

Summary

Large house price declines can adversely affect macroeconomic performance and financial stability, as seen during the global financial crisis of 2008 and other historical episodes. These macro-financial links arise from the many roles housing plays for households, small firms, and financial intermediaries, as a consumption good, long-term investment, store of wealth, and collateral for lending, among others. In this context, the rapid increase in house prices in many countries in recent years has raised some concerns about the possibility of a decline and its potential consequences.

Against this backdrop, this chapter studies and quantifies house prices at risk—a measure of downside risks to future house price growth—in a sample of 32 advanced and emerging market economies and major cities. The chapter finds that lower house price momentum, overvaluation, excessive credit growth, and tighter financial conditions predict heightened downside risks to house prices up to three years ahead. The measure of house prices at risk helps forecast downside risks to GDP growth over and above other simpler measures of house price imbalances, and thereby adds to early-warning models for financial crises. Estimates show that downside risks to house prices have rotated since the global financial crisis, with most countries at higher risk at the end of 2007 facing lower risks today, but in many advanced and emerging market economies house prices remain at risk.

This chapter also explores the relationship between policies and house prices at risk. While house price levels should not be considered a direct target for monetary or macroprudential policies or for capital flow management measures, the link between policy actions and downside risks to house prices can shed light on how these actions map into housing sector vulnerabilities and financial stability. The results indicate that a tightening of macroprudential policies is associated with a reduction of downside risks to house prices. This is especially the case for policies aimed at strengthening the resilience of borrowers, such as limits to the maximum loan-to-value or debt-service-to-income ratios. Monetary policy can also influence downside risks through its relationship with financial conditions, but on top of that, the chapter finds that an unexpected easing of the monetary policy rate is associated with lower downside risks to house prices, but only in the short term in advanced economies. Thus, the overall results point to a higher effectiveness of targeted and timely macroprudential policies than monetary policy in reducing downside risks. The relationship with capital flow management measures is more nuanced, with some results suggesting a temporary association between a tightening of those measures and lower downside risks in advanced economies.

What can policymakers do with this knowledge? In addition to building buffers for banks and ensuring households do not overborrow, policymakers in charge of financial stability can use estimates of house prices at risk to complement other surveillance indicators of housing market vulnerabilities and guide macroprudential policy actions aimed at building buffers and reducing vulnerabilities. Downside risks to house prices could also provide relevant information for monetary policymakers when forming their views on the downside risks to the economic and inflation outlook.

Introduction

Developments in the housing market are important for households, firms, and banks. Housing serves both as a long-term investment and a good that is consumed as it is used and generates considerable utility for households (a consumption good). In most countries, housing makes up a large share of households' wealth, and higher house prices increase households' net worth and thus can boost consumption. Housing is also an important source of collateral that homeowners can use to borrow when facing temporary income shocks and to obtain financing for their small businesses.¹ On the other hand, rising housing prices may lock out potential buyers from buying a house if they have trouble coming up with a down payment, or may reduce households' disposable income if they must cut their spending to meet increasing mortgage or rental outlays. This can dampen economic growth and depress firm sales and profits. Households spend significant amounts of money on housing-related services. Notably, housing consumption and investment accounted for about one-sixth of the US and the euro area economies in 2017, representing one of the largest components of GDP in both cases. Finally, in many countries, mortgages and other housing-related lending make up a large fraction of banks' assets; hence changes in house prices can significantly affect the quality of banks' portfolios and profitability.²

House price dynamics and macroeconomic and financial stability are tightly connected. Recessions are deeper and last longer when house prices fall more and more quickly (Claessens, Kose, and Terrones

2012). More than two-thirds of the nearly 50 systemic banking crises in recent decades were preceded by boom-bust patterns in house prices. The 2007–08 global financial crisis is a case in point, in which the housing crisis spilled over onto other sectors and resulted in a full-blown crisis. Moreover, certain housing market characteristics, such as higher loan-to-value ratios and greater reliance on wholesale markets, are associated with increased risks of crises (Cerutti, Dagher, and Dell'Ariccia 2015). Furthermore, the interactions between house prices and credit volumes may result in self-reinforcing feedback loops where an increase in house prices facilitates an expansion in credit (through collateral effects) that puts further upward pressure on house prices. When that process is reversed, large declines in house prices may be followed by a collapse in credit and GDP growth. Such a pattern was observed in the run-up to the global financial crisis and its aftermath (Alter, Feng, and Valckx 2018).

In recent years, the simultaneous increase in house prices in many countries has raised concerns about the potential consequences of coordinated, large declines. In many countries and cities, house prices have increased substantially over the past five years (Figure 2.1)—a pattern that reflects the increased synchronization of house prices (see Chapter 3 of the April 2018 *Global Financial Stability Report* [GFSR]). Heightened synchronicity can signal the presence of downside risks to economic activity, especially when leverage is high.³ Central banks have also expressed concern over the high growth of house prices and the consequent risks to their respective economies.⁴ To the extent that the likelihood of large house price declines—or, put differently, downside risks to house prices—has increased amid the decades-long decline in interest rates and rising household leverage, macroeconomic and financial stability risks may also have increased.⁵

The authors of this chapter are Nico Valckx (team lead), Andrea Deghi, Mitsuru Katagiri, Oksana Khadarina, and Sohaib Shahid, with contributions from Adrian Alter, Elizabeth Mahoney, Peichu Xie, and Janice Yi Xue, under the guidance of Dong He, Fabio Natalucci, and Claudio Raddatz. Monica Devi and Breanne Rajkumar provided editorial assistance.

¹For a discussion on the role of housing for smoothing consumption from income shocks, see Aron and others (2012) and Favalukis, Ludvigson, and Van Nieuwerburgh (2017). For the use of housing as a source of financing for small firms, see Banerjee and Blickle (2018) and Schmalz, Sraer, and Thesmar (2016).

²See Kara and Vojtech (2017). Rising house prices boost bank capital by increasing the value of houses owned by banks and the value of the collateral pledged by borrowers. The financial accelerator model of Bernanke, Gertler, and Gilchrist (1996) maintains that endogenous developments in credit markets, such as variations in net worth or collateral, amplify and propagate shocks to the real economy.

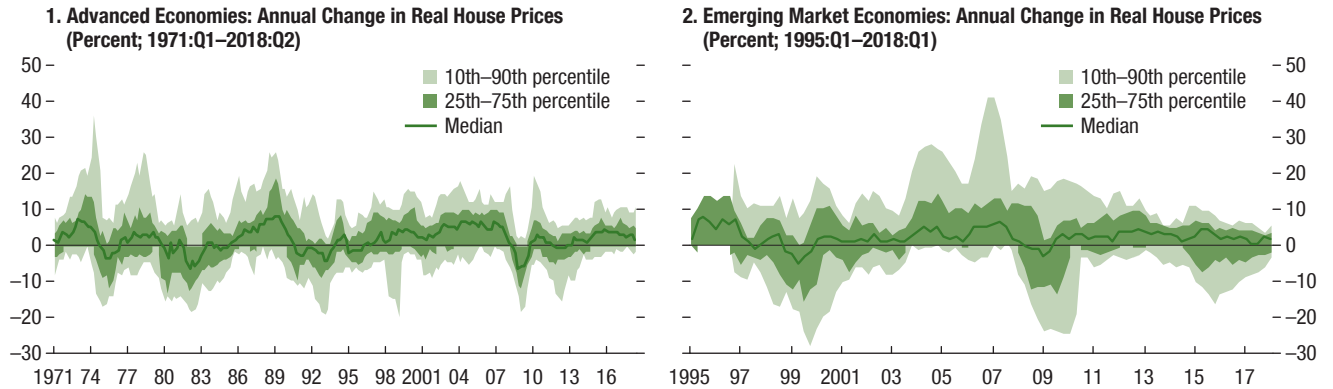
³This is in line with recent academic studies that examined the role of global house price determinants (Cesa-Bianchi, Ferrero, and Rebucci 2018; Hirata and others 2012).

⁴See, for example, the Bank of Canada November 2018 *Financial System Review*, Reserve Bank of Australia April 2018 *Financial Stability Review*, European Central Bank November 2018 *Financial Stability Review*, US Federal Reserve System 2018 *Financial Stability Report*, and *China Financial Stability Report* 2018.

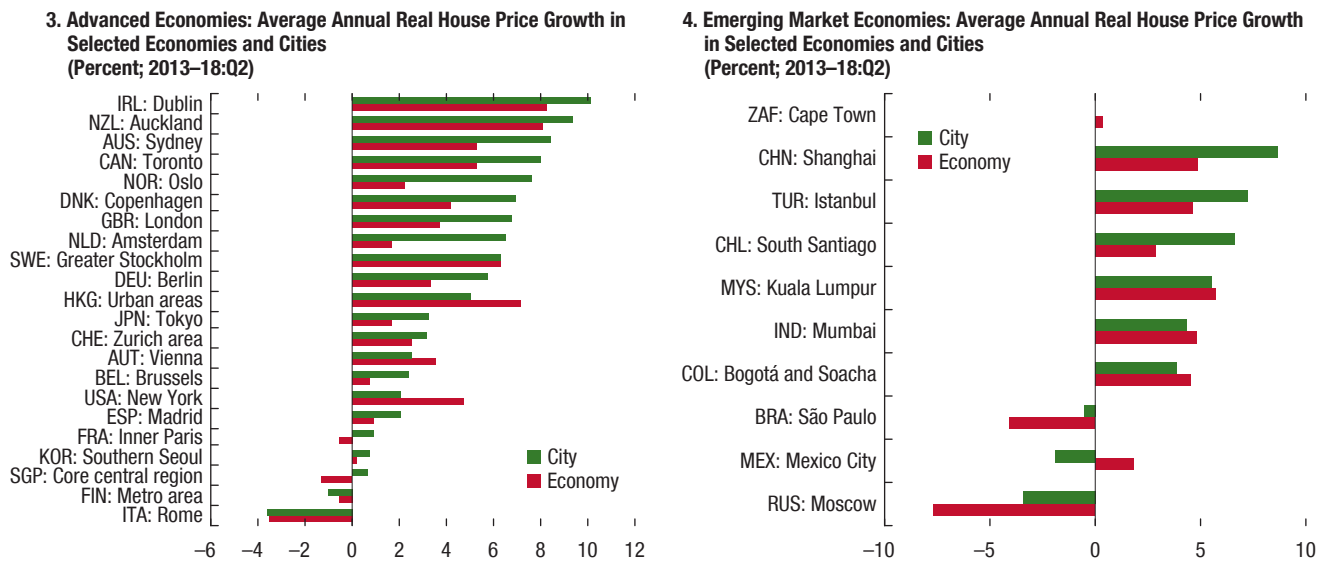
⁵In this context, the April 2008 *World Economic Outlook* points out that spillovers from the housing sector to the rest of the economy are larger in economies where mortgage credit is easier to

Figure 2.1. Historical Developments in Real House Prices

Comovement in house prices in advanced and emerging market economies is prevalent, but differences can be large ...



... and in most economies, real house prices have increased considerably since 2013.



Sources: Bank for International Settlements; national statistical offices; Organisation for Economic Co-operation and Development; and IMF staff calculations. Note: Panels 1 and 2 show the distribution of four-quarter real house price changes (median, interquartile, and 10th–90th percentile range) for advanced and emerging market economies. For Chile, the data are available to 2017:Q4; for Malaysia, 2016:Q4; for Dublin, 2016:Q4, and for Oslo, 2017:Q4. Data labels in the figure use International Organization for Standardization (ISO) country codes.

To quantify downside risks to house prices, this chapter develops a methodology to model (large) house price declines with a given (low) probability and horizon—that is, house prices at risk. The evidence of disproportionate macroeconomic consequences of large declines in house prices makes the understanding and measurement of downside risks to house prices valuable for financial stability monitoring and policymaking.

This chapter builds on the growth-at-risk (GaR) framework of the October 2017 GFSR⁶ to study downside risks to house prices at various horizons in a sample of advanced and emerging market economies, at both the country and city level. Following that framework, the chapter identifies the size of very large

⁶The growth-at-risk approach, a summary measure for financial stability, links current financial conditions to the distribution of future growth outcomes. Specifically, growth at risk refers to the set of outcomes that fall into the 5th percentile of (conditional) forecast densities of global growth. See also Adrian and others (2018).

access, and that easy monetary policy seems to have contributed to the run-up in house prices and residential investment.

declines in future house prices (that is, downside risks to future house prices) within the lowest (least likely) quantiles of its conditional distribution, typically the 5th percentile. Using a statistical technique known as quantile regression, it is possible to study how house prices at risk move when the conditioning variables change. This framework is used to address the following questions:

- How do factors identified in past studies that affect expected house prices, or relate to housing vulnerabilities, help forecast downside risks to the growth of future house prices (that is, unlikely but possible steep declines, as measured by house prices at risk)? Does this relationship vary with the length of the forecast?
- What is the relationship among macroprudential policy, monetary policy, capital account openness, and capital flow measures, and house prices at risk? Is there evidence that these policies may reduce downside risks to house prices—even when that is not their primary aim?
- What does elevated house prices at risk tell us about possible downside risks to economic growth and financial stability?

The main findings are as follows:

- *House prices at risk move in response to pricing factors.* The house-prices-at-risk measure deteriorates in response to changes in fundamental factors, which include tightening of financial conditions,⁷ a decline in real GDP growth, and higher credit growth. It also worsens with greater house price overvaluation—a measure of deviation from fundamentals. These effects vary with the horizon over which house price risks are evaluated and are generally more pronounced in the short term. The relationship between these variables and house prices at risk (at the 5 percent quantile) is stronger than that with median house prices (at the 50 percent quantile), and these effects appear to be stronger at the city level than the country level. Additional results also suggest that downside risks to house prices move together across advanced economies ahead of major crises.

⁷Chapter 1 contains a more detailed description of current financial conditions in advanced and emerging market economies, and a new methodology (building on Chapter 3 of the April 2017 GFSR). The measure for financial conditions used here does not include house prices.

- *The house-prices-at-risk measure is a useful early-warning indicator that can be used for financial stability surveillance.* Adding the house-prices-at-risk measure to standard growth-at-risk and financial-crisis-prediction models enhances the predictive power of these models. Thus, while house price levels should not be considered a target for either monetary, macroprudential, or capital flow management policies, the house-prices-at-risk measure can be used to gauge financial stability risks and provides useful information to evaluate the need for prospective policy action.
- *Macroprudential and monetary policy measures can reduce downside risks to house prices.* All else equal, a tightening of macroprudential housing measures in response to rising vulnerabilities in housing markets, such as tighter constraints on loan-to-value and debt-service-to-income ratios, lowers downside risks to house prices. Similarly, easier monetary policy improves house prices at risk in the short term (up to one year) in advanced economies and may have longer-lasting effects through financial conditions.
- *Capital inflows seem to increase downside risks to house prices in advanced economies, which may justify capital flow management measures in specific cases.* Evidence finds that a surge in capital inflows simultaneously raises the likelihood of high house price growth in the short term and downside risks to house prices in the medium term. Capital flow management measures can support macroeconomic policy adjustment and financial stability during capital inflow surges when other policy options are limited, or timing is crucial (IMF 2017). More detailed city-level evidence suggests that the relationship between various capital flows and house prices at risk varies with the type of capital flows and across countries.

