CHAPTER 3 LESSONS FOR MONETARY POLICY FROM ASSET PRICE FLUCTUATIONS

The current crisis gives occasion to revisit an old question: should monetary policy be used to prevent asset price busts? The question has at least three aspects, each of which is addressed in this chapter. First, we examine the historical evidence in search of consistent macroeconomic patterns that could be used as reliable leading indicators of asset price busts. Second, we examine the role of monetary policy in the buildup to the current crisis. In particular, we assess the validity of accusations that policymakers created the current crisis by reacting insufficiently to growing inflation pressure or that they raised the likelihood of an asset price bust by placing insufficient weight on credit and asset prices when setting interest rates. Third, we consider whether the goal of monetary policy should be expanded beyond just the stability of goods price inflation, how this could be done, and the potential tradeoffs involved.

The chapter presents the following findings. Inflation and output do not typically display unusual behavior ahead of asset price busts. By contrast, credit, the share of investment in GDP, current account deficits, and asset prices typically rise, providing useful leading indicators of asset price busts. These patterns can also be observed in the buildup to the current crisis. Also, in the period since 1985, the stance of monetary policy has not generally been a good leading indicator of future house price busts, consistent with the evidence that inflation and output are poor leading indicators. There is some association between loose monetary policy and house price rises in the years leading up to the current crisis in some countries, but loose monetary policy was not the main, systematic cause of the boom and consequent bust. If monetary policymakers are to blame, it is mainly for acting too narrowly and not reacting strongly enough to indications of growing financial vulnerability.

This chapter makes the case that putting more emphasis on macrofinancial risk could bring stabilization benefits. Simulations suggest that using a macroprudential instrument designed specifically to dampen credit market cycles would help counter accelerator mechanisms that inflate credit growth and asset prices. In addition, a stronger monetary reaction to signs of overheating or of a credit or asset price bubble could also be useful. Such a broader approach to monetary policy might require that concern for macrofinancial stability be explicitly included in central banks' mandates. However, expectations should be realistic. It is difficult to discern whether credit and asset price booms or surging current account deficits are driven by benign or malign developments. Even the best leading indicators of financial vulnerability are noisy, sometimes sending false signals and raising the risk of policy errors.

The first section of this chapter examines asset price busts during the past 40 years, presenting evidence on the typical costs of such episodes, outlining patterns in macroeconomic variables leading up to the busts, and identifying potential leading indicators of future busts. The second section analyzes whether these patterns held for a cross section of advanced economies in the years leading up to the current crisis. The third section looks at the role of monetary policy in these countries, paying particular attention to the associations between monetary conditions, credit expansion, and house price appreciation. Next, the chapter uses a model-based approach to explore the potential role of monetary and macroprudential policy in dampening house price rises and credit expansion.

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The final section discusses policy implications. Data sources and transformations are explained in Appendix 3.2.

Asset Price Busts in the Modern Era

This section examines busts in house and stock prices over the past 40 years. The focus is on key macroeconomic variables in the run-up periods in an attempt to identify systematic patterns in their behavior. The issue of whether or not policymakers should respond to these leading indicators is taken up later in the chapter.

The focus on the run-up to house price and stock price busts is a relatively novel contribution to the literature. Borio and Lowe (2002a) and Gerdesmeier, Reimers, and Roffia (2009) present empirical evidence on how booms in credit, asset prices, and investment have predictive power for banking crises and asset price busts, respectively. In this chapter, house prices and stock prices are examined separately, leading to new results. In particular, we find a recurring pattern of deteriorating current account balances in the run-up to house price busts. Furthermore, this chapter identifies patterns in asset price busts after 1985 that are unique compared with busts that occurred before 1985.[1]

Stylized Facts about Asset Price Busts

The first task for this analysis is to define asset price busts. This chapter uses a simple methodology, similar to that used by Bordo and Jeanne (2002).[2] Busts are defined as periods when the four-quarter trailing moving average of the annual growth rate of the asset price, in real terms, falls below a particular threshold. The threshold is set at –5 percent for house prices and –20 percent for stock prices.[3] A higher threshold (in absolute terms) is used for stock prices due to the fact that stock prices are typically more volatile. This methodology is objective, easily reproducible, and can be applied consistently across countries. In addition, the thresholds also pick up the major well-known asset price busts—Japan in the early 1990s, the dot-com episode in the 2000s—while still leaving asset price busts as relatively infrequent episodes.

Applying this technique to data for real stock and real house prices identifies 47 house price busts and 98 stock price busts from 1970 to 2008 (Table 3.1).[4] House price busts are generally longer lasting and are associated with greater output loss. The average house price bust lasts for two and a half years, whereas stock price busts last for about one and a half years.[5] The cumulative decline in output below trend is

[1]A related strand of literature focuses on asset price booms. Adalid and Detken (2007) and Detken and Smets (2004), for example, document stylized facts on real and financial variables around asset price booms and analyze the influence of liquidity shocks and monetary policy during these episodes. A related paper, Mendoza and Terrones (2008), looks at booms in domestic credit and the associated behavior of macroeconomic and microeconomic variables around these episodes.

[2]Bordo and Jeanne (2002) define a bust as a period when the three-year moving average of the growth rate of asset prices is smaller than the average growth rate minus a multiple of the standard deviation of growth rates. The thresholds that are used in this chapter for housing and equity busts are roughly equal to the average growth rate of the respective asset prices across the whole sample minus one standard deviation of the growth rates. Bordo and Jeanne use a multiple of 1.3 times the standard deviation of growth rates.

[3]To be clear, a bust occurs when the following condition holds:

$$\frac{g_{t-3} + g_{t-2} + g_{t-1} + g_t}{4} < x \,,$$

where g is the growth rate of the asset price and x is the relevant threshold (–5 for house prices and –20 for stock prices). If the condition holds, then the periods t–3 through t are labeled as a bust.

[4]The data set consists of quarterly observations on asset prices and macroeconomic variables for 21 advanced economies from 1970 to 2008. Subject to data limitations, the sample includes the following countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. Details are in Appendix 3.2.

[5]The duration of a bust is the amount of time the four-quarter moving average of the growth rate of the asset price remains below the relevant threshold. Because periods t–3 to t are labeled as a bust, there is a minimum duration of one year for all busts.

Table 3.1. House Price and Stock Price Busts from 1970 to 2008

	Full Sample		Before 1985		1985–2008	
	House prices	Stock prices	House prices	Stock prices	House prices	Stock prices
Total number of busts	**47**	**98**	**22**	**41**	**25**	**57**
Number of busts per country	2.76	4.67	1.29	1.95	1.47	2.71
Cumulative decline in prices (percent)[1]	–17.71	–37.38	–19.43	–35.27	–15.58	–38.90
Duration (quarters)	10.02	6.98	11.22	7.92	9.74	6.29
Cumulative decline in output (percent relative to trend)[2]	–4.27	–1.31	–5.41	–1.33	–3.27	–1.29

Note: Values are mean values.
[1]Cumulative price decline is measured over the entire duration of the bust period.
[2]Cumulative decline in output is measured as the accumulated deviation from a one-sided Hodrick-Prescott filter with a smoothness parameter of 1600 for the first four quarters of a bust.

roughly 4¼ percent for the first year after the onset of a house price bust,[6] compared with a 1¼ percent decline after stock price busts. These findings mirror those of previous issues of the *World Economic Outlook* (WEO) (April 2003 and April 2008), as well as those of Claessens, Kose, and Terrones (2008).

Figure 3.1 shows that asset price busts are relatively evenly distributed before and after 1985—a year that broadly marks the beginning of the "Great Moderation," a period characterized by substantially lower macroeconomic volatility in advanced economies (see McConnell and Pérez-Quirós, 2000, and Galí and Gambetti, 2009). Several episodes are clustered across countries, including busts in 1974–75, 1983, 1992, and 2008. The current episode is the most widespread cluster of busts for both house prices and stock prices.

Patterns in Macroeconomic Variables in Run-Ups to a Bust

Asset price busts, particularly house price busts, are long and costly. Can they be predicted? Theory suggests that it is not possible to predict the timing of asset price movements, particularly large drops, with a high degree of accuracy. If it were, investors would sell, or short, these assets, and there would be no boom-bust cycles. Even so, there may be some regular patterns in the behavior of macroeconomic variables that can help indicate the likelihood of a bust, even if they provide only limited insight into its timing.

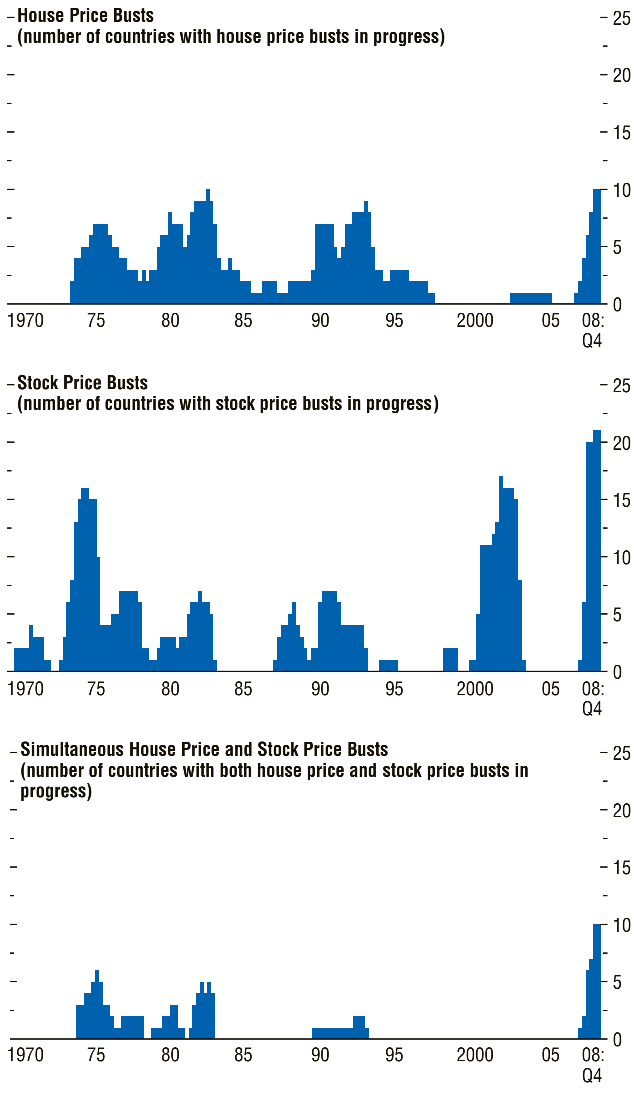
Before exploring whether there are such macroeconomic patterns, we must first correct for slow-moving trends. Although this analysis focuses, to a large extent, on growth rates, there are slow-moving trends in these rates over the four decades covered by the sample. For example, for almost all the countries, inflation rates were markedly lower during the 1990s than during the 1970s, and therefore looking at deviations from an average calculated on the basis of the full sample would be misleading. The same holds true for output growth, reflecting a diminishing impetus from post–World War II catch-up and population aging. To correct for such slow-moving trends, a trailing eight-year moving average is used as a filter to isolate large or abnormal movements in these variables. The choice of filter was based on three factors. First, it is easily reproducible. Second, the trends for the variables under study are fairly slow moving. Third, this measure—unlike centered moving averages or the popular two-sided Hodrick-Prescott (HP) filter—does not include any information unavailable at the time.[7]

[6]Trend output is measured using a one-sided Hodrick-Prescott (HP) filter with a smoothing coefficient of 1600.

[7]As a robustness check, the analysis was also carried out using a rolling HP filter with a slow-moving trend. Qualitatively similar patterns were obtained. The smoothness parameter was set to 400,000 following Borio and Lowe (2004). See Kannan, Rabanal, and Scott (forthcoming a) for results using this detrending procedure.

Figure 3.1. Asset Price Busts

House price busts and stock price busts have occurred at relatively regular frequencies over the past 40 years. There have been several episodes of clustering, including the present one, during which house price and stock price busts occurred simultaneously in a few economies.



