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How to Deal with Real Estate Booms: Lessons from Country Experiences

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Abstract

The financial crisis showed, once again, that neglecting real estate booms can have
disastrous consequences. In this paper, we spell out the circumstances under which a more
active policy agenda on this front would be justified. Then, we offer tentative insights on
the pros and cons as well as implementation challenges of various policy tools that can be
used to contain the damage to the financial system and the economy from real estate
boom-bust episodes.

CONTENTS

I. INTRODUCTION

Real estate booms and busts can have far-reaching consequences. These booms are generally accompanied by fast credit growth and sharp increases in leverage, and when the bust comes, debt overhang and deleveraging spirals can threaten financial and macroeconomic stability. These dangers notwithstanding, the traditional policy approach to real estate booms has been one of "benign neglect". This was based on two main premises. First, the belief that, as for other asset prices, it is extremely difficult to identify unsustainable real estate booms, or "bubbles" (sharp price increases not justified by fundamentals), in a timely manner. Second, the notion that the distortions associated with preventing a boom outweigh the costs of cleaning up after a bust. The recent crisis has challenged (at least the second of) these assumptions.

The bursting of the real estate bubble in the U.S. led to the deepest recession since the Great Depression, and quickly spread to other countries; in particular those with their own home-grown bubbles. Traditional macroeconomic policy rapidly reached its limits, as monetary policy rates approached the zero bound and sustainability concerns emerged on the fiscal front. Despite the recourse to less standard policy tools (ranging from bank recapitalization to asset purchase programs and quantitative easing), the aftermath of the crisis has been characterized by a weak recovery, as debt overhang and financial sector weakness continue to hamper economic growth. It remains true that bubbles are difficult to identify with certainty. But this task can be made easier by narrowing the focus to episodes involving sharp increases in credit and leverage, which are, after all, the true source of vulnerabilities. While early intervention may engender its own distortions, it may be best to undertake policy actions on the basis of a judgment call (as with inflation) if there is a real risk that inaction could result in catastrophe.

Yet, a call for a more preventive policy action raises more questions than it provides answers. What kind of indicators should trigger policy intervention to stop or slow down a real estate boom? Even assuming policymakers were fairly certain that intervention were warranted, what would be the policy tools at their disposal? What are their impacts? What are their negative side effects and limitations? What practical issues (including political economy considerations) would limit their use? This paper explores these questions.

The paper opens with a summary of how real estate boom-bust cycles may threaten financial and macroeconomic stability. Then, it discusses different policy options to reduce the risks associated with real estate booms, drawing upon several country experiences and the insights from an analytical model. The paper concludes with a brief discussion of guiding principles in using public policy measures to deal with real estate booms and busts.

II. THE CASE FOR POLICY ACTION ON REAL ESTATE BOOMS

Before the crisis, the main policy tenet in dealing with an asset-price boom was that it was better to wait for the bust and pick up the pieces than to attempt to contain/prevent the boom altogether. Given this prescription, the characteristics of a particular asset class (such as, for example, how purchases are financed and what agents are involved, or whether the asset has consumption value besides investment value) were secondary details. Yet, if the

effectiveness of post-bust policy intervention is limited and the costs are large, these details are critical to determine whether it is worth attempting to contain a boom before it reaches dangerous proportions. From this standpoint, several frictions and externalities make the case for early policy intervention in real estate market booms stronger than for booms in other asset classes.

Leverage and the link to crises

From a macroeconomic stability perspective, what matters may be not the boom in itself, but how it is funded. Busts tend to be more costly when booms are financed through credit and leveraged institutions are directly involved. This is because the balance sheets of borrowers (and lenders) deteriorate sharply when asset prices fall.[2] When banks are involved, this often leads to a reduced supply of credit with negative consequences for real economic activity. In contrast, booms with limited leverage and bank involvement tend to deflate without major economic disruptions. For example, the burst of the dot-com bubble was followed by a relatively mild recession, reflecting the minor role played by leverage and bank credit in funding the boom.

Real estate markets are special along both these dimensions. The vast majority of home purchases and commercial real estate transactions in advanced economies involve borrowing. And banks and other levered players are actively involved in the financing. Moreover, homebuyers are allowed leverage ratios orders of magnitude higher than for any other investment activity. A typical mortgage loan carries a loan-to-value ratio of 71 percent on average across a global sample of countries. In contrast, stock market participation by individuals hardly ever relies on borrowed funds. When it does, loans are subject to margin calls that prevent the buildup of highly leveraged positions. As a comparison, in the U.S., the ratio of mortgage loans to real estate assets held by the household sector hovered around 45 percent during the 2000s while the ratio of security credit to holdings of corporate equity was less than 5 percent.

During the current crisis, highly-levered housing markets had a prominent role. In particular, the decline in U.S. house prices was at the root of the distress in the market for mortgage-backed securities. When house prices started to fall below the nominal value of loans, both speculative buyers and owner-occupiers that were unwilling or unable to repay their mortgages could not roll them over or sell their properties and started to default (Mayer et al., 2008). As uncertainty about the quality of the underlying loans increased, the value of mortgage-backed securities began to decline. Investors holding these securities and their issuers, both often highly leveraged themselves, found it increasingly difficult to obtain financing and some were forced to leave the market. This, in turn, decreased the available funds for mortgage financing, starting a spiral. The role of the boom and associated leverage

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[2]As illustrated in models in the tradition of Kiyotaki and Moore (1997), the collateral role of property magnifies the swings as real estate cycles become highly correlated with credit cycles. A potentially destabilizing two-way amplification process develops between rising house prices and credit boom during the upswing, and declining prices and a credit crunch during the downturn.

in explaining defaults is evident in Figure 1 that plots the increase in delinquency rates against house price appreciation during the boom years for different U.S. regions and also shows the leverage of households. While the size of the house price boom and level of leverage at the end of the boom are correlated, note that the increase in mortgage delinquency rates was more pronounced in regions with higher leverage for similar boom sizes. Further, commercial banks' exposure to real estate grew rapidly in the 2000s, reaching 54 percent, almost double the steady level hovering around 30 percent observed from 1960 to 1985 (Igan and Pinheiro, 2010). Higher exposure to real estate in a bank's balance sheet, in turn, is often associated with higher sensitivity of bank stock returns to real estate market developments (Allen et al., 2009) and with greater reduction in lending when the real estate market collapses (Gan, 2007).

This pattern is not limited to the U.S. nor is new to this crisis. The amplitude of house price upturns prior to 2007 is statistically associated with the severity of the crisis impact across countries (Figure 2).[3] Put differently, the U.S. market may have been the initial trigger, but the countries that experienced the most severe downturns were those with real estate booms of their own. Historically, many major banking distress episodes were associated with boom-bust cycles in property prices (Figure 3). For example, of the 46 systemic banking crises for which house price data are available more than two thirds were preceded by boom-bust patterns in house prices. Similarly, 35 out of 51 boom-bust episodes were followed by a crisis. By contrast, only about half the crises follow a boom-bust in stock prices and only about 15 percent of stock market boom-busts precede systemic banking crises (virtually all of these cases coincide with a real estate boom-bust).[4]

A distinguishing feature of "bad" real estate boom-bust episodes is the coincidence between the boom and the rapid increase in leverage and exposure of households and financial intermediaries. In the most recent episode, these coincided in more than half of the countries in a 40-country sample (Text Table 1). Almost

Text Table 1. Booms, Crises, Macroeconomic Performance

Boom	followed by financial crisis	followed by poor performance	followed by financial crisis *or* poor performance	followed by financial crisis *and* poor performance	Number of countries
Real estate	53%	77%	87%	43%	30
Credit	67%	78%	93%	52%	27
Real estate but not credit	29%	71%	71%	29%	7
Credit but not real estate	100%	75%	100%	75%	4
Both	61%	78%	91%	48%	23
Neither	27%	18%	45%	0%	11

Notes: The sample consists of 40 countries. The numbers, except in the last column, show the percent of the cases in which a crisis or poor macroeconomic performance happened after a boom was observed (out of the total number of cases where the boom occurred). The last column shows the number of countries in which a boom occurred. A real estate boom exists if the annual real house price appreciation rate during 2000-2006 is above the ad-hoc threshold of 1.5 percent or the annual real house price appreciation rate in the upward phase of the housing cycle prior to the crisis exceeds the country-specific historical annual appreciation rate. A credit boom exists if the growth rate of bank credit to the private sector in percent of GDP is more than the arbitrary cut-off of 20 percent or it exceeds the rate implied by a country-specific, backward-looking, cubic time trend by more than one standard deviation. A financial crisis is a systemic banking crisis as identified in Laeven and Valencia (2010). Poor performance is defined as more than 1 percentage point decline in the real GDP growth rate in 2008-09 compared to the 2003-07 average.

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[3] Claessens et al. (2010).

[4] See, for instance, Herring and Wachter (2000) and Reinhart and Rogoff (2008) for more on the link between real estate booms and banking busts.

all the countries with "twin booms" in real estate and credit markets (21 out of 23) ended up suffering from either a financial crisis or a severe drop in GDP growth rate relative to the country's performance in the 2003-07 period. Eleven of these countries actually suffered from both damage to the financial sector and sharp drop in economic activity. In contrast, of the seven countries that experienced a real estate boom, but not a credit boom, only two went through a systemic crisis and these countries, on average, had relatively mild recessions.

Wealth and supply-side effects

Real estate is an important, if not the most important, storage of wealth in the economy. For instance, in the U.S., real estate constitutes roughly a third of total assets held by the non-financial private sector. Additionally, the majority of households tend to hold wealth in their homes rather than in equities: only half of American households own stock (directly or indirectly) while homeownership rate hovers around 65 percent. This comparison is not specific to the U.S. and actually is more striking in some European economies, e.g., 23 percent of French households hold stocks but 56 percent are homeowners and the respective ratios in the U.K. are 34 and 71 percent (see, for instance, Guiso et al., 2003). Therefore, for a shock of similar magnitude, the wealth effect of changes in house prices is much larger than those in other asset prices (Case et al., 2005).[5]

In addition, the supply-side effects associated with house price dynamics can be substantial. The construction sector, a significant contributor to value added, takes property prices as a signal and adjusts production accordingly. As a result, the interaction between real estate boom-busts and economic activity is not limited to financial crises, but extends to "normal times". In most advanced economies, house price cycles tend to lead credit and business cycles (Igan et al., 2009). This suggests that fluctuations in house prices create ripples in the economy through their impact on residential investment, consumption, and credit while the reverse effect is not as prominent, implying that the housing sector is a *source* of shocks. In the U.S., a sharp decline in the abnormal contribution of residential investment to growth is a good predictor of recessions (Leamer, 2007). More generally, in advanced economies, recessions that coincide with a house price bust tend to be deeper and last longer than those that do not. Cumulative loss in GDP during recessions associated with housing busts is three times the damage done

Text Table 2. Recessions with and without House Price Busts

	without bust	with bust	with severe bust
Duration	3.2	4.5 **	4.6 **
Amplitude	-2.0	-3.2 *	-4.1 **
Cumulative loss	-3.5	-10.4 **	-14.0 *

Source: Reproduced from Table 8 in Claessens, Kose, Terrones (2008).
Notes: The sample includes 21 OECD countries. Mean values are shown. Duration is expressed in quarters. Severe busts are those that are in the top half of all house price bust episodes. * and ** indicate that the difference between means of recessions with house price busts and recessions without house price busts is significant at the 10 percent and 5 percent levels, respectively.

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[5] Stock markets are typically susceptible to larger fluctuations; therefore, one could expect the wealth loss associated with stock market busts to be bigger in absolute terms. For instance, during the dot-com bust, the value of American households' equity holdings declined by 44 percent or US$5.4 trillion. The real estate bust that started at the end of 2006 has *so far* brought about a 15 percent decline in the value of real estate assets held by households, wiping out US$3.7 trillion off their wealth. Interestingly, however, the total wealth lost during the real estate bust, standing at US$10 trillion or 13 percent of end-2006 total household assets, exceeds that lost during the dot-com bust, which reached US$2.8 trillion or 6 percent of end-2000 total assets, because of the spillover to other asset markets from the housing downturn.

during recessions without busts (Text Table 2). Again, by contrast, recessions that occur around equity price busts are *not* significantly more severe or persistent than those that do not (Claessens et al., 2008).

Illiquidity, opacity, and network effects

Boom-bust cycles are an intrinsic feature of real estate markets given the delay in supply response to demand shocks and the slow pace of price discovery due to opaque and infrequent trades as well as illiquidity owing to high transaction costs and the virtual impossibility of short sales.[6] These features frequently lead to deviations from equilibrium. In other words, even in the absence of distortions introduced by institutional features of real estate finance systems and policy actions, real estate prices and construction activity can be expected to display large swings over long periods (Ball and Wood, 1999; Igan and Loungani, 2010).[7]

Network externalities also complicate the picture. Homeowners in financial distress (and in particular in negative equity) have diminished incentives to maintain their properties and do not internalize the effects of this behavior on their neighbors. Similarly, foreclosures (and the associated empty houses) tend to diminish the value of neighboring properties beyond their effect through fire sales. These dynamics highlight the indivisibility (because of which distressed sales weigh heavily on prices as sellers cannot put only a portion of their property on the market) and the double role of real estate as investment and consumption good. These characteristics may also impose constraints on the economy's adjustment mechanisms: households with negative equity in their homes may be reluctant or unable to sell and take advantage of job opportunities elsewhere, reducing mobility and increasing structural unemployment. The preferential tax treatment of homeownership exacerbates this problem, by creating a wedge between the cost of owning and renting, and hence, inducing the loss of this tax shelter when an owner becomes a renter. Indeed, U.S. regions where house prices have declined more, pushing an increasing number of households into negative-equity territory, experienced sharper declines in the mobility rate (defined as the portion of households that move from the region to another region). This relationship survives when changes in the mobility rate are regressed on changes in employment and house prices and their interaction.[8] Hence, a housing bust may weaken the positive association between

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[6] The slope of the supply curve is particularly relevant for the characteristics (such as frequency and magnitude) of boom-bust cycles and how these cycles affect the rest of the economy. If the supply curve is flat, effect of a demand shock on prices is small and the spillovers to aggregate activity occur mainly through the increase in quantities, e.g. construction value added, limiting the spillovers through leverage (which could threaten financial stability). If the supply curve is steep, prices move more and, while direct impact on economic activity may be limited, leverage would amplify spillovers with implications for both macroeconomic and financial stability.

[7] Another factor that could delay adjustment of prices to fundamentals in real estate markets is the existence of large set of investors with adaptive expectations (Case and Shiller, 2003; Piazzesi and Schneider, 2009).

[8] This simple panel-data analysis uses data from the U.S. Bureau of Economic Analysis, Federal Housing Finance Agency, and Internal Revenue Service covering U.S. states from 2000 to 2008.

employment growth and mobility.[9] Micro data from the European Community Household Panel confirms this effect. The probability of an individual moving is adversely affected if the household has a mortgage, potentially hurting job creation (Boeri and Garibaldi, 2010).

III. POLICY OPTIONS

The crisis has lent some support to the camp favoring early intervention in real estate boom-bust cycles. Policy proved to be of limited effectiveness in cleaning up the mess and there have been large costs associated with the bust. While the issue remains of distinguishing "bubbles"—that is, price misalignments relative to economic fundamentals—from large or rapid movements in prices, better yardstick indicators (such as price-income and price-rent ratios, measures of credit growth, and leverage) can be developed to guide the assessment of the risks posed by a run-up in prices and the decision to take action against "bad" booms. Similar to other policy decisions, action may have to be taken under considerable uncertainty when the costs of inaction can be prohibitively high.

If we accept the notion that intervention may be warranted even though it is often difficult to separate good from bad booms, the question arises as to which policy lever is best suited to reining in the latter. The main risks from real estate boom-bust cycles are associated with increased leverage in both the real (in particular, households) and financial sectors. In that context, one could think of policies as targeting two main objectives (not to be taken as basis for a mutually exclusive categorization): (i) preventing real estate booms and the associated leverage build-up at household and banking sectors altogether, (ii) increasing the resilience of the financial system to a real estate bust. Table 1 gives a summary of policy measures available to achieve these objectives along with their pros and cons.

It should be recognized at the onset that there is no silver bullet. Each policy will entail costs and distortions, and its effectiveness will be limited by loopholes and implementation problems. Broad-reaching measures (such as a change in the monetary policy rate) will be more difficult to circumvent, and hence potentially more effective, but will typically involve greater costs. More targeted measures (such as maximum loan-to-value ratios) may limit costs, but will be challenged by loopholes, jeopardizing efficacy.

What follows are explorations. We examine the potential role of monetary, fiscal, and macroprudential policies. We discuss the benefits and challenges associated with the various policy options, using cases studies of countries with experience in the use of particular measures and, where possible, cross-country evidence. Finally, policy options are also examined through the lens of a stylized theoretical model.

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[9] Ferreira et al. (2010) also find evidence of a negative relationship between negative equity and mobility micro data from the American Housing Survey. It should, however, be noted that a recent study challenges their findings arguing that certain observations were systematically left out (Schulhofer-Wohl, 2010).

A. Monetary Policy

Can monetary policy tightening stop or contain a real estate boom? Arguably, an increase in the policy rate makes borrowing more expensive and reduces the demand for loans. In addition, higher interest payments lower the affordability index (defined as the ratio of median household income to income necessary to qualify for a traditional mortgage loan[10]) and reduce the number of borrowers that can qualify for a loan of given size. Moreover, indirectly, to the extent that monetary tightening reduces leverage in the financial sector, it may reduce the financial consequences of a bust even if it does not stop the boom (Adrian and Shin, 2009; De Nicolo et al., 2010).

Yet, monetary policy is a blunt instrument for this task. First, it affects the entire economy and is likely to entail substantial costs if the boom is limited to the real estate market. Put differently, a reduction in the risk of a real estate boom-bust cycle may come to the cost of a larger output gap and the associated higher unemployment rate (and possibly an inflation rate below the desired target range). Obviously, these concerns are minimized when the boom occurs in the context (or as a consequence) of general macroeconomic overheating. In that context, the distortions associated with monetary tightening would be minimized. Indeed, when financial constraints are present and real estate represent an important vehicle for collateral, a policy rule reacting to real estate price movements (in addition to inflation and the output gap) can actually improve over a traditional Taylor rule by reducing welfare loss (see Section IV).

A second concern is that, during booms, the expected return on assets (in this case, real estate) can be much higher than what can be affected by a marginal change in the policy rate. It follows that monetary tightening may not directly affect the speculative component of demand.[11] If that is the case, it may have the perverse effect of leading borrowers (who would have otherwise qualified for standard mortgages) towards more dangerous forms of loans (such as interest-only, variable-rate loans, and in some cases foreign-currency loans).[12] Further affecting the efficacy of monetary policy is free capital mobility: real estate booms

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[10] A traditional mortgage loan here is a 30-year, 20 percent down, fixed-rate, fully-amortizing contract. The lender is assumed to require mortgage payments not to exceed 25 percent of borrower's income. This reflects common practices in U.S. mortgage markets while the characteristics of a traditional mortgage may vary from one country to another.

[11] Another way of stating this argument follows from thinking of house prices as the sum of two components: fundamentals-driven and bubble. The fundamentals-driven component would be, more or less mechanically, affected by monetary policy. But the bubble component tends to have a life of its own with less responsiveness to policy rates as inefficiencies in real estate markets allow positively serially correlated returns (see, for instance, Case and Shiller, 1989), making speculation more attractive and bubbles harder to break once they have started. See Allen and Carletti (2010) for more on the role of speculation in real estate bubbles, as well as on the role monetary policy in real estate markets.