The remainder of the chapter is organized as follows. First, downside risks to house prices are placed within the broader macro-financial stability framework. Next, the chapter describes the data used and provides some preliminary statistics. The chapter then turns to the measurement of house prices at risk, examines their importance for macro-financial stability and growth, and evaluates the role of various policies that may mitigate downside risks. The last section presents policy recommendations and conclusions.

Conceptual Framework

There is an extensive body of research on the determinants of house price valuations, but little effort has focused on how they relate to the likelihood of a large decline in house prices (downside risk). Several studies have related the expected growth of house prices to household income, macroeconomic and financial conditions, leverage, speculative bubbles, macroeconomic policies, and structural factors such as population growth and urbanization.⁸ But the relationship among these and other variables and the risk of large house price declines has received much less attention in the literature. A few studies find that domestic credit, interest rates, international liquidity, and bank deregulation can influence the probability of house price busts (Agnello and Schuknecht 2011; Muellbauer and Murphy 2012). Others have documented that households' expectations of a continued increase in house prices seem to have played a significant role in the US housing boom and bust around the global financial crisis of 2008 (Kaplan, Mitman, and Violante 2017; Burnside, Eichenbaum, and Rebelo 2016; Fuster, Laibson, and Mendel 2010).⁹

Downside risks to house prices are an integral part of the broader financial stability framework, in which macro-financial imbalances adversely affect the real economy (Figure 2.2). Adrian and others (forthcoming) argue that financial stability risks reflect the interaction of macro-financial imbalances—also called vulnerabilities—and negative shocks, which are hard to predict. These vulnerabilities increase because of excessive risk taking by lenders and borrowers during

good times. In the housing sector, this process relates easy financial conditions, and hence easy credit—reflecting a low price of risk—to vulnerabilities in the form of household overborrowing (excessive household leverage) and overvalued house prices (which deviate from fundamentals). With heightened vulnerabilities, adverse shocks can be amplified by cutbacks in, or rising prices of, credit (reflecting binding borrowing constraints), resulting in a feedback loop of large house price declines, weakened household balance sheets, declines in real activity, increases in credit risk, and declines in the value of collateral in the banking sector, and tightening of financial conditions that mutually reinforce one another.¹⁰

In this framework, downside risks to house prices are closely related to variables usually considered as determinants of house prices in a nonlinear manner that may change with the horizon of analysis. These variables include financial conditions, leverage, GDP growth, and house price overvaluation (see next section for details), which are directly or indirectly related to vulnerabilities in the housing sector that make large house price declines more likely to occur. The relationship is nonlinear because an adverse shock leads to large declines in house prices only when it is amplified by borrowing constraints that are more likely to bind when vulnerabilities are high.¹¹ The relationship between these variables and downside risks may also change with the horizon of analysis because of the endogenous accumulation of vulnerabilities. For instance, while loose financial conditions today may make borrowing easier and thus reduce downside risks, the resulting expansion in borrowing may increase vulnerabilities in the future and increase downside risks to future house prices.

The nonlinear relationship among factors associated with the accumulation of vulnerabilities and downside risks to house prices can be modeled using quantile regressions. This statistical technique is an extension of a linear regression that describes how a

⁸A number of studies find that house price valuation is tied to household income, macro-financial conditions, and structural factors such as population growth and urbanization (see Capozza and others 2002; Girouard and others 2006; Gattini and Hiebert 2010; Saiz 2010; Algeri 2013). Others point to the role of leverage, credit constraints, and bank deregulation (Duca, Muellbauer, and Murphy 2011; Favara and Imbs 2015; Mian and Sufi 2016), and the presence of speculative bubbles in housing markets (Himmelberg, Mayer, and Sinai 2005; Black, Fraser, and Hoesli 2006; Shiller 2007; Granziera and Kozicki 2015; Cerutti and others 2017; Kholodilin, Michelsen, and Ulbricht 2017). Finally, macroeconomic policies, ranging from taxation to macroprudential regulation, monetary policy, and capital flow measures, may have an impact on house prices and housing market conditions in some cases (Poterba 1984; Dokko and others 2011).

⁹Households that extrapolate from recent trends are likely to increase their borrowing during housing booms, which may amplify house price and leverage cycles, impair financial stability, and lead to “irrational exuberance” (Shiller 2013).

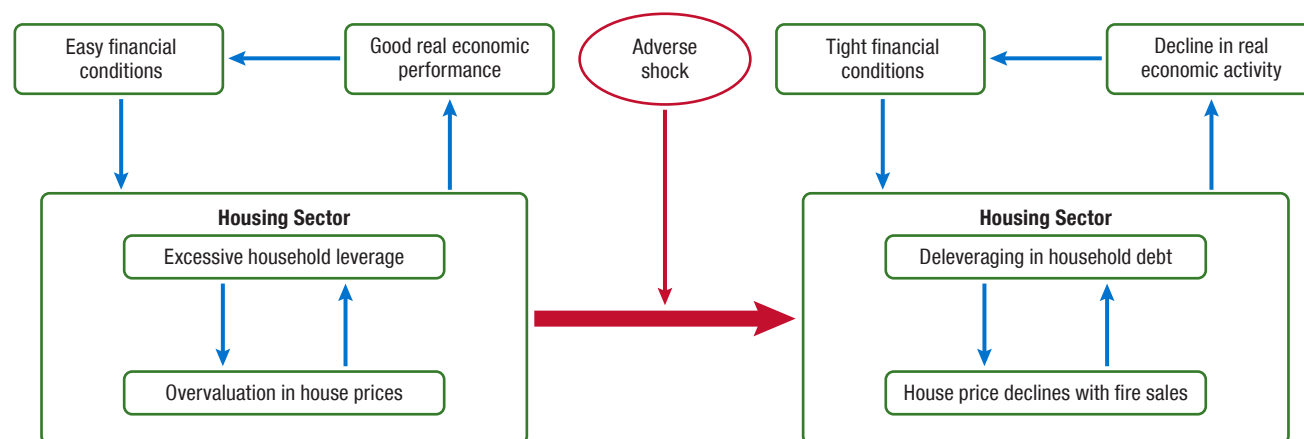
¹⁰The key components of this mechanism can be replicated in a state-of-the-art calibrated general equilibrium model with house prices and collateral constraints, which can also be used to study the effectiveness of policies (see Online Annex 2.1 at www.imf.org/en/Publications/GFSR).

¹¹This means that, for a given distribution of shocks, an increase in vulnerabilities should result in a larger shift in the left tail of the distribution of house price growth than in the central part of the distribution.

Figure 2.2. House Prices and Financial Stability

Accumulation of vulnerability in the housing sector under easy financial conditions ...

... may result in a vicious cycle between the housing, financial, and real economic sectors.



Source: IMF staff.

set of conditioning variables relates to different parts of the distribution—known as quantiles—of the variable of interest (in this case, the future growth in house prices). It can, therefore, be directly applied to study how financial conditions, leverage, GDP growth, and overvaluation relate to house prices at risk and to median house price growth, while controlling for other factors. By allowing the estimated relationship to vary across quantiles, this methodology can capture the nonlinear interaction between vulnerabilities and shocks predicted by the framework. For instance, an increase in leverage that increases vulnerability may have limited consequences for median house price growth—and therefore a weak estimated correlation with the median quantile. However, the same increase would increase the probability of large house price declines and thus result in a significant estimated correlation with the lowest quantiles captured by the house-prices-at-risk measure (see Online Annex 2.1).

An Overview of Developments in House Prices

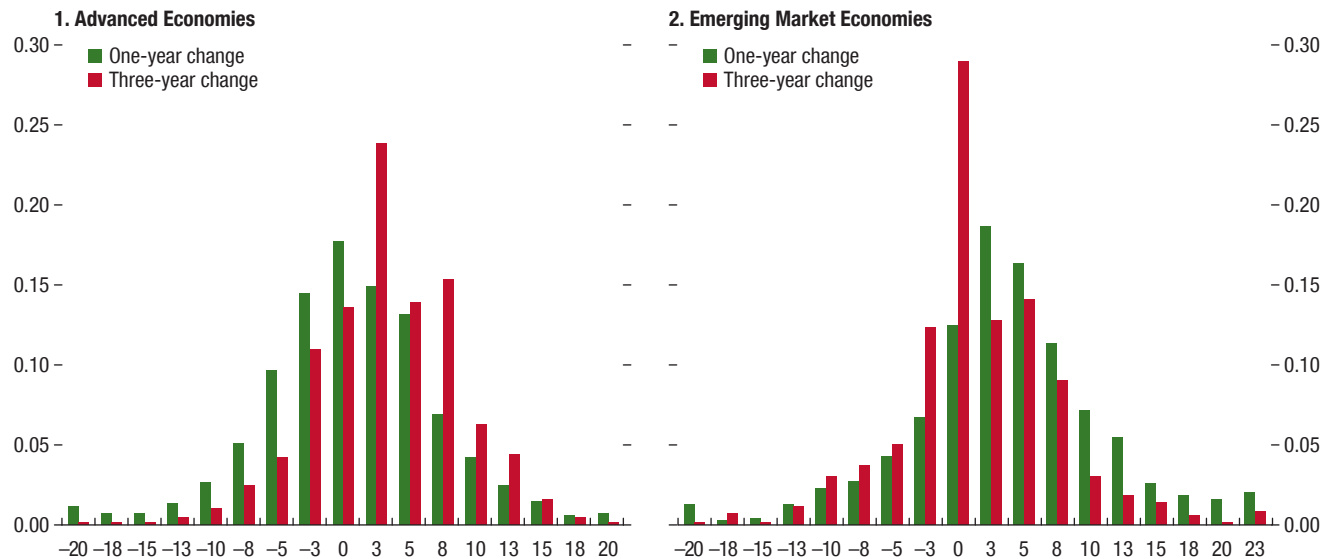
Real house prices tend to increase over time, but declines have occurred across a broad range of advanced and emerging market economies since the early 1990s. Data are collected for 22 major advanced economies and 10 emerging market economies (four in Latin America and three in east Asia, as well as in Russia, South Africa, and Turkey) and their major

cities.¹² The average (annualized) one-year and three-year growth rates of real house prices are very similar from the first quarter of 1990 to the fourth quarter of 2017—the longest possible consistent time series for most variables—at about 2 percent a year in advanced economies and 2.6 percent a year in emerging market economies (Figure 2.3, panels 1 and 2). Negative real growth in house prices occurs in about half of the observations in advanced economies and in a third of the observations in emerging market economies over a one-year horizon. In advanced economies, a 10.5 percent decline in average (annualized) real house prices occurs once every 20 years or, put differently, is associated with a 5 percent probability of downside risk. In emerging market economies, the 5 percent greatest decline in average growth in real house prices corresponds to a 12 percent decline in real house prices.

Variables related to fundamental house price valuations and vulnerabilities are also informative about downside risks to housing. As described in the previous section, the conceptual framework relates house price risks to household leverage, financial conditions,

¹²City-level analysis includes 31 cities, which are the largest cities for each of the 32 countries in the sample, except South Africa. Cities were selected on the basis of data availability and the top 50 cities for global investors identified by Cushman and Wakefield (2017). See Online Annex 2.1 for details.

Figure 2.3. Frequency Distribution of Real House Price Growth (Percent)



Source: IMF staff calculations.

Note: This figure shows the relative frequency of one-year and three-year quarterly real house price changes (annualized).

overvaluation, and real GDP growth.¹³ A simple look at the bivariate relationship between measures of these variables and different parts of the distribution of house price growth seems to confirm these predictions (Figure 2.4):

- *Financial conditions* reflect financial factors affecting house prices and are an overall metric of the pricing of risk in the economy. Tighter financial conditions are associated with lower house prices in the future, more strongly when house price growth is most negative, that is, in the lower tail (5th percentile) of the distribution (Figure 2.4, panel 1).
- *Real GDP growth* is a proxy for development in households' real income. Lower real GDP growth is generally associated with lower house price growth (Figure 2.4, panel 2).
- *The credit-to-GDP ratio* captures movements in leverage of economic agents and is an overall metric of financial vulnerability. When the ratio is above its

¹³Traditional house price valuation models based on price/rent, price/income, or fundamentals also include financial factors such as interest rates and leverage; household and macroeconomic conditions, such as wage or income growth, (un)employment, and real GDP growth; and structural factors such as mortgage structures, demographics, and other factors. Differences in tax systems and geographical features may also influence fundamental values, but their quantitative effects are harder to ascertain.

long-term mean, the negative relationship is more pronounced (Figure 2.4, panel 3).

- *The price-to-GDP per capita ratio*¹⁴ is a valuation metric for housing and captures the degree of deviation from fundamental valuation levels and has a more negative relationship with future house prices than with median or high growth in house prices (Figure 2.4, panel 4).

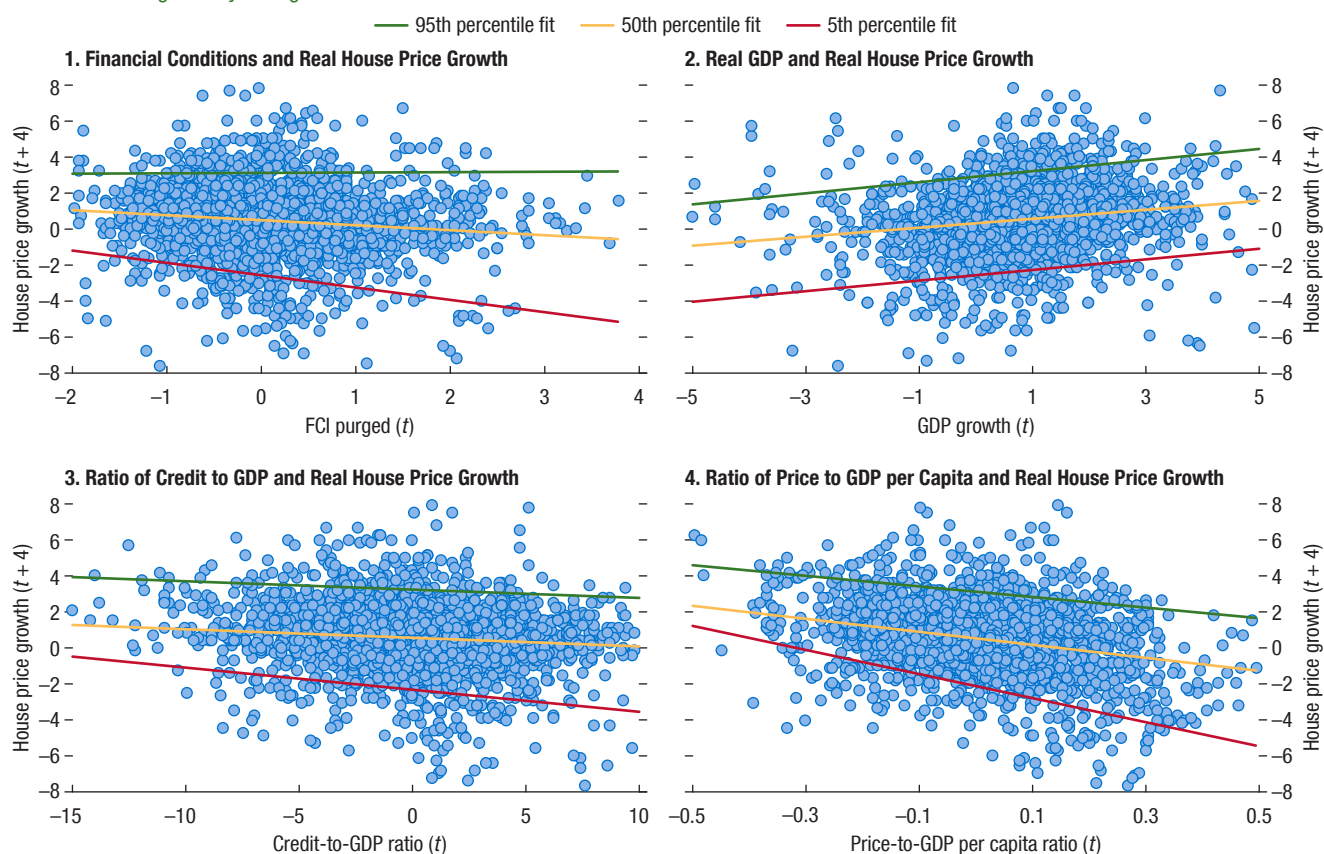
Empirical Analysis: The Behavior of House Prices at Risk

House prices at risk appear to broadly respond to past price dynamics and fundamental factors (Figure 2.5, panels 1 and 2). Separate models are run for the group of advanced and emerging market economies to maintain some homogeneity in the characteristics of countries included in each group. In addition to the four factors described in the previous section, the models also control for past growth in house prices. The latter captures momentum effects, which may also

¹⁴Results are qualitatively similar when other misalignment measures are used, such as price-rent ratio, price-income ratio, or model-based measures that capture misalignments as deviations from fundamentals.