Source: IMF staff calculations.

However, results derived using a one-sided filter should be interpreted carefully. For a variable experiencing a temporary but persistent increase in its growth rate, the deviation from a trailing moving average eventually gets smaller as the trend "catches up" with the higher growth rate. This could, erroneously, be interpreted as a return to normal behavior, even though the variable continues to experience high growth. The choice of an eight-year window for the moving average mitigates this problem somewhat because it lengthens the period over which a boom must persist in order for the trend to catch up.

What patterns do we observe using this detrending procedure? Figure 3.2 shows the behavior of eight key macroeconomic variables around the onset of house price busts before 1985 and during and after 1985. Three factors motivated the decision to split the sample. As mentioned, 1985 marks roughly the beginning of the Great Moderation. Second, the dynamics of asset price busts in the pre-1985 period may have been very different because of the different nature of shocks, such as the two oil crises of the 1970s. Third, during the post-1985 period, financial markets were more liberalized and monetary policy was more consistent—a macroeconomic environment much more similar to today's than to the one before 1985.

Several interesting findings emerge from Figure 3.2. Run-ups to house price busts in 1985 and after feature higher-than-normal growth rates of credit relative to GDP, large deteriorations in current account balances, and higher-than-normal ratios of investment to GDP. Both house and stock prices also grow faster than the eight-year moving average trend, though the difference does not vary significantly from zero within the two years before the busts. Of equal interest, output growth does not display any significant deviation from the measured trend, and inflation is actually *below* its eight-year moving average. Before 1985, there is no pattern of rapid increases in credit relative to GDP or deteriorating current account balances in the run-up to busts, although there are large deviations in inflation coinciding with the two oil crises.

The post-1985 period shows a similar pattern of large increases in credit growth and in the ratio of investment to GDP during the run-up to stock price busts, as shown in Figure 3.3. There are, however, two notable differences between the behavior of macroeconomic variables before stock price busts and before house price busts. First, output growth tends to be significantly higher than trend during the run-up to stock price busts. Second, there is no deterioration in current account balances as there is for house price busts. Even though the median current account balance deteriorates in the year leading up to a stock price bust, the level is not significantly different from zero.

As shown in Table 3.1, asset price busts, particularly house price busts, are costly events. Do macroeconomic variables display different patterns in the run-up to particularly costly house price busts? Figure 3.4 shows the behavior of the same set of variables solely for house price busts from 1985 to 2008. The observations are divided into house price busts that were associated with large falls in output and those that were not.[8] The growth rate of credit relative to output, the share of residential investment in GDP, and the rate of increase of house prices themselves are all higher in costly busts than in episodes that were not as costly. Interestingly, there is no significant difference in inflation and output growth in the run-up to a high-cost bust compared with other busts.

Can These Indicators Predict Asset Price Busts?

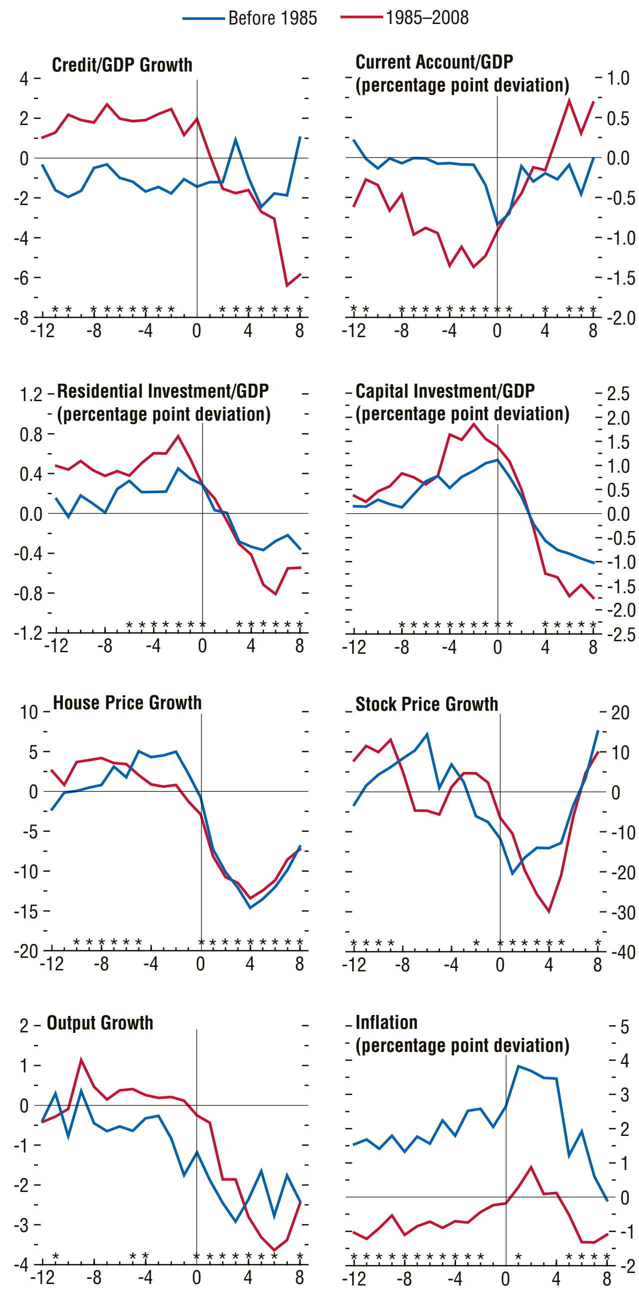
There are then some common patterns in the run-up to asset price busts, specifically, a significant expansion in domestic credit and investment shares, often in conjunction with current account deficits, during the two to three years before a bust. But how predictive are

[8]Output losses are computed over the entire duration of a bust. Those that fall in the bottom quartile in terms of total change in output are labeled "high-cost" losses.

Figure 3.2. Selected Macroeconomic Variables before and during House Price Busts

(Median percent deviation from trailing eight-year moving average, unless otherwise noted; asterisk indicates statistically significant difference of post-1985 deviation from zero; t = 1 denotes first quarter of bust)

Since 1985, house price busts have been typically preceded by large deviations in credit relative to GDP, the current account balance, and investment. Output and inflation, on the other hand, do not display such large deviations.

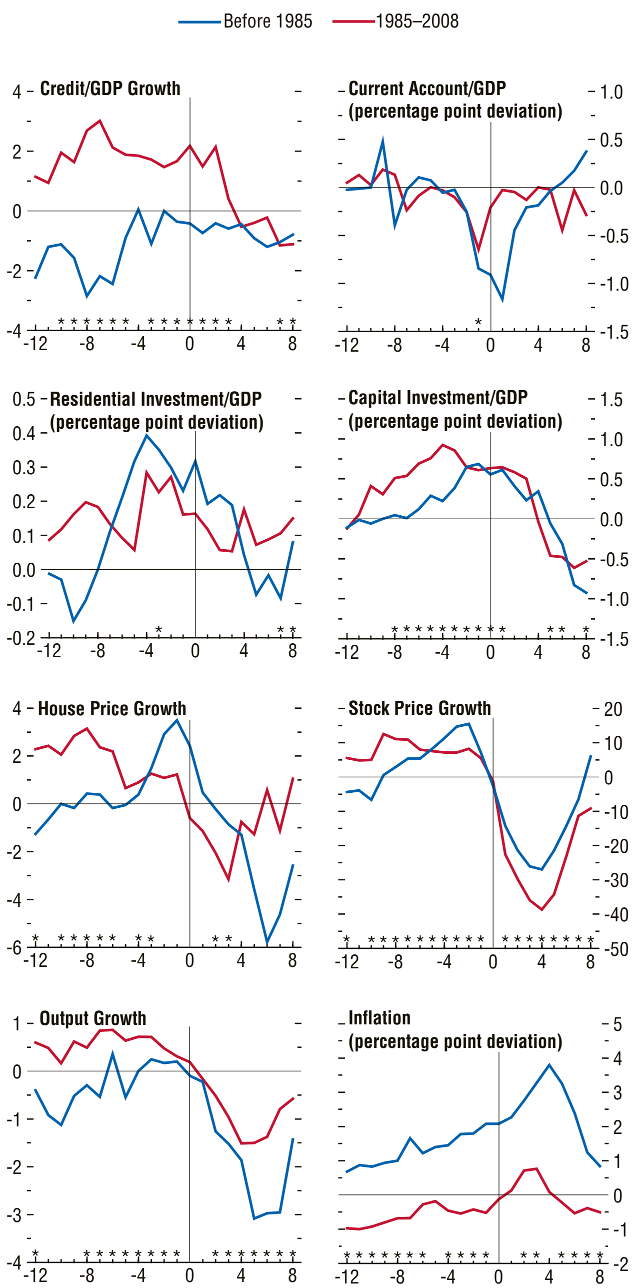


Source: IMF staff calculations.

Figure 3.3. Selected Macroeconomic Variables before and during Stock Price Busts

(Median percent deviation from trailing eight-year moving average, unless otherwise noted; asterisk indicates statistically significant difference of post-1985 deviation from zero; t = 1 denotes first quarter of bust)

The run-up to a stock price bust in the post-1985 period features large increases in credit and capital investment. Unlike house price busts, however, there is no significant deviation in current account balances relative to trend.



Source: IMF staff calculations.

these variables? From a policymaker's perspective, monitoring, or even reacting to, abnormal growth in these macroeconomic variables can be justified only if they help gauge the risks of asset price busts.

To assess the predictive ability of these variables, we use an approach pioneered by Kaminsky, Lizondo, and Reinhart (1998) and Kaminsky and Reinhart (1999).[9] The approach involves determining whether excessively large movements in particular variables are associated with subsequent busts. Large movements are defined as deviations from an underlying trend, for which the eight-year moving average is used. When the deviation from trend exceeds a particular threshold, we say an "alarm" has been raised. For each quarter, the threshold for each variable for a given country is computed based on observations over the previous 15 years.[10] Whether these alarms are deemed informative depends on their association with subsequent busts.

The choice of a threshold above which an alarm is raised presents an important trade-off between the desire for some warning of an impending bust and the costs associated with a false alarm. A very high threshold, for example, leads to infrequent alarms, because only extreme movements in the variables are captured. These extreme movements may be strong signals of impending asset price busts—and thus reduce the likelihood of a false alarm—but they may miss a large number of busts. With a low threshold, on the other hand, less extreme movements in the variables would more frequently raise alarms. Policymakers would very likely be alerted to impending busts, but would also be subject to a lot of false alarms. Choosing thresholds that minimize the ratio of false to legitimate alarms balances this trade-off.

[9]The analysis of the predictive ability of macroeconomic variables with regard to asset price busts is related to the literature on early warning systems (see Berg and others, 2000, for a survey).

[10]The use of this moving 15-year window dictates that these statistics are calculated and presented only for 1985 and after.

Table 3.2. Classification of Observations Based on Variable Thresholds

	Asset Price Bust 1–3 Years Later	No Asset Price Bust 1–3 Years Later
Alarm raised	A	B
No alarm	C	D

Here, the same percentile threshold is used for a particular variable across all countries, but the actual cutoff value differs from country to country because of the varying distributions of the variables.[11]

Each observation for a given variable can be classified into one of four categories, as shown in Table 3.2. Deviations in the credit-to-GDP ratio illustrate how the observations can be classified. The 90th percentile of the distribution of this variable has the smallest ratio of false alarms to legitimate alarms, which makes this a suitable threshold. An observation on this variable above the 90th percentile is considered to raise an alarm, placing the observation in the first row of the matrix. If an asset price bust occurs within a particular time frame (discussed later) after the alarm, that alarm is considered a legitimate alarm and is placed into cell A. If there is no bust, that alarm is considered to be only noise and is placed into cell B. An analogous classification procedure determines the placement of observations into cells C and D. Ideally, all observations would fall into cells A or D, which correctly predict the occurrence or nonoccurrence of a bust.

