Monetary policy and financial imbalances: facts and fiction

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1. INTRODUCTION[1]

The current financial crisis raises yet again the issue of whether and how central banks should react if they perceive an asset-price bubble to be forming.[2] With the benefit of hindsight, it seems self-evident that they should have constrained the rise in asset prices, the expansion of credit and the increase of leverage of the financial system in the years before the crisis erupted. Moreover, there is broad agreement that tighter regulatory policies would have been desirable. Such policies should aim to ensure that market participants perform the required risk analysis, limit the complexity and opaqueness of the financial system, remove conflicts of interests such as those faced by rating agencies and align managers' private incentives to take risks with the social costs that they entail. Moreover, such policies should broaden the scope of the regulatory umbrella to cover all systemically important institutions, irrespectively of whether they are banks or not.

What remains more controversial is whether and how central banks *in their role of monetary policy makers* should have reacted to the build-up of the bubble. Since rapid

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[2] The notion of an "asset price bubble" has two meanings in the literature. In the policy literature it is best thought of as an usually large and protracted increase in asset prices that is poorly understood by observers. By contrast, in the formal literature on rational bubbles it refers to a situation in which there is a known deviation between the fundamental value and actual price of the asset, which is expected to grow sufficiently quickly to make rational to hold the asset despite the known overvaluation and risk of a crash. See Blanchard and Watson (1982).

credit extension typically plays a key enabling role in episodes of rising asset prices, many have argued that central banks should have raised interest rates, thereby increasing the cost of credit and reducing the demand for assets. But there is little agreement whether such a policy was desirable and whether it would have been feasible. There are two sides to the debate.

A growing number of observers have argued that central banks should take an *activist approach* and react to, or lean against, signs of financial imbalances when setting monetary policy. Central banks operating with explicit or implicit inflation targets react in principle to all developments – including rapid credit growth and asset-price increases that are the defining characteristics of an asset-price bubble – that influence aggregate demand and impact on the outlook for inflation. But the activist view goes further than so in arguing that monetary policy makers should react to financial imbalances *over and beyond* what they imply for inflation at the two-to-three-year policy horizon that central banks typically employ. Slowing asset-price increases is warranted, it is argued, because a bursting asset-price bubble can have disproportionately large effects on inflation and economic activity at longer time horizons than those central banks normally consider when setting interest rates.

The activist view relies on four empirical propositions being true.[3] First, central banks can determine in real time what constitutes an asset-price bubble by looking for signs of *financial imbalances* that are supposedly easily identifiable. Second, such imbalances contain information that is useful for forecasting the likely future path of inflation and output, also beyond the two-to-three-year horizon. Third, monetary policy can be used to influence asset prices. Furthermore, there is no risk of “nonlinearities” in the sense that a small increase in interest rates might lead to a collapse in asset prices and trigger a deep recession. Fourth, the improvement in economic performance resulting from a tightening of monetary policy to forestall an asset-price bubble exceeds the short-run costs of inflation falling below target and economic activity being weaker than it otherwise would have been.

The competing view, which we call the *wait-and-see approach*, is that central banks have insufficient information to conduct policy in this way.[4] Instead, they should focus on the outlook for inflation and output when setting interest rates and not react to hypothetical future collapses in asset values. However, if asset prices were to decline abruptly, central banks should be quick to reduce interest rates and to take whatever other measures are necessary to forestall a recession and inflation falling below the desired level.

These polar opposite views of the nexus between monetary policy, financial imbalances and macroeconomic performance arise as consequence of radically different assessments of how easy it is to diagnose such imbalances and of the effects of monetary policy on asset prices and macroeconomic conditions. In the hope of distinguishing

[3] See also the discussion in Kohn (2006).
[4] See Kohn (2006, 2008).

between what is fact and what is fiction, in this paper we explore some key elements of the activist view. It is organized as follows.

In the second section we review some of the relevant literature, focussing on four testable propositions. Many proponents of the activist view maintain that financial imbalances and the likelihood that an asset-price bubble is forming can be assessed in real time by looking at deviations of credit and asset prices from trend. Following this suggestion, we construct indicators of financial imbalances and explore four propositions that we believe arise from the activist view. First, such imbalances contain information about future inflation and output, particularly at time horizons beyond those typically used by central banks in setting monetary policy. Second, this information is especially useful when trying to predict the occurrence of highly adverse macroeconomic outcomes (which we define below). Third, monetary policy has predictable effects on asset prices. Fourth, these effects are large relative to the effects monetary policy has on real economic activity and inflation, implying that central banks can tighten monetary policy in order to slow asset-price increases without depressing real economic activity and inflation excessively.

In Section 3 we discuss the data, which are quarterly and stem from 18 countries. To measure financial imbalances, we compute property-price, equity-price and credit “gaps” that are defined by the deviations of asset prices and credit from one-sided trends. Our empirical evidence shows that credit gaps are positively correlated with property-price gaps but uncorrelated with equity-price gaps. However, the correlation between, on the one hand, the credit and the asset-price gaps and, on the other, future output gaps or inflation is much weaker. This suggests that measures of financial imbalances computed in this way are unlikely to be useful for forecasting economic conditions.

Section 4 reviews the information content of asset prices and credit for output and inflation. We estimate forecasting models on data ending in 1999, and use these to provide out-of-sample forecasts for the period 2000 to 2008. Since the activist hypothesis suggests that large positive financial imbalances risk having a major impact on macroeconomic conditions, but “small” imbalances and situations in which credit and asset prices are below trend have not, we consider nonlinear models and interact the credit and asset-price gaps with a threshold indicator that is unity when credit and asset prices exceed the threshold and zero otherwise. While the definition of the threshold is arbitrary, the notion that asset prices and the level of credit expansion only matter under these conditions is closer in spirit to the activist view than the idea that they are always of importance. We first consider a model that contains the output gap, inflation, and the interest rate, which are the variables that central banks monitor as a matter of course. We think of this as our benchmark model. Then, we add the deviations of credit and asset prices from trend, the “gaps,” in various combinations to this model as regressors and investigate the improvement in forecasting precision for output and inflation.

We draw two main conclusions in this section. First, credit and asset prices do not contain much information about future inflation and output gaps beyond that already included in the current output gap, inflation rate and interest rate. Though there is some evidence that only large deviations of credit and asset prices from their long-run sustainable values matter, the improvement in forecasting precision is limited and depends on the country and the variable considered. Second, beyond two to three quarters, the economy is essentially unforecastable in the sense that the unconditional mean of the variable is the best predictor. This finding, which conflicts with the assumptions underlying the activist hypothesis, supports the findings in other studies, see e.g. Stock and Watson (2003).

The current crisis demonstrates that the burst of a financial bubble may cause a severe recession and even deflation. In Section 5 we therefore estimate probit models for the occurrence of "highly adverse macroeconomic outcomes", which we define as (a) an average output gap of less than minus one percent in a time span of four quarters; or (b) annual inflation being either negative or declining by more than two percentage points in a time span of four quarters. Such events are of course rare and we are therefore required to estimate panel probit models and thus pool the data. This analysis shows that the information in credit and asset-price gaps does indeed improve forecasts at long horizons of four to five years. While this finding is supportive of the activist hypothesis, the result again depends on the country and the precise specification of the model considered. Without prior knowledge of these details, credit and asset prices are unlikely to guide monetary policy makers in setting interest rates.

Section 6 investigates whether monetary policy can affect asset prices and what the consequences for output and inflation would be of doing so. To address this question we estimate panel VARs that allow the coefficients to vary depending on whether financial imbalances are present or not. We thus are able to study whether the responses to monetary policy shocks differ during periods when a bubble is forming. Our results show that while monetary policy does have important effects on asset prices, those effects are not particularly large relative to those it has on inflation and output. This suggests that attempts to lean against asset-price increases by using interest-rate policy are likely to put considerable downward pressures on real economic activity and inflation. Moreover, the effects of monetary policy shocks during boom periods do not appear to be fundamentally different from those in ordinary times. Overall, monetary policy seems to be a too blunt tool to deal with financial imbalances.

Of course, these results are sensitive to the Lucas critique and one could argue that an announcement that monetary policy in the future would lean against financial imbalances would change the behaviour of households and financial institutions and reduce the frequency of bubbles. In fact, we interpret our empirical results as suggesting that a leaning against the wind policy will *only* be successful if it elicits such behavioural changes. While such changes are possible, they are by no means guaranteed.

Finally, Section 7 concludes. Our main conclusion is that the findings we present here provide little support for the idea that financial imbalances contain information about future inflation and economic activity and the notion that small changes in monetary policy can be used to prevent financial imbalances from developing at little cost to real output foregone. Overall, the notion that using monetary policy to lean against the wind is an effective way to ensure financial stability seems to be based less on fact and more on fiction.

2. RELATED LITERATURE

The literature on monetary policy and asset prices is large and is currently developing rapidly, and a separate paper would be required to overview it properly. In this section we proceed more modestly. We first review a selection of papers that consider whether central banks should respond to asset prices over and beyond what these imply for expected inflation at the standard two-to-three-year horizon. Since there are sharply diverging views in the literature on whether a central bank can determine in real time whether an asset-price bubble is forming and its likely consequences for the economy, we then consider the link between financial imbalances and future economic conditions. Finally, we discuss the empirical evidence on the impact of monetary policy on output, inflation and asset prices.

2.1. The “wait-and-see” versus the “activist” approach

In an influential paper, Bernanke and Gertler (1999) study whether central banks should gear monetary policy to asset prices. Since the answer to this question depends on the structure of the economy and the nature of the shocks hitting it, the analysis is conducted using a version of the financial accelerator model proposed by Bernanke, Gertler and Gilchrist (1999), which is modified to allow for non-fundamental movements in asset prices that in turn may influence economic activity. The authors consider the stabilising effects of several different monetary policy regimes. The main findings are that responding aggressively to expected inflation – including any expected deflation arising from a bursting asset-price bubble – stabilises the economy effectively. Furthermore, directly responding to asset prices brings no extra benefits. One reason for this perhaps surprising finding is that asset-price bubbles expand aggregate demand in the model and thus raise inflation pressures which the central bank already responds to.

Similar conclusions are drawn by Gilchrist and Leahy (2002), who also simulate a version of the Bernanke, Gertler and Gilchrist (1999) model, and who consider shocks to future economic conditions and net worth.[5] Importantly, the authors find that interest rates are more stable when monetary policy reacts aggressively to expected inflation, since agents’ expectations of future policy reflect the monetary policy regime in force. This finding underscores the importance of credibility in setting monetary policy.

While the analyses of Bernanke and Gertler (1999) and Gilchrist and Leahy (2002) are persuasive, it should be noted that the only asset prices considered in the models are equity prices. Since it is generally recognised that movements in property prices play a more important role than movements in equity prices in boom-bust cycles and episodes of financial instability, this is a shortcoming of the analysis.

[5] Other papers that reach sceptical conclusions about the desirability of the central bank responding to asset prices are Tetlow (2006) and Gilchrist and Saito (2006).

Arguably the most cogent arguments for why central banks should attach some weight to asset prices when setting monetary policy is put forth by Cecchetti et al. (2000). The authors also simulate a version of the model proposed by Bernanke, Gertler and Gilchrist (1999), but conclude that a policy of reacting to equity prices is in fact superior to one that entails solely reacting aggressively to expected inflation. They also argue that public awareness that the central bank is leaning against asset-price bubbles would reduce the likelihood that they develop, increasing the desirability of such a policy. Loisel et al. (2009) advance a similar argument, and show that in presence of uncertainty about the productivity of a new technology, the central bank can discourage herd behaviour and increase welfare by responding to asset prices.

Cecchetti et al. (2000) also consider the frequent claim that it is difficult for central banks to know when equity markets are seriously overvalued. They note that dealing with unobservables, such as the equilibrium level of equity prices, is unavoidable in monetary policy and conclude that there is no inherent reason why central banks would have greater difficulties estimating the extent to which asset prices are misaligned than the likely size of the output gap or the deviation of unemployment from the NAIRU.

Bordo and Jeanne (2002, 2004) also consider the potential usefulness of leaning against asset-price bubbles that are caused by episodes of excessive optimism. Using a theoretical model, they show that optimal policy is highly nonlinear. Thus, when asset-price bubbles are small, the central bank should not react to asset prices since the unwinding of a “small” bubble is not likely to cause a credit crunch. Similarly, when asset-price bubbles are large, tightening monetary policy risks triggering a credit crunch and macroeconomic weakness, suggesting that it is not desirable to react by monetary policy. Instead, the central bank should wait for the uncertainty to be resolved and relax monetary policy if the bubble bursts. In an intermediate range, however, proactive monetary policy is useful in reducing the risk that a large bubble, and a large crash, will occur.

A more recent literature argues that as interest rates decline, banks and other financial institutions become more prone to take risks.[6] This suggests that if weak growth and low inflation were to require central banks to adopt a very expansionary stance of monetary policy for an extended period, as happened after the burst of the “dot.com” bubble in 2001, the result could be a sharp increase in level of risk in the financial system. However, the appropriate way to avoid such a development would presumably be to tightening the regulation and supervision of financial institutions in periods when interest rates are unusually low and risk taking increases, rather than to tightening monetary policy which has too blunt an effect on the economy.

Overall, we interpret the theoretical literature as suggesting that there is little benefit from responding mechanically with monetary policy to the level of asset prices, but that more elaborate strategies may be desirable. However, these are much more demanding from an information perspective and may be difficult to implement in practice.

[6] See Rajan (2005) for an early and particularly clear discussion. Jiménez et al. (2007), Altunbas et al. (2009) and Maddaloni and Peydró (2009) provide supporting empirical evidence.

2.2. Financial imbalances and future economic conditions

Bernanke and Gertler (2001) discuss the difference between their finding that gearing monetary policy to expected inflation is optimal and the conclusion by Cecchetti et al. (2000) that leaning against the wind it desirable. They argue that while they assume that the central bank did not know the shocks hitting the economy, Cecchetti et al. (2000) implicitly assume that the central bank knows that a bubble has formed and that it will necessarily burst within a given period. This suggests that the desirability of leaning against asset prices depends crucially on the central bank's ability to diagnose asset-price bubbles in real time and to assess their longevity.

While Cecchetti et al. (2000) argue that this is not an impossible task, they do not propose how this can be done in practice. In a widely cited paper, Borio and Lowe (2002) argue that cumulative deviations of credit and equity prices from real-time (one-sided) trends that exceed a pre-specified threshold can be used to diagnose financial imbalances and argue that the empirical evidence indicate that they are useful for predicting future banking crises. However, their analysis leaves important questions unanswered. For instance and most obviously, the authors do not explore the hypothesis that these correlations arise only because some obviously important variables, such as short-term interest rates and output gaps, have incorrectly been omitted from the analysis. Similarly, the association of credit growth and property-price changes they observe does not imply that credit growth predicts future property-price developments. Gerlach and Peng (2005) investigate data from Hong Kong, which has undergone extreme swings in property prices and bank lending in the last three decades, and demonstrate that while property prices contain information about future bank lending, the reverse is not true. The results in the cross-country study of Hofmann (2003) suggest that this finding is general.

Furthermore, the statistical methodology used by Borio and Lowe (2002), which is due to Kaminsky and Reinhart (1999), does not allow for formal hypothesis testing. It is therefore difficult to know what significance should be attached to the findings in the paper. Furthermore, their research methodology does not permit them to assess whether asset prices are essential for setting monetary policy since any information they contain may already be embedded in standard monetary policy indicators.

2.3. Financial imbalances and monetary policy

Several papers have demonstrated that the severity of asset-price declines and their macroeconomic effects depend on the extent to which asset prices rose before the bubble burst (e.g. IMF 2003). This finding has been interpreted as suggesting that financial imbalances and asset-price bubbles build up during economic expansions and that the longer this process continues, the larger the expected unwinding when the bubble finally bursts. As a consequence, it is argued, it makes sense for central banks to lean against the wind by tightening monetary policy when asset prices rise in order to insure against a particularly severe future recession (ECB 2005).