Figure 2.4. Determinants of Real House Prices

The relationship between declines in real house prices and variables related to financial conditions, real GDP growth, household leverage, and overvaluation is generally stronger in the lower tail than elsewhere.



Source: IMF staff calculations.

Note: Panels 1–4, respectively, depict the association between one-year-ahead real house price growth and current financial conditions, real GDP growth, the detrended credit-to-GDP ratio, and the detrended price-to-GDP ratio. Lines show the estimated relationship between these variables and real house prices at the 5th (red line), 50th (yellow line), and 95th (green line) quantiles. An increase in the FCI represents a tightening of the pricing of risk in the economy. FCI = financial conditions index; t = current quarter; $t + 4$ = one-year (four quarters) ahead.

be relevant because house price cycles persist for a long time.^{15,16} The results are as follows:

- *Financial conditions:* A one-standard-deviation tightening of financial conditions,¹⁷ reflecting a higher

¹⁵Other, more structural, variables affect expected house prices and are considered in the literature but are not included because data are not available. Because some of them, such as population growth and urbanization, are slow moving, they can be partly absorbed using fixed effects. Also, lagged house prices could capture the role of persistent omitted variables, such as supply restrictions.

¹⁶Estimations are performed with standardized variables, which have a mean of zero and standard deviation—a measure of dispersion—equal to one. This allows for a direct comparison of the impact of these variables. Online Annex 2.1 describes the methodology in more detail.

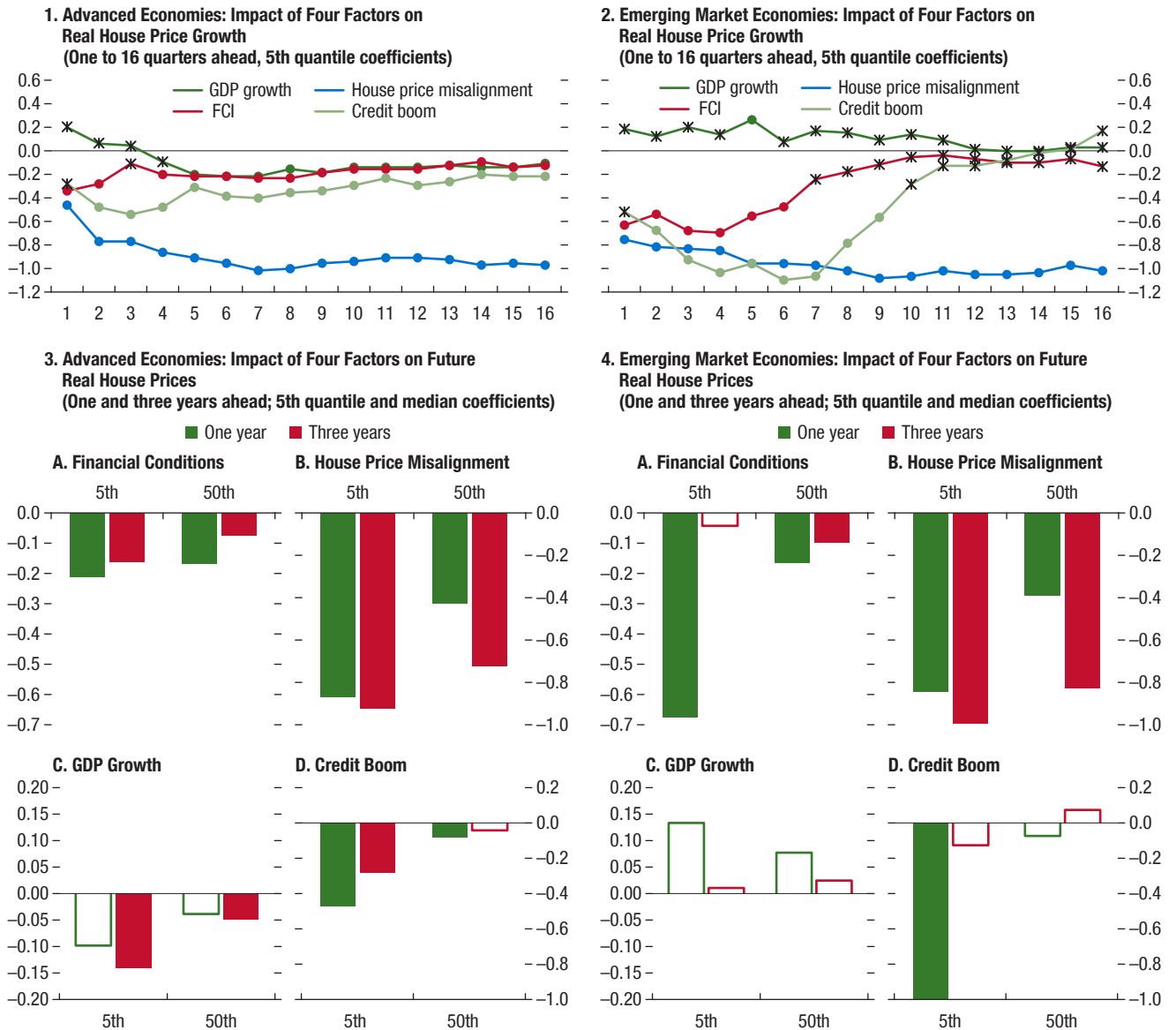
¹⁷In comparison, the global financial crisis entailed a 2.3 standard deviation shock to financial conditions in advanced economies

underlying price of risk for the economy, is associated with 0.3 to 0.7 percentage point higher downside risk to house prices in the short term (with a stronger impact in emerging market economies), but diminishes to 0.1 percentage point in advanced economies and becomes insignificant for emerging market economies over longer horizons. Hence, the relationship between financial conditions and house prices at risk is much stronger in the short term than in the medium term. The medium-term

(1.4 in emerging market economies). The GDP growth shock was 2.2 standard deviations in advanced economies and 1.7 in emerging market economies, and the overvaluation shock was about 0.2 standard deviation across both groups.

Figure 2.5. House Prices and Fundamentals: Quantile Regression Results

Variables related to financial conditions, real GDP growth, household leverage, and overvaluation are informative about sharp declines in real house prices.



Source: IMF staff calculations.

Note: Panels 1 and 2 show panel quantile coefficients for four standardized variables in regression with average real house price growth over different horizons, estimated at the 5th percentile. Black markers indicate insignificant coefficients; colored circles denote coefficients significant at the 10 percent level or higher. Panels 3 and 4 (A–D) show coefficients from panel quantile regressions estimated at the 5th and 50th (median) quantiles for one- and three-year real house price growth and lagged house prices, financial conditions, house price misalignment, real GDP growth, and a credit boom dummy. All variables (except the credit boom dummy) are standardized so that magnitudes of coefficients indicate relative importance of variables. Colored bars indicate that the coefficients are statistically significant at the 10 percent level or higher. Outlined bars indicate insignificant coefficients. FCI = financial conditions index.

association between financial conditions and house prices at risk turns positive in a smaller model that excludes the measure of house price overvaluation, which suggests that easy financial conditions today increase downside risks to house prices in the future through an intermediate increase in overvaluation.¹⁸

- *Real GDP growth*: One-standard-deviation higher real GDP growth, reflecting an improvement in households' real incomes, is associated with an insignificant reduction in downside risks to house prices one to three quarters ahead in advanced economies, but appears to have an opposite and significant relationship over longer horizons. In emerging market economies, the association between GDP growth and downside risks to house prices is positive but not statistically significant.
- *Overvaluation (house price misalignment)*: A one-standard-deviation increase in the ratio of house prices-to-GDP-per capita—a proxy for overvaluation—appears consistently and significantly related to higher downside risks to house prices over time. This is because it likely signals a correction in house prices of between 0.5 and 1.0 percentage point in advanced economies and 0.7 to 1.0 percentage point in emerging market economies.
- *Credit booms*:¹⁹ Finally, credit booms tend to be linked with a worsening of the house-prices-at-risk measure by up to 0.5 percentage point at short horizons in advanced economies (three quarters ahead) and up to 1 percentage point at medium-term horizons (up to seven quarters) in emerging market economies.

A comparison with median house prices shows that the effects of fundamental factors and overvaluation are generally more pronounced at the lower tail (Figure 2.5, panels 3 and 4). More specifically, the analysis uncovers the following patterns:

- *Financial conditions*: A tightening of financial conditions is associated with larger negative house

prices at risk in both advanced and emerging market economies than for median house prices.

- *Real GDP growth*: Higher real GDP growth is more strongly correlated with downside risks to house prices than median house prices in advanced economies, in both the short term (one year ahead) and medium term (three years ahead). In emerging market economies, on the other hand, higher GDP growth is correlated with lower downside risks to house prices, albeit not significantly.
- *Overvaluation (house price misalignment)*: A shock to the ratio of house prices to per capita GDP is more strongly related to downside house prices than to median house prices.
- *Credit booms*: Credit booms tend to be more strongly related to large negative house price corrections at short- and medium-term horizons than to median house prices, in both advanced and emerging market economies.

House prices at risk fluctuate substantially over time and display cyclical short-term comovement. In advanced economies, downside risks to house prices were high in the early 1990s during the Nordic banking crises, and immediately before the global financial crisis in 2008 (Figure 2.6, panels 1 and 3). At the same time, the cross-country distribution also widened during these periods—and more recently as well—which suggests greater heterogeneity in housing market downside risks. For emerging market economies, significant cross-country heterogeneity is evident in the early 1990s, around the Asian and Russian financial crises of 1997 and 1998, and before the global financial crisis of 2008. However, in the most recent period, median house prices at risk do not display a pronounced cyclical trend (Figure 2.6, panels 2 and 4). Further research indeed suggests that downside risks to house prices appear to synchronize across advanced economies before major financial crises and global recessions (see Box 2.1).²⁰

Tail risks have rotated over time, and the distribution of future house price growth can provide rich information on the risk profile. Most countries where the

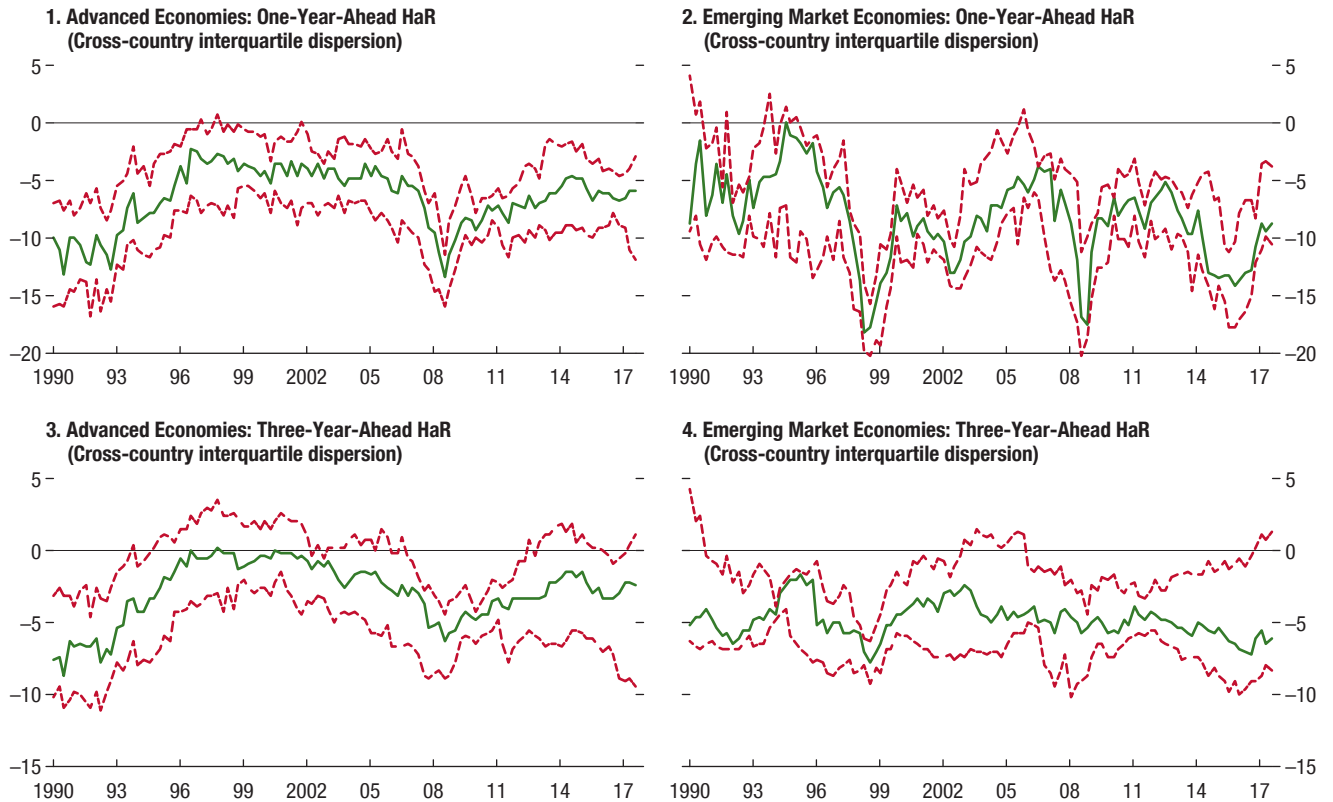
¹⁸When using noncumulative quarterly changes in house prices as the dependent variable, the trade-off is also more visible.

¹⁹Credit booms are defined as periods during which the credit-to-GDP ratio is above the long-term trend. The fact that credit booms have an immediate effect on house price risk is likely due to the definition of the boom variable, which signals overstretched household balance sheets instantaneously, rather than gradually building up.