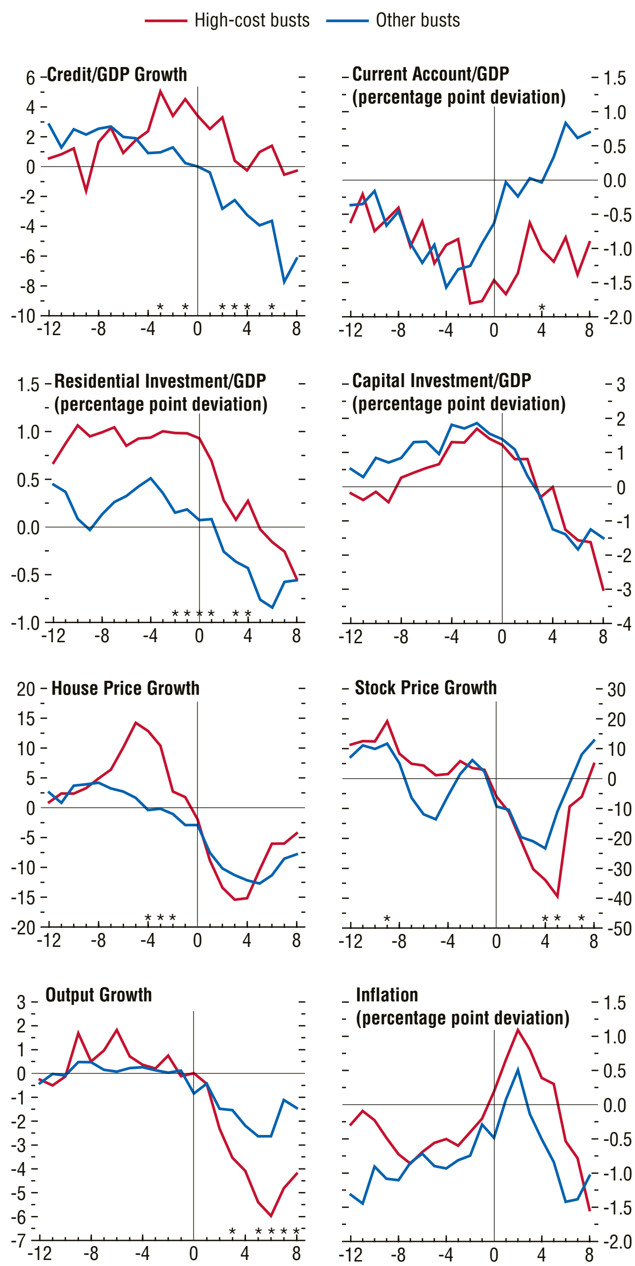
Two statistics that can be derived from this approach are of particular interest. The first is a measure of the conditional probability of a bust, which is the probability that a bust will occur within a particular time horizon once an alarm

[11]More specifically, we choose the threshold based on percentiles of the distribution of deviations such that the noise-to-signal ratio—defined as the ratio of the share of false alarms to legitimate alarms—is minimized. To avoid the influence of extreme observations, we limit our grid search to four percentiles: 70th, 75th, 80th, and 90th. For the thresholds used, see Table 3.5 in Appendix 3.1.

Figure 3.4. Selected Macroeconomic Variables before and during High-Cost and Other House Price Busts, 1985–2008

(Median percent deviation from trailing eight-year moving average, unless otherwise noted; asterisk indicates statistically significant difference between medians; t = 1 denotes first quarter of bust)

House price busts that are associated with larger output losses typically feature larger deviations in credit growth, residential investment, and house price growth. No significant differences are found for output growth and inflation.

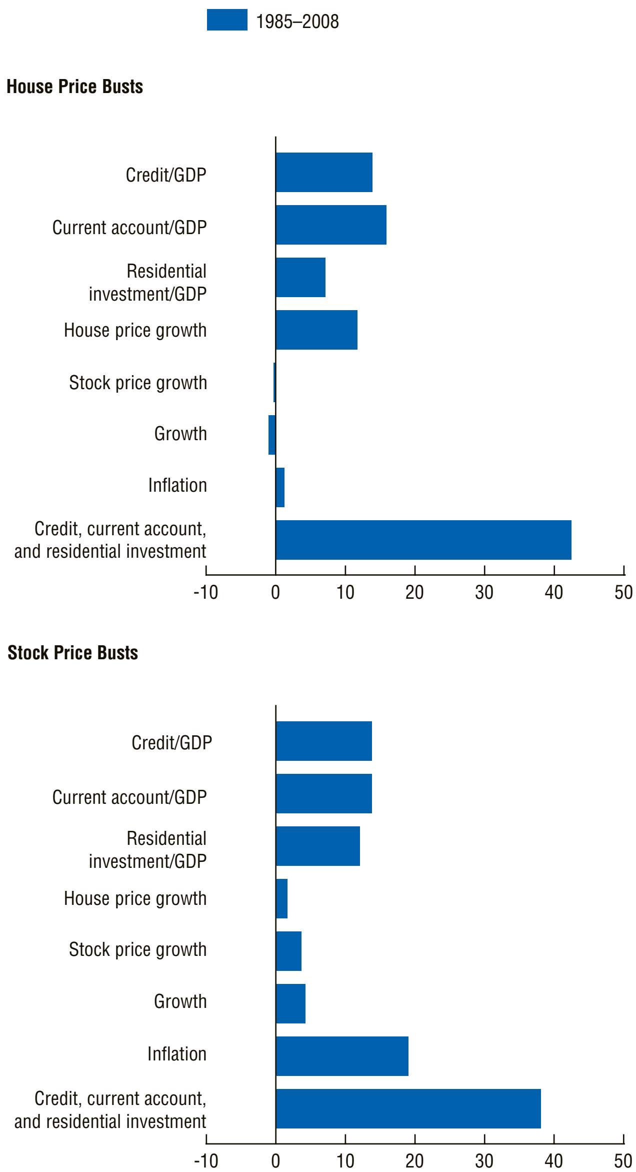


Source: IMF staff calculations.

Figure 3.5. The Probability of an Asset Price Bust

(Percent of times a bust occurs 1–3 years after an alarm is raised relative to the unconditional probability of a bust)

For house price busts since 1985, large deviations in credit, current account, and residential investment to GDP are particularly predictive of the likelihood of an impending bust. In the case of stock price busts, these variables are also more predictive than the unconditional probability, though the difference is smaller.



Source: IMF staff calculations.

has been raised based on a particular variable.[12] The second is a measure of the predictive ability (or lack thereof) of the variables, which essentially captures the proportion of periods during which a bust occurred one to three years in the future but for which no alarm was raised.[13] These two statistics capture the trade-off involved in the choice of a suitable threshold. An extremely high threshold that identifies only one observation from the sample will perform well on the conditional probability measure if a bust occurs within a particular time horizon, but will fare poorly on the other measure because no alarm would be raised for most of the busts.

Computing these probabilities also involves selecting the appropriate time horizon. If the horizon is too short, the alarm will have no operational relevance because any action by policymakers would be too late to affect the economy and forestall or mitigate the bust. If the horizon is too long, the alarm becomes uninformative, meaning that it loses its predictive ability. We chose a horizon that considers an alarm legitimate if it successfully predicts a bust within three years, with a minimum lead time of one year.

Figure 3.5 shows the difference between the conditional probability of a bust occurring one to three years after an alarm has been raised and the unconditional probability of a bust over the same horizon. This gauges the predictive ability of the conditional probability measures. In the sample, the unconditional probability of a house price bust occurring one to three years in the future is 14 percent during the post-1985 period. For stock price busts, the corresponding probability is 29 percent.

In the post-1985 period, large deviations in credit relative to GDP, in the current account balance, in the residential investment share of GDP, and in house prices themselves are particularly predictive of an impending house

[12]In terms of the matrix presented in Table 3.2, this statistic can be computed as A divided by (A+B).

[13]In this case, the relevant statistic is C divided by (A+C).

price bust. Large deviations in the credit-to-GDP ratio, for example, are associated with a 28 percent probability of a house price bust one to three years in the future, which is twice the unconditional probability of such a bust. Large deviations in output and inflation—the conventional components of monetary policy rules in the academic literature—have little ability to predict house price busts. For stock price busts, output and inflation perform slightly better as leading indicators, but credit, the current account balance, and residential investment have much more predictive ability, as they do for house price busts. The degree of significance of the marginal predictive ability of these variables is confirmed in a formal econometric (probit) analysis (see Table 3.6 in Appendix 3.1).

These results suggest that large deviations in the ratios of credit, the current account, and residential investment to GDP are significant predictors of asset price busts. What happens when all three variables raise alarms at the same time? The bottom bars in each panel of Figure 3.5 indicate that 56 percent of these occasions were associated with a house price bust one to three years in the future.[14] The ratio is roughly the same in the case of predicting stock price busts.

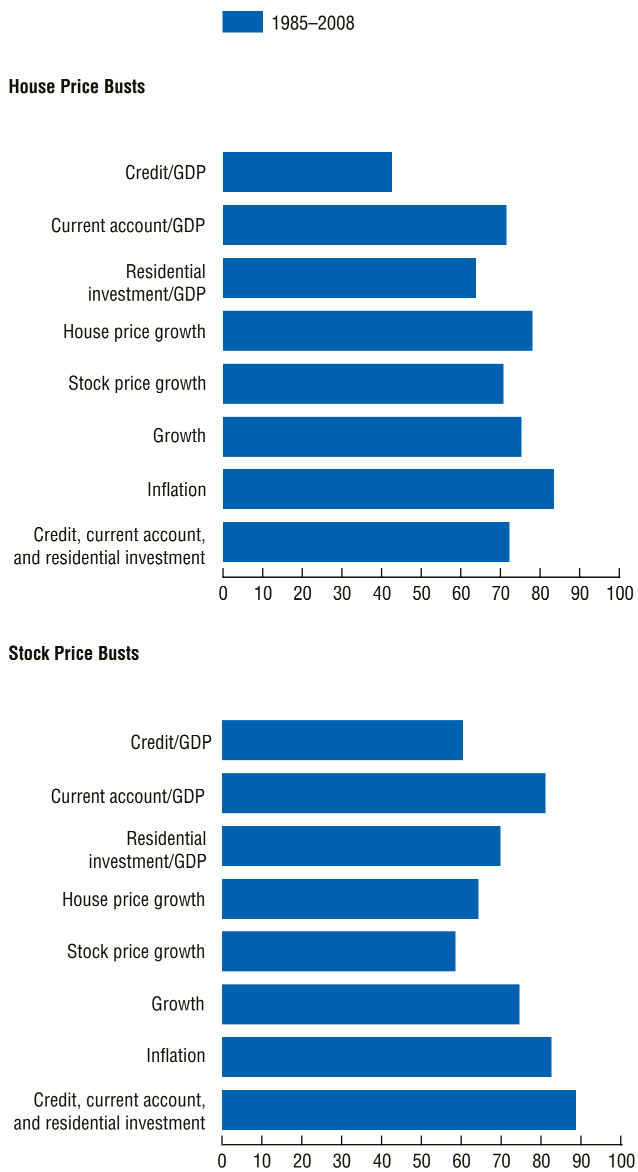
These results should be interpreted with caution. As mentioned, the most predictive thresholds for these variables may be those that result in identification of just a few observations that yield particularly reliable alarms. When considering the simultaneous raising of alarms by all three variables, this restriction becomes more severe. To complement the analysis, therefore, we look at the proportion of periods during which the indicators fail to raise an alarm one to three years ahead of a bust (Figure 3.6). Large deviations in variables such as credit to GDP, current account to GDP, and residential investment to GDP raise alarms in advance of a bust only one-quarter to one-half of the time during

[14]The percentage is computed as the sum of the percentage indicated in the bar and the unconditional probability of each type of bust.

