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In 2007 all ECB publications feature a motif taken from the €20 banknote.

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Abstract

The paper analyses the short-run impact of periods of strong monetary growth on inflation dynamics for 15 industrialised economies. We find that, over a 3-year horizon, the positive link between monetary aggregates and prices holds in approximately fifty percent of the cases. An econometric investigation suggests that a contemporaneous increase in the gap measures of the real stock price and real housing price and strong dynamics of loans to the private sector significantly increase the probability of turning an episode of excessive money growth into an inflationary outburst.

Keywords: Inflation, money growth, quantity theory of money.
JEL: E31; E40.

Non-technical summary

The existence of a positive relationship between money and prices is well acknowledged in the economic literature. A large consensus can be found on both the direction and the dimension of the effect of an increase in the monetary aggregate on prices developments. The statement that in equilibrium monetary policy is neutral hinges on the quantity equation which in turn defines a positive "one-to-one" relationship between monetary and price growth over a long-term horizon. The theoretical consensus on money neutrality is also supported by well documented empirical evidence, in both time-series and cross-countries analysis. The economic profession, however, highlights that, since money is not the sole cause of price developments in the short run and that a certain period of time must elapse before the "one-to-one" relation emerges, the neutrality may not to hold over shorter horizons.

With the present paper we try to evaluate *ex post* the leading properties of money (in the broad sense of episodes of excessive monetary growth) for prices dynamics in the short run (i.e. three years after the episode) by looking at episodes of sustained monetary growth over the last three decades in 15 industrial economies. Moreover, we try to disentangle the characteristics that may turn an increase in money growth into a sudden rise in the inflation rate. In particular, the behaviour of stock markets, housing prices as well as credit to the private sector around these episodes are assessed in order to determine whether they may help to distinguish inflationary from non-inflationary episodes of sustained monetary expansion.

We find that, over a 3-year horizon, the positive link between monetary aggregates and prices holds approximately in fifty per cent of the cases. An econometric investigation based on probit regressions suggests that factors like contemporaneous large deviations of stock prices and housing price from trend developments and strong dynamics of credit to the private sector significantly increase the probability of turning an episode of excessive money growth into an outburst of inflation. In addition, as expected, also the magnitude of the episode positively contributes to the inflationary outcome, while the length of the period of strong money growth does not seem to matter for the inflationary outcome.

1. Introduction

The existence of a positive relationship between money and prices is well acknowledged in the economic literature. A large consensus can be found on both the direction and the dimension of the effect of an increase in the monetary aggregate (regardless of the definition adopted) on prices developments. The statement that, in equilibrium, monetary policy is neutral hinges on the quantity equation which in turn defines a positive "one-to-one" relationship between monetary and price growth over a long-term horizon. The theoretical consensus on money neutrality is also supported by well documented empirical evidence, in both time-series and cross-countries analysis.[2] The economic profession, however, highlights that, since money is not the sole cause of price developments in the short run and that a certain period of time must elapse before the "one-to-one" relation emerges, the neutrality may not to hold over shorter horizons. This implies that, in order to forecast inflation, monetary aggregates may not show good leading properties in the short to medium run. Indeed, the role of money as an informational variable for monetary policy decisions is an open issue. Empirical works provide mixed results and the findings seem mainly to depend on the selected countries and the historical periods considered (e.g., Stock and Watson, 1999; Dwyer and Hafer, 1999; Trecroci and Vega, 2000; Nicoletti Altimari, 2001; Leeper and Roush, 2002).

The aim of this paper is twofold. First, we are interested in identifying episodes of sustained monetary growth over the last three decades in industrial economies. The idea is to evaluate *ex post* the leading properties of money (in the broad sense of episodes of excessive monetary growth) for prices dynamics in the short run (i.e. three years after the episode). Second, we try to disentangle the characteristics that may turn an increase in money growth into a sudden rise in the inflation rate. In particular, the behaviour of stock markets, housing prices as well as credit to the private sector around these episodes are assessed in order to determine whether they may help to distinguish inflationary from non-inflationary episodes

[2] See, for instance, Lucas (1980), Lothian (1985), McCandless and Weber (1995), Jaeger (2003), Gerlach and Svensson (2003) and Benati (2006) among many others.

of sustained monetary expansion. The analysis of the interrelationships among money, credit and asset prices, which can be dated at least as back as Kindleberger (1978), has recently regained relevance in the current context of low and stable inflation in almost all industrialised economies. In such an environment, inflationary pressures normally associated with unsustainable developments in real and financial variables may take longer to emerge and symptoms may show up in advance in excessive credit and asset prices growth (Bordo and Jeanne, 2002; Borio and Lowe, 2002; Machado and Sousa, 2006).