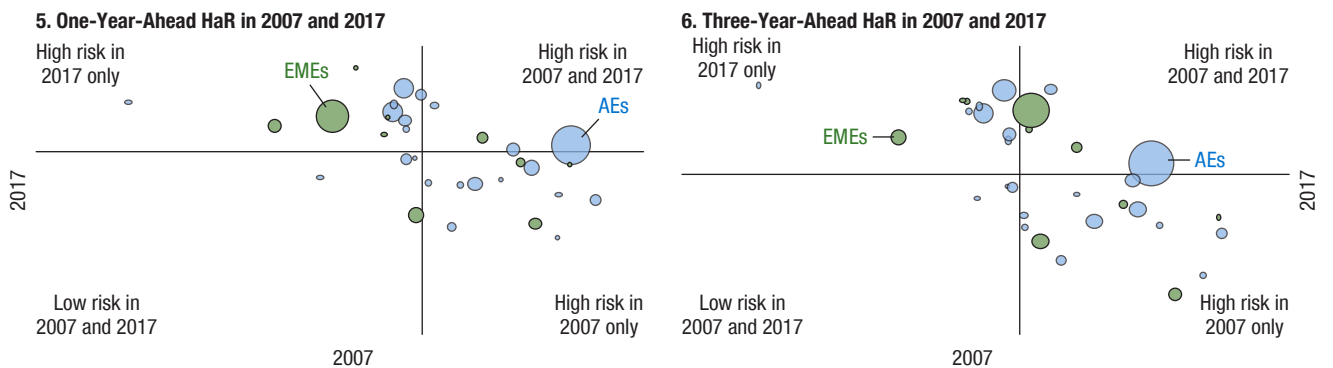
²⁰While downside risks do not seem to become more synchronized over time, their cyclical short-term comovement, measured by instantaneous quasi-correlations, is similar to that of average house prices documented in Chapter 3 of the April 2018 GFSR (see Box 2.1). This suggests that global factors may play a role in downside risks to house prices.

Figure 2.6. Evolution of House Prices at Risk and Shifts in Riskiness

House prices at risk fluctuate substantially over time and across countries and display cyclical short-term comovement.



Countries that were more at risk from house price decline in 2007 seemed less vulnerable in 2017, but some remained at relatively high risk at both periods.

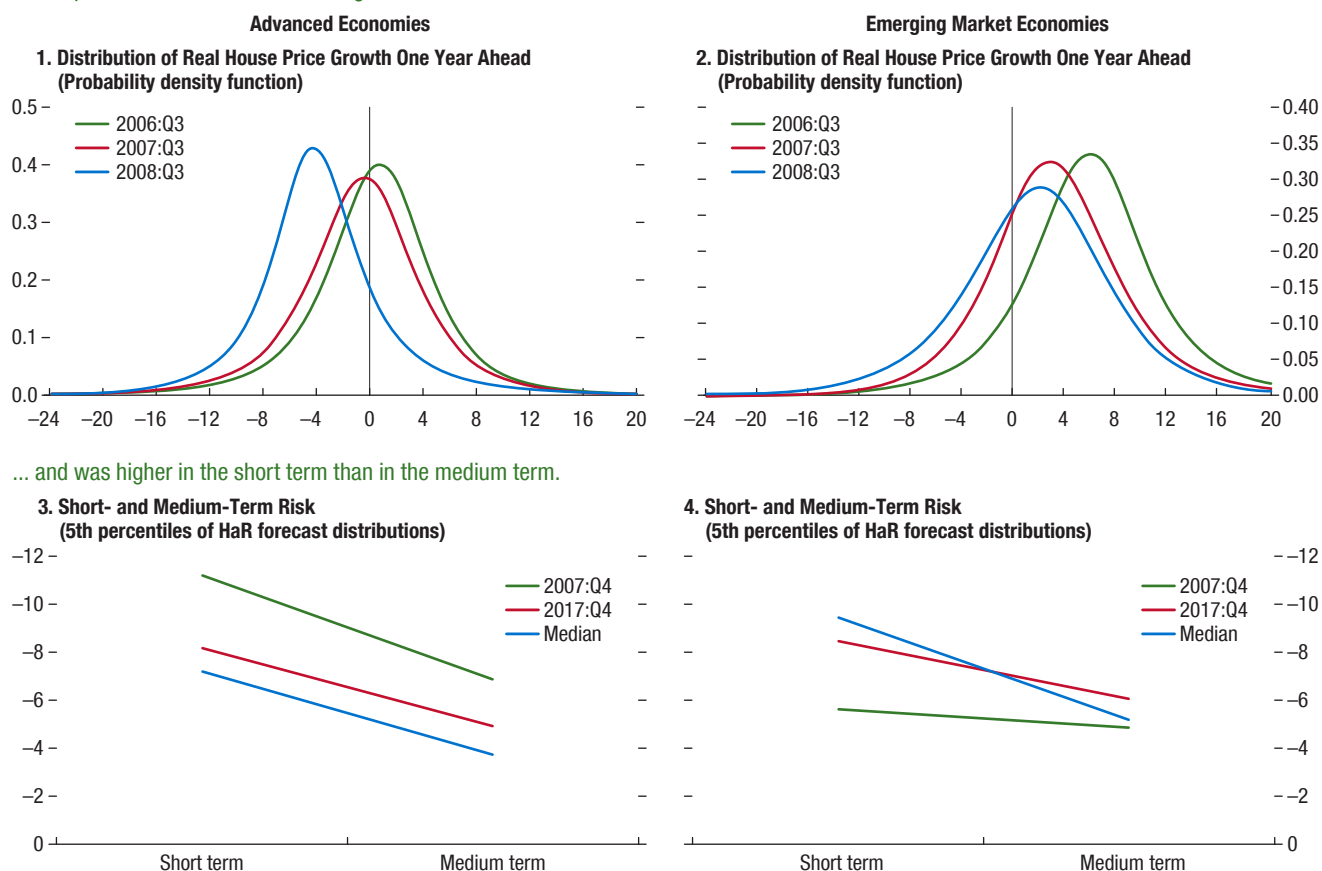


Source: IMF staff calculations.

Note: Panels 1–4 depict the one- and three-year-ahead HaR distribution across advanced and emerging market economies. Panels 5 and 6 show the one- and three-year-ahead HaR levels in 2007:Q4 and 2017:Q4 for advanced and emerging market economies (blue and green, respectively) relative to the overall median HaR. Bubble size indicates the country’s 2017 purchasing-power-parity-weighted GDP in US dollars. Estimates are based on the panel quantile regression model used in Figure 2.5. AEs = advanced economies; EMEs = emerging market economies; HaR = house prices at risk.

Figure 2.7. Predictive Distributions of House Price Risks

House price risk increased before the global financial crisis ...



Source: IMF staff calculations.

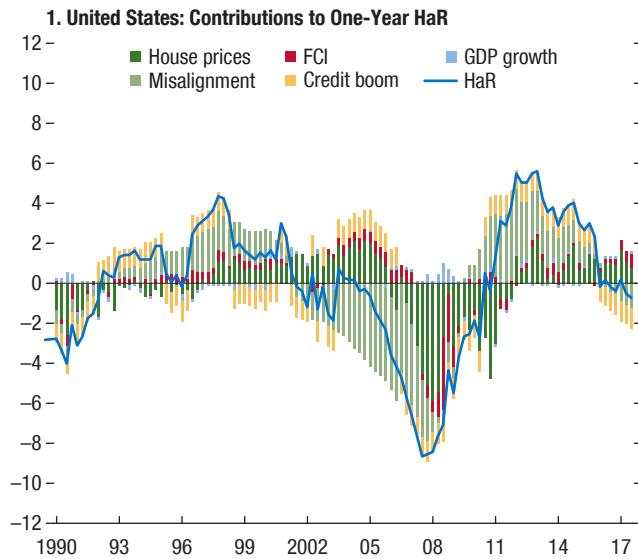
Note: Panels 1 and 2 show skewed-*t* predictive distributions of the one-year-ahead real house price growth before the global financial crisis of 2008 (2006:Q3 until 2007:Q3 and 2008:Q3). Panels 3 and 4 show point estimates of HaR in the short term (one year ahead) and medium term (three years ahead) for 2007:Q4, 2017:Q4, and across the entire sample, based on the panel quantile regression model used in Figure 2.5, weighted by 2017 GDP in purchasing-power-parity terms. HaR = house prices at risk.

house-prices-at-risk measure was relatively high in the fourth quarter of 2007 seem to have lower downside risk in the fourth quarter of 2017, and vice versa (Figure 2.6, panels 5 and 6). While this is true for both one- and three-year-ahead house prices at risk, the latter also shows that several countries—both large and small—remain in the high-risk quadrant in both periods. More broadly, the predicted distribution of house price growth shifts noticeably over time. For instance, both the mean and the tail of the distribution shifted progressively to the left ahead of the global financial crisis in both advanced economies and emerging market economies (Figure 2.7, panels 1 and 2). This suggests that the left tails and the overall shape of the house price distribution may serve as important early-warning signals.

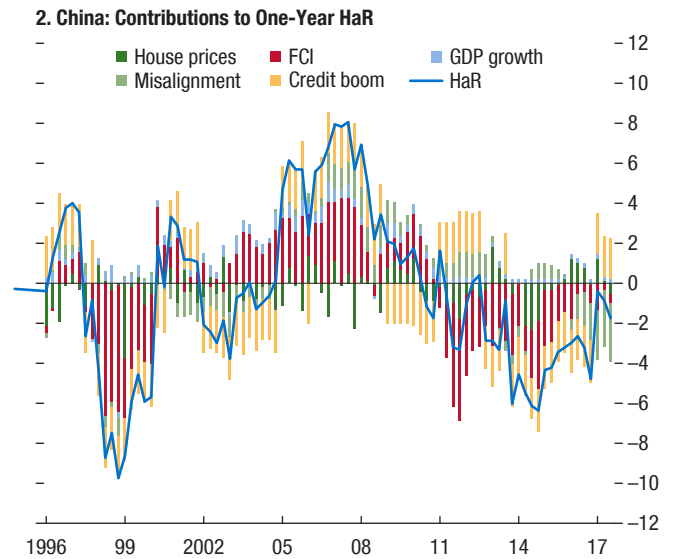
The one- and three-year-ahead house-prices-at-risk measures suggest a different rotation of short- and medium-term risks in advanced and emerging market economies. Generally speaking, downside risks to house prices appear higher in the short term than in the medium term in both country groups (Figure 2.7, panels 3 and 4). That said, on a GDP-weighted basis, the level of both short- and medium-term house price risks seems to have decreased in advanced economies and increased in emerging market economies between the fourth quarter of 2007 and the fourth quarter of 2017, especially in the short term. Yet in advanced economies, the level of downside house price risk in the fourth quarter of 2017 is above the overall median.

Figure 2.8. Factors Affecting House Prices at Risk in the United States and China
(Annual percent change)

Since late 2016, US HaR appears to have deteriorated gradually ...



... whereas HaR was more volatile in China and was driven mainly by financial conditions.



Source: IMF staff calculations.

Note: The figure shows the decomposition of the estimated one-year-ahead HaR at the 5th percentile into contributions of past house prices, financial conditions, real GDP growth, house price misalignment, and credit boom. The (negative) constant term is not shown. FCI = financial conditions index; HaR = house prices at risk.

These fluctuations in house prices at risk over time are explained by the evolution of several factors. The effects of changes in the fundamentals on house prices at risk can best be illustrated by concrete examples, such as the one-year-ahead house-prices-at-risk fluctuations for the United States and China, as the largest advanced and emerging market economies, respectively (Figure 2.8). Specifically,

- *In the United States*, house prices at risk gradually deteriorated beginning in the early 2000s, leading up to the global financial crisis. This pattern was initially related to house price overvaluation. Over time, past house price movements and credit also started to have a negative effect, partially offset by relatively loose financial conditions. Once the global financial crisis set in, the tightening of financial conditions weighed negatively on house prices at risk. Since late 2016, US house prices at risk appear to have deteriorated gradually due to overvaluation concerns and high credit growth, but they have been partly offset by still-easy financial conditions and past house price momentum.
- *In China*, house prices at risk seem more volatile, partly following the volatility in house price growth.

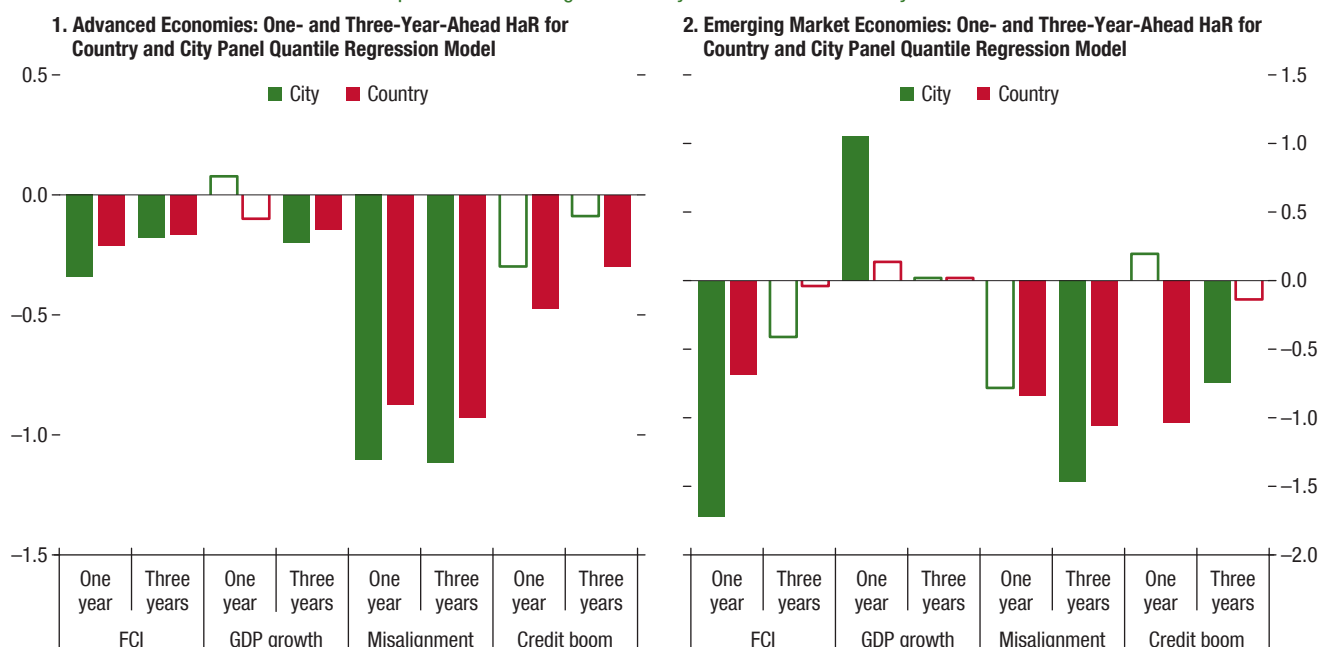
Easy financial conditions kept house price risks contained until 2010. After 2010, high credit-to-GDP gaps and tightening of financial conditions contributed to increased downside risks. Since 2016, house price overvaluation has also contributed to the deterioration of house prices at risk.

The findings are valid when applied to city-level data, although the magnitude of the response to various factors differs from the country-level analysis. A comparison of city- and country-level results finds that the relationship between financial conditions and house prices at risk is larger at the city level than at the country level (Figure 2.9), especially among emerging market economies. This result may reflect the fact that most cities included are also major financial centers in each of the countries in the sample, and as such are more responsive to financial factors than the rest of the country. It could also reflect the fact that major cities' housing markets tend to face more supply constraints, such as regulations and land shortages (Paciorek 2013).

Analysis with new data shows that the house-prices-at-risk model can be used for forecasting and surveillance. A model that forecasts well in the data sample

Figure 2.9. City- and Country-Level Comparisons of House Prices at Risk (Coefficients)

The effect of financial conditions on house prices at risk is larger at the city level than at the country level.