[12] See, for instance, Brzoza-Brzezina et al. (2007) for evidence that, in the Czech Republic, Hungary and Poland between 1997 and 2007, restrictive monetary policy led to a decrease in domestic currency lending but simultaneously accelerated foreign-currency-denominated loans.

are often associated with strong capital inflows, especially in emerging markets, and higher interest rates may create complications on this front.[13]

Finally, the effectiveness of a change in the policy rate will also depend on the structure of the mortgage market. In systems where mortgage rates depend primarily on long-term rates the pass-through from the policy rate to the real estate market may be limited, depending on the relationship between long and short rates.

To a large extent, empirical evidence supports these concerns, leading to the bottom line that monetary policy could in principle stop a boom, but at a very high cost.

At first glance, there is little evidence across countries that the pre-crisis monetary stance had much to do with the real estate boom. Inflationary pressures were broadly contained throughout the period and changes in house prices do not appear correlated with real interest rates or other measures of monetary conditions. For instance, in advanced economies, the extent of the recent house price boom was uncorrelated with estimated Taylor residuals[14], except in a subsample of eurozone countries (IMF, 2009).

An explanation for this lack of a relationship may be in the rapid decline in import prices driven by the integration of low-cost emerging market economies—notably China—into global production chains that may have offset relatively high inflation in nontradable sectors.[15] Indeed, plotting nominal house price growth in the 10 years to the end of 2008 against the change in the relative price level of imports over the same time period shows an extremely robust negative relationship across countries (Figure 5, top panel), particularly once one conditions on the asymmetric impact of ECB monetary policy in the core and periphery of the eurozone. These simple scatter-plots suggest that housing booms were indeed more salient in countries which experienced a decline in import prices relative to the general price level. This, in turn, suggests that buoyant conditions extended beyond the housing sector and the domestic economy as a whole was overheating.

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[13] It is beyond the scope of this paper to discuss capital inflows and their relationship with asset price booms, we refer the interested reader to Ostry et al. (2010) and references therein for the associated literature and policy recommendations.

[14] The Taylor Rule posits that monetary policy should respond to inflation and the output gap and, using the suggested coefficients in the classical version, can be expressed as: interest rate $= 1 + 1.5*$inflation $+ 0.5*$output gap. The difference between the actual policy interest rate and that suggested by the rule, i.e., the Taylor residual, gives a rough measure of the policy stance with negative values suggesting "too loose" policy. In estimating the Taylor residuals, the following assumptions are maintained: an equilibrium real interest rate of 200 basis points, an inflation target of 2 percent, and a zero output gap in equilibrium.

[15] IMF (2006) finds that globalization reduced CPI inflation by more than 1 percentage point in some advanced economies during some periods, particularly in the wake of the Asian crisis in 1998 and again after the 2001 recession. Assuming that monetary policy followed a classical Taylor Rule based on CPI, this would have tended to reduce policy interest rates by up to 200 basis points. This point is particularly critical because well-founded models for analyzing monetary policy in open economies (e.g. Galí and Monacelli, 2005; Benigno and Benigno, 2006) emphasize that optimal policy responds primarily to inflation in the price of domestically produced goods, not to CPI inflation.

After controlling for this issue by computing the Taylor residuals based on domestic inflation rather than overall CPI inflation, the relationship between the monetary-policy stance and house prices is robust and statistically significant (Figure 5, bottom panel).[16] But the slope of this relationship suggests that economic significance is weak and it would be very costly to use monetary policy to stop a boom: the policymakers would have to "lean against the wind" dramatically to have a meaningful impact on real estate prices, with large effects on output and inflation.

This intuition is confirmed by a panel vector autoregression.[17] This exercise suggests that, at a 5-year horizon, a 100 basis point hike in the policy rate would reduce house price appreciation by 1 percentage point. But it would also instigate a decline in GDP growth of 0.3 percentage points. To put things in context, between 2001 and 2006, real house prices rose 48 percent in a global sample of 55 countries. A 500-basis-points tightening would have cut the boom by roughly 5 percentage points to 43 percent (still well above the historical average of 27 percent increase in house prices over a five-year period). And it would have reduced real GDP growth by 1.5 percentage points over this 5-year period.[18]

Consistent with these estimates, the experiences of Australia and Sweden suggest that marginal changes in the policy rate are unlikely to tame a real estate boom. They were among the few countries that used monetary policy to 'lean against the wind' during the global real estate boom. Australia increased the policy rate by 300 basis points between April 2002 and August 2008 while Sweden had a 325 basis-point hike between December 2005 and September 2008.[19] This tightening notwithstanding, house prices in both countries increased substantially, gaining 80 percent in real terms between 2000 and 2007.

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[16] Using median regressions (a technique that minimizes problems associated with outliers) of house price growth on each of the two Taylor residuals, including in each case time fixed effects to control for global factors driving the real estate cycle, we find that the relationship for the GDP-deflator-based Taylor residual is statistically significant while the apparent negative relationship for the CPI-based residual is not. This echoes IMF (2009), which looked at Taylor residuals using CPI inflation and found only limited evidence for a relationship between monetary policy and the housing boom.

[17] Details of the estimation and a discussion of the impulse responses are in the Appendix.

[18] This back-of-the-envelope calculation may be underestimating the effectiveness of a large hike on house prices because of potential non-linearity.

[19] The Reserve Bank of Australia, on its media release dated May 8, 2002, stated that "The strong rises in house prices […] have also been associated with a rapid expansion in household debt, a process that carries longer-term risks […] To persist with a strongly expansionary policy setting […] could fuel other imbalances such as the current overheating in the housing market […]" in communicating its decision to raise the cash rate target (the full statement is available at http://www.rba.gov.au/media-releases/2002/mr-02-10.html). Sveriges Riksbank, on its press release dated January 20, 2006, said "As before, there is also reason to observe that household indebtedness and house prices are continuing to rise rapidly. Against this background, the Executive Board decided to raise the repo rate by 0.25 percentage points […]" (the full statement is available at http://www.riksbank.com/templates/Page.aspx?id=20017). See also Bloxham et al. (2010) and Giavazzi and Mishkin (2006) for more on Australian and Swedish monetary policies, respectively.

Part of the problem may be that speculation is unlikely to be stemmed by changes in the monetary policy stance. Indeed, there is some evidence that conditions on the more speculative segment of mortgage markets are little affected by changes in the policy rate. For example, in the U.S., denial rates (calculated as the proportion of loans originated to applications received) in the market for prime mortgages appear highly related to changes in the Federal Funds rate, with banks becoming more choosy when the rate increases. In contrast, denial rates for subprime loans (typically more linked to speculative purchases) do not seem to move systematically with monetary policy (Figure 6).

B. Fiscal Tools

Most tax systems involve favorable treatment of debt-financed home ownership.[20] In theory, for households to be indifferent between renting and owning, rent should equal the user cost of owning (Poterba, 1984). Complicating this equation, aside from rent controls, is the fact that tax treatment of owner-occupied housing may significantly alter the latter. Under neutral treatment, imputed rents and capital gains would be fully taxed and mortgage interest payments would be fully deductible. In reality, however, imputed rents and capital gains are seldom taxed (e.g. two out of three OECD countries treat these as tax-exempt). Transaction, capital gains, and property taxes, all indirect ways of taxing imputed rents, partially offset the bias towards ownership created by this treatment but mortgage interest tax relief is often large enough to undo this partial offset.[21] Moreover, mortgage interest tax relief encourages levered property purchases.

Can tax treatment of home ownership and housing-related debt be adjusted in a cyclical manner to curb house price increases? Hypothetically, in a tax system where imputed rents and capital gains are exempt while mortgage interest and property taxes are deductible, increasing property taxes or trimming down mortgage interest tax relief could reduce house prices, especially for higher-income households that are subject to higher marginal income tax rates.[22] Property taxes, arguably, are better suited for cyclical implementation since it is administratively easier to reset tax rates than to abolish/re-establish or change mortgage interest deductibility rules and they can be tailored better to local real estate market dynamics.[23] A better tool yet may be cyclical transaction taxes (of which capital gains taxes

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[20] See, for instance, Cremer and Gahvari (1998) and Bourassa and Grigsby (2000) for more on the economic reasons that shape tax treatment of owner-occupied housing.

[21] Note that the extent of this partial offset will depend on various factors such as deductibility of capital gains and the extent of pass-through from property taxes to rents.

[22] Formally, $R = UC = P[(1 - \tau_m)(i + \tau_p) + \beta + m + d - \pi]$ where R is the rent, UC is the user cost, P is the house price, τ_m is the marginal tax rate, i is the nominal mortgage interest rate, and τ_p is the property tax rate on owner-occupied houses. i measures the cost of foregone interest that the homeowner could have earned on an alternative investment. β, d, and m are the recurring holding costs consisting of the risk premium on residential property, depreciation, and maintenance. π is the expected capital gains.

[23] In addition, to the extent that the value of the tax shelter is factored into house prices, reduction or abolishment of mortgage interest deductibility may lead to a higher house price level in the short run.

and registration fees are two components) that could, in theory, automatically dampen the boom phase of the real estate cycle as well as discourage speculative activity.

Transaction taxes

The level of transaction taxes does not appear to have a clear relationship with house price dynamics. In theory, one would expect higher transaction taxes to "thin" the market but, at the same time, to reduce the probability of bubbles by limiting speculative activity. Empirically, the relationship remains ambiguous. On the one hand, Belgium, with its high transaction taxes reaching as high as 16.5 percent, has had very modest house price movements with quarterly appreciation not exceeding 2 percent during upturns and depreciation not falling below -2 percent during downturns since the 1970s. On the other hand, Japan also with substantial transaction taxes, experienced one of the most notable real-estate bubbles to date (for more on the Japanese real estate bubble and land taxation, see IMF, 2001).

Transaction taxes/subsidies that change with real estate conditions may be, in theory, more promising.[24] On the bust side, the use of time-limited tax credits linked to house purchases in the U.S. and the suspension of stamp duty in the U.K. helped stabilize the housing market. And, especially in the U.S., the stabilization in prices and revival of activity disappeared with the expiration of the tax breaks (IMF, 2010). On the boom side, China and Hong Kong SAR have recently introduced higher stamp duties to dampen real estate prices and discourage speculation. Their experience, however, indicates that transaction volume responds more than prices do (suggesting that the associated collateral costs are high) and the impact of the introduction of the tax may be transient.

Property taxes

To address the question of how property taxes affect price dynamics we use data from the U.S. covering 243 metropolitan areas.[25] Based on an instrumental variables strategy, which can provide a causal interpretation running from tax rates to house price growth, a one standard deviation ($5 per $1000 of assessed value) increase in property tax rates is found to

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[24] See Allen and Carletti (2010) for a theoretical framework in which transaction taxes that are higher the greater the rate of real estate price appreciation can limit speculative motivations.

[25] Teasing out significant causal relationships from a small cross-country sample is confounded by a number of challenges: results can be sensitive to which countries are included in the sample, and standard econometric problems of endogeneity (extracting the correct causal relationship from the estimated correlation) and omitted variable bias (controlling for all the other factors that vary between countries and could affect price developments) are pronounced. Differences in national house price definitions and methodologies create additional noise. Focusing instead on one country has a number of advantages: many of the housing market determinants that vary across countries (such as monetary policy, central government fiscal policy, and the treatment of mortgage loans in the banking system) are relatively constant across geographical areas within a country. Data comparability issues are minimized as the house price measurement is standardized across areas. At the same time, there is substantial variation in property tax rates, which are set at the local government level.

be associated with a 0.9 percentage point decline in average annual price growth (compared to annual growth of around 5.6 percent per year).[26] Moving from the minimum tax rate in the sample (some $2.60 per $1000) to the maximum ($26) is estimated to cut average price growth by 4.3 percentage points per year. The impact on price volatility around the trend growth rate is similar: a one standard deviation increase in tax rates leads to a reduction in the standard deviation of house price growth of around 0.8 percentage points, around one quarter of the average level of volatility in the sample.

This evidence suggests that higher rates of property taxation can help limit housing booms as well as short-run volatility around an upward trend in prices. One interpretation is that property taxes, indirectly taxing imputed rent, may mitigate the effect of other tax treatments favoring homeownership and perhaps reduce speculative activity in housing markets. Of course, caveats apply in deriving implications from this evidence in the international context. The results may be specific to the U.S. housing market, whose characteristics differ markedly from those in many other advanced economies, let alone emerging markets. Moreover, property tax rates clearly did not cause (or prevent) the emergence of a national housing boom in the U.S., although they may have limited its impact on some areas, and the impact at the national level of a hypothetical national property tax might be very different from the localized impact of local taxes. Finally, endogeneity of tax rates remains an important issue: municipalities often face pressure to reduce tax rates when markets are booming and tax revenues are high, challenging the ability of policymakers to use property taxes as a countercyclical tool.[27]

Mortgage interest tax deductibility

Tax reforms that reduce the value of mortgage interest relief can lead to lower loan-to-value ratios, pointing to the role of tax incentives favoring debt-financed homeownership (see Hendershott et al., 2003, for the U.K. and Dunsky and Follain, 2000, for the U.S.). Tax reforms advocating removal or reduction of this tax shelter are estimated to cause around 10 percent immediate decline in house prices (see Agell et al., 1995, for Sweden and Capozza et al., 1996, for the U.S.). Yet, all of these are one-off changes, hinting at the difficulties in using mortgage interest tax deductibility rules in a cyclical way.

Overall, evidence on the relationship between the tax treatment of residential property and real estate cycles is inconclusive. At the structural level, tax treatment of housing does not appear to be related to the cross-country variation in the amplitude of housing cycles: during the most recent global house price boom, real house prices increased significantly in some countries with tax systems that are highly favorable to housing (such as Sweden) as well as in countries with relatively unfavorable tax rules (such as France). Similarly, appreciation was muted in countries with both favorable systems (e.g. Portugal) and unfavorable (e.g. Japan).

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[26] The results are presented in Appendix Table 2, Panel A.

[27] On a related note, while they may have an impact on prices, neither transaction nor property taxes get directly to credit and leverage.

Looking at other housing market indicators, the tax treatment of housing is not significantly related to the ratio of mortgage debt to GDP, while levels of homeownership (the main excuse for favorable tax treatment of housing) are, if anything, *negatively* related to the degree to which the tax system is favorable to owning one's own home (although the relationship is, again, not statistically significant). Other research has painted a similarly ambiguous picture. For instance, in the eurozone, more favorable tax treatment of housing may be associated with greater house price volatility (van den Noord, 2005). However, in a broader sample of economies, taxation was not the main driver of house price developments during the recent global housing boom (Keen et al., 2010).

Summarizing, even if fiscal tools can, in a one-off setting, dampen volatile house price dynamics and the build-up of vulnerabilities associated with debt-financed homeownership, scope for the use of such tools in a cyclical setting is likely to be limited given the political economy angle of fiscal policy perceived to be interventionist. In addition, the institutional setup in most countries separates tax policy from monetary and financial regulation policies, making it extremely hard to implement changes in tax policies as part of a cyclical response with financial stability as the main objective. Moreover, local governments may use lower property or transaction tax rates to attract residents during good times if the burden in the case of a bust is shared with other jurisdictions. The ability of cyclical transaction taxes to contain exuberant behavior in real estate markets may be further compromised if homebuyers do not respond to these taxes fully, because they consider them to be an acceptable cost for an investment with high returns and consumption value. Also, during a boom phase, the incentives to "ride the bubble" may increase efforts to circumvent the measure by misreporting property values or folding the tax into the overall mortgage amount. Finally, as with most tax measures, the distortions created by a cyclical transaction tax may hurt the price discovery process, which tends to be rather slow in real estate markets already, and also the mobility of households with potential implications for the labor market.

C. Macroprudential Regulation

At least in theory macroprudential measures such as higher capital requirements or limits on various aspects of mortgage credit could be designed to target narrow objectives (for instance, household or bank leverage) and tackle the risks associated with real estate booms more directly and at a lower cost than with monetary or fiscal policy.

Against the benefit of a lower cost, these measures are likely to present two critical shortcomings. First, they may be easier to circumvent as they target a specific type of contracts or group of agents. When this happens, these measures can be counterproductive, as they may lead to liability structures that are more difficult to resolve/renegotiate in busts. Second, they may be more difficult to implement from a political economy standpoint. Over time, monetary policy decisions have come to be accepted as a necessary evil thanks to central banks increasingly achieving credibility and independence. Using measures that were previously confined to the realm of micro-prudential supervision to achieve systemic results would likely be considered as an unnecessary intrusion into the functioning of markets. The more direct impact of these measures would also complicate implementation as winners and losers would be more evident than in the case of macro policies.

We focus our analysis on three specific sets of measures. First, capital requirements or risk weights that change with the real estate cycle. Second, dynamic provisioning, that is, the practice to increase banks' loan loss provisions during the upswing phase of the cycle. And third, the cyclical tightening/easing of eligibility criteria for real estate loans through loan-to-value (LTV) and/or debt-to-income (DTI) ratios.[28] Unlike monetary and fiscal policy options that mostly aim at preventing or pricking bubbles, some of these macroprudential tools may be able to achieve both objectives: (i) reducing the likelihood and/or magnitude of a real estate boom (for instance, by imposing measures to limit household leverage), and (ii) strengthening the financial system against the effects of a real estate bust (for example, by urging banks to save in good times for rainy days).

An important caveat is in order before we start our analysis. A major limitation in assessing the effectiveness of macroprudential tools stems from the fact that macroprudential policy frameworks are still in their infancy, and only a handful of countries have actively used them.[29] For example, out of 36 countries for which information is available, as of September 2010, 81 percent have reported not having any restrictions on the type of mortgage loans (e.g. interest-only or negative amortization loans, which are more likely to be used by speculators) financial institutions can extend to borrowers (Text Table 3). While limits on loan-to-value and debt-to-income ratios are reported to exist in roughly half of the countries, a closer look reveals that these are often applicable only to a subset of mortgages (e.g. those insured by the government) or are recommended best practice guidelines rather than strictly-enforced rules. Only 3 countries have reported actively using such limits to respond to real estate market developments. On the tools that are more "defensive" in nature than "preventative", a similar picture emerges: a mere 11 percent of the countries in the survey have applied cyclically-adjusted real-estate-specific risk weights with 14 percent requiring institutions to provide countercyclical loan loss provisioning on real estate loans (sometimes through a rules-based

Text Table 3. Survey-Based Assessment of Policy Frameworks as of September 2010

| | Monetary policy framework | | Tax system | | Regulatory structure | | | | | | | |
| | | | | | Restrictions on ... | | | | | | | |
	Credit growth explicitly considered?	Property prices explicitly considered?	Transactions tax?	Mortgage interest deductibility?	which financial institutions can extend mortgage loans?	type of mortgages?	loan-to-value ratio?	debt-to-income ratio?	mortgage credit growth rate?	real-estate-specific loan loss provisioning?	real-estate-specific risk weights?	full recourse on mortgages?
No	78%	64%	6%	39%	50%	81%	53%	50%	94%	61%	56%	25%
Yes	22%	36%	94%	61%	50%	19%	47%	50%	6%	39%	44%	75%
directly (not through e.g. the rent component of CPI)	14%	8%										
subject to restrictions			64%	44%								
cyclically-based										11%	11%	

Notes: The numbers correspond to the proportion of respondents giving a particular answer. Country-by-country responses to this brief in-house survey are in Appendix Table 1.

[28] Other measures not discussed here include cyclical ceilings on portfolio exposure to real estate, speed limits on real estate lending, and restrictions on certain type of loans. These tools have been used even more sparingly.

