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Asset price booms and monetary policy

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1. Introduction

Following a long bull market and the exuberance associated with the new economy boom of the 1990s, stock market indices have fallen sharply and persistently over the past two to three years. Historically, asset price crashes have often been associated with sharp declines in economic activity and financial instability. Large falls in asset prices can not only have substantial wealth effects on consumption. They also reduce collateral values, which may lead to cuts in bank lending, thereby exacerbating the fall in spending and leading to further knock-on effects on asset prices, lending and economic activity. While since the start of the new millennium many industrial countries have experienced economic slowdowns as stock prices have fallen, the current downturns have not been particularly severe and the financial sector has been quite resilient. One possible factor is that in many countries house prices have continued to rise. Nevertheless, policy makers have come under pressure for not having responded earlier to the build-up of the asset price boom, thereby possibly preventing or alleviating the subsequent bust and its effects on economic activity and inflation.[1]

In this paper we address a number of monetary policy issues associated with the occurrence of large asset price booms and busts. The paper has two objectives. First, we want to characterise the real and financial developments surrounding asset price booms. Following the recent work by Borio and Lowe (2001), Helbling and Terrones (2003), Bordo and Jeanne (2002) and

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[1] See, for example, Greenspan (2002).

Mishkin and White (2003), we identify asset price booms since the early 1970s and characterise what happens during the boom and immediately following it. We define asset price booms as a period in which aggregate real asset prices are more than 10 percent above their recursively estimated Hodrick Prescott trend. In light of the discussion above, our focus is on the behaviour of monetary policy during those booms as captured by changes in short-term interest rates and money and credit aggregates. Given that our data set ends in 2001, it is still too early to analyse the consequences of the most recent asset price booms and busts. We therefore focus our historical analysis on the 1970s and 1980s and try to investigate to what extent the characteristics of the historical asset price booms and busts correspond to the features that can be detected in the most recent asset price booms. Amongst the asset price booms in the 1970s and 1980s, we make a distinction between those booms that were followed by a large recession and those that were not and compare the features – including the monetary policy response - of the 1990s booms with those characteristics.

We find that the average length of aggregate asset price booms in the eighteen industrial countries we study has increased from 1.5 years in the 1970s and early 1980s to 3.6 years in the late 1980s and 5.1 years in the late 1990s. Their occurrence is, however, not uniform across countries. Asset price booms are typically associated with a substantial increase in the output gap and the investment and housing investment/GDP ratio relative to its trend. Moreover, these booms are supported by relatively easy monetary conditions, as captured by low interest rates relative to a Taylor rule benchmark, and abundant monetary and credit conditions as indicated by rising money and credit gaps. In contrast, on average inflation does not move very much during the boom. Overall, these features are also evident in the booms of the 1990s. Those booms of the 1970s and 1980s that were followed by a large recession and in some cases financial fragility are typically longer, give rise to significantly greater real and monetary imbalances, and, in particular, are characterised by a big boom and bust in real estate markets. In contrast to the low-cost asset price booms, the high-cost ones are also characterised by rising inflation following the boom, in spite of the large drop in output and investment.

Second, in light of this historical experience, we then review the theoretical literature on how central banks should respond to such asset price booms. Should central banks have responded earlier to the boom in order to reduce the size of the bust and its effects? Should central banks be more aggressive in responding to the downward phase than they normally would have

done? Four different strands of the literature can be distinguished. The early work of Bernanke and Gertler (2000) and Cechetti et al (2000) focused on whether it was useful to include a response to asset prices in addition to the response to an inflation forecast. Dupor (2001, 2002) analyses the trade-off that may arise between price stability and asset price stabilisation when there are frictions in the credit market and non-fundamental shocks in asset markets. Borio and Lowe (2001) and Bordo and Jeanne (2002) focus on the implications of the non-linearities that may arise as financial imbalances increase the probability of a self-fulfilling bust in collateral values and credit, possibly leading to financial fragility. Finally, a small number of papers have focused on the incentive and moral hasard effects that may arise when a central bank responds too aggressively to an asset price collapse (e.g. Caballero and Krishnamurthy, 2003; Illing, 2001; and Miller et al, 2000).

The literature review highlights that the optimal monetary policy response is not necessarily easy to characterise. As shown in Smets (1997) and Dupor (2002), the optimal response very much depends on the underlying source of the asset price increase. In particular, the direction of the policy response may be different depending on whether asset prices are driven by improved productivity or over-optimistic expectations. Given the uncertainty surrounding estimates of equilibrium values of asset prices, such an assessment of the sources of the shocks will in general not be an easy task. As discussed in Dupor (2001) and illustrated in this paper with the model of Smets and Wouters (2003), non-fundamental asset price shocks may introduce a trade off between inflation stabilisation and asset price stabilisation. However, compared to cost-push shocks, the time inconsistency problem would appear to be much less as such shocks will typically tend to move the output gap and inflation in the same direction. A characterisation of optimal monetary policy becomes even more complicated when one allows for the probability that a rise in financial imbalances may results in a financial crisis with large negative effects on economic activity and price stability. As shown in Bordo and Jeanne (2002), the optimality of a pre-emptive tightening of policy will then depend on a careful assessment of the probability of a bubble emerging and an estimate of the costs of such pre-emptive action. Our empirical results may be seen as consistent with recent findings that the build-up of large real, financial and monetary imbalances may provide a good indicator of problems to come (e.g. Borio and Lowe). However, whether a more pre-emptive tightening than historically observed would have been successful in preventing or alleviating the subsequent asset price collapse without imposing too high a cost remains a question for research. Finally, we believe more research needs to be done on the incentive and moral

hasard effects of a reactive policy approach, whereby the central bank only responds when the asset price collapse occurs. To the extent that such an approach provides implicit insurance to the private agents against large asset price collapses, it may ex ante lead to larger run-up in financial imbalances and increase the vulnerability of the private sector to asset market shocks.

1. Asset price booms and monetary policy: the stylised facts

In this section we describe the average development of real and financial indicators before during and following an aggregate asset price boom. In the following, we first lay out the methodology for identifying asset price booms. Then we analyse how on average the economy evolved before, during and following the asset price booms of the 1970s and 1980s with a focus on monetary conditions. Finally, we distinguish between those booms that were followed by a collapse in output growth and those that were not and attempt to identify the different characteristics between those two types of booms and how these characteristics compare with those of the most recent asset price increases in the 1990s.

1.1. Methodology

In order to identify asset price booms we use the BIS data set on aggregate real asset prices. In this data set an aggregate real asset price index is computed as a weighted average of real equity prices and real residential and commercial real estate prices, where the weights are based on the relative share of those assets in the private sector's wealth.[2] We define an asset price boom as a period in which the aggregate real asset price index is continuously more than 10% above its trend.[3] The trend is calculated recursively using a one-sided Hodrick-Prescott filter with a smoothing parameter of 1000. Following Borio and Lowe (2002), we use the asset price gap rather than its growth rate to define a boom. This allows us to better capture the extent of financial imbalances as it disregards periods of rapid asset price growth directly

[2] For a description of how the aggregate real asset price index is constructed, see Borio, Kennedy and Prowse (1994) and Borio and Lowe (2001).

[3] Many thanks to Steve Arthur and Claudio Borio from the BIS for providing us their data set.

following an asset price collapse. It also allows for sustained periods of asset price growth only slightly above trend to generate a boom as imbalances can accumulate. Borio and Lowe (2002) have shown that such gap measures (in particular applied to credit) are relatively better predictors of financial instability. One consequence of this definition is that different asset price booms can be of different length. In order to be able to compare financial and economic developments in different asset price booms, we therefore either calculate the average growth rate during the boom or in case of level variables the change during the boom. The pre-boom period is defined as the year before the asset price boom, while the post-boom period is defined as the two years following the boom.[4]

Table A in the appendix lists each of the 37 aggregate asset price booms that we identify in this way. Figure A in the appendix plots the aggregate asset price index and indicates the asset price boom periods as shaded areas. We find boom episodes in every country, although they are not equally spread over each of the 18 countries considered. It is interesting to note that less than five boom years are found in the three largest countries of the euro area (Germany, France and Italy) and Belgium and Canada. In contrast more than eight boom years spread over two or three successive periods are detected in Finland, Ireland, the Netherlands, Norway, Sweden and the United Kingdom. Over the whole sample, the average length of the asset price booms is somewhat greater than three years. This hides, however, a lot of variation across asset price booms. The longest successive boom period identified in this data set lasts for nine years. It is the asset price boom in Finland from 1981 till 1989. In addition, there are five additional successive boom periods lasting for 6 years or longer (Spain: 1986-91; Ireland: 1995-2001; the Netherlands: 1994-2001; Norway: 1996:2001; New Zealand: 1982-87). There is a tendency of the asset price booms to become longer. The average length increases from 1.5 years in the 1970s and early 1980s to 3.6 years in the late 1980s and 5.1 years in the late 1990s. However, most of the boom episodes took place in the second half of the 1980s (17 compared to 10 in the 1970s and 9 in the 1990s). In this context, it is worth noting that one factor which may have contributed to the larger number of asset price booms in the 1980s is the financial deregulation that took place mostly around that period.