However, these studies do not address the critical question of what consequences responding with monetary policy to these developments might have for output and inflation. In particular, while a leaning-against-the-wind policy might reduce the risk of a sudden and large collapse of asset prices, it would also reduce current real economic activity. Assenmacher-Wesche and Gerlach (2008a, b, c) present panel VAR estimates for 17 countries suggesting that the output losses of this policy could be dramatic. If so, the wait-and-see approach appears more appropriate. As we discuss below, these estimates do not capture the possibility that the adoption of a leaning-against-the-wind policy will change the behaviour of economic actors, which in turn may reduce the likelihood that an asset market bubble develops. Nevertheless, the estimated impact on real GDP is so large that even if it were much smaller the point remains valid.

Furthermore, as suggested by the formal analysis in Bordo and Jeanne (2002, 2004) and the experiences of the US in 1929 and Japan in 1989-90, there is a risk that leaning against a “large” bubble may trigger a collapse in asset prices. Unless monetary policy is exceptionally nimble, this risks leading to a large recession and many years of poor economic growth.

Finally, there is always the possibility that an asset-price bubble may bursts on its own even before the effect of monetary policy on asset prices has materialised. If so, a tightening of monetary policy in response to financial imbalances could coincide with the contractionary effects on the economy of an imploding bubble. Rather than reducing macroeconomic volatility, monetary policy activism could instead tend to destabilise the economy.

Overall, this analysis suggests that in addition to studying to what extent measures of financial imbalances predict future economic conditions, it is of interest to investigate how monetary policy impacts on asset prices.

3. CREDIT GAPS AND FINANCIAL IMBALANCES

Our empirical work relies on quarterly data spanning 1986 to 2008 from a cross-section of countries and uses panel-econometric methods to draw conclusions that we believe have general validity. This research strategy warrants several comments.

First, there is an inherent risk that our views on monetary policy and financial imbalances may be excessively influenced by a few specific episodes, such as the experiences of Japan in the last two decades. Since there is a natural tendency when studying occurrences of financial imbalances and their resolution to focus on those that were associated with the most pronounced asset-price bubbles, there is a risk of sample selection bias. It is therefore useful to consider data from a range of countries that have had different experiences with respect to size, duration and frequency of asset price bubbles. In the subsequent analysis we therefore use data for 18 economies: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the UK and the US.

Second, one drawback with this approach is that it requires us to focus on a few macroeconomic time series for each country and thus leads us to disregard other data – such as housing starts, price-to-rental ratios and risk spreads in financial markets – that may provide information useful for diagnosing financial imbalances in real time, but that may only be available for a few countries and for short periods. The macro perspective provided in this study could thus usefully be complemented with country-specific studies incorporating such data.

Third, while the panel approach provides a natural way of summarising the data, it imposes a number of restrictions on them. The standard fixed-effects estimator assumes that all countries share the same economic structure and allows only for country-specific differences in levels of the data. By contrast, the mean-group estimator suggested by Pesaran and Smith (1995) provides an estimate of the average effect while assuming that there are differences across countries. Thus, it provides an estimate for a hypothetical "average" economy.

Fourth and finally, the quarterly data starts in 1986 in order to avoid the more turbulent, high inflation period that ended in the first half of the 1980. Macroeconomic developments have been much calmer since the mid-1980s than in the fifteen years before. This has made it more difficult to find variables that forecast future inflation and economic activity (see Stock and Watson 2007). However, the earlier period is characterised by large macroeconomic fluctuations, including in asset prices and credit, which arose largely as a consequence of poor monetary policy responses and large oil price shocks.[7] Since then a number of institutional developments have taken place – including increased central bank independence, improved decision-making procedures and a strengthening of transparency arrangements – which imply that data from the earlier period are not representative for modern economies. Since the experiences of the 1970s are of little relevance today, we start estimating in 1986 recognising that modern central banks face a much harder forecasting problem than central banks in the 1970s.[8]

The data set ends in 2008 and thus covers the beginning of the global financial crisis triggered by the developments in the US subprime mortgage market. The fact that the recent financial markets turmoil is included in the sample allows us to study the predictive ability of financial imbalances in a period in which they triggered a massive economic downturn. We next discuss the data and present the criteria we use to measure financial imbalances.

[7] Indeed, the sharp rise in oil prices in 2007 elicited strong monetary policy responses across the world in sharp contrast to the episodes in the 1970s.

[8] Moreover, and as noted by Ahearne et al. (2005) and Girouard and Blöndal (2001), many countries deregulated their mortgage markets during the early to mid-1980s, suggesting that estimates relying on older data are unlikely to be representative. Goodhart and Hofmann (2008), as a part of their robustness analysis, also study a sub-sample spanning 1986 to 2006 and find that this later period indeed differs from the earlier part of their sample. However, their data series are somewhat different from those we use here.

3.1. Measuring credit

In this study we use BIS and IMF data on credit as measured by claims of the financial sector on the domestic non-financial private sector.[9] While the IMF uses a harmonized framework to structure the credit data, the BIS adopts the classification from the national statistics, which varies considerably across countries.[10] For Canada, Sweden and the US, where institutions other than banks are important providers of credit, the IMF statistics contain an additional section that aggregates credit from banks and non-bank financial institutions, which we use as our preferred measure.[11]

For most countries, data from both sources are quite similar, as evidenced by the credit-to-GDP ratios shown in Figure 1. For the US and Japan (and to a lesser extent Canada and Denmark), the IMF data result in much higher ratios. This is due to the fact that when defining credit we opt for data on lending from the whole financial sector instead of a strict definition of credit from banks only, whereas the BIS data seem to employ a narrower definition of lenders.[12] Though a measure of credit including credit to the financial sector may be better able to predict financial crises that are caused by excessive leverage, our aim is to predict CPI inflation and output. For that purpose, credit to the non-financial sector seems more appropriate.

By contrast, for France, Australia, Sweden, Norway and the Netherlands, the IMF data indicate lower credit volumes than the BIS statistics. Though it is difficult to trace back the precise reason for these differences, they seem mainly due to whether interbank bond holdings, i.e., bonds issued by one bank that are held by another bank, are included in the credit aggregate. While the IMF employs a framework of sectoral balance sheets and therefore excludes interbank bond holdings, the national statistics differ in this respect. Nevertheless, despite the difference in levels, the correlation of the credit gaps derived from the BIS and the IMF credit data is high (0.88).

Because of its reliance on a unified framework we use the IMF credit data in the empirical analysis conducted below. Nevertheless, the IMF aggregates frequently exhibit breaks. In the case of a recognised break, as marked by a specific flag in the IMF statistics, we link the series using the growth rate from the BIS credit series, which often does not show a break at the same time.

[9] Some of the criteria for choosing the relevant credit aggregate to capture financial imbalances are discussed in the Appendix.
[10] Since the BIS database does not contain credit data for Ireland and Austria, we take them from the OECD.
[11] Of course, to the extent that credit was created by institutions not covered by the official statistics we are unable to include it in our measure of the credit gap.
[12] For Japan, e.g., the credit aggregate from the BIS covers only domestically licensed banks, but other institutions like cooperative and rural banks, branches of foreign banks, housing and loan corporations etc. are not included.

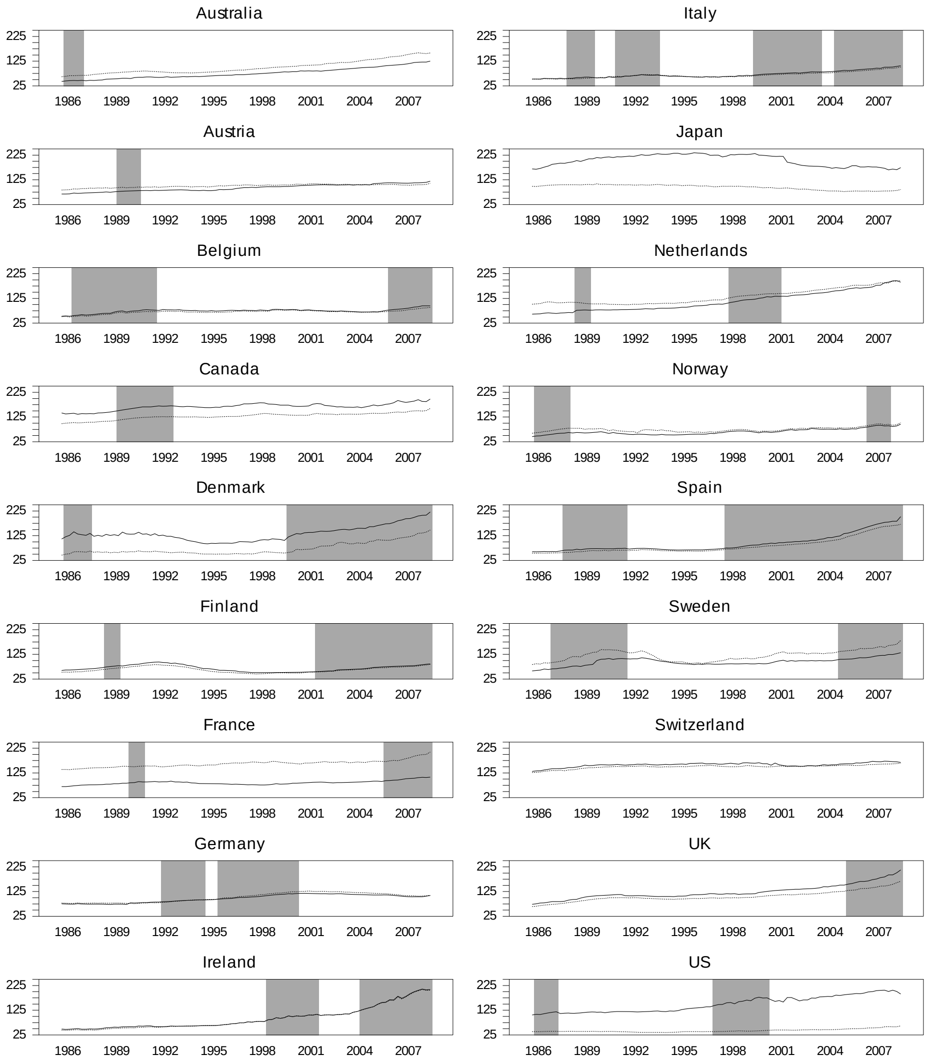

Figure 1. Credit-to-GDP ratios from the IFS (solid) and the BIS (dashed) statistics

Figure 1 shows that in all countries the credit-to-GDP ratio has risen over time. It varies between 43 percent for Australia in 1986 and 235 percent for Japan in 1996. Countries with below average credit ratios include mostly continental European countries, including Belgium, Finland, France, Germany, Italy and Norway. In contrast, in Denmark, Ireland, Spain, the UK and the US the credit ratio exceeds 200 percent in 2008.

3.2. Defining financial imbalances

Much of the literature defines financial imbalances by deviations of credit and asset prices from trend because this concept stresses the importance of cumulative processes that are not captured by growth rates.[13]

To compute the trend we use a one-sided HP filter, that is, we calculate the trend recursively and use the most recent value for the asset-price and credit gaps, based on a smoothing parameter of $\lambda = 100000$.[14] Note that the large value for λ implies that changes in the trend are penalized heavily so that the HP-filtered trend is virtually indistinguishable from a linear trend. Though this trend measure can be computed in real time, it consists of a series of end-of-sample estimates of the trend, which are inherently difficult to estimate. Furthermore, when new observations become available, in general the estimates of the past realisation of the trend also change, which may lead us to change our past assessment about financial imbalances. By computing the trend recursively – as it is done in the literature – we do not update past observations. Detken and Smets (2004, p. 10) note that this approach generates boom periods that start earlier than when calculated from an ex-post trend. Nevertheless, the result from this approach is highly dependent on the length of the starting window for the trend and tends to identify more boom periods in the later part of the sample because the trend estimate becomes more precise, leading to larger deviations from trend. Moreover, while the HP-filter normally results in a gap with a zero mean over the sample period, the recursively calculated gap does not have this property.

Another issue is how to choose a threshold to define excessive deviations from trend. Borio and Lowe (2002) argue that deviations of the credit-to-GDP ratio from a one-sided HP-filtered trend exceeding four percent are informative about the likelihood of future banking crises.[15] In addition and following Adalid and Detken (2007), we impose a minimum duration of four quarters because we are also working with quarterly data and want to focus on more persistent misalignments.

Figure 1 also marks the periods in which the credit-to-GDP ratio deviated by more than four percent from a one-sided HP trend. As explained above, this provides a real-time indication of whether a credit bubble is forming. Except for Japan and Switzerland, all countries in our sample experienced periods of large credit gaps, though they are unevenly distributed across countries. Spain and Italy stand out with 60 and 52 quarters of credit gaps exceeding four percent. In total, there are 424 quarters with large positive credit gaps out of a total of 1656 observations. Many countries experienced large positive credit gaps in the late 1980s and early 1990s. It can be seen that episodes of large credit gaps tend to become longer at the end of the sample, suggesting that excessive credit creation did play a central role in setting the stage for the recent crisis.

[13] Adalid and Detken (2007), Borio and Drehman (2009), Borio and Lowe (2002), Detken and Smets (2004), Goodhart and Hofmann (2008).

[14] Nevertheless, for calculating the output gap we apply the usual value of $\lambda = 1600$ to quarterly data and revise the earlier estimates.

[15] Borio and Drehmann (2009) state that their results are robust to variations in the threshold between two and six percent.

Nevertheless, almost half of the countries did not experience large credit gaps in the recent past.

Though it is often argued that credit expansion is closely linked to asset-price bubbles, it seems more intuitive to define asset-price bubbles relying on price data for certain assets.[16] Next we review the behaviour of equity prices and residential property prices for the 18 countries in our sample. While Borio and Lowe (2002) and Adalid and Detken (2007) use an asset-price index that combines property and equity prices, the IMF (2003) finds that property-price bubbles are less frequent and have a larger impact on the economy than equity-price bubbles, which makes it preferable to investigate them separately.

[16] Alternatively, one could use the interest rate as the price for credit. Nevertheless, credit rates deviate from money market rates because of risk premia and the creditworthiness of the borrowers. It is therefore difficult to find credit interest rates for the countries in our sample.

