cholesky decomposition with the following order: log real GDP, corporate debt, household debt, log real house prices, and short-term interest rates. Household debt and corporate debt were scaled by GDP. The results are robust to a Nickell bias correction (using panel general method of moments techniques) and other specifications (for example, ordering, number of lags, changes instead of levels). Dashed lines represent 90 percent confidence intervals, computed using 500 Monte Carlo simulations.
Micro-level panel survey data analysis confirms the impact of house prices on consumption and the role of debt. In Korea, the rise in the local house price index between 2008 and 2014 had a positive effect on household consumption, which is consistent with the initial positive response of GDP to house price shocks shown in the panel vector autoregression analysis. 3

3This empirical exercise uses tracked samples of households between 2008 and 2014 and controls for changes in household income, demographic information, and city-level aggregates.

Such an effect is present only for homeowners, suggesting that the increase in house prices raises collateral value as well as perceived wealth for these households (Figure 2.4.2, panel 1). Similarly, in Australia, homeowners increased consumption in response to higher local house prices between 2012 and 2015, and the effect was stronger for households with high financial leverage. This finding indicates that higher household debt reinforces the impact of house prices on the real economy (Figure 2.4.2, panel 2).
Box 2.5. The Impact of Macroprudential Policies on Household Credit

This box finds that macroprudential loan-targeted measures successfully reduce the growth of real household credit in both advanced economies and emerging market economies.

Many countries introduced or tightened macroprudential policy measures to limit systemic risk in the aftermath of the large credit boom that preceded the global financial crisis (Figure 2.5.1, panel 1). In theory, macroprudential policies reduce systemic risk by correcting externalities operating through the financial system. Such externalities include aggregate demand externalities and strategic complementarities among financial institutions, which amplify credit and asset price cycles.1

1See, for example, Hanson, Kashyap, and Stein 2011; De Nicolo, Favara, and Ratnovski 2012; and IMF 2013.

Figure 2.5.1. Macroprudential Policy Tools and Household Credit Growth

1. Number of Macroprudential Policy Tools and Real Household Credit Growth

2. Effect of Individual Macroprudential Tools (Percentage points)

3. Effect of Combined Policies, Average by Type (Percentage points)

Source: IMF staff calculations.

Note: In panel 1, the macroprudential policies show the cumulative sum of tightening (+) and loosening (–) policies. Panel 2 shows the estimated average effects on real household credit growth of one tightening event for each macroprudential measure, one at a time, in a panel regression of 62 countries (32 advanced economies and 30 emerging market economies). In panel 3, All comprises all 14 measures considered. Loan consists of demand-side and supply-side loans. Demand includes debt-service-to-income ratios and loan-to-value ratios. Supply measures are classified into General, Capital, and Loans. Supply (General) consists of reserve requirements, liquidity requirements, limits on foreign exchange positions, and taxes on financial institutions. Supply (Capital) consists of capital requirements, conservation buffers, the leverage ratio, and the countercyclical capital buffer. Supply (Loans) consists of limits on bank credit growth, loan loss provisions, loan restrictions, and limits on foreign currency loans. Shaded bars depict significant effects at the 10 percent confidence levels. See Annex 2.2 for estimation details. AEs = advanced economies; EMEs = emerging market economies.
In both advanced and emerging market economies, targeted macroprudential measures successfully reduce real household credit growth. From a set of 14 measures, 5 measures related to credit have robust negative effects (Figure 2.5.1, panel 2). These measures are limits on the debt-service-to-income (DSTI) ratio, limits on the loan-to-value (LTV) ratio, loan contract restrictions, limits on bank credit growth, and loan loss provisions. On average, a tightening of these measures leads to a 1 to 3 percentage point decline in real household credit growth, similar to Kuttner and Shim’s (2016) results for LTV and DSTI ratio limits.² The effects are generally stronger in emerging market economies, corroborating the findings of Cerutti and others (2017).³

On the other hand, measures that are not targeted to loans do not exhibit strong effects in contracting household credit. Reserve requirements also tend to have negative effects, but they are smaller and less significant than targeted measures.⁴ Leverage limits, conservation buffers, and limits on foreign exchange positions are positively associated with subsequent growth in household credit. Other measures, such as capital requirements and taxes on financial intermediaries, do not have significant effects. However, a tightening of general supply measures should increase the resilience of the financial system to aggregate shocks by building buffers. Previous studies also find weaker effects of nontargeted and capital measures and may explain their lack of effectiveness, including leakages. For example, tightening capital requirements may have little effect when banks hold ample capital. When examining the effects of measures by type, demand-side measures (DSTI and LTV) as well as loan-targeted supply-side measures (on domestic credit growth and loan loss provisions) are found to be effective (Figure 2.5.1, panel 3).⁵

²Other studies, using different data and methodologies, also show that tighter LTV and DSTI ratios reduce household credit growth. See Lim and others 2011; Arregui and others 2013; Crowe and others 2013; Krznar and Morsink 2014; and Jácome and Mitra 2015.

³Loan restrictions and limits on credit growth also appear to effectively contain corporate credit growth, to the tune of 2 to 3 percentage points, while other measures have a weak or insignificant impact. The latter could reflect firms’ better access to (international) debt markets than households.

⁴See Arregui and others 2013; Crowe and others 2013; Vandenbussche, Vogel, and Detragiache 2015; and Kuttner and Shim 2016.

⁵Combining same-type measures allows the effects of multiple measures adjusted at the same time to be controlled for. For example, Kuttner and Shim (2016) report that changes in DSTI and LTV ratio limits are often coordinated.
Annex 2.1. Data Sources

### Annex Table 2.1.1. Countries Included in the Sample for Household Debt and Data Sources

<table>
<thead>
<tr>
<th>Country</th>
<th>Source</th>
<th>Start Year</th>
<th>Country</th>
<th>Source</th>
<th>Start Year</th>
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Sources: IMF staff.

Note: BIS = Bank for International Settlements; CEIC = CEIC Data Co. Ltd.; ECRI = Economic Cycle Research Institute; Haver = Haver Analytics; IMF, MFS = Monetary and Financial Statistics database; JST = Jordà-Schularick-Taylor Macrohistory Database.
Annex Table 2.1.2. Household Survey Data Sources

<table>
<thead>
<tr>
<th>Country</th>
<th>Name of Survey</th>
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<td>Australia</td>
<td>Household, Income and Labour Dynamics in Australia Survey</td>
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<tr>
<td>Canada</td>
<td>Luxembourg Wealth Study, Survey of Financial Security</td>
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<tr>
<td>Euro Area</td>
<td>European Central Bank's Household Finance and Consumption Survey; Luxembourg Wealth Study (LWS)</td>
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<td>Japan</td>
<td>Keio Household Panel Survey</td>
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<td>Korea</td>
<td>Korean Labor and Income Panel Study; Korean Statistical Information Service</td>
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<td>China</td>
<td>China Household Finance Survey</td>
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</table>

Source: IMF staff.

Annex Figure 2.1.1. Loan Characteristics, Rules, and Regulations

Source: IMF staff calculations.

Note: Figure is based on an IMF desk survey of the prevalence of certain debt characteristics in 80 countries. The desk survey reveals that a majority of countries have financial protection regulations (against predatory lending practices) and loan transparency rules and regulations (through credit registries or credit bureaus). In 80 percent of the sample, recourse is commonplace in loan agreements, whereas early prepayment restrictions feature in about 40 percent of the countries surveyed. Tax deductibility is common in half of the sample, with limitations on how much debt (or interest payments) households can deduct from their taxes. Fixed-rate mortgages (with the initial rate fixed for 10 or more years) are offered in most countries. Administrative restrictions on land supply are more prevalent in advanced economies (about 60 percent) than in emerging market economies (44 percent), whereas natural restrictions exist in about 30 percent of the countries surveyed (related to size of the country, livable land area, population density, and the like). FIX = fixed rates are offered; GOV = administrative restrictions on land supply; NAT = natural restrictions on density of development, such as topography and geography; PEN = restrictions on early payment; PROT = consumer financial protection legislation in place; REC = mortgage loans are full recourse; TAXD = debt or interest payments are tax deductible; TAXL = limits on TAXD exist; TRA = credit registry.
### Annex Table 2.1.3. Description of Explanatory Variables Used in the Chapter

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
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<td><strong>Macro-level Variables</strong></td>
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<tr>
<td>Nominal GDP</td>
<td>Gross domestic product, current prices, national currency</td>
<td>Jordà-Schularick-Taylor Macrohistory database; Penn World Table; IMF, World Economic Outlook database</td>
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<tr>
<td>Real GDP</td>
<td>Gross domestic product, constant prices, national currency</td>
<td>IMF, World Economic Outlook database</td>
</tr>
<tr>
<td>Real Private Consumption</td>
<td>Private final consumption, constant prices, national currency</td>
<td>IMF, World Economic Outlook database</td>
</tr>
<tr>
<td>Consumer Price Index</td>
<td>Consumer prices, period average, index</td>
<td>IMF, International Financial Statistics database</td>
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<tr>
<td>Population</td>
<td>Population, in millions of persons</td>
<td>IMF, World Economic Outlook database</td>
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<tr>
<td>Unemployment</td>
<td>Unemployment rate (percent)</td>
<td>Bloomberg Finance L.P.; IMF, International Financial Statistics database; Thomson Reuters Datasream</td>
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<td>Interest Rate</td>
<td>Three-month Treasury bill rate, money market rate, interbank market rate (percent)</td>
<td>Bloomberg Finance L.P.; Thomson Reuters Datasream</td>
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<td>Bank Equity Index</td>
<td>Equity price index of the banking sector (or financial sector if banking sector price index not available)</td>
<td>Bloomberg Finance L.P.; Thomson Reuters Datasream</td>
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<tr>
<td>Stock Market Index</td>
<td>Overall stock price index</td>
<td>Bloomberg Finance L.P.; Thomson Reuters Datasream</td>
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<td>Banking Crisis</td>
<td>Systemic banking crisis defined as (1) significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations); (2) significant banking policy intervention measures in response to significant losses in the banking system</td>
<td>Laeven and Valencia 2013</td>
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<td>Real House Price Index</td>
<td>House price index deflated by consumer price index</td>
<td>Jordà-Schularick-Taylor Macrohistory database; OECD, Global Property Guide; and IMF staff calculations</td>
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<td>Exchange Rate</td>
<td>National currency units per US dollar, period average</td>
<td>Thomson Reuters Datasream</td>
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<td>Real Effective Exchange Rate</td>
<td>Real effective exchange rate, based on consumer price index</td>
<td>IMF, Monetary and Financial Statistics database</td>
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<td>Exchange Rate Regime</td>
<td>De facto exchange rate arrangement of the country</td>
<td>Ilzetzki, Reinhart, and Rogoff 2017 data set</td>
</tr>
<tr>
<td><strong>Institutional Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Risk Index</td>
<td>Measure of a country’s ability to pay its way by financing its official, commercial, and trade debt obligations; index ranges from 50 (least risk) to a low of 0 (highest risk)</td>
<td>International Country Risk Guide, PRS Group</td>
</tr>
<tr>
<td>Financial Development Index</td>
<td>Over all financial development index</td>
<td>Svyritzenka 2016</td>
</tr>
<tr>
<td>Capital Account Openness Index (Chinn-Ito Index)</td>
<td>An index measuring a country's degree of capital account openness</td>
<td>Chinn and Ito 2006 data set (updated)</td>
</tr>
<tr>
<td>Official Supervisory Power</td>
<td>Whether the supervisory authorities have the authority to take specific actions to prevent and correct problems; index ranges from 0 (no powers) to 14 (most powers)</td>
<td>Barth, Caprio, and Levine 2013</td>
</tr>
<tr>
<td>Overall Capital Stringency</td>
<td>Whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined; index ranges from 0 (least stringent) to 7 (most stringent)</td>
<td>Barth, Caprio, and Levine 2013</td>
</tr>
<tr>
<td>Income Share Held by Highest 20 Percent</td>
<td>Percentage share of income or consumption that accrues to subgroups of the population indicated by deciles or quintiles</td>
<td>World Bank, World Development Indicators</td>
</tr>
<tr>
<td>Income Share Held by Lowest 20 Percent</td>
<td>Percentage share of income or consumption that accrues to subgroups of the population indicated by deciles or quintiles</td>
<td>World Bank, World Development Indicators</td>
</tr>
</tbody>
</table>

Source: IMF staff.