[29] Note that, of course, some of these tools have been used before, but mostly with microprudential objectives.

framework, sometimes at the discretion of the supervisory authority).[30] In addition to the lack of a track record, the fact that these measures have been typically used in combination with macroeconomic policy tools complicates further the challenge to attribute observed developments to a specific policy measure.

Yet, much can be learned from case studies. Following the Asian crisis, some countries in the region (particularly, Hong Kong SAR, Korea, Malaysia, and Singapore) have taken a more heavy-handed approach to deal with risks posed by real estate booms. Spain, following a period of significant credit growth, put in place a dynamic provisioning framework as early as July 2000. Countries in Central and Eastern Europe have experimented with various measures to control the rapid growth in bank credit to the private sector in the 2000s. Table 2 presents some stylized facts on the effects of various policy responses to real estate (and credit) booms. Table 3 gives more details on particular country cases, some of which are used in the discussion that follows on the efficacy of different tools. On the whole, success stories appear to be few, perhaps to some extent reflecting the learning curve in expanding the policy toolkit, improving the design of specific tools, and sorting out implementation challenges (Figure 4). The cases that appear to have the most success (that is, slowing down the boom and avoiding systemic crisis in the bust) almost always have involved some macroprudential measures.

Higher capital requirements/risk weights

Background

Capital regulation has a procyclical effect on the supply of credit. During upswings, better fundamentals reduce the riskiness of a given loan portfolio, improving a bank's capital adequacy ratio and its ability to expand its asset holdings. In a downturn, the opposite happens, possibly leading to deleveraging through fire sales. The broadly-discussed proposal of procyclical capital requirements could help reduce this bias.[31] Further, by forcing banks to hold more capital in good times, it would help build buffers for future losses (see Gordy and Howells, 2006, and references therein).

In the context of real estate, the procyclical element of capital regulation is largely absent. In most countries, existing rules do not take collateral values into consideration or reflect the heterogeneity among loans backed by real estate, other than the commercial-residential distinction. Under Basel II's standard approach, risk weights for property loans are fixed (50

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[30] Reflecting the commonly-accepted 'benign neglect' approach prior to the crisis, not only the macroprudential policy frameworks but also the macroeconomic policy frameworks do not currently incorporate mechanisms to directly respond to real estate market developments. The proportion of countries that report explicitly considering mortgage credit growth or property price appreciation in policy decisions is less than 15 percent.

[31] The discussion focuses on the price-related measures of capital regulation but exposure limits would have similar implications working as a quantity-based measure.

percent for residential mortgages and 100 percent for commercial property loans).[32] As a result, mortgage loans with predictably different default probabilities (for instance, because of different LTV ratios or their exposure to different aggregate shocks) are often bundled in the same risk category and no adjustment is made through time to account for the real estate cycle.[33] In this context, capital requirements or risk weights linked to real estate price dynamics could help limit the consequences of boom-bust cycles. By forcing banks to hold more capital against real estate loans during booms, these measures could build a buffer against the losses associated with busts. And, by increasing the cost of credit, they might reduce demand and contain real estate prices themselves.[34] Finally, weights could be fine-tuned to target regional booms.

Implementation challenges

A few caveats are in order. First, absent more risk-sensitive weights, an across-the-board increase in risk weights (or capital requirements) carries the danger of pushing lenders in the direction of riskier loans (this is essentially the risk-shifting effect identified by models in the spirit of Stiglitz and Weiss, 1981). Thus, the introduction of procyclical risk weights for real estate loans should be accompanied by the implementation of a finer cross-sectional risk classification as well. Second, as with any other measure increasing the cost of bank credit (when credit is in high demand), procyclical risk weights may be circumvented through recourse to non-bank intermediaries and off-balance sheet activities. Third, these measures will lose effectiveness when actual bank capital ratios are well in excess of regulatory minima (as often happens during booms). Fourth, while improving the resilience of the banking system to busts, tighter requirements are unlikely to have a major effect on credit availability and prices. Put differently, they are unlikely to reduce vulnerabilities in the real (household) sector. Finally, regulators may be reluctant to allow banks to reduce risk weights during a bust (when borrowers become less creditworthy).

Evidence

The empirical evidence on the effectiveness of these measures is mixed. In an effort to contain the rapid growth in bank credit to the private sector and the associated boom in asset markets, several countries have raised capital requirements and/or risk weights on particular groups of real estate loans. Some attempts (such as the cases of Bulgaria, Croatia, Estonia,

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[32] Risk weights are generally set higher for commercial real estate loans than residential real estate loans, given the higher risk profile of commercial real estate due to more volatile price dynamics and the dependence of borrower's ability to service the debt on rental income.

[33] Fixed risk weights are applicable only under the standard approach of Basel II. Under internal-rating-based approach, regulators (and banks) can split loans into sub-categories based on several risk indicators and vary risk weights accordingly. Indeed, a few countries have experimented with applying higher risk weights to high-LTV loans (see Table 3 for more information).

[34] Obviously, the increase in the cost of borrowing may have a side effect: credit rationing may set in, reducing welfare gains associated with access to finance.

and Ukraine) have failed to stop booms and the associated post-bust damage to the financial sector; others (such as the case of Poland) were at least a partial success (Table 3).[35]

Yet, it is not easy to say why measures taken in one country may have been more effective than those taken elsewhere or how much other developments account for the observed changes. Furthermore, even in countries where tighter capital requirements appeared to produce some results on controlling the growth of particular groups of loans, real estate price appreciation and the overall credit growth remained strong.

This evidence highlights the implementation challenges associated with these tools: with limited effect on overall credit growth and household leverage, lenders and borrowers may find new, less regulated types of credit. At times, these may go beyond regulatory perimeters (e.g. loans extended by finance companies or mortgage brokers rather than commercial banks) or even national borders (e.g. financing provided by banks in neighboring countries).

Dynamic provisioning

Background

Dynamic provisioning (the practice of mandating higher loan loss provisions during upswings) can help limit credit cycles.[36] The mechanics and benefits are similar to those of procyclical capital requirements. By forcing banks to build (in good times) an extra buffer of provisions, it can help cope with the potential losses that come when the cycle turns (see, for example, the case of Spain; Table 3). It is, however, unlikely to cause a major increase in the cost of credit, and thus to stop a boom. That said, one advantage over cyclical capital requirements is that dynamic provisioning would not be subject to minimums as capital requirements are, so they can be used when capital ratios maintained by banks are already high.

Provisioning for property loans could be made a specific function of house price dynamics. In periods of booming prices, banks would be forced to increase provisioning, which they would be allowed to wind down during busts. As in the case of risk weights, provisioning requirements could depend on the geographical allocation of a bank's real estate portfolio.

Implementation challenges

As noted, this type of measure is primarily targeted at protecting the banking system from the consequences of a bust. Consequently, it is not meant to have a significant impact on credit

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[35] Evidence on exposure limits is more limited: only Malaysia tried decreasing the maximum real estate exposure but the measure came in too late in April 1997, just before the Asian crisis hit the markets. In a more structural sense, many countries have constant exposure limits but there is no apparent relationship between the level of these limits and real estate boom-bust episodes.

[36] As it has been the case for capital requirements, procyclicality of regulations governing loan loss provisions has been subject to criticism before the crisis (see, for instance, Laeven and Majnoni, 2003).

and contain other vulnerabilities associated with a boom, such as increases in debt and leverage in the household sector. In addition, practical issues and unintended effects such as calibration of rules with rather demanding data requirements and earnings management (which may raise issues with tax authorities and securities markets regulators) should be discussed in each country's context to design a framework that best fits the country's circumstances. There are also other shortcomings, similar to those of procyclical risk weights (being primarily targeted at commercial banks, dynamic provisioning may be circumvented by intermediaries outside of the regulatory perimeter). Lastly, application of the measure to domestically-regulated banks only may hurt their competitiveness and shift lending to banks abroad, raising cross-border supervision issues.

Evidence

The experience with these measures suggests that they are effective in strengthening a banking system against the effects of a bust, but do little to stop the boom itself. Spain led the countries who have adopted some form of countercyclical provisioning and constitutes an interesting case study to provide a preliminary assessment on its effectiveness.

As member of the eurozone, Spain's ability to respond to a booming local real estate market with macroeconomic policy is limited. Starting in 2000 and with a major revision in 2004, the Bank of Spain required banks to accumulate additional provisions based on the 'latent loss' in their loan portfolios (for more details on the Spanish dynamic provisioning framework, see Saurina, 2009). Dynamic provisions forced banks to set aside, on average, the equivalent of 10 percent of their net operating income. Yet, household leverage grew by a still high 62 percent in Spain. At the end of 2007, just when the real estate bust started, total accumulated provisions covered 1.3 percent of total consolidated assets, in addition to the 5.8 percent covered by capital and reserves (so far, the value of the housing stock decreased by roughly 15 percent in real terms). Hence, Spanish banks had an important buffer that strengthened their balance sheet when real estate prices started to decline and the economy slipped into recession.

Limits on loan-to-value and debt-to-income ratios (LTV and DTI)

Background

A limit on LTV will prevent the build-up of vulnerabilities on the borrower side (in particular in the household sector). Containing leverage will reduce the risks associated with declines in house prices. Put differently, the lower the leverage, the greater the drop in prices needed to put a borrower into negative equity. In turn, this will likely result in fewer defaults when the bust comes, as more borrowers unable to keep up with their mortgages will be able to sell their houses. In addition, in case of default, lenders will be able to obtain higher recovery ratios. On the macro front, a limit on LTV will reduce the risk that a large sector of the real economy ends up with a severe debt overhang. In addition, it will reduce the pool of borrowers that can obtain funding (for a given price) and thus will reduce demand pressures and contain the boom.

Similar to limits on LTV, DTI limits will rein in the purchase power of individuals reducing the pressure on real estate prices. In particular, they will be effective in containing speculative demand (they will screen out borrowers that would only qualify for a mortgage on the assumption the house would be quickly turned around). They will also reduce vulnerabilities as borrowers will have an 'affordability' buffer and will be more resilient to a decline in their income or temporary unemployment.

Implementation challenges

One practical issue with implementing LTV limits is that lenders are generally quick to find ways to circumvent the restrictions. For instance, in the U.S., during the housing boom, the practice of combining two or more loans to avoid the mortgage insurance (which kicked in when LTV exceeded 80 percent) became common.[37] A ban on second liens or LTV applied to a borrower's overall exposure would improve effectiveness. Similarly, an obvious way to get around a DTI limit would be to extend sequential loans and report the ratios separately. In Hong Kong SAR, where regulators impose maximum limits on the debt service ratio (which takes into account the payments the borrower has to make on non-mortgage loans as well), supervisors often encounter cases where lenders choose not to report all outstanding debt obligations. In addition to minimize the effect of these limits, circumvention may entail significant costs, as it results in more liability structures that can complicate debt resolution during busts (for example, in the U.S., it is often second-lien holders to object to restructuring).

The coverage perimeter of these measures is also an issue: in Korea, lower LTV limits for loans with less than three years of maturity spurred a boom in loans originated with maturity of three years *and* one day. Circumvention may also involve shifting of risks not only across mortgage loan products but also outside the regulatory perimeter through expansion of credit by non-bank, less-regulated financial institutions and/or by foreign banks (which may result in increased currency mismatches as the proportion of FX-denominated loans rises).

The narrow target nature of these measures may increase political economy obstacles (as happened in the case of Israel[38]), particularly since the groups more impacted by LTV and DTI limits tend to be those more in need of credit (poorer and younger individuals). In addition, unlike with more "macro" measures, the consequences of these limits are immediate and transparent. Beyond these political economy considerations, LTV and DTI limits, by rationing sensitive groups out of credit markets, will entail a cost in terms of diminished intertemporal consumption smoothing and lower investment efficiency.[39]

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[37] With these "piggyback" loans the first lien would cover 80 percent of the home value and the remainder would be split between a second lien loan and a downpayment (which could be as low as zero).

[38] http://www.businessweek.com/news/2010-05-24/bank-of-israel-may-increase-housing-loan-provisions-update1-.html

[39] Another concern related to credit rationing that may be associated with LTV limits is that, by changing the status of second liens, such limits may constrain borrowers' ability to use second mortgages for starting new businesses or other small business financing. Yet, according to survey evidence, only a small portion of home

To contain these costs, countries have adopted more targeted approaches (trying to protect more vulnerable groups and aiming at those they consider to be market-destabilizing speculators). For instance, Korea differentiates the limits across regions based on the extent of house price appreciation.[40] China and Singapore impose lower limits on second mortgages in an effort not to hurt owner-occupiers. Hong Kong SAR has cut-offs on property values to target the high-end segment of the real estate market. Although less controversial, these limits also receive criticism and opposition from property developers and lenders. In countries where these groups have political influence, effective execution of LTV and DTI limits may still pose a challenge. Even when the policymaker can surmount such political economy problems, calibrating and timing the changes in limits is unlikely to be an easy task as demonstrated by the recent Korean experience, where bubble fear rapidly turned into concern that the real estate markets had become too weak because the macroprudential policy response was too strong, forcing the authorities to reverse the tightening of eligibility criteria.

Evidence

Establishing a causal link running from LTVs to price and credit dynamics is a hard task. In a simple cross-section of 21 (mostly) developed countries, maximum LTV limits are positively related to house price appreciation between 2000 and 2007 (Figure 7). Back-of-the-envelope calculations suggest a 10 percentage point increase in maximum LTV allowed by regulations to be associated with a 13 percent increase in nominal house prices. Regressions on a panel of U.S. regions from 1978 to 2008 deliver a smaller impact of LTV at loan origination: roughly 5 percent increase in house prices for a 10 percentage point increase in LTV.[41] Duca et al. (2010) construct a series for LTV faced by first-time home buyers and estimate a cointegration model of house price-to-rent ratios at the national level for the U.S. between 1979 and 2007. Their results imply an impact of 8-11 percent on house prices from a 10 percentage point increase in LTV for first-time home buyers, assuming rents remain constant.

It must be noted that there are major drawbacks with this analysis. In the international sample, a major concern is the lack of time dimension. In many countries, there is no data available for multiple points in time. Even when data availability is not the problem, very few countries have time variation in maximum LTV allowed since this is not an active part of the regulatory agenda. Another issue, which also applies to the estimates based on U.S. data analysis, is that in many cases there are no *mandatory* maximum limits in practice and the

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equity lines of credit were used for such purposes in the U.S.: the main purposes were home improvement, financing of real estate (e.g. to reduce downpayment on first home or to purchase second home), durable goods purchase, and debt consolidation (http://money.cnn.com/2003/10/01/commentary/everyday/sahadi/).

[40] An area is designated as 'speculative' in Korea if the following criteria are met: (i) nominal house prices rose more than 1.3 times the nationwide inflation rate over the past month and (ii) either the average appreciation rate over the past 2 months is higher than 1.3 times the average national appreciation rate over the past 2 months, or the average appreciation rate over the past 12 month is higher than the average national HPI appreciation rate over the past 36 months.

[41] These regressions are presented in Appendix Table 2, Panel B.

values reported are simple guidelines for mortgage insurance or prudential concerns. In fact, the data for U.S. regions are the actual LTVs because there is not variation across regions in the LTV guidelines. Hence, because of the feedback loop between mortgage credit availability and house price movements, endogeneity remains a concern.

That said, a review of the experience of countries that experimented with mandatory LTV limits changing in response to real estate market developments also suggests that they can be quite effective but perhaps for short periods (see the cases of Korea and Hong Kong SAR; Table 3). For instance, when the Korean authorities introduced LTV limits in September 2002, month-on-month change in house prices went down from 3.4 percent to 0.3 percent immediately and remained low until April 2003. Subsequent reductions in LTVs were also followed by significant drops in house price appreciation rate. A similar pattern applies to DTI limits, with month-on-month change dropping from 2.3 percent in July 2005 to 0.2 percent in August 2005 with the introduction of the measure. Interestingly, the measures had a much smaller or no impact on prices in 'non-speculative' areas where the limits were untouched. The impact on year-on-year changes, however, has been smaller since prices tend to start increasing at a faster pace again after the first immediate reaction. In Hong Kong SAR, prudent lending practices guided by LTV and DTI limits have been credited with pausing the house price boom briefly in 1994 and guarding the system against the fallout from the crash in 1997 (Wong et al., 2004).[42]

IV. MODEL-BASED EVALUATION OF POLICY OPTIONS

The objective of this section is to provide a quantitative evaluation of the policy trade-offs discussed in the previous sections. To that purpose, it builds a dynamic stochastic generalized equilibrium (DSGE) model that takes into account a housing sector and credit markets.[43] The advantage of DSGE models over traditional macroeconomic models, especially in analyzing the impact of policy shocks and structural changes, is that they are less subject to the Lucas critique since they rely on optimization of microeconomic decisions. The disadvantage, in addition to computational challenges, is that they do not have the capability to replicate non-linear dynamics often observed in macroeconomic aggregates, especially in a crisis context. Hence, the analysis actually looks at policy responses to *any* fluctuation in house prices, not to unsustainable booms.[44] The model-based analysis supports the view that tools that are narrower in focus (by addressing a specific rigidity) can perform better.

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[42] Actions in Hong Kong SAR taken over the past few months appear to be less effective though, but the reason for that may be the fact that the boom in this case appears to be driven less by domestic demand/supply and credit conditions and more by external factors, in particular, the capital flows from mainland China. IMF (forthcoming) looks into the issue of managing capital inflows using different policies.

[43] Such models have increasingly become the standard in studying the role of credit market frictions and macroprudential tools in a macroeconomic setting (see, for instance, Christiano et al., 2009; IMF, 2009; Cúrdia and Woodford, 2010; Iacoviello and Neri, 2010; and Angelini et al., 2010). See Kannan et al. (2009) for more on the theoretical underpinnings of the particular model used here.

[44] At this time, designing a tractable model of bubbles that can be incorporated into a medium-scale macroeconomic model remains a challenge. All house price fluctuations in the model come from fundamentals and reflect the expected present discounted value of rents. It should also be noted that the model is based on a

That said, considering that bubbles are hard to identify in real time from fundamentals-driven movements and that even non-boom fluctuations in house prices have an impact on aggregate economic activity through wealth and supply-side effects, the model-based analysis can help us understand and quantify the trade-offs associated with different policies. All in all, the analysis in this section supports the view that, in theory, tools that are closer to the target (such as macroprudential measures that alter interest rate spreads or the quantity of credit on particular markets) and narrower in focus perform better.

The model involves three components to introduce a housing sector and credit markets into the standard macroeconomic set-up. First, households, make decisions about how much to invest in a durable good (which in this instance is housing), in addition to choosing their consumption of nondurable goods. Housing has a double function in this economy: it provides a flow of services and is the main vehicle for accumulating wealth. Second, in order to create the need for a credit market, there is a distinction between two types of households. (If all agents in the economy behave the same way, then credit is in zero net supply and asset and bond prices only represent shadow prices without actual transactions taking place.) Hence, we introduce agents that are more impatient than others and have preference for consuming early and for borrowing. Third, the lending rate is modeled as a spread over the policy rate that depends on the balance sheet position of potential borrowers, a banking sector markup, and a policy instrument. Hence, for example, rising house prices raise market valuations of borrowers' collateral, improve their balance sheet position, and therefore lead to a fall in lending rates even if monetary policy has not eased. Credit market conditions can change—because of, say, changes in perceptions of risk—which could lead banks to adjust their markups and thus alter the lending spread.[45]

The feedback loop between credit spreads, house prices and balance sheets of households helps accelerate a rise in residential investment, nondurable consumption, and prices, and is a main source of concern for the policymaker because of its impact on output and inflation. Therefore, the policymaker may choose to alter the course of this feedback loop by adjusting the policy instrument, which may take the form of a macroprudential tool such as a limit on loan-to-value ratios or a fiscal tool such as tax deductibility of mortgage interest.