Source: IMF staff calculations.

Note: Panels show coefficient estimates of alternative panel quantile regressions for HaR at the 5th percentile, for one year ahead and three years ahead, in advanced and emerging market economies and major cities. Red bars depict the magnitude of the effects of the four factors in the model estimated at the country level, and green bars depict the city-level effects (for major cities in each country, except for South Africa, for which no major city data were available). Colored bars indicate that the coefficients are statistically significant at the 10 percent level or higher, whereas outlined bars indicate insignificant coefficients. FCI = financial conditions index; HaR = house prices at risk.

used to estimate it does not necessarily do so when applied to new data, or out of sample. However, the latter is crucial for the model’s usefulness for surveillance, where it will be applied to future data. One way to evaluate how well the model performs out of sample is to compare the quantiles of the distribution estimated using the full sample with those using information only up to a given point in time. Such a comparison for the United States and China shows that these out-of-sample predictions closely track the in-sample predictions for one-year-ahead growth in house prices (Figure 2.10). This result suggests that the model accurately signals downside house price vulnerabilities in real time, even in light of well-documented changes in financing structures in the United States and elsewhere in the run-up to the financial crisis. Similar results are obtained for the other countries in this study and for other more sophisticated out-of-sample methods.²¹

²¹Additional robustness exercises for the out-of-sample performance of house prices at risk included pseudo- R^2 measures that measure

House Prices at Risk and Financial Stability

Sharp declines in house prices help forecast risks to real GDP growth. Growth at risk measures the degree to which future GDP growth faces downside risks, and its relationship with measures of financial vulnerabilities, including in the housing sector, is a metric for financial stability (see Chapter 3 of the April 2018 GFSR and Adrian and others 2018). Given that large declines in house prices are associated with contractions in GDP growth and financial stability risks (see “Conceptual Framework” section), a deterioration in house prices at risk should help forecast downside risks to GDP growth, over and above other measures of house price imbalances that are only indirectly related

the predictive power of house prices at risk in out-of-sample analysis relative to the historical quantiles, and the estimation of the empirical cumulative distribution of the probability integral transformation at the country level, as in Adrian, Boyarchenko, and Giannone (forthcoming). In most countries, the predictive distribution was well within the critical values given by Rossi and Sekhposyan (2017).

Figure 2.10. Out-of-Sample Forecasting Accuracy
(In-sample versus out-of-sample forecasts, annual percent change)

Out-of-sample predictions closely track the in-sample estimates for one-year-ahead house prices at risk.



Source: IMF staff calculations.

Note: The figure compares in-sample and out-of-sample forecasts, using the real house price baseline model from Figure 2.5 (green lines) and using recursive estimation for the out-of-sample model (red lines). The out-of-sample analysis shown in this figure uses a country-specific model instead of the panel model to illustrate the fit of the model in a concrete application. This reduces the degrees of freedom of the estimation and the robustness of the results when applied to low quantiles of the distribution. For that reason, the figure shows results for the 20th and 25th percentiles for the United States and China, respectively.

to future risks. The empirical findings confirm this hypothesis (Figure 2.11, panels 1 and 2).²² An increase in downside risks to house prices (a lower, more negative house-prices-at-risk measure) is associated with an increase in future downside risk to GDP growth. Furthermore, the association with downside risks is stronger than with median growth, consistent with studies on booms and busts in house prices and recessions (see Introduction). The highest impact of house prices at risk is four to eight quarters into the future, with a 1 percent improvement in the house-prices-at-risk measure preceding on average a 0.3 percentage point improvement in growth at risk. This association is robust to adding various credit quantity measures to the growth-at-risk model, indicating that it is not

²²The house-prices-at-risk measure also reduces the impact effect of the financial conditions index on growth at risk. When the effect of the financial conditions index on growth at risk is looked at alone, the downside risk of the financial conditions index in the short term is higher. However, when the house-prices-at-risk measure is added to the growth-at-risk model, the downside risk from financial conditions indices is mitigated in the short term, indicating that the house-prices-at-risk measure is absorbing some of the effect of the financial conditions index.

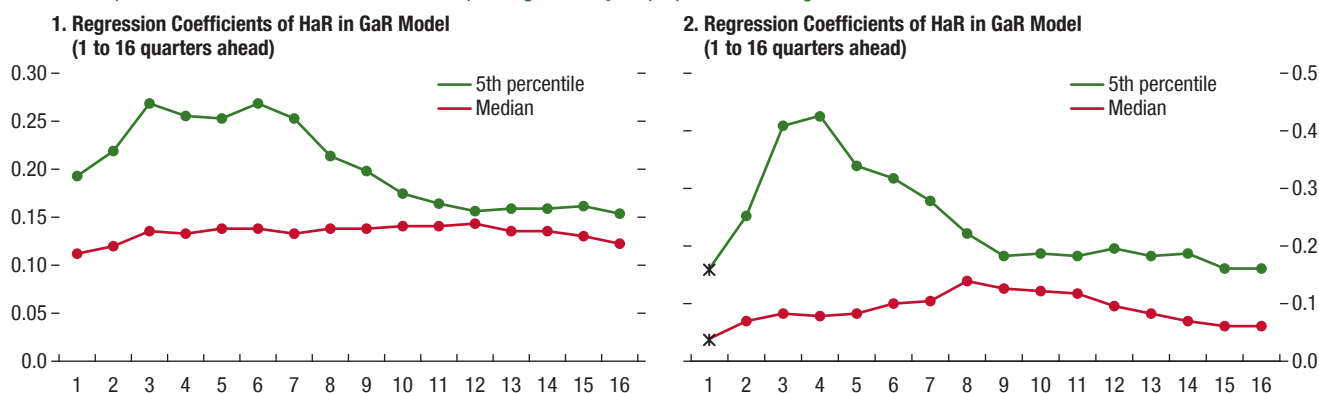
simply capturing the correlation of growth at risk with credit, and to adding indirect measures of house price imbalances, such as the growth in house prices or overvaluation metrics. Thus, the house-prices-at-risk measure serves as a leading indicator for financial stability risks as captured by the growth-at-risk model.

The house-prices-at-risk measure also helps predict episodes of financial crisis. Another way of evaluating the usefulness of the house-prices-at-risk measure for financial stability surveillance is to study whether a more adverse measure today helps predict the occurrence of financial crises.²³ The analysis shows that adding the house-prices-at-risk measure to standard statistical models for crisis prediction that relate the probability of a crisis to GDP growth, financial conditions, and the credit-to-GDP gap helps improve the accuracy of the models. This occurs across all horizons (one, two, and three years) and for both advanced

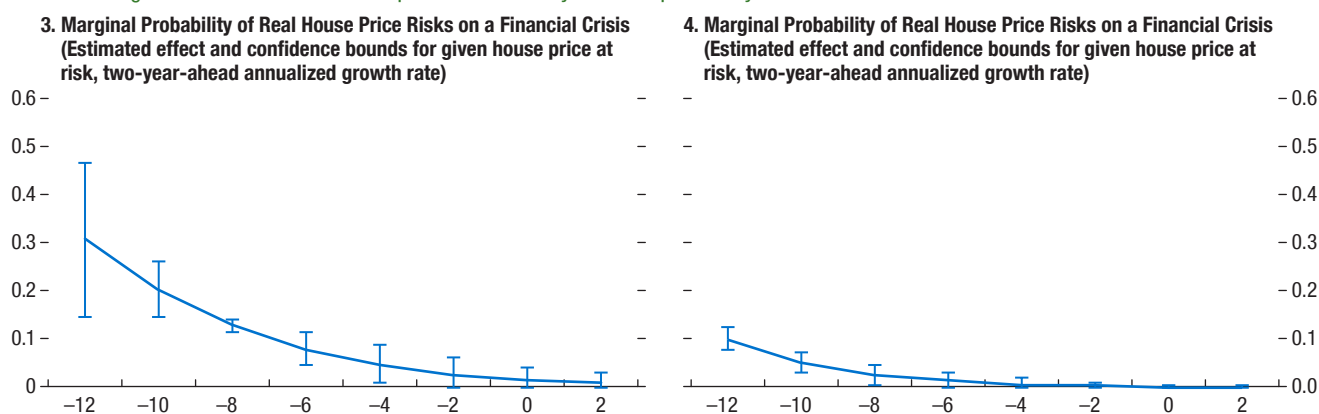
²³Financial crises correspond to systemic banking crises, as identified by Laeven and Valencia (2018). Crises are rare and need to be identified carefully through qualitative and quantitative criteria. The growth-at-risk framework, as used in Adrian and others (2018), provides an alternative approach.

Figure 2.11. House Prices at Risk and Financial Stability

The house-prices-at-risk estimate used in this chapter significantly helps predict future growth at risk ...



... and the largest downside risks to house prices substantially raise the probability of a financial crisis.



Source: IMF staff calculations.

Note: Panels 1 and 2 depict a positive and significant association between GaR and HaR, at the 5th quantile and at the median over different projection horizons. Black markers indicate insignificant coefficients; colored circles denote coefficients significant at the 10 percent level or higher. Panels 3 and 4 show marginal probabilities of real house price declines (HaR) at given values on the occurrence of a financial (banking) crisis from a model with fixed effects, output growth, the financial conditions index, credit-to-GDP gap, and HaR. Vertical lines delineate the 95 percent confidence bounds around the point estimates. GaR = growth at risk; HaR = house prices at risk.

and emerging market economies. According to the estimates, an annualized house-prices-at-risk measure of -12 percent—that is, an estimated 5 percent probability of a 12 percent decline in real house prices two years ahead—implies a 31 percent probability of a financial crisis two years ahead in advanced economies and a 10 percent probability in emerging market economies (Figure 2.11, panels 3 and 4).

Policies and House Prices at Risk²⁴

By taming the accumulation of vulnerabilities or increasing buffers, policymakers can also reduce

downside risks to house prices. Macroprudential policy can be used to reduce systemic risks by, among other things, taming the accumulation of vulnerabilities arising from housing market valuation risks or household financial vulnerabilities. Macroprudential measures can also be used to build buffers in financial intermediaries to allow them to absorb initial shocks and break negative feedback loops (Adrian, Boyarchenko, and Giannone, forthcoming; Alam and others, forthcoming). Monetary policy is mainly focused on inflation risk but may implicitly consider house prices because housing market developments underpin risks

²⁴The analysis also tested for effects of fiscal policy measures (results not reported) pertaining to changes in property tax rates, the tax base, and interest deductibility in personal income taxation,

based on the Tax Policy Reform database from Amaglobeli and others (2018). However, results were not significant, which may be partly due to the smaller sample size (across countries and time).

to the general economic and inflation outlook. Fiscal policy measures may also affect housing markets as they pertain to property taxation, interest deductibility, housing subsidies, and the like. Foreign buyers may be attracted to investing in housing abroad, but foreign governments may impose capital flow measures to restrict their effect on local house prices. More broadly, a surge in capital flows reflecting strong global risk appetite for a country's assets could also contribute to unsustainable credit expansions, which under certain circumstances could be curtailed by capital flow management measures.

In a theoretical model, macroprudential policy is more effective than monetary policy to reduce growth at risk. In the model,²⁵ household debt generally surpasses the socially optimal level because no individual household takes into account the consequences of selling its house at fire sale prices on overall house prices, collateral values, and macroeconomic performance (a so-called pecuniary externality). Simulations of this model under different policy reactions suggest that tightening macroprudential policy in response to higher household debt can prevent a housing crisis, or mitigate its adverse effects, by curbing run-ups in household debt before the crisis. Monetary policy that deviates from output-inflation stabilization and responds to high credit-to-GDP ratios before the crisis can also mitigate the adverse effects of housing crises on GDP, but to a lesser extent than macroprudential policy. This is because monetary policy fails to fully curb the rise of household debt before the crisis and affects other components of output beyond the housing sector. These results indicate that containing the accumulation of vulnerabilities through macroprudential policy more effectively reduces downside risks than monetary policy. In practice, however, if the macroprudential toolkit is incomplete, or the decision-making process is imperfect, monetary policy might still have to take downside risks to house prices into consideration, even when it is not the preferred policy tool from a theoretical perspective. In addition, the fact that there is significant information value in house prices at risk for growth at risk suggests that house prices at risk impact monetary policy objectives directly.

Empirical results show that macroprudential policies help reduce downside risks to future house prices. Macroprudential policy measures may affect house

prices at risk in three ways. First, they may have a direct effect where tightening these measures reduces house prices at risk—consistent with macroprudential policy measures leading to the accumulation of buffers, so that house prices at risk are lower for any combination of factors.²⁶ Second, macroprudential policies may change how other factors, such as financial conditions or credit, are related to house prices at risk. This could occur if, for instance, a credit expansion in the presence of macroprudential policy measures were to flow to less-leveraged households. Third, macroprudential policy measures may affect the variables that are related to house prices at risk—previous studies find, for instance, some evidence that macroprudential policy measures reduce credit growth. The evidence indicates that a tightening of borrower-based macroprudential policy measures, such as restrictions on loan-to-value and debt-service-to-income ratios, affects house prices at risk directly, but the relationship does not depend on financial conditions or credit. Macroprudential policy measures shift the entire term structure of house prices at risk upward (Figure 2.12, panels 1 and 2). In advanced economies, the effect seems to have a maximum impact between four and eight quarters ahead, while in emerging market economies, the impact is highest in the short term, but remains mostly steady until about 12 quarters ahead.²⁷ Specifically, a one-unit tightening of macroprudential measures during a credit boom could lower the one-year-ahead average house prices at risk by up to 2 percentage points (annualized), from -9.4 percent to -7.4 percent. Results are qualitatively similar for broader credit-related measures in advanced economies, but not significant in emerging market economies. That said, the use of

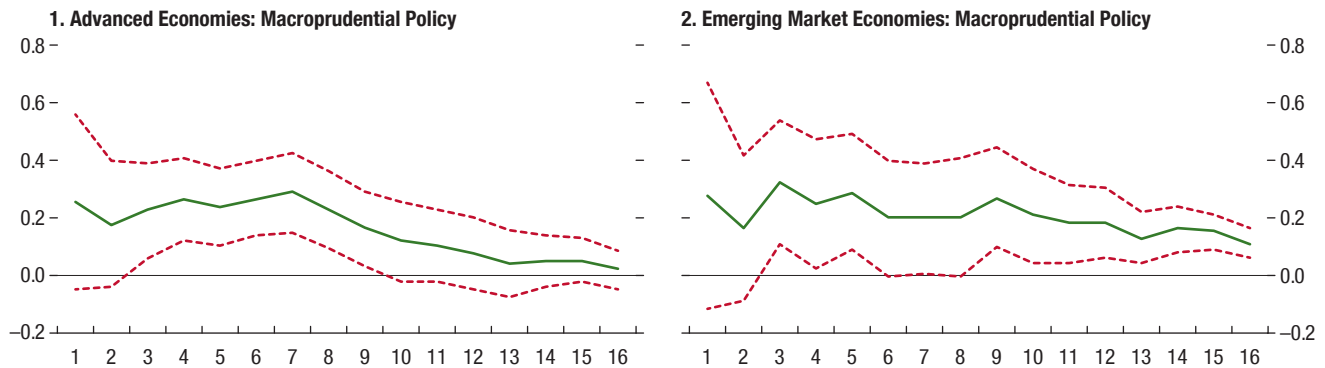
²⁶As a measure of macroprudential policy, the chapter uses the IMF's Integrated Macroprudential Policy (iMaPP) database, which has data on tightening and loosening for a range of macroprudential policy measures (see Alam and others, forthcoming). While not directly reflecting the level or intensity of the measures, cumulative and rolling-window scores proxy that to some extent (where tightening increases, and loosening lowers, the measures' unit scores). The measure used here combines information on loan-to-value and debt-service-to-income ratios, which are the most relevant measures for the housing sector and are often employed together (Kuttner and Shim 2016).