Note: OECD = Organisation for Economic Co-operation and Development.
Annex 2.2. Methodology

This annex provides a general overview of the methodologies behind the various econometric exercises performed in this chapter.

Logit Analysis

The logit model analyzes how levels and changes in household debt affect financial stability. The model is given by

\[
\log \frac{P[S_{it} = 1 | X_{it}]}{P[S_{it} = 0 | X_{it}]} = \Psi_{0i} + \Psi_1 X_{it} + \Psi_2 X_{it} I (\text{HiDebt}) + \epsilon_{it}, \quad (A2.2.1)
\]

in which \( X_{it} \) refers to a vector of lagged changes and levels of household and corporate debt-to-GDP ratios, while the third term refers to interactions with an indicator \( I (\text{HiDebt}) \). The latter takes the value of one if country \( i \) experiences household debt exceeding 65 percent of GDP. Country fixed effects (\( \Psi_{0i} \)) were included in the estimation. The main metric to compare model performance is the area under curve. Annex Table 2.2.1 contains the underlying estimates.

Household Debt and Bank Equity Returns

This exercise provides an alternative measure of banking stress and assesses the role of household debt for future bank equity returns. According to the efficient market hypothesis, past household credit growth should not be correlated with future bank stock returns if investors correctly price the risks associated with the rise in household debt to the banking sector. However, downside risks may be neglected by investors during credit booms when market sentiments are high (for example, Cheng, Raina, and Xiong 2014; Baron and Xiong 2017), leading to systematic predictability of bank stock declines following increases in household debt. Following Baron and Xiong (2017), the empirical specification is given by

\[
r_{ct} k - r_{ct} k - e = \alpha_c + \gamma_t + \beta_h \Delta (\text{HHD}_c) + \beta_f \Delta (\text{NFCD}_c) + \beta_d \times \text{DivYld}_c + X_c \delta + \epsilon_{c,t}, \quad (A2.2.2)
\]

in which \( r_{ct} k \) is the return in year \( k \) of the banking sector index in country \( c \); \( \text{government bond} \)

---

### Annex Table 2.2.1. Logit Analysis: Probability of Systemic Banking Crisis

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Debt</td>
<td>4.037***</td>
<td>2.501***</td>
<td>1.270</td>
<td>2.091</td>
<td></td>
</tr>
<tr>
<td>( \Delta ) Household Debt</td>
<td>(0.783)</td>
<td>(0.925)</td>
<td>(1.276)</td>
<td>(1.716)</td>
<td></td>
</tr>
<tr>
<td>Corporate Debt</td>
<td>0.879</td>
<td>0.536</td>
<td>(0.761)</td>
<td>(0.743)</td>
<td></td>
</tr>
<tr>
<td>( \Delta ) Corporate Debt</td>
<td>(6.482)</td>
<td>(6.334)</td>
<td>(3.954)</td>
<td>(4.220)</td>
<td></td>
</tr>
<tr>
<td>( \Delta ) Household Debt ( \times ) High HH Debt</td>
<td>24.41*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{High HH Debt} )</td>
<td>(1.411)</td>
<td>(14.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-5.949***</td>
<td>-3.741***</td>
<td>-5.465***</td>
<td>-5.224***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.594)</td>
<td>(0.150)</td>
<td>(0.681)</td>
<td>(0.732)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,223</td>
<td>1,033</td>
<td>1,033</td>
<td>1,020</td>
<td></td>
</tr>
<tr>
<td>Country Cluster</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Country Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Area under Curve</td>
<td>0.700</td>
<td>0.791</td>
<td>0.806</td>
<td>0.840</td>
<td></td>
</tr>
<tr>
<td>Number of Crises</td>
<td>46</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Number of Clusters</td>
<td>40</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Pseudo ( R^2 )</td>
<td>0.0612</td>
<td>0.142</td>
<td>0.153</td>
<td>0.204</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.218)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IMF staff calculations.

Note: Robust standard errors in parentheses. All regressors are lagged. The third lag of household debt change was used based on significance. High household debt (High HH Debt) dummy variable is set at 65 percent of GDP, representing the top quintile of the distribution. Banking crises are taken from the updated database by Laeven and Valencia (2013).

*** \( p < 0.01 \); ** \( p < 0.05 \); * \( p < 0.1 \).
yield, and DivYld_{i,t} is the dividend yield of the banking sector,

\[
\Delta \left( \frac{\text{HHD}_{i,t}}{\text{GDP}_{i,t}} \right)_{c,t} = \left( \frac{\text{HHD}_{i,t}}{\text{GDP}_{i,t}} \right)_{c,t} - \left( \frac{\text{HHD}_{i,t}}{\text{GDP}_{i,t}} \right)_{c,t-1}
\]

and

\[
\Delta \left( \frac{\text{NFCD}_{i,t}}{\text{GDP}_{i,t}} \right)_{c,t} = \left( \frac{\text{NFCD}_{i,t}}{\text{GDP}_{i,t}} \right)_{c,t} - \left( \frac{\text{NFCD}_{i,t}}{\text{GDP}_{i,t}} \right)_{c,t-1}
\]

normalized by the standard deviation of each variable for each country, and \( X_{i,t} \) includes control variables such as the past levels of household debt and corporate debt ratios.

The baseline model is estimated using the specification above. Two similar models are also estimated using probit analysis and quantile regressions. The probit analysis examines the relationship between past increases in the household debt ratio and the probability of bank equity crashes occurring in the next one to five years. Bank equity crashes are defined as having an annual stock return below the mean return by at least one standard deviation. In the quantile regressions, the relationship between past increases in the household debt ratio and future bank equity returns at different quantiles is examined.

**Time Series Analysis of Household Debt, Income, and Consumption**

Panel regressions are estimated following Mian, Sufi, and Verner, forthcoming, estimating future real GDP growth on changes in household debt and corporate debt ratios and lagged GDP growth rates. Different specifications are estimated, with changes in the debt ratio calculated over the past three years. In addition, level effects, thresholds, and nonlinearities are tested. Regression estimates are further differentiated by various groupings: advanced and emerging market economies, various institutional factors, and loan terms. Estimations are also performed over different time periods (before and after the global financial crisis) and were qualitatively very similar.

Specifically, the following general equation was estimated:

\[
\Delta_{bX_{i,t} + b} = \alpha_i^{b_h} + \beta_{HII}^{b} \Delta_{HII} d_{HII}^{b_h} + \beta_{F}^{b} \Delta_{F} d_{F}^{b_h} + \Delta_{X_{i,t-1}} + \Gamma + \epsilon_{i,t}^{b_h}\quad (A2.2.4)
\]

in which \( \alpha_i^{b_h} \) are country fixed effects, \( \Delta \) refers to three-year differences, \( d_{HII}^{b_h} \) and \( d_{F}^{b_h} \) are the household debt-to-GDP ratio and nonfinancial firm debt-to-GDP ratio, and \( b = 0, \ldots, 6 \) is the forecast horizon. The matrix \( X_{i,t} \) includes higher-order lags of the dependent variable as additional controls. Right-hand variables are lagged by one year. Annex Table 2.2.2. provides a summary of the major panel regression estimates.

**Micro Data Analysis**

Euro area panel data allow the effects of household leverage on consumption, using a longitudinal household panel, to be tested. Specifically, from a broader euro area household finance and consumption survey of 15 to 20 countries for 2010 and 2014, data for Belgium, Cyprus, Germany, Malta, and the Netherlands allow testing for the effects of initial household debt-to-income and loan-to-value ratios on changes in the consumption-to-income ratio.

The following cross-sectional regression is estimated, at the household level, with change in household food consumption (percent of income) as the dependent variable:

\[
\Delta C_{i,2014} = \alpha_i + \beta_{1} DTI_{i,2010} + \gamma \text{Controls} + \epsilon_i\quad (A2.2.5)
\]

in which debt-to-income ratio (DTI_{i,2010}) is a proxy for past household indebtedness; household characteristics (such as employment, education, age of the household head, household’s net wealth and size) are considered Controls. In addition, the model includes country fixed effects (\( \alpha_i \)).

**Macroprudential Policies and Household Credit Growth**

Analysis in Box 2.5 gauged the effectiveness of macroprudential tools for reducing household credit growth. More specifically, the following panel regression equation was estimated:

\[
C_{i,t} = \rho C_{i,t-1} + \beta \text{MaPP}_{i,t-1} + \gamma X_{i,t-1} + \alpha_i + \mu_i + \epsilon_{i,t}\quad (A2.2.6)
\]

in which \( \alpha_i \) and \( \mu_i \), denote country and year fixed effects, \( i \) denotes country, and \( t \) the time period (quarter). The dependent variable, \( C_{i,t} \), refers to year-over-year growth rate of real household credit. The main independent variable, MaPP, is the policy change indicator (that is, tightening or loosening) compiled by IMF staff for each of the 14 macroprudential tools (that is, limits on the debt-service-to-income ratio, loan-to-value ratio, loan restrictions, limits on bank

---

Note: The page contains technical economic and statistical expressions related to household debt, financial stability, and macroprudential policies. The content involves regression analysis, household debt metrics (e.g., debt-to-income ratio), and the effects of macroprudential policies on household credit growth.
### Annex Table 2.2.2. Panel Regression Estimates for Three-Year-Ahead Growth Regression on Household Debt and Policy Interaction Variables

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change HHD/GDP</td>
<td>0.104</td>
<td>0.141</td>
<td>-0.588*</td>
<td>-0.062</td>
<td>-0.241*</td>
<td>-0.109</td>
<td>0.015</td>
<td>-0.758**</td>
<td>-0.796*</td>
</tr>
<tr>
<td>Change FirmD/GDP</td>
<td>-0.036*</td>
<td>-0.037*</td>
<td>-0.028*</td>
<td>-0.034*</td>
<td>-0.037*</td>
<td>-0.035*</td>
<td>-0.012*</td>
<td>-0.032*</td>
<td>-0.031*</td>
</tr>
<tr>
<td>HHD30 × ΔHHD</td>
<td>-0.261*</td>
<td>-0.367*</td>
<td>-0.373*</td>
<td>-0.360*</td>
<td>-0.280*</td>
<td>-0.435*</td>
<td>-0.080*</td>
<td>-0.310*</td>
<td>-0.304*</td>
</tr>
<tr>
<td>Financial Openness Index × ΔHHD</td>
<td>-0.120*</td>
<td>-0.301*</td>
<td>-0.123*</td>
<td>-0.093*</td>
<td>-0.03</td>
<td>-0.588*</td>
<td>-0.058*</td>
<td>-0.090**</td>
<td></td>
</tr>
<tr>
<td>Financial Risk Index × ΔHHD</td>
<td>0.016*</td>
<td></td>
<td>0.020*</td>
<td>0.019*</td>
<td></td>
<td>-0.006***</td>
<td>-0.004*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income Inequality × ΔHHD</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transparency × ΔHHD</td>
<td>0.285*</td>
<td></td>
<td>0.264*</td>
<td>0.202*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Development Index × ΔHHD</td>
<td>0.369*</td>
<td></td>
<td>0.394***</td>
<td>0.445**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Openness Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Openness Index × Fixed FX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Openness Index × ΔHHD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**R² Adjusted**
- 0.581
- 0.572
- 0.575
- 0.56
- 0.57
- 0.568
- 0.585
- 0.616
- 0.618

**Observations**
- 1,002
- 1,002
- 1,002
- 1,002
- 1,002
- 1,002
- 1,002
- 1,002
- 1,002

**Number of Countries**
- 57
- 57
- 57
- 57
- 57
- 57
- 57
- 57
- 57

**Akaike Information Criterion**
- 6.16
- 6.18
- 6.17
- 6.2
- 6.18
- 6.19
- 3.95
- 6.08
- 6.07

**F-statistic**
- 16.1
- 15.6
- 15.7
- 14.8
- 15.4
- 15.3
- 16.4
- 16.7
- 16.6

**Log Likelihood**
- -2,991
- -3,001
- -2,998
- -3,015
- -3,004
- -3,006
- -1,885
- -2,942
- -2,938

Source: IMF staff estimates.