Figure 3.6. The Failure of the Indicators to Predict an Asset Price Bust

(Percent of quarters the variables failed to raise an alar m 1–3 years before a bust)

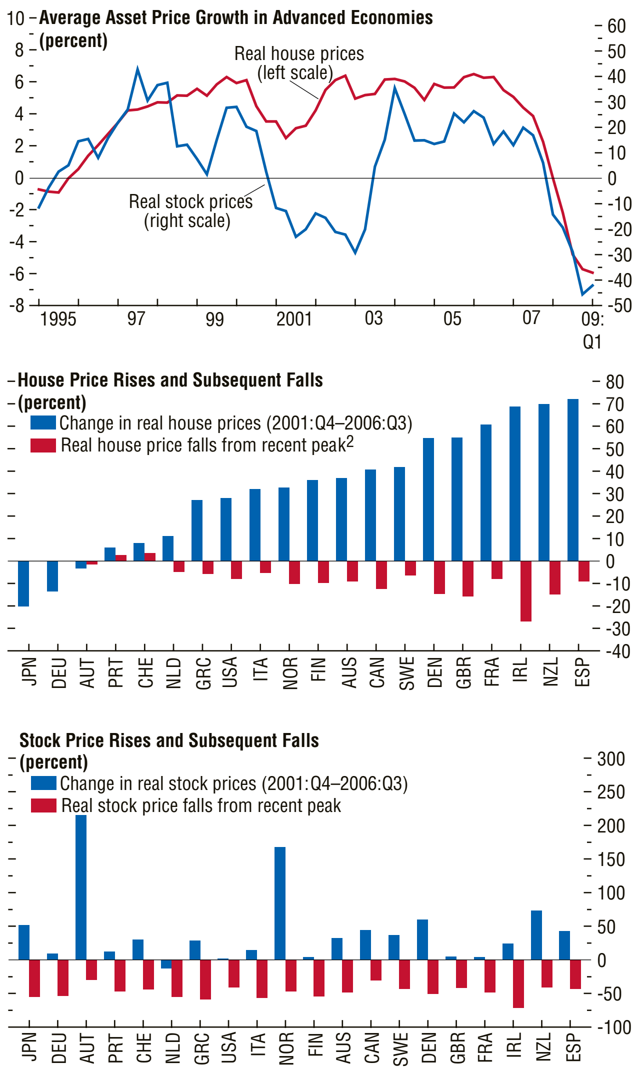
Even though large deviations in credit, the current account, and investment to GDP are good predictors of asset price busts, they raised alarms only about one-quarter to one-half of the time prior to a bust in the post-1985 period.



Source: IMF staff calculations.

Figure 3.7. Recent Developments in House and Stock Prices[1]

With the exception of Germany and Japan (which are experiencing secular declines in house prices), most economies have experienced strong rises in asset prices, followed by sharp falls. The extent of house price falls is related to the extent of previous house price rises. The extent of recent stock price falls is similar across countries but does not closely relate to the extent of previous rises.



Sources: Bank for International Settlements; Bloomberg Financial Markets; Haver Analytics; IMF, *International Financial Statistics;* Organization for Economic Cooperation and Development; and IMF staff calculations.

[1]AUS: Australia; AUT: Austria; BEL: Belgium; CAN: Canada; CHE: Switzerland; DEN: Denmark; DEU: Germany; ESP: Spain; GBR: United Kingdom; GRC: Greece; FIN: Finland; FRA: France; IRL: Ireland; ITA: Italy; JPN: Japan; NLD: Netherlands; NOR: Norway; NZL: New Zealand; PRT: Portugal; SWE: Sweden; USA: United States.

[2]Not shown for Germany and Japan as real prices declined through the 2001:Q4–2006:Q3 period.

the post-1985 period. The most reliable indicator is credit, which raises an alarm in one-half of all cases.

In summary, large booms in credit and investment, as well as deteriorating current account balances, substantially increase the probability of a bust occurring in the near future. When these indicators raise an alarm, the probability of a bust is more than twice the unconditional probability. Nonetheless, even the best indicator failed to raise an alarm one to three years ahead of roughly one-half of all busts since 1985. Thus, asset price busts are difficult to predict.

Macroeconomic Patterns ahead of the Current Crisis

These findings lead to the following question: Do the patterns associated with previous episodes of asset price busts show up ahead of the current crisis? Undoubtedly, recent years saw several important developments, such as innovations in securitization, that might suggest the current crisis is fundamentally different from previous crises. However, for house prices, this crisis had a very familiar macroeconomic pattern: house price busts were preceded by strong growth in credit, worsening current account balances, and house price booms.

Figure 3.7 shows average annual real house and stock price growth across all economies in the sample from the start of 1995 through 2008. Apart from the current episode, stock prices experienced one other boom-bust cycle during this period. Real house prices registered strong growth rates, on average, until 2007. Subsequently, most economies experienced falls in asset values that are severe by historical standards. Asset price paths differ widely across countries. From the fourth quarter of 2001 through the third quarter of 2006, real house prices rose strongly in Ireland, New Zealand, and Spain, but fell in Austria, Germany, and Japan.[15] Consistent with the results from

[15]These dates were chosen because they cover the period during which most economies (except for Austria,

previous issues of the *World Economic Outlook* (April 2003 and April 2008), larger house price increases have generally, though not uniformly, been followed by larger decreases from recent peaks. Except for Germany and Japan, which have been experiencing long-term declines in real house prices, the correlation between house price rises and subsequent falls is 0.79.[16] In contrast, the recent fall in stock prices was relatively uniform across countries and was largely unrelated to previous stock price rises.

Were the macroeconomic indicators identified in the previous section associated with the recent asset price busts? Figure 3.8 shows the proportion of countries that experienced house price busts for which the credit-to-GDP, residential-investment-to-GDP, and current-account-to-GDP variables were raising alarms, based on the definitions in the previous section. Signs of a residential investment boom, in some cases funded by current account declines, are apparent in at least half the economies one to three years before the onset of house price busts. Credit growth was unusually high in roughly half the economies over almost the entire three-year period. The alarm from the current account is more muted until about one year ahead of the bust, when it was raised for nearly half the countries.

Figure 3.9 shows how recent cross-country variations in house price changes are associated with variations in credit growth, residential investment, and current account relative to GDP. Economies with the largest house price appreciations also had large increases in residential investment as a share of GDP, large current account deficits as a share of GDP, and large expansions of credit relative to the expansion in output. Furthermore, stronger credit growth was also typically matched by more severe deteriorations in household balance sheets: a version of a

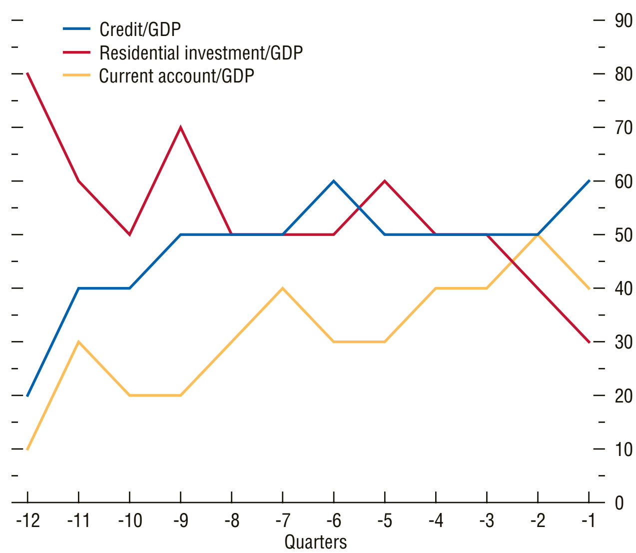
Germany, and Japan) experienced steady rises in house prices, ending with the peak in house prices in Ireland.

[16]House price falls are defined as the percentage difference between the recent peak in the economy's house prices and the latest data available (either 2008:Q3 or 2008:Q4, depending on the economy).

Figure 3.8. Warning Signs for Recent House Price Busts

(Percent of countries with recent house price busts that raised alarms)

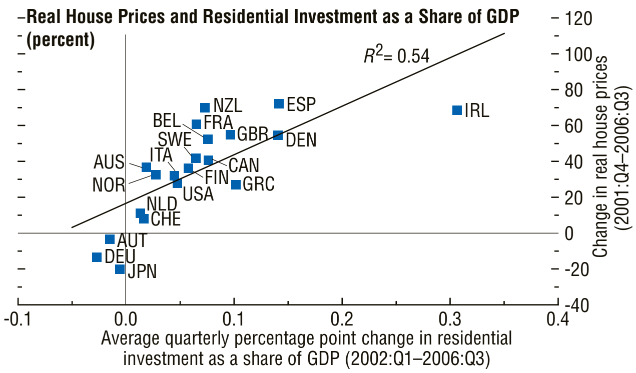
Residential investment booms were observed for more than half the economies that subsequently experienced a house price bust. Credit booms and large deviations from trend in current account balances were also observed for a significant proportion of these economies.

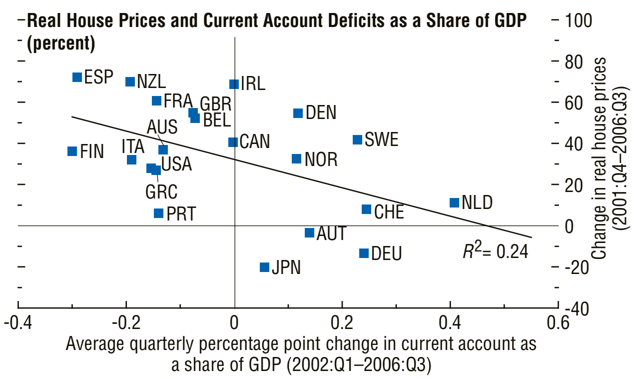


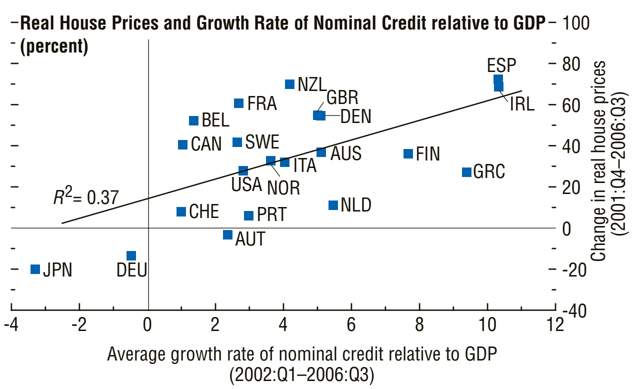
Source: IMF staff calculations.

Figure 3.9. Macroeconomic Patterns Underlying Recent House Price Booms[1]

Larger real house price booms in recent years have been associated with larger increases in residential investment, deteriorations in current account balances, and larger expansions in credit.







Sources: Bank for International Settlements; Bloomberg Financial Markets; Haver Analytics; IMF, *International Financial Statistics;* Organization for Economic Cooperation and Development; and IMF staff calculations.
[1]See Figure 3.7 for country abbreviations.

household "quick ratio"—the ratio of liabilities to liquid assets (deposits and currency)—was found to be highly associated with house price growth (Figure 3.10).[17] At the macroeconomic level, therefore, the evidence suggests that this was a conventional crisis in that it displayed patterns historically evident in asset price booms and busts. A key question, then, is whether these boom-bust cycles resulted from monetary policy actions.

The Role of Monetary Policy

Two criticisms have been leveled against monetary policymakers:

- The first criticism is that monetary policy was too loose from 2002 to 2006—in particular, that central banks held the policy rate below the level specified by a simple rule for reacting to an output gap and inflation.[18] Had monetary policymakers not deviated from a Taylor rule, goes the argument, the rise in asset prices—and, by implication, the current crisis—would have been avoided. Note that the essence of this argument is that monetary excesses were the main cause of the booms and subsequent busts.
- The second criticism argues that setting monetary policy by looking only at consumer price index (CPI) inflation and the output gap is too narrow an approach: in a simple version, monetary policy should lean against unsustainable asset price rises or developments that raise financial vulnerability, even at the cost of more variability in inflation and output.[19]

[17]These measures were constructed from nonconsolidated household balance sheet data from the Organization for Economic Cooperation and Development (OECD). The ratio of loans to disposable income fitted poorly. The United Kingdom and United States stand out with very high maturity ratios (ratios of long- to short-term liabilities), but these do not have explanatory power for house price changes during this period.