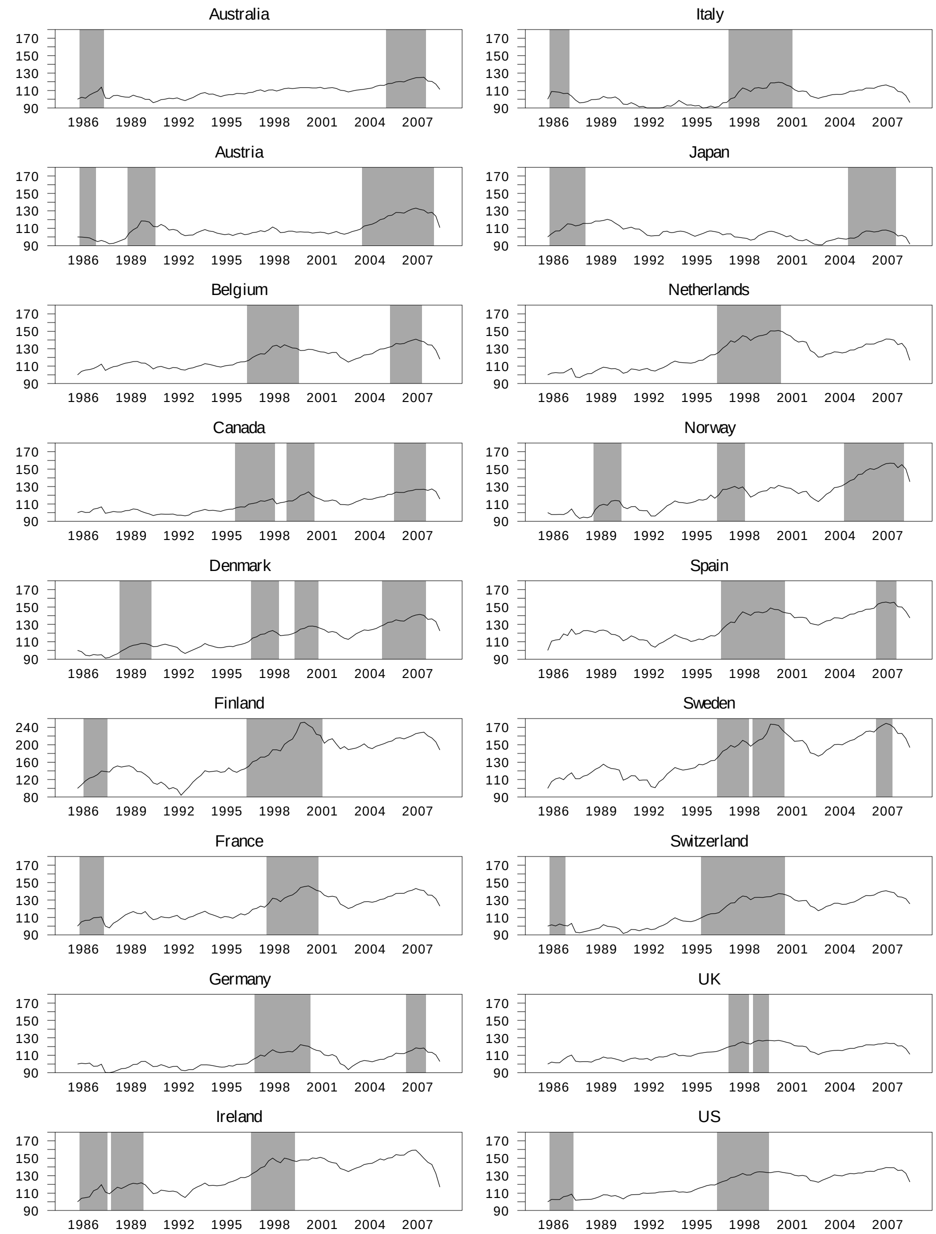

Figure 2. Real equity prices and misalignment periods (shaded areas)

Figure 2 shows real equity prices, deflated with the consumer price index (CPI), for the countries in our sample, together with periods of large equity-price gaps, based on a 10 percent threshold as proposed by Adalid and Detken (2007). Following Adalid and Detken (2007), we require the deviation to last at least for four quarters. Our 10 percent threshold is much lower than the 40 to 60 percent threshold Borio and Drehmann (2009) recommend. Nevertheless, using a 40 percent threshold, that is, the lower bound of the range proposed by Borio and Drehmann (2009), results in equity-price bubbles occurring only in Austria, Finland and Norway. This seems too restrictive.

Interestingly, equity-price misalignment are relatively evenly distributed across countries. In total, our definition gives us 393 quarters of large equity price gaps, which is comparable to the 424 quarters of excessive credit gaps we have.[17] In many countries the equity-price misalignments occur around 2000, that is, before the burst of the "dot-com bubble". Nevertheless, also in the late 1980s and around 2006 large equity-price gaps can be observed for several countries in the sample.

With respect to the property-price gap, the choice of a threshold is even more difficult. Borio and Drehmann (2009) argue that a threshold in the range of 15 to 25 percent would be suitable for identifying financial imbalances. Adalid and Detken (2007) use a 10 percent threshold with a minimum duration of four quarters, whereas Goodhart and Hofmann (2008) set their threshold at 5 percent and require a minimum duration of twelve quarters. In order to keep the definition of the different indicators comparable, we maintain our minimum-duration requirement of four quarters. In addition, we set the threshold such that we obtain a similar number of quarters that are classified as boom periods as in the case of equity-price and the credit gap indicators.

Figure 3 shows the results when a threshold of 7.5 percent is used, which classifies 528 quarters as periods of property-price misalignments. Though this is slightly more than a quarter of the observations, a higher threshold would have excluded the boom episodes in Japan and the US which are generally recognised as property-price bubbles.[18] Looking at Figures 1 to 3, it is apparent that there is considerable variation across countries in the way financial imbalances evolve.

From Figure 3 we note that neither Austria nor Germany experienced property-price misalignments. It turns out that many countries experienced episodes of large property-price gaps in the late 1980s and the early 1990 (e.g. Belgium, Canada, Finland, France, Ireland, the Netherlands, Spain and the UK). Moreover, except for Austria, Germany, Ireland, Japan and the Netherlands, all countries also experienced positive gaps at the end of the sample period.

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[17] Adalid and Detken (2007) also classify about a fourth of their total observations as boom period though they apply their threshold to a combined asset-price index comprising equity and property prices.
[19] See, for instance, Detken and Smets (2004), Gerlach and Peng (2005), Riiser (2005) and Tsatsaronis and Zhu (2004).

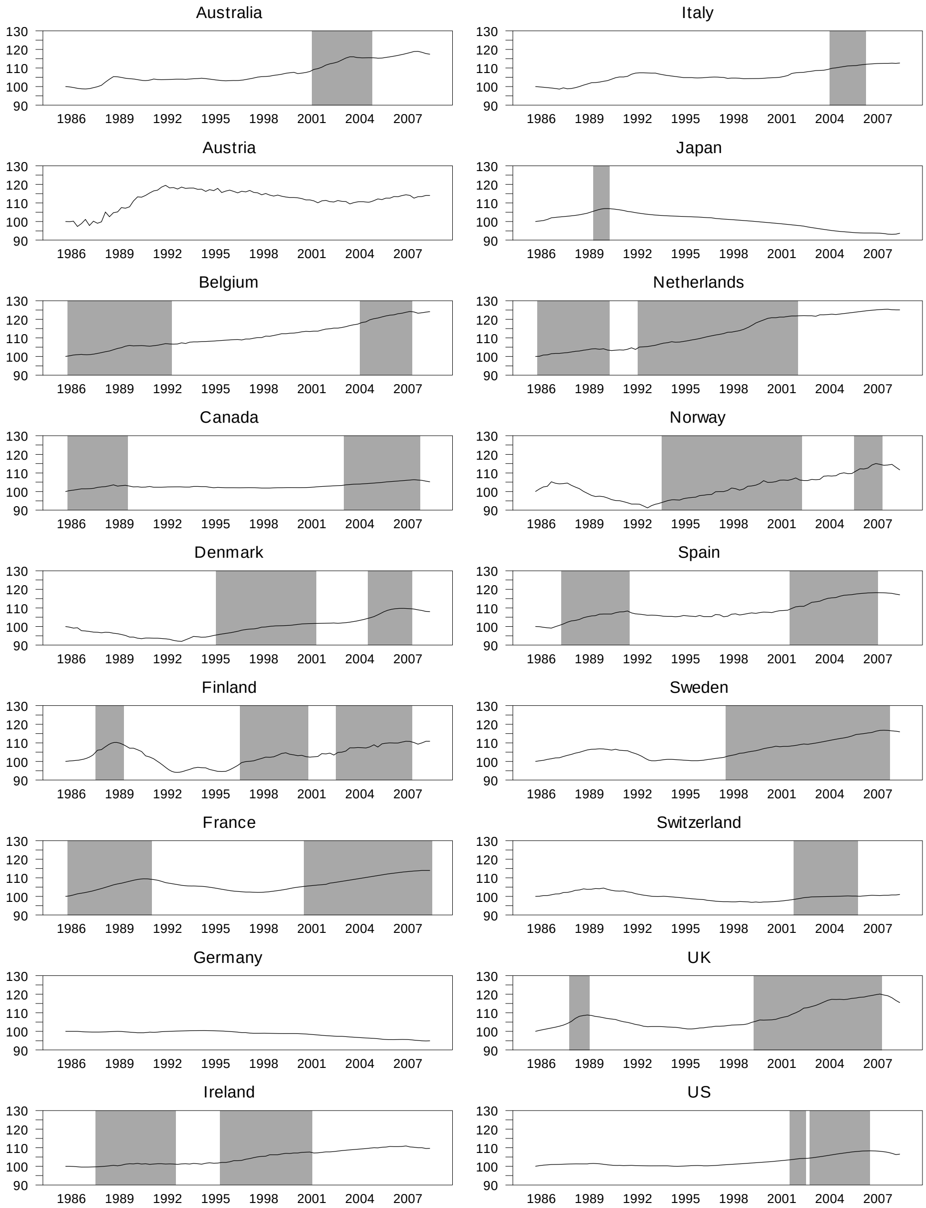

Figure 3. Real property prices and misalignment periods (shaded areas)

The evidence presented in Figures 2 and 3 warrants several comments. First, the equity-price gaps display much larger movements than the property-price gaps, with the standard deviation of the equity-price gap being twice as large as the standard deviation of the property-price gap. Second, the property-price and equity-price gaps are almost unrelated as evidenced by a correlation coefficient of 0.16. Third, there seems to be an negative correlation between country size and the amplitude of asset-price fluctuations in that many of the smaller countries show large fluctuations in both gap variables, whereas large economies such as the US, Japan or Germany seem to have experienced smaller misalignments.

In sum, while the choice of the threshold is arbitrary, the resulting episodes of asset-price misalignments broadly correspond to those identified in the literature. Moreover, though a change in the threshold of course leads to a reclassification of boom periods, the changes are relatively minor. What is more important is the way the trend is calculated, in particular the choice of the starting window and whether past estimates of the gap are updated as more observations become available.

Table 1: Correlation between credit, property-price and equity-price gaps

Correlation of credit gap in t with	Property-price gap in $t + k$	Property-price gap in $t - k$	Equity-price gap in $t + k$	Equity-price gap in $t - k$
$k = 0$	0.31	0.31	-0.10	-0.10
$k = 4$	0.14	0.47	-0.23	0.06
$k = 8$	-0.02	0.54	-0.34	0.12
$k = 12$	-0.15	0.54	-0.36	0.15

Many studies have found that episodes of rapid credit expansion are associated with deviations of asset prices from their long-run trends.[19] To explore this, Table 1 reports correlation coefficients of the credit gap with the asset-price gaps over various leads and lags. Several aspects of this table warrant comments. First, while the contemporaneous correlation between the credit gap and the equity-price gap is close to zero, credit gaps are contemporaneously correlated with property-price gaps. Moreover, the correlations rise to about 0.50 as we consider credit gaps increasingly forward in time. There are thus important dynamic correlations in the data that we need to understand. Second, the correlations between the current credit gap and future asset-prices gaps are *negative*. This matches poorly with the idea that excessively high credit growth leads to high asset-price deviations from trend. Furthermore, the current credit gap is positively correlated with past asset-price gaps, which suggests that credit tends to rise in response to increasing property- and, to a lesser extent, equity-prices.

There are several possible explanations for these surprising correlations. The most obvious is that movements in asset prices Granger cause movements in credit. Since asset prices are forward-looking variables that depend on perceptions of future economic conditions, this is not surprising. Another possibility is that these correlations reflect important variables that have been omitted from the analysis. For instance, the analysis disregards monetary policy and interest rates. It may be that these correlations arise because central banks have tended to tighten monetary policy in response to positive credit gaps (for instance, because these are positively correlated with other variables that

[19] See, for instance, Detken and Smets (2004), Gerlach and Peng (2005), Riiser (2005) and Tsatsaronis and Zhu (2004).

central banks do respond to, such as output gaps and inflation), which in turn depresses future asset prices.

Whatever the explanation, it seems clear that in order to understand properly the correlations between credit gaps and asset prices, a multivariate analysis that allows for dynamics and explicitly takes into account key macroeconomic variables – in particular interest rates, output gaps and inflation – is necessary.

3.3. Financial imbalances and macroeconomic outcomes

So far we have defined the central variables in our analysis and have reviewed their correlations over time. Next we turn to their interpretation.

Borio and Lowe (2002, p. 22) conclude that *"[f]ailure to respond to these* [*financial*] *imbalances, either using monetary policy or another policy instrument, may ultimately increase the risk of both financial instability and subsequently deflation (during the period in which the imbalances are unwound)."* It has also been shown that recessions associated with financial crises tend to be long and the recovery slow (Rogoff and Reinhart 2008, IMF 2008). We therefore next investigate the link between financial imbalances and macroeconomic variables.

Table 2 reports the average correlations at various leads and lags of the output gap and inflation with the credit and asset-price gaps for the 18 economies in our sample. In interpreting these it should be kept in mind that they do not control for important third variables, such as the stance of monetary policy.

Table 2: Correlations between macroeconomic variables and financial imbalances

Correlation of output gap in *t* with	Credit gap in *t* + *k*	Credit gap in *t* – *k*	Equity-price gap in *t* + *k*	Equity-price gap in *t* – *k*	Property-price gap in *t* + *k*	Property-price gap in *t* – *k*
k = 0	0.12	0.12	0.17	0.17	0.26	0.26
k = 4	0.22	0.09	-0.21	0.29	0.07	0.28
k = 8	0.14	-0.00	-0.35	0.31	-0.08	0.17
k = 12	0.03	-0.09	-0.29	0.18	-0.14	0.02
Correlation of inflation in *t* with	**Credit gap in *t* + *k***	**Credit gap in *t* – *k***	**Equity-price gap in *t* + *k***	**Equity-price gap in *t* – *k***	**Property-price gap in *t* + *k***	**Property-price gap in *t* – *k***
k = 0	0.28	0.28	-0.18	-0.18	-0.02	0.02
k = 4	0.16	0.36	-0.29	0.00	-0.15	0.15
k = 8	0.05	0.36	-0.28	0.10	-0.28	0.24
k = 12	-0.08	0.32	-0.18	0.16	-0.25	0.28

We first consider the correlations of output gaps and inflation with the credit gap. Interestingly, the credit gap is positively correlated with past output gaps but with future inflation. This suggests that the output gap moves in advance of credit gaps, and provides additional support for the notion that by reacting to the output gap, central banks can indirectly lean against bubbles. The correlation with respect to inflation supports the use of credit aggregates as suitable leading indicators for inflation.

The correlations of the output gap with past property- and equity-price gaps are positive, suggesting that the latter do contain information about the future state of the economy. While inflation is positively correlated with past property-price gaps, the correlation with past equity-price gaps is low. This arguably reflects the fact that property prices enter the CPI via the rents whereas equity prices are not part of the CPI. Moreover, it implies by reacting to inflation with monetary policy, central banks will not prevent equity-price bubbles from emerging.

Next we consider the correlations of future equity- and property-price gaps with the current output gap and inflation, which are negative. One possible explanation for these correlations is that a positive current output gap or inflation above its mean leads the central bank to tighten monetary policy, triggering a fall in equity and property prices.

3.4. Defining adverse macroeconomic conditions

To investigate formally the link between financial imbalances, recession and deflation, we next define an indicator variable that signals "adverse macroeconomic conditions" (AMCs). We start with defining these by relying on the behaviour of real economic activity. Of course, the results of our forecasting exercise depend on the definition of the AMCs indicator. Unfortunately, a variety of different approaches have been suggested in the literature and it is impossible to investigate all of them here. While the NBER had developed recession chronologies for the US, such measures are not readily available for all countries in our sample. Based on the data we have, we instead consider the average output gap over four successive quarters. We define an "adverse state" when the average output gap for the current and the next three quarters exceeds minus one percent. This threshold value was selected so as to match as closely as possible the NBER recession dates.[20] Borio and Lowe (2004) also define negative output events as an output gap exceeding minus one percent.