Note: All panel estimations include country fixed effects, time fixed effects, and base effects. Estimations are performed over a constant sample (for which data on all variables are available). Standard errors are robust estimators. Fixed FX = fixed exchange rate regime dummy; HHD = household debt; HHD30 = dummy if household debt-to-GDP ratio exceeds 30 percent; income inequality = difference between income share of top 20 percent and the bottom 20 percent income groups; transparency = a dummy variable, whether a credit registry or other form of borrower information data transparency exists.*** p < 0.01; ** p < 0.05; * p < 0.1.
credit growth, loan loss provisions, reserve requirements, liquidity requirements, limits on foreign exchange positions, capital requirements, conservation buffers, leverage ratio, countercyclical capital buffer, limits on foreign currency loans, and taxes on financial institutions) or macroprudential group indices (that is, all MaPPs, loan MaPPs, demand, supply, supply [general], supply [capital], and supply loans). MaPPs are the cumulative sum of the number of policy changes over the past year (that is, the past four quarters) to reflect the potential delayed effects. A vector of control variables, \( X_{it} \), such as real output growth and domestic interest rates, is also included. The model is estimated with quarterly data from 62 countries (32 advanced economies and 30 emerging market economies) from the first quarter of 1990 to the fourth quarter of 2015, using both panel fixed effects and the system generalized method of moments technique as outlined by Arellano and Bover (1995).

References


Colibion, Olivier, Yurij Gorodnichenko, Marianna Kudlyak, and John Mondragon. 2017. “Does Greater Inequality Lead to...


Summary

Changes in the state of the financial system can provide powerful signals about risks to future economic activity. As in the run-up to the global financial crisis, financial vulnerabilities, understood as the extent to which the adverse impact of shocks on economic activity may be amplified by financial frictions, often increase in buoyant economic conditions when funding is widely available and risks appear subdued. Once these vulnerabilities are sufficiently elevated, they entail significant downside risks for the economy. Thus, tracking the evolution of financial conditions can provide valuable information for policymakers regarding risks to future growth and, hence, a basis for targeted preemptive action.

This chapter develops a new, macroeconomic measure of financial stability by linking financial conditions to the probability distribution of future GDP growth and applying it to a set of major advanced and emerging market economies.

The analytical approach developed in the chapter can be a significant addition to policymakers’ toolkit for macro-financial surveillance. The chapter shows that changes in financial conditions shift the distribution of future GDP growth. While a widening of risk spreads, rising asset price volatility, and waning global risk appetite are significant predictors of large macroeconomic downturns in the near term, higher leverage and credit growth provide a more significant signal of increased downside risks to GDP growth over the medium term.

Thus, at the present juncture, low funding costs and financial market volatility support a sanguine view of risks to the global economy in the near term. But the increasing leverage signals potential risks down the road. A scenario of rapid decompression in spreads and an increase in financial market volatility could significantly worsen the risk outlook for global growth. These findings underscore the importance of policymakers maintaining heightened vigilance regarding risks to growth during periods of benign financial conditions that may provide a fertile breeding ground for the accumulation of financial vulnerabilities.

A retrospective, real-time analysis of the global financial crisis shows that forecasting models augmented with financial conditions would have assigned a considerably higher likelihood to the economic contraction that followed than those based on recent growth performance alone.

Improvements in predictive ability of severe economic contractions, even over short horizons, can be important for timely monetary and crisis-management policies. The ability to harness longer-horizon information from asset prices and credit aggregates can also help in the design of policy rules to address financial vulnerabilities as they develop. The richness of the results obtained across countries suggests that there is significant scope for policymakers to further adapt the approach used in this chapter to specific country conditions including, importantly, to reflect structural changes in financial markets and the real economy.
Introduction

The global financial crisis was a powerful reminder that financial vulnerabilities can increase both the duration and severity of economic recessions. Financial vulnerabilities, understood as the extent to which the adverse impact of shocks on economic activity may be amplified by financial frictions, usually grow in buoyant economic conditions when investment opportunities seem ample, funding conditions are easy, and risk appetite is high. Once these vulnerabilities are sufficiently high, they can entail significant downside risks for the economy.

This interplay between shocks, financial vulnerabilities, and growth suggests that financial indicators can provide important intelligence regarding risks to the economic outlook. Policymakers have devoted considerable attention to translating the information content of financial indicators into an assessment of financial vulnerability. Approaches that have been used include expert judgment, stress tests, and heatmaps based on multiple early-warning indicators and broad financial conditions indices. These approaches all assess financial vulnerability by linking the state of the financial system to the probability of a financial crisis or bank capital shortage.

Because policymakers care about the whole distribution of future GDP growth, linking the state of the financial system to such a distribution would enhance macro-financial surveillance. Policymakers would then be able to specify bad outcomes in terms of their risk preferences. For example, it would be possible to calculate the likelihood of output growth being below a given level and to identify thresholds for financial indicators, such as leverage, that signal heightened tail risks to growth.

This chapter develops a new analytical tool that maps financial conditions into the probability distribution of future GDP growth. In this chapter, financial conditions correspond to combinations of key domestic financial market asset returns, funding spreads, and volatility; domestic credit aggregates; and external conditions such as measures of global risk sentiment. The methodological approach extends a nascent literature that derives a direct empirical link between financial conditions and risks to the real economy and applies it to 21 major advanced and emerging market economies over the near and medium term.

The chapter examines how financial conditions provide information regarding risks to future economic growth across countries and time horizons. In advanced economies, there may be a stronger association between financial variables and future economic activity than in emerging market economies because more economic risks are traded in deeper financial markets. But, in both cases, asset prices may remain buoyant until shortly before risks materialize, as the run-up to the global financial crisis showed. Thus, incorporating information on credit aggregates such as leverage into measures of financial conditions may improve forecasts of risks to growth, especially over the medium term.

The chapter addresses the following specific questions:

• Do changes in financial conditions signal risks to future GDP growth? Are they equally informative for advanced and emerging market economies, about the intensity of recessions and the strength of booms, and over different time horizons?

• What types of financial variables are more informative regarding the risks to growth at different time horizons and in different countries?

• Could we have used financial conditions to shed light on the likelihood of extremely negative growth outcomes of the past, such as the global recession following the bankruptcy of Lehman Brothers?

• How can policymakers make use of this new tool of macro-financial surveillance?

The main findings are as follows:

• Changes in a country’s financial conditions shift the distribution of future GDP growth in both advanced and emerging market economies. A tightening of financial conditions, reflected in a decompression in spreads or an increase in asset price volatility, is a significant predictor of large macro-economic downturns within a one-year horizon. Moreover, in emerging market economies, tighter financial conditions could also portend stronger booms over the subsequent four quarters, possibly because of procyclical capital flows.

Prepared by a staff team consisting of Jay Surti (team leader), Mitsuru Katagiri, Romain Lafarguette, Sheheryar Malik, and Dulani Seneviratne, with contributions from Vladimir Pillonca, Áquiles Farias, André Leitão Botelho, Kei Moriya, and Changchun Wang, under the general guidance of Claudio Raddatz and Dong He. The chapter team has benefited from discussions with Norman Swanson, Nellie Liang, and Domenico Giannone. Claudia Cohen and Breanne Rajkumar provided editorial assistance.
• Asset prices are most informative about risks to growth in the short term, whereas credit aggregates provide more information over longer time horizons. A rising cost of funding and falling asset prices signal a greater threat of severe recession at time horizons of up to four quarters. Higher leverage signals increased downside risk to growth at horizons between one and three years.

• Movements in commodity prices and exchange rates affect the real economy in a significant, albeit complex, manner, making a simple economic interpretation of their predictive content challenging. On the other hand, a souring of global risk sentiment increases downside risks to growth at short time horizons of one quarter.

• In addition to these common patterns, there is heterogeneity in the information content of financial conditions for growth risks across countries. For example, while asset prices are no longer informative over horizons longer than a year for advanced economies, they remain so for emerging markets.

• A retrospective real-time analysis of the global financial crisis shows that forecasting models augmented by financial conditions would have assigned a much higher likelihood to the economic contraction that followed than those based on recent growth performance alone.

The chapter’s approach to linking financial conditions and risks to growth can help policymakers in numerous ways. The findings underscore the importance of policymakers maintaining heightened vigilance regarding risks to growth during periods of benign financial conditions that may provide a fertile breeding ground for the accumulation of financial vulnerabilities. Policymakers may respond to signals of an imminent near-term dire economic outcome with crisis-management-type discretionary policy actions that encompass a range of monetary and macroprudential tools. More broadly, this also helps in the design of policy rules to address financial vulnerabilities as they develop through the introduction of appropriate countercyclical macroprudential tools. In this regard, the output of the forecasting models could be used to calibrate parameters of structural macro-financial models used to guide such policy.1 The richness of the results obtained across countries suggests that there is significant scope for authorities to further adapt the broad approach used in this chapter to specific country conditions, including, importantly, to reflect structural changes in financial markets and the real economy.

The rest of this chapter is organized as follows. The next section discusses conceptual issues related to the links between macro-financial conditions, financial vulnerabilities, and risks to the outlook for economic growth. The subsequent section looks at how asset prices and financial aggregates combine to signal short- to medium-term risks to future GDP growth. The section after that provides an empirical assessment of the degree to which the information contained in measures of financial conditions can help forecast risks to economic growth in major advanced and emerging market economies over horizons up to one year. The final section discusses policy implications. Annexes explain the potential policy applications, construction of financial conditions, and modeling of risks to growth in more detail.

Financial Conditions and Risks to Growth: Conceptual Issues

Economic growth has a complex and nonlinear relationship with shocks and financial vulnerabilities. Theory and recent experience both support the view that financial vulnerabilities increase risks to growth.2 When investment opportunities seem abundant and the means of financing them are easily and cheaply available, financial vulnerabilities tend to increase. Once such vulnerabilities are sufficiently high, they can amplify and prolong the impact of shocks on economic activity. GDP growth responds nonlinearly to shocks in the presence of financial vulnerabilities, which increases the likelihood of severely negative economic outcomes.3 Under such circumstances, assessments of both the baseline growth outlook and the risks to such an outlook are informed not only by the span and severity of relevant risk factors that are the source of shocks, but also by the intelligence provided by the interplay of factors that increase financial vulnerability.

1Just as estimated vector autoregression models have been used to calibrate the parameters of linear dynamic general equilibrium models used to pin down optimal monetary policy rules (for example, Christiano, Eichenbaum, and Evans 2005; Del Negro and Schorfheide 2009).

2Empirical evidence shows that recessions accompanied by financial crises are typically much more severe and protracted than ordinary recessions (Claessens, Kose, and Terrones 2011a, 2011b).