[18]See Taylor (2007 and 2008). Taylor cites Ahrend, Cournède, and Price (2008) as support for the argument that policy failures were widespread and not limited to the U.S. Federal Reserve.

[19]See, among others, Borio and Lowe (2002b and 2004) and White (2006). A more far-reaching ver-

These criticisms are difficult to answer conclusively because they require assessing the counterfactual—what would have happened had different policy choices been made. However, an analysis of monetary conditions and asset prices during the years before the recent asset price busts sheds some light on the validity of the first criticism. (The validity of the second is evaluated in the following section using a model-based approach.)

Overall, since 1985, monetary policy conditions are generally not a good leading indicator of house price busts. Figure 3.11 tracks two standard measures of monetary policy stance in the run-up to house price busts. As in the previous section, patterns around busts before 1985 and during and after 1985 are examined separately. The upper panel shows the behavior of real policy rates,[20] and the lower panel shows the deviation of these rates from a standard Taylor rule, which takes into account business cycle developments.[21] There is some evidence of loose monetary policy in the run-up to house price busts before 1985. One interpretation is that monetary policy during that period did not react sufficiently to inflation, such as that generated by the oil shocks.

In the period since 1985, taken as a whole, real policy rates were typically above trend in the run-up to a house price bust and high when compared with those implied by a Taylor rule. Furthermore, the dynamics of real rates suggest that, if anything, rates actually increased in the years leading up to a bust. However, both real interest rates and residuals from Taylor rules

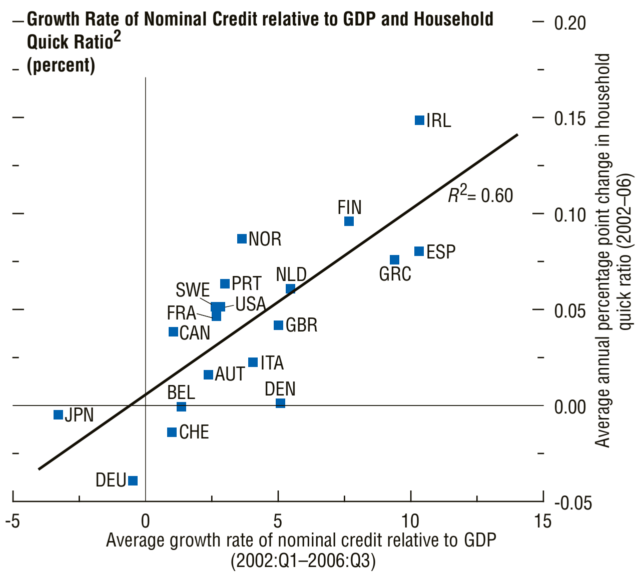
sion of this criticism is that current implementations of best-practice monetary policy—especially in formal inflation-targeting regimes—can themselves raise overall macroeconomic instability by focusing exclusively on too narrow a definition of stability—namely, goods market inflation. A related criticism—the "paradox of credibility"—is that success at lowering and anchoring inflation expectations may encourage a form of money illusion (see, for example, Borio and Shim, 2007).

[20]As in the previous section, these data are presented as deviations from an eight-year trailing average.

[21]The rule has weights of 1.5 on deviations of inflation from its target level and 0.5 on the output gap. See Taylor (1993).

Figure 3.10. Recent House Price Booms and Household Balance Sheets[1]

Larger credit expansions have been associated with larger deteriorations in balance sheets.



Sources: Bank for International Settlements; Haver Analytics; IMF, *International Financial Statistics;* Organization for Economic Cooperation and Development; and IMF staff calculations.

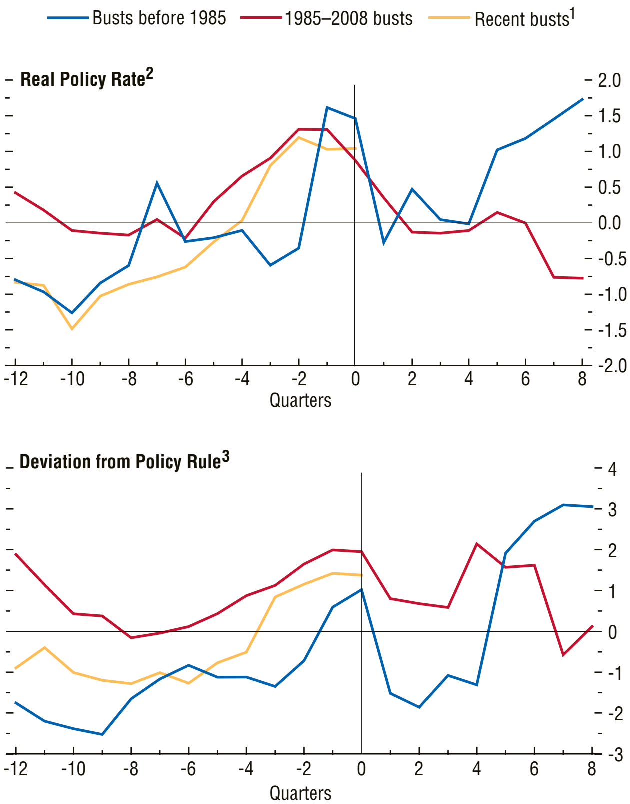
[1]See Figure 3.7 for country abbreviations.

[2]Ratio of liabilities to liquid assets (deposits and currency).

Figure 3.11. Monetary Policy before House Price Busts

(Percentage points; t = 1 denotes first quarter of bust)

In the post-1985 period as a whole, house price busts have typically not been preceded by loose monetary policy. However, monetary policy may have been too loose, on average, in recent years.



Source: IMF staff calculations.
[1]Recent busts comprise 10 busts beginning after 2007:Q1 in Australia, Canada, Denmark, Finland, Ireland, New Zealand, Norway, Spain, United Kingdom, and United States.
[2]Deviation from eight-year moving average.
[3]Deviation from a policy rule of the form $r = r^* + 0.5\,(\pi - \pi^*) + 0.5\,(y - y^*)$, where the starred variables are computed as the trailing eight-year moving average.

were negative, on average, one to three years before the recent busts, followed by a sharp tightening of monetary conditions during the year preceding the crash. This may be evidence of overly loose monetary policy. However, in most economies, policymakers looking only at CPI inflation would not have seen obvious signs of a problem during this period. Figure 3.12 shows that core inflation in the United States, the euro area, and, on average, the other advanced economies (with the exception of Japan) stayed within 1–3 percent throughout the period during which credit was expanding and asset prices were booming. One interpretation advanced at the time—which is addressed in the next section—is that higher asset prices and demand for credit reflected expected gains in productivity.

If monetary policy were the fundamental cause of house price booms over the past decade, there would be a systematic relationship between monetary policy conditions and house price gains across economies. Certainly, average real policy rates were low and even negative in some economies, and Taylor rule residuals were mostly negative, suggesting that monetary policy was generally accommodative across economies during this period. But there is, at best, a weak association with house price developments within the euro area (Figure 3.13, blue lines).[22] And there is virtually no association between the measures of monetary policy stance and house price increases in the full sample (Figure 3.13, black lines). For example, whereas Ireland and Spain had low real short-term rates and large house price rises, Australia, New Zealand, and the United Kingdom had relatively high real rates and large house price rises. Moreover, the association between measures of the monetary policy stance and real stock price growth is

[22]The real policy rate here is constructed by deflating nominal gross policy rates by Consensus Economics expectations of gross CPI inflation one year forward. (Consensus Economics expectations data are not available for all economies in the sample before 1995, which prevented their use in measuring real rates in the previous sections.)

extremely weak, whether assessed during the global house price boom (2001:Q4–2006:Q3; not shown) or during a later period, when stock markets rallied from their troughs (2003:Q1) through the stock market declines of 2007 (Figure 3.14).

The fairly regular behavior of inflation and output and the fact that Taylor rule residuals were not associated with recent asset price rises across economies in the sample suggest that monetary policy was not the main or systematic source of the recent asset price booms.[23] At the same time, evidence outlined in previous sections underscores that the asset price bust that started in 2007 did not come out of the blue, in the sense that key macroeconomic variables showed patterns similar to those ahead of historical asset price booms and busts. Should policymakers have reacted to these signals and alarms, by placing greater emphasis on financial stability and less emphasis on inflation? This question is addressed in the next section.

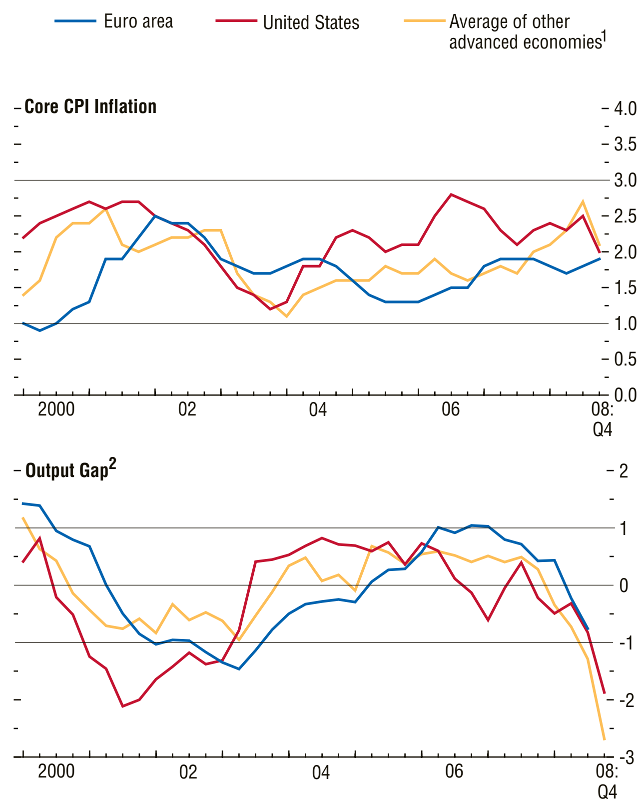
Should Policymakers React to Asset Market Fluctuations?

This analysis has identified a number of macroeconomic variables that are often associated with asset price busts, although their predictive ability is not as consistent nor as strong as policymakers might hope. Those same variables do reasonably well in explaining the differences across economies in house price rises leading up to the current crisis. This suggests that central bankers should consider reacting more strongly to indicators other than just output and inflation in order to mitigate damaging asset price boom-bust cycles. There are three important

[23]One assumption in this analysis is that monetary policy decisions in one economy were independent of those in other economies, which is a common conclusion given floating exchange rates and a free flow of capital. Some argue that monetary policy decisions in the United States have more influence on monetary conditions in other economies than this assumption allows. This awaits rigorous empirical testing.