Nevertheless, basing the definition of recession on the output gap can be problematic (see Canova 1999) because it is derived as the deviation from an estimated trend; a procedure that may shift business cycle turning points. We therefore cross-checked our results using the business cycle chronologies from the ECRI, which are available for twelve countries in our sample and use the same methodology as the NBER. Our results

[20] Applying the above definition, our indicator signals recessions in the US in 1990Q4 to 1991Q3 and 2002Q1 to 2003Q1. The NBER dates are 1990Q3 to 1991Q4 and 2001Q1 to 2001Q4. While our indicator views the first adverse state as having started one quarter later and as having ended one quarter earlier than the NBER recession, the second adverse state is shown as having occurred about a year later than the NBER recession. Moreover, our indicator signals the start of a third adverse state in 2008Q3, which is three quarters after the latest turning point the NBER has announced for 2007Q4. By contrast, using the conventional definition of two successive quarters of negative GDP growth we would obtain only a single recession quarter in 1990Q4 and two additional ones in 2008Q3-Q4.

remain unchanged when we use the ECRI indicator instead of our definition of AMCs as the dependent variable in our regressions.

Proponents of the activist view might argue that our forecast exercise is biased towards not finding a systematic relation between asset-price booms and recessions because our definition of recessions does not depend on whether the recession was caused by an asset-price boom or a banking crises. Of course, some recessions occur for other reasons than financial imbalances, implying that credit and asset-price gaps are unlikely to be helpful in predicting them. However, studying only the sub-set of sharp macroeconomic contractions that are due to financial imbalances seems circular, since credit and asset prices predict these by definition. We nevertheless think that our forecast exercise is not unduly unfair to the activist view since the credit and asset-price gaps enter our model only during those periods when financial imbalances actually were present. In that way we ensure that only those recessions that happened in a certain period after a financial imbalance are actually regressed on the credit and asset-price gaps..

Figure 4 shows the output gap together with our indicator. We obtain 261 quarters with AMCs when the output gap is used to define them or about 15 percent of the observations. This accords well with conventional wisdom regarding the frequency of recessions. The figure also shows that adverse states tend to be correlated internationally. Most countries experience a recession around 1990 to 1992 and a second one in 2001 to 2002. With respect to the second downturn in 2001-2002, our indicator does not signal recessions in Australia, France, Italy, Spain and the UK. By contrast, several countries experienced large negative output gaps at the beginning of the sample, including Australia, Belgium, Canada, Finland, France, Germany, Japan, the Netherlands, Spain, Switzerland and the UK.

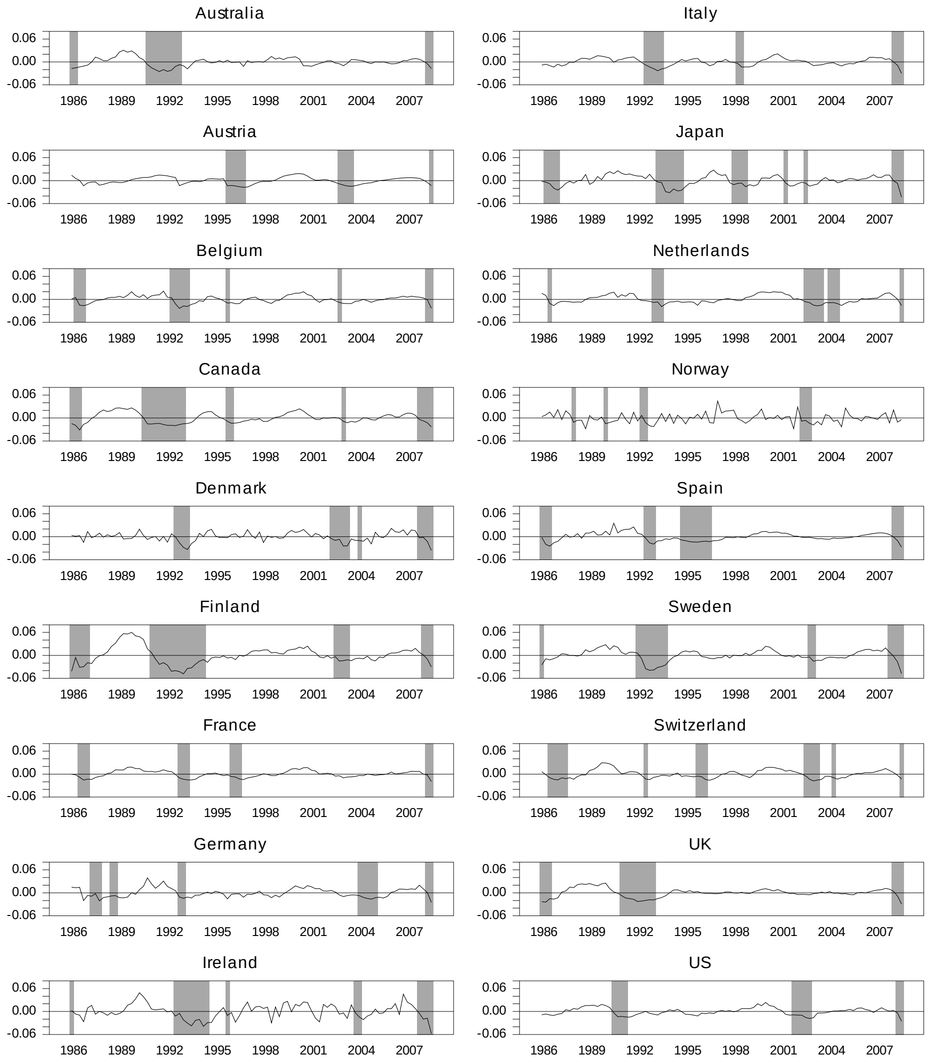

Figure 4. Output gap and adverse output states (shaded areas)

Next we consider defining AMCs by relying exclusively on the behaviour of inflation. Only Japan experienced deflation – a prolonged period of falling prices – in our sample.[21] We therefore define AMCs as a situation in which the inflation rate is either negative or it falls by more than two percentage points over the current and the next three quarters. This yields a total of 156 quarters or about nine percent of the observations (see Figure 5). In contrast to those computed using data on output, however, these states are less evenly distributed across countries. In particular, Japan

[21] Several countries had negative inflation rates during a few quarters, namely Finland, Germany, The Netherlands, Norway, Sweden and Switzerland. These events, however, were of a temporary nature and cannot be regarded as deflations.

stands out with 42 percent of the observations in the bad state. By contrast, for Austria, Belgium, France and Italy only the most recent drop in inflation rates is considered as moving the economy into an adverse state. It is noticeable that all countries are in an adverse state after the recent drop in inflation.

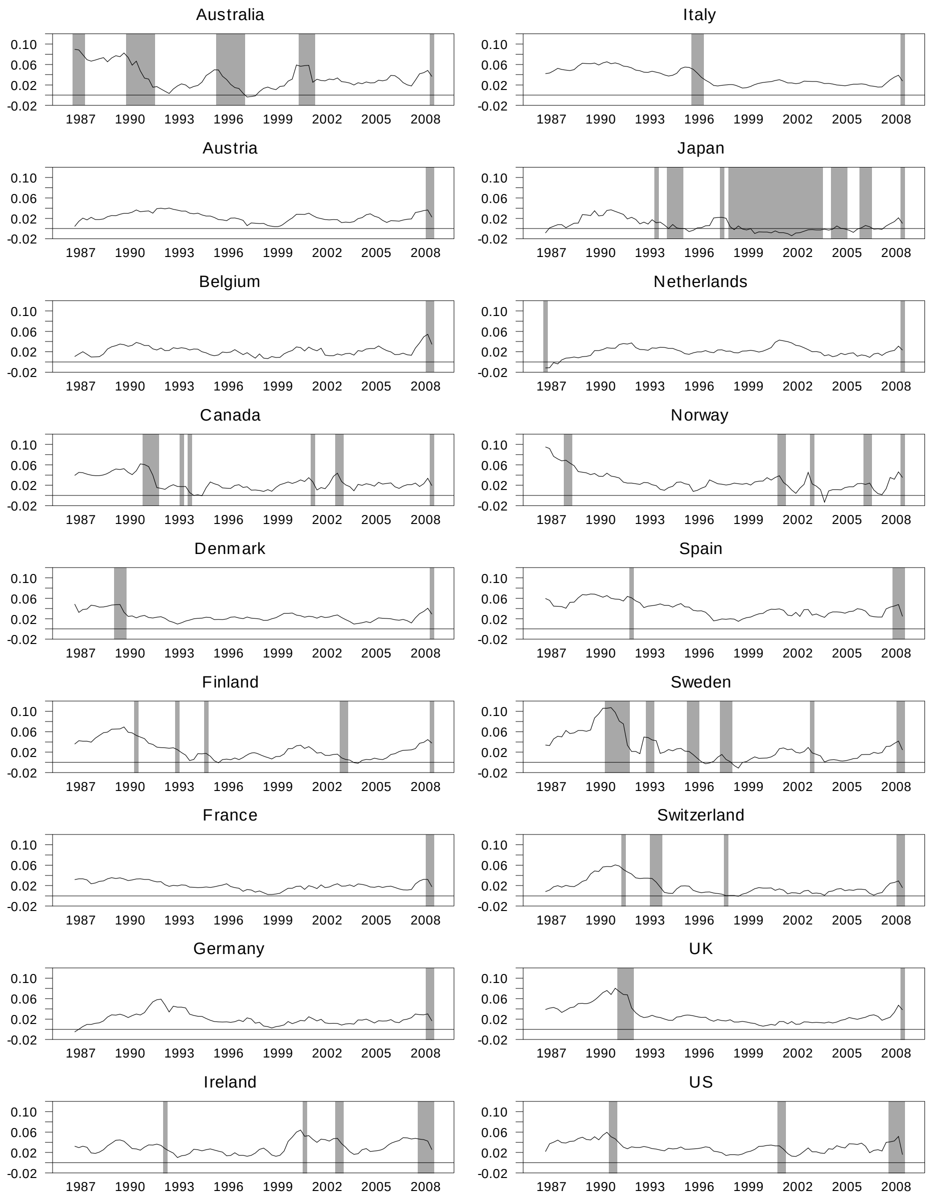

Figure 5. Inflation and adverse inflation states (shaded areas)

4. THE PREDICTIVE ABILITY OF CREDIT AND ASSET PRICES

In this section we turn to the important question of the information content of the indicators of financial imbalances. Before turning to the results, several issues warrant discussion.

First, most of the literature investigates whether measures of financial imbalances contain information useful for predicting the burst of an asset-price bubble and its effects on asset prices and financial stability.[22] While that is appropriate from a financial stability perspective, here we focus on the information they contain about future inflation and output, since these are the central goal variables for monetary policy makers. The motivation for posing the forecasting question in this way is simple: there is plainly no reason for central banks to adjust monetary policy in response to evidence that financial imbalances are forming if the resolution of such imbalances does not have any macroeconomic effects. While the forecasting exercise is somewhat different from that of Borio and Lowe (2002), banking and financial crises are typically associated with severe macroeconomic developments (see IMF 2008), suggesting that in practice there may not be a major difference between predicting financial crises and predicting severe macroeconomic weakness.

Nevertheless, we find that indicators of financial imbalances have little forecasting power for inflation and the output gap, also at longer horizons. While this finding reflects the difficulty of forecasting macroeconomic variables at long horizons, it raises doubts about the feasibility of the activist view. When considering the prediction of adverse macroeconomic conditions, however, our results are somewhat more positive.

Second, large deviations of credit and asset prices from trend, which are particularly likely to contain information about future economic conditions, and severe economic downturns occur only rarely. Since episodes in individual countries do not provide enough information to assess the systematic relations between asset prices and the macro economy, we use a panel approach.

Third, in practice central banks of course use much more information than the few time series we study here and consequently are better able to assess whether financial imbalances are forming in real time. Thus one can argue that our forecast exercise will not do justice to the activist approach. Nevertheless, if there is a *systematic* relation between asset-price bubbles and macroeconomic outcomes, we should be able to find some predictive ability of the indicators we are considering, even if by using more information we could improve our results. If the ability of asset prices to predict output and inflation is limited, they are unlikely to be useful information variables for policy purposes.

[22] See, in addition to the papers already cited, Alessi and Detken (2009), Agnello and Schuknecht (2009), Gerdesmeier et al. (2009).

4.1. Predicting output and inflation using threshold analysis

To assess the information content of credit and asset prices we estimate single-equation models with either the output gap or inflation as dependent variables. We fit the models using data until the last quarter of 1999 and then perform recursive out-of-sample forecasts starting in the first quarter of 2000.[23] Since the activist view asserts that financial imbalances are helpful in forecasting the economy at horizons beyond the two-to-three-year period central banks focus on, we consider forecasts up to 20 quarters ahead. The number of observations we can evaluate to assess predictive content of credit and asset-price gaps therefore ranges from 36 for the one-quarter horizon to 16 for the 20-quarter-ahead forecasts.

When forecasting at horizons more than one quarter ahead, we can either estimate a vector autoregressive system and compute dynamic forecasts that are obtained by conditioning future forecasts on the model's own lagged forecasted values. Alternatively, we can compute direct multi-step forecasts from single-equation regressions conditioned on the most recently observed data. We opt for this second approach. While the dynamic forecasting approach is optimal if the assumed model is correctly specified, this assumption is unlikely to hold in practice and direct forecasts are often more precise, especially if the forecast horizon extends far into the future as in our case (see Bhansali 2002). In particular, direct forecasts do not rely on potential misspecifications in the equations for the right-hand-side variables, which, as for instance equity prices, may be much harder to forecast than output or inflation.

Though adding more regressors always improves the in-sample fit of a model, it does not necessarily improve the out-of-sample forecast performance. In the previous section we discussed three different measures of financial imbalances that may have predictive content for output and inflation. With this in mind, we choose the following approach for the forecast evaluation. Our benchmark model, against which we will evaluate the information content of the credit and asset-price gaps, contains the current realisation of the short-term interest rate, the output gap and inflation. These variables are generally used to characterise monetary policy decisions of central banks.[24] The alternative models add all possible combinations of the credit and asset-price gaps to this benchmark specification. This results in seven different models that are listed in Table 2.

Table 3: Models

Model	Variables included
Benchmark	Inflation, output gap, interest rate
Model C	Benchmark model plus credit gap
Model E	Benchmark model plus equity-price gap

[23] Though the predictive content of credit and asset prices for macroeconomic outcomes can also be assessed by testing whether they are Granger causal for the output gap and inflation, out-of-sample forecasts constitute a much stronger test of their usefulness for forecasting (Stock and Watson 2003, Estrella and Mishkin 1998).

[24] It should be noted that since the interest rate is among the regressors, our forecasts are conditioned on the current stance of monetary policy.

Model P	Benchmark model plus property-price gap
Model CE	Benchmark model plus credit gap and equity-price gap
Model CP	Benchmark model plus credit gap and property-price gap
Model EP	Benchmark model plus equity-price gap and property-price gap
Model CEP	Benchmark model plus credit gap, equity-price gap and property-price gap

When forecasting with the gap variables, it is essential not to use future observations when calculating the trend. We therefore follow Borio and Lowe (2002) and compute all gap variables using a one-sided HP filter.

The activist view holds that only situations in which credit and asset prices are distinctly above trend are indicative of severe financial imbalances that raise the risk of a financial crisis and serious macroeconomic dislocation. As discussed in Section 3, we therefore define indicator variables that take the value of unity if the credit, the equity-price or the property-price gaps are sufficiently large to indicate a financial imbalance. Instead of using the full time-series information from the credit and asset price gaps in our regressions, we interact them with the indicator variables. The resulting series equal zero if the threshold is not surpassed and equal the original gap series if it is. We chose a threshold of 4 percent for the credit gap, 10 percent for the equity-price gap and 7.5 percent for the property-price gap. Since these values are arbitrary, we performed a robustness check by increasing and decreasing the threshold values by 50 percent.