The paper is linked to two different strands of the recent empirical literature on monetary analysis. The first analyses the leading indicator properties of monetary aggregates for inflation and the relationship between money and prices in general (Bachmeier and Swanson, 2005; De Grauwe and Polan, 2005; Bruggeman et al., 2005; Assenmacher-Wesche and Gerlach, 2006a), while the second ones relate episodes of significant imbalances in money and other financial variables to banking crises and financial instability in general (Borio and Lowe, 2004; Detken and Smets, 2004; Van den Noord, 2006).

We find that, over a 3-year horizon, the positive link between excess money growth and price dynamics holds in less than fifty per cent of the cases. An econometric investigation based on probit regressions suggests that factors like contemporaneous large deviations of stock prices and housing price from trend developments and strong dynamics of credit to the private sector significantly increase the probability of turning an episode of excessive money growth into an outburst of inflation. In addition, as expected, also the magnitude of the episode positively contributes to the inflationary outcome, while the length of the period of strong money growth does not seem to matter for the inflationary outcome.

The paper is structured as follows. Section 2 illustrates the dataset and the selection criteria of the money growth episodes, while Section 3 proposes a preliminary analysis of the average behaviour of some financial and macroeconomic variables during the selected episodes and in the three-year period immediately following them. Section 4 presents an econometric investigation of the circumstances that may lead to an inflationary outcome. Section 5 draws some conclusions by relating our results to the current empirical literature.

2. Data description and episodes' selection

The study analyses the developments of financial, real and monetary indicators around periods of strong monetary growth. In particular, we make use of historical series of a broad monetary aggregate, roughly equivalent to M2 or M3 (depending on the country considered) and year-on-year changes in the consumer price index. As for asset prices, we consider stock market developments (represented by the share prices index available for each country), and housing price dynamics. Macroeconomic variables include nominal and real GDP, output gap and nominal investment (gross fixed capital formation), while financial variables are represented by the short-term (three-month money market) and long-term (ten-year government bond yield) interest rates and the nominal and real effective exchange rates. With regard to credit, we use credit to the private sector (or loans to the private sector when available). We also consider several indexes of oil and commodity prices and indicators of fiscal sustainability.[3]

The dataset used for the analysis consists of quarterly data collected for 15 main industrial economies and the euro area and spans over more than three decades. Whenever available, data start in 1970 Q1 and end in 2006 Q1. The countries considered are: Australia, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States.

To select excessive money growth episodes we made use of a measure proposed by Borio and Lowe (2004), which focus their attention on the cumulative building of imbalances. They suggest looking at the "money gap", which is defined as the deviation of the ratio of money to GDP from its trend. The trend is here calculated using a Hodrick-Prescott filter (with a smoothing parameter of 1600) over the whole sample.[4] Starting from this principle, we sorted out only periods of continuative imbalances, namely our episodes are selected according to their length. In particular, we select an episode only when the deviation of the ratio of money to GDP from the trend persists for at least one year (four consecutive

[3] All series are seasonally adjusted. Whenever available, quarterly series are calculated as averages of monthly series. See the Appendix for a detailed description of the series used and of their sources.
[4] In the same vein we constructed the gap measures for credit to the private sector, stock prices, housing prices, output, inflation and investment.

quarters). The only exception was that, when we found a single negative quarter within an already established episode, we considered it as part of the excessive money growth period. As an example, during the eight quarters from 1984 Q4 to 1986 Q3, Australia witnessed only a single quarter (1985 Q2) in which the ratio of money to GDP was (slightly) negative. We thus considered the full 8-quarter length instead of starting the episode from 1985 Q3.[5]