[4] As a robustness check we also plan to redo this exercise using fixed windows to define asset price booms, as in the literature on the effects of fiscal consolidations (Giavazzi and Pagano, 199?). The main advantage of this is that it is easier to compare booms across countries. Of course, doing so risks distorting the picture if several boom episodes belong to the same boom period.

Figure A in the appendix shows the aggregate asset price index together with two of its components (equity prices and residential real estate prices). While in a number of countries real estate prices and equity prices move very much in tandem (e.g. United States, Sweden, United Kingdom), in other countries the correlation appears quite low (e.g. Germany). This partly explains why in the late 1990s no aggregate asset price booms are detected in the latter countries in spite of large equity price booms. Equity prices are typically much more volatile than real estate prices. Another stylised fact is that real estate prices typically lag equity prices (Borio and Lowe, 2002). Both features are a reflection of the fact that transaction costs in equity markets are much lower than in real estate markets, so that real estate prices typically only respond sluggishly to changing economic conditions.[5]

2.2. Economic and financial developments during asset price booms

In order to characterise the typical behaviour of the economy around asset price booms, Table 1 computes the average growth rate or the change over the boom period of various economic indicators, as well as the average in the year before the boom and in the two years following the boom. Because we do not have data yet regarding the post-boom period in the late 1990s, we perform this exercise excluding the nine late-1990s asset price booms.

The upper part of Table 1 shows that real aggregate asset prices rise on average by 11 percent during the boom and fall quite significantly after the boom by 6.4 percent. The growth rate of asset prices is, however, also high in the year before the boom (8.5 percent). Turning to the equity price and real estate price components, it is clear that equity prices rise even stronger the year before the boom (by 15 percent), while house prices mostly pick up during the boom (by 10.2 percent on average per year). This confirms the behaviour observed in the time series plots discussed above that equity prices usually lead house prices by one or two years. The average drop in both equity and house prices is quite considerable in the two years following the boom. Somewhat surprisingly, the collapse in asset prices following the boom is not

[5] See, for example, Peersman and Smets (2003) who investigate the response of equity and real estate prices to a monetary policy shock.

reflected in a depreciation of the real exchange rate. So, on average the collapse of asset price booms in our sample does not coincide with an exchange rate crisis.

The second panel of Table 1 describes developments in output and its components around asset price booms. The behaviour of average real GDP growth mirrors the behaviour of the asset prices: growth is high during and one year before the boom (4 percent per annum) and drops to 0.7 percent after the boom. Consistent with other evidence the growth of consumption is somewhat less volatile, while the growth of total and housing investment is much more volatile. The output gap, which analogously with the asset price gap used to define the booms is modelled as the log deviation of real GDP from a recursively estimated Hodrick Prescott filtered trend, increases by 2 percentage points during the boom. While the consumption/GDP ratio remains more or less constant during the boom, both the total investment and housing investment/GDP ratio rise quite considerably above their trend during the boom (+3.6 and + 4.4 percentage points respectively). As a result there appears to be a considerable overhang in the investment and housing investment ratio (7.2 and 8.9 percentage points respectively). The drop in those ratios two years following the boom is even more remarkable (-9.6 and –10.3 percentage points respectively), suggesting an asymmetric behaviour of investment around asset price booms and busts. This provides some back-up for the financial accelerator theories as discussed in Kocherlakota (2000).

Turning to the behaviour of inflation and interest rates, it is clear that on average inflation is not much affected. It remains roughly constant around its initial average level of 6.8 percent. At first sight, this seems to confirm the observation by Borio and Lowe (2002) that inflation by itself is not a very good indicator of financial imbalances. Nominal and real interest rates rise quite considerably during the boom (by about 1.5 percentage points), but as shown by the Taylor rule calculations, this rise is not enough to keep the monetary policy stance in line with the rising output gap and the higher equilibrium real rate. Nominal interest rates fall short of the Taylor rule benchmark by about 1 percentage point.[6] The relatively loose monetary policy stance is confirmed by the behaviour of money and credit aggregates around asset price booms (the bottom panel of Table 1). In line with the growth in asset prices and economic

[6] The Taylor benchmark is calculated using a coefficient of 1.5 on the deviation of inflation from the inflation objective and 0.5 on the output gap. The inflation objective, the equilibrium real interest rate and potential output are all calculated using a recursively estimated, one-sided Hodrick-Prescott filter.

activity, real credit and money growth are quite strong before and during the boom, but drop considerably in the two years following the boom. In order to measure the degree of credit and money overhang, the two last rows of Table 1 report the deviation of the credit/GDP ratio and the money/GDP ratio from their respective recursively estimated HP filtered trends. The money overhang rises from 1.8 percent in the pre-boom year to 3.2 percent at the end of the boom. A similar pattern can be observed in the development of the credit gap. As discussed in Borio and Lowe (2001), such a credit gap has relatively good predictive power for subsequent financial crises. Together with the evidence on interest rates, this suggests that monetary conditions are on average relatively loose during asset price booms.

2.3. Recessions and asset price collapses

Overall, the stylised facts described in Section 2.2 are consistent with a credit/collateral driven asset price boom and bust cycle. In such a cycle loose monetary conditions contribute to high money and credit growth, which stimulates spending, leads to an increase in asset prices and collateral values, which in turn results in even looser financing conditions, higher lending, growth, etc. This virtuous cycle is then reversed when asset prices drop. The sharpness of the resulting contraction in asset prices and economic activity suggests that the financial accelerator mechanism is indeed at work. Consistent with observations by Borio, English and Filardo (2003), on average inflation does not increase during the boom, suggesting that by itself it is a poor indicator of the asset price boom reversal to come. In contrast, various recursively estimated gap measures that attempt to estimate the degree or real and financial imbalances, such as the money, credit and investment overhang, do increase quite substantially during the boom. Of course, the evidence is only suggestive. In particular, there has been no attempt to distinguish this story from one in which those patterns are the outcome of underlying business cycle shocks.

In order to sharpen the picture somewhat, in this section we compare the asset price booms that were followed by a sharp recession with those that were succeeded by a relatively mild slowdown in growth. From a policy perspective, it is important to know what are the characteristics of asset price booms that eventually are likely to result in a severe collapse in output. From an academic perspective, it is important to see whether high-cost booms are characterised by features that suggest the working of a collateral/balance sheet channel. In

this section, we distinguish between high-cost and low-cost asset price booms. High cost booms are those booms that were followed by a drop of more than 2.8 percent in average real growth (comparing the two years following the boom with the average growth during the boom). The cut-off point was chosen such that most of the asset price booms in the 1980s that resulted in a banking crisis are classified as high-cost asset price booms.[7] The only exception is Australia, where the boom of 1988-90 is classified as low-cost.[8] Table A in the appendix shows that there are 16 high-cost and 12 low-cost asset price booms. The average length of the high-cost booms is one year greater (3.5) than that of the low-cost booms (2.5). This suggests that the longer the asset price boom lasts, the more financial imbalances build up and the more severe the following collapse.

Table 2 compares the economic developments in high and low-cost asset price booms. First, it is clear that the average growth rate of aggregate asset prices during the boom is about the same in high-cost and low-cost booms, although the total increase is larger in high-cost booms because they last one year longer on average. What is different is the composition in equity price and real estate price increases. In the high-cost booms real house prices on average rise at a faster rate (about 11 percent) than equity prices, while the reverse is the case in low-cost booms.[9] The high cost of the asset price collapse appears in the first place to be associated with the greater collapse in house prices, as equity prices drop by about the same amount. There does not appear to be a significant difference in the behaviour of the real exchange rate across the two types of asset price booms.