As dependent variables we consider the output gap and inflation. We investigate the forecast performance of the seven different models listed in Table 3, containing all possible combinations of the three gap variables, using the Root Mean Squared Forecast Error (RMSFE), which is widely used to assess forecasting performance. For inflation, we calculate the RMSFE based on the cumulative predicted growth rates over the forecast horizon, i.e., we assess how well the models are able to predict the price level over the forecast horizon.[25] By contrast, for the output-gap models we report the RMSFE in a specific quarter, which entails the assumption that the alternative models lead to the same trend forecast as our benchmark model.[26] We report the ratio of the RMSFE of the model being considered to the RMSFE of the benchmark model. Values below unity indicate that the alternative model performs better than the benchmark model. Since the time-series dimension of our data set is large, we estimate the models country-by-country without restricting the regression coefficients to be identical across countries. In total, we have 2880 different regressions (i.e., for 18 countries, 8 models and 20 time horizons) for each variable we want to forecast, giving us 2520 relative RMSFEs. We

[25] We are grateful to an anonymous referee for making this suggestion.

[26] Results are slightly more favourable if output growth is used instead of the output gap as three of the alternative models are able to outperform the benchmark model at a forecast horizon of 20 quarters.

summarize this information by plotting the average ratio of the RMSFEs of each model relative to the benchmark model.[27]

Since the indicators do not signal the presence of financial imbalances in all countries, the number of RMSFEs that can be evaluated relative to the benchmark model declines.[28] The RMSFEs for Models C, P, CE and CP are therefore based on a sample of only 16 countries. Finally, when it comes to Models CP and CEP that are based on the joint occurrence of credit and property-price gaps, results relate to only 14 countries.

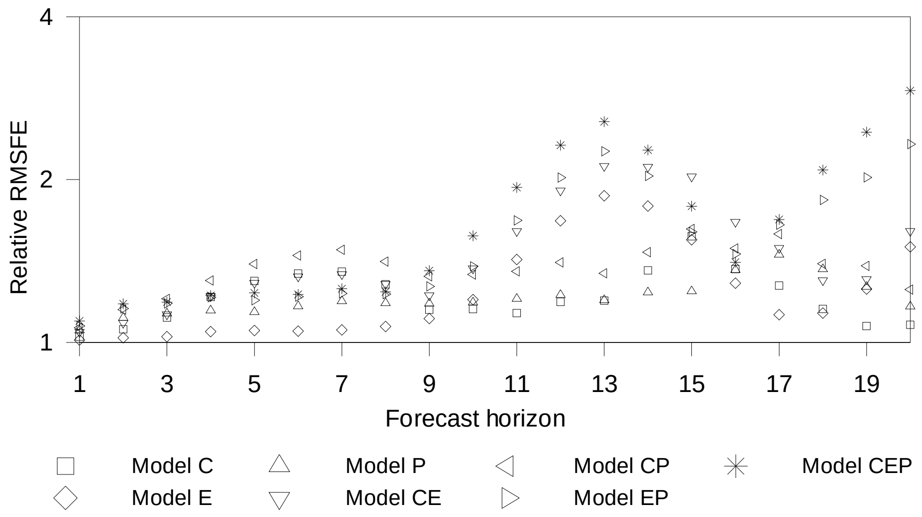

Figure 6. Relative RMFSE for the output gap

Figure 6 shows the forecast results from the threshold models as plots of the average RMSFE across countries from the alternative model relative to the benchmark model containing only past inflation, the output gap and the interest rate. We conclude that there is no evidence that the gap variables have any predictive power beyond that included in the current output gap, inflation rate and short-term interest rate. Not surprisingly, Model CEP with the highest number of additional regressors, performs worst at long horizons, indicating that the gap variables mainly introduce noise.

Of course, the choice of thresholds is arbitrary and results will change if the threshold is changed. To check the robustness of our results we therefore increase and decrease all thresholds by 50 percent. Figures 8 and 9 show the resulting relative RMSFEs for the output gap from this exercise.

[27] Results are robust to alternative choices of the benchmark model. Our benchmark model performs better at short horizons of up to three quarters for the output gap and up to seven quarters for inflation relative to simpler benchmarks like the unconditional mean or an AR(1) model. Nevertheless, the gap variables are unable to improve forecast performance relative to simpler benchmark model.

[28] While all countries experienced at least some periods with equity-price gaps exceeding the threshold, Austria and Germany did not face large property-price gaps while Japan and Switzerland did not experience large credit gaps.

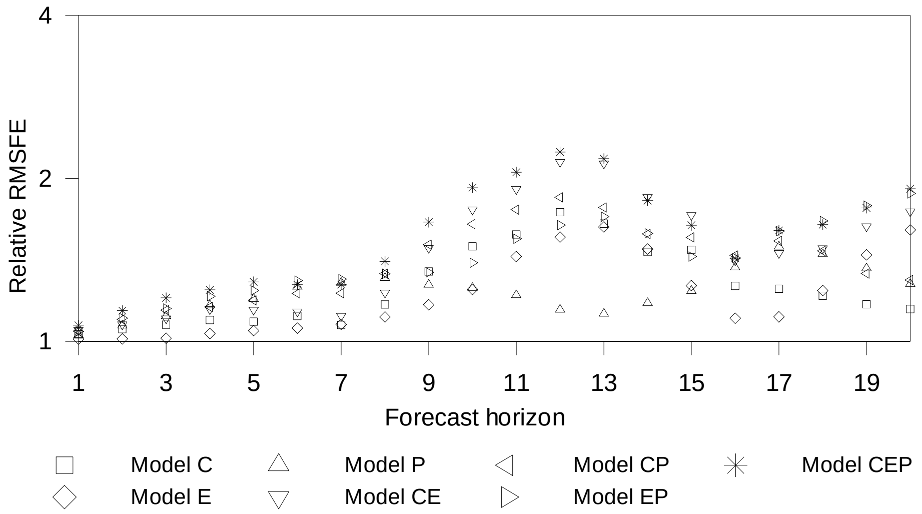

Figure 7. Relative RMFSE for the output gap with thresholds decreased by 50 percent

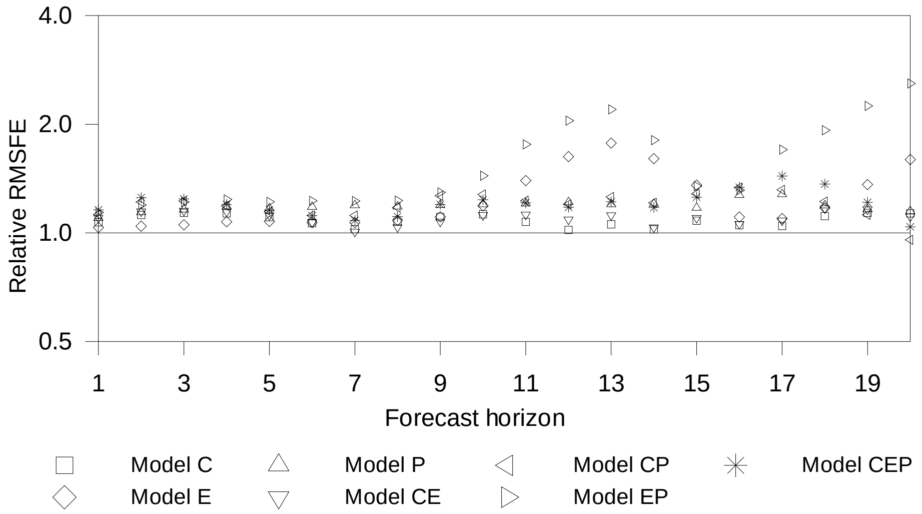

Figure 8. Relative RMFSE for the output gap with thresholds increased by 50 percent

While decreasing the thresholds by 50 percent has almost no effect on the relative RMSFEs, it seems that forecast performance can be enhanced (but remain worse than the benchmark model) by setting a higher threshold for the equity-price gap, which matches with the results by Borio and Lowe (2002) who recommend a value of 40 to 60 percent. Nevertheless, it has to be borne in mind that with a higher threshold more and more countries are omitted from the analysis, which also affects the results. Overall, we conclude that the disappointing forecast performance of the gap variables is not due to the choice of the threshold.

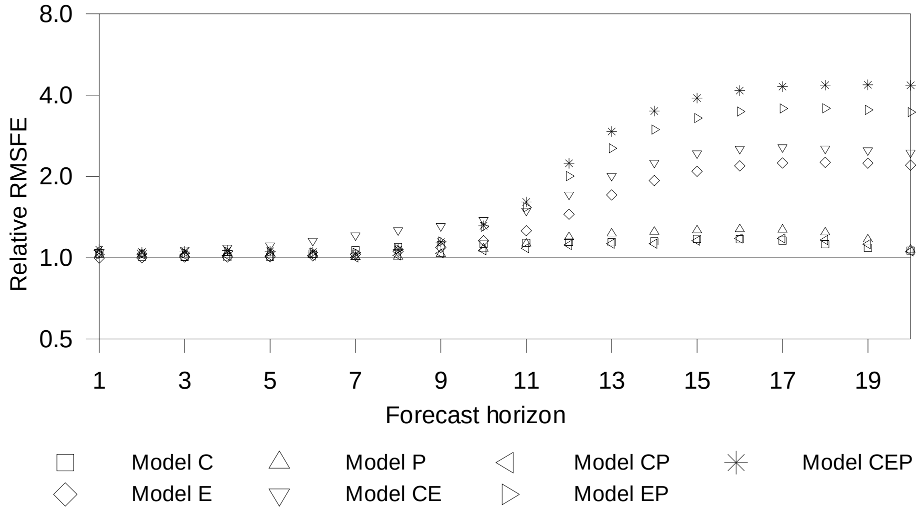

Figure 9. Relative RMSFE for inflation

We next turn to the information content of the gap variables for inflation. Figure 9 indicates that the alternative models also in this case perform worse than our benchmark model, especially at longer horizons. In particular, models including equity prices lead to much worse forecasting performance than the benchmark model.

Figures 10 and 11 show the relative RMSFEs for inflation when the thresholds are decreased and increased by 50 percent and indicate that our results are robust to the choice of the threshold in a reasonable range.

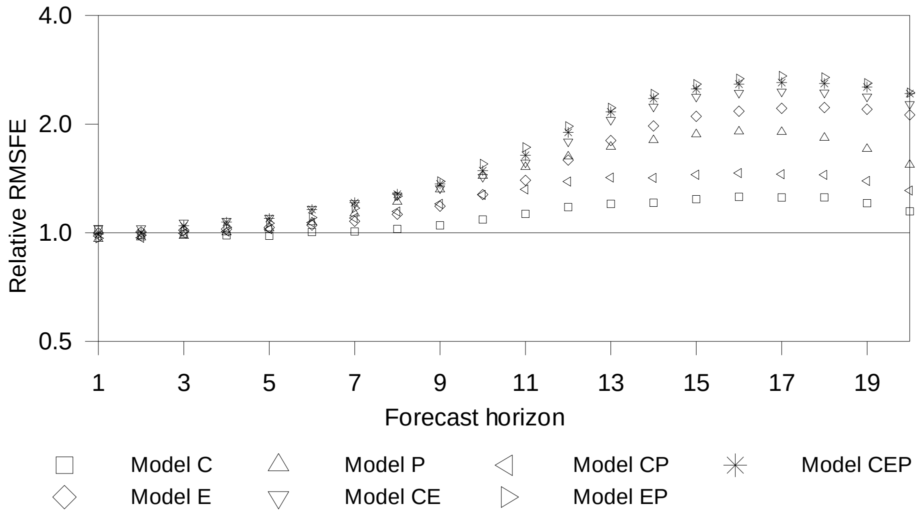

Figure 10. Relative RMSFE for inflation with thresholds decreased by 50 percent

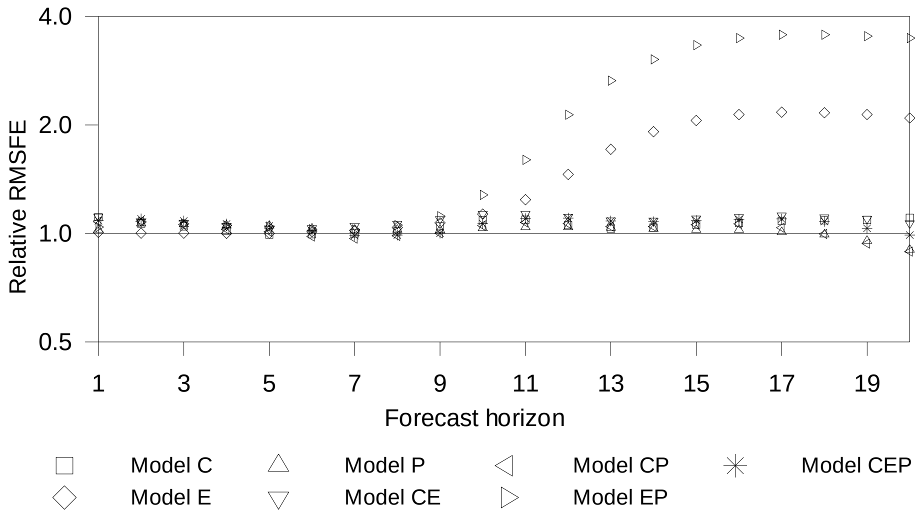

Figure 11. Relative RMSFE for inflation with thresholds increased by 50 percent

These results indicate that the best performance of the credit and asset-price gaps is obtained when forecasting inflation with the thresholds increased by 50 percent. To investigate these results in more detail, we next test for how many countries the RMSFE is smaller than in the benchmark model.

Table 4 presents results from tests of equal forecast errors for our seven models relative to the benchmark model. Since our models are nested, we use the F-test proposed by Clark and McCracken (2001) in order to assess how frequently the forecasts from the alternative models significantly improve on those from the baseline model.[29] When interpreting the results, we must keep in mind that the thresholds have not been exceeded by some countries in the sample. For those countries the alternative model is by definition identical to the benchmark model and they are consequently not included in the comparison. Table 4 therefore indicates the number of countries for which the credit and asset-price gaps produce significantly better forecasts relative to the number of countries that enter in the comparison.

Table 4: Clark-McCracken tests for inflation with 50 percent increased thresholds

Horizon	Model C	Model E	Model P	Model CE	Model CP	Model EP	Model CEP
1	3 / 14	7 / 17	5 / 13	1 / 13	4 / 12	2 / 12	4 / 11
2	4 / 14	7 / 17	3 / 13	3 / 13	4 / 12	1 / 12	3 / 11
3	5 / 14	5 / 17	3 / 13	4 / 13	3 / 12	1 / 12	1 / 11
4	6 / 13	7 / 17	3 / 13	4 / 12	2 / 11	1 / 12	2 / 10
5	7 / 13	5 / 17	3 / 13	4 / 12	1 / 11	3 / 12	0 / 10
6	6 / 12	5 / 17	4 / 13	3 / 12	5 / 10	3 / 12	1 / 10
7	6 / 12	4 / 17	2 / 13	3 / 12	5 / 10	2 / 12	3 / 10
8	6 / 12	5 / 17	4 / 13	4 / 12	4 / 10	2 / 12	4 / 10
9	7 / 12	5 / 17	3 / 13	6 / 12	4 / 10	4 / 12	4 / 10
10	7 / 12	5 / 17	4 / 13	5 / 12	5 / 10	6 / 12	5 / 10
11	7 / 12	6 / 17	4 / 13	6 / 12	4 / 10	5 / 12	3 / 10
12	7 / 12	7 / 17	5 / 13	6 / 12	4 / 10	6 / 12	3 / 10
13	6 / 11	6 / 17	5 / 12	6 / 11	3 / 9	4 / 11	3 / 9
14	5 / 11	6 / 17	4 / 11	6 / 11	3 / 8	4 / 10	3 / 8
15	5 / 11	6 / 17	3 / 11	6 / 11	3 / 8	3 / 10	3 / 8
16	5 / 11	6 / 17	3 / 10	5 / 11	3 / 8	3 / 10	3 / 8
17	5 / 11	6 / 17	3 / 10	5 / 11	3 / 8	3 / 10	3 / 8
18	4 / 11	6 / 17	3 / 10	5 / 11	3 / 8	3 / 10	3 / 8
19	4 / 11	6 / 17	5 / 10	5 / 11	4 / 8	6 / 10	4 / 8
20	3 / 11	6 / 17	3 / 10	4 / 11	2 / 8	7 / 10	5 / 8

Notes:
The first entry indicates the number of countries in which the RMSFE from the alternative model is significantly lower than that of the benchmark model. The second entry shows the number of countries for which the alternative model differs from the benchmark model. The results are obtained with the Clark-McCracken (2001) MSE-F test using a 5 percent level of significance.