3Annex 3.1 provides a framework for understanding the joint dynamics of financial vulnerabilities and growth risks in a structural macro model.
Several factors cause financial vulnerabilities to grow in a buoyant macro-financial environment. Ease of borrowing and high asset prices reduce the incentives to manage liquidity and solvency risks. Perceptions of high investment returns relative to the cost of funding and of the improved quality of collateral incentivize households and firms to increase their leverage without taking into account the potential negative externalities resulting from their collective borrowing decisions (Bianchi 2011; Korinek and Simsek 2016; Bianchi and Mendoza, forthcoming). Booming asset prices also boost the capital adequacy, lending capacity, and risk appetite of financial intermediaries (Brunnermeier and Pedersen 2009; Adrian, Moench, and Shin 2010; Adrian and Shin 2014). As intermediaries respond by increasing short-term wholesale funding to finance long-term credit exposures, maturity mismatches and other balance sheet weaknesses accumulate in the financial sector. For example, lenders’ incentives to invest in costly underwriting are reduced, which can result in significant mispricing of credit risk (Gorton and Ordoñez 2014).

The need to lower significant debt and correct balance sheet mismatches can clog financial intermediation, investment, and growth for a long time once the credit cycle turns. With vulnerabilities substantially elevated, even small negative shocks can cause significant reversals because they force lenders to face up to the true quality of exposures and collateral. This results in a significant tightening in credit conditions. Some firms and households may be forced into default, while others may have to liquidate assets. The ensuing pressure on lenders’ profits and collateral values can then generate further rounds of contraction in credit, investment, and growth. In addition to the direct negative impact of these events on lenders’ profits, rising volatility and risk spreads constrain lenders’ capacity to bear risk by increasing the capital required as a buffer against existing exposures (He and Krishnamurthy 2013; Brunnermeier and Sannikov 2014). In such circumstances, risk-bearing capacity will be affected not only by capital constraints but also by funding liquidity concerns (Gertler, Kiyotaki, and Prestipino 2017).

A large body of empirical work has examined the information content of asset prices in forecasting the baseline growth outlook. Various asset prices have been found to be useful predictors of future output growth in some countries and in some periods. Combining forecasts obtained from models with individual asset prices appears to result in more consistent, higher-quality forecasts. Short-term yields on risk-free securities and term spreads capture the stance of monetary policy and therefore contain useful information about future economic activity (Laurent 1988; Estrella and Hardouvelis 1991; Bernanke and Blinder 1992; Estrella and Mishkin 1998; Ang, Piazzesi, and Wei 2006). Corporate bond spreads signal changes in the default-adjusted marginal return on business fixed investment (Philippon 2009) and shocks to the profitability and creditworthiness of financial intermediaries (Gilchrist and Zakrajšek 2012). There is some evidence that elevated stock-return volatility can be a useful predictor of output contraction over short horizons (Campbell and others 2001), although empirical evidence for the predictive content of stock returns is weak (Campbell 1999; Stock and Watson 2003).

The key departure of this chapter is to focus on the information content of financial indicators in forecasting risks to growth. In addition to asset prices, credit aggregates can also be expected to provide information on the risks to growth in the short, medium, and long term. For example, a combination of low leverage and buoyant asset prices is likely to correspond, over the short term, to high expected growth (an optimistic baseline outlook) and a low likelihood of adverse outcomes (sanguine risk outlook as represented, potentially, by a probability density of short-term growth with relatively low variance). On the other hand, theory suggests that such an environment might be ideal for a buildup of vulnerabilities over the medium term, ultimately increasing the likelihood of low growth outcomes. As such a possibility becomes more certain, spreads and market volatility would rise and asset prices would fall. Other financial variables can

Stock and Watson (2003) produce a comprehensive survey of the literature up to the early 2000s.

Gilchrist and Zakrajšek (2012) demonstrate the superiority of their constructed bond spread over alternative proxies for the default spread investigated in the earlier literature; for example, the Baa-Aaa bond spread (Bernanke 1983), the commercial paper–Treasury bill spread (Stock and Watson 1989; Friedman and Kuttner 1998), and the so-called junk bond spread (Gertler and Lown 1999).

Financial indicators can be classified into two types. Fast-moving asset prices tend to signal risks to growth over the near term, whereas balance sheet aggregates change gradually over time and may indicate risks over longer horizons. The evolution of aggregates and prices is not by any means independent. For example, the growth in aggregates may, beyond a point, change market expectations of risks. This would be reflected in tightening spreads, which then signal risks to growth in the near term. For a discussion, see Adrian and Liang 2016 and Krishnamurthy and Muir 2016.
also be very informative in the context of small open advanced economies and emerging market economies. These variables include the nominal exchange rate and commodity prices, which may affect the cost of external funding and the availability of international collateral (Caballero and Krishnamurthy 2006).

This chapter refers to such a combination of financial indicators, or an index constituted of them, as financial conditions. The term “financial conditions” often refers to the ease of funding (Chapter 3 of the April 2017 Global Financial Stability Report [GFSR]), but here it is used to refer to the combination of a broad set of financial variables that influence economic behavior and thereby the future of the economy.7

This chapter examines two alternative approaches to constructing measures of financial conditions from the information contained in several financial indicators. One attractive option is a single financial conditions index (FCI). An important advantage of such a univariate FCI is the parsimony with which it aggregates the information content of multiple financial indicators. Parsimony is highly desirable for forecasting because it reduces parameter uncertainty, but it may lead to suppressing the information provided by certain variables by commingling them with other, more volatile indicators in a single index. For example, the higher variability of asset prices and risk spreads may lead them to dominate univariate FCIs, with credit aggregates being assigned small factor loadings (as is indeed the case in the application described below). Since credit aggregates may carry significant information about risks to growth at longer horizons, the chapter pursues a second approach wherein financial indicators are partitioned into three separate groups based on economic similarity. The three subindices are the domestic price of risk (risk spreads, asset returns, and price volatility), credit aggregates (leverage and credit growth), and external conditions (global risk sentiment, commodity prices, and exchange rates). The separation of a large set of financial indicators into these three predetermined categories is a reasonable compromise between maintaining parsimony, allowing various classes of indicators to provide separate signals about risks to growth at different horizons, and being able to provide a more direct economic interpretation of the various subindices.

The chapter’s empirical framework is centered on forecasts of the probability distribution of future growth outcomes based on financial conditions in a way that allows for nonlinearity and state dependence. Building on the literature on conditional density forecasting and recent research on forecasting the distribution of growth in the United States, the chapter uses financial conditions to forecast the probability distribution of future GDP growth in major advanced and emerging market economies for horizons of up to three years through quantile projections.8 The flexibility of this approach captures the rich nonlinear interaction between shocks, financial vulnerabilities, and economic outcomes predicted by theory. For instance, consider two combinations of financial indicators that forecast the same future median growth rate. The first combination forecasts much greater downside growth risk (that is, a probability density with a significantly fatter left tail) than the second. This indicates that for a constant distribution of fundamental shocks, the economy is more likely to experience a very bad economic outcome in the future under the first configuration than under the second. In this sense, the first combination signals a financial system that is more vulnerable. These density forecasts can subsequently be exploited to construct measures of risks to economic growth associated with the state of the financial system.

Such an approach provides a natural way of assessing financial vulnerability that has several distinct advantages. First, the estimated link between financial conditions and the distribution of future economic activity would provide a close measure of financial vulnerability, understood as the extent to which the financial system amplifies shocks. Second, to the extent that policymakers care about the whole distribution of future GDP growth, it provides a complete depiction of the risks to economic activity associated with the state of the financial system. Third, it allows policymakers to define risk tolerance in terms of GDP growth, which is more general than in terms of the probability of a financial crisis as defined under specific criteria or another ad hoc metric. For instance, this approach gives precise answers to questions such as the probabil-

7This notion of financial conditions is similar to the definition proposed by Hatzius and others (2010). See Annex 3.2 for details on the construction of financial conditions used in this chapter.

8See Annex 3.3 for details on the empirical framework. Conditional density forecasting is surveyed by Tay and Wallis (2000); Corradi and Swanson (2006); and Komunjer (2013). The chapter’s methodology builds on some recent studies (Adrian, Boyarchenko, and Giannone 2016; De Nicolò and Lucchini 2017) that establish a direct empirical link between financial conditions and risks to economic growth.
icity of GDP growth being less than –3 percent one year ahead given the current—or any hypothetical—state of the financial system.

**How Do Changes in Financial Conditions Indicate Risks to Growth?**

Over a horizon of one to four quarters, tighter financial conditions—as reflected in higher univariate FCIs—predict increased downside risks to GDP growth in most advanced economies and a more uncertain growth outlook in several emerging market economies. An increasing domestic price of risk signals an elevated threat of imminent, severe recession in advanced and emerging market economies. Rising leverage is a significant predictor of elevated downside risk over the medium term. Country-specific results vary considerably, suggesting a rich interplay of the drivers of growth risk.

**What Underpins Economies’ Financial Conditions Indices?**

The drivers of economies’ FCIs vary considerably across a sample of major advanced and emerging market economies. An increase in the FCI corresponds to tighter financial conditions, that is, higher spreads and volatility, lower asset prices, worsening risk sentiment, exchange rate depreciation, and unfavorable commodity price movements. Beyond this common finding, the relative importance of these factors in determining the evolution of FCIs varies considerably across countries. Higher corporate funding costs and worsening global risk sentiment (as captured by rising levels of the Chicago Board Options Exchange Volatility Index [VIX] and Merrill Lynch Option Volatility Estimate [MOVE] Index) tighten financial conditions across the board. But while sovereign spreads are clearly important in emerging market economies, they are rarely so in advanced economies. And while increasing commodity prices loosen financial conditions in exporters such as Australia, Brazil, Canada, Chile, and Russia, they tighten them in commodity-importing countries. Exchange rate appreciation uniformly loosens financial conditions. In the case of emerging market and small open economies, this may reflect the correspondence of an appreciating exchange rate with strong capital inflows. In general, asset price shocks appear to be more important in driving changes in FCIs than credit aggregates. This pattern, however, may reflect the slower speed at which credit adjusts relative to changes in GDP at turning points in the economic cycle, especially at the end of economic booms preceding financial crises.

**What Information Do Univariate FCIs Convey about Future Growth?**

An increase in the FCI would signal higher downside risks in both advanced and emerging market economies. An increase in the global FCI signals heightened downside risk to world GDP growth (Figure 3.1). Movements in the FCI are especially powerful signals of changes in downside tail risk to the global economy but are less informative about the baseline growth outlook and the strength of economic booms. This is reflected in the fact that the forecast of the left tail of the distribution of global GDP growth decreases significantly in response to an increase in the FCI both one quarter and four quarters ahead. In contrast, the forecasts of the central tendency of GDP growth (as captured by the median growth rate) and of the strength of booms (at the right tail of the growth distribution forecasts) are considerably less responsive to changes in the FCI, and their movement is apparent only for large changes in the FCI such as those observed in the global financial crisis. This is also the case for individual countries—the forecasts of the worst-case outcomes (at the 5th percentile of the future GDP growth distribution) are between 3 times (United States) and more than 10 times (Australia) more sensi-
tive to changes in FCIs than the forecasts of the central tendency of economic growth.

Easing of global financial conditions through 2016 signaled reduced tail risk to global growth for 2017. This is evident in the upward movement in the bottom tail of the GDP growth density forecast (5th percentile) for the world economy (Figure 3.1) and a similar movement in several countries, including Australia, Brazil, South Africa, Turkey, and the United States (Figure 3.2).13

Nonetheless, FCIs do carry significant information regarding upside risks to future economic growth for emerging markets (Figure 3.3). In Brazil, Korea, and Mexico, higher levels of the FCI portend a more uncertain growth outlook at a one-year horizon, as reflected in coefficients of opposite signs at the lowest and highest quantiles (which imply fatter and longer tails at both ends of the distribution of future GDP growth). In some commodity-exporting countries, such as Chile, tightening FCIs appear to signal risk of stronger recessions as well as economic booms of lower intensity (Figure 3.3, panel 2).