The model has conventional New Keynesian features; in particular, prices and wages do not adjust immediately. To make the model more realistic, we assume that consumption and residential investment adjust slowly, and it is costly for workers to shift from producing consumption goods to building houses, and vice versa. The presence of these nominal and real frictions means that monetary policy can stabilize the economy, because it influences interest rates and, hence, spending on durables and housing. The presence of financial

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closed-economy framework, potentially underestimating the aggregate effects associated with house price increases. While these caveats may limit the ability to derive strong policy conclusions, the model still offers an organized framework to discuss implications of various policy options.

[45] Note that banks are modeled as financial intermediaries that simply channel funds from savers to borrowers. A main shortcoming of the model is that the banking sector markup is exogenous and independent of the balance sheet of the banks.

frictions means that not only monetary policy but also macroprudential policy can play a role by responding to credit market conditions.

The objective is to determine which policy regime is better at stabilizing the economy in the face of pressures on the housing market—policies that can help prevent financial vulnerabilities, rather than help pick up the pieces after a bust. The conclusions that can be drawn from this analysis depend crucially on which shocks drive the house price boom. To illustrate the importance of correctly identifying the drivers of the housing boom, we test the policy regimes with two shocks: a financial shock that prompts a relaxation in lending standards, and a positive productivity shock that leads to an increase of income and demand for both nondurables and housing.[46]

Effectiveness of monetary policy

Our starting point is to assume that the central bank follows a standard Taylor-type rule, whereby the central bank raises rates whenever CPI inflation is running above target, or when the economy is expanding at a faster rate than its fundamentals suggest (i.e., the output gap is positive). We set the coefficients that determine the reaction to deviations from the targeted inflation and output as 1.5 and 0.5, respectively, as standard in the literature. Then, as alternative policy rules, we include the reaction to nominal house price inflation, nominal mortgage credit growth, or both.

The top panel of Table 4 shows the results of this exercise. For the case of a productivity shock, the inclusion of either house prices or credit in the policy rule would lead to an improvement of welfare mostly due to a decline of output gap volatility, yet it looks like reacting only to real estate prices would suffice. Intuitively, this is because the shock in this case reflects a change in one of the fundamentals, namely, income, that drives house prices. By responding to real estate prices, the policymaker can smooth out the adjustment path and limit the accelerator effect to output. In the case of a financial shock, there is merit to responding to both real estate prices and credit. This stems from the increased strength of the feedback loop: the financial shock creates a "credit boom" and pushes house prices up with immediate consequences for output while, in the case of a productivity shock, the push comes from fundamentals and credit fluctuations are mere responses to readjustment in house prices. In other words, the optimal policy choice of responding to credit reflects the merit of attacking directly to the source that triggers the feedback loop.

If both productivity and financial shocks are present, an interesting finding emerges: reacting to credit is superior to reacting to real estate prices. The mechanism behind this result hinges upon the characteristics of the feedback loop. The rise in house prices is driven both by the shift in fundamentals due to the productivity shock and by cheaper credit because of the financial shock. Output fluctuations can be reduced by monetary policy accommodating the effect of the shocks on house prices, but a better option is to directly respond to credit growth

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[46] Nolan and Thoenissen (2009) show that total factor productivity and financial shocks explain a large fraction of the fluctuation in main U.S. macroeconomic variables.

as it helps keep in check the push on house prices while at the same time containing the relaxation in credit conditions.[47]

All in all, a moderate expansion of central bank's objectives to include real estate prices as one of the monetary policy targets could result in an improvement of welfare. When faced with a financial shock, reacting to credit growth may also be justified to stabilize the output gap.

Effectiveness of fiscal policy

Taxes on homeownership and housing transactions, in principle, can curb demand for housing and tame exuberance in real estate markets. To analyze the effectiveness of capital gains / property taxes and cyclical transaction taxes, we assume that, on top of the standard Taylor rule, the policymaker can impose a property tax on home-owners. The tax receipts are paid back as a lump sum to households. The policymaker can set two parameters in the tax rule. First, the steady-state level tax rate, and second, the cyclical reaction of the tax rate to house price inflation. Using tax rates to reduce house-price volatility and the associated accelerator effects implies small welfare improvements (middle panel in Table 4). This suggests that fiscal policy is much less effective than using other (extended monetary and regulatory) policy tools. This limited effect results from the fact that high property taxes are needed to have some bite in reducing the volatility of house prices. But, the reduced house price volatility comes with a trade-off, namely, a wedge between real house prices and their fundamental price. The inefficiency associated with such distorted prices leads to a smaller improvement in welfare.

Fiscal policy could also be used to deal with real estate booms given the differential treatment of debt-financed homeownership in many countries. In particular, interest payments on mortgages are, at least partially, tax-deductible. By creating a wedge between debt-financed ownership and non-debt-financed ownership, mortgage interest tax deductibility affects the user cost of housing. This could affect credit conditions and, hence, house price dynamics, by inducing a discrepancy between the (after-tax) lending rate and the deposit rate. Yet, in this model, this is isomorphic to any other tool that would directly affect the lending spread; for example, countercyclical LTV would achieve the same purpose. We study policy tools that have a direct impact on the lending spread under macroprudential policy tools next.

Effectiveness of macroprudential policy

In the model, policies that can directly affect the spread that financial intermediaries charge between lending and deposit rates may also help stabilize the cyclical movement in the economy. One such tool to achieve this would be to change the LTV in a countercyclical

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[47] A concern could be that the improvement in welfare reflects the far-from-optimal coefficients on the reaction to the output gap and inflation. Hence, we optimize all coefficients of the Taylor rule and still find a role for reacting to real estate prices and mortgage credit.

manner: by lowering the LTV when house prices increase, the supervisory authority would be forcing the volume of credit to be cut down, increasing the spread and hence reducing the accelerator effect.[48]

In order to demonstrate how this macroprudential rule works, Figure 8 shows the impulse-response to a 1 percent permanent reduction in the steady-state LTV. Initially, interest rate spreads increase 25 basis points, and credit decreases on impact by 0.3 percent.[49] The increase in lending rates leads to a decline in private consumption (0.15 percent), consumer prices (0.02 percent), residential investment (0.2 percent) and real house prices (0.07 percent). Because of this contractionary effect, the central bank provides support by cutting the policy rate (which equals the deposit rate in this economy) and this helps cushion the downturn. Over the medium term, residential investment and house prices return to their initial values and credit is permanently reduced by 1 percent.[50]

Moving from the effect of a permanent change in LTV to how systematic cyclical changes in LTV can help stabilize the business cycle, we examine whether welfare can be improved if LTV is tied to certain observables such as credit growth and house price inflation. We specify a cyclical LTV rule that reacts linearly to fluctuations in those variables, much in the spirit of standard monetary policy rules. The results are in the bottom panel of Table 4.

Under a productivity shock, introducing a macroprudential instrument that reacts countercyclically to one of the two indicators brings important welfare gains, mostly due to the fact that the volatility of the output gap is greatly reduced. We run a horse-race by optimizing the coefficients of the rule with respect to the two indicators, and find that having the LTV react to nominal credit growth is superior than having it react to house price fluctuations. One interpretation of this finding is that the macroprudential instrument directly addresses the financial friction in the model, so it is optimal to have it react to excessive credit growth: by increasing lending rates countercyclically, the macroprudential instrument is able to slow down the feedback loop between credit, house prices, and spreads. Even when the coefficients on the Taylor rule are optimized, there is a role for the macroprudential instrument to react to nominal credit growth. The macroprudential policy could in principle be able to perfectly offset a financial shock by changing the LTV requirement aggressively and, hence, induce a change in the lending spread of the exact opposite magnitude as the financial shock. Of course, in a world where there are implementation delays, this would not be possible.

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[48] Other policy proposals have considered the effects of changing capital and liquidity requirements (BIS, 2010; Angelini et al., 2010). As the BIS (2010) document acknowledges, all these macroprudential policies have the effect of working through the spread between lending and deposit rates.

[49] The BIS (2010) document estimates that an increase of 1 percent in bank capital requirements also leads to an increase of 25 basis points in the spread between lending rates and the cost of funds for banks. Hence, the exercise here can also be thought of as an increase in capital requirements.

[50] Note that, in the long run, prices are set to equal their marginal cost of production, and hence it is not possible for regulatory policy to affect house prices in the long term by restricting the amount of credit.

When both shocks hit, under the original Taylor rule, a strong reaction to deviations of nominal credit growth from steady-state values would lead to significant welfare improvements. Compared to all policies that start with the original coefficients of the Taylor rule, the macroprudential instrument delivers the highest welfare. When the Taylor rule is optimized, expanding monetary policy to react to real estate market developments and using the macroprudential tools deliver virtually the same outcome.

V. CONCLUSION

The correct policy response to real estate booms is, like many other policymaking decisions, an art more than a science. Of the policy options considered, macroprudential measures appear to be the best candidates to achieve the objective of curbing real estate prices and leverage because of their ability to attack the problem at its source, their adaptability to accommodate the specific circumstances in different locations at different times, and their added benefit of increasing the resilience of the banking system.

As a whole, the core principles in guiding policymakers to design an effective policy toolkit to deal with real estate booms emerge as follows:

- Widen the policy perspective to recognize imbalances that do not necessarily show up in traditional measures of inflation targets and output gaps

- Recognize the local features of real estate markets and use targeted macroprudential tools rather than across-the-board monetary policy responses to respond to excessive and destabilizing movements in prices and activity

- Complement measures aiming to reduce the risk of bubbles with those aiming to increase the resilience of the financial system and well-defined resolution frameworks to speed up the cleaning in the aftermath of bubbles that survive the first line of defense

- Minimize distortions due to special treatment of housing and homeownership and strengthen supply-side response to mitigate the impact of demand shocks in the longer horizon

When it comes to applying these principles in practice, two important questions arise. First, what are the potential complementarities and conflicts between monetary and macroprudential policies and what is the best policy design framework to accommodate these? Undoubtedly, there is a complex relationship between the objectives of macroeconomic and financial stability, the primary objectives of monetary and macroprudential policy, respectively. Take the option of raising capital requirements for loans secured by real estate, which would increase the cost of borrowing in this segment through interest rate changes, which could also spillover to other loan types. Any kind of credit rationing that may stem from this move could also alter real activity. Both consequences are in the realm of monetary policy. In turn, recent studies show that loose monetary policy can fuel risk-taking incentives and build-up of leverage, which could warrant tighter macroprudential rules. Given these interactions, the best option may be to

consider the macroprudential policy framework alongside, not apart from, the monetary policy decision.

Second, should the macroprudential framework be based on discretion or rules? On the one hand, a discretionary framework has the advantage that the measures could be better calibrated to particular situations and circumvention may be less likely because of the temporary nature of the measure (less incentive, less time to learn). On the other hand, a rules-based framework could be better because political economy problems may be less severe (no fight to put measures in place during a boom), adjustment of private agents' behavior to the new framework may already accomplish a certain degree of prudence, and time inconsistency is not an issue. At the end, the best option may be a design with robust rules that allow discretion when needed.

REFERENCES

Adrian, Tobias and Hyun Song Shin, 2009, "Money, Liquidity, and Monetary Policy," *American Economic Review*, Volume 99 (2), pp. 600-605.

Agell, Jonas, Peter Englund, and Jan Södersten, 1995, "Svensk skattepolitik i teori och praktik (Swedish Tax Policy in Theory and Practice)," Appendix No. 1 to the Tax Reform Evaluation Report (SOU 1995:104).

Allen, Franklin and Elena Carletti, 2010, "What should Central Banks do about Real Estate Prices?," mimeo.

Allen, Marcus T., Jeff Madura, and Kenneth J. Wiant, 2009, "Commercial Bank Exposure and Sensitivity to the Real Estate Market," *Journal of Real Estate Research*, Volume 10 (2), pp. 129-140.

Angelini, Paolo, Stefano Neri, and Fabio Panetta, 2010, "Macroeconomic Stabilization Policies: Grafting Macroprudential Tools in a Macroeconomic Framework," Bank of Italy Working Paper.

Ball, Michael and Andrew Wood, 1999, "Housing Investment: Long-Run International Trends and Volatility," *Housing Studies*, Volume 14 (2), pp. 185-209.

Benigno, Gianluca and Pierpaolo Benigno, 2006, "Designing Targeting Rules for International Monetary Policy Cooperation," *Journal of Monetary Economics*, Volume 53 (3), pp. 473-506.

BIS, 2010, "Assessing the Macroeconomic Impact of the Transition to Stronger Capital and Liquidity Requirements," Interim Report by the Macroeconomic Assessment Group established by the Financial Stability Board and the Basel Committee on Banking Supervision, Bank for International Settlements: Basel, Switzerland.

Bloxham, Paul, Christopher Kent, and Michael Robson, 2010, "Asset Prices, Credit Growth, Monetary and Other Policies: An Australian Case Study," Reserve Bank of Australia Research Discussion Paper No. 2010-06.

Boeri, Tito and Pietro Garibaldi, 2010, "The Labor Market Consequences of Adverse Financial Shocks," mimeo.

Borio, Claudio and Ilhyock Shim, 2007, "What Can (Macro-)Prudential Policy Do To Support Monetary Policy?," BIS Working Paper No. 242.

Bourassa, Steven C. and William G. Grigsby, 2000, "Income Tax Concessions for Owner-Occupied Housing," *Housing Policy Debate*, Volume 11 (2), pp. 521-546.

Brzoza-Brzezina, Michal, Tomasz Chmielewski, and Joanna Niedzwiedzinska, 2007, "Substitution between Domestic and Foreign Currency Loans in Central Europe: Do Central Banks Matter?," National Bank of Poland Working Paper.

Capozza, Dennis R., Richard K. Green and Patric H. Hendershott, 1996, "Taxes, Mortgage Borrowing and House Prices," Wisconsin-Madison CULER Working Paper No. 96-06, University of Wisconsin Center for Urban Land Economic Research.

Caprio, Gerard Jr. and Daniela Klingebiel, 2003, "Episodes of Systemic and Borderline Financial Crises," World Bank Dataset.

Case, Karl E., John M. Quigley, and Robert J. Shiller, 2005, "Comparing Wealth Effects: The Stock Market versus the Housing Market," *B.E. Journal of Macroeconomics*, Volume 5 (1), pp.1-34.

Case, Karl E. and Robert J. Shiller, 1989, "The Efficiency of the Market for Single-Family Homes," *American Economic Review*, Volume 79 (1), pp. 125-137.

Case, Karl E. and Robert J. Shiller, 2003, "Is There a Bubble in the Housing Market?," *Brookings Papers on Economic Activity*, Volume 34 (2), pp. 299-362.

Christiano, Lawrence, Martin Eichenbaum, and Sergio Rebelo, 2009, "When is the Government Spending Multiplier Large?," NBER Working Paper No. 15394.

Claessens, Stijn, M. Ayhan Kose, and Marco E. Terrones, 2008, "What Happens During Recessions, Crunches and Busts?," IMF Working Paper No. 08/274.

Claessens, Stijn, Giovanni Dell'Ariccia, Deniz Igan, and Luc Laeven, 2010, "Cross-Country Experiences and Policy Implications from the Global Financial Crisis," *Economic Policy*, Volume 25, pp. 267-293.

Cremer, Helmuth and Firouz Gahvari, 1998, "On Optimal Taxation of Housing," *Journal of Urban Economics*, Volume 43 (3), pp. 315-335.

Cúrdia, Vasco and Michael Woodford, 2009, "Credit Spreads and Monetary Policy," NBER Working Paper No. 15289.

De Nicolo, Gianni, Giovanni Dell'Ariccia, Luc Laeven, and Fabian Valencia, 2010, "Monetary Policy and Bank Risk Taking," IMF Staff Position Note No 10/09.

Duca, John V., John Muellbauer, and Anthony Murphy, 2010, "House Prices and Credit Constraints: Making Sense of the U.S. Experience," Oxford University Working Paper.

Dunsky, Robert M. and James R. Follain, 2000, "Tax-Induced Portfolio Reshuffling: The Case of the Mortgage Interest Deduction," *Real Estate Economics*, Volume 28, pp. 683–718.

FDIC, 1997, *History of the 80s – Volume I: An Examination of the Banking Crises of the 1980s and Early 1990s*, Federal Deposit Insurance Corporation: Washington, DC.

Ferreira, Fernando, Joseph Gyourko, and Joseph Tracy, 2010, "Housing Busts and Household Mobility," *Journal of Urban Economics*, Volume 68 (1), pp. 34-45.

Galí, Jordi and Tommaso Monacelli, 2005, "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *Review of Economic Studies*, Volume 72 (3), pp. 707-734.

Gan, Jie, 2007, "The Real Effects of Asset Market Bubbles: Loan- and Firm-Level Evidence of a Lending Channel," *Review of Financial Studies*, Volume 20, pp.1941-1973.

Giavazzi, Francesco and Frederic S. Mishkin, 2006, "An Evaluation of Swedish Monetary Policy between 1995 and 2005," Report prepared for the Sveriges Riksbank.

Gordy, Michael B. and Bradley Howells, 2006, "Procyclicality in Basel II: Can We Treat the Disease Without Killing the Patient?," *Journal of Financial Intermediation*, Volume 15, pp. 395-417.

Guiso, Luigi, Michael Haliassos, and Tullio Jappelli, 2003, "Household Stockholding in Europe: Where Do We Stand and Where Do We Go?," *Economic Policy*, Volume 18 (36), pp. 123-170.

Hendershott, Patric H., Gwilyn Pryce, and Michael White, 2003, "Household Leverage and the Deductibility of Home Mortgage Interest: Evidence from U.K. House Purchases," *Journal of Housing Research*, Volume 14, pp. 49–82.

Hilbers, Paul, Inci Otker-Robe, and Ceyla Pazarbasioglu, 1997, "Analysis of and Policy Responses to Rapid Credit Growth," in *Rapid Credit Growth in Central and Eastern Europe*, eds. Charles Enoch and Inci Otker-Robe, Palgrave MacMillan: New York, NY.

Iacoviello, Matteo and Stefano Neri, 2010, "The Role of Housing Collateral in An Estimated Two-Sector Model of the U.S. Economy," *American Economic Journal: Macroeconomics*, Volume 2 (2), pp. 125.64.

Igan, Deniz, Alain N. Kabundi, Francisco Nadal-De Simone, Marcelo Pinheiro, and Natalia T. Tamirisa, 2009, "Three Cycles: Housing, Credit, and Real Activity," IMF Working Paper No. 09/231.

Igan, Deniz and Prakash Loungani, 2010, "Global Housing Cycles," forthcoming IMF Working Paper.

Igan, Deniz and Marcelo Pinheiro, 2010, "Exposure to Real Estate in Bank Portfolios," *Journal of Real Estate Research*, Volume 32 (1), pp. 47-74.

IMF, 2001, *Country Report No. 01/220 - Japan: Selected Issues* (Section 4. Real Estate and the Macroeconomy in Japan), International Monetary Fund: Washington, DC.

IMF, 2006, *World Economic Outlook (WEO): Globalization and Inflation* (Chapter 3. How Has Globalization Affected Inflation?), International Monetary Fund: Washington, DC.

IMF, 2009, *World Economic Outlook (WEO): Sustaining the Recovery* (Chapter 3. Lessons for Monetary Policy from Asset Price Fluctuations), International Monetary Fund: Washington, DC.