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[7] The index of banking crises is taken from Bordo, Eichengreen, Klingebiel and Martinez-Peria (2001). The banking crises included are Australia (1989), Denmark (1987), Finland (1991), Japan (1992), Norway (1987), New Zealand (1987), Sweden (1991). There are also a number of episodes with banking problems identified in Bordo et al (2001) which were not preceded by asset price booms as we have defined them: Germany (1977), France (1994), United States (1984).

[8] This appears to be partly due to the fact that 1990 is classified as a boom year, whereas in fact real estate prices and, particularly, equity prices already fell quite considerably in that year. The banking crisis is dated 1989, i.e. in the midth of our three year boom period. It turns out that a large part of the adjustment process happened during the boom so that our relative measure of growth differences comparing post boom growth with boom growth showed a relatively benign reduction.

[9] Equity prices grow much more in the year before the boom starts for high-cost booms, which confirms the leading property of equity markets. The fact that average boom growth is lower for high-cost booms could also hint at some anticipation of problems to come.

Turning to real developments, it is not surprising that the growth rates before and during the high-cost asset price booms are greater than those in the low-cost booms. By assumption, the main difference is, however, that real GDP growth rates in the high-cost booms are negative in the post-boom period, while they remain relatively high and positive in the low-cost booms. More interesting is the large increase in housing investment before and during the high-cost booms. Consistent with the large fall in house prices, it is also this component of aggregate demand that drops fastest in the post-boom period. These observations are confirmed by the behaviour of the output gap and the consumption and investment ratios. During high-cost booms the output gap rises by 3 percent (compared to 0.6 percent in low-cost booms), whereas the investment/GDP ratios increase by more than 5 percent (1 percent for low-cost booms). The most visible difference between high- and low-cost booms is the nearly 16 percentage points drop of the housing investment ration relative to its trend (compared to only 3 percentage points following the low-cost booms). In contrast, the changes in the consumption/GDP ratio are more similar during high and low-cost booms (about +1 percent during the boom).

Another difference between high and low-cost booms is the behaviour of inflation. During high-cost booms the inflation rate rises slightly during the boom and much more after the boom (in total by about 1.5 percentage point). In contrast, inflation falls by about –1.30 percentage points in the low-cost booms. The combination of a smaller rise in the output gap and a fall in inflation may suggest that positive supply factors are more dominant behind the asset price developments in low-cost booms. In response to the rise in inflation during high-cost booms, real and nominal interest rates rise by about 1.60 percentage points. According to a standard Taylor rule this is, however, not enough to keep the monetary policy stance from implicitly easing. The looser monetary conditions during the high-cost booms are also captured in the higher real money and credit growth rates and the sharper rise in the money and credit overhang.

Overall, the picture is consistent with the stories that assign a large role to the interaction between asset prices, collateral values, credit and economic activity (e.g. Kiyotaki and Moore, 1997). Those asset price booms that lead to larger financial imbalances as captured by money and credit gaps and larger asset price increases, but contain the seeds of a subsequent collapse. As financial imbalances increase, the risks of a collapse also increases. As real estate is the primary asset used for collateral, it is mainly the rise and fall in real estate prices and the

associated investment that contributes to the rise and fall in output gaps. While inflation does not respond very much during the boom, there is a clear difference between high and low cost booms in the two years following the boom. This suggests that there would not necessarily have been a conflict between a more pronounced pre-emptive tightening during the high-cost booms and the maintenance of price stability over the medium term. The results do not reject the view that the various real and monetary gaps could have been used as indicators suggesting such a pre-emptive tightening.

2.4. Are the 1990s different from the 1980s?

As discussed in Section 2.2, we identified nine aggregate asset price booms in the late 1990s (Australia, Denmark, Finland, Ireland, the Netherlands, Norway, Sweden, the United States and the United Kingdom). As in many cases it is still a bit early to evaluate the effects of the recent downturn of asset prices, it is interesting to compare the features of those asset price booms with those of the 1970s and 1980s. The right-hand panel of Table 2 gives the main economic developments during the late 1990s booms. It is remarkable how similar the average growth rate of aggregate asset prices has been in the 1990s compared to the 1970s and 1980s. The average length of the asset price booms is, however, considerably longer as mentioned above. Regarding the decomposition in equity and house prices, it appears that in the 1990s the strongest growth took place in equity markets. In contrast, house prices rose less dramatically, one of the features also seen in the low-cost asset price booms of the 1970s and 1980s.

Also the real GDP growth rates have been quite similar in the asset price booms of the 1990s, although the increase in housing investment has been relatively more subdued. However, the housing investment/GDP ratio appears to have increased quite dramatically during the booms of the 1990s (by 10.25 percentage points), be it from a relatively low level.

Turning to monetary conditions, in contrast to the 1980s nominal and real interest rates have actually fallen during the booms of the 1990s, which also in the light of the strong rise in the output gap has contributed to a considerable easing of the monetary policy stance. Somewhat surprisingly, the easier monetary conditions are not so much reflected in our measures of

money and credit overhang which remain negative in spite of relatively strong real money and credit growth.

Overall, many features of the 1990s booms are similar to those observed in the 1980s. It appears as if asset price characteristics of the nineties resemble previous low-cost booms, while changes in the stance of monetary policy (i.e. deviations from Taylor rule, credit and money growth, as well as the change in the credit ratio) look worryingly similar to previous high-cost booms. (the reduction of the money overhang would remain a puzzle, as far as it could not be explained by a fall in the rate of change of trend velocity in the 90s

3. The optimal policy response to asset price booms and busts

The previous section has shown that historically interest rates do not appear to have responded very strongly to asset price booms. In this section, we review some of the academic literature on the optimal response to asset prices in the light of these stylised facts. In the first subsection we discuss the role of non-fundamental asset price shocks in creating a trade-off between inflation and output gap and asset price stabilisation. This follows work by Dupor (2001, 2002). In the second section, we discuss the implications of the asymmetric effects of an asset price collapse as highlighted by Kiyotaki and Moore (1997) and Kocherlakota (2000). The implications of such asymmetric effects have been examined in a simple three-period model by Bordo and Jeanne (2002).[10] Finally, in the last section we briefly emphasise the moral hasard problems that may arise when central banks are perceived to respond aggressively to an asset price collapse. As indicated by Miller et al (2000) and Illing (2001) this may lead to a put option on asset prices and may exacerbate the development of financial imbalances in the run-up.

3.1. Asset prices and the inflation/output gap stabilisation trade-off

A number of authors (e.g. Bernanke and Gertler, 2000; Cecchetti et al, 2001 and Gilchrist and Leahy, 2001) have examined to what extent central banks should respond to asset prices in

[10] An early discussion can be found in Kent and Lowe (1998).

addition to their optimal response to an inflation forecast. Bernanke and Gertler (2000) and Gilchrist and Leahy (2001) come to the conclusion that not much is to be gained from responding to asset prices in addition to the implicit response that comes through the effect of asset prices on the inflation forecast. In contrast, Cecchetti et al (2001) do find an additional positive effect on inflation and output gap stabilisation and relate this to the fact that asset prices may have implications for price stability at a different horizon from that in a typical inflation forecast. The notion that the relevant policy horizon may be different for asset price and credit market shocks is also acknowledged in recent speeches by monetary policy makers (e.g. Issing, 2003 and Bean, 2003).[11]

Two additional remarks are worth making in this respect. First, as pointed out by Smets (1997), how monetary policy makers respond to observed asset price movements with the aim of maintaining price stability will very much depend on the source of the asset price movements. For example, when equity prices rise because of a permanent rise in total factor productivity, then monetary policy may want to accommodate the boom by keeping the real interest rate unchanged. In contrast, when equity prices rise because of non-fundamental shocks in the equity market (e.g. over-optimistic expectations about future productivity), then the optimal policy will be to respond by raising interest rates.

Secondly, as emphasised by Dupor (2001, 2002), frictions in credit markets will generally create a trade-off between stabilising inflation and stabilising asset prices. Stabilising inflation is optimal from the perspective of reducing the misallocation of resources across various goods-producing sectors and alleviating resulting distortions in the consumption – leisure trade-off. In the presence of non-fundamental asset price shocks, stabilising asset prices is optimal because it reduces distortions on the investment margin. However, with only one instrument, the short-term interest rate, the central bank can not achieve both targets at the same time. Stabilising asset prices will lead to a rise in interest rates, a fall in consumption, an increase in labour supply and a fall in inflation.