In contrast to what Figure 11 suggests, the most noticeable improvement can be seen in the case of Model C at horizons of two to three years, where forecasts improve for half or more of the countries considered. This is compatible with many central banks' practice of monitoring credit aggregates as indicators of inflation pressures. Turning to the results at long forecasting horizons the improvement for Models CP and P relative to the benchmark turns out to be based on a small sample since forecasts improve significantly only for two or three countries. Surprisingly, models including equity and property prices improve inflation forecasts in a majority of countries at horizons of 19 and 20 quarters. Nevertheless, these results are based on about half of the countries in the sample only, and may therefore not be robust.

[29] The Clark-McCracken test is valid for one-step-ahead forecasts. For multistep forecasts the distribution applies if the unrestricted model contains one additional regressor, which is the case for Models C, E and P (see Clark and McCracken 2004). For the other models, the asymptotic distribution depends on nuisance parameters and the results thus have to be interpreted with care.

Overall, while there is some information in the credit and the asset-price gaps for inflation, there is less so for the output gap. However, while the activist view implies that large gaps may lead to financial instability that could cause deflation, we generally find a *positive* relation between the credit gap and inflation at those horizons where the credit gap performs best. Moreover, there is considerable variation as to the variable, the country and the horizon for which credit and asset-price gaps improve the forecasting performance. The information content therefore seem limited and unreliable.

4.2. Predicting adverse macroeconomic conditions

The results presented above show that the information contained in the gaps typically worsens the accuracy of forecasts for output and inflation and thus suggests that no importance should be attached to these measures of financial imbalances in setting policy. But these exercises assume that the central bank is equally concerned about all macroeconomic outcomes. We therefore now turn to the more important issue of whether measures of financial imbalances contain information useful in assessing the risk of AMCs.

So far we have studied the forecasting performance on a country-by-country basis. When predicting the occurrence of AMCs, however, we often have only one or two such episodes in the data for each country. We therefore move to a panel setting, estimating the forecasting regressions jointly for all countries but allowing for country specific intercepts (fixed effects). Moreover, when assessing the forecast performance of the model it is important to capture as many episodes of AMCs as possible. Since the panel increases the degrees of freedom, we start our forecasting exercise in 1995. In that way we can explore whether the models forecast the recession that occurred in many countries around 2001 and the current recession.

One might argue that this approach leaves too few observations to estimate the model initially, as only the recessions occurring in many countries around 1990 are captured in the estimation. Figure 4, however, shows that several countries experienced a downturn also around 1986. Moreover, the economic situation in the early 1990s was quite different for the countries in our sample, with the US leading the downturn whereas some European countries first experienced a boom after the opening of the Iron Curtain but underwent a slowdown later. Our initial sample for one-step-ahead forecasts consists of 630 observations, of which 136 are classified as AMCs when relying on the output gap. Moreover, the number of observations is increased throughout the forecast exercise as the model is re-estimated.

In defining AMCs we rely on the indicators discussed in Section 3.3. Thus, when using the output gap, we identify an AMC as a situation with the average output gap for the current and the next three quarters of less than minus one percent. For inflation, we define it as the annual inflation rate being either negative or decreasing by more than two percentage points over the current and the next three quarters. In the following regressions the occurrence of such severe events are captured by an indicator variable that takes the value of unity if the event occurs and zero otherwise.

We compare the predictive ability of our benchmark model (which included lagged interest rates, inflation and the output gap) over forecast horizons up to 20 quarters ahead, to the alternative models shown in Table 3. As in the previous section, we interact the gap variables with an indicator that signals misalignments, since only in these instances they can be expected to play a role in the business cycle. While our benchmark model includes those variables that are helpful to predict conventional AMCs, which may occur for many other reasons than financial imbalances, the alternative models allow large credit and asset-price gaps to contribute to the prediction of AMCs related to financial crises.

In a probit framework it is no longer useful to report the RMSFE. We follow the literature and report the noise-to-signal ratio. It is defined as the share of "false alarms" (type II errors), divided by the share of correct AMC signals, that is, fields [B/(B+D)]/[A/(A+C)] in Table 5. Focussing on the noise-to-signal ratio is useful if the sample is highly unbalanced with only few occurrences of AMCs since in that case a naive forecast of the economy being in the "normal" state at all points in time leads to a high share of correct predictions.[30] For a model to predict better than a purely random indicator, the noise-to-signal ratio should be smaller than unity.

Table 5. Noise-to-signal ratio

		True state of the economy	
		AMC	**No AMC**
Predicted state of the economy	AMC	Correct prediction (A)	Type II error (B)
	No AMC	Type I error (C)	Correct prediction (D)

The literature that seeks to predict asset-price bubbles and their effects on the economy generally regards a forecast as correct if the predicted event occurs within the coming three years (see Borio and Drehmann, 2009). To translate this idea into a regression-based approach, we set the dependent variable in our regression to unity if an AMC occurs in the current or the next three quarters. Our results are thus comparable to those in the literature that use a one-year horizon to evaluate the signals from the gap variables.[31]

Before investigating the forecast performance of the probit models we check the explanatory power of the models in sample. Figure 12 shows the pseudo-R^2 from the probit regressions, when the output gap is used to define AMCs. It can be seen that the explanatory power of the benchmark model is highest at lags of eight to twelve quarters.

[30] In our measure we do not consider different preferences of policy makers for type I and type II errors. See Alessi and Detken (2009) for a discussion of different loss functions.

[31] While it is clear that by extending the horizon the number of correctly predicted events will increase, Borio and Drehmann (2009, Table 1) surprisingly obtain also a decrease in type II errors with a longer horizon.

While the fit of the model increases when the credit and asset-price gaps are added, in particular at long horizons, the difference in explanatory power is limited.

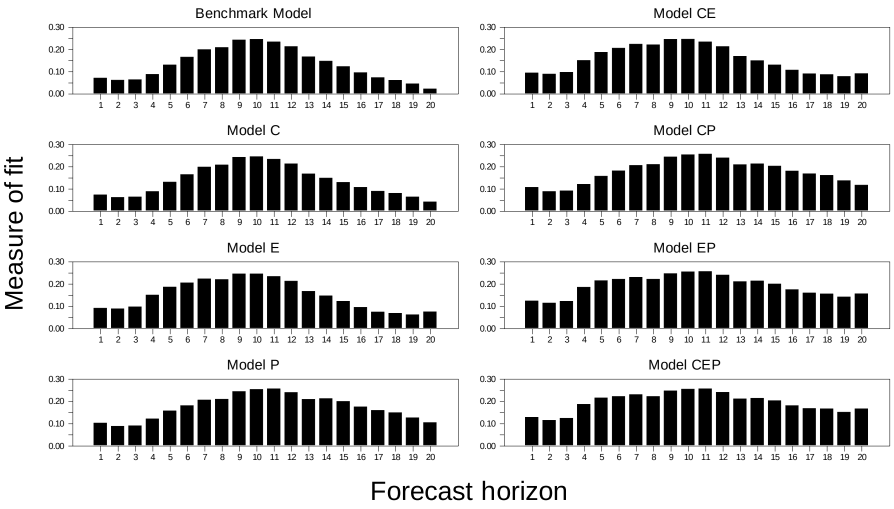

Figure 12. Fit of the probit models for adverse output states

Figure 13 shows that the explanatory power of the models for adverse inflation states is much lower and essentially negligible. Nevertheless, also in this case does the inclusion of the credit and asset-price gaps lead to an increase in explanatory power at horizons of 18 to 20 quarters.

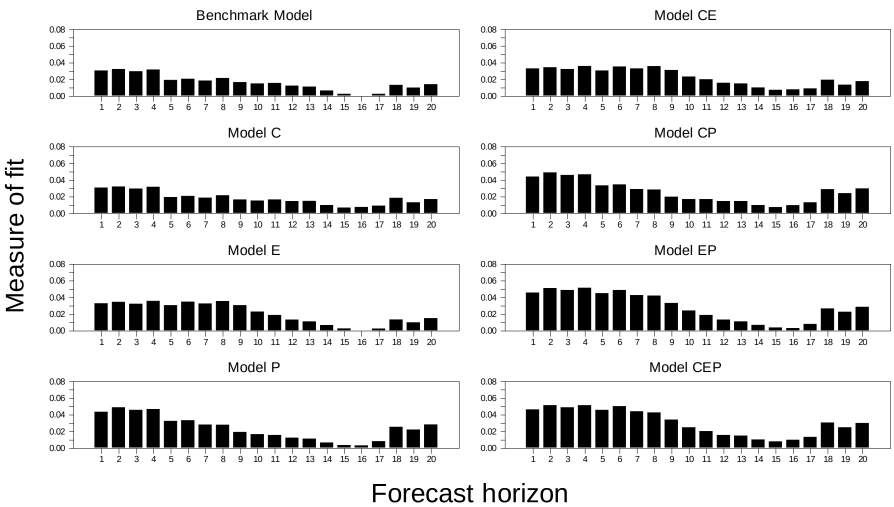

Figure 13. Fit of the probit models for adverse inflation states

An improved in-sample-fit, however, does not imply better out-of-sample predictions. We therefore next compare the forecasting ability of the models that include the gap variables with our benchmark model.

In a probit model the dependent variable is a zero-one indicator that signals if an certain event occurred at a specific observation. The fit of this model can be interpreted as the likelihood of the event occurring. In what follows, we say that the model predicts an event if the fitted probability exceeds a cut-off level. A cut-off level of 0.5 might be a natural choice, but by this rule only few AMCs are predicted. We therefore use a cut-off level of 0.3 for adverse output states and 0.2 for adverse inflation states.[32] Moreover, when evaluating the forecast performance of the models with the noise-to-signal ratio discussed below, at least one correct prediction for an AMC state is necessary for this statistic to be defined, which requires setting the cut-off level low enough. In general, the choice of a threshold entails two type of errors. First, some adverse states may be missed (type I error) and, second, some "normal" states may be incorrectly classified as adverse (type II error). Changing the cut-off level inevitably increases the probability of one type of errors relative to the other.

Figure 13 shows the relative noise-to-signal ratio for adverse output states. A value below unity indicates that the alternative model produces better forecasts than the benchmark model. Looking at Figure 13 it seems that financial imbalances are indeed useful for forecasting adverse output states at longer horizons. In general, the majority of alternative models leads to a lower noise-to-signal ratio than the benchmark model. At horizons beyond five quarters, in particular models including the property-price gap, either alone or in combination with some other gap variable, produce better forecasts.

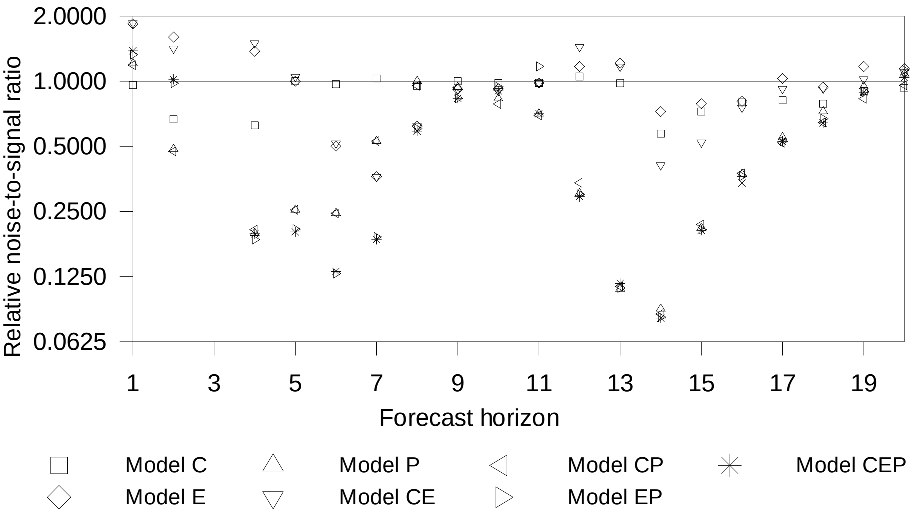

Figure 14. Relative noise-to-signal ratio for adverse output states

We again explore the robustness of the results by decreasing and increasing the values of the thresholds that define the misalignments of credit and asset prices by 50 percent. Figure 15 shows that results change little when the thresholds are either decreased or increased by 50 percent.

[32] These cut-off levels are chosen such that they equal approximately the fraction of observations at which AMCs prevailed.

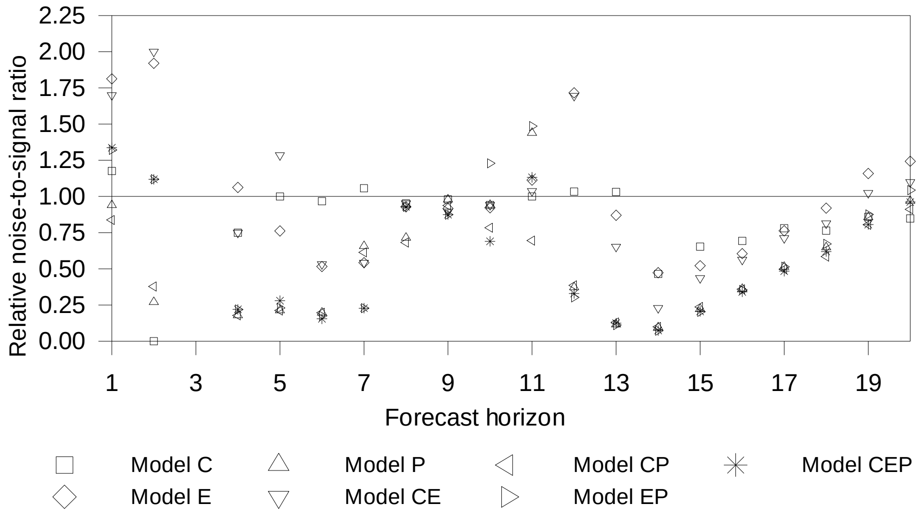

Figure 15. Relative noise-to-signal ratio for adverse output states with 50 percent decrease in thresholds

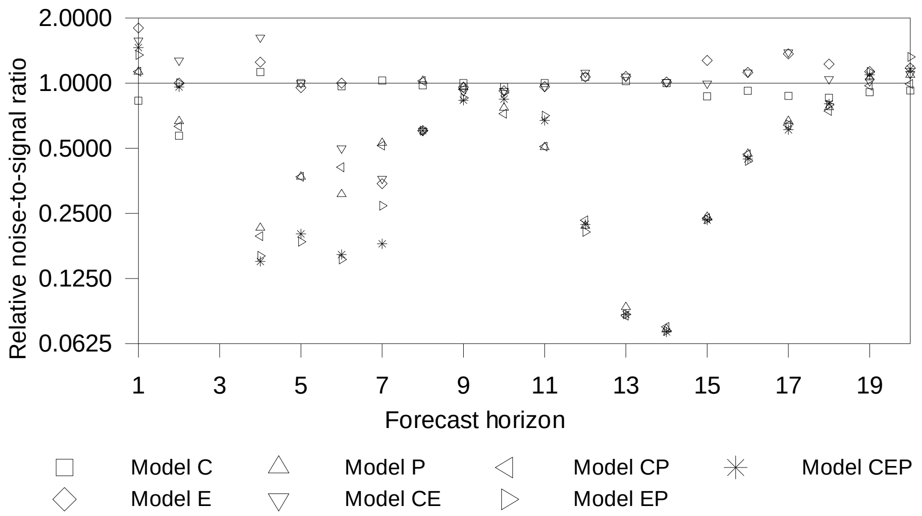

Figure 16. Relative noise-to-signal ratio for adverse output state with 50 percent increase in thresholds

We next investigate the forecast performance of the probit model for the output gap in more detail. Since the Clark and McCracken (2001) test is not applicable to probit models, we regress the noise-to-signal ratios for all countries, models and forecast horizons on country dummies, dummies for the different models and dummies for the forecast horizon. Table 6 presents the results from this regression. The average noise-to-signal ratio is 0.44 and thus below unity, indicating that the models are useful for predicting adverse output states. Interestingly, the dummy variables for the models including the property-price gap are significantly negative, indicating that they add predictive power to the benchmark model. Not surprisingly, the noise-to-signal ratio generally increases with the forecast horizon, implying that on average at horizons of around nine quarters and more a completely random signal would perform as well. Finally, it turns out that in France, Italy, Japan, Norway and the UK the models are significantly more successful than in the US in predicting adverse output states, whereas recessions seem to be especially difficult to predict in Germany.