In order to ensure the existence of a 3-year period clear after the end of each episode, we considered only episodes ending before 2003 Q1, so that the available number of cases turned out to be 77 (see Table 1).[6] Although for each country there are at least two cases, episodes are not evenly distributed among countries, partly due to the different data availability. Australia witnessed 9 episodes, followed by Norway, Sweden and the United States which experienced 6 episodes. France and Switzerland, at the opposite, underwent only 2 and 3 episodes, respectively. Excluding the euro area, there are 15 episodes in the 1970s, 23 in the 1980s, 27 in the 1990s and 6 which ended after 2000. The length of the episodes ranges from 4 to 20 quarters. In particular, there are 32 cases which lasted less than two years (4 to 8 quarters), and 39 with a length between 2 and 5 years (9 to 20 quarters). Finally, it is worth noting that the list of the selected episodes is consistent with the periods of financial distress identified by the empirical literature (Bordo et al., 2001; Borio and Lowe, 2002; Detken and Smets, 2004; Van den Noord, 2006).

Once the set of excessive money growth episodes has been determined, these episodes are distinguished between those "inflationary" and those "non-inflationary" on the basis of the following criterion. We first calculate the average increase in both the consumer price index and the inflation gap − where the latter is defined as the difference between the inflation rate and its trend value − in the 3-year period (i.e. 12 quarters) after the end of the monetary episode:

$$(1) \qquad \overline{\pi}_{3yr} = \sum_{t=1}^{12} \pi_t \Big/ 12 \qquad \text{or} \qquad \overline{\pi}^{gap}_{3yr} = \sum_{t=1}^{12} \pi^{gap}_t \Big/ 12 \,,$$

[5] According to this rule, we adjusted the length of 6 episodes, which would have anyway been selected, and added one episode of 7 quarters which instead would not have been selected according to the four consecutive quarter-length rule. However, the results of the paper are not affected by this marginal adjustment.

[6] In the empirical analysis of the following sections we will consider only 71 episodes by dropping out the aggregated euro area data, since we include the five individual largest euro area countries.

where $\overline{\pi}_{3yr}$ ($\overline{\pi}^{gap}_{3yr}$) represents the average inflation rate (average inflation gap) in the 3-year period after the monetary episode, while π_t (π^{gap}_t) represents the inflation rate (inflation gap) at time *t*.

Then, we proceed by labelling as "inflationary" all the excess money growth episodes that were followed in the three years after by an increase in the consumer price index or in the inflation gap with respect to their value during the episodes of at least 1 time the standard deviation. In other words, we compared the average value of each of the two indicators over the 12-quarter period after the end of the episodes with the corresponding average value of the indicator over the episode length. When the difference between the two values is above 1 time the standard deviation, we judge the excess money growth episode as "inflationary", as explained by the following formula:[7]

(2) $(\overline{\pi}_{episode} - \overline{\pi}_{3yr}) > 1 * std$ or $(\overline{\pi}^{gap}_{episode} - \overline{\pi}^{gap}_{3yr}) > 1 * std$,

where $\overline{\pi}_{episode}$ ($\overline{\pi}^{gap}_{episode}$) represents the average inflation rate (average inflation gap) in the excess money growth period.

It should be noted that the time-span considered is in line with the idea of short-run horizon and consistent with the time intervals that have been adopted in a number of inflation targeting regimes (Stevens, 2003). In addition, we regarded as inflationary also those episodes in which the consumer price index or the inflation gap peaked at values larger than 2 times the standard deviation in any of the quarters of the 3-year period following the episode, although the overall average increase was below 1 time the standard deviation. According to the latter rule, we could add other 6 cases for a total of 33 inflationary episodes (35 when including also the euro area, see Table 1).

[7] Given the broad time span of our sample, we considered the standard deviation of both inflation and inflation gap in each separate decade. Thus, for instance, episodes in the 1970s in order to be classified as inflationary had to breach a threshold much larger than that of the 1990s.