IMF, 2010, *World Economic Outlook (WEO): Recovery, Risk, and Rebalancing* (Box 1.4. Dismal Prospects for the Real Estate Sector), International Monetary Fund: Washington, DC.

IMF, forthcoming, "Managing Capital Inflows: What Tools to Use?," Staff Position Note, International Monetary Fund: Washington, DC.

Kannan, Prakash, Pau Rabanal, and Alasdair Scott, 2010, "Monetary Policy and Financial Stability Rules in a Model with House Price Booms," IMF Working Paper No. 09/251.

Keen, Michael, Alexander Klemm, Victoria Perry, 2010, "Tax and the Crisis," *Fiscal Studies*, Volume 31 (1), pp. 43-79.

Kiyotaki, Nobuhiro and John Moore, 1997, "Credit Cycles," *Journal of Political Economy*, Volume 105 (2), pp. 211-248.

Laeven, Luc and Giovanni Majnoni, 2003, "Loan Loss Provisioning and Economic Slowdowns: Too Much, Too Late?," *Journal of Financial Intermediation*, Volume 12 (2), pp. 178-197.

Laeven, Luc and Fabian Valencia, 2010, "Resolution of Banking Crises: The Good, the Bad, and the Ugly," IMF Working Paper No. 10/146.

Leamer, Edward E., 2007, "Housing IS the Business Cycle," NBER Working Paper No. 13428.

Mayer, Chris, Karen Pence, and Shane M. Sherlund, 2008, "The Rise in Mortgage Defaults," FRB Finance and Economics Discussion Series No. 2008-59.

Nolan, Charles and Christoph Thoenissen, 2009, "Financial Shocks and the U.S. Business Cycle," *Journal of Monetary Economics*, Volume 56 (4), pp. 596-604.

Ostry, Jonathan D., Atish R. Ghosh, Karl Habermeier, Marcos Chamon, Mahvash S. Qureshi, and Dennis B.S. Reinhardt, 2010, "Capital Inflows: The Role of Controls," IMF Staff Position Note 10/04.

Piazzesi, Monika and Martin Schneider, 2009, "Momentum Traders in the Housing Market: Survey Evidence and a Search Model," *American Economic Review*, Volume 99 (2), pp. 406-411.

Poterba, James M, 1984, "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach," *Quarterly Journal of Economics*, Volume 99 (4), pp. 729-752.

Reinhart, Carmen M. and Kenneth S. Rogoff, 2008, "This Time is Different: A Panoramic View of Eight Centuries of Financial Crises," manuscript.

Saurina, Jesús, 2009, "Dynamic Provisioning: The Experience of Spain," Crisis Response Note 7, The World Bank Group.

Schulhofer-Wohl, Sam, 2010, "Negative Equity Does Not Reduce Homeowners' Mobility," Federal Reserve Bank of Minneapolis Working Paper No. 682.

Stiglitz, Joseph E. and Andrew Weiss, 1981, "Credit Rationing in Markets with Imperfect Information," *American Economic Review*, Volume 71 (3), pp. 393-410.

Taylor, John B., 1993, "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, Volume 39 (1), pp. 195-214.

Wong, Jim, Laurence Fung, Tom Fong, and Angela Sze, 2004, "Residential Mortgage Default Risk in Hong Kong," Hong Kong Monetary Authority Working Paper.

APPENDIX

Stocktaking on the Current Status of Policy Frameworks

Gathered from various national and international sources, Appendix Table 1 gives a country-by-country account of monetary, fiscal, and regulatory frameworks in the context of real estate markets as of September 2010.

P-VAR Analysis of Monetary Policy

To analyze the relationship between monetary policy conditions and house price changes (examined in Section III.A) in a more formal setting, we run a panel vector autoregression (P-VAR) on quarterly data spanning 22 countries over the 1990-2007 period. The P-VAR includes six macroeconomic variables, ordered as GDP, CPI, house prices, the nominal effective exchange rate, the import price deflator, and the policy interest rate. All variables except the policy rate are in natural logarithms. In addition, all variables are de-trended by taking the residuals from a linear-quadratic time trend and country-specific intercepts. Estimation is via generalized method of moments (GMM) following Love and Ziccino (2006). The ordering of variables implies that policy responds contemporaneously to all the other variables in the system, but that other macroeconomic variables respond only with a lag to policy. This seems reasonable, except perhaps in the case of the exchange rate. Results are robust to an alternative ordering with the policy rate ordered after house prices but before the exchange rate and import prices. Note that the ordering implies that import prices respond contemporaneously to exchange rate changes; hence, the exogenous shocks to import prices should be unrelated to exchange rate developments.

Of particular interest are the responses of the other variables to exogenous import price shocks (e.g. as brought about by opening up of the Chinese economy). Following a negative shock to import prices, monetary policy is relaxed, output increases, house prices rise. Some of the house price response can be attributed to the output channel: a decrease in import prices acts as a positive supply shock, pushing up potential and actual output. Since house prices co-move with output, house prices will tend to rise even as the price of goods decreases. However, part of the impact of the import price shock is transmitted via monetary policy, since the house price response to a policy relaxation is positive and significant.

Looking at the share of the variation in house prices that can be accounted for by the different structural shocks identified in the P-VAR, the share that can be attributed to import price shocks increases steadily over time. At a 10-year horizon, more than 16 percent of total house price variation is due to import price shocks (greater than the share for any other variable apart from shocks to house prices themselves), with monetary policy shocks accounting for a further 8 percent. Import price shocks also appear to be a significant determinant of the monetary policy stance, accounting for around 13 percent of the variance in the policy rate at each horizon and exceeding the variance share attributable to shocks to the domestic price level. Thus, the monetary policy response appears to play a key role in transmitting import price shocks to the housing market.

Appendix Table 1. Policy Frameworks in the Context of Real Estate Booms by Country as of September 2010

| | Monetary policy framework | | Tax system | | Regulatory structure | | | | | | | |
| | | | | | Restrictions on … | | | | | | | |
	Credit growth explicitly considered?	Property prices explicitly considered?	Transactions tax?	Mortgage interest deductibility?	which financial institutions can extend mortgage loans?	type of mortgages?	loan-to-value ratio?	debt-to-income ratio?	mortgage credit growth rate?	real-estate-specific loan loss provisioning?	real-estate-specific risk weights?	full recourse on mortgages?
Argentina	no	no	yes, 0.15%	yes, subject to a ceiling	no, all banks and financing companies except credit unions	yes (cannot be indexed to inflation)	yes, de facto limit of 80%	yes, 30%	no	no	no	no
Australia	no, monitored but not stated as an objective	yes, to the extent that they are reflected in rents and housing purchase costs	yes, 5.5%	yes for investment properties, no for owner-occupied housing	no, but subject to special licensing	no	no, but high LTV may trigger higher capital adequacy ratings and private mortgage insurance requirements	no, but private mortgage insurance may require limits	no	yes	yes	yes
Austria	Eurosystem	Eurosystem	yes, 3.5%	yes for business purposes, no for private purposes with few exceptions and subject to a ceiling	no, all licensed institutions allowed	yes, on FX mortgages	no	no	no	no	no	yes, subject to a minimum for livelihood
Belgium	Eurosystem	Eurosystem	yes, 10-12.5% registration tax on existing buildings, 21% VAT on new buildings	yes, subject to a ceiling	no	no	no	no	no	yes	yes	yes
Bulgaria	no	no	yes	no	yes, only banks and some other non-bank financial institutions allowed	no	no	no	no	no	yes	yes
Canada	no	yes, through the "house replacement" and "mortgage interest cost" components of CPI	yes	no	yes, only federally-regulated institutions	no	yes, 80% for privately insured mortgages and 90% for government insured mortgages	yes, 45% for all existing debts	no	?	?	yes
Colombia	no	yes, to the extent that they are reflected in rental housing	yes, registration tax	yes	no	no	no	no	no	yes	no	?
Croatia	no	no	yes	no	no	no	no	no	no	yes	yes	yes
Cyprus	Eurosystem	Eurosystem	yes, 20%	no	no	no	yes, 80% for primary residence and 70% for commercial real estate	no	no	no	no	no

Appendix Table 1. Policy Frameworks in the Context of Real Estate Booms by Country as of September 2010 - continued

| | Monetary policy framework | | Tax system | | Regulatory structure | | | | | | | |
| | | | | | Restrictions on … | | | | | | | |
	Credit growth explicitly considered?	Property prices explicitly considered?	Transactions tax?	Mortgage interest deductibility?	which financial institutions can extend mortgage loans?	type of mortgages?	loan-to-value ratio?	debt-to-income ratio?	mortgage credit growth rate?	real-estate-specific loan loss provisioning?	real-estate-specific risk weights?	full recourse on mortgages?
Czech Republic	no	yes, through the "imputed rental" component in the targeted measure of inflation	yes, 3%	yes, subject to a ceiling	no	no	no	no	no	no	yes	yes
Egypt	no	no	yes, 2.5%	no	yes, only banks and mortgage companies allowed	no	no	yes, 40%	no	no	yes	?
Estonia	currency board	currency board	no, primary residence and summer house are exempt from the 21% tax applied to capital gains on other property	yes, subject to a ceiling	no	no	no	no	no	no	no	yes
Finland	Eurosystem	Eurosystem	yes, 1.6-4%	yes, subject to a ceiling	no	no	no (encouraged to avoid 90% and above)	no	no	no	no	no
France	Eurosystem	Eurosystem	yes, 5.1%	yes, subject to a ceiling and time limit (announced to be removed in 2011)	yes, only authorized credit institutions	no	no	no	no	no	no	yes
Germany	Eurosystem	Eurosystem	yes, 3.5%	no (abolished for properties bought after 1998)	no	no	yes, 80% for residential and 60% for commercial (60% for Pfandbriefe)	no	no	no	yes, indirectly as the treatment depends on the value of property	yes
Greece	Eurosystem	Eurosystem	yes, 9-11%	yes	no, all deposit-taking institutions allowed	no	no	yes, 30-40%	no	no	yes	yes (until recently)
Hong Kong	currency board	currency board	yes	no	yes, only commercial banks	yes	yes, HKMA actively sets LTVs	yes, 50%	no	no	no	yes
Hungary	no	no	yes	no	yes	yes	yes	no	yes	no	no	yes
Iceland	yes	yes, through the housing component based on imputed rents (that are affected by market prices for housing)	yes, 0.4% (plus 1.5% stamp duty on mortgage at issuance)	yes, subject to a ceiling	no	no	no	no	no	yes	yes	yes
India	yes	yes	yes, 12.5-14.5%	yes, subject to a ceiling	no	no	yes, 90%	no	yes	yes	yes	no
Indonesia	no	yes	yes	no	yes, banks and finance companies only	no	no	no	no	no	no	no

Appendix Table 1. Policy Frameworks in the Context of Real Estate Booms by Country as of September 2010 - concluded

	Monetary policy framework		Tax system		Regulatory structure							
					Restrictions on …							
	Credit growth explicitly considered?	Property prices explicitly considered?	Transactions tax?	Mortgage interest deductibility?	which financial institutions can extend mortgage loans?	type of mortgages?	loan-to-value ratio?	debt-to-income ratio?	mortgage credit growth rate?	real-estate-specific loan loss provisioning?	real-estate-specific risk weights?	full recourse on mortgages?
Korea	only indirectly	only indirectly	yes	yes	yes	yes	yes	yes	no	no	no	no
Lithuania	currency board	currency board	no	yes (abolished on Jan 31, 2010)	no	no	no	no	no	yes	yes	yes
Malaysia	no	yes, through housing costs of owner-occupied dwellings using imputed rents	yes, 5% (effective Jan 2010)	yes, subject to a ceiling and time frame and one residential unit	yes, commercial and islamic banks	no	yes, 90%	no	no	yes, cyclically-based as provisions increase with the period in default regardsless of collateral value	yes	no
Malta	Eurosystem	Eurosystem	yes, 5%	no	no	no	no	no	no	no	no	yes
Netherlands	Eurosystem	Eurosystem	yes, 6%	yes	yes, only licensed institutions	no	no (planning to introduce 100% limit-and 112% for mortgages with government guarantee- in 2011)	yes	no	no	no	yes
Norway	yes	yes	yes, 2.5%	yes	no	no	yes, 90%	yes, ~30%	no	no	no	yes
Poland	yes	yes, to the extent that prices move with rental housing, included in the target measure	yes	no (abolished in 2007)	yes, all except credit cooperatives	no	yes, 'recommendation T'	yes, 'recommendation T'	no	no	no	yes
Russia	no	no	yes, subject to restrictions	yes, subject to restrictions	yes, only licensed institutions	no	yes, but only for loans purchased by state agency (60%)	yes, but only for loans purchased by state agency (45%)	no	yes	no	yes
Slovak Republic	yes	no	yes	yes	yes	yes, only residential	yes	no	no	no	no	…
Spain	Eurosystem	Eurosystem	yes	yes, subject to a ceiling	no	no	no	no	no	yes, cyclically-based	yes, higher for high-LTV	yes
UAE	no	no	no	no	no	no	no	no	no	no	no	no
Ukraine	no	no	yes, 1%	yes	yes	yes	yes, 100%	yes	yes	yes, cyclically-based as reserve requirements for forex loans were increased when credit activity was on the rise	yes, cyclically-based as reserve requirements for forex loans were increased when credit activity was on the rise	yes
United Kingdom	no	no	yes, 0-4%	no	no	no	no	no	no	no	no	yes
United States	no	yes, through the "owner's equivalent rent" component	yes	yes	no	no	yes, mortgage insurance required for LTV>80%	no	no	no	yes	yes/no, depends on the state
Uruguay	no	yes, to the extent that prices affect rents	yes, 36.8%	no	no	no	yes, 90% but only for 'special loans'	yes, 20-30%	no	yes, subject to a dynamic setting that applies to all loans	no	yes

Appendix Table 2. Results of Regression Analyses

Panel A. House Prices and Local Property Tax Rates in 243 U.S. Metropolitan Statistical Areas between 1998 and 2007

Dependent Variable	Price Growth			Price Volatility		
	I	II	III	IV	V	VI
Estimation Method	OLS	OLS	2SLS	OLS	OLS	2SLS
Property Tax Rate	-0.048**	-0.052***	-0.183***	-0.075***	-0.041***	-0.157***
	[0.022]	[0.015]	[0.043]	[0.024]	[0.014]	[0.050]
Housing Supply Elasticity		-0.202**	-0.212***		-0.025	-0.068
		[0.083]	[0.079]		[0.026]	[0.069]
Population Growth		0.467***	0.292***		0.122	-0.025
		[0.083]	[0.108]		[0.106]	[0.124]
Per Capita Income Growth		1.123***	0.954***		-0.416***	-0.432***
		[0.136]	[0.158]		[0.143]	[0.153]
SD (Population Growth)					0.431***	0.283
					[0.163]	[0.191]
SD (Per Capita Income Growth)					-0.113*	-0.138**
					[0.061]	[0.063]
Longitude		0.779***	0.669***		0.143	0.076
		[0.105]	[0.114]		[0.110]	[0.118]
Longitude^2		0.004***	0.003***		0.001	0.0004
		[0.001]	[0.001]		[0.001]	[0.001]
Share of Foreign-Born		6.834***	10.191***		6.381***	10.071***
		[1.996]	[2.159]		[1.773]	[2.383]
Share of Unmarried Households		44.756***	66.911***		20.293**	43.900***
		[9.353]	[12.108]		[8.419]	[14.830]
Price Growth					0.787***	0.715***
					[0.077]	[0.079]
Constant	6.024***	35.879***	32.391***	4.135***	5.686	3.782
	[0.296]	[4.962]	[5.442]	[0.342]	[5.136]	[5.475]
Observations	307	243	243	307	243	243
R-squared	0.01	0.72	0.66	0.02	0.83	0.80
Identification test stat Chi2[1]			0.48			0.82
P-value			0.49			0.37
Underidentification test stat Chi2[2]			33.54			22.49
P-value			0.00			0.00
Weak identification stat			34.65			13.82
Crit. Value [10% Maximal IV size]			19.93			19.93
Crit. Value [15% Maximal IV size]			11.59			11.59
Anderson-Rubin Wald test F[2,233]/F[2,230]			11.69			7.027
P-value			0.00			0.00

Panel B. House Prices and Loan-to-Value Ratios in 50 U.S. States between 1978 and 2008

Dependent Variable	Annual House Price Appreciation			
	I	II	III	IV
LTV, lagged	0.132	0.273*	0.464**	0.429**
	[0.128]	[0.160]	[0.191]	[0.181]
State fixed effects	No	Yes	Yes	Yes
Year fixed effects	No	No	Yes	Yes
State*Year fixed effects	No	No	No	Yes
Observations	1528	1528	1528	1528
R-squared	0.00	0.00	0.10	0.16

Notes: In Panel A, we analyze price developments in the U.S. at the Metropolitan Statistical Area (MSA) level. MSAs are agglomerations of counties, typically centered on a large urban conurbation. Counties are included in a particular MSA (or, in the majority of cases, in no MSA) based on factors such as commuting patterns. This means that an MSA typically corresponds to a unified local housing market. Price growth and volatility are measured by the mean and standard deviation, respectively, of change in log annual average price index. In the 2SLS estimation, the excluded instruments are latitude and commuting time (column III) and latitude and the Wharton Residential Land Use Regulatory Index (column VI). In Panel B, we analyze price developments in the U.S. at the state level. House price data come from FHFA (formerly OFHEO), information on property tax rates is provided by NHBA. LTVs are as reported at loan origination and are obtained from the Monthly Interest Rate Survey of the FHFB. Other data sources include U.S. Census Bureau and BEA. Robust standard errors are in brackets. ***, **, * correspond to significance at the 1, 5, 10 percent level, respectively.
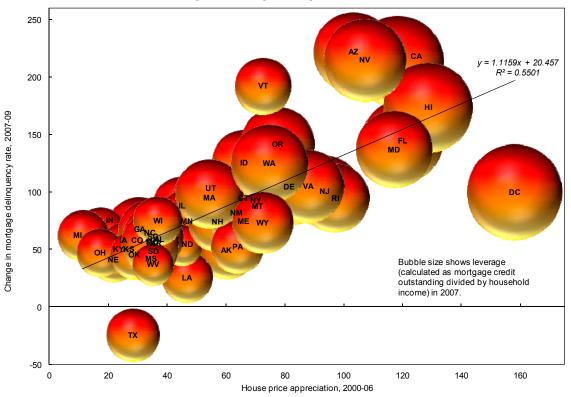
Figure 1. Leverage: Linking Booms to Defaults

$y = 1.1159x + 20.457$
$R^2 = 0.5501$

Bubble size shows leverage (calculated as mortgage credit outstanding divided by household income) in 2007.