Table 6: Probit regression results when AMCs are captured by the output gap

Dummy variables	Coeff-icient	t statistic	Dummy variables	Coeff-icient	t statistic	Dummy variables	Coeff-icient	t statistic
Constant	0.44	1.82	Germany	2.03	7.07	Horizon 7	0.90	3.56
Model C	0.05	0.31	Ireland	0.38	1.48	Horizon 8	-0.27	-0.69
Model E	-0.04	-0.22	Italy	-0.54	-2.34	Horizon 9	0.49	3.34
Model P	-0.39	-2.78	Japan	-0.83	-3.47	Horizon 10	0.80	2.42
Model CE	0.04	0.24	Netherlands	-0.30	-1.29	Horizon 11	0.94	3.86
Model CP	-0.39	-2.92	Norway	-0.76	-3.24	Horizon 12	1.41	7.93
Model EP	-0.43	-3.41	Spain	-0.34	-0.98	Horizon 13	0.80	6.73
Model CEP	-0.43	-3.89	Sweden	0.00	-0.02	Horizon 14	1.28	5.47
Australia	-0.51	-1.66	Switzerland	0.48	1.21	Horizon 15	2.05	5.70
Austria	0.22	0.55	UK	-0.74	-2.88	Horizon 16	1.88	10.40
Belgium	0.27	1.05	Horizon 2	-0.24	-2.51	Horizon 17	1.64	8.92
Canada	0.19	0.78	Horizon 3	0.05	0.33	Horizon 18	1.49	8.55
Denmark	0.42	1.27	Horizon 4	0.34	1.63	Horizon 19	1.24	10.84
Finland	-0.41	-1.65	Horizon 5	0.26	1.53	Horizon 20	1.02	9.52
France	-0.59	-2.27	Horizon 6	0.73	3.98			

Notes:
The dependent variable is the change in the number of correct predictions for the adverse output state. The number of observations is 1187, $R2 = 0.30$. t-values are based on heteroscedasticity and autocorrelation consistent standard errors.

So far, the results seem quite favourable for the credit and asset-price gaps as predictors of AMCs. We next investigate the share of AMCs that are actually predicted using our threshold of 0.3. Figure 17 shows for each model the share of correct predictions of AMCs (i.e., cell A in Table 5) and the share of type II errors in percent. At intermediate horizons of eight to eleven quarters none of the models is able to predict more than four percent of AMCs. At long horizons more AMCs are predicted correctly, but the share of type II errors also increases, leading on balance to as many false alarms as correct predictions. Thus, although the credit and the asset-price gaps improve the forecasts, they remain far from satisfactory.[33]

[33] By lowering the cut-off level used to define the prediction of an event from the probit model, the number of correct predictions rises but so does the number of type II errors.

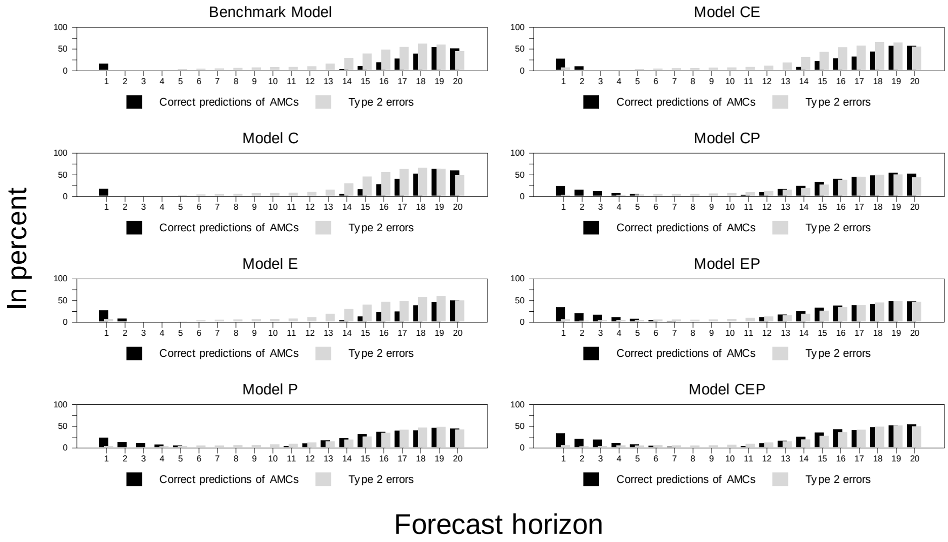

Figure 17. Share of correct predictions for adverse output states

We next turn to the results for adverse inflation states, which are shown in Figure 18. Since the relative noise-to-signal ratios generally exceed unity, it appears that the alternative models provide less precise signals than the benchmark model. Only at horizons of six and 12 to 17 quarters do the incorporation of the financial variables improve forecasts when AMCs are defined using inflation states.

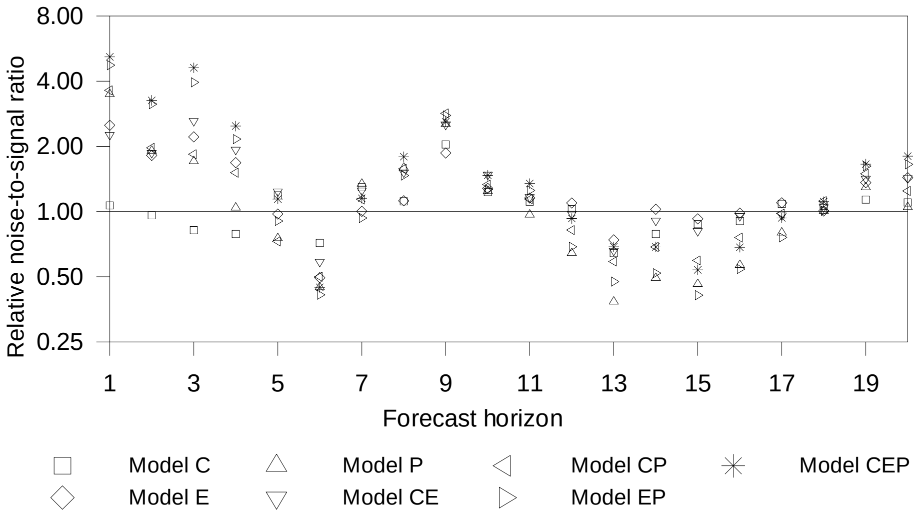

Figure 18. Relative signal-to-noise ratio for adverse inflation states

We check again for robustness by decreasing and increasing the thresholds for the gap variables by 50 percent. The results are shown in Figures 18 and 19. These remain broadly unchanged, indicating that robustness is not an issue.

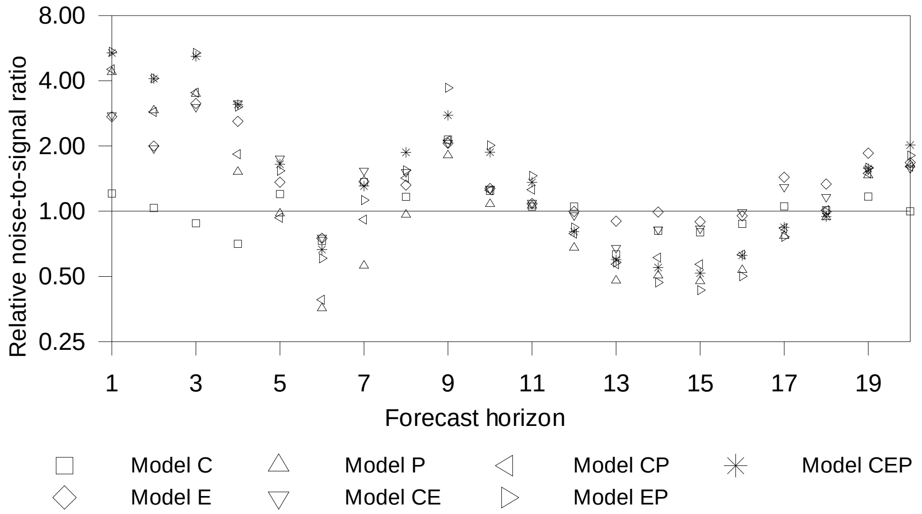

Figure 19. Relative signal-to-noise ratio for adverse inflation states with 50 percent decrease in threshold

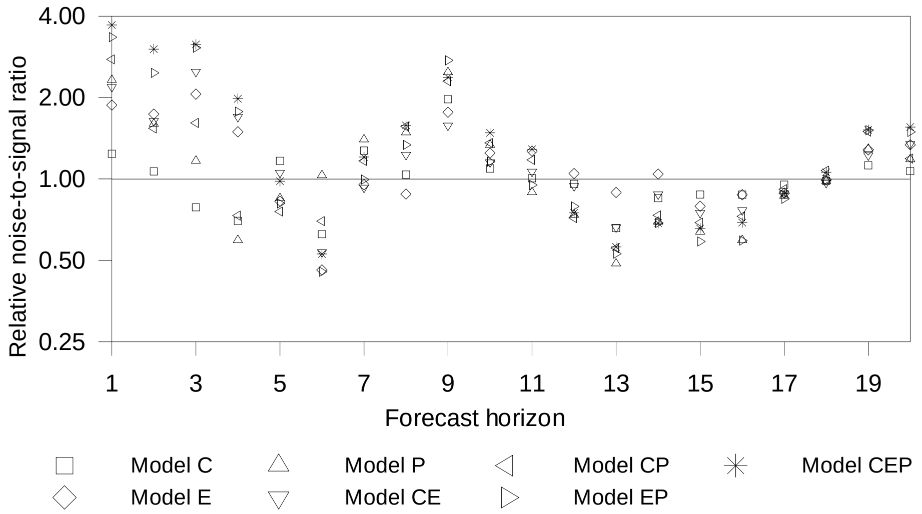

Figure 20. Relative signal-to-noise ratio for adverse inflation states with 50 percent increase in threshold

Though our forecasting exercise is subject to several caveats, we believe that it provides little if any evidence supportive of the activist view. One can imagine several different responses to this finding.

First, it could be argued that the sample period we study was far too placid to contain much variation – and thus information – in the data. However, as we discussed earlier, we think it would be imprudent to base policy on older data that, as is well established, was generated during a period with a very different monetary policy regime in place.

Second, it may be that the lack of support for the activist view arises because the measures of financial imbalances that we study are too coarse, in particular since they lack any theoretical underpinnings. This critique is apt, but of course applies to all studies that have used indicators of financial imbalances of the type pioneered by Borio and Lowe (2002). For instance, one possibility would be to use price-earnings ratios (or dividend yields) to try to detect bubbles in equity prices and analogue constructs to assess property prices. We agree with this view; here we only show that the measures of financial imbalances proposed to date do not contain much useful information.

Third, one may hypothesise that using better data, in particular more detailed data on property prices and credit, may improve the forecasting performance. While this possibility is well worth exploring, to date there is little indication in the literature that the information content of the indicators of financial imbalances are sensitive to the exact choice of data. We are therefore doubtful whether this will lead to better out-of-sample predictions.

Fourth, one may argue that the poor forecasting performance reflects the inherent problem of predicting rare events on the basis of a short sample, and that one should not overestimate the lack of statistical power. While we agree with the first part of that statement, whether the second part makes sense depends on the costs of tightening monetary in response to a perceived bubble which in fact is not one; in the next section we show that these are large. Thus, we find the issue of statistical power is germane and not merely of academic interest.

But even if one were to agree that all of these criticism contain a grain of truth, it is hard to avoid concluding that the ability of these measures of financial imbalances to predict the future evolution of the economy has been vastly exaggerated by the proponents of the activist view. As a consequence, any monetary policy strategy to deal with bubbles that is based on measures of financial imbalances such as those studied here must be seen as highly unlikely to be successful.

5. CAN MONETARY POLICY INFLUENCE ASSET PRICES?

Next we turn to another aspect of the activist hypothesis, namely that a tightening of monetary policy can help prevent asset-price bubbles from becoming too large without causing an excessive contraction in real economic activity or a large decline in inflation. Assenmacher-Wesche and Gerlach (2008c) study the effects of monetary policy shocks using a panel VAR incorporating prices, real GDP, interest rates, credit, property prices and equity prices, and estimated on data on the same countries studied here. They demonstrate that the effects of monetary policy shocks on real economic activity are large relative to those on property and equity prices, suggesting that a leaning-against-the-wind policy is likely to be costly in terms of output foregone. Furthermore, while equity prices respond rapidly to monetary policy shocks, property prices decline only gradually. These different time profiles suggest that it is difficult to stabilise both asset prices.

However, that analysis is subject to three shortcomings. First, the estimates stem from a sample period in which few, if any, central banks leaned against asset prices. This raises the possibility that the behaviour of the economy could change if central banks announced that they would lean against financial imbalances and proceeded to do so. If so, it is sometimes argued, rising asset prices would not attract new investors that borrow to enter the market and sustain the upswing since they would expect the central bank to tighten monetary policy if prices rose too sharply. Thus, provided that central banks' announcements are credible, bubbles may never form. Under this view, no past data can contain information about a leaning against the wind policy.

However, another interpretation of such a policy is that it broadly corresponds to the current monetary policy practice by many central banks, except that on occasion interest rates would be changed marginally in response to financial market developments. Under this view, past data would be informative about the behaviour of the economy even under a new leaning against the wind policy.

Second, Assenmacher-Wesche and Gerlach (2008c) do not incorporate credit in their analysis. Rapid expansion of credit has played a central role in many historical episodes of financial bubbles and one naturally hesitates to accept an analysis that disregards it.

Third, the estimates assume that there is a single regime in force, an assumption that clashes with the idea that bubble periods in some sense are "different" from other periods (for instance, because "irrational exuberance" dwarfs the effects of monetary policy). Following the approach of Goodhart and Hofmann (2008), who estimate a VAR separately for boom periods which they treat as exogenously given, we re-estimate the panel VAR in Assenmacher-Wesche and Gerlach (2008c), but allow the parameters to shift depending on whether the gap variables signal that a financial imbalance is forming.

Below we estimate a panel VAR to study the effects of monetary policy on asset prices, real economic activity and inflation under the assumption that a leaning against the wind policy may not be so different from the conduct of monetary policy in recent years so as to render past data uninformative. Furthermore, we incorporate real credit in the analysis: our system consists of the CPI, real GDP, real property prices, the short-term interest rate, real credit and real equity prices. We also distinguish between "normal" times and episodes of financial imbalances, which we identified as periods in which the credit gap exceeds four percent. The reason for not choosing the equity or property-price gap as the indicator is that we are mainly interested in the response of property and equity prices to monetary policy shocks. By selecting episodes based on the property-price and equity-price gap indicators we bias results to finding large increases in these variables after a monetary policy shock since we estimate the coefficients on periods in which asset prices rose considerably. By interacting all right-hand side variables in the VAR with the chosen indicator, we can estimate the impulse responses to monetary policy shocks under the hypothesis that there were financial imbalances and compare them to the impulse responses obtained for normal times.