In order to illustrate both points, Figures 1 and 2 plot the impulse responses to respectively a temporary positive productivity shock and a non-fundamental positive shock to equity prices in a DSGE model with sticky prices and wages estimated on euro area data by Smets and

[11] See also Brousseau and Detken (2001).

Wouters (2003). The estimated parameters are taken from Smets and Wouters (2003). In this model, investment is a function of the value of capital (equity prices) due to the presence of investment adjustment costs. Each figure plots three impulse responses corresponding to three alternative monetary policies. The dotted lines correspond to the responses under the estimated reaction function, which takes the form of a modified Taylor rule that includes the output gap and deviations of inflation from a target.[12] The solid line corresponds to the responses under an optimal simple first-difference Taylor rule. The optimised coefficients on the output gap is 0.15, while the one on inflation is 0.5. Finally, the line with triangles corresponds to the optimal policy reaction when the central bank is able to commit. In the latter cases, the loss function of the central bank is assumed to be a weighted average of deviations of inflation from an inflation target and the output gap, defined as the difference between actual output and the efficient flexible price level of output with equal weights.

Figures 1 and 2 show that in response to both shocks output, investment and equity prices rise. However, the optimal monetary policy response is quite different in both cases. In the presence of a positive productivity shock, both nominal and real interest rates fall (monetary policy is eased) in order to avoid an output gap opening up. It is clear that the more aggressive easing under the optimal policies succeeds in significantly closing the output gap and reducing the degree of disinflation. Compared to the actual historically estimated monetary policy response, the optimal policy response under the assumed loss function would boost equity prices. In contrast, the optimal response to a non-fundamental shock to equity prices is quite different. In this case, both nominal and real interest rates increase. Instead of a negative output gap, a positive output gap arises. Again, under the assumed loss function the optimal policy under commitment is much more aggressive than the estimated reaction function. The optimal policy succeeds in closing the incipient positive output gap by raising interest rates aggressively and persistently. However, as pointed out by Dupor (2001), there is a cost in the sense that the burden of adjustment falls mainly on consumption, and inflation actually falls under the optimal policy. It is this trade-off which may make it costly to lean too agressively against the non-fundamental asset price boom and its stimulative effect on investment.

Finally, it is interesting to note that the simple first-difference Taylor rule is able to mimick the much more complicated optimal reaction function under commitment. The differences are

[12] See Smets and Wouters (2003) for the parameter estimates.

only minor. This suggests that at least in this model without non-linearities or widely different lags in the various transmission channels there is no need for an explicit response to asset prices. However, it is the case that an increase in the variance of the equity price shocks will have an effect on the relative weight of inflation and the output gap. Everything else equal a higher variance of equity price shocks will increase the relative reaction coefficient to the output gap [to check].

While non-fundamental equity price shocks may generally create an incentive to deviate from the sole pursuit of price stability, there are a number of factors that should be taken into account before putting this recommendation in practice. First, the central bank may not be able to commit to its future policies. As in the presence of cost-push shocks, a conservative central banker who puts relatively more weight on inflation stabilisation may in that case be able to obtain a better outcome. Second, in the exercise pursued above, we have assumed that the central bank can perfectly distinguish between both shocks in spite of the fact that they give rise to a similar positive response to output, investment and equity prices. In practice, central banks have a difficult time distinguishing fundamental from non-fundamental sources of asset price movements. Estimates of the equilibrium value of asset prices are surrounded by a high degree of uncertainty. In such circumstances, the central bank will face a signal extraction problem and may only gradually learn which shock has actually hit the economy. As in the case of potential output uncertainty (e.g. Ehrmann and Smets, 2002), this may again limit the ability of central banks to stabilise asset prices around the appropriate level and argue for a reduced weight on asset price stabilisation.[13] The example studied in the section also abstracts from the fact that most asset price bubbles build on good fundamentals. As was clear in the asset price booms of the late 1990s, the rise in equity prices due to positive productivity developments was amplified by over-optimistic expectations which led to a further rise in asset prices, easier financing conditions and more buoyant investment and economic activity. As shown by Jermann and Quadrini (2003), such optimism may also lead to higher measured productivity growth as smaller, but high-growth firms find it easier to enter the market.

[13] Dupor (2002) analyses both the discretionary case and the case of imperfect information in a similar model to the one used in this Section.

3.2 Asymmetric effects of asset price collapses and monetary policy

While a part of the literature on optimal monetary policy has focused on how to respond to asset prices in linearised models, the more interesting question is how monetary policy should deal with the possibility of a build-up of financial imbalances typical of asset price booms. Indeed, as argued in Borio and Lowe (2000) and Borio, English and Filardo (2003) the question is not so much whether central banks should prick asset price bubbles, but whether they should lean against the build-up of financial imbalances which may later unwind at a much larger cost.

The basic mechanism of how asset price collapses may have disproportionate effects on lending and economic activity when agents are highly leveraged is well understood and has recently been formalised by Kiyotaki and Moore (1997) and Kocherlakota (2000) amongst others. The latter shows that in the face of credit constraints that depend on the value of collateral, a shock to income may be amplified, prolonged and have asymmetric effects in the sense that a negative shock has larger effects than a positive one. Such effects presumably also take place in the non-linearised version of the financial accelerator model of Bernanke, Gertler and Gilchrist (2000). An alternative mechanism is through the resulting fragility of the banking sector. Indeed many of the largest asset price booms and busts observed in the 1980s have been accompanied by a banking crisis. In such cases, a rise in non-performing loans leads to a contraction of the supply of bank lending which may in turn exacerbate the economic crisis and lead to failures of banks, further increasing the fragility of the banking sector.

Bordo and Jeanne (2002) propose a stylised model to investigate the optimal response of monetary policy to asset price booms when this risks leading to large collapses in lending and economic activity. Bordo and Jeanne (2002) distinguish between two monetary policy approaches: a reactive and a pro-active approach. Under the reactive approach, monetary authorities wait and see whether the asset price collapse occurs and, if it does, respond accordingly. Under the pro-active approach, the monetary authorities may attempt to contain the rise in asset prices and domestic credit in the boom phase in the hope of mitigating the consequences of a bust, if it occurs. Central bankers appear to be divided between both approaches. Defending his track record in the face of the recent collapse in stock prices,

Greenspan (2002) made a case for the first approach. He argued that, first, it would be very difficult to identify a clear overvaluation of asset prices with the risk of a subsequent bust much in advance. Second, when such risks are more clearly identified, policy action would often come too late and would have to be so large that it would trigger the asset price bust. In contrast, Borio and Lowe (2002) and Borio, English and Filardo (2003) have argued for a more pro-active and pre-emptive approach, whereby central banks would pursue a tighter policy to reduce the build-up of debt and the associated vulnerabilities, even if this implies lower inflation than would otherwise have been desirable.[14]

In a stylised model in which the likelihood and the severity of a possible financial crisis depends on the build-up of debt, Bordo and Jeanne (2002) find that the optimal monetary policy depends on the economic conditions, including the private sector's beliefs, in a rather complex way. Basically, they find that a proactive approach is optimal when the risk of a bust is large and the monetary authorities can defuse it at a relatively low cost. However, they also find that there is tension between these two conditions. As investors become more exuberant, the risks associated with a reversal in market sentiment increase. At the same time, leaning against the wind of investors' optimism requires more radical and costly monetary actions. Overall, the various linkages between asset prices, financial stability and monetary policy are complex because they are inherently non-linear and involve extreme (tail probability) events. This implies that simple monetary policy rules may not be appropriate as a guide for monetary policy in such circumstances. Instead, monetary authorities must take a stance on the probability of such events and evaluate to what extent their actions may reduce this probability.

As emphasised by Borio and Lowe (2002) and Borio, English and Filardo (2002), one crucial factor in coming to such an assessment is whether during asset price booms financial and real imbalances are building up. Central bankers are often sceptic about whether they are able to identify asset price bubbles that may lead to sudden reversals and financial instability.[15] Large asset price booms may be one indicator of the build-up of such imbalances, but as indicated in Section 2 above they are not sufficient. However, those asset price booms that resulted in a

[14] See also Crockett (2001).