Figure 3.12. Inflation and Output for Advanced Economies in Recent Years
(Percent)

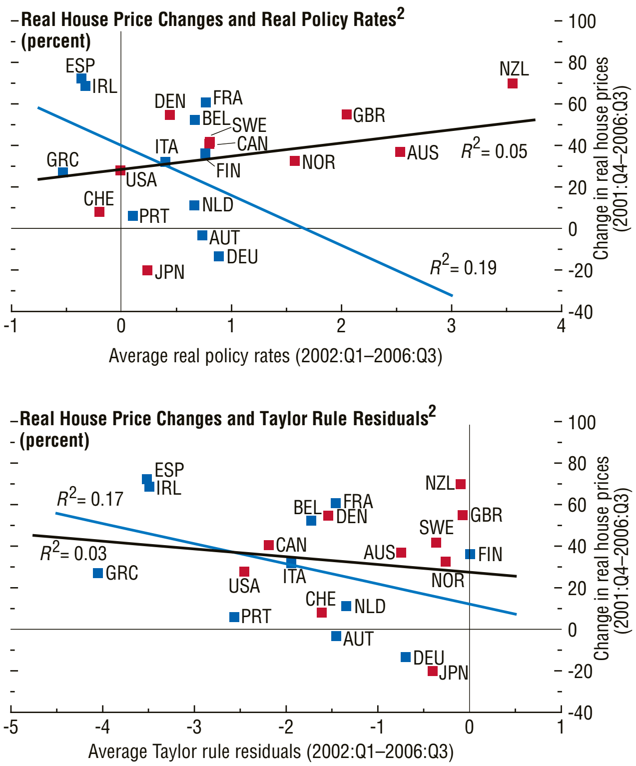
Core consumer price index (CPI) inflation and output gaps stayed within narrow ranges for most economies in recent years, during which time credit expanded rapidly and asset prices boomed.



Sources: Haver Analytics; and IMF staff calculations.
[1]Japan omitted.
[2]Estimate of output gap using rolling Hodrick-Prescott filter.

Figure 3.13. House Prices and Monetary Conditions[1]

In economies with common nominal monetary policy rates, looser real monetary conditions in recent years were associated with larger rises in real house prices. Across advanced economies as a whole, there was little significant correlation in recent years between real monetary conditions and real house prices.



Sources: Bank for International Settlements; Bloomberg Financial Markets; Haver Analytics; national authorities; Organization for Economic Cooperation and Development; Thomson Datastream; and IMF staff calculations.

[1] See Figure 3.7 for country abbreviations.

[2] Euro area economies are designated by blue squares. Other advanced economies are designated by red squares. Blue lines are fitted to a subsample of euro area economies. Black lines are fitted to the whole sample of advanced economies.

questions to be addressed in assessing the appropriate policy responses:

- What are the potential gains from reacting to signs of emerging financial vulnerability, such as excessive credit growth?
- Is monetary policy the appropriate tool for reacting to such indicators, or should other policies be used?
- What are the trade-offs between focusing policy on stabilizing output and CPI inflation and attempting to reduce the risk of asset price booms and busts?

This section addresses these questions with simulations conducted using a model economy with some of the key features relevant for examining the potential role of monetary policy in mitigating the effects of asset price booms. Because housing wealth is generally more important than equities for most households, and because house purchases typically require bank credit, the focus is on house price booms rather than stock price booms.[24]

A Model for Analyzing House Price Booms

The model used here has conventional New Keynesian foundations; in particular, prices generally do not adjust immediately. This means that monetary policy has a potential role in stabilizing the economy because it influences real interest rates. Consumption and residential investment adjust slowly, and it is costly for workers to shift from producing consumption goods to building houses, and vice versa. In addition, there are a number of modifications to the standard model with regard to the characterization of households and financial markets, which create a special role for the housing market.[25] First, households make choices about

[24] For a model that considers the monetary policy implications of stock price fluctuations, see Christiano, Motto, and Rostagno (2007). For simplicity, there is no capital used in production, and the economy is closed.

[25] The model draws on elements of models by Aoki, Proudman, and Vlieghe (2004); Cúrdia and Woodford (2009); Iacoviello (2005); and Monacelli (2009). See also the April 2008 WEO. The accelerator mechanism goes

the consumption of nondurable goods and how much to invest in housing. Housing is an asset that provides services and is the main vehicle for accumulating wealth in this economy. Second, there is a distinction between borrowers and lenders, creating conditions for leverage. Third, the lending rate is modeled as a spread over the policy rate that depends on loan-to-value ratios, the markup charged over funding (policy) rates, and, in some cases (discussed later), a macroprudential instrument. Hence, lending rates can change for a number of reasons: for example, a rise in house prices will raise market valuations of borrowers' collateral, lower the average loan-to-value ratio, 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 or competitiveness in lending—which could lead banks to adjust their markups and therefore alter the lending spread. Both of these mechanisms help accelerate a rise in residential investment, nondurable consumption, and prices. In some simulations, policymakers can affect spreads directly, using a macroprudential tool, in addition to influencing lending rates via policy rates. Finally, debt is important for financing the purchase of houses—the loan-to-value ratio fluctuates around an average over time of 80 percent.

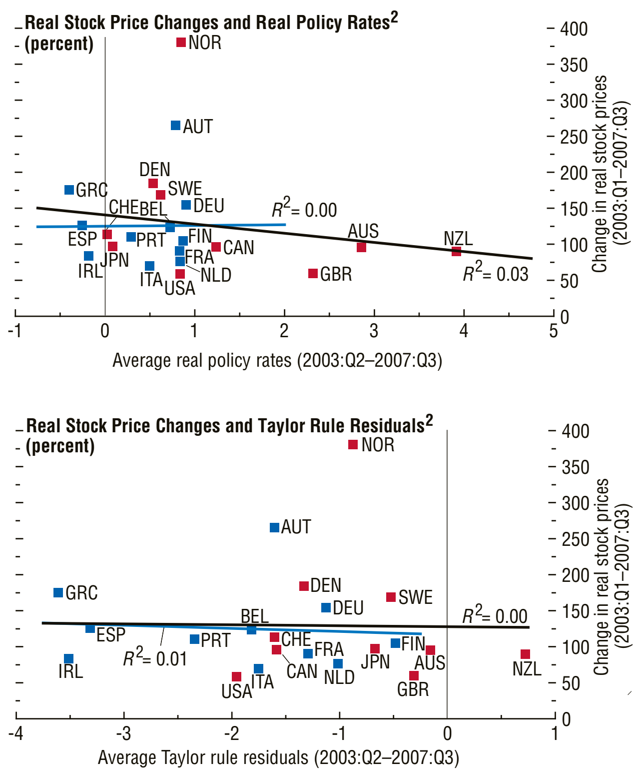
The behavior of the model economy is examined under different policy regimes, following shocks that produce sustained rises in residential investment and house prices.[26] The objective is

back to Bernanke, Gertler, and Gilchrist (BGG, 1998); unlike BGG, the accelerator in this model works through housing finance rather than firms' capital. For a detailed description of the model, see Kannan, Rabanal, and Scott (forthcoming b).

[26]We rank policy regimes in terms of the evenly weighted variances of the output gap and CPI inflation. The output gap in this model is the difference between aggregate and potential output (GDP). Potential output is defined as the level of aggregate production in this economy when nominal rigidities and financial frictions are removed—that is, prices are assumed to be flexible in both sectors, all agents have the same discount factor, and there is no spread between borrowing and lending rates. The output gap is an appropriate target, from a welfare

Figure 3.14. Stock Prices and Monetary Conditions[1]

There has been little significant correlation between real monetary conditions in recent years and real stock prices, whether in economies with common nominal monetary policy rates or across advanced economies as a whole.



Sources: Bloomberg Financial Markets; IMF, *International Financial Statistics;* and IMF staff calculations.
[1]See Figure 3.7 for country abbreviations.
[2]Euro area economies are designated by blue squares. Other advanced economies are designated by red squares. Blue lines are fitted to a subsample of euro area economies. Black lines are fitted to the whole sample of advanced economies.

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.[27] Although asset booms can arise from expectations of future capital gains, without any change in fundamentals, we do not model bubbles or "irrational exuberance."[28] Similarly, we do not attempt to model events that trigger house price crashes.

Policymakers are assumed to have nominal short-term interest rates and, potentially, the macroprudential instrument at their disposal. The macroprudential instrument affects lending rates—policymakers can directly offset, to some degree, fluctuations in spreads caused by the changes in collateral values and financial shocks. This is a simple shortcut intended to mimic the effects of, say, regulations that require banks to set aside more capital as asset prices rise, hence raising the margin that banks have to charge over funding costs (the policy rate).

The baseline policy regime is a *standard Taylor rule,* specified with a weight of 1.5 on CPI inflation and 0.5 on the output gap. With that benchmark, we investigate gains to be achieved by incorporating indicators of potential financial vulnerability. Hence, the second regime is implemented as an *augmented Taylor rule*, in which monetary policy rates react to changes in nominal credit, in addition to CPI inflation and the output gap.[29] The third regime introduces a *macroprudential rule* that specifies the reaction of a macroprudential instrument (which alters the spread between the lending and the policy rate) to lagged nominal credit changes (the same variable as in the augmented Taylor rule). Combining the macroprudential instrument with the augmented Taylor rule produces the third policy regime.[30] The final policy regime is a variation on the third, in which the weight on each variable is determined by an optimization procedure that seeks the best response to the particular shock being considered. All variables in these policy rules are lagged.[31]

perspective, because GDP is the sum of output of both consumption and the housing sector. Monetary and regulatory policy should aim to reduce the impact of nominal and financial distortions in the economy. CPI inflation is the rate of change of prices for consumption goods and does not include house price inflation; hence, it is not fully appropriate as a welfare metric. We deliberately assess the policies in terms of CPI inflation to facilitate comparison with most of the monetary policy literature and conventional goals of central bankers; in general, assessing policies in terms of house price inflation as well would strengthen the case for broader policies.

[27]The financial shock can be thought of as a reduction in the margin banks charge over funding costs, caused by an increase in competition and a quest for market share or by a reduction in perceived lending risk. The productivity increase is modeled as a shock to labor-augmenting productivity of nondurable consumption goods. Both shocks are temporary but quite persistent—they follow AR(1) processes with persistence parameters set at 0.95. Note that, once the shock hits the economy, we assume both households and policymakers immediately understand what the shock is and how it will be transmitted through the economy.

[28]This is not a comment on the likelihood of bubbles; it is a reflection of the fact that there are currently no tractable models of irrational bubbles that can be incorporated into models of this type.

[29]Nominal credit is defined as real credit multiplied by the GDP deflator, which is a weighted average of CPI and house price indices.

[30]In these three regimes, all monetary policy reactions are smoothed by imposing a weight of 0.7 on the lagged nominal interest rate and 0.3 on the policy variables. (The weight is optimized in the fourth regime.)

[31]These lags are introduced on the grounds that, in real life, policymakers have data for the output gap and inflation only after some delay; data for money aggregates and credit are available more readily. Including contemporaneous credit in the rules would increase the value of credit as an indicator and therefore bias the conclusions in favor of extended frameworks. To avoid this, credit is also introduced with a lag.