We estimate the panel VAR using a combination of the fixed effects and the mean group estimator, which is simpler but close in spirit to the pooled mean group estimator by Pesaran et al. (1999). It is well known that estimation of dynamic panels involves a bias (Holtz-Eakin et al. 1988), but in our case the time dimension is large and this bias is likely to be negligible. What will matter, however, is the bias introduced by possibly heterogeneous slope coefficients across countries. The solution to this bias would be to use the mean-group estimator by Pesaran and Smith (1995). Since there are few episodes of imbalances in our sample, this strategy is not feasible with our data. As it is likely that the impact of the financial variables differs across countries, due to different structures of financial markets, we interact the financial indicators with country-specific dummies in the VAR.[34] By contrast, we assume that the coefficients on lagged inflation, output and interest rates are identical across countries. We estimate the VAR with two lags.

We compare the reaction of the variables to a 25 basis point monetary policy shock during a boom period and compare them to their reaction during normal times, and focus on monetary policy shocks since this is the empirical counterpart to asking what effect a change in monetary policy has (see Walsh 2003, Chapter 1). Though systematic monetary policy accounts for the main part of movements in the interest rate, an investigation of the effect attributable to monetary policy (comparable to the ceteris-paribus assumption in theoretical model) requires disentangling the endogenous reactions and the exogenous shocks.

To identify monetary policy shocks, we use a Choleski decomposition, with the variables ordered as above. Note that to identify a monetary policy shock, only the relative position of the interest rate among the other variables in the VAR matters. While it is standard in the monetary transmission literature to order output and prices before the interest rate (see Christiano et al. 1999), the inclusion of credit, property and equity prices warrants discussion. We chose to order property prices before the interest rate, under the argument that housing markets respond only gradually to changes in interest rates, but that underlying disturbances correlated with movements in the stock of housing can impact on interest rates within the quarter. In turn, this implies that credit and equity prices are ordered after the interest rate. Although central banks react to changes in credit and equity prices (because they influence aggregate demand and inflation pressures), barring exceptional circumstances one would not expect any reactions to be instantaneous but rather to occur if credit aggregates or equity prices rise or fall for some time. By imposing a triangular identification structure we thus assume that output, the price level and property prices react only with a lag to monetary policy shocks, whereas credit and equity prices may respond immediately.

We present impulse responses for boom and no-boom periods. Impulse responses from a nonlinear system are more difficult to interpret since they depend on the initial state of the economy and on the type of shock hitting the system.[35] In particular, in the analysis

[34] Like for the mean-group estimator, we compute the impulse responses based on the average of the country-specific coefficients.

[35] Another implicit assumption is that the shock hits at the moment where the credit gap equals its threshold. By having the threshold effect operating only at the time of the shock the nonlinearity of the responses is likely to be underestimated (see Koop et al. 1996).

reported below it is assumed that during the time horizon for which the response is calculated the system does not change from one state to the other.

Figure 21 shows the impulse responses of the variables in the system to a monetary policy shock during episodes of financial imbalances and “normal” times. The solid line shows the reaction to a 25 basis point increase in the short-term interest rate during periods with financial imbalances, together with the 68 percent confidence bounds (dotted lines). The long dashes are the median impulse-responses in “normal” times. The shaded area indicates the 68 percent bootstrapped confidence interval for those times.[36]

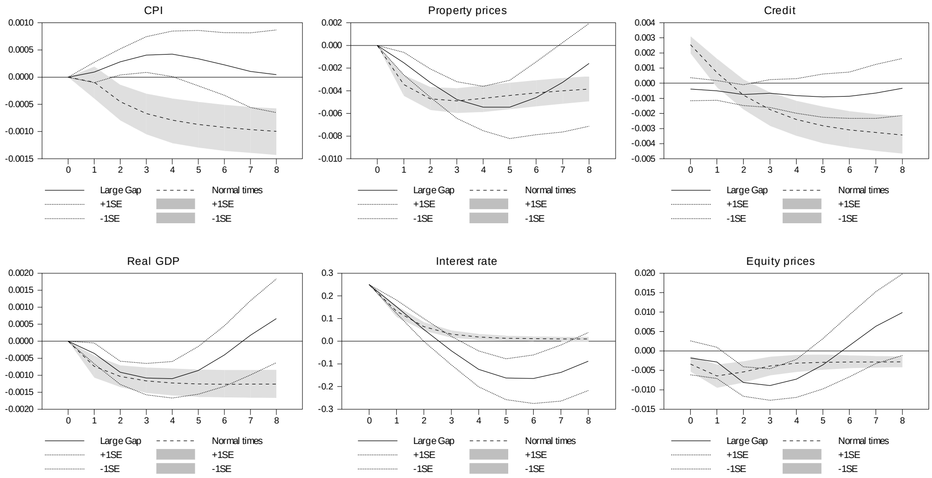

Figure 21. Impulse responses to monetary policy shock during credit booms (solid) and normal times (dashed, shaded)

We first discuss the reactions of the variables to a 25 basis point monetary policy shock in normal times. After a monetary policy shock the interest rate slowly returns to its benchmark level. The CPI and real GDP start to fall. Real credit increases on impact but then decreases after real GDP, suggesting that the decrease is demand driven. Property and equity prices decrease ahead of GDP, which is in line with the existence of a wealth effect that impacts on consumption. While property prices decrease gradually, equity prices reach their trough in the first quarter after the shock, indicating that it may be difficult to stabilize both at the same time.

Our results are comparable to the estimates of Jarocinski and Smets (2008). We find a 0.12 percent deviation of GDP and a 0.5 percent deviation of residential property prices after a year in response to a 25 basis point shock in the interest rate. The response in equity prices is slightly larger with 0.6 percent. Nevertheless, this indicates that monetary policy faces a high cost when attempting to stabilize asset prices. If the central bank tries to bring equity prices down by 10 percent (which was our definition of a financial imbalance) back to trend, this would require an increase in the interest rate by 4

[36] The bootstrap simulations have been performed drawing from two different sets of residuals. The simulated data then were reconstructed using the indicator variable. The confidence bounds are based on 1000 replications.

percent and reduce output by more than 2 percent. Of course, this may be less of a concern if the central bank responds to output consequences of a financial bubble. However, in that case the policy is no different from a standard flexible inflation targeting strategy.

We now turn to the difference between the responses in normal and boom times. First, the dynamics in boom times are less precisely estimated since they are based on a smaller number of observations. Therefore, only in few cases the differences between the normal response and the response in boom times are significant. Second, the responses in boom times are more volatile. This is true for the interest rate, which is lowered below baseline after four quarters after the monetary policy shock, which leads real GDP, equity prices and credit to return to baseline much quicker in boom periods than in normal times.

Third, while the CPI falls in response to a monetary policy shock in normal times, there is a price puzzle during boom times, suggesting that the price level is not affected or even increases when the interest rate is increased.

Fourth, while in normal times credit falls only after two quarters, in boom periods credit falls immediately. By contrast, property and equity prices reach their troughs later.

Fifth, while the trade-off between asset prices and output is slightly more favourable during boom periods than in normal times in the sense that a monetary policy shock induces a larger reaction in asset prices and a smaller reaction in GDP, the differences are insignificant.

Overall, our findings imply that monetary policy has a relative large impact on economic activity, suggesting that leaning against asset price increases may have large output costs.[37]

6. CONCLUSIONS

The present financial crisis has raised the question what role financial stability considerations should play in the setting of monetary policy. In this paper we have studied two aspects of this question.

First, we have explored whether macroeconomic measures of financial imbalances defined by the deviation of credit and property and equity prices from one-sided trends can serve as useful policy indicators. This is an important issue since it has been asserted that such measures contain information about future economic activity and inflation beyond the traditional two-year horizon used by most central banks. In particular, evidence that such financial imbalances are forming ostensibly suggests that inflation and output may be unexpectedly low some years out, as the unwinding of the bubble may lead to sharp recession.

The data we study here, which stems from 18 countries and span a twenty year period, provide little support for this hypothesis. While it cannot be excluded that this conclusion may be overturned by using indicators that have theoretical underpinnings –

[37] These reactions are symmetrical and do not depend on the fact that we are considering an cut in interest rates.

such as price-earnings ratios (or earnings-yields) for equity prices and analogue constructs for property prices – and better data, it seems to us that the information content of indicators of financial imbalances has been exaggerated, perhaps vastly so. To us, it seems more appropriate for policy to focus on making the financial system resilient to shocks rather on forecasting the unwinding of financial imbalances, which is an exercise that our empirical works suggests is exceedingly unlikely to be successful.

Second, we study the effects of monetary policy shocks on asset prices both in normal times and in bubble periods. Interestingly, we find that the notion that a monetary policy tightening will be powerless to slow asset price increases is incorrect. However, while monetary policy influences property and equity prices, it also has a large impact on real economic activity. As a consequence, tightening monetary policy to depress asset prices is likely to be costly in terms of real output foregone. Of course, if an asset price bubble is associated with an increase in economic activity, this argument is moot. But in that case, a standard flexible inflation targeting strategy, which entails responding to both deviations of inflation from target and economic activity, but not to financial developments per se, would be more appropriate.

That said, a leaning-against-the-wind policy could be thought of as an entirely new policy framework in which the central bank announces that it will react to financial imbalances and in doing so engenders stabilising expectations. If this description is correct, there are no estimates that can be used to evaluate the effects of such a policy. But since the estimates presented above suggest that a leaning-against-the-wind policy would have large costs in terms of real economic activity, it must be adopted in the firm belief that the macroeconomic effects here do *not* come to pass. That seems quite a stretch.

Overall, financial imbalances contain little information useful for forecasting future economic conditions, in particular beyond the standard 2-3 year horizon, and that reacting to them with monetary policy is likely to be associated with large output losses. The notion that an activist monetary policy strategy offers an effective way to deal with bubbles and financial imbalances seems to be a fiction poorly grounded in facts. In turn, this suggests that ensuring greater financial stability in the years ahead will require a much better regulatory and supervisory framework, which is the focus of much work at the present time.

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7. APPENDIX: DEFINITION OF THE DATA

Credit can be defined in a number of different ways depending on the type of financial assets involved and on who the borrowers and the lenders are. Since different credit aggregates potentially evolve over time in conflicting ways, it is not obvious which precise aggregate to use in the empirical work below. Somewhat surprisingly, much of the literature on credit and asset-price cycles does not consider measurement issues.[38] We therefore discuss some of these here.

Credit is the provision of financial resources by one agent to another that creates a financial claim for the lender and a liability for the debtor. Statistics as compiled, for example, by the IMF or the BIS generally focus on a narrow definition of credit that excludes holdings of shares because they differ in their characteristics from other debt instruments. While it might be interesting to consider only mortgage credit, which arguably is more closely tied than overall credit to developments in the residential real estate sector, only few countries provide the relevant data. Moreover, it is not clear that it would be the appropriate measure to use. Mortgage credit is a part of, and thus captured by data on, overall credit extension to the nonfinancial private sector. However, some movements in mortgage credit – such as secondary mortgages used to finance purchases of durable goods – are unrelated to the housing market and will reduce the information content of mortgage lending.[39] Moreover, one can imagine a situation in which non-mortgage lending plays a role in triggering an asset-price bubble, the wealth effect of which leads to an expansion of aggregate demand and therefore to greater economic activity and rising inflation.

[38] By contrast, there is an extensive literature on whether money is best measured by aggregates like M1, M2 or M3 or other indices.

[39] For instance, a second mortgage used to purchase a car is a case in point.

With respect to lenders, the IMF distinguishes between the central bank, deposit taking banks and other financial institutions. Focussing solely on the central bank as provider of credit to the economy does not seem useful since banks are the most important supplier of funds to the non-bank sector. (Analogously, it is generally found that M0 is a too narrow measure of money since it neglects money creation by banks.) A somewhat wider definition of credit would therefore combine lending from deposit-taking banks and the central bank. While this generally captures most of the lending in continental European countries, in the US, the UK, Sweden and elsewhere, non-bank financial institutions that are often not included in the banking (credit) statistics provide a significant share of financing. We therefore use the broadest definition of credit including all financial institutions in the economy.[40]

Another distinction concerns to whom credit is provided. First, we are not interested in interbank credit, that is, lending that is internal to the financial sector. Since we seek to forecast broad macroeconomic conditions (and not the likelihood of asset-price bubbles that may be driven by gross lending in the financial sector), it seems preferable to use measures of credit capturing lending to the entire non-bank, private resident sector. For the euro area countries we use credit aggregates based on national (as opposed to euro-area-wide) residency.

Residential property prices are from the data base of the Bank for International Settlements (BIS). Quarterly data over the whole sample period are available for Australia, Austria, Canada, Switzerland, Denmark, Finland, France, the Netherlands, Sweden, the UK and the US.[41] For Belgium we splice an older series for small and medium-sized houses to the residential property price series for all dwellings from 1988 on. For Spain we link the residential property prices of existing dwellings with those of owner-occupied homes in 2005. For Ireland and Norway we interpolate annual data with the Chow-Lin (1971) procedure, using a rent index and an index of residential construction cost as reference series, and link the resulting series to the BIS quarterly data that start in 1988 and 1991, respectively.[42] The same interpolation procedure is applied to annual property price data for Germany and Italy.[43] For Japan the semi-annual series on residential land prices is interpolated.[44]

Turning to the sources of the other data, the CPIs (all items) and the equity-price indices (all shares) are from the OECD Main Economic Indicators (MEI) data base. We use a three-month interbank rate for Austria, Denmark, Switzerland, Spain, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway and the UK, a three-month Treasury bill rate for Belgium, Sweden and the US, and a three-month commercial paper

[40] Nevertheless, trade credit that is extended between agents in the private non-financial sector, is not covered by this definition.
[41] For Australia and Austria, missing values for the first two quarters of 1986 were generated using the growth of residential construction cost.
[42] Annual data for Norway are from Eitrheim and Erlandsen (2004).
[43] Annual property price data for Italy are taken from Cannari et al. (2006).
[44] In Japan, a market for old homes practically does not exist as houses are normally torn down after a few decades. As a consequence, land prices determine the value of housing, see the Economist (2008).

rate for Australia, Canada and Japan.[45] All interest rates are from the OECD's MEI. For Finland and Denmark missing data for 1986 were replaced with data from the IFS (call money rate). For the euro-area countries we use the three-month EURIBOR rate after 1998. Because of a large spike in the Irish interest rate at the time of the ERM crisis in 1992 we removed this spike by regressing the series on a dummy that takes the value of unity in 1992Q4 and zero otherwise. Nominal and real GDP data were taken from the BIS data base. For Ireland annual GDP data before 1997 were interpolated with the Chow-Lin (1971) procedure using industrial production as the reference series. Except for interest rates and equity prices all data are seasonally adjusted.

The credit gap is calculated as the deviation of the log ratio of credit to nominal GDP from its HP-filtered trend. The equity price gap is the deviation of log equity prices deflated by the CPI from their HP-filtered trend. The property price gap is the deviation of log property prices deflated by the CPI from their HP trend.

For the HP filter we use λ=100000 for quarterly data which is the value that assures the same degree of smoothing as $\lambda = 1600$ for annual data. The thresholds we use for signalling large misalignments are 4 percent for the credit gap, 7.5 percent for the property-price gap and 10 percent for the equity-price gap.

[45] To eliminate a large spike during the ERM crisis we regressed the three-month interest rate for Ireland on a dummy, which is unity in 1992Q4 and zero elsewhere, and used the fitted value in the analysis.