²⁷According to Choi, Kodres, and Lu (2018), tightening nine macroprudential policies on annual house prices from a broad set of countries appeared to take two years to have the intended effect, and in the first year after implementation real housing prices rose instead of falling. For European countries, the November 2018 *Regional Economic Outlook: Europe* finds mixed evidence on the ability of macroprudential policies to contain house price growth amid accommodative monetary policy.

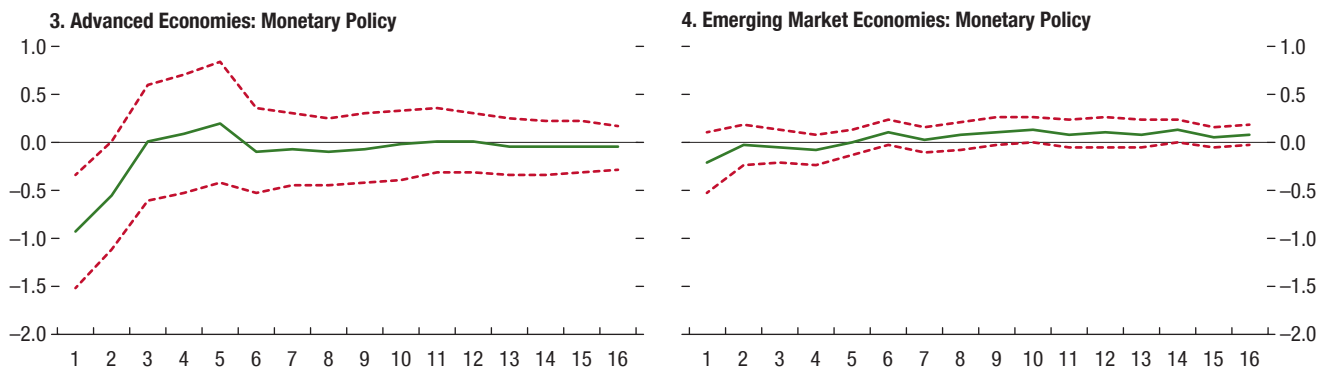
²⁵See Online Annex 2.2 at www.imf.org/en/Publications/GFSR for details.

Figure 2.12. Effects of Macroprudential and Monetary Policy and Capital Flows on House Prices at Risk

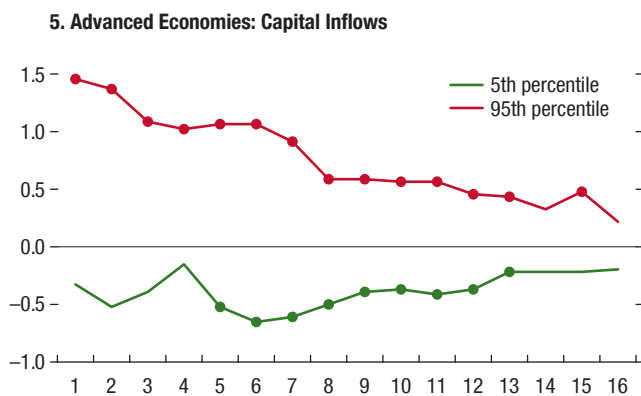
Tightening of macroprudential policy seems to improve the house prices at risk measure.



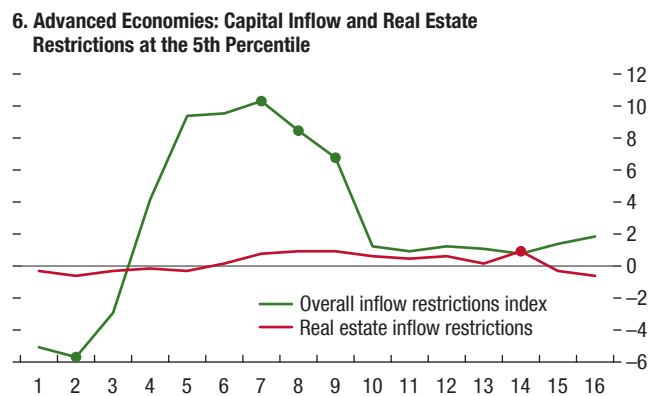
Monetary policy shocks have no significant impact on house prices at risk over longer horizons, nor in emerging markets.



Capital inflows increase downside risks in advanced economies ...



... but tightening of capital flow management measures may improve house prices at risk temporarily.



Source: IMF staff calculations.

Note: Panels show the effect of various policies on the house-prices-at-risk estimation. In panels 1 and 2, macroprudential policy measures have a statistically significant level-shifting effect on house prices at risk (reducing downside risk). The macroprudential policy variable used here is based on a three-year rolling window of debt-service-to-income and loan-to-value measures, and is purged for credit to GDP to remove potential endogeneity. In panels 3 and 4, for advanced economies, monetary policy, as captured by predicted residuals of a feedback rule (see Online Annex 2.1), has a significant effect (initially increasing downside risks, but less so over time). In panel 5, total capital inflows (as a percentage of GDP) at the 95th percentile tend to increase upside risks to house prices, and at the 5th percentile, they tend to increase downside risks to house prices. In panel 6, proxies for changes in capital flow management measures appear to reduce downside risks to house prices over some intermediate horizons. Dashed lines in panels 1–4 denote 95 percent confidence bounds for statistical significance and dots in panels 5 and 6 show statistical significance at the 10 percent level or higher.

macroprudential policies should not be targeted to house price levels but to the buildup of financial vulnerabilities signaled by downside risks to house prices. Their application should be mindful of broader implications for systemic risk, to avoid downward spirals in credit and prices when the economy and the housing market are in a fragile state.

Monetary policy tightening contributes to a deterioration of house prices at risk over a short horizon in advanced economies.²⁸ Isolating the role of monetary policy from that of financial conditions is difficult because the latter is a key channel through which monetary policy operates. The analysis focuses on “shocks” to traditional monetary policy, understood as unexpected deviations of the short-term policy rate from an expanded Taylor rule.²⁹ The analysis shows that these shocks have a short-lived, negative relationship with house prices at risk only in advanced economies (Figure 2.12, panels 3 and 4). This may be because these housing markets are more developed and integrated with capital markets than in emerging market economies, such that changes in the short-term policy rate would directly pass through to house prices. The fact that monetary policy shocks could influence house prices at risk might affect the way monetary policymakers think about this transmission channel. Moreover, the inclusion of these monetary policy shocks weakens the short-term relationship between financial conditions and house prices at risk, indicating that part of this relationship was associated with changes in the short-term policy rate.

Capital inflows seem to increase downside risks to house prices in advanced economies. Capital inflows may contribute to systemic risk through a number of channels, including credit and asset price booms, larger foreign currency exposures and noncore bank funding, and increased interconnectedness (IMF 2017). Among their potential consequences for asset price booms, capital inflows have come under scrutiny for

potentially affecting house prices.³⁰ In this context, the analysis indicates that, in advanced economies, an increase in capital inflows raises the likelihood of high house price growth—upside risk captured by the 95th percentile—in the short term and downside risks to house prices in the medium term (two to three years ahead) (Figure 2.12, panel 5). An increase in capital inflows of 1 percent of GDP would raise upside risks by 1.5 percent one quarter ahead and downside risks by 0.5 percent eight quarters ahead. Among emerging market economies, the analysis reports no robustly significant relationship between capital inflows and downside or upside risks to house prices, although when opening by type of capital, there is some evidence that portfolio flows reduce and foreign direct investment increases downside risks to house prices at some horizons. The weaker relationship between overall capital inflows and downside risks among emerging markets is consistent with these housing markets being less globally integrated (see Chapter 3 of the April 2018 GFSR and Box 2.2). Finally, an in-depth analysis shows that, even among advanced economies, the consequences of various types of capital flows for downside risks to house prices vary across groups of countries, with a clearer relationship with those most highly financially integrated.³¹ This heterogeneity across types of flows and groups of countries indicates the convenience of assessing the relationship on a case-by-case basis when data are available. Boxes 2.2 and 2.3 include detailed analysis for Canada and the United States, and China, respectively.

The tightening of capital flow management measures might improve house prices at risk in advanced economies at some horizons. Financial stability concerns arising from capital inflows can be adequately addressed through macroprudential policies, such as those discussed in this section. Capital flow management measures, on the other hand, can support macroeconomic policy adjustment and financial stability in certain circumstances, such as during capital inflow surges, when other policy options are limited or timing is crucial (IMF 2017). Within this broad context, the relationship between capital flow management measures and downside risks to house prices may

²⁸Monetary policy shocks are identified by regressing a country’s short-term policy rate on a set of controls and using the residuals as the identified shocks. The set of controls includes contemporaneous and lagged values for inflation, log GDP, and log foreign GDP (to capture external risks), as well as lagged values of the short-term rate and a quadratic time trend.

²⁹A Taylor rule is a reduced-form approximation of the response of the central bank’s policy rate to changes in inflation, output, or other economic conditions.

³⁰Recent examples where foreign buyers have played a role in housing markets include Australia, Canada, Hong Kong Special Administrative Region, New Zealand, and the United Kingdom.

³¹Box 2.1 also shows that downside risks are more synchronized among more integrated economies.

provide additional information on their likely consequence along this specific dimension. Results show that, in advanced economies, a tightening of capital flow management measures seems to briefly increase downside risks to house prices in the very short term (one to three quarters ahead)—possibly because of reverse causality—and reduce downside risks (improve house prices at risk) between one and two years ahead by about 3 percent (annualized) in each quarter, with no significant effect at longer horizons (Figure 2.12, panel 6). While the overall indicator of capital flow management measures used does not distinguish those tightened for macroprudential reasons (so-called capital flow management/macroprudential measures), tightening of real estate inflow restrictions, which is more likely to be motivated by these considerations, is not significantly related to downside risks to house prices, although the lack of significance could reflect fewer instances of such restrictions.³²

Conclusion and Policy Recommendations

This chapter lays out a new methodology to estimate downside risk to house prices and finds it to be a useful early-warning indicator that can be used for financial stability surveillance. Using panel quantile regression techniques based on the growth-at-risk model of Adrian and others (2018), the chapter finds that house prices at risk—associated with the likelihood of large house price declines—reflect fundamental factors and overvaluation, as well as past price dynamics. The most recent data seem to point to an increase in downside risks to house prices over the next one to three years in some countries. This may be a cause for concern for financial stability and for the global macroeconomic outlook over the medium term. The latter concern is borne out by the fact that house prices at risk have a significant impact on growth at risk—a summary measure for financial stability used in Chapter 1 of this report and previous GFSRs. As such, the current analysis enhances the financial stability framework by adding downside risks to house prices to the financial stability monitoring toolkit. Policymakers can use or adapt the framework laid out in this chapter for surveillance of financial stability risks from the

³²There are only 12 episodes of tightening of real estate restrictions in the data. The analysis does not yield significant results for interactions between the level or tightening of restrictions and capital inflows.

housing sector. Episodes of increased synchronization of downside risks also appear to strengthen the case for international policy coordination to mitigate adverse spillovers from house price downside risks.

Some macroprudential policies appear to be effective in reducing house prices at risk. Although macroprudential policy focuses on building buffers and reducing vulnerabilities and should not target house prices, heightened downside risks to house prices signal a build-up of systemic risks and could complement other indicators for the activation of macroprudential policies, which appear to have a significant additional effect on house prices at risk. The effectiveness of macroprudential policy measures is also consistent with the small theoretical model laid out in the chapter. The relationship between macroprudential policy measures and house prices at risk is especially significant for so-called borrower-based measures, such as restrictions on loan-to-value and debt-service-to-income ratios, which is another reason countries should add these types of measures to their macroprudential policy toolkit and monitor their development over time. This is in line with a risk management approach to macroprudential policy, which should target some level of downside risk. However, it is important to make the distinction between targeting downside risks and targeting levels of asset prices, as the former can be directly influenced by building macroprudential buffers, while the latter are difficult to target. Moreover, macroprudential policymakers should be mindful of broader implications for systemic risk to avoid precipitating declines in house price levels when the economy and the housing market are in a fragile state.

The ability of monetary policy to mitigate downside risks to housing prices, beyond its relationship with financial conditions, seems more limited. Financial conditions, which are partly driven by monetary policy actions, have a clear relationship with downside risks to house prices. Beyond this indirect effect, conventional monetary policy shocks seem to have only a short-term influence in advanced economies, where an unexpected loosening reduces the house-prices-at-risk measure for a few quarters. Thus, in general, monetary policy would influence downside risks to house prices mainly through its impact on financial conditions—an issue that has been much discussed recently (see the April 2017 GFSR). That said, the short-term association documented in advanced economies may be a useful consideration in cases where the macroprudential toolkit

is incomplete or the macroprudential decision-making process is inadequate, especially given the association between house prices at risk and downside risks to GDP growth, a traditional objective of monetary policy.

Capital inflows seem to be associated with higher house prices in the short term and more downside risks to house prices in the medium term in advanced economies, which might justify capital flow management measures under some conditions. The aggregate analysis finds that a surge in capital inflows tends to increase downside risks to house prices in advanced economies, but the effects depend on the types of flows and may also be region- or city-specific. At the city level, case studies for Canada, China, and the United States find that flows of foreign direct investment are generally associated with lower future risks, whereas other capital inflows (largely corresponding to banking flows) or portfolio flows amplify downside risks to house prices in several cities or regions. Altogether, when nonresident buyers are a key risk for house prices, contribut-

ing to a systemic overvaluation that may subsequently result in higher downside risk, capital flow measures might help when other policy options are limited or timing is crucial. As in the case of macroprudential policies, these measures would not amount to targeting house prices but, instead, would be consistent with a risk management approach to policy. In any case, these conditions need to be assessed on a case-by-case basis, and any reduction in downside risks must be weighed against the direct and indirect benefits of free and unrestricted capital flows, including better smoothing of consumption, diversification of financial risks, and the development of the financial sector.³³

³³IMF (2012) notes that (1) capital flows should be handled primarily through macroeconomic policies, in turn supported by sound financial supervision and regulation and strong institutions; (2) in certain circumstances, capital flow measures can be useful to support macroeconomic adjustment and safeguard financial stability; and (3) capital flow measures should not substitute for warranted macroeconomic adjustment (see also Group of Twenty 2018).

Box 2.1. Synchronization of House Prices at Risk across Countries

This box examines whether and how downside risks of house prices move in tandem across countries; that is, whether there is significant cross-country synchronicity in house prices at risk. Results indicate sharp increases in the synchronization of downside risk across countries immediately before global recessions, especially among advanced economies. Differences in financial openness and in the use of capital controls targeting the real estate sector seem to affect the synchronization of downside risks to house prices.

Short-term cross-country comovement in downside risks to house prices increases sharply immediately before major recessions or financial crises among advanced economies. Panel 1 of Figure 2.1.1 depicts the instantaneous quasi-correlation (a measure of short-term comovement used in Chapter 3 of the April 2018 *Global Financial Stability Report*) of three-year-ahead house prices at risk among all countries. This synchronicity measure increases sharply before major economic downturns or financial crises. This may reflect common shocks affecting the tail risk of housing markets propagating across countries. The increase in short-term comovement before recessions is present only within advanced economies (Figure 2.1.1, panel 2).