Table 1

Episodes of "excessive" monetary growth

Country	Money growth gap>0%	No. of quar-ters	No. of epis.	Inflat. epis.
Australia	1972 Q4 - 1974 Q2	7	9	**yes**
	1975 Q2 - 1976 Q1	4		**no**
	1977 Q4 - 1978 Q4	5		**yes**
	1980 Q1 - 1981 Q2	6		**no**
	1983 Q1 - 1983 Q4	4		**no**
	1984 Q4 - 1986 Q3	8		**yes**
	1989 Q3 - 1991 Q4	10		**no**
	1996 Q4 - 1997 Q3	4		**no**
	1999 Q1 - 2000 Q1	5		**yes**
Canada	1972 Q1 - 1972 Q4	4	5	**yes**
	1978 Q4 - 1983 Q1	18		**no**
	1986 Q4 - 1987 Q3	4		**no**
	1990 Q3 - 1993 Q4	14		**no**
	1996 Q1 - 1998 Q4	12		**yes**
Denmark	1975 Q4 - 1978 Q1	10	4	**yes**
	1984 Q2 - 1988 Q4	19		**no**
	1992 Q2 - 1994 Q3	10		**yes**
	1996 Q4 - 1999 Q3	12		**yes**
Euro area	1982 Q3 - 1983 Q3	5	6	**no**
	1984 Q2 - 1985 Q3	6		**no**
	1987 Q1 - 1989 Q2	10		**yes**
	1992 Q3 - 1994 Q3	9		**no**
	1996 Q1 - 1997 Q3	7		**no**
	1998 Q4 - 2000 Q1	6		**yes**
France	1990 Q3 - 1993 Q4	14	2	**no**
	1995 Q3 - 1996 Q3	5		**no**
Germany	1982 Q1 - 1985 Q2	14	4	**no**
	1988 Q1 - 1990 Q2	10		**yes**
	1993 Q2 - 1994 Q4	7		**no**
	1998 Q4 - 2000 Q2	7		**yes**
Italy	1978 Q1 - 1980 Q1	9	4	**yes**
	1984 Q4 - 1987 Q4	13		**yes**
	1992 Q2 - 1994 Q4	11		**no**
	1996 Q2 - 1997 Q1	4		**no**
Japan	1971 Q3 - 1974 Q1	11	5	**yes**
	1978 Q4 - 1980 Q2	7		**yes**
	1981 Q4 - 1984 Q1	10		**no**
	1987 Q2 - 1991 Q3	18		**no**
	1998 Q1 - 1999 Q4	8		**no**

Country	Money growth gap>0%	No. of quar-ters	No. of epis.	Inflat. epis.
Nether-lands	1982 Q2 - 1983 Q2	5	4	**no**
	1989 Q3 - 1991 Q1	7		**no**
	1992 Q4 - 1994 Q4	9		**no**
	1998 Q4 - 2000 Q2	7		**yes**
New Zealand	1981 Q1 - 1981 Q4	4	4	**no**
	1985 Q2 - 1988 Q2	13		**no**
	1991 Q1 - 1993 Q4	12		**yes**
	1996 Q2 - 1998 Q3	10		**yes**
Norway	1971 Q4 - 1973 Q2	7	6	**yes**
	1976 Q4 - 1978 Q1	6		**yes**
	1979 Q1 - 1979 Q4	4		**yes**
	1988 Q1 - 1989 Q1	5		**no**
	1991 Q4 - 1996 Q3	20		**yes**
	1998 Q1 - 1999 Q3	7		**yes**
Spain	1984 Q1 - 1985 Q4	8	4	**no**
	1989 Q2 - 1991 Q3	10		**no**
	1993 Q4 - 1994 Q4	5		**no**
	1995 Q4 - 1998 Q2	11		**yes**
Sweden	1973 Q1 - 1975 Q4	12	6	**no**
	1981 Q3 - 1983 Q4	10		**no**
	1986 Q4 - 1988 Q3	8		**yes**
	1991 Q3 - 1994 Q3	13		**no**
	1996 Q2 - 1998 Q1	8		**no**
	1999 Q4 - 2001 Q4	9		**no**
Switzer-land	1977 Q1 - 1980 Q1	13	3	**yes**
	1987 Q1 - 1989 Q4	12		**yes**
	1996 Q1 - 1999 Q3	15		**no**
United Kingdom	1972 Q1 - 1975 Q1	13	5	**yes**
	1981 Q4 - 1985 Q1	14		**no**
	1989 Q3 - 1992 Q4	14		**no**
	1996 Q3 - 1999 Q2	12		**no**
	2000 Q3 - 2001 Q4	6		**no**
United States	1971 Q3 - 1973 Q3	9	6	**yes**
	1976 Q2 - 1978 Q2	9		**yes**
	1982 Q3 - 1983 Q4	6		**yes**
	1986 Q2 - 1988 Q3	10		**yes**
	1990 Q4 - 1993 Q4	13		**no**
	2001 Q3 - 2003 Q1	7		**yes**

Note: all the samples start in either in 1970 or 1971, with the exception of the Euro area (1980 Q1), France (1981 Q4), Germany (1975 Q4), Italy (1977 Q1), Netherlands (1978 Q1), New Zealand (1979 Q4) and Spain (1981 Q4).