Change in mortgage delinquency rate, 2007-09

House price appreciation, 2000-06

Sources: Federal Housing Finance Agency, Mortgage Bankers Association, Bureau of Economic Analysis, U.S. Census Bureau.
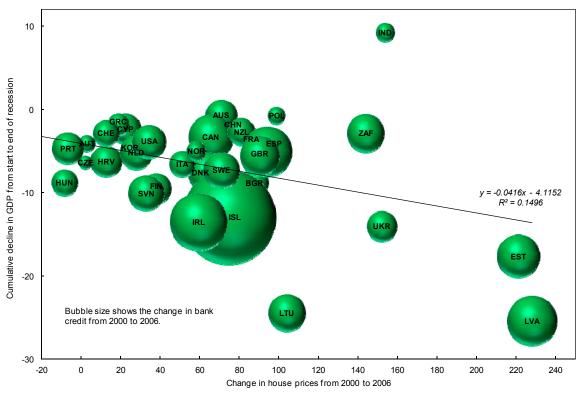
Figure 2. House Price Run-Up and Severity of Crisis
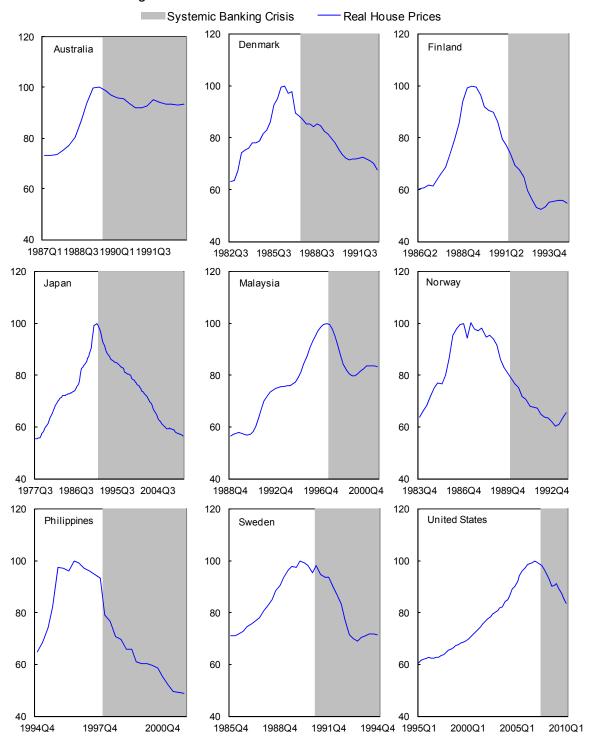

Source: Claessens et al (2010).

Figure 3. House Price Boom-Busts and Financial Crises

Sources: OECD, Global Property Guide, IMF staff calculations.
Note: Crisis dates, shown in gray, are from the 2003 update of the Caprio-Klingebiel Database (1996, 1999) by Caprio, Klingebiel, Laeven, and Noguera, further complemented in Laeven and Valencia (2010).
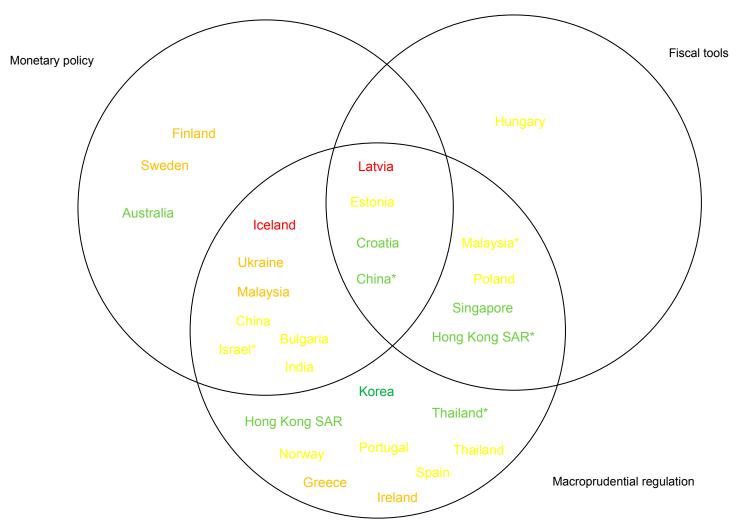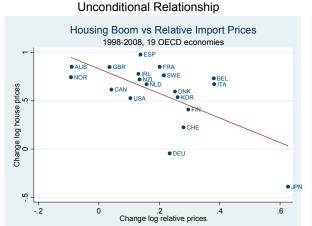
Figure 4. Policy Responses and Effectiveness in Dealing with Real Estate Booms
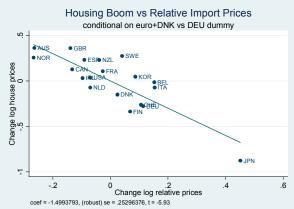

Sources: IMF country reports; Hilbers, Otker-Robe, and Pazarbasioglu (2007); Borio and Shim (2007); Laeven and Valencia (2010); authors' calculations.

Notes: The colors of country names indicate the effectiveness of policy response in terms of the impact on real estate price and credit growth rates and the incidence of a systemic banking crisis. A score of 1 is assigned if the percent decline in a growth rate is in the top quintile of the cross-country distribution. A score of 0 (1) is assigned if the boom episode was followed by a (borderline) systemic crisis and a score of 2 is assigned if there were no crisis. Hence, the final score (i.e., the sum of all scores) range from 0 to 4, 4 being the best outcome with largest decline in the magnitude of the boom and avoidance of a crisis. Red, orange, yellow, green, and dark green correspond to scores of 0, 1, 2, 3, and 4, respectively. * indicates that the episode is incomplete but there has been no crisis so far. For each country, the period during which the policies were implemented reflects the country experience in Table 3. China, Hong Kong SAR, Malaysia, and Thailand have employed different combinations of policy tools during different episodes: China monetary and macroprudential tools in 2005-07 and all three sets of tools in 2009-10; Hong Kong SAR macroprudential tools in 1991-97 and macroprudential and fiscal tools in 2009-10; Malaysia monetary and macroprudential tools in 1994-97 and macroprudential and fiscal tools in 2009-10; Thailand macroprudential tools in 2003 and 2010.
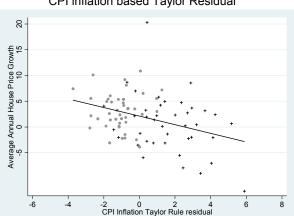
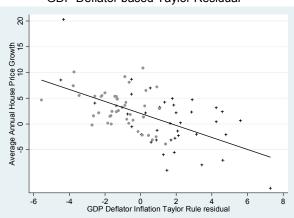## Figure 5. House Price Boom, Relative Import Prices, and Taylor Residuals

Notes: The relative price level of imports is measured as the ratio of the implicit price deflator for imports of goods and services to the GDP deflator, taken from the IMF's WEO database. The top left chart plots the simple bivariate relationship; the top right chart shows the partial relationship, controlling for the asymmetric impact of ECB monetary policy inside the eurozone, which appears to have been a key factor in driving the divergent house price dynamics within this region. The ECB sets a single monetary policy for the entire eurozone, but since economic conditions vary significantly across the currency area, this policy is too tight in some countries and too loose in others, relative to policy set optimally for each country. For instance, domestic demand growth was extremely weak at the core (Germany), but very robust in some countries in the periphery (e.g. Ireland and Spain), and policy was thus too tight for the former and too loose for the latter. As a crude way of capturing this asymmetry, the regression underlying the top right chart includes, in addition to the relative price term, a dummy variable that takes the value of -1 for Germany, 1 for eurozone countries other than Germany (including Denmark as its currency is tightly pegged to the euro), and 0 for non-eurozone countries. This variable is a statistically and economically significant determinant of the magnitude of house price appreciation; together the two variables account for more than three quarters of the total cross-sectional variation in the extent of the housing boom across our set of 19 advanced economies. The Taylor residual shown in the bottom charts is based on 5-year averages covering quarterly data for 22 countries since the start of the 1990s. The bottom left chart uses CPI inflation to construct the Taylor residual; the bottom right chart uses the GDP deflator. In each case observations for the last two periods, covering the period after 2000 that generally coincides with the peak of the housing boom, are shown in gray; earlier observations are shown in black.

Figure 6. Mortgage Loan Granting and Monetary Policy

Sources: Home Mortgage Disclosure Act database, Federal Reserve Board.
Notes: All values are expressed in percent. Subprime lenders are identified based on the list prepared by the Department of Housing and Urban Development. Denial rate is calculated as the number of denied mortgage loan applications divided by the total number of applications.

Figure 7. Maximum LTV and House Prices

$y = 1.3006x - 46.772$
$R^2 = 0.1728$

Sources: EMF, BIS, OECD, UNECE, ECLAC, IADB, IUHF, IUT, national statistics, and central bank statistics.

Figure 8. Impulse Response to a One-Percent Permanent Reduction in the Loan-to-Value Ratio

Table 1. Policy Options to Deal with Real Estate Booms

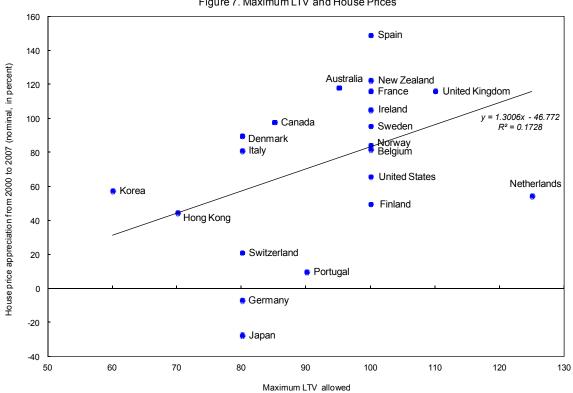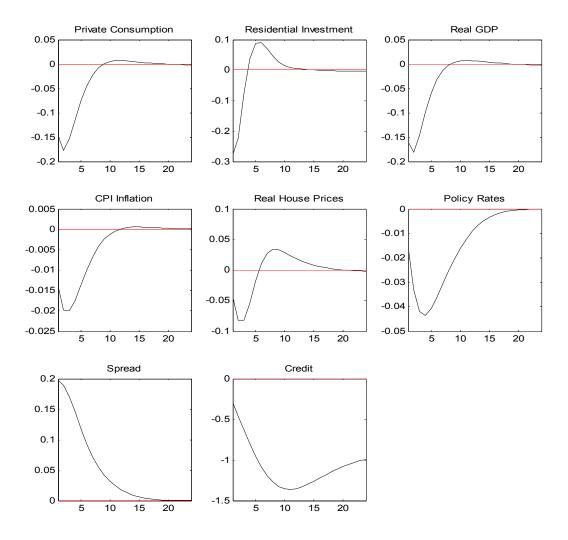|	Potential impact	Side effects	Practical issues
Macroeconomic Policy			
Monetary measures			
Interest rates / Reserve requirements — responding to property prices and/or real estate loan growth	potential to prevent booms, less so to stop one that is already in progress	inflict damage to economic activity and welfare	identifying 'doomed' booms and reacting in time; constraints imposed by monetary regime
Fiscal measures			
Transaction / Capital gains taxes linked to real estate cycles	automatically dampen the boom phase	impair already-slow price discovery process	incentive to avoid by misreporting, barter, folding the tax into the mortgage amount
Property taxes charged on market value	(could) limit price increase and volatility	-	little room for cyclical implementation
Abolition of mortgage interest deductibility	reduce incentives for household leverage and house price appreciation	-	little room for cyclical implementation
Regulatory Policy			
Macro-prudential measures			
Differentiated capital requirements for real estate loans / Higher risk weights on real estate loans	increase cost of real estate borrowing while building buffer to cope with the downturn	costs associated with potential credit rationing	may get too complicated to enforce, especially in a cyclical context; effectiveness also limited when capital ratios are already high
Dynamic provisioning for loans collateralized by real estate	increase cost of real estate borrowing while building buffer to cope with the downturn	earnings management	data requirements and calibration
Limits on mortgage credit growth	(could) limit household leverage and house price appreciation	loss of benefits from financial deepening	move lending outside the regulatory periphery
Limits on exposure to real estate sector	(could) limit leverage and price appreciation as well as sensitivity of banks to certain shocks	costs associated with limiting benefits from specialization	shift lending to newcomers for whom exposure limits do not yet bind or outside the regulatory periphery
Limits on loan-to-value ratio / Limits on debt-to-income ratio	(could) limit household leverage and house price appreciation while decreasing probability of default	costs associated with potential credit rationing	calibration is difficult, circumvention is easy

Table 2. Stylized Facts on Policy Responses to Real Estate Booms: Stocktaking

Measure	To address ...	Used in ...	Impact?
Macroeconomic			
Monetary tightening	Rapid credit growth and/or real estate boom	Croatia, Iceland, Latvia, Ukraine; Australia, Israel, Korea, Sweden	Not always effective, capital flows and currency switching risk are are major limitations
Maintaining a flexible and consistent FX policy	Rapid credit growth	Poland, Romania	FX-denominated credit growth slowed down in Poland but not in Romania
Fiscal tightening or removal of incentives for debt financing (e.g. mortgage interest tax relief)	Rapid credit growth and/or real estate boom	Estonia, Netherlands, Poland, United Kingdom; Lithuania, Spain	Limited effect on house prices, slightly more on household leverage
Additional/higher transaction taxes to limit speculative activity	Real estate boom	China, Hong Kong SAR, Singapore	Some effect on transaction acitivity, but not long lasting
Macro-prudential			
Higher/differentiated capital requirements or risk weights by loan type	Rapid credit growth and/or real estate boom	Bulgaria, Croatia, India, Poland, Norway	Not always effective, some side-effects of shifting the risk elsewhere in the system
Tighter/differentiated loan classification and provisioning requirements	Rapid credit growth and/or real estate boom	Bulgaria, Croatia, Greece, Israel, Ukraine	Limited effect
Dynamic provisioning	Resilience to cyclical downturn/bust	China, Colombia, India, Spain, Uruguay	So far so good
Tightening eligibility requirements, e.g. limits on loan-to-value ratios	Real estate boom	China, Hong Kong SAR, Korea, Malaysia, Singapore; Sweden	Short-lived effect on prices and mortgage activity

Notes: The table gives a snapshot, it is not meant to be a comprehensive and detailed list of cases where authorities took one or more of the measures listed to address credit/real estate developments. Bolivia and Peru have also put in place a dynamic provisioning framework and Romania had employed a battery of policy measures to address rapid credit growth; yet these countries are not included in the table due to lack of house price data. Dynamic provisioning in China and India is discretionary rather than rules-based.

Table 3. Country Experiences with Various Policy Responses

Country	Background	Action	Outcome
Australia	The boom that started in 1996 has been unprecedented both in amplitude and duration. High immigration and urbanization, supply shortages, and low interest rates pushed up prices, leading to the largest deviation in price-income ratios in record since 1970. The boom was briefly interrupted by the ripple effects of the global financial crisis but rebounded quickly on the back of policy measures aimed at addressing the fallout from the crisis (e.g. increased assistance to first-time home buyers). House prices, as of mid-2010, are 129 percent higher, in real terms, than they were in 1995 while mortgage debt to GDP ratio has almost tripled over the same period.	The RBA has used monetary policy to 'lean against the wind', especially in the early phases (2002-03). It has also use its regular communication channels to express some level of concern about a housing bubble and high household indebtedness. The Treasury recently sounded the alarm on a 'property bubble', warning market participants of the risks of a bust.	It is not clear how effective leaning against the wind has been in limiting property price appreciation and household debt build-up. House prices leveled off through 2004 and 2005; but they picked up again in 2006 (amidst further policy rate hikes) and household debt levels hardly lost pace.
Bulgaria	Like in many other countries in the region, credit, especially to households and in the form of mortgages, grew rapidly following the transition and at the prospects of EU membership. A credit boom was accompanied by a house price boom in early 2000s.	In the first stage, moral suasion was tried through public statements and meeting with 'aggressive' banks. Later on, rules were put in place. Through 2004 and 2005, loan classification and provisioning requirements were tightened and more stringent rules on capital adequacy were adopted (in particular, restriction on conditions under which current profits can be counted in the capital base). Differential risk weights were introduced: mortgages with LTV exceeding 70 percent would be risk-weighted at 50 percent and, if this is violated, the risk-weight on the loan would be 100 percent. Tighter reserve requirements were implemented in 2004 by reducing the share of vault cash in eligible assets and broadening the liability base to deposits and securities with longer maturity and repos. Marginal reserve requirements for banks exceeding the average credit growth rate came into effect in February 2005 aimed at cutting rapid credit growth.	Credit growth decelerated somewhat but it was only in late 2008, with the global financial crisis, that it came to a significant halt. Similarly, house price appreciation remained strong, recording 42 percent from 2005 to 2008. On the positive side, capital adequacy ratios had reached adequate levels by 2006 and credit risk in the corporate sector seemed to be contained, sparing the banking system from a full-blown systemic crisis. Yet, risks in the household sector had actually increased and foreign borrowing by banks to fund these loans created significant vulnerabilities.
China	Construction boomed and property prices increased 30 percent between 2000 and 2005. Worries of overheating were quickly abandoned in 2008, but the downturn following the global financial crisis was cut short partly owing to government initiatives to support real estate markets as part of the crisis mitigation package. Strong income growth, coupled with restrictions on investing abroad and limited array of investment instruments at home, and capital inflows have boosted property prices further, renewing concerns of a bubble. House price appreciation remained in excess of 10 percent over the past year.	A maximum LTV of 80 percent was established as early as 2001, and a reduction to 70 percent was urged for certain segments in 2005 and 2006. Limits on DTI exceeding 50 percent were introduced in 2004. These were accompanied by increases in the mortgage rate and reserve requirements. Starting in late 2009, the authorities adopted a new battery of measures to tame property markets. These so far included folding back of certain tax incentives (December 2009), tightening of eligibility criteria for land development projects (December 2009), issuance of "National 11' measures to increase supply of low-income housing (January 2010), issuance of 'National 19' measures to prevent land hoarding (March 2010), requiring state-owned enterprises to exit property lending business if it is not already their core (March 2010), ordering banks not to extend loans to speculators, to raise minimum mortgage rates on second homes to 1.1 times the base rate while increasing downpayments from 20 to 30 percent for first homes and from 40 to 50 percent for second homes, issuance of 'New National 10' measures to curb price appreciation (through taxes, mortgage rates, and supervision), to halt release of mortgages for third homes in regions with overheated prices, to restrict purchases by non-residents, prohibit insurance funds from investing in real estate (April 2010), tighten the definition of second home mortgage -on household, rather than individual, basis and applicable even if a previous mortgage has been fully repaid (June 2010). Moral suasion, often part of the action, became more pronounced in August 2010 when the Ministry of Land and Resources announced that it has prepared a list of companies that hold rights to unused plots of land for the banking regulator to conduct a risk assessment (80 percent of these plots may be repossessed by the government) while CBRC advised commercial banks to stop lending to third-home buyers and, if not, to raise the downpayment to 60 percent and the mortgage rate to 1.5 times the base rate.	The first wave of measures in 2005-07 were credited for the controlled growth of mortgage loans, which stood at 11 percent of GDP in 2008 up from 9 percent in 2004. Prices also climbed up at a slower rate in 2006-07. The second wave, however, appears to be less effective (at least so far). There is little indication of slowing down in transaction activity and price appreciation, apart from short-lived drops such as the one induced by the measures taken in April 2010 (prices and activity surged again in August). Moreover, despite efforts to limit further investment in the 'speculative' segments of the real estate market, developers continue to add construction projects into the pipeline in high-end residential and commercial market segments while affordable housing segment lags behind.