Greater financial openness is associated with higher synchronization of downside risk. When countries are differentiated by the degree of de facto financial openness (as proxied by the stock of foreign assets plus foreign liabilities in percent of GDP) (Figure 2.1.1, panel 3), the short-term comovement of downside risks increases sharply around global recessions among open pairs—that is, when both countries are classified as having a high degree (above the median) of financial

openness. Closed pairs with a low degree of financial openness (below the median), in contrast, do not display significant short-term comovement.

Capital flow management measures related to real estate may help mitigate the synchronization of downside risk around major recessions and financial crises. International capital flows are sometimes criticized for spreading economic disturbances across countries or are cited as a channel through which foreign investors may speculate for excessive profits. In this regard, a large body of empirical research emphasizes the ineffectiveness and potential costs of capital controls.¹ However, a new strand of—mostly theoretical—research suggests that capital flow management measures may actually contribute to financial stability and sound macroeconomic management.² Panel 4 of Figure 2.1.1 indicates that the short-term comovement of downside risks around major recessions/crises is much lower among country pairs with restrictions in place than among country pairs without such restrictions on capital flows related to real estate.³ This suggests that well-targeted capital controls may mitigate the synchronicity of the downside risk of house prices during such extreme events.

¹See, for example, Prati, Schindler, and Valenzuela (2012); and Klein and Shambaugh (2015).

²See, for example, Farhi and Werning (2012); Jeanne (2012); and Korinek (2018).

³Fernández and others (2016) use the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions database to construct capital controls by inflows and outflows for 10 asset categories in 100 countries over the period 1995–2013. Here, three of their real estate measures are used: purchase abroad by residents, purchase locally by nonresidents, and sale locally by nonresidents.

The author of this box is Peichu Xie.

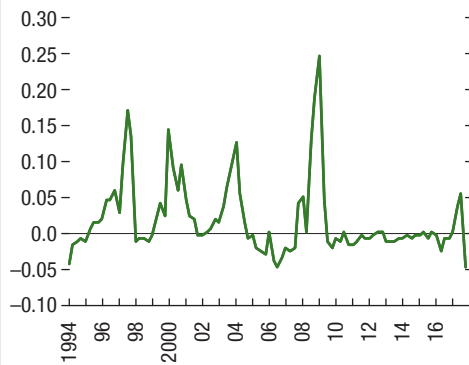
Box 2.1 (continued)

Figure 2.1.1. Instantaneous Quasi-Correlation of Downside Risks in House Prices
(Global median)

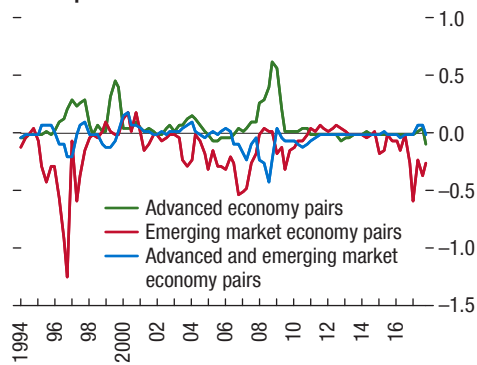
Short-term comovement of downside risks increases sharply around global recessions ...

... and mostly among advanced economies.

1. Synchronization of HaR at Global Level



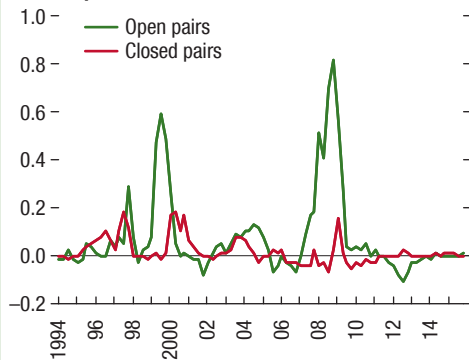
2. Synchronization of HaR within Different Country Groups



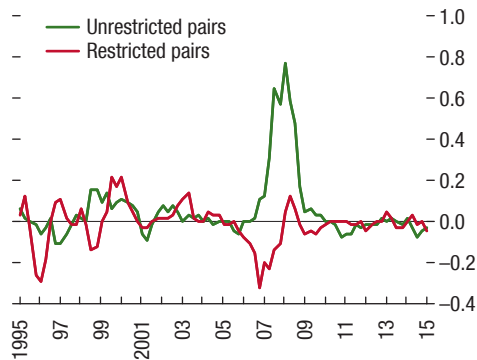
The degree of financial openness may partly contribute to this synchronization.

Capital flow management measures can help mitigate the synchronization of downside risks around recessions.

3. Synchronization of HaR by Level of Financial Openness



4. Synchronization of HaR by Level of Capital Flow Controls to Real Estate Sector



Source: IMF staff calculations.

Note: Panels 1 and 2 show the global median of the instantaneous quasi-correlation of downside risk of housing prices (HaR) within all countries and among different country groups. Panel 3 shows the global median of the instantaneous quasi-correlation of HaR within pairs with different levels of financial openness. Panel 4 shows the global median of the instantaneous quasi-correlation of HaR within pairs with different levels of strictness in capital controls over the real estate sector. In panel 3, open pairs are those in which foreign assets plus foreign liabilities/GDP for both countries in the pair are higher than the median in a given quarter; otherwise, they are grouped as closed pairs. In panel 4, restricted pairs are those in which both countries in the pair have stricter restrictions in capital flows related to the real estate sector than the average; otherwise, they are grouped as unrestricted pairs. The HaR measure and countries comprise 22 advanced economies and 10 emerging market economies (see Online Annex 2.2). HaR = house prices at risk.

Box 2.2. City-Level House Prices at Risk in the United States and Canada

This box applies the house-prices-at-risk concept to a number of cities in the United States and Canada, using quarterly data from 1980 to 2018. Downside risks to house prices in the United States appear to have fallen over the past decade while having increased over the past two years in Canada. Capital flows are significantly associated with downside risks to key residential housing markets, but the net effect depends on the types of flows and cities.

Across US and Canadian cities, downside risks to house prices have changed substantially over time, with US housing markets generally being riskier. Over the past four decades, downside risks¹ across US cities show larger swings on average than in Canada, suggesting that US housing markets are more susceptible to abrupt booms and busts (Figure 2.2.1, panels 1 and 2). Nonetheless, in Canada, there is considerable dispersion in downside risks to house prices in several cities, as reflected by the volatility of the lower bound (5th percentile). Over the past two years, however, overall Canadian downside risks have deteriorated, approaching levels seen around the global financial crisis.

Among other factors, city-level overvaluation, proxied by the house-price-to-income ratio, is associated with a deterioration in one-year-ahead house prices at risk (Figures 2.2.1, panels 3 and 4). Housing markets in such US cities as Miami, Tampa, and Phoenix seemed particularly overvalued before the global financial crisis, which made them more prone to large declines. In 2018, US house prices seemed less overvalued, judging from the price-to-income ratio, which would make a potential bust of the housing market much more contained than in 2008. In contrast, the housing market in Canada headed in the opposite direction, especially in such cities as Hamilton, Toronto, and Vancouver, where valuations look overstretched, much as in 2008. At the same time, tail risks to Canadian house prices have generally increased, reflecting tighter financial conditions,

overvaluation, and different types of capital flows (see discussion that follows).

The dynamics of housing markets in global cities are partially driven by capital flows, which seem to both amplify and mitigate downside risks to house prices across US and Canadian cities (Figure 2.2.1, panels 5 and 6).² More specifically, sensitivity to capital flows seems to differ for inflows of foreign direct investment and other types of investment:

- Foreign direct investment, which is typically long-term investment, is generally associated with less future risk to several US and Canadian housing markets (Figure 2.2.1, panels 5 and 6). For example, a 1 percentage point increase in foreign direct investment inflows to the United States is significantly associated with a reduction of about 1–2 percentage points in house prices at risk in US tech-friendly cities such as San Francisco, Seattle, and Portland, Oregon.
- Other capital inflows (that is, not foreign direct investment or portfolio flows), which are generally attributed to foreign bank transactions, are found to amplify downside risks to house prices in such cities as Las Vegas, Miami, Los Angeles, Toronto, Vancouver, and Calgary. In Canada, the effects are most pronounced for the major cities in Alberta, a province sensitive to oil price fluctuations and where real house prices almost tripled over the past four decades but have recently seen a correction.

Against this backdrop, capital flow management measures could alleviate house price downside risks. For instance, additional property taxes on foreign home buyers were recently introduced in Vancouver and Toronto. Given that downside risks to house prices in several cities are sensitive to capital inflows other than foreign direct investment or portfolio flows, measures targeted at these regional inflows might alleviate overvaluation pressure in these housing markets and reduce downside risks, but the heterogeneity of the city-level effects also suggests that their broader impact may be limited.

The authors of this box are Adrian Alter and Elizabeth Mahoney.

¹Downside risks are defined as the 5 percent value at risk for a one-year-ahead horizon (see Online Annex 2.2 for details).

²Recent studies have found compelling evidence that housing markets in global cities such as London and New York may be affected by foreign capital (Sá and Wieladek 2015; Badarizna and Ramadorai 2018; Sá 2016).

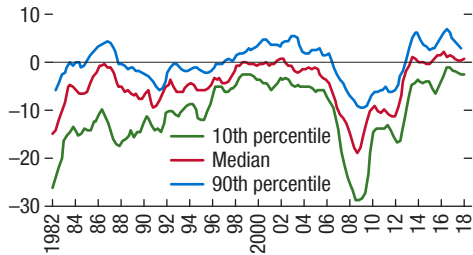
Box 2.2 (continued)

Figure 2.2.1. Downside Risks to House Prices in the United States and Canada

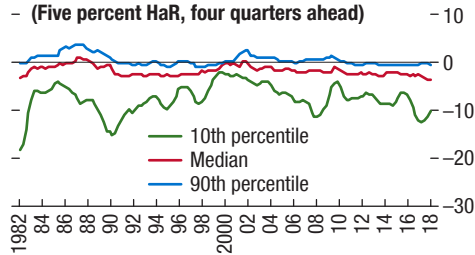
Housing downside risks across US cities are more volatile, with a large drop around the GFC.

On average, cycles of downside risks across Canadian cities are relatively stable.

1. Downside Risks to House Prices across US Cities (Five percent HaR, four quarters ahead)



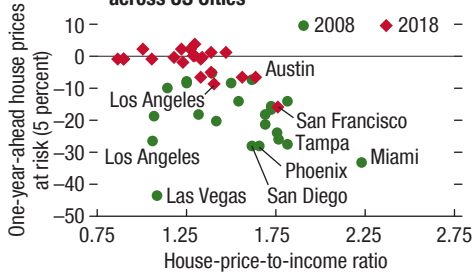
2. Downside Risks to House Prices across Canadian Cities (Five percent HaR, four quarters ahead)



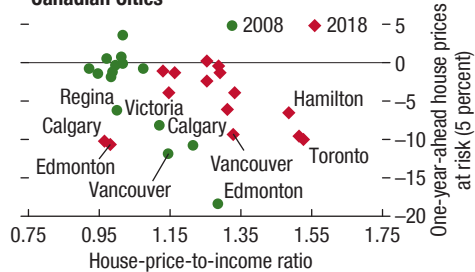
Valuations came down for most US cities in 2018 compared with 2008, partially mitigating tail risks.

Amid stretched valuations, several Canadian cities were particularly vulnerable to downside risks in 2018.

3. House Prices at Risk and Valuations across US Cities



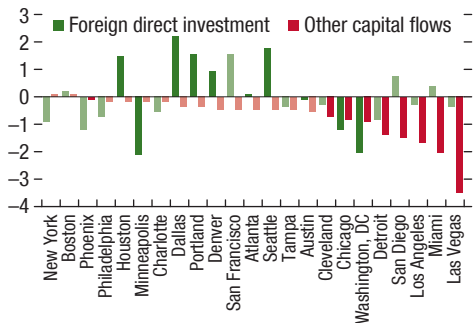
4. House Prices at Risk and Valuations across Canadian Cities



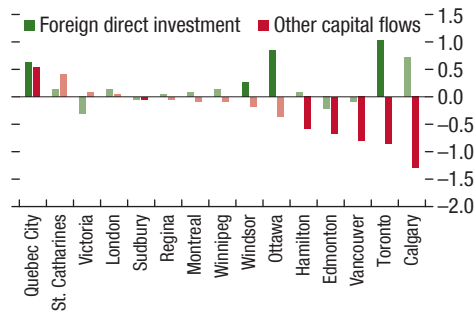
FDI inflows have a positive role in mitigating risk ...

... whereas other capital inflows are a negative driver.

5. Capital Flows as Drivers of HaR in the United States (Selected American cities; coefficients: 10th percentile; HaR four quarters ahead)



6. Capital Flows as Drivers of HaR in Canada (Selected Canadian cities; coefficients: 10th percentile; HaR four quarters ahead)



Source: IMF staff calculations.

Note: Panels 1 and 2 show the 10th and 90th percentiles of the cross-sectional city distribution in each period. In panels 3 and 4, one-year-ahead estimates of 5 percent HaR refer to 2019:Q1 and 2009:Q1, respectively. City-level house-price-to-income ratios refer to 2008 and 2018, respectively. Other capital flows refers to capital flows other than foreign direct investment or portfolio capital flows. Dark green and red bars refer to coefficients significant at the 10 percent level. FDI = foreign direct investment; GFC = global financial crisis; HaR = house prices at risk.

Box 2.3. Province-Level House Prices at Risk in China

This box estimates house prices at risk for 31 provinces and municipalities in China and finds that both country-wide macro-financial conditions and province-specific developments matter. The most recent data show slightly worsening downside risks to house prices since late 2015 as a result of overvaluation and tightening financial conditions.

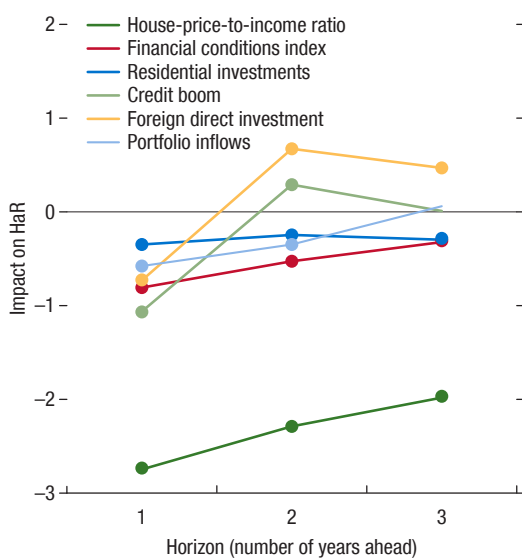
China has experienced rapid growth in housing investment and house prices over the past two decades. Real estate investment grew from about 4 percent of GDP in 1997 to 13 percent in 2018 (with a peak of 15 percent of GDP in 2014). Residential investment

The authors of this box are Sohaib Shahid and Peichu Xie, with assistance from Janice Yi Xue.

accounts for more than two-thirds of total real estate investment. Bank lending to the real estate sector, through mortgages and loans to property developers, accounts for 25 percent of total bank loans and about half of all new loans in 2016.