Thus, surprisingly, the inflationary outcome characterises less than half of the episodes. Even selecting those episodes for which the period of excessive money growth was lengthy and thus which *ex ante* were supposed to have a higher probability of becoming inflationary, only in 47% of the cases did inflation occur within the 3-year period following them.[8] It is also worth noting that the relative share of inflationary episodes is significantly different across countries. For instance, in the United States and Norway 5 times out of 6 the episodes of strong monetary increase were followed by a significant acceleration of inflation, while in Sweden and Spain, only one time out of 6 and 5, respectively, did periods of excess money growth lead to inflation.[9]

In order to investigate to a broader extent the short-run relationship between money and prices, in the following two sections we analyse the macroeconomic and financial context in which the excess money growth episodes took place. In particular, in Section 3 we compare − both qualitatively and statistically − the behavioural pattern of a number of macroeconomic variables in inflationary and non-inflationary episodes, in order to get some insights about which variables may possibly serve as useful indicators of the building up of inflationary pressures.

The results of the paper are rather robust to the selection criteria employed as regards both the definition of excessive money growth and inflationary outcome. All the following changes in both definitions did not lead to any significant modification in the results of the paper. We adjusted the selection criterion by using a 3- and 5-quarter length definition. In both cases the number of episodes changed by less than 10%: in the latter case we lost 7 episodes and in the former we added 6. We looked at a 2-year post-episode period for price dynamics assessment (i.e. we shortened the horizon) and we lost only 4 inflationary episodes. In addition, we adjusted the average increase in the consumer price index in a range of 0.7 to 1.3 times the standard deviation, which only led to marginal changes in the number of inflationary episodes. Finally, we employed a different threshold for the determination of

[8] In the present analysis we do not control for the effect of interest rate changes on money velocity, which may have affected the link between money and inflation. Assenmacher-Wesche and Gerlach (2006b) show that, when taking this into account, the quantity theory of money is somewhat strengthened.

[9] As regards the 38 periods which were not followed by a significant increase of inflation, in 23 cases the inflation gap was almost unchanged, in four cases it increased slightly and 11 times it actually decreased, but significantly so only in 4 episodes.

excess money growth episodes following Borio and Lowe (2004): money growth was considered to be "excessive" when the money to GDP gap exceeded (on average) a value of 2%. Even though the number of episodes was significantly reduced to 52, the inflationary outcome turned out to be only marginally affected. We recorded an increase in the probability of price pressures from 47% to 49%.

3. A preliminary statistical analysis

As explained in the previous section and as evident from Table 1, money growth episodes can be of different length. Therefore, in order to be able to compare the behaviour of a number of macroeconomic variables during and immediately after the selected excess money growth episodes, we calculate the average values of the annual growth rates (or levels) of a set of main macroeconomic and financial variables both during the episodes and over the twelve quarters after the episodes. These average developments are presented in the tables and charts below. More precisely, the tables report, for each variable, the average value (across countries and periods) during and in the three years after each type of episode (i.e. inflationary and non-inflationary).[10] The charts instead illustrate the average developments during each type of episode as well as throughout the three years after them. As a matter of fact, looking at the average developments three years after the episode allows us to detect important behavioural dynamics which may be overlooked when considering the simple 3-year average.

[10] A similar analysis based on the median values leads to the same conclusions.

Table 2

Average levels of some macroeconomic variables during and after the episodes and significance of the differences across episodes (inflationary versus non-inflationary)

	Inflationary episodes		Non-inflationary episodes	
	During	After	During	After
Inflation gap	**-0.86****	**0.68****	**0.17****	**-0.28****
Real stock price growth	5.32	**-2.00****	6.78	**6.80****
Real house price growth	**3.44****	2.39	**0.54****	1.73
Real GDP growth	**3.25****	2.71	**1.92****	2.56
Investment growth	**8.08****	**7.97****	**3.31****	**4.97****
Money gap	**2.50****	**-1.50****	**2.07****	**-1.10****
Credit gap	