Different properties of advanced and emerging market economy business cycles may account for the differing significance of the information provided by changing FCIs across countries. Some emerging market economies and commodity exporters may have a more pronounced and symmetrical boom-bust cycle that is closely tied to export-commodity prices and global risk sentiment. Positive developments in either factor can motivate significant capital inflows, relaxing domestic financial constraints on growth.14 When the risk environment reverses, capital flows may retreat, exchange rates can depreciate, and investment and growth can decline (Aguiar and Gopinath 2007). This may explain why a tightening of financial conditions can move the density of GDP growth to the left (Figure 3.3, panel 2). More broadly, increases in FCIs in emerging market economies may reflect domestic interest rate hikes targeted at attenuating overheating due to high domestic demand. But the higher interest rates may attract

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13 The exact magnitude of the movements can be improved by further country-specific calibration that, for instance, increases the number of financial indicators used in FCI construction, but the direction of the movements indicated by the model is quite robust and showcases the potential of this methodology.

14 For the role of commodity prices in explaining the cyclical movements of capital flows to emerging market economies, see, for example, Chapter 4 of the April 2017 Regional Economic Outlook for the Western Hemisphere.
Figure 3.2. Risk of Severe Recessions Is Especially Sensitive to a Tightening of Financial Conditions in Major Advanced and Emerging Market Economies
(One-year-ahead density forecasts; left scale = percent; right scale = standard deviations)

Sources: Bloomberg Finance L.P.; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: The country-specific financial conditions indices (FCIs) are constructed using the methodology described in Annex 3.2. The median (red) line at each point in time denotes the forecast of the 50th quantile of GDP growth made four quarters earlier using the methodology described in Annex 3.3. The shaded area is bound at the top and bottom by, respectively, the forecasts of the 95th and 5th quantiles of GDP growth made four quarters earlier.
capital inflows and thereby extend ongoing credit and economic booms. This may explain why tightening of financial conditions appears to be a good indicator of growing positive and negative risks around the baseline (Figure 3.3, panels 1, 3–4).

Which Asset Prices and Aggregates Best Signal Growth Risks at Various Time Horizons?

Asset prices are differentially informative regarding the domestic price of risk across countries. Term and interbank spreads, followed by corporate and sovereign spreads, are the most important risk indicators for the investment and growth outlook across advanced economies. The dynamics of house prices are particularly important in countries where either the share of homeownership and floating-rate mortgages is high (such as the United Kingdom) or the mortgage market is a key node that underpins pricing and activity in systemic funding markets (as in the United States). The evidence for emerging market economies is more challenging to interpret for two reasons. First, data are much more limited and are available only for more recent years. Second, in many countries, financial market activity is often focused on equity and government bond markets. Unsurprisingly, therefore, analysis of available data suggests that for these countries, sovereign spreads and equity returns are most significant.

Domestic asset prices are the dominant driver of growth risks in the short term, while credit aggregates...
are the dominant drivers in the medium term. Results from a panel quantile regression with country fixed effects, estimated separately for advanced and emerging market economies, highlight some common patterns in the relationship between these FCI components and risks to growth.

- **Domestic price of risk:** Tightening of financial conditions caused by a rising price of risk is a significant predictor of downside growth risks over horizons of up to one year. This inverse relationship between the price of risk and the growth forecast is stronger in the left tail of the distribution of future growth and is more significant for advanced economies (Figure 3.4, panels 1–4). The price of risk becomes uninformative over longer horizons in advanced economies. In emerging market economies, an interesting pattern arises—a higher price of risk signals lower downside (tail) risks at two- to three-year horizons. One possible explanation is the negative impact of tighter domestic financial conditions on leverage and balance sheet expansion, which appears to be associated with lower risks to growth in both the short and medium term (Figure 3.4, panels 5–6).

- **Leverage:** Higher credit growth and credit to GDP signal greater downside risk to growth at horizons of one year and longer. The relationship is economically more significant at the lower quantiles of GDP growth and in advanced economies than in emerging market economies (Figure 3.5, panels 1–2). Over shorter time horizons (one quarter), however, the information content differs across countries, with rising leverage continuing to signal higher downside risks in emerging market and large advanced economies but signaling lower downside risks in small open advanced economies.

- **External conditions:** While changing external conditions convey statistically significant information regarding risks to future growth, their information content represents a complex combination of forces. For example, movements in exchange rates can reflect different risk implications through real and financial channels, each of which may be more potent at different horizons. And the impact of changes in commodity prices on risks to growth will differ depending on whether a country is a commodity exporter or importer. Consequently, the signal given by changes in external conditions proved difficult to interpret in a straightforward manner. Nonetheless, a clearer interpretation arises when isolating changes in global risk sentiment from the other external variables. Higher global risk aversion, reflected in a higher VIX, signals greater downside risks to growth in the short term, including a larger threat of an imminent recession (Figure 3.6). However, increases in the VIX also signal lower downside risks to growth at longer horizons of one to two years, possibly because, in most cases, tighter global financial conditions slow the growth of leverage and balance sheet mismatches, which may lessen medium-term growth risks.

The view that emerges from these results is that the prevailing low funding costs and financial market volatility support a positive view of risks to the global economy in the short term, but increasing leverage signals potential risks down the road. In such circumstances, a scenario of a rapid decompression in spreads and increase in financial market volatility could significantly worsen the risk outlook for global growth.

**How Well Do Changes in Financial Conditions Forecast Downside Risks to Growth?**

Severely adverse growth performance during the global financial crisis is used to demonstrate the potential use of measures of financial conditions in improving forecasts of risks to growth at horizons of up to one year. Augmenting growth forecast models based on past growth performance with financial conditions significantly improves forecasting ability. This is reflected in the greater likelihood that is assigned to the actual negative growth outcomes during that period.

Applying the univariate FCIs to historical episodes highlights the index’s power to help predict future economic downturns over short horizons. Notably, the model was used to predict the distribution of growth for the first quarter of 2009, broadly corresponding to the peak of the global financial crisis.

- At a one-quarter horizon (that is, in the fourth quarter of 2008), conditioning the risk forecast of future growth on financial conditions (besides economic growth) adds significantly to capturing

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15Formally, a separate model of the kind described in Annex 3.2 was examined with the external conditions subindex defined as a global risk sentiment index (equal to the change in the VIX).
Figure 3.4. Higher Price of Risk Is a Significant Predictor of Downside Growth Risks within One Year
(Quantile regression coefficients)

1. Advanced Economies: One Quarter Ahead
Economic significance is highest over one quarter ...

2. Emerging Market Economies: One Quarter Ahead
... albeit less so in emerging market economies.

3. Advanced Economies: One Year Ahead
It remains so over one year in advanced economies ...

4. Emerging Market Economies: One Year Ahead
... and in emerging market economies.

5. Advanced Economies: Two Years Ahead
Price of risk becomes uninformative over longer horizons in advanced economies ...

6. Emerging Market Economies: Two Years Ahead
... but, in emerging market economies, higher funding costs signal lower risk over longer horizons.

Sources: Bloomberg Finance L.P.; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: The panels depict coefficient estimates on the price of risk index in pooled quantile regressions of one-quarter-ahead, four-quarters-ahead, and eight-quarters-ahead GDP growth for advanced economies (left column) and emerging market economies (right column). The coefficients are standardized by centering and reducing (zero mean, unit variance) both the dependent variable and the regressors to enable comparison across quantiles, across time horizons, and between advanced and emerging market economies. The coefficient estimate for a given quantile should be read as the impact of a one standard deviation change in the price of risk on the future quantile of GDP growth also expressed in terms of standard deviations. The vertical lines in the green bars denote confidence intervals at 10 percent and, where they cross the x-axis, correspond to absence of statistical significance of the regressor.
imminent tail risks to growth, both at the epicenter of the crisis (that is, the United States) and in a commodity-exporting emerging market economy (Chile). Notably, the likelihood attached to poor growth outcomes around the actual realization is significantly higher if rapidly tightening financial conditions are incorporated into the growth forecast (the density in red) as opposed to a model whose only information for forecasting is the growth outcome (the density in blue) in the fourth quarter of 2008 (Figure 3.7).16

16GDP growth exhibits a high degree of persistence in the sample of advanced and emerging market economies covered by this chapter’s analysis. Consequently, from a forecasting perspective, a quantile autoregression model of GDP growth represents a conservative and hard-to-beat benchmark against which to assess the marginal conditioning information content of financial conditions. The quantile autoregression model is unlikely to forecast rare (severe) recessions
CHAPTER 3  FINANCIAL CONDITIONS AND GROWTH AT RISK

• These results remain robust in a broader cross section of countries. Among countries that experienced a significant growth downturn during the crisis, adding FCIs to an autoregressive growth forecasting model significantly increases the conditional likelihood of a GDP growth outcome less than or equal to the actual growth outturn one quarter ahead (Table 3.1). In addition to predicting a fatter left tail for the growth distribution, the average growth forecasts including FCIs are closer to the actual severe economic contraction experienced by these countries in the first quarter of 2009, and well below the market consensus, which remained relatively optimistic even after the collapse of Lehman Brothers (Table 3.2).

The exercise also shows that conditioning on univariate FCIs may not work as well at longer horizons. This possibility is evident when comparing the relative predictive ability of the autoregressive growth model with the model augmented with FCIs at one- and four-quarter horizons for the first quarter of 2009. In the case of the global financial crisis, examining the behavior of sampled countries’ FCIs through 2008 is revealing. Close examination shows why the forecasting gain differs once the information set is augmented with FCIs at different time horizons. In the first quarter of 2009, GDP growth for most countries was among the worst in their recent economic history. The Lehman Brothers bankruptcy, at the beginning of the fourth quarter of 2008, was the bellwether for a swift and severe deterioration in financial conditions. Risk spreads and market volatility increased steeply, and asset values crashed. The information emanating from FCIs throughout the fourth quarter of 2008 clearly signaled potential negative fallout for economic activity. By contrast, economic indicators took additional time to catch up to the actual magnitude of the decline.

and macroeconomic crises well. A good test of the predictive contribution of financial indicators for such growth episodes would be to examine how their addition to the conditioning information set would change the likelihood assigned to the realized (bad) growth outcome at various horizons.

17Results are presented for a selection of advanced and emerging market economies in Tables 3.1–3.3, even though similar results are obtained for other sampled countries that experienced a recession at the time of the global financial crisis. Results for countries that did not experience an economic contraction suggest that the model augmented with FCIs does not generate false alarms—that is, significantly lower conditional probability of a recession at one- and four-quarter forecast horizons.

Figure 3.7. Probability Densities of GDP Growth for the Depths of the Global Financial Crisis
(Probability)

Accounting for financial conditions generates a more pessimistic outlook for risks to growth one quarter before 2009:Q1.