[15] See, for example, Greenspan (2002) and Goodfriend (1998). See also Bean (2003) for a discussion of the recent experience at the Bank of England with how to respond to the rise in house prices.

costly subsequent adjustment usually are accompanied by an increase in the money and credit overhang and a strong rise in real estate investment and house prices. Indeed, Borio and Lowe (2002) find that a measure of credit overhang works relatively well in predicting financial crises. As discussed in ECB (2003) and Issing (2002), the evidence that money and credit indicators may, in certain circumstances, provide useful early information for the development of financial instability, is one of the reasons for assigning a prominent role to monetary analysis in the ECB's monetary policy strategy.

A second important factor is whether monetary policy actions will be able to affect the ex-ante build-up of such imbalances without creating disinflation and a costly recession. Here the evidence that was presented is less informative, because we may not have identified those episodes in which a strong response of monetary policy may have prevented large asset price booms and a subsequent costly collapse. However, the evidence of Section 2.3 did suggest that the high-cost asset price booms of the 1980s were characterised by a relatively loose monetary policy stance and a tendency for inflation to start rising. This suggests that a more pre-emptive policy tightening may have been appropriate.Whether it would have been successful in reducing the run-up of asset prices and debt and thereby in preventing or alleviating the subsequent collapse, is difficult to assess.

3.2 The reactive approach and incentive effects

Finally, it is important to recall that the emergence of asset price booms and busts is partially endogenous to the monetary policy regime. In the literature on how to respond to asset prices discussed above, it is often forgotten that a strong response ex-post may have ex-ante consequences on the likelihood and strength of the asset price boom and the build-up of financial imbalances. There are a number of papers that have explicitly or implicitly addressed this issue. Miller et al (2001) discuss the emergence of a so-called "Greenspan put". They argue that the recent stock market bubbles could have been less due to simple irrational exuberance but more due to an exaggerated faith in the share price stabilising powers of the US Fed. Within the framework of Allen and Gale's (2000) risk shifting model Illing (2000) also assumes an asymmetric reaction function of the central bank in the sense that it would supply liquidity in a crisis but be hesitant to withdraw it after the banking panic is successfully avoided. Higher inflation is necessary to prevent the banking panic as inflation

reduces the real value of deposits. After a bad signal about the expected return of the risky asset has been received, the central bank reduces the real value of deposits so that the latter equals the early liquidation value of the risky asset, which obliterates the incentive for a bank run. It is shown how this asymmetric behaviour of the central bank ex-ante creates a bubble in asset prices and thus increases financial fragility, even without any of the standard "ingredients" like irrational exuberance, an agency problem or uncertainty about the future supply of credit.[16]

Bean (2002) builds a model in which firms need to decide how much to invest one period in advance taking into account the probability that there may be a financial crisis which will lead to a loss in productivity of their investment. The paper shows that under commitment the central bank may want to act more agressively against inflation compared to a situation where there is no credit crunch possible, because this will reduce its ex-post response in mitigating the effects of the financial crisis and thereby lead to less over-investment ex ante by firms. Considering the possibility of a credit crunch leads to less gradualist policy when moving from discretion to commitment. Expectations of future output gaps are still useful in returning inflation to target, but do also encourage overinvestment and thus increase the costs of a financial crisis. [17] Finally, in the context of a model of a currency crisis, Caballero and Krishnamurthy (2002) discuss the optimal inflation targeting policy in a two-period model. They show that given the possibility of sudden-stop events, in which foreign funds are not anymore available to finance domestic investment, the optimal monetary policy would be expansionary. It thus should not try to stabilise the exchange rate. The reason is incentive related. The private sector would simply not take out sufficient insurance against exchange rate depreciations, in case the central bank would be known to tighten monetary policy in times of exchange rate crises.

The pictures of the development of asset prices shown in the appendix give the idea of a clear boom and bust pattern that is reminiscent of the typical stop and go policies of the 1960s and 1970s. Clearly, the emergence of such boom-bust patterns will be endogenous to the monetary

[16] It should be noted that Illing (2000) argues that the asset price bubble created by moral hasard is small, so that the optimal monetary policy would still be to stabilise the banking sector.

[17] One should add that Bean himself noted that this result is unlikely to be robust as he assumed that a change in today's interest rates has no direct effect on the level of borrowing in the economy.

policy regime. One of the important policy issues that need to be resolved is whether a monetary policy focused on price stability will be sufficient to reduce the boom and bust features of asset markets seen in many industrial countries.

4. Conclusions

(to be completed)

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Table 1:

Financial and real developments during aggregate asset price booms in the 1970s and 1980s

	Pre-boom year	Boom period	Post-boom period
Avg length	-	2.8 years	-
AvgΔ aggregate asset prices	8.5	11.2	-6.4
AvgΔ equity prices	15.4	9.9	-9.7
AvgΔ real estate prices	4.7	10.3	-4.1
AvgΔ real exchange rate	7.6	9.0	8.1
AvgΔ real GDP	4.1	4.0	0.7
AvgΔ real consumption	3.7	4.3	0.8
AvgΔ investment	6.2	7.5	-3.9
AvgΔ housing investment	8.6	6.6	-5.0
Output gap	1.0	3.0 (2.0)	-0.8 (-3.8)
Consumption/GDP	-0.6	0.3 (0.9)	0.5 (0.2)
Investment/GDP	3.5	7.2 (3.6)	-2.6 (-9.7)
Housing investment/GDP	4.4	8.9 (4.4)	-1.4 (-10.3)
AvgΔ CPI	6.8	6.8	7.2
Nominal interest rate	9.3	10.7 (1.4)	11.1 (0.4)
Real interest rate	2.4	4.1 (1.7)	4.2 (0.1)
Deviation from Taylor rule	-0.4	-1.0 (-0.5)	-1.1 (-0.1)
AvgΔ real credit growth	8.2	8.5	2.6
AvgΔ real money growth	5.7	5.2	0.6
Domestic credit/GDP	0.5	2.3 (1.8)	1.0 (-1.3)
Money/GDP	1.8	3.2 (1.5)	2.3 (-0.9)

Notes: AvgΔ refers to the average annual growth rate during the period. The other entries refer to levels at the end of the period. In this case the number between brackets reflects the change in the level over the period.

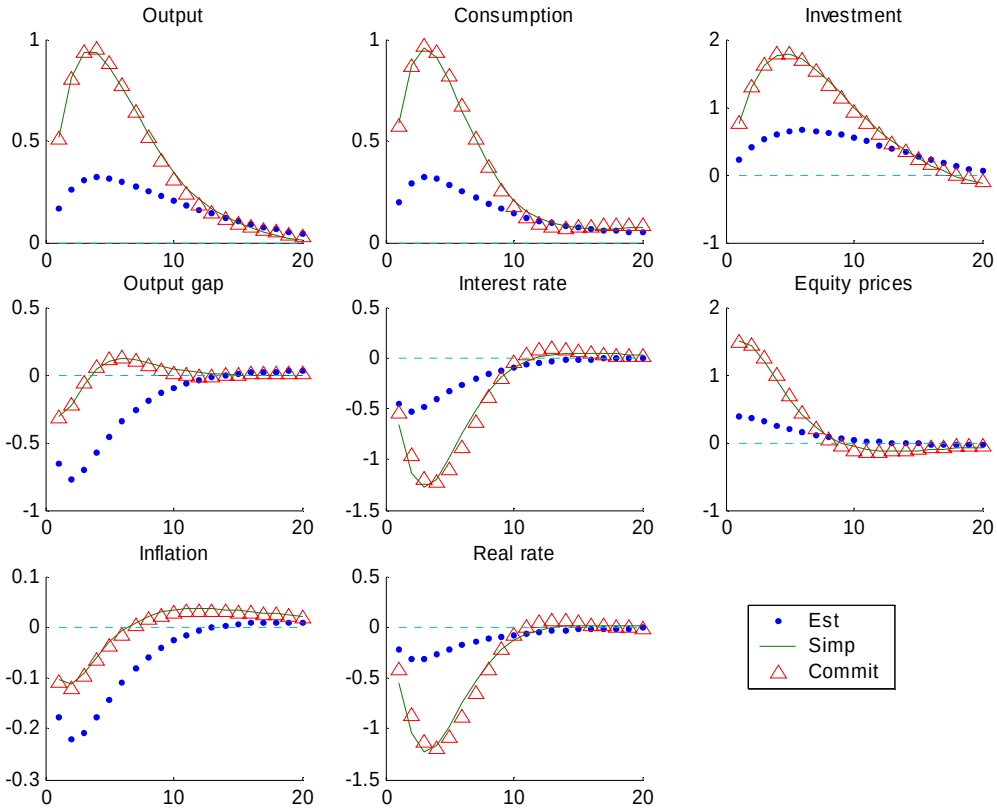
Table 2:

Financial and real developments during aggregate asset price booms (1970-2001)

	High and low-cost asset price booms: 1970s and 1980s			Asset price booms in the 1990s	
	Pre-boom H / L	Boom H / L	Post-boom H / L	Pre-boom	Boom
Avg length	-	3.25 / 2.25	-	-	5.1
AvgΔ agg. asset prices	10.0 / 6.6	10.9 / 11.8	-8.9 / -3.2	8.9	11.5
AvgΔ equity prices	21.9 / 6.8	7.4 / 13.3	-10.7 / -8.4	10.4	19.6
AvgΔ real estate prices	4.4 / 5.1	11.4 / 8.8	-6.9 / -0.5	3.8	7.4
AvgΔ real exchange rate	8.3 / 6.7	10.5 / 7.0	9.5 / 6.2	4.3	2.8
AvgΔ real GDP	4.0 / 4.1	4.6 / 3.2	-0.2 / 2.5	3.6	4.0
AvgΔ real consumption	3.9 / 3.4	5.0 / 3.4	0.0 / 2.0	3.1	3.8
AvgΔ investment	6.9 / 5.4	8.2 / 6.7	-7.0 / 0.2	6.7	6.3
AvgΔ housing investm.	11.1 / 5.4	7.3 / 5.6	-8.8 / 0.1	3.7	4.2
Output gap	0.7 / 1.3	3.8 / 1.9	-1.9 / 0.7	2.1	4.6
Consumption/GDP	-0.7 / -0.6	0.3 / 0.2	0.9 / 0.0	-0.3	0.3
Investment/GDP	2.8 / 4.4	8.5 / 5.4	-4.8 / 0.3	1.1	4.3
Housing/GDP	4.0 / 5.0	9.8 / 7.7	-6.0 / 4.6	-2.6	7.6
AvgΔ CPI	6.9 / 6.8	7.2 / 6.3	8.5 / 5.5	2.2	2.3
Nominal interest rate	9.32 / 9.3	10.9 / 10.4	11.6 / 10.5	5.8	4.9
Real interest rate	2.3 / 2.5	4.0 / 4.2	3.4 / 5.1	3.7	2.6
Dev. From Taylor rule	0.5 / -1.6	-0.8 / -1.2	-1.3 / -0.7	-4.0	-4.7
AvgΔ real credit growth	8.3 / 8.0	9.5 / 7.1	2.1 / 3.2	4.5	8.9
AvgΔ real money growth	6.0 / 5.4	6.1 / 4.3	-0.5 / 1.8	3.3	5.3
Domestic credit/GDP	-0.1 / 1.3	2.6 / 1.8	1.6 / 0.0	-7.8	-5.5
Money/GDP	0.8 / 2.8	3.1 / 3.3	2.6 / 2.0	1.1	-2.4

Figure 1

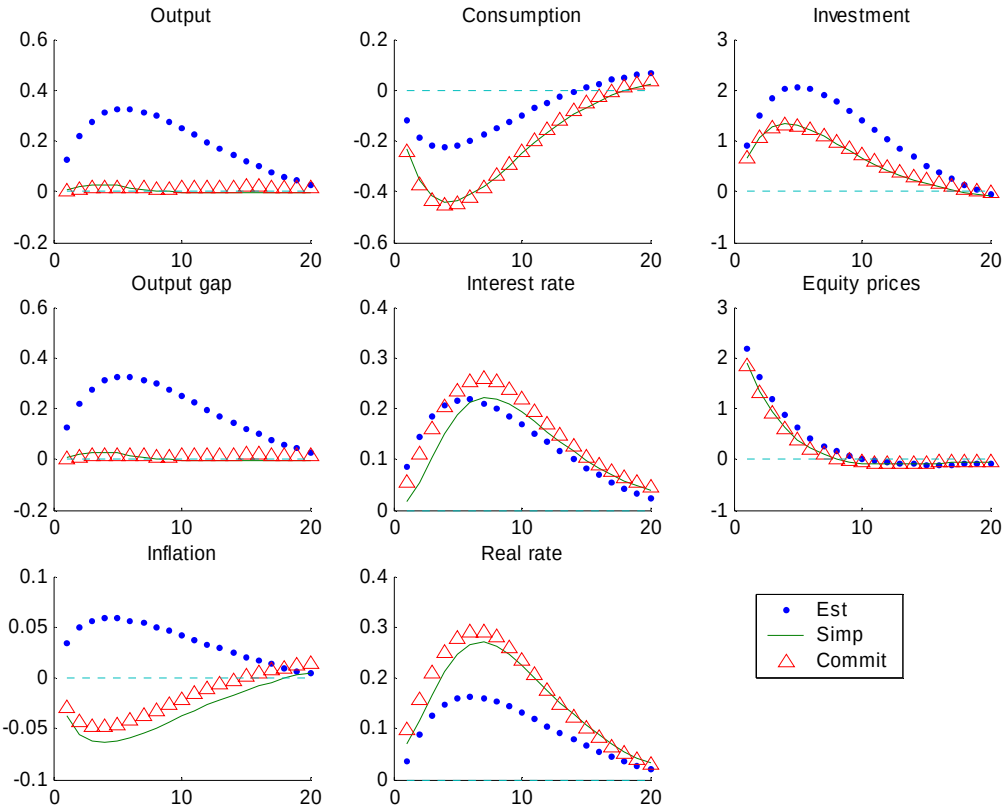
Estimated and optimal response to a positive productivity shock



Note: Impulse responses based on the DSGE model estimated on euro area data by Smets and Wouters (2003).

Figure 2

Estimated and optimal response to a non-fundamental equity price shock



Note: Impulse responses based on the DSGE model estimated on euro area data by Smets and Wouters (2003).

Appendix:

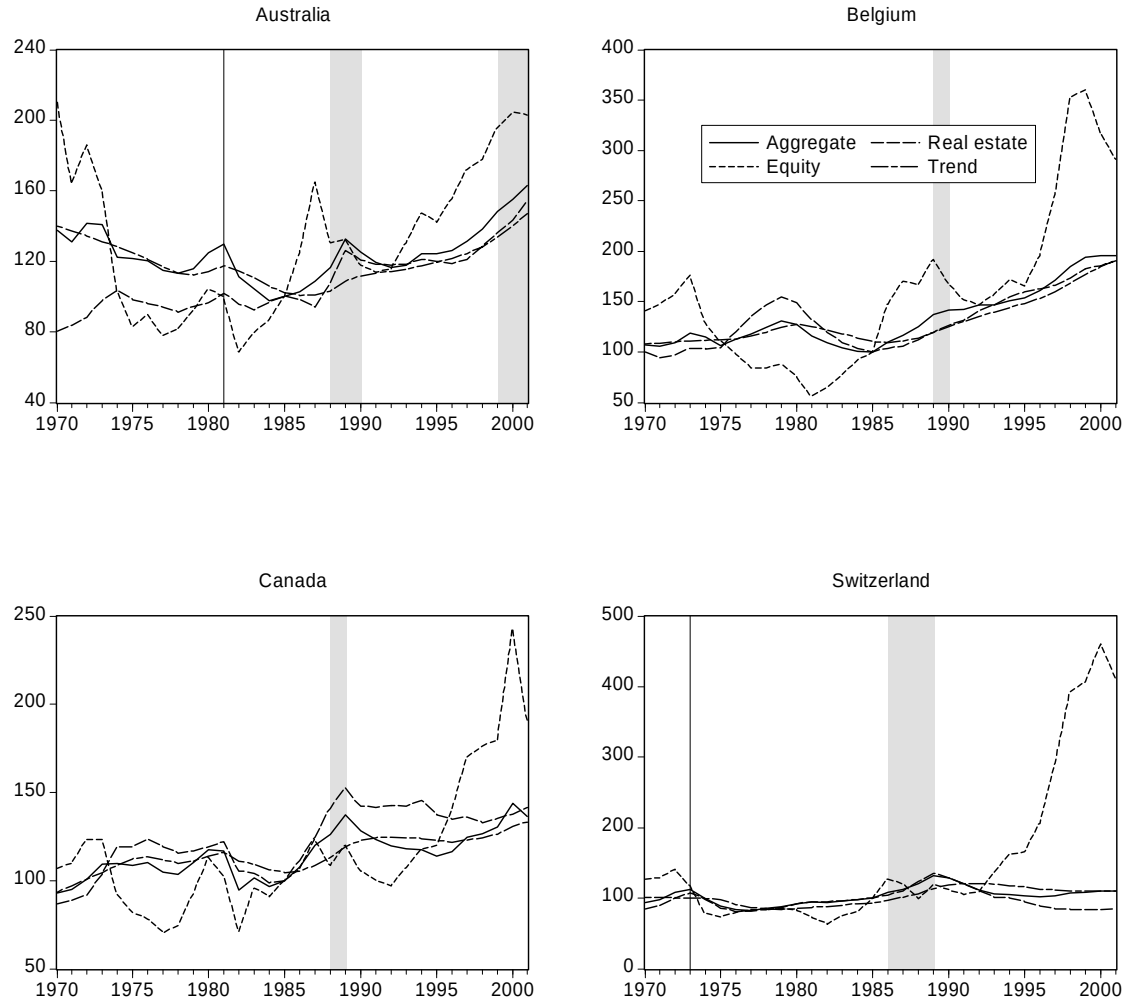
Table A

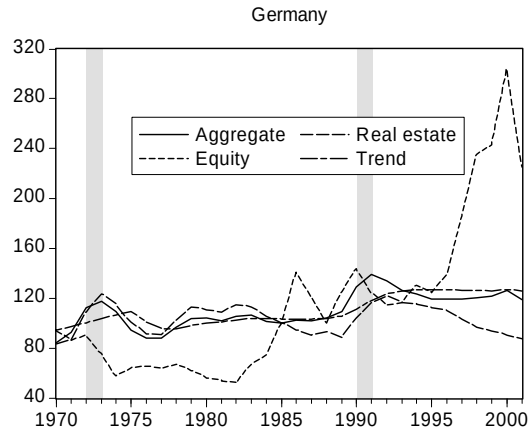
Aggregate asset price booms in industrial countries (1970-2001)

	1970-80s: High-cost	1970-80s: Low cost	1990s
Australia	81	88-90	99-01
Belgium		89-90	
Canada	88-89		
Switzerland	73	86-89	
Germany	72-73; 90-91		
Denmark	73; 84-86		97-01
Spain	86-91		
Finland	81-89		97-00
France		89-90	
Ireland	78-81	89	95-01
Italy		81; 90-91	
Japan	73; 86-90		
Netherlands		77; 89-90	94-01
Norway	84-87	73	96-01
New Zealand		82-87	
Sweden	87-90		96-00
United States		86-87	96-00
United Kingdom	72-73; 85-89		98-00

Figure A

Aggregate asset prices and asset price booms in industrial countries (1970-2001)