The Performance of Policy Rules in Reaction to Financial Shocks

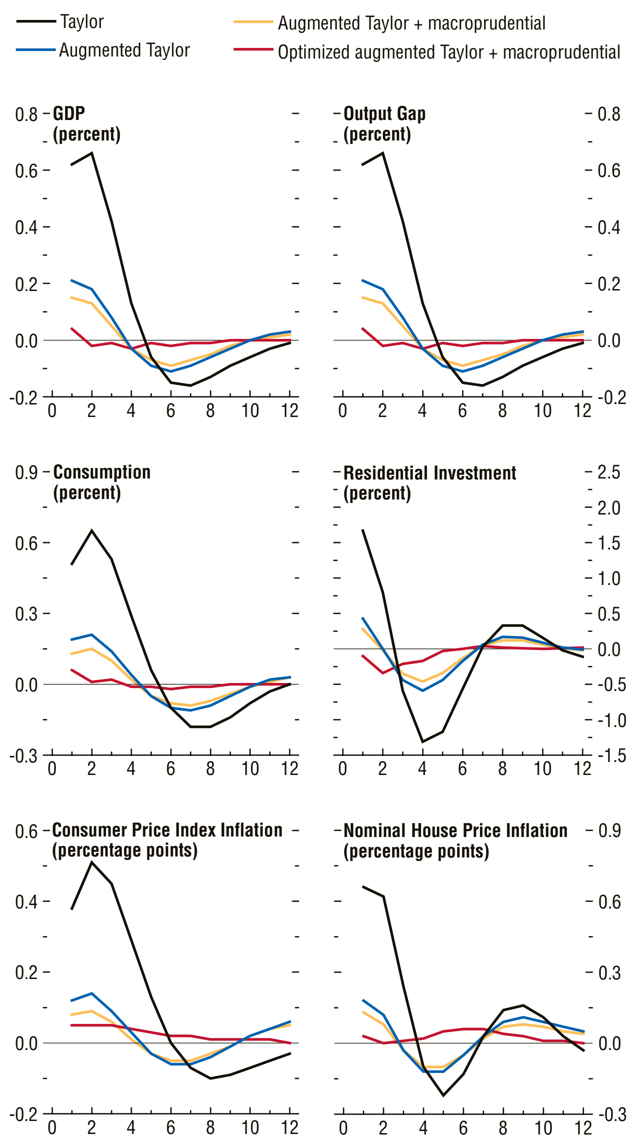
Figure 3.15 shows the response to a financial shock, modeled as a relaxation in lending standards that immediately reduces lending rates by 100 basis points in the baseline Taylor policy regime (black line). Three other paths are shown, corresponding to the other policy regimes. In the Taylor policy regime, monetary policy is guided by the simple Taylor rule with no macroprudential reaction. The financial shock causes an immediate increase in residential investment and house prices. Because banks are assumed to lower lending rates when collateral rises, the shock feeds on itself: housing demand raises house prices, collateral values increase, lending rates are lowered, and households take out more loans. This is the credit accelerator mechanism at work. In addition, lower rates lead to higher demand for nondurable consumption goods, pushing up CPI inflation. Some characteristics of a house price bust are evident in the aftermath of this shock: as financial conditions normalize, residential investment—and with it, house prices—must *undershoot* for a period to bring the housing stock back to equilibrium. This process spills over to the rest of the economy, causing a temporary recession and raising volatility in all markets. The reaction of a central bank following a simple Taylor rule is straightforward: to the extent that the output gap and CPI inflation are positive following the increase in housing demand, policy rates are raised. Eventually, output and inflation stabilize.

The second policy regime is the augmented Taylor rule, under which the central bank reacts directly to credit in addition to the output gap and inflation. For illustration, we assume the central bank puts the same weight (0.5) on changes in nominal credit as on the output gap (Table 3.3, upper panel, second row). This rule produces greater stability across the board as shown in the figure: the volatility of residential investment is lower, there is a considerable reduction in the volatility of GDP and the

Figure 3.15. Effects of a Financial Shock

(Deviation from steady state; quarters on x-axis)

The figure shows impulse response to an unanticipated financial shock in the first quarter. The size of the shock is normalized such that it leads to a 1 percent decline of the lending rate on impact under the Taylor rule regime. Paths denote different policy regimes.



Source: IMF staff calculations.

Table 3.3. Parameters and Performance of Policy Regimes in Reaction to Financial Shocks

	Weights under Each Regime				
	Lagged interest rates in monetary policy rule	Inflation in monetary policy rule	Output gap in monetary policy rule	Nominal credit in monetary policy rule	Nominal credit in macroprudential rule
Taylor	0.7	1.5	0.5	. . .	. . .
Augmented Taylor	0.7	1.5	0.5	0.5	. . .
Augmented Taylor + macroprudential	0.7	1.5	0.5	0.5	0.5
Optimized augmented Taylor + macroprudential	0.0	13.2	3.2	0.0	0.8

	Performance			
	Standard deviation of inflation	Standard deviation of output gap	Loss[1]	Ranking
Taylor	0.512	0.624	0.652	4
Augmented Taylor	0.110	0.076	0.018	3
Augmented Taylor + macroprudential	0.092	0.061	0.012	2
Optimized augmented Taylor + macroprudential	0.018	0.040	0.002	1

Source: IMF staff calculations.

[1]Loss equals the sum of the variances of output gap and consumer price index inflation.

output gap, and house prices and CPI inflation are less volatile (see also the standard deviations in Table 3.3, lower panel, second row, compared with those in the first row).[32]

Macroeconomic stabilization is even better served under the third policy regime, under which the central bank complements the augmented Taylor rule with the use of the macroprudential instrument (Table 3.3, lower panel, third row). For illustration, the growth rate of nominal credit in the macroprudential rule has a weight of 0.5, with the other weights maintained as for the augmented Taylor rule. The macroprudential rule allows policymakers to directly counter the relaxation of lending standards that induces borrowers to take on more debt as house prices rise.

To summarize, adding another indicator to the monetary policy reaction function can improve macroeconomic stability when the economy is hit by a financial shock. The responses hint that policy reactions guided by the standard Taylor rule are too weak in the face of loosened lending standards and credit accelerator effects, with the consequence that housing investment is insufficiently dampened. But the parameters in the augmented Taylor and macroprudential rules used here are ad hoc. In fact, if the objective is simply to stabilize the output gap and inflation, the optimal weights on the output gap and inflation in the monetary policy rules under this sort of "microfounded" model are generally much higher than the Taylor weights (see Woodford, 2001). This implies that the improvement in stability

[32]The volatility of interest rates is lower as well, even though the policy rule is more aggressive. This is because a model with fully forward-looking private agents, such as this one, has very strong expectational effects—households anticipate a stronger reaction from the central bank and factor it into their decision making. The result is that monetary policy works through the threat of a stronger reaction, rather than by actually delivering that stronger reaction.

from adding nominal credit to the monetary policy rule and employing the macroprudential instrument could simply indicate that, under the baseline Taylor rule, the reaction to the output gap and inflation is insufficient.

To address this issue, we also model a policy regime with the augmented Taylor and macroprudential rules optimized to minimize the variation in the output gap and in inflation. As expected, the optimized rules are the most successful in stabilizing the economy and come close to producing the efficient reaction—no output gap at all.[33] More interesting are the optimized weights (Table 3.3, upper panel, fourth row). Optimal monetary policy is very aggressive—the weights on the output gap and inflation are multiples of those in either the standard Taylor rule or typical estimated monetary reaction functions, and the optimized weight on interest rate smoothing is zero. The weight on nominal credit in setting the policy rate is zero.[34] Crucially, however, the optimal weight on nominal credit in the macroprudential rule is *not* zero; in fact, it is slightly more than the weight used before (0.8). Hence, macroprudential policy is unambiguously useful for dealing with financial shocks, even when the central bank is free to use policy rates very aggressively. Using the macroprudential tool is a more efficient reaction to loosening credit markets than simply raising policy rates, because it tackles the problem at its root.

The Performance of Policy Rules in Reaction to Productivity Shocks

Broader and more aggressive policy regimes can improve stability in the face of financial shocks, but they raise the possibility of policy mistakes in the face of other types of shocks. This is evident from the second set of simulations, which shows the reactions to an increase in productivity in the nondurable goods sector that, in the case of the Taylor rule, delivers an immediate 1 percent increase in output (Figure 3.16).[35] The results of this shock also resemble a housing boom: residential investment, house prices, and the demand for credit all rise, just as in response to a financial shock. However, the prices of consumption goods fall. Indeed, the fact that CPI inflation was contained in recent years while asset prices surged led many policymakers to conclude that asset price rises were being driven by positive productivity shocks.

The best policy for dealing with a productivity shock is for the central bank to accommodate the improvement in productivity as much as possible. Policies to suppress private sector borrowing would be misguided, as shown in the figure: following the augmented Taylor and macroprudential rules, with the same parameter values as for the financial shock, accentuates the downward pressure on prices (CPI index) and output, because of the reaction to credit growth. The result is that the output gap and inflation are *more* volatile, not less (Table 3.4, lower panel, second and third rows). Among the first three policy regimes—Taylor, augmented Taylor, augmented Taylor with macroprudential instrument—the best is the standard Taylor rule. The optimized regime has higher weights on the output gap and inflation, as before, but the model does not support using the macroprudential tool at all (Table 3.4, upper panel, fourth row). These results suggest that policy reactions to indicators of potential financial vulnerability should be neither automatic nor rigid—policymakers need room for discretion.

[33]The efficient reaction is desirable from a welfare point of view but is not possible within this model because of nominal rigidities and distortions in financial markets.

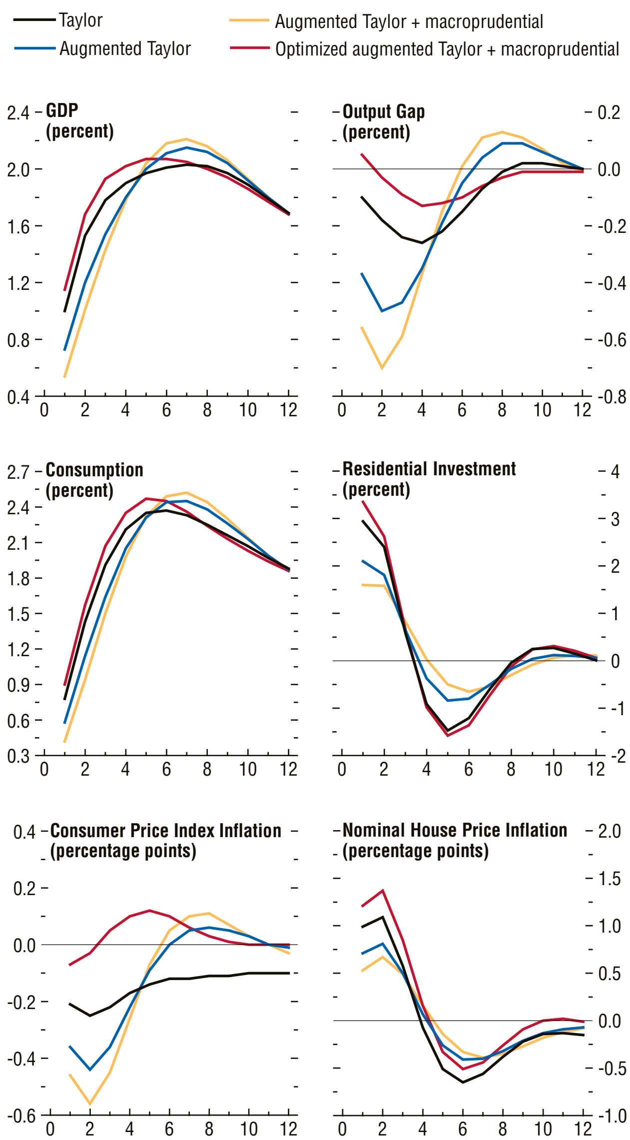
[34]In the augmented Taylor rule, the weight on credit was positive, and this held even when this rule was combined with a macroprudential instrument. This reflected lower-than-optimal Taylor rule weights on the output gap and inflation (0.5 and 1.5, respectively). A similar result is documented in Iacoviello (2005).

[35]Although the shock is centered on the production of nondurable consumption goods, households spend more on residential investment and nondurables consumption because of expectations for higher income.

Figure 3.16. Effects of a Productivity Shock

(Deviation from steady state; quarters on x-axis)

The figure shows impulse response to an unanticipated productivity shock in the first quarter. The size of the shock is normalized such that it leads to a 1 percent increase in real GDP on impact under the Taylor rule regime. Paths denote different policy regimes.



Source: IMF staff calculations.

Policy Rules with Multiple Shocks

In the real world, economies are affected by multiple shocks of various types. Optimal policy rules must strike a balance among the optimal responses to each different type of shock and must reflect the relative importance of the shocks in driving the economy. Consequently, the case for using a macroprudential tool will depend, among other things, on the mixture of shocks facing a particular economy. Figure 3.17 shows how the optimal weight on changes in nominal credit in the macroprudential rule rises as financial shocks become relatively more important than productivity shocks.[36] When there are no financial shocks, there is no need for the macroprudential tool. When there are only financial shocks, the optimal weight on nominal credit in the macroprudential rule in this model is 0.8, as shown above. Ideally, then, policymakers would be able to use discretion to deal appropriately with different types of shocks as they arise, rather than reacting rigidly with fixed rules.