1. United States

2. Chile

Sources: Bloomberg Finance L.P.; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: The figure displays conditional probability distributions of one-quarter-ahead GDP growth based on a parametric, T-skew density, fitted over quantile regression estimates as described in Annex 3.3. In particular, it includes two conditional distributions of growth based on two forecasting models that use either growth or growth and financial conditions indices (FCIs) to predict future growth (in 2009:Q1). The figure also includes the realized values of GDP growth (black vertical line). Blue density = model with single regressor (one-quarter-lagged GDP growth); red density = model with two regressors (one-quarter-lagged GDP growth and one-quarter-lagged FCI).
Table 3.1. Forecast of GDP Growth Distribution for the Global Financial Crisis with and without Financial Conditions Indices *(Cumulative probability of actual 2009:Q1 growth outturn, percent)*

<table>
<thead>
<tr>
<th>Selected Advanced Economies</th>
<th>Real-time FCI Augmented</th>
<th>FCI Augmented</th>
<th>Autoregressive</th>
<th>Selected Emerging Market Economies</th>
<th>Real-time FCI Augmented</th>
<th>FCI Augmented</th>
<th>Autoregressive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Germany</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Brazil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One quarter ahead for 2009:Q1</td>
<td>5.4</td>
<td>2.4</td>
<td>0.0</td>
<td>One quarter ahead for 2009:Q1</td>
<td>35.5</td>
<td>39.6</td>
<td>7.5</td>
</tr>
<tr>
<td>Four quarters ahead for 2009:Q1</td>
<td>0.1</td>
<td>0.4</td>
<td>0.0</td>
<td>Four quarters ahead for 2009:Q1</td>
<td>4.2</td>
<td>5.0</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>Sweden</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Chile</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One quarter ahead for 2009:Q1</td>
<td>6.5</td>
<td>5.9</td>
<td>4.8</td>
<td>One quarter ahead for 2009:Q1</td>
<td>6.4</td>
<td>8.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Four quarters ahead for 2009:Q1</td>
<td>0.0</td>
<td>0.8</td>
<td>0.5</td>
<td>Four quarters ahead for 2009:Q1</td>
<td>4.0</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>South Africa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One quarter ahead for 2009:Q1</td>
<td>29.8</td>
<td>29.5</td>
<td>5.8</td>
<td>One quarter ahead for 2009:Q1</td>
<td>7.2</td>
<td>4.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Four quarters ahead for 2009:Q1</td>
<td>0.8</td>
<td>2.8</td>
<td>1.5</td>
<td>Four quarters ahead for 2009:Q1</td>
<td>5.3</td>
<td>6.2</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>United States</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Turkey</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One quarter ahead for 2009:Q1</td>
<td>46.7</td>
<td>30.3</td>
<td>8.5</td>
<td>One quarter ahead for 2009:Q1</td>
<td>31.5</td>
<td>27.1</td>
<td>5.3</td>
</tr>
<tr>
<td>Four quarters ahead for 2009:Q1</td>
<td>2.6</td>
<td>4.0</td>
<td>4.2</td>
<td>Four quarters ahead for 2009:Q1</td>
<td>3.5</td>
<td>2.3</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Sources: Bloomberg Finance L.P.; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: The table depicts the cumulative probabilities of a growth outcome in 2009:Q1 of less than or equal to the actual growth outturn (quarter over quarter, annualized) in that period drawn from conditional density forecasts of GDP growth made four quarters earlier (that is, in 2008:Q1). The left column depicts probabilities from the model with financial conditions indices (FCIs) estimated with information available in real time. The middle column depicts probabilities from the model with FCIs estimated with full in-sample information. The right column depicts probabilities from the autoregressive model of GDP growth. Autoregressive = quantile regression of one-year-ahead GDP growth on current quarter GDP growth; FCI augmented = quantile regression of one-year-ahead GDP growth on current quarter GDP growth and FCI.

Table 3.2. Market Consensus Forecasts for the Global Financial Crisis Were Considerably More Optimistic Than Forecasts Based on Financial Conditions

<table>
<thead>
<tr>
<th>Growth Forecasts Conditional on Lagged GDP and FCI</th>
<th>Consensus Growth Forecasts</th>
<th>Growth Outturn in 2009:Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>3.1</td>
<td>4.6</td>
</tr>
<tr>
<td>Canada</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>France</td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Mexico</td>
<td>2.6</td>
<td>2.8</td>
</tr>
<tr>
<td>South Africa</td>
<td>2.7</td>
<td>4.7</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1.9</td>
<td>2.8</td>
</tr>
<tr>
<td>Turkey</td>
<td>3.4</td>
<td>4.8</td>
</tr>
<tr>
<td>United States</td>
<td>1.9</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Sources: Bloomberg Finance L.P.; Consensus Economics; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: Columns 2 and 3 of the table denote, respectively, the conditional mean forecasts for (quarter over quarter, annualized) GDP growth in 2009:Q1 made one quarter and one year earlier based on an ordinary least squares regression of future GDP growth on current quarter FCI and GDP growth. Columns 4 and 5 denote market consensus forecasts for 2009:Q1 made one quarter and four quarters earlier, respectively. Column 6 depicts the actual growth outturn. FCI = financial conditions index.

Based on data available as of August 3, 2017.
This explains why autoregressive-conditional quantile forecasts were behind the curve, even at the end of 2008. A few quarters earlier, in early 2008, FCIs had risen from their boom-time lows but were only at their historical averages (for emerging market economies) or at levels corresponding to recessions significantly milder than the outturn of the first quarter of 2009 (for advanced economies). Consequently, one year ahead, conditioning on FCIs does not result in significantly different predictions of growth during the global financial crisis relative to either consensus forecasts or autoregressive-conditional quantile forecasts.

Partitioning the FCI constituents into subindices enables the forecasts conditioned on financial indicators to regain relative predictive gains over longer time horizons in several countries (Table 3.3). One-year-ahead conditional forecasts for annual growth assign significantly higher likelihood to growth outcomes less than or equal to the outturn of the first quarter of 2009 when the forecasts are based on information in financial indicators than when based only on lagged GDP growth. This is the likely consequence of separating credit aggregates from asset prices, thereby allowing their information to gain greater weight at horizons beyond one quarter.

Real-time conditional density forecasts of economic growth are almost identical to those reported above for in-sample forecasts (Figures 3.8 and 3.9). Hence, using information in FCIs and in partitioned financial indicators available only up to one to four quarters earlier than the first quarter of 2009 would result in conditional likelihoods being assigned to the actual growth outcomes that are very similar to those obtained through in-sample forecasts using financial indicators (Tables 3.1 and 3.3).  

18 The contribution of each financial indicator to its group subindex is determined according to a methodology designed to improve forecast performance as discussed in Annex 3.2.

19 This is implied by the fact that real-time forecasts of the quantiles of future GDP growth obtained through recursive estimation are almost identical to (or, below the median quantile, often lower than) those obtained through the in-sample forecasts. The fact that a majority of financial indicators are available only from the mid-1990s to the mid-2000s, especially for emerging market economies, prevents backtesting of the model’s forecasting ability relative to earlier crisis-related recessions, for example, in Sweden (1990–92), Mexico (1994), east Asia (1997), and Turkey (2000–01), among others. More generally, low-frequency and limited time series data on real and financial variables preclude implementation with sufficient power of appropriate out-of-sample forecast evaluation tests described in Corradi and Swanson 2006 and Komunjer 2013.

### \textbf{Table 3.3. Forecast of GDP Growth Distribution for the Global Financial Crisis: Comparing Partitioned and Univariate Financial Conditions Indices with Autoregressions}

\textit{(Cumulative probability of actual 2009:Q1 growth outturn, percent)}

<table>
<thead>
<tr>
<th>Selected Advanced Economies</th>
<th>Selected Emerging Market Economies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Real-time Partitioned Financial Variables</td>
</tr>
<tr>
<td>Germany Four quarters ahead for 2009:Q1</td>
<td>0.8</td>
</tr>
<tr>
<td>Sweden Four quarters ahead for 2009:Q1</td>
<td>7.1</td>
</tr>
<tr>
<td>United Kingdom Four quarters ahead for 2009:Q1</td>
<td>6.4</td>
</tr>
<tr>
<td>United States Four quarters ahead for 2009:Q1</td>
<td>24.7</td>
</tr>
<tr>
<td>Brazil Four quarters ahead for 2009:Q1</td>
<td>14.0</td>
</tr>
<tr>
<td>Chile Four quarters ahead for 2009:Q1</td>
<td>12.7</td>
</tr>
<tr>
<td>South Africa Four quarters ahead for 2009:Q1</td>
<td>5.4</td>
</tr>
<tr>
<td>Turkey Four quarters ahead for 2009:Q1</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Sources: Bloomberg Finance L.P.; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: The table depicts the cumulative probabilities of a growth outcome in 2009:Q1 of less than or equal to the actual growth outturn (quarter over quarter, annualized) in that period drawn from conditional density forecasts of GDP growth made four quarters earlier (that is, in 2008:Q1) according to the four alternative methodologies. Autoregressive = quantile regression of one-year-ahead GDP growth on current quarter GDP growth; FCI = financial conditions index; FCI augmented = quantile regression of one-year-ahead GDP growth on current quarter GDP growth and FCI; partitioned financial variables = quantile regression of one-year-ahead GDP growth on current quarter GDP growth and subindices of financial indicators.
Figure 3.8. In-Sample and Recursive Out-of-Sample Quantile Forecasts: One Quarter Ahead
(Percent)

Sources: Bloomberg Finance L.P.; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: This figure shows the estimates of the 5th (bottom), 50th (middle), and 95th (top) quantiles of GDP growth based on the quantile regression model where one-quarter-ahead GDP growth is regressed on current date financial conditions index and GDP growth.
Figure 3.9. In-Sample and Recursive Out-of-Sample Quantile Forecasts: Four Quarters Ahead
(Percent)

1. Germany

2. Brazil

3. United Kingdom

4. Chile

5. Sweden

6. Turkey

7. United States

8. South Africa

Sources: Bloomberg Finance L.P.; Haver Analytics; IMF, Global Data Source and World Economic Outlook databases; Thomson Reuters Datastream; and IMF staff estimates.

Note: This figure shows the estimates of the 25th (bottom), 50th (middle), and 75th (top) quantiles of GDP growth based on the quantile regression model with partitioned financial indicators replacing the univariate financial conditions index.
This augurs well for the parameter stability of the chapter’s forecast model, demonstrating that its forecasts and relative predictive ability are not an artifact of incorporating events such as the global financial crisis into estimates of its parameters.

Policy Implications

The chapter’s findings underscore the importance of policymakers maintaining heightened vigilance regarding risks to growth during periods of benign financial conditions that may provide a fertile breeding ground for the accumulation of financial vulnerabilities. Changes in the domestic price of risk appear to be potent signals of imminent threats to growth and can be useful for swift deployment of monetary easing and crisis-management policy actions. Incorporating information in slower-moving indicators could help better calibrate countercyclical policies, even though doing so systematically would require combining the information derived from the models described in this chapter with appropriate structural models.

This chapter develops a new macroeconomic measure of financial stability by linking financial conditions to the probability distribution of future GDP growth. Since policymakers care about the whole distribution of future GDP growth, linking the state of the financial system to such a distribution would enhance macro-financial surveillance. Policymakers would be able to specify bad outcomes in terms of their risk preference or tolerance and undertake appropriate action based on the information provided by financial conditions. Thus, the new modeling approach can be a powerful tool for forecasting and policy development.

Financial conditions contain useful information with which to help forecast risks to economic growth at short- and medium-term horizons. Thus, the tools used and developed in this chapter can help policymakers assess the risks to the real economy associated with various states of the financial system. For example, at the current juncture, elevated leverage signals downside risks to growth in the medium term, although in the short term, this risk is mitigated by the low price of risk. However, a scenario of rapid decompression in spreads and an increase in financial market volatility would add to the risks arising from leverage, significantly worsening the growth outlook.

Policymakers could use the information provided by such a surveillance framework to identify imminent threats and take swift countervailing action over very short horizons. If a rapid increase in the price of risk at a time of elevated leverage or balance sheet mismatches indicates an imminent threat to the economy, policymakers can quickly ease monetary policy and deploy a wide range of crisis-management and -prevention measures to prevent tail events or reduce their magnitude. During the global financial crisis, bilateral and multilateral swap lines, general creditor guarantees, asset purchase programs, and emergency liquidity facilities, among others, were marshalled by a number of countries at relatively short notice.