Table 3. Country Experiences with Various Policy Responses - continued

Country	Background	Action	Outcome
Croatia	Reconstruction efforts and return of refugees following the end of the war and substantial economic reforms jump-started the housing markets. With the restoration of political and macroeconomic stability, capital started flowing in and growth prospects improved. Mortgage credit grew rapidly at an annual rate of 31 percent between 2003 and 2007. House prices surged by a cumulative rate of 30 percent over the same period.	Starting from 2001, a long list of measures was taken. In addition to fiscal consolidation and monetary tightening, speed limits on credit were introduced through various measures. These included direct credit controls obliging banks whose loan portfolio grew by more than 4 percent per quarter to buy central bank bills at penalty rates in an amount twice as high as 'excess credit' (January through December 2003, reintroduced in 2007 at half the amount) and applying higher capital adequacy standards to rapidly growing banks (early 2004), in addition to measures targeted at currency risk such as additional liquidity requirements increasing the ratio of foreign liquid assets to foreign borrowing to 24 percent (January 2003, increased to 35 percent in February 2005 but cut down to 32 percent in March 2005), marginal reserve requirement of 35 percent on foreign borrowing (July 2004), and higher risk weights for loans extended to debtor with currency mismatch (2005). In 2006, maximum LTV limit of 75 percent on mortgage loans was introduced. At the same time, approval of new loans was prohibited if the borrower's average monthly income does not cover the total repayment obligations.	Credit growth slowed down somewhat in 2003 and 2004, but resumed its speed again until the global financial crisis hit. Overall, impact on foreign borrowing was small, if any, while there were some unintended consequences. In particular, borrowers with access to foreign lenders shifted their borrowing from domestic banks and subsidiaries of foreign banks to the parent banks abroad. Risks were shifted not only across borders but also through the regulatory perimeter with funding by leasing companies increasing and insurance companies bearing a substantial part of the risk in banks' retail portfolios. In addition, circumvention attempts (e.g. collateralization, asset swaps, accelerated NPL write-offs) contaminated monetary and banking statistics. On the positive side, house price dynamics were not as strong as in some neighboring countries despite foreign demand for properties on the Adriatic Coast. Yet, it is hard to say how much of this was due to the LTV and DTI regulations since house price appreciation faltered only in 2008 as the global financial crisis gained momentum.
Estonia	Against the background of the recovery after the 1992-94 banking crisis and the accession to the EU, house prices quadrupled in real terms between 1999 and 2007. Mortgage credit grew at an annual rate of 52 percent from 2000 to 2006, bringing the outstanding loans to GDP ratio from a very low 5 percent in 2000 to 36 percent in 2007.	The central bank and the supervisory authority used moral suasion stressing the importance of conservative lending practices in meetings with the banks and advising the general public on the risks of rapid credit growth in regular communications. In an effort to reduce incentives for debt-financed home ownership, mortgage interest tax deductibility was reduced in 2004. Later in 2006, risk weights for mortgage loans were raised from 50 to 100 percent, the reserve requirement base was extended to include half of the amount of mortgage loans with risk weight less than 100 percent and liabilities to foreign banks on a gross basis, and reserve requirements in general were increased from 13 to 15 percent.	Mortgage credit growth remained robust, and so did house price appreciation. It is hard to say how much worse things have been without moral suasion and the reduction of mortgage interest tax deductibility. It is, however, clear that the measures did not stop a very strong boom-bust cycle and the severe fallout in economic activity from the global financial crisis. The measures taken later to increase the cost of mortgage loans may have been a little bit too late to contain the boom itself, but they may have helped with the silver lining that the banking sector dodged a systemic crisis.
Finland	Amidst financial deregulation and capital inflows, real house prices increased by 116 percent while outstanding household debt rose from 28 percent of GDP to 45 percent from 1979 to 1989.	The policy response came only in the later phase of the boom. Through 1988-90, cash reserve requirements were increased, on eight occasions, from 5.3 percent to 8 percent. The ratio was lowered to 7 percent in December 1990. Between February and December 1989, 'supplementary reserve agreement' increased the cash reserve requirement further for high-speed lending, namely, lending to individuals growing more than 20 percent. The measure was abolished in early 1990.	Perhaps the measures were too little, too late. The bust came revealing the underlying vulnerabilities and the crisis hit hard, costing an estimated 21 percent of GDP in output loss (Caprio and Klingebiel, 2003).
Greece	Stimulated by the favorable economic conditions on the way to the euro adoption, household credit growth accelerated, rising by 30 percent in 1998 and pushing the outstanding household debt to disposable income ratio from 27 percent in 2000 to 52 percent in 2004. Mortgage loans were, in particular, grew fast, bringing the mortgage debt to GDP ratio from a mere 4 percent in 1995 to 23 percent in 2004. Real house price appreciation reached 67 percent over the same period.	The authorities imposed direct credit controls by requiring non-remunerated deposits for an amount equivalent to the growth of credit above specified rates in April 1999, doubling the penalty for excess growth in July 1999, and extending the measure through March 2000; the restrictions were lifted shortly after in April 2000. To prevent a flood of liquidity when compliance with the eurozone's 2 percent reserve requirement, freed-up reserves were converted to blocked interest-bearing deposits at the central bank and gradually released by end-2001. In 2005, additional measures were introduced to address the unsubdued lending to households. These included higher provisioning ratios for doubtful consumer loans from 84 to 100 percent and a limit of 40 percent on household debt servicing ratios.	There is hardly any evidence that the measures accomplished what they had set out to do. Rapid credit growth and house price appreciation continued at a robust pace in 2006. In general, it is likely that the efficacy of the macro-prudential measures were at least partially undone by the accommodative monetary conditions, as a result of financial convergence with the eurozone.

Table 3. Country Experiences with Various Policy Responses - continued

Country	Background	Action	Outcome
Hong Kong SAR (1990s)	With naturally limited land supply and one of the world's largest public housing sectors, Hong Kong real estate markets have been historically volatile. In the run-up to the Asian crisis, real estate prices started inflating in the late 1980s and accelerated in 1993. Mortgage loans as a percent of GDP also grew rapidly.	Maximum LTV limits have been in effect since the 1990s, possibly due to awareness of real estate bubbles gained from the Japanese experience. In 1991, the limit was reduced from 80-90 percent to 70 percent. As prices accelerated, additional measures including real estate exposure limits of 40 percent of total loan portfolio and a ceiling of 15 percent per annum on mortgage lending growth were introduced in 1994. LTV limit was further reduced to 60 percent for luxury residences in 1997 while the exposure limit of 40 percent was abolished in July 1998, after the market plunged.	House prices paused for what looked like a smooth lending in 1994, but then accelerated again at the end of 1995. Similarly, mortgage debt to GDP ratio kept on rising sharply. So, there appears to be little evidence that the measures were successful in preventing the bubble. Yet, the bust, comparable in magnitude to the Nordic crisis, hardly hurt the banks, which provide virtually the entire supply of housing finance. Hence, even when they cannot stop the herd, macro-prudential measures may help limit the damage to the banking system.
Hong Kong SAR (2000s)	Following the boom-bust between 1995 and 2003, prices increased modestly until the second half of 2007, but then accelerated. Not counting the brief but sharp downturn around the global financial crisis in the second half of 2009, as of 2010Q3, house prices have increased 45 percent since 2007Q2.	Since September 2009, the authorities have made several moves to tighten loan eligibility criteria. Maximum LTV for properties with value of HK$20 million or more was lowered to 60 down from 70 percent in October 2009. The rule was tightened again in August 2010 by extending the 60 percent limit to properties valued at or above HK$12 million as well as to non-primary-residence loans and by putting a loan cap of HK$7.2 million on mortgages subject to the 70 percent LTV guideline. Also, the limit on DTI was standardized at 50 percent from the previous 'range' of 50-60 percent. In addition, the stamp duty was increased from 3.75 to 4.25 percent on transactions above HK$20 million with no option to defer payment starting in April 2010. Plans to increase land supply were announced in August 2010. At the same time, Hong Kong Mortgage Corporation stopped providing insurance on mortgage applications with LTV greater than 90 percent, down from the previous hurdle of 95 percent. In October 2010, immigration based on property investment (the 'Capital Investment Entrant Scheme') was temporarily suspended and land provision for 20,000 private residential units annually was pledged for the next 10 years. In November 2010, with the aim of further clamping down on speculators, stamp duty was increased as high as 15 percent for properties re-sold within six months of purchase and LTV limits were tightened (50 percent for non-owner-occupied residential properties, commercial/industrial/company-owned properties, properties carrying a mortgage based on borrower's net worth, and residential properties valued at or above HK$12 million; 60 percent for residential properties valued between HK$8 million and HK$12 million, subject to a loan cap of HK$6 million; 70 percent for residential properties valued below HK$8 million, subject to a loan cap of HK$4.8 million).	So far, the impact has been limited. Prices remain on the rise with transaction activity bouncing back after small, temporary declines immediately after the interventions. The question remains on whether the measures are targeting the actual source of the froth in real estate markets: LTVs at origination have been stable and there is no indication of rapid growth in household indebtedness. Instead, buyers from mainland China appear to be the main drivers of real estate market activity. If this is the case, the question arises of whether macro-prudential policy targeted at domestic credit is the appropriate response to a boom driven by "outside" forces rather than domestic dynamics.
Hungary	A house price rally, driven mainly by new housing subsidies, characterized the first few years of the 2000s. A combination of grants for young couples with children to construct, improve, and buy homes, tax relief for new residential construction, stamp duty waivers, and interest rate subsidies for mortgages spurred loans to households for house purchase, which in December 2003 stood almost five times its level in December 2001 in nominal terms. Real house price appreciation was 11 percent per annum during this period.	The subsidies were substantially reduced in December 2003 and January 2004, marking a peak in the house price cycle and significantly reducing the growth in mortgage lending. Banks rushed to fill in the void by offering foreign-currency-denominated loans at rates near the old, subsidized ones. The shift got attention: the central bank issued a report in 2006 warning about the substantial risk to financial stability posed by foreign borrowing and followed up with a survey on foreign-currency mortgage holders in January 2007 concluding that most borrowers did not understand what would happen if the forint depreciated. Efforts to promote financial literacy among the public (e.g. a pilot program in high schools to teach rudimentary finance) followed.	House prices stabilized in 2005 but credit to households, especially in foreign currency, continued to grow fast. The banking system was not able to absorb the losses when house prices started to decline rapidly in the second half of 2007 and the global financial market turmoil began. Going forward, policymakers appear to be more vigilant: regulation to safeguard future household credit quality have come into effect in 2010, including 75 percent LTV limit for all mortgage and long-term consumer loans denominated in forint and even lower limits applying to loans in foreign currency (effective March 1) and modification in banks' scoring systems for approval of household loans such that the monthly installment for a loan denominated in foreign currency will be lower than the installment for a comparable forint loan (June 1).

Table 3. Country Experiences with Various Policy Responses - continued

Country	Background	Action	Outcome
Iceland	House prices increased 75 percent from 2000 to 2007 while the mortgage credit to GDP ratio doubled to 121 percent. The enormous increase in credit was mostly financed through short-term foreign borrowing by deposit money banks.	Liquidity requirements were tightened (February 1999), the key policy rate was raised several times between 1998 and 2001, and moral suasion was exercised to limit risk-taking and use of short-term foreign capital in the financial institutions. Monetary policy eased following the burst of the dot-com bubble, but tightening resumed in the second quarter of 2004.	Early on, liquidity requirements appeared to coincide with an improvement in liquidity positions and reduction of short-term foreign liabilities as credit growth slowed down. Yet, these initial effects did not last: both credit and house price increases gained momentum with the easing of monetary policy and did not show any pause in response to higher policy rates that followed. Since the last monetary policy hike pricked the bubble in late 2008, Iceland has become a textbook example of dangers posed by credit and asset price booms. (Also important were the decision to allow local investor groups -who had major expansion plans- gain controlling stakes in the banks, a decision considered to be political and dissented by the Financial Supervisory Authority, and dismissing poor quality of capital, sometimes coming from connected parties, and large cross-exposures.)
India	Strong economic growth and urbanization started a real estate boom, especially in large city centers. Construction activity soared but supply still lagged behind demand, marred by inadequate infrastructure and redtape in planning and land-use laws. Commercial rents sky-rocketed while residential property prices rose more than 20 percent from 2002 to 2005. Credit to the private sector, including loans to households for housing and consumer credit, grew rapidly.	As a temporary counter-cyclical measure, risk weights on housing and consumer credit loans were increased by 25 basis points in October 2004. This was followed up by an increase in risk weights for housing loans from 50 to 75 percent, for consumer credit from 1000 to 125 percent, and for commercial real estate exposure from 100 to 125 percent in July 2005. At the face of continuing boom, general provisions for standard assets were increased across the board from 0.25 to 0.4 percent in October 2005 and the risk weight on commercial real estate exposure was further increased to 150 percent in May 2006. Also, general provisions for standard advances in specific sectors (personal loans, loans and advances qualifying as capital market exposures, commercial real estate loans, and residential real estate loans above Rs.20 lakh) were increased from 0.4 to 1 percent in April 2006 and to 2 percent in January 2007. To address interconnectedness, in 2007, risk weights and general provisions on exposure to systematically important non-deposit-taking financial companies were increased from 100 to 125 percent and from 0.4 to 2 percent, respectively. Meanwhile, cash reserve requirements were increased from 4.5 percent to 5, 5.5, and 6 percent in 2004, 2006, and 2007, respectively. More recently, in November 2010, additional measures were proposed including a mandatory ceiling of 80 percent on LTVs for residential real estate loans, an increase in the risk weights of housing loans above Rs.75 lakh to 125 percent (irrespective of the LTV), and increase standard asset provisioning for housing loans with 'teaser rates' to 2 percent.	Commercial rents plunged in the first half of 2008 and residential property prices followed in the second half of the same year. As of June 2010, decline in commercial real estate has topped 39 percent while the residential segment slid 24 percent from the peak, and signs of gradual stabilization are emerging. Remarkably given the magnitude of the bust, the financial system appears to be sound, notwithstanding some recent deterioration in asset quality. The authorities underline that this is in line with the objective they had set, which was not to stop the boom itself (which may have curtailed much-needed increase in access to finance) but to prepare the banking system for the bust.
Ireland	Financial deregulation, positive macroeconomic outlook, immigration flows and rising household formation rates set the stage for a rapid escalation of real estate prices and credit in the mid-1990s. Also, capital gains taxes on non-owner-occupied property were cut in half and residential property taxes were fully removed, slashing the user cost of housing. Mortgage debt to GDP grew by an astonishing 159 percent between 1996 and 2005 while house prices rose by 217 percent.	Policy response came only at the end: the authorities announced in March 2006 higher risk weights for mortgages, up from 50 to 100 percent of the loan value, on the portion of each loan exceeding 80 percent of the property value as of May 2006. The objective was stated as building a buffer for the excesses of the previous years as strong competition deteriorated lending standards with the average LTV at origination rose from 80 percent in 2000 to 92 percent in 2004 and most borrowers getting loans with zero downpayment.	Mortgage credit growth slightly slowed down in April right after the announcement of the semi-LTV limit but picked up again in May and remained somewhat robust until December 2006, coinciding with the peak of house prices. On an annual basis, both mortgage credit growth and house price appreciation started to decline after the implementation of the limit. It is hard to say whether it was the policy measure that pricked the bubble or the start of the downturn was already in the making on the own dynamics of the market. In any case, the late action did not have time to build the desired buffers and it was not enough to prevent the banks from getting into trouble.

Table 3. Country Experiences with Various Policy Responses - continued

Country	Background	Action	Outcome
Israel	After remaining almost flat for several years, house prices increased 20 percent in real terms since 2008Q3. The developments were partly due to low interest rates and to limited supply, but there have also been reports of heightened activity by property acquisition groups. Mortgage credit also has been exhibiting double-digit annual growth rates.	In May 2010, the central bank published draft guidelines that required banks to increase provisions for mortgages with high LTV, in a bid to curb rapidly rising credit and prices. The proposed rules urged lenders to re-examine their housing credit risks and envisioned that banks would put aside an additional provision of at least 0.75 percent of the outstanding loan with LTV in excess of 60 percent. In July 2010, the benchmark interest rate was increased for the first time in four months, citing concern over a speculative property bubble. In October 2010, a narrower version of the first set of guidelines was adopted requiring banks to provide more capital for highly-levered floating-interest-rate mortgages. Under the new directive, housing loans greater than NIS 800,000 where LTV is above 60 percent and the ratio between the floating interest rate part of the loan and the total sum of the loan equals or exceeds 25 percent will be subject to a 100 percent risk weight (up from 35 and 75 percent, respectively).	The construction industry criticized the draft directive dated May 2010 arguing that they would hurt young couples and a rule limiting DTI to 40 percent would be a better solution. To date, the first directive remains in draft format. It is too early to say whether the measures taken will prevent a real estate bubble; the signs so far have not abated with house prices continuing to increase at the same rate.
Korea	In the aftermath of the Asian crisis, expansive policies to stimulate the economy created a credit boom (in particular, credit cards), the bust of which came in 2003 and left policymakers with a desire for tougher regulation. Real house prices increased by 26 percent from 2001Q1 to 2003Q3. After stalling in 2004, prices appreciation resumed in 2005 and recorded an increase of 14 percent between 2005Q1 and 2007Q1.	Maximum LTV limits were introduced in 2002; these were complemented with maximum DTI limits in August 2005. FSS lowered LTV limits in speculative areas twice in June and October 2003, first to 50 percent and then to 40 percent down from 60 percent, but provided some exceptions for certain loans. In 2006, these exceptions were abolished for loans extended by banks and the LTV reduction was expanded to loans made by non-bank intermediaries bringing the ratio from 60-70 percent to 50 percent while DTI limits in speculative areas were reduced to 40 percent. In July 2009, FSS lowered LTV limits in non-speculative areas as well. It also tightened DTI limits twice in February 2007 and again in September 2009.	Overall, both LTV and DTI appear to be effective but the impact does not seem to last long. Moreover, the impact appears to be rather small on average with year-on-year credit growth rate decreasing by 0.7 percentage points (against an average growth rate of 12 percent) and house price appreciation declining by 0.3 percentage points (against an average appreciation rate of 4 percent) during the month following the tightening. Comparing the two tools is not easy; as a first pass, LTV limits seem to have a slightly larger effect but DTI limits may be better-targeted as the dynamics in non-speculative areas are affected less. Moreover, since the effect is short-lived, it may be hard to obtain the desired outcome in a single move: for instance, in 2003, markets responded to the introduction of LTV limits and subsequent decreases appeared to bring things back in control, but it took three sequential moves to slow down credit growth and tame house price appreciation through 2003-04. At their current level of 40 percent and 50-60 percent in speculative and non-speculative areas, respectively, LTVs are already very low, limiting room for further reductions, were boom dynamics to return. DTI tightening last year may have been too strong, demonstrating the difficulty of calibrating these tools. The fear that the market has "softened too much" led to relaxation of the rule and adoption of several other measures (e.g. exemption from income verification evidence for low-income borrowers, waiver period of two years on transactions taxes for owners of multiple properties) in August 2010.
Latvia	Amid a rebound from the 1995-96 banking crisis, the EU accession process, demand from neighboring Russia, and a limited supply of newly constructed dwellings, house prices boomed by 85 percent, in real terms, between 2004 and 2007. Mortgage credit to GDP ratio tripled from 11 to 34 percent as a result of a growth rate that averaged 84 percent per annum over the same period. More than two-thirds of the loans made to households were denominated in foreign currency.	Policy measures initially focused on monetary tightening to abate the rapid growth in credit while ensuring macroeconomic stability. A raise in refinancing rates in March 2004 was followed by higher reserve requirements of 4 percent up from 3 percent in July 2004. The reserve base was expanded to include liabilities to foreign banks in January 2005 and then again to include liabilities with a maturity of more than two years in May 2006. Meanwhile, the reserve requirements were raised gradually from 4 to 6 percent in August 2005, then to 8 percent in December 2005. Loans with LTV above 70 percent were not allowed to qualify for preferential risk weighting (50 percent until December 2007 and 35 percent thereafter) and were weighted at the standard 100 percent. In May 2007, a maximum LTV for all residential mortgages exceeding 1000 times the minimum salary (12,000 lats at the time), whether they are extended by regulated or -non-regulated lenders, was introduced at 90 percent. This mandatory limit remained in effect until July 2008. Additionally, to reduce speculation and the deterioration in lending standards, land and mortgage registration fees were increased, additional taxes on speculative transactions were introduced, and income certification requirements implemented.	The measures taken between 2004 and 2006 did not stop lending or property price appreciation. Credit growth was dampened for a couple of months at best while house prices continued their steep ascent. Actually, higher interest rates may have worked in the opposite direction than intended by attracting capital inflows. In early 2007, signs of the impending crash were already visible with one out of three borrowers facing difficulties in servicing their debt.