Large downside risks to house prices may adversely affect economic and financial stability in China. Based on quarterly provincial data from 2005 to 2017, panel quantile regressions confirm that China’s provincial downside housing risks and global house prices at risk are related to the same factors (Figure 2.3.1). Across all provinces, a deterioration in house prices at risk is associated with credit booms, tighter financial conditions, increases in provincial price-to-income and in residential-investment-to-GDP ratios; the latter reflects an expansion in the supply of housing. Foreign direct

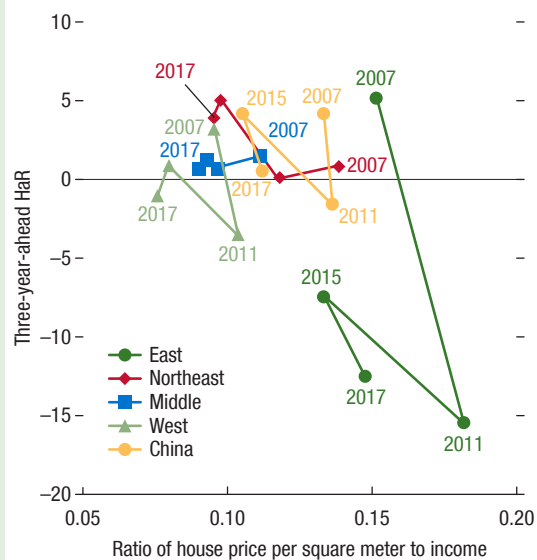
Figure 2.3.1. Impact of a One Standard Deviation Factor Shock on House Prices at Risk across China’s Provinces



Sources: Haver Analytics; IMF, World Economic Outlook database; and IMF staff calculations.

Note: House-prices-at-risk determinants include province-level house price growth, price-to-income ratio, real GDP growth, credit boom, financial conditions index, foreign direct investment, and portfolio investments. Colored circles = significant at 10 percent level. HaR = house prices at risk.

Figure 2.3.2. Three-Year-Ahead House Prices at Risk and Valuation across Regions in China (Median HaR, in percent and price-per-square-meter-to-income ratio)



Sources: Haver Analytics; and IMF staff calculations.

Note: HaR = house prices at risk.

Box 2.3 (continued)

investment has an overall positive effect on house prices at risk, while portfolio flows are associated with increased downside risks.¹

Over the past decade, China has undergone frequent house price cycles, and provincial house prices at risk seem to have an important early-warning dimension. Three-year-ahead house prices at risk reached all-time lows in 2011 with the rapid pace of increases in property prices, which had led to high

¹Similar to the US and Canadian city-level house price analysis (Box 2.2), the effect of capital inflows varies by type and region: when panel quantile regressions are estimated by region, foreign direct investment—driven by long-term commitments—is associated with less downside risk from the second year onward, especially for the East and Northeast. Portfolio investment—reflecting more speculative sentiment—is associated with significantly higher downside risks to house prices in the short term for all regions, except the Northeast.

price-to-income valuation ratios, especially in eastern provinces. Since 2015, house prices at risk started to deteriorate again after an easing cycle ended, pointing to renewed downside risks.² That said, loosening financial conditions and lower price-to-income ratios cushioned some of the deterioration of house prices at risk until 2015 (Figure 2.3.2). Nevertheless, large regional differences in downside risks to house prices are apparent, likely reflecting the fragmented housing market and policies across regions. This may justify targeted policies from a regional risk management perspective, including long-term, structural policies, such as household registration reforms and social security (Ding and others 2017).

²Easing and tightening periods are identified from year-over-year growth of sales, prices, and inventory momentum, following Ding and others (2017).

References

- Adrian, Tobias, Nina Boyarchenko, and Domenico Giannone. Forthcoming. “Vulnerable Growth.” *American Economic Review*.
- Adrian, Tobias, Federico Grinberg, Nellie Liang, and Sheheryar Malik. 2018. “The Term Structure of Growth-at-Risk.” IMF Working Paper 18/180, International Monetary Fund, Washington, DC.
- Adrian, Tobias, Dong He, Fabio Natalucci, and Nellie Liang. Forthcoming. “Macrofinancial Linkages and Global Financial Stability.” IMF mimeo, International Monetary Fund, Washington, DC.
- Agnello, Luca, and Ludger Schuknecht. 2011. “Booms and Busts in Housing Markets: Determinants and Implications.” *Journal of Housing Economics* 20 (3): 171–90.
- Alam, Zohair, Adrian Alter, Jesse Eiseman, Gaston Gelos, Heedon Kang, Machiko Narita, Erlend Nier, and Naixi Wang. Forthcoming. “Digging Deeper—Evidence on the Effects of Macroprudential Policies from a New Database.” IMF Working Paper, International Monetary Fund, Washington, DC.
- Algieri, Bernardina. 2013. “House Price Determinants: Fundamentals and Underlying Factors.” *Comparative Economic Studies* 55 (2, June): 315–41.
- Alter, Adrian, Alan Xiaochen Feng, and Nico Valckx. 2018. “Understanding the Macro-Financial Effects of Household Debt: A Global Perspective.” IMF Working Paper 18/76, International Monetary Fund, Washington, DC.
- Amaglobeli, David, Valerio Crispolti, Era Dabla-Norris, Pooja Karnane, and Florian Misch. 2018. “Tax Policy Measures in Advanced and Emerging Economies: A Novel Database.” IMF Working Paper 18/110, International Monetary Fund, Washington, DC.
- Aron, Janini, John V. Duca, John Muellbauer, Keiko Murata, and Anthony Murphy. 2012. “Credit, Housing Collateral, and Consumption: Evidence from Japan, the U.K., and the U.S.” *Review of Income and Wealth* 58 (3, September): 397–423.
- Badarınza, Christian, and Tarun Ramadorai. 2018. “Home Away from Home? Foreign Demand and London House Prices.” *Journal of Financial Economics* 130 (3): 532–55.
- Banerjee, Ryan N., and Kristian S. Blichke. 2018. “Financial Frictions, Real Estate Collateral, and Small Firm Activity in Europe.” Staff Report 868, Federal Reserve Bank of New York, October.
- Bernanke, Ben, Mark Gertler, and Simon Gilchrist. 1996. “The Financial Accelerator and the Flight to Quality.” *Review of Economics and Statistics* 78 (1, February): 1–15.
- Black, Angela, Patricia Fraser, and Martin Hoesli. 2006. “House Prices, Fundamentals and Bubbles.” *Journal of Business, Finance and Accounting* 33 (9–10, November/December): 1535–55.
- Burnside, Craig, Martin Eichenbaum, and Sergio Rebelo. 2016. “Understanding Booms and Busts in Housing Markets.” *Journal of Political Economy* 124 (4): 1088–147.
- Capozza, Dennis R., Patric H. Hendershott, Charlotte Mack, and Christopher J. Mayer. 2002. “Determinants of Real House Price Dynamics.” NBER Working Paper 9262, National Bureau of Economic Research, Cambridge, MA.
- Cerutti, Eugenio, Ricardo Correa, Elisabetta Fiorentino, and Esther Segalla. 2017. “Changes in Prudential Policy Instruments—A New Cross-Country Database.” *International Journal of Central Banking* 13 (1): 477–503.
- Cerutti, Eugenio, Jihad Dagher, and Giovanni Dell’Ariccia. 2015. “Housing Finance and Real-Estate Booms: A Cross-Country Perspective.” IMF Staff Discussion Note 15/12, International Monetary Fund, Washington, DC.
- Cesa-Bianchi, Ambrogio, Andrea Ferrero, and Alessandro Rebucci. 2018. “International Credit Supply Shocks.” *Journal of International Economics* 112 (May): 219–37.
- Choi, Seung M., Laura E. Kodres, and Jing Lu. 2018. “Friend or Foe: Cross-Border Linkages, Contagious Banking Crises, and Coordinated Macroprudential Policies.” IMF Working Paper 18/09, International Monetary Fund, Washington, DC.
- Claessens, Stijn, Ayhan Kose, and Marco E. Terrones. 2012. “How Do Business and Financial Cycles Interact?” *Journal of International Economics* 87 (1, May): 178–90.
- Cushman and Wakefield. 2017. “Winning in Growth Cities.” December 19. <https://cushmanwakefield.turtl.co/story/59d48cf5d1c76a6148cabb4f>.
- Ding, Ding, Xiaoyu Huang, Tao Jin, and W. Raphael Lam. 2017. “Assessing China’s Residential Real Estate Market.” IMF Working Paper 17/248, International Monetary Fund, Washington DC.
- Dokko, Jane, Brian Doyle, Michael T. Kiley, Jinill Kim, Shane Sherlund, Jae Sim, and Skander Van den Heuvel. 2011. “Monetary Policy and the Global Housing Bubble.” *Economic Policy* 26 (66): 237–87.
- Duca, John V., John Muellbauer, and Anthony Murphy. 2011. “House Prices and Credit Constraints: Making Sense of the U.S. Experience.” *Economic Journal* 121 (552): 533–51.
- Farhi, Emmanuel, and Ivan Werning. 2012. “Dealing with the Trilemma: Optimal Capital Controls with Fixed Exchange Rates.” NBER Working Paper 18199, National Bureau of Economic Research, Cambridge, MA.
- Favara, Giovanni, and Jean Imbs. 2015. “Credit Supply and the Price of Housing.” *American Economic Review* 105 (3, March): 958–92.
- Favilukis, Jack, Sydney C. Ludvigson, and Stijn Van Nieuwerburgh. 2017. “The Macroeconomic Effects of Housing Wealth, Housing Finance, and Limited Risk Sharing in General Equilibrium.” *Journal of Political Economy* 125 (1): 140–223.
- Fernández, Andrés, Michael W. Klein, Alessandro Rebucci, Martin Schindler, and Martín Uribe. 2016. “Capital Control Measures: A New Dataset.” *IMF Economic Review* 64 (3, August): 548–74.
- Fuster, Andreas, David Laibson, and Brock Mendel. 2010. “Natural Expectations and Macroeconomic Fluctuations.” *Journal of Economic Perspectives* 24 (4, Fall): 67–84.

- Gattini, Luca, and Paul Hiebert. 2010. "Forecasting and Assessing Euro Area House Prices through the Lens of Key Fundamentals." Working Paper 1249, European Central Bank, Frankfurt, September.
- Girouard, Nathalie, Mike Kennedy, Paul Van Den Noord, and Christophe André. 2006. "Recent House Price Developments: The Role of Fundamentals." OECD Working Paper/475, Organisation for Economic Co-operation and Development, Paris.
- Granziera, Eleonora, and Sharon Kozicki. 2015. "House Price Dynamics: Fundamentals and Expectations." *Journal of Economic Dynamics and Control* 60 (November): 152–65.
- Group of Twenty. 2018. "The IMF's Institutional View on Capital Flows in Practice." Prepared by the staff of the International Monetary Fund, Washington, DC.
- Himmelberg, Charles, Christopher Mayer, and Todd Sinai. 2005. "Assessing High House Prices: Bubbles, Fundamentals and Misperceptions." *Journal of Economic Perspectives* 19 (4): 67–92.
- Hirata, Hideaki, M. Ayhan Kose, Christopher Otrok, and Marco E. Terrones. 2012. "Global House Price Fluctuations: Synchronization and Determinants." NBER Working Paper 18362, National Bureau of Economic Research, Cambridge, MA.
- International Monetary Fund (IMF). 2008. "Housing and the Business Cycle." *World Economic Outlook Update*, Washington, DC, April.
- . 2012. "The Liberalization and Management of Capital Flows—An Institutional View." Washington, DC, November.
- . 2017. "Increasing Resilience to Large and Volatile Capital Flows: The Role of Macroprudential Policies." IMF Policy Paper, Washington, DC.
- Jeanne, Olivier. 2012. "Capital Flow Management." *American Economic Review* 102 (3): 203–06.
- Kaplan, Greg, Kurt Mitman, and Giovanni L. Violante. 2017. "The Housing Boom and Bust: Model Meets Evidence." NBER Working Paper 23694, National Bureau of Economic Research, Cambridge, MA.
- Kara, Gazi, and Cindy M. Vojtech. 2017. "Bank Failures, Capital Buffers, and Exposure to the Housing Market Bubble." FEDS (Finance and Economics Discussion Series) Working Paper 2017–115, Board of Governors of the Federal Reserve System, Washington, DC.
- Kholodilin, Konstantin, Claus Michelsen, and Dirk Ulbricht. 2017. "Speculative Price Bubbles in Urban Housing Markets in Germany." DIW Berlin Discussion Paper 1417, forthcoming in *Empirical Economics*.
- Klein, Michael W., and Jay C. Shambaugh. 2015. "Rounding the Corners of the Policy Trilemma: Sources of Monetary Policy Autonomy." *American Economic Journal: Macroeconomics* 7 (4): 33–66.
- Korinek, Anton. 2018. "Regulating Capital Flows to Emerging Markets: An Externality View." *Journal of International Economics* 111: 61–80.
- Kuttner, Kenneth N., and Ilhyock Shim. 2016. "Can Non-Interest Rate Policies Stabilize Housing Markets? Evidence from a Panel of 57 Economies." *Journal of Financial Stability* 26: 31–44.
- Laeven, Luc, and Fabian Valencia. 2018. "Systemic Banking Crises Revisited." IMF Working Paper 18/206, International Monetary Fund, Washington, DC.
- Mian, Atif, and Amir Sufi. 2016. "Who Bears the Cost of Recessions? The Role of House Prices and Household Debt." Chapter 5 in *Handbook of Macroeconomics*, edited by John B. Taylor and Harald Uhlig. Amsterdam: Elsevier.
- Muellbauer, John, and Anthony Murphy. 2012. "Booms and Busts in the UK Housing Market." *Economic Journal* 107 (445, November): 1701–27.
- Paciorek, Andrew. 2013. "Supply Constraints and Housing Market Dynamics." *Journal of Urban Economics* 77 (September): 11–26.
- Poterba, James M. 1984. "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach." *Quarterly Journal of Economics* 99 (4): 729–52.
- Prati, Alessandro, Martin Schindler, and Patricio Valenzuela. 2012. "Who Benefits from Capital Account Liberalization? Evidence from Firm-Level Credit Ratings Data." *Journal of International Money and Finance* 31 (6): 1649–73.
- Rossi, Barbara, and Tatevik Sekhposyan. 2017. "Macroeconomic Uncertainty Indices for the Euro Area and Its Individual Member Countries." *Empirical Economics* 53 (1, August): 41–62.
- Sá, Filipa. 2016. "The Effect of Foreign Investors on Local Housing Markets: Evidence from the UK." Discussion Paper 11658, Centre for Macroeconomics, London.
- , and Tomasz Wieladek. 2015. "Capital Inflows and the US Housing Boom." *Journal of Money, Credit and Banking* 47 (S1): 221–56.
- Saiz, Albert. 2010. "The Geographic Determinants of Housing Supply." *Quarterly Journal of Economics* 125 (3): 1253–96.
- Schmalz, Martin C., David A. Sraer, and David Thesmar. 2016. "Housing Collateral and Entrepreneurship." *Journal of Finance* 72 (1, February): 99–132.
- Shiller, Robert J. 2007. "Understanding Recent Trends in House Prices and Home Ownership." NBER Working Paper 13553, National Bureau of Economic Research, Cambridge, MA.
- . 2013. *Irrational Exuberance: Revised and Expanded Third Edition*. Princeton, NJ: Princeton University Press.