The framework developed in this chapter could potentially help policymakers design policy actions to respond in a timely manner to threats to financial stability indicated by changes in financial conditions. It is natural to think of calibrating policy actions on the state of financial conditions—much as monetary policy action is calibrated to information on inflation and output under standard Taylor rules. For example, countercyclical macroprudential tools, such as bank capital buffers and limits on loan-to-value ratios, could be designed and calibrated to contain the growth of financial vulnerabilities in the presence of loose financial conditions. In this regard, the estimated forecast relationships from the GDP growth-at-risk model of this chapter can also be used to calibrate structural models that are amenable to counterfactual analysis and policy development.\footnote{One option could be to use the conditional density forecasts of GDP growth to calibrate the higher moments (for example, conditional volatility or skewness) of structural models that embed financial accelerator mechanisms such as the one described in Annex 3.1.}

Practical implementation of forecasting of risks to growth based on financial conditions will require data gaps to be closed. This need strengthens the case for greater data-gathering efforts. It also points to a need for continuous calibration of these types of models as data gaps gradually close and for incorporation of country-level information that may substitute for the lack of standard financial indicators. In this way, policymakers and others could significantly improve on the forecasting power of the models presented here by incorporating rich country-level information to complement the models’ broad financial indicators. As local financial markets undergo structural developments, and authorities consider certain financial indicators to

\footnote{One option could be to use the conditional density forecasts of GDP growth to calibrate the higher moments (for example, conditional volatility or skewness) of structural models that embed financial accelerator mechanisms such as the one described in Annex 3.1.}
be increasingly relevant, these could also be gradually incorporated into the analysis.21

Annex 3.1. Financial Vulnerabilities and Growth Hysteresis in Structural Models22

An Illustrative Simulation

A simulation exercise of a structural model is conducted to illustrate the nonlinear response of output growth to shocks depending on the level of financial vulnerabilities. The exercise shows that embedding an occasionally binding funding constraint on borrowers in an otherwise standard New Keynesian (NK) open economy structural model is sufficient to generate two key stylized facts. These are, first, that the steady-state probability distribution of GDP growth is negatively skewed and, second, that asset prices and credit aggregates are leading indicators of risks to GDP growth.

In the presence of financial frictions, the response of output growth to shocks is highly nonlinear. Recent advances in macroeconomic theory have clarified the importance of financing constraints on borrowers and intermediaries in generating this response. In their seminal contributions, Bernanke and Gertler (1989); Kiyotaki and Moore (1997); and Bernanke, Gertler, and Gilchrist (1999) clarified the role of credit market frictions in determining fluctuations in real economic activity. Their linear real business cycle models embed a financial accelerator mechanism in which endogenous developments in credit markets propagate and amplify shocks to the real economy. Although these models explain how financial frictions increase the amplitude of real business cycles, they do not shed light on how and when they can increase the duration of those cycles or generate extreme, unlikely negative outcomes (asymmetry, or tail risk). The key insight of recent advances in business cycle theory is that this outcome depends on individual financial decisions of banks, firms, and households that fail to take into consideration dynamic credit supply externalities implied by their decisions. That is, individual borrowers fail to take into account the fact that once aggregate leverage is sufficiently high, shocks can activate occasionally binding collateral constraints (OBCCs). This, in turn, can generate a vicious cycle of deleveraging and negative asset price spirals that clog credit intermediation, consumption, investment, and growth.23

The simulation exercise embeds an OBCC into an NK open economy dynamic general equilibrium model. The OBCC is modeled as in Kiyotaki and Moore 1997. To tease out implications for optimal policy, nominal frictions based on an open economy NK model are incorporated in the spirit of Galí and Monacelli 2005. The main features of the model are as follows: Households are endowed with tradable goods as in Bianchi 2011, while they produce nontradables using capital and labor. Households maximize their lifetime utility by choosing an intertemporal portfolio of tradable and nontradable goods for consumption and supplying labor to the production process. Their borrowing must be lower than a fixed fraction of their capital value (that is, there is a collateral constraint). The nontradables sector is monopolistically competitive, and price setting is subject to nominal frictions. Asset prices are determined under a fixed supply of capital. Nominal interest rates are set under a standard Taylor rule responding to inflation and output. The exchange rate is pinned down by the uncovered interest parity condition. The parameters are calibrated based on standard values in the literature of an OBCC model and an open economy NK model, including Bianchi 2011 and Galí and Monacelli 2005.

The simulated density of future output is shown to be negatively skewed; that is, it has a fat left tail, indicating a greater risk of severe recession. The unconditional distribution of future output (Annex Figure 3.1.1, panel 3) is negatively skewed—the skewness measure, at −1.51, is statistically significant. In the simulation, as in reality, the collateral constraint does not typically bind. Thus, the evolution of all economic variables, including output, is standard for the most part. However, when the OBCC binds (a rare event), output and asset prices decline significantly because

21The methodology developed in this chapter is used to model the impact of financial vulnerabilities on GDP growth. It is flexible in the inputs it can receive. In countries where risks to the real economy posed by amplifiers, whether real or fiscal, are not traded in deep financial markets, corresponding nonfinancial indicators could also be used as inputs.

22Prepared by Mitsuru Katagiri. (This annex is a summary of Katagiri, forthcoming.)

23For models embedding OBCCs on end-borrowers, see Bianchi 2011; Korinek and Simsek 2016; and Bianchi and Mendoza, forthcoming. For OBCCs or value-at-risk constraints on intermediaries, see He and Krishnamurthy 2013 and Brunnermeier and Sannikov 2014.
of the vicious cycle of asset fire sales and tighter credit conditions, and output suffers.

The simulation exercise clearly indicates the utility of conditioning the growth outlook on asset prices. Risk premiums in the simulation exercise are defined as the return on capital minus the inverse of the stochastic discount factor, as is standard.24 Annex Figure 3.1.1 shows the conditional density of output in period \( t \), given that the risk premium in period \( t - 1 \) is less than 30 basis points (the case of high asset prices depicted in panel 1) and more than 30 basis points (the case of low asset prices depicted in panel 2). Those two panels indicate that when risk premiums rise (equivalently, when asset prices fall), the conditional density of one-period-ahead output shifts to the left and becomes negatively skewed. Higher risk premiums predict a lower average value of one-period-ahead output and a more pessimistic risk outlook (fatter left tail).

Asset prices and credit aggregates can also be useful leading indicators of recessions or financial crises. The relationship between one-period-ahead output and risk premiums (Annex Figure 3.1.2, panel 1) indicates that the lower quantile of output declines significantly with rising risk premiums, whereas its upper quantile is significantly less sensitive. The relationship between one-period-ahead output and the credit-to-GDP ratio shows that a financial crisis occurs only when the ratio is at a historically high level (Annex Figure 3.1.2, panel 2). Finally, risk premiums and credit-to-output ratios are significantly higher than their steady-state values for several periods before a crisis (Annex Figure 3.1.3).

**Calibrating Policy Rules to Attenuate Risks to Growth from Financial Vulnerability**

Macroundential policy contingent on the state of financial conditions can mitigate the adverse real effects of financial crises. The decentralized equilibrium described in the previous section of this annex is not socially optimal because agents fail to take into consideration the negative systemic externalities of their leverage choices on asset prices. Borrowers’ resulting excess leverage increases the frequency of financial crises.

\[24\] Note that risk premiums based on this definition are not directly observable in the data, but are conceptually close to the excess return of risk assets as defined in Gilchrist and Zakrajšek 2012 and hence can be calculated from financial market data.
Bianchi (2011) and Bianchi and Mendoza (forthcoming) show that a macroprudential tax (that is, a tax on debt before the crisis) that is contingent on the state of financial conditions can prevent excess leverage and implement the socially optimal outcome as a decentralized equilibrium. This socially optimal outcome can also be implemented by a regulation on loan-to-value (LTV) ratios.

Once the optimal state-contingent macroprudential policy (taxes on debt or LTV regulation) is introduced, vulnerability to a recession (as measured by the negative skewness of the output distribution) is significantly mitigated. In the baseline simulation of the equilibrium without optimal macroprudential policy, severe economic contractions are preceded by several periods of excessive leverage and, shortly before the crisis, by sharply rising risk premiums.

Source: IMF staff estimates.

Note: The crisis happens in period 5 (t) in the figures. The crisis is defined as a period in which output declines by more than 3 percent. The red dashed lines denote steady-state values.
the probability of a recession driven by a financial crisis is 1.3 percent, and the skewness of the density of future GDP growth at $-1.51$ is statistically significant. Implementation of the state-contingent debt tax or state-contingent LTV regulation reduces these values to, respectively, 0.5 percent and $-0.66$.

A simple policy rule conditioned on financial indicators comes close to implementing the optimal macroprudential policy. The optimal policy itself is a complex nonlinear function of state variables and is probably too complicated to implement in practice. 25

Fortuitously, a simple rules-based macroprudential policy responding to vulnerability measures does a good job of mitigating the harmful effects of financial crises. Risk premiums are used to improve the performance of a simple rules-based macroprudential policy because they have predictive power for the crisis. Annex Figure 3.1.4 compares the evolution of real and financial indicators under a simple policy rule whereby debt taxes are a linear function of risk premiums to the baseline equilibrium. Policy based on a simple linear rule delivers almost the same performance as the optimal policy, implying that financial conditions such as risk premiums are useful for conducting macroprudential policies in practice. 26

25The nonlinearity stems from the fact that policymakers should raise borrowing costs through taxes or LTV regulations only when a crisis is predicted.

26There are two caveats. First, all crises in the OBCC model are caused by a simple collateral constraint, whereas many other factors can contribute to financial crises. Second, the model assumes that policymakers can immediately respond to vulnerabilities. If there is a delay in policy reactions or their transmission to the real economy, the policy implications may be different.
Annex Table 3.2.1. Country Coverage

<table>
<thead>
<tr>
<th>Country</th>
<th>Country</th>
<th>Country</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Germany</td>
<td>Mexico</td>
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<td>Brazil</td>
<td>India</td>
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<tr>
<td>France</td>
<td>Korea</td>
<td></td>
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</tr>
</tbody>
</table>

Source: IMF staff.

Annex 3.2. Estimating Financial Conditions Indices

Univariate Financial Conditions Indices

A simple way to build a summary measure of financial conditions is to construct univariate financial conditions indices (FCIs) following the approach in the April 2017 GFSR, although with some important modifications. The main change is that the coverage of financial indicators is expanded to include additional information relevant to assessing domestic financial vulnerabilities. FCIs will therefore also include variables that summarize global risk sentiment (Chicago Board Options Exchange Volatility Index [VIX], Merrill Lynch Option Volatility Estimate [MOVE] Index), credit aggregates that directly indicate the level of financial vulnerability in the economy, and commodity prices and exchange rates that may influence and reflect the ease of funding and financial constraints—for example, by altering borrowers’ net worth.

Following the methodology presented in Annex 3.1 of the April 2017 GFSR, FCIs are reestimated for 11 advanced economies starting in 1973 and for 10 emerging market economies starting in 1991. A set of 19 financial indicators is used to capture both domestic and global developments influencing a country’s financial conditions (see Annex Table 3.2.1 for country coverage and Annex Table 3.2.2 for variables included and data sources). The FCIs are estimated based on Koop and Korobilis 2014 and build on the estimation of the time-varying parameter vector autoregression model of Primiceri (2005) and dynamic factor

\[ x_t = \lambda^f_t Y_t + \lambda^f_t f_t + u_t, \]

\[ \begin{bmatrix} Y_t \\ f_t \end{bmatrix} = B_1 \begin{bmatrix} Y_{t-1} \\ f_{t-1} \end{bmatrix} + B_2 \begin{bmatrix} Y_{t-2} \\ f_{t-2} \end{bmatrix} + \ldots + \epsilon_t, \]

in which \( x \) is a vector of financial indicators, \( Y \) is a vector of macroeconomic variables of interest (including real GDP growth and inflation), \( \lambda^f \) are regression coefficients, \( \lambda^f_t \) are the factor loadings, and \( f_t \) is the latent factor, interpreted as the FCI.