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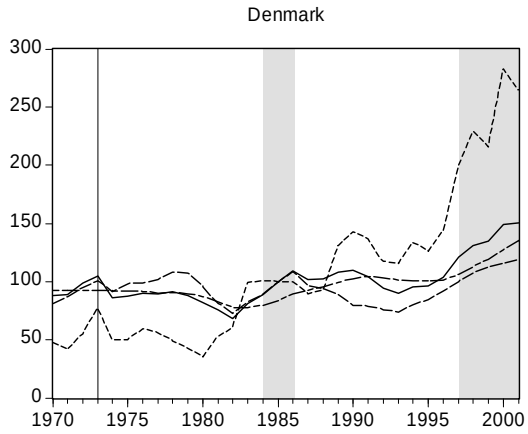
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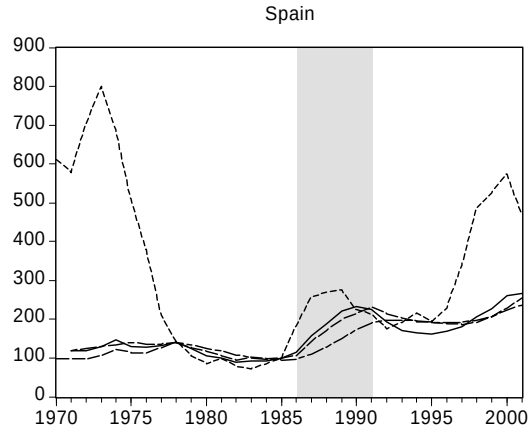
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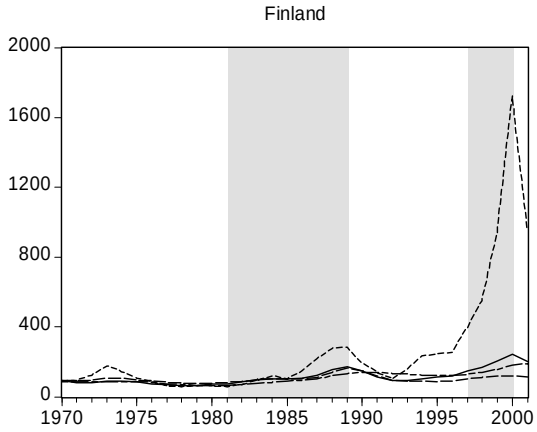
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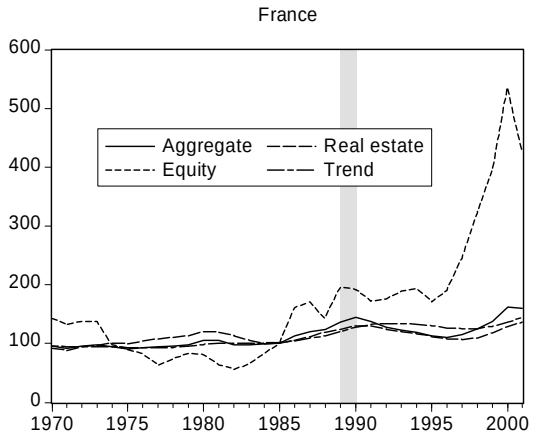
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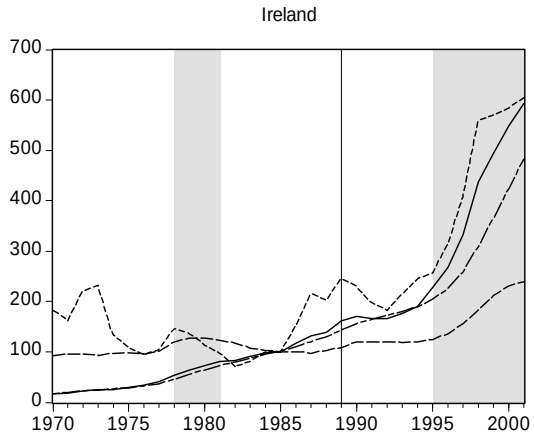
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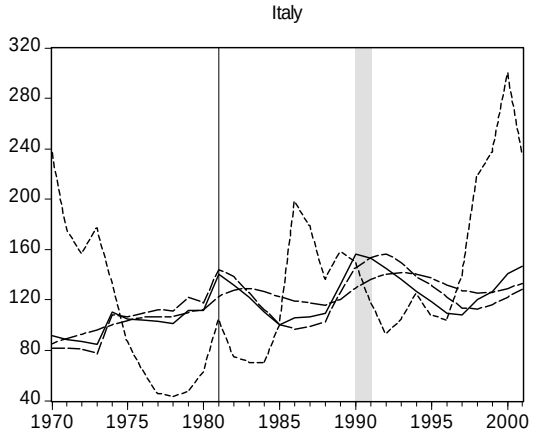
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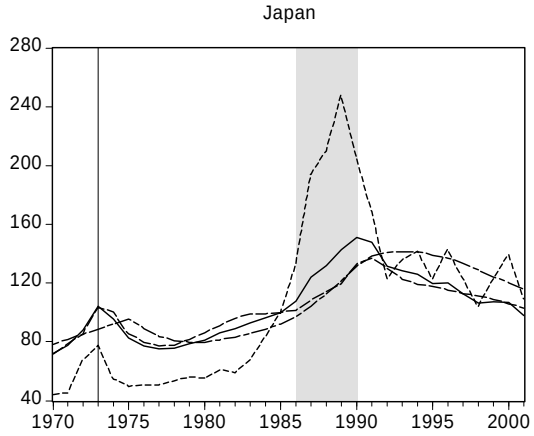
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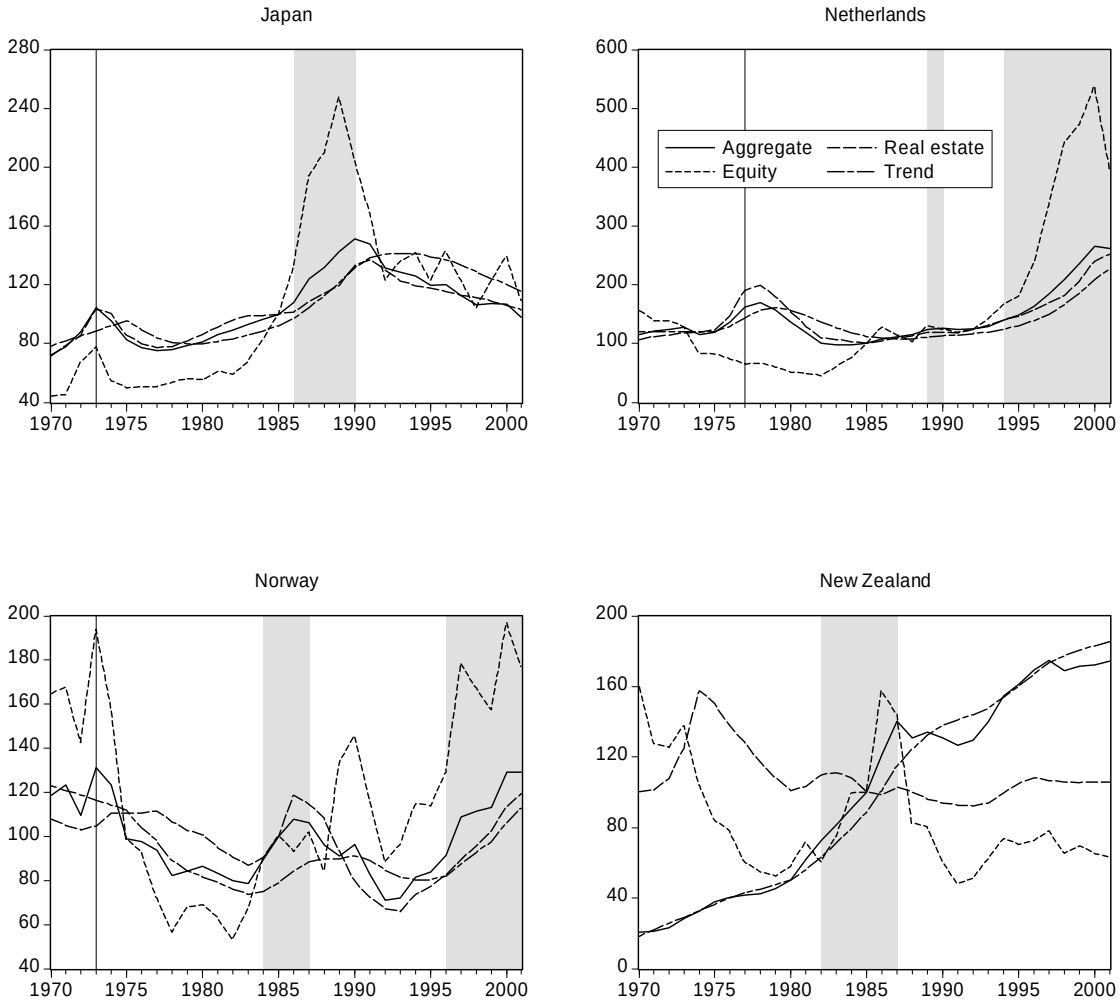
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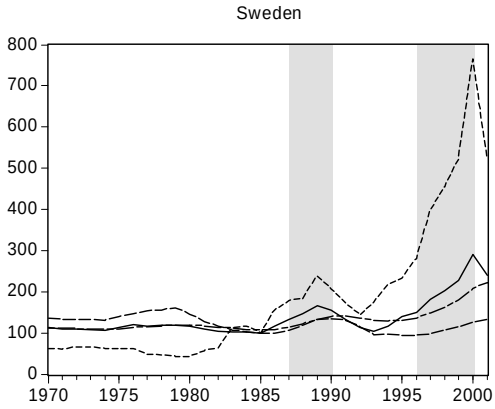
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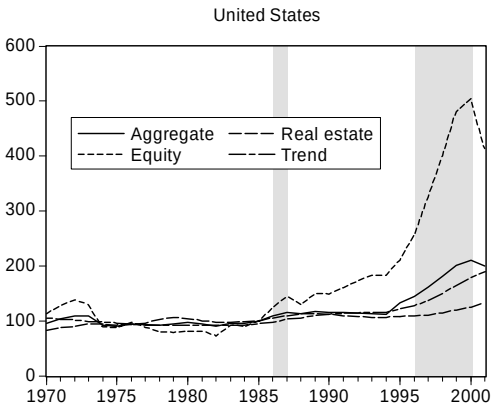
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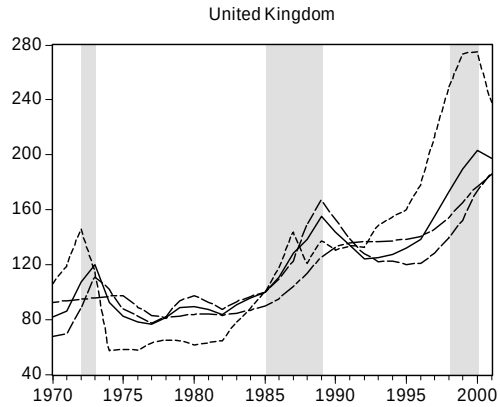
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2000

Data appendix

The data frequency is annual. The period covered is 1970 until 2001 for most series and most countries. We consider 18 countries, which are Australia, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Sweden, US and UK. The asset price indices have been kindly supplied by Steve Arthur and Claudio Borio from the BIS (See Borio, Kennedy and Prowse (1994) and Borio and Lowe (2001) on these indices). The aggregate indices are weighted by the actual share of the asset components (equity, residential property, commercial property) in the respective economy. We used the real asset price indices as deflated by consumer prices by the BIS.

The following data are from the OECD Economic Outlook, with the series code in parenthesis:
Real private consumption (CPV), consumer prices (CPI), the nominal effective exchange rate (EXCHEB), real housing investment (IHR), real private investment (IPV), a broad monetary aggregate (MONEYS), the short term interest rate (IRS), nominal and real GDP (GDP and GDPV).
Domestic credit is from the IMF's International Financial Statistics, code 32. For the euro area countries domestic credit has been updated from 1999 until 2001 with growth rates obtained from the ECB's Monetary Transmission Network database.
Monetary aggregates for the euro area countries are M3 data from the ECB's Monetary Transmission Network database.
The short term interest rates for Norway and Sweden are from the IMF's International Financial Statistics, lines 60zb and 60b, respectively.
The figures referring to monetary aggregates (either growth rates or ratio trend deviations) are computed without the two boom periods for Denmark as no monetary data were available.
The figures referring to domestic credit aggregates (either growth rates or ratio trend deviations) are computed without the single boom periods for both Belgium and New Zealand as no credit data were available.
The rate of change of the real effective exchange rate is computed by simply adding the growth rates of nominal effective exchange rate index and domestic inflation. It thus neglects price developments of trading partners.

The real interest rate is simply the difference between the short term interest rate and current inflation.

The ratios to GDP for output components were computed by dividing the real variable by real GDP. The ratios for the nominal variables, money and credit were computed as ratios to nominal GDP. The recursive trends were derived by extending the window for the HP filter period by period. The starting window for the first (non-recursive) trend estimates were the following, 1970-1975 for the real aggregate asset price indices, real GDP, the money ratio, the consumption ratio, the private investment ratio and the housing investment ratio; 1971-1975 for the inflation rate; 1970-1985 for the credit ratio and 1971-1985 for the real interest rate. The base periods differ due to missing data availability for some countries with regard to the respective variable. The recursive HP trends are estimated with a lambda of 1000 in order to increase the persistence of the trend component.