How do these conclusions compare with those from other studies? As far as we know, this is the first time the coordination of monetary and macroprudential rules has been formally evaluated using a macroeconomic model of this type,[37] although there is abundant literature on monetary policy and asset prices. The debate persists over whether central banks should react directly to asset prices.[38] The analysis here sug-

[36]More precisely, the exercise involves specifying a sequence of variance-covariance matrices in which the ratio of the variance of the financial shock increases, while the variance of the productivity shock and the covariance of the two shocks stay fixed at 1 and zero, respectively, then optimizing the weights for all variables in the augmented Taylor and macroprudential rule regime for each of the variance-covariance matrices in the sequence.

[37]Gray and others (forthcoming) find a role for a financial stability indicator in the monetary policy rule. Gruss and Sgherri (2009) study the welfare implications of procyclical loan-to-value ratios in a two-country model. However, because the model does not have a nominal side, the reaction of monetary policy cannot be addressed.

[38]Two well-known examples are Bernanke and Gertler (2001), who conclude that there is no role for asset prices in monetary policy rules, and Cecchetti and others

gests that policymakers should be concerned not so much with asset price rises per se as with other conditions that can be associated with them: lax lending standards, excessive credit expansion, overinvestment, and deteriorating external balances. These conditions give policymakers a strong reason to react.

Nonetheless, the simulations presented here are highly stylized, and many potentially important factors are omitted. The model captures some relevant features of the world, but it has not been adapted to fit any particular economy. In particular, the characterization of the macroprudential tools is very simple and glosses over important practical questions about how such tools would be managed and how effective they would be in certain financial systems.[39] Hence, the results are only suggestive, and a great deal more research is required.

Policy Conclusions

Monetary policymakers in advanced economies with flexible exchange rate regimes have been guided in recent years by the principle that stabilizing inflation forms the best policy for promoting economic growth and welfare. At the time this approach was gaining favor, it was suggested that stable inflation would also reduce risk premiums and increase financial stability. A number of central banks now have explicit mandates to target CPI inflation, and they have been strikingly successful in keeping inflation in check. But this approach has not been sufficient to prevent asset price busts; the current crisis is no exception. Asset price busts have typically been preceded by rising investment, expanding credit, and deteriorating current account balances. Again, the current bust is no exception.

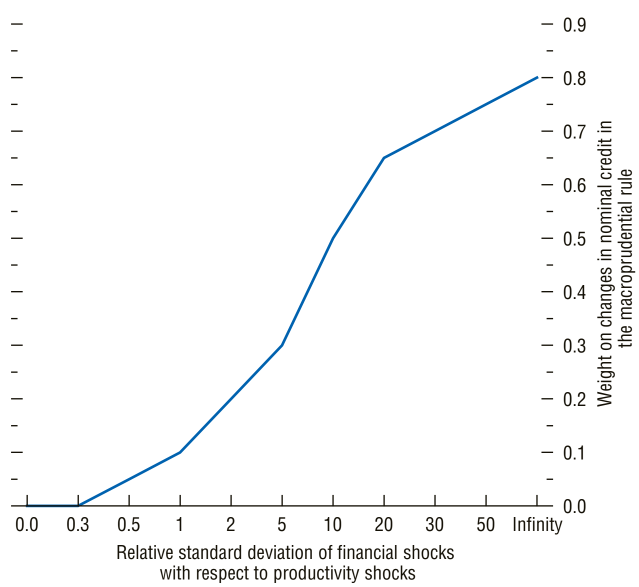
Monetary policy does not appear to be the main cause of recent asset price booms. To the extent that monetary policymakers bear responsibility for the crisis, it is for acting too narrowly—

(2000), who argue that central banks should react to asset prices.

[39]See BIS (2009) for a useful discussion.

Figure 3.17. Optimal Weight on Nominal Credit in the Macroprudential Rule

As the importance of financial shocks increases, the macroprudential tool becomes more useful.



Source: IMF staff calculations.

Table 3.4. Parameters and Performance of Policy Regimes in Reaction to Productivity Shocks

	Weights under Each Regime				
	Lagged interest rates in monetary policy rule	Inflation in monetary policy rule	Output gap in monetary policy rule	Nominal credit in monetary policy rule	Nominal credit in macroprudential rule
Taylor	0.7	1.5	0.5	. . .	. . .
Augmented Taylor	0.7	1.5	0.5	0.5	. . .
Augmented Taylor + macroprudential	0.7	1.5	0.5	0.5	0.5
Optimized augmented Taylor + macroprudential	0.0	3.5	12	0.3	0.0

	Performance			
	Standard deviation of inflation	Standard deviation of output gap	Loss[1]	Ranking
Taylor	0.199	0.162	0.066	2
Augmented Taylor	0.184	0.220	0.082	3
Augmented Taylor + macroprudential	0.233	0.276	0.130	4
Optimized augmented Taylor + macroprudential	0.072	0.080	0.011	1

Source: IMF staff calculations.
[1]Loss equals the sum of the variances of output gap and consumer price index inflation.

paying too little attention to emerging signs of financial vulnerability—rather than for failing to control CPI inflation. By accommodating loosening credit conditions and rising debt, monetary policymakers increased the risks of a bust.

The evidence suggests that policymakers should react more strongly to signs of increasing macrofinancial risk. The findings in this chapter do not support the idea that central banks should react automatically to changes in asset prices, still less that they should try to determine some appropriate level for asset prices. But they should examine what is driving asset price movements and be prepared to act in response. This applies particularly to housing, which represents a larger share of wealth than equities for most households and typically involves significant levels of debt. One possibility is that central bank mandates be expanded to include concern for financial vulnerabilities. In addition, macroprudential tools could be used to help tackle problems in financial markets, which may help limit the need for aggressive monetary policy reactions.

However, expectations must be realistic. Even the best leading indicators of asset price busts are imperfect—in the process of trying to reduce the probability of a dangerous bust, central banks may raise costly false alarms. Also, rigid reactions to indicators and inflexible use of policy tools will likely lead to policy mistakes. Discretion is required. Therefore, implementing a broader framework for monetary policy in order to mitigate macrofinancial risks further increases the importance of correctly identifying the sources of shocks driving changes in credit, investment, balance sheets, and external balances. Central bankers implementing broader policies would need to explain very carefully the basis for their actions, their immediate objectives, and how their actions are consistent with the longer-term objective of price stability. Moreover, monetary and macroprudential policies need to be coordinated, requiring greater information exchange and more consultation among monetary and supervisory authorities. These represent significant practical issues that must be carefully addressed before the framework for monetary policy is broadened or additional instruments are implemented. And neither a broader mandate nor additional instruments replace the need for fiscal and regulatory frameworks that are designed to make economies as robust as possible to asset price busts and provide policymakers the flexibility to respond to such events with stimulus policies.

Appendix 3.1. Econometric Methods

The main author of this appendix is Prakash Kannan.

This appendix addresses two issues. First, in most cases, the indicators of impending asset price busts could be highly correlated, such that the marginal information from some of the variables is insignificant when the information from other variables is accounted for. (Table 3.5 shows the thresholds used for the indicators.) Second, it is not straightforward to compute the statistical significance of these indicators, making it difficult to state the level of confidence associated with particular indicators. To remedy these problems, the analysis is complemented with a probit model. Probit models are nonlinear regressions that seek to explain binary variables. In the case of this exercise, the binary variable in question takes on a value of 1 if there is an asset price bust between one and three years in the future and zero otherwise.[40]

The results from the probit analysis are shown in Table 3.6. The coefficients represent the marginal increase in the probability of a bust evaluated at the mean level of the other variables.[41] For the post-1985 sample, a 10 percentage point increase in the credit-to-GDP ratio relative to an eight-year moving average—the typical increase in the run-up to a house price bust—increases the probability of a house price bust by 4.4 percent, which is roughly one-third higher than the unconditional probability of about 15 percent. Current account balances and residential investment are also significant predictors of house price busts; for example, a 1½ percentage point deterioration of the current account relative to its eight-year moving average, a magnitude typically found in the run-up to a bust, implies a one-third increase in the probability of a house price bust over the unconditional probability. Meanwhile, for house price busts during 1985–2008, output growth and inflation are not significantly associated with the likelihood of a bust.

Deviations in residential investment shares and credit are also found to be significant predictors of a stock price bust. A 10 percentage point increase in the credit-to-GDP ratio is associated with an increase in the probability of a stock price bust of 6.4 percent—roughly 20 percent higher than the unconditional probability of a stock price bust. The coefficient on current account balances with regard to stock price busts, however, appears to be of the wrong sign for the post-1985 portion of the sample.

Table 3.5. Percentiles Used as Thresholds for Alarms

	House Price Bust	Stock Price Bust
Credit/GDP	90	90
Current account/GDP	90	90
Residential investment/GDP	90	90
House price growth	90	70
Stock price growth	70	70
Growth	75	80
Inflation	90	90

Note: Entries in the table denote the percentile of the distribution of the respective variable where the noise-to-signal ratio (defined as the ratio of false alarms to correct alarms) is minimized. The grid search was limited to the 70th, 75th, 80th, and 90th percentiles.

[40]Probit models have been used in the context of predicting currency crises (Frankel and Rose, 1996, and Milesi-Ferretti and Razin, 1998).

[41]Variables are measured as deviations relative to the eight-quarter trailing moving average, as earlier.

Table 3.6. Marginal Probabilities Based on Probit Regressions

	Full Sample		Before 1985		1985–2008	
	House price bust	Stock price bust	House price bust	Stock price bust	House price bust	Stock price bust
	(1)	(2)	(3)	(4)	(5)	(6)
Credit/GDP	0.241**	0.546***	–0.864*	0.052	0.443***	0.638***
	(2.180)	(4.070)	(–1.740)	(0.130)	(4.280)	(4.210)
Current account balance	–3.910***	0.691	–3.472***	–2.851***	–3.191***	1.768**
	(–7.560)	(1.200)	(–3.640)	(–2.990)	(–5.440)	(2.510)
Residential investment/GDP	1.956	6.392***	4.621	4.801	2.456*	7.327***
	(1.520)	(5.280)	(1.370)	(1.550)	(1.930)	(5.290)
House price growth	0.798***	0.577***	2.147***	1.046***	0.455***	0.318
	(5.240)	(3.110)	(5.140)	(3.170)	(2.910)	(1.340)
Stock price growth	0.249***	0.337***	0.577***	0.323***	0.111***	0.349***
	(6.060)	(5.250)	(4.890)	(2.660)	(2.680)	(4.660)
Output growth	–0.413	1.686**	–0.916	0.280	–0.160	2.428
	(–0.810)	(2.540)	(–0.940)	(0.290)	(–0.300)	(2.620)
Inflation	2.511***	4.373***	3.786***	4.721***	0.681	3.732***
	(7.180)	(7.030)	(5.460)	(5.470)	(1.640)	(4.130)
N	1,699	1,580	435	419	1,264	1,161
Pseudo R^2	0.14	0.10	0.16	0.15	0.15	0.10

Source: IMF staff calculations.

Note: Dependent variable takes a value of 1 if there is a bust between 12 and 4 quarters ahead and zero otherwise. Estimation is carried out using robust standard errors. *Z*-statistics are reported in parentheses. ***, **, and * refer to significance at the 1, 5, and 10 percent level, respectively. Marginal probabilities computed at the mean values of other variables are reported. Variables are measured as deviations from an eight-year moving average

Appendix 3.2. Data Sources

Variable	Source
Nominal house prices	Bank for International Settlements, Haver Analytics, Organization for Economic Cooperation and Development (OECD)
Real house prices	OECD
Real stock prices	Bloomberg Financial Markets, International Financial Statistics (IFS) database
Real credit	IFS database
Nominal credit	IFS database
Real private consumption	OECD
Real residential investment	OECD
Output	OECD
Current account	OECD
Consumer price index	Haver Analytics (Core Personal Consumption Expenditures), OECD, IFS database
Quick ratio	OECD
Policy rates	Bloomberg Financial Markets, national authorities, Thomson Datastream
Real long-term interest rates	IFS database

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