Univariate FCIs offer a parsimonious way of summarizing the information in several financial indicators, which could be advantageous from a forecasting perspective because it can help reduce parameter uncertainty. However, the weight of each variable is not necessarily driven by economic considerations of relative importance as suggested either by theory or by country-specific characteristics. For example, movements in asset prices may be effective in pinpointing risks at short horizons, but slower-moving credit aggregates are likelier to yield more information at longer time horizons. Moreover, while asset prices are likely to be an adequate summary of financial vulnerabilities in some advanced economies, credit aggregates may possess significantly greater information content in emerging market economies. Consequently, financial indicators need not receive the same weight across different time horizons and countries; therefore, as described in the second section of this annex, the chapter also uses an approach that seeks to exploit the information content of

\[ \text{models of Doz, Giannone, and Reichlin (2011)}. \]

This approach has two advantages. First, it can control for current macroeconomic conditions. Second, it allows for dynamic interaction between the FCIs and macroeconomic conditions, which can also evolve over time. The model takes the following form:

\[ x_t = \lambda^f_t Y_t + \lambda^f_t f_t + u_t, \]

\[ \begin{bmatrix} Y_t \\ f_t \end{bmatrix} = B_1 \begin{bmatrix} Y_{t-1} \\ f_{t-1} \end{bmatrix} + B_2 \begin{bmatrix} Y_{t-2} \\ f_{t-2} \end{bmatrix} + \ldots + \epsilon_t, \]

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### Annex Table 3.2.2. Data Sources

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<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
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<td><strong>Domestic-Level Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Term Spreads</td>
<td>Yield on 10-year government bonds minus yield on three-month Treasury bills</td>
<td>Bloomberg Finance L.P.; IMF staff</td>
</tr>
<tr>
<td>Interbank Spreads</td>
<td>Interbank interest rate minus yield on three-month Treasury bills</td>
<td>Bloomberg Finance L.P.; IMF staff</td>
</tr>
<tr>
<td>Change in Long-Term Real Interest Rate</td>
<td>Percentage point change in the 10-year government bond yield, adjusted for inflation</td>
<td>Bloomberg Finance L.P.; IMF staff</td>
</tr>
<tr>
<td>Corporate Spreads</td>
<td>Corporate yield of the country minus yield of the benchmark country; JPMorgan CEMBI Broad is used for emerging market economies where available</td>
<td>Bloomberg Finance L.P.; Thomson Reuters Datastream</td>
</tr>
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<td>Equity Returns</td>
<td>Log difference of the equity indices</td>
<td>Bloomberg Finance L.P.</td>
</tr>
<tr>
<td>House Price Returns</td>
<td>Log difference of the house price index</td>
<td>Bank for International Settlements; Haver Analytics; IMF staff</td>
</tr>
<tr>
<td>Equity Return Volatility</td>
<td>Exponential weighted moving average of equity price returns</td>
<td>Bloomberg Finance L.P.; IMF staff</td>
</tr>
<tr>
<td>Change in Financial Sector Share</td>
<td>Log difference of the market capitalization of the financial sector to total market capitalization</td>
<td>Bloomberg Finance L.P.</td>
</tr>
<tr>
<td>Credit Growth</td>
<td>Percent change in the depository corporations’ claims on private sector</td>
<td>Bank for International Settlements; Haver Analytics; IMF, International Financial Statistics database</td>
</tr>
<tr>
<td>Sovereign Spreads</td>
<td>Yield on 10-year government bonds minus the benchmark country’s yield on 10-year government bonds</td>
<td>Bloomberg Finance L.P.; IMF staff</td>
</tr>
<tr>
<td>Banking Sector Vulnerability</td>
<td>Expected default frequency of the banking sector</td>
<td>Moody’s Analytics, CreditEdge; IMF staff</td>
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<tr>
<td>Exchange Rate Movements</td>
<td>Change in US dollar per national currency exchange rate; for the United States, Bloomberg Finance L.P.’s DXY index is used</td>
<td>Bloomberg Finance L.P.; IMF Global Data Sources and International Financial Statistics databases</td>
</tr>
<tr>
<td>Domestic Commodity Price Inflation</td>
<td>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</td>
<td>Bloomberg Finance L.P.; IMF Global Data Sources database; United Nations, COMTRADE database; IMF staff</td>
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<td>Trading Volume (equities)</td>
<td>Equity markets’ trading volume, calculated as level to 12-month moving average</td>
<td>Bloomberg Finance L.P.</td>
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<tr>
<td>Market Capitalization (equities)</td>
<td>Market capitalization of the equity markets, calculated as level to 12-month moving average</td>
<td>Bloomberg Finance L.P.; Thomson Reuters Datastream</td>
</tr>
<tr>
<td>Market Capitalization (bonds)</td>
<td>Bonds outstanding, calculated as level to 12-month moving average</td>
<td>Dealogic; IMF staff</td>
</tr>
<tr>
<td>Change in Credit to GDP</td>
<td>Change in credit provided by domestic banks, all other sectors of the economy, and nonresidents (in percent of GDP)</td>
<td>Bank for International Settlements; Haver Analytics; IMF staff</td>
</tr>
<tr>
<td>Real GDP Growth Inflation</td>
<td>Percent change in GDP at constant prices</td>
<td>IMF, World Economic Outlook database</td>
</tr>
<tr>
<td></td>
<td>Percent change in the consumer price index</td>
<td>Haver Analytics; IMF, International Financial Statistics database</td>
</tr>
<tr>
<td><strong>Global-Level Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIX</td>
<td>Chicago Board Options Exchange Market Volatility Index</td>
<td>Bloomberg Finance L.P.; Haver Analytics</td>
</tr>
<tr>
<td>MOVE</td>
<td>Merrill Lynch Option Volatility Estimate Index</td>
<td>Bloomberg Finance L.P.</td>
</tr>
</tbody>
</table>

Source: IMF staff.

Note: CEMBI = Corporate Emerging Markets Bond Index; DXY = Dollar Index Spot; MOVE = Merrill Lynch Option Volatility Estimate Index; VIX = Chicago Board Options Exchange Volatility Index.
Data Partitioning Based on Linear Discriminant Analysis

The individual financial indicators are aggregated into groups using linear discriminant analysis (LDA), a data-reduction technique (Annex Table 3.2.3). LDA aims 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 by 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, equal to one when future GDP growth at a one-year horizon is below the 20th percentile of historical outcomes and equal to 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 aggregates only information about the common trend among financial indicators.  

Annex Table 3.2.3. Partitioning of Financial Indicators into Groups

<table>
<thead>
<tr>
<th>Price of Risk</th>
<th>Leverage</th>
<th>Foreign Shocks</th>
<th>Persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial and Real Indicators (when available)</td>
<td>Term spread</td>
<td>Credit to GDP (quarterly)</td>
<td>Bilateral exchange rate (US dollar to local currency)</td>
</tr>
<tr>
<td></td>
<td>Corporate spread</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short-term rate</td>
<td></td>
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<tr>
<td></td>
<td>Real long-term rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sovereign spread</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Interbank spread</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equity returns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equity historical volatility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>House price returns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IMF staff.

Annex 3.3. The Conditional Density of Future GDP Growth

Quantile Regressions

The estimation of the conditional density forecast is conducted through quantile projections. This approach starts by using quantile regressions to directly estimate the conditional quantiles ($q$) of the forecast distribution of GDP growth ($y$) $h$ quarters ahead, as a function of both its current level and current financial conditions ($FC$):

$$y_{t+h,q} = \beta_{h,q} FC_t + \gamma_{h,q} y_t + \epsilon_{t+h,q}$$  

(A3.3.1)

In the baseline approach, $FC$ corresponds to a predetermined univariate financial conditions index (FCI) constructed in the manner described in Annex 3.2.

The empirical model is subsequently modified to investigate the relative significance of asset prices, credit aggregates, and global or foreign factors in signaling risks to GDP growth in the near to medium term:

$$y_{t+h,q} = \alpha_{p,q} p_t + \beta_{Agg,q} Agg_t + \gamma_{y,q} y_t + \phi_{f,q} f_t + \epsilon_{t+h,q}$$  

(A3.3.2)

in which $p$, $A gg$, and $f$ correspond to the principal components of the price of risk (asset prices and risk spreads),

31Prepared by Sheheryar Malik and Romain Lafarguette.

32For an introduction to quantile regression, see Koenker 2005. As highlighted by 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 include the desirability 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, allowing for time-varying structural parameters and the optimal weighting of predictors depending on country, horizon, and the relevant portion of the distribution; and the ability to avoid overfitting (compared with more complex models such as copulas and extreme value theory).

50LDA 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 2013 for a thorough exposition of the LDA technique.
credit aggregates, and global or foreign variables (commodity prices, exchange rates, and global risk sentiment). This approach disentangles the contribution of changes in the price of risk from evolving credit aggregates and shocks to the external environment when it comes to forecasting risks to GDP growth. It thereby provides insight into which variables signal growth tail risks over various time horizons. This can help policymakers and others design a surveillance framework that seeks to embed information flowing in at different frequencies.

**Deriving the Density Forecast**

The quantile regression in equation (A3.3.1) delivers an estimate for the conditional quantile function (or inverse cumulative distribution function) $\hat{q}$ quarters ahead—that is, $\hat{q}_{t+h|y_{t}} = \{\hat{\beta}_{q} + \hat{\phi}_{q} FC + \hat{\gamma}_{q} y_{t}\}$. Given the noisiness of such estimates in practice, recovering the corresponding predictive probability density function will inevitably require smoothing of the quantile function. In this chapter, this is accomplished via fitting a parametric form skewed $t$ distribution.53

For each quarter, the analysis attempts to pin down four parameters of the predictive density $\{\mu_{t+h}, \beta_{t+h}, \gamma_{t+h}, \xi_{t+h}\}$ by minimizing the squared distance between the estimated quantile function, $\hat{q}_{t+h|y_{t}}$, and (theoretical) quantile function $q_{t+h|y_{t}}(\mu_{t+h}, \beta_{t+h}, \gamma_{t+h}, \xi_{t+h})$, corresponding to the above skewed $t$ distribution (see Giot and Laurent 2003). The four parameters ($\mu$, $\beta$, $\gamma$, $\xi$) are, respectively, the location, scale, degrees of freedom, and the shape of skewed $t$ distribution. Specifically, the 5th, 25th, 50th, 75th, and 95th percentiles are matched via

$$\mu_{t+h} = \argmin_{\mu} \left\{ \sum_{q} (q_{t+h|y_{t}}(\mu_{t+h}, \beta_{t+h}, \gamma_{t+h}, \xi_{t+h}) - \hat{q}_{t+h|y_{t}}(\mu_{t+h}, \beta_{t+h}, \gamma_{t+h}, \xi_{t+h}))^{2} \right\},$$

in which $\mu_{t+h} \in \mathbb{R}$, $t+h > 0$, $\gamma_{t+h} > 2$, and $\xi_{t+h} > 0$. Notwithstanding the skewness property, choice of a skewed $t$ functional form is advantageous from the perspective of flexibility. For example, $\nu \to \infty, f(y; \mu, s, \nu, \xi) \approx \text{characterized by tail properties resembling a Gaussian distribution. Moreover, the density is symmetric for } \xi = 1$.

**References**