Table 3. Country Experiences with Various Policy Responses - continued

Country	Background	Action	Outcome
Malaysia (1990s)	After increasing at a modest 3 percent per year in 1993-94, house prices accelerated to an annual growth rate of 13 percent in 1995-96. More striking, however, was the boom in the commercial real estate segment. Office rents rose by 50 percent between 1990 and 1996. Related, the growth in bank loans for non-residential property purchase far exceeded that in loans for residential property purchase.	The statutory reserve requirement was increased from 8.5 to 11.5 percent in 1994, and then again to 13.5 percent in 1996. A maximum LTV limit of 60 percent was introduced in 1995. In April 1997, exposure to property lending in a bank's portfolio was restricted to be below 20 percent. In addition, purchases by foreigners were restricted.	The measures were credited for their contribution to the slowdown in property prices and lending to the real estate sector. They did not, however, prevent the systemic banking crisis following the bust.
Malaysia (2000s)	The boom-bust in the 1990s left the market with a significant supply hangover, in particular at the high-end condo segment. There have also been considerable additions to supply at the lower-end as a consequence of mass building of housing units by government agencies. The residential mortgage credit growth gained speed starting in 2001 and house prices recorded an increase of 4 percent in 2004, after lingering with roughly 1.6 percent increase per annum during 2000-03. Concerns about rapidly rising household indebtedness were exacerbated by the reports about lax lending standards (e.g. cash rebates and interest-bearing schemes allowing circumvention of the official 90 percent LTV limit) and the desire to preemptively stop another possible era of exuberance and overbuilding.	In 2005, risk weight on non-performing residential mortgage loans was increased from 50 to 100 percent. Following the global financial crisis, policy priorities changed and a stimulus package, that included a tax relief on housing loan interest up to MYR 10,000 for three years and deferred loan repayments for one year for retrenched homeowners, was announced in March 2009. However, during the summer, capital gains tax was reinstated on properties sold within five years of acquisition (the 5 percent tax was abolished in April 2007); in January 2010, the price floor for foreign buyers was hiked to MYR 500,000, twice the previous level; in November 2010, a new LTV limit of 70 percent was introduced for third residential property purchases.	The spike in prices that happened at the end of 2009 has already shown signs of subsiding and lending for construction and other real estate activities slowed down somewhat.
Norway	After rebounding from the systemic banking crisis in 1991 (that was preceded by a real estate boom), both house prices and credit grew modestly from 1993 to 1996. Credit to households picked up in mid-1996 and house prices posted double-digit annual growth rates in 1997.	In 1998, with the objective to safeguard bank soundness, risk weights on loans with LTV above 60 percent were raised from 50 to 100 percent. (The previous limit that triggered the higher risk weights was 80 percent LTV.)	Both credit and house prices slowed down significantly in 1999, but it is hard to say whether it was the macro-prudential measure or first the Asian crisis and then the dot.com bubble burst that led to these observation. The measure was discontinued in 2001, as credit recovered to its pre-measure growth rate.
Poland	Credit to the private sector grew rapidly starting in the latter part of the 1990s as financial liberalization took hold and loans started growing from a low base to meet the pent-up demand. Loans to households, often as mortgages, were in many cases the fastest-growing segment, pushing house prices up in the process. The share of mortgage loans denominated in foreign currency in housing loans increased from 9 percent in 1999 to 50 percent in 2001. Real estate price appreciation picked up much later: prices declined in real terms from 2000 to 2004 but doubled between 2005 and 2008.	The Commission for Financial Supervision adopted a new capital adequacy regulation that expanded the existing foreign exchange regulation to cover additional risks from FX-denominated loans in 2002. The measure stipulated that in calculating capital requirements banks should assume buffers for exchange rate risk with the buffer increasing with the maturity of the loan. It is worth noting that monetary tightening in response to the rapid credit growth in this situation may have been less effective, even counterproductive, because it could encourage currency switching by decreasing the relative price of FX loans and fueling expectations of further appreciation of the zloty. The Commission followed its watch on FX-denominated mortgage loans with 'Recommendation S' in June 2006. The measure urged lenders to assess creditworthiness for borrowers applying for an FX-denominated mortgage loan under buffers for the FX risk and by applying the same interest rate as the one on zloty loans while requiring them to show the borrower a simulation of mortgage payments under zloty depreciation and interest rate hikes. In their efforts to contain risks with mortgage credit growth, the Polish authorities also abolished mortgage interest deductibility in 2007. In addition, 'Recommendation T' was passed in February 2010 to reduce risks further, updating earlier recommendations and introducing additional restrictions on borrower eligibility (e.g. denying loans to lower-income applicants with more debt service ratios exceeding 50 percent). Recently, intentions to increase the risk weights on foreign-currency mortgages as well as to limit the share of these loans in total loan portfolio of banks have been announced.	The share of foreign-currency loans in all housing loans stabilized starting in 2002. The measures on capital adequacy and Recommendation S may be credited for curbing FX lending, yet it is hard to say how much other developments (e.g. depreciation of zloty against the euro and narrowing of interest rate spreads) account for the observed changes. After all, total (mortgage) credit growth remained high after a brief hold-up in 2002-03. It should be noted that Poland still had significant house price appreciation between 2004 and 2008 and is currently going through a downturn, although the banking system did not suffer from a crisis of its own. Noteworthy is the fact that banks may have found ways around the stricter regulations by easing credit standards elsewhere, in particular, by extending maturities and decreasing minimum income thresholds for all mortgage loans. At the end, the measures might have had some success in curbing FX lending, at least for a while, but they might have created risk shifting as well: borrower quality appears to be higher for FX-denominated mortgage loans, for which non-performing loan ratio was 0.9 percent as of September 2009, much lower than the 2.4 percent on zloty-denominated mortgage loans.

Table 3. Country Experiences with Various Policy Responses - continued

Country	Background	Action	Outcome
Portugal	From 1996 to 2000, house prices rose by a rather modest 17 percent. By comparison, growth in mortgage credit was remarkable as mortgage debt to GDP ratio doubled from 21 to 41 percent, mostly driven by the marked fall in bank interest rates.	Tighter capital requirements for mortgage loans with LTV above 75 percent were implemented and provisions for general consumer credit risk were raised to 1.5 percent in mid-1999. New reporting requirements and guidance were put in place to monitor liquidity and reliance on short-term market borrowing. A national council of supervisors was formed in 2000 to promote coordination among supervisors responsible for different part of the financial system.	Credit to households decelerated significantly in the second half of 1999, following the ECB interest rate rise. The economic slowdown culminating in the 2003 recession reduced the pace of credit growth further but mostly for consumer loans. Mortgages continued to grow at a slower but still high rate, bringing the mortgage debt to GDP ratio to 62 percent in 2007.
Singapore	Land supply is closely regulated through the Government Land Sales (GLS) program and a large portion of the housing market is controlled by the government (similar to Hong Kong SAR). Housing & Development Board (HDB) has authority over public housing, which has developed side-by-side with the much smaller private housing segment. (Public housing has been mostly 'privatized' by allowing 99-year leases on dwellings being traded at open market prices.) Residential Property Act limits foreign ownership of landed homes, further segmenting the market by forcing a sub-market specializing on expatriates. Real estate cycles have been strong, with the most recent one involving an increase of 45 percent in real house prices from 2004Q2 to 2008Q1. During the global financial crisis, prices declined 4 percent, but they rebounded sharply recording an increase of 36 percent since 2009Q2.	Particular loan types (e.g. interest absorption scheme and interest-only housing loans) were abolished and assistance to property developers that were implemented as part of the crisis stimulus package (in the form of permissions to extend project completion period by one year for government residential sites, to re-assign GLS sites to another company, to extend maximum disposal period from 2 to 4 years, to defer property taxes on land under development for all property types for up to 2 years) were discontinued in September 2009 while GLS program was reinstated. In February 2010, a seller's stamp duty on all residential land and properties sold within one year was introduced while LTV limit was reduced from 90 to 80 percent. Other measures followed in August 2010, including extension of holding period for stamp duty to three years, further reduction of LTV limit to 70 percent for second and subsequent mortgages, extending housing grants to lower-income households (those earning between S$8,000 and S$10,000) for purchase of new flats, increasing the supply of properties and shortening the completion time of build-to-order flats, lengthening the minimum occupancy period for non-subsidized flats from 3 to 5 years, and banning concurrent ownership of HDB flats and private residential properties. In October 2010, new curbs on foreign ownership of landed homes were unveiled, raising the penalties on breach of the Residential Property Act. Most recently, in January 2011, Seller's Stamp Duty was raised and the holding period for its imposition was increased from 3 to 4 years while LTV limit was lowered again, to 60 percent for individuals with one or more outstanding housing loans at the time of the new purchase and to 50 percent for purchasers that are not natural individuals.	Sales of all property types started to decline in the second quarter of 2010 and dropped by 16 percent in the third quarter. Apartment and condominium (non-landed properties) price appreciation also slowed down considerably. However, price appreciation for single-family houses (landed properties) continues to accelerate. This may be an indication of the speculative forces, reinforcing the suspicions of the authorities, who are not expected to give up and actually intensify their efforts to cool down the real estate markets.
Spain	Several factors got together to create the longest recorded boom that ran from 1996 to 2007. Waves of immigrants and foreign property investors started flowing in while demographic changes pushed household formation rates up. A multiplier effect came from the effects of financial liberalization and convergence with the rest of the EU, pressing down real interest rates and making both traditional and new forms of mortgage loans more readily available to potential buyers. This was combined with a tight rental market where the quality and quantity of rental property does not measure up. As a result, house prices skyrocketed, going up 121 percent from trough to peak.	Banco de Espana adopted its first own version of countercyclical provisioning frameworks in July 2000. The initial regime required banks to accumulate provisions based on the 'latent loss' in their loan portfolios; the revision in 2004 (to accommodate the adoption of IFRS by the EU) introduced two components, alpha and beta, to get a collective assessment of credit losses and calculate the specific provisions. Alpha and beta are computed using historical, loan-level credit registry data for six different risk categories, e.g., mortgages with LTV below 80 percent belong to a lower risk category, and hence have higher alpha and beta parameters, than those with LTV above 80 percent. Dynamic provisions based on this formula roughly account, on average, for 10 percent of the net operating income.	So far, the banking system has fared well, keeping the distress level at the 'borderline' crisis category according to the classification in Laeven and Valencia (2010), especially considering the situation in real estate as well as the overall economy. At the end of 2007, just when the real estate bust started, total accumulated provisions covered 1.3 percent of total consolidated assets, in addition to the 5.8 percent covered by capital and reserves. It should be noted that dynamic provisioning system was not specifically designed to limit household leverage or house price appreciation and it did not stop a herd or prevent the bust: household leverage grew by a still high 62 percent during the boom phase and house prices slipped by 13-20 percent, depending on the source of the estimates (to date). Provisions accumulated as a result of dynamic provisions, at a high level at the onset of the recession, have gone down significantly as a percentage of nonperforming loans.
Sweden	Amidst financial deregulation and capital account liberalization, tax reforms in the 1980s was not optimal in hindsight: real house prices increased 40 percent from 1986 to 1990 while the ratio of bank lending to GDP rose from 43 percent to 68 percent. Then came the bust with prices going down 31 percent through 1995, started recovering in 1996. Real house price appreciation accelerated in 2006, reaching double-digit annual rates.	After the systemic banking crisis in 1991-95, one of the lessons the policymakers took away was not to leave real estate booms on their own. Riksbank, watching closely over the real estate market developments, started to tighten monetary policy in January 2006. The decision was communicated to the public as driven by concerns over potential risks posed to financial stability by rapidly rising house prices and household indebtedness. This policy of leaning against the wind that continued until September 2008 was criticized by some for having an independent focus on house prices. Most recently, a maximum LTV limit of 85 percent was introduced in October 2010.	After the introduction of these measures, both real estate prices and lending to households continued to rise until the global financial crisis. Further, they bounced back quickly in 2009. Effects of the newly-introduced LTV limit on real estate markets remains to be seen.

Table 3. Country Experiences with Various Policy Responses - concluded

Country	Background	Action	Outcome
Thailand (early 2000s)	Burnt by the bad memories of the land price bubble prior to the Asian crisis, the authorities were cautious watching credit growth, and prices in some segments of housing markets, reach double-digit annual growth rates again in 2003.	A maximum LTV limit of 70 percent for high-end real estate (i.e. condominiums, lands, and residences valued at or more than 10 million baht) was introduced in 2003. At the same time, tighter eligibility requirements for mortgage loans were announced.	House prices moderated, and so did credit growth. Actually, housing markets entered a downturn starting around 2006.
Thailand (late 2000s)	House prices have been declining since 2006, with the speed of decline accelerating in 2008. Yet, in 2010Q2, prices spiked posting a 10 percent quarter-on-quarter increase and commercial bank loans grew strongly over the summer.	In 2009, the LTV rule was relaxed by increasing the limit from 70 to 80 percent but risk weights for loans with LTV greater than 80 percent were set at 75 percent against the 35 percent for loans with LTV below 80 percent, with the aim to support real estate market activity while maintaining sound risk management practices in the banking system. In November 2010, at the first sign of revival in housing markets and credit growth regaining strength, the tide was reversed: the LTV rule will be extended to dwellings valued less than 10 million baht with LTV set at 90 percent for condominiums, effective 2011, and at 95 percent for low-rise housing units, effective 2012.	It is too soon to see the effectiveness of the measures taken, but, in 2010Q3, house prices declined again while bank credit growth remained robust.
Ukraine	Driven by high economic growth rates, pent-up demand, and a supply shortage of better-quality dwellings, real estate prices skyrocketed starting in the second half of 2001. By the end of 2003, house prices had doubled in real terms. Credit to the private sector grew at an annual average rate of 51 percent during this period with loans to households, especially for house purchase, being an even faster-growing major component.	To minimize credit risks associated with this extremely rapid growth and as part of reforms to strengthen the soundness of the banking sector, a range of measures were taken starting from 2004. Minimum capital adequacy ratio was increased from 8 to 10 percent in March 2004 while loan classification rules and related-party lending regulations were tightened. Resolutions to raise and improve the quality of bank capital were issued in April 2004. Also, some monetary tightening was induced through an increase in overnight refinancing rates, changes limiting the eligibility of vault cash to be included in reserve requirements and banks' access to central bank resources, and elimination of the long-term refinancing facility. In March 2007, higher reserve requirements were set for certain high-risk loan categories ('kindred consumer credits portfolio'). In July 2007, tougher criteria for borrower solvency were introduced. In December 2008, reserve requirement ratios were significantly raised, reducing the origination of foreign-currency loans to borrowers with no sources of inflow of FX proceeds.	House prices boomed even more in the 2004-07 period until they peaked in the second quarter of 2007, rising 172 percent more and bringing the peak-to-trough increase to 450 percent between 2001 and 2007. Growth in credit to the private sector also remained strong at an annual average rate of 58 percent from January 2004 to September 2009. One complication limiting the effectiveness of the prudential measures might have been the decision to peg the hryvnia to the US dollar in April 2005. Indeed, foreign-currency-denominated loans grew at a faster pace than domestic-currency-denominated loans.
United States	Between 2000 and 2006, against a background of financial innovation and cheap credit, real estate prices increased rapidly, by 69 percent nationwide (45 percent in real terms). Some states such as California and Florida saw nominal house prices grow 150 percent during the boom. Mortgage debt also grew rapidly especially in certain segments such as loans to borrowers with spotty credit history (subprime) and loans with non-standard features ('exotic' loans).	No nationwide measure was taken to moderate the boom. Yet, starting with North Carolina in 1999, many states adopted anti-predatory lending laws aiming to decrease the incidence or raise the cost of riskier mortgages. While there is substantial variation in the particular provisions included in these laws, they typically extend the coverage of the Federal Home Ownership and Equity Protection Act (HOEPA) by including home purchase and open-end mortgage credit, by lowering the annual percentage rate and the thresholds that trigger fees and points, and by prohibiting or restricting the use of balloon payments and prepayment penalties. (It is interesting to note that legislation to prohibit predatory lending at the federal level was proposed several times during the period between 2000 and 2006 but never passed the Congress. Similarly, attempts by the Federal Reserve Board to issue guidelines to limit banks' exposure to commercial real estate and use of exotic loans (e.g. negative amortization) failed.)	Legal restriction against predatory lending was effective in the sense that subprime loan origination in states with a law in place was lower. Interestingly, the reduction in subprime lending seems to be due to decreased applications for these loans rather than due to increased loan denial rates, suggesting that lenders chose to market such risky loans less aggressively in these regions. Moreover, not all laws are equal: coverage and the extent of prohibitions as well as the legal enforcement mechanisms seem to matter for the efficacy of the law. Furthermore, credit to minority groups were constrained most by the enactment of these laws, a potential political issue. Finally, price dynamics do not appear to be affected significantly by the existence of the laws and neither do the default rates following the downturn.

Sources: IMF country reports; Hilbers, Otker-Robe, and Pazarbasioglu (2007); Borio and Shim (2007).
Note: Country selection based on occurrence of real estate boom and policy measures taken in response.

Table 4. Performance of Policy Rules in a DSGE Model

	Productivity shock			Financial shock			Both shocks		
	Variance		Welfare (inverse)	Variance		Welfare (inverse)	Variance		Welfare (inverse)
	Output gap	CPI inflation		Output gap	CPI inflation		Output gap	CPI inflation	
Original Taylor	*0.21*	*0.11*	*0.057*	*0.31*	*0.04*	*0.100*	*0.52*	*0.12*	*0.282*
Monetary Policy									
Original Taylor + response to real estate prices	0.12	0.11	0.028	0.05	0.01	0.003	0.44	0.13	0.210
Original Taylor + response to mortgage credit	0.13	0.12	0.031	0.12	0.03	0.016	0.23	0.13	0.070
Original Taylor + response to both prices and credit	0.12	0.11	0.028	0.03	0.01	0.001	0.23	0.13	0.070
Optimized Taylor + response to both prices and credit	0.07	0.11	0.016	0.01	0.01	0.0002	0.07	0.11	0.016
Fiscal Policy									
Original Taylor + constant tax	0.21	0.11	0.058	0.31	0.04	0.100	0.51	0.12	0.274
Original Taylor + cyclical tax	0.20	0.11	0.053	0.31	0.04	0.096	0.50	0.13	0.267
Original Taylor + both constant and cyclical taxes	0.21	0.11	0.057	0.31	0.04	0.095	0.49	0.13	0.259
Optimized Taylor + both constant and cyclical taxes	0.08	0.12	0.021	0.28	0.03	0.081	0.37	0.15	0.158
Macro-Prudential Policy									
Original Taylor + rule on real estate prices	0.15	0.11	0.035	0.03	0.01	0.001	0.46	0.13	0.223
Original Taylor + rule on mortgage credit	0.14	0.12	0.033	0.004	0.001	0.00002	0.22	0.13	0.066
Original Taylor + rules on both prices and credit	0.14	0.12	0.033	0.003	0.001	0.00001	0.22	0.13	0.066
Optimized Taylor + rules on both prices and credit	0.07	0.11	0.016	0.003	0.000	0.00001	0.07	0.11	0.017

Note: Welfare is measured as the un-weighted sum of the variances of the output gap and CPI inflation around the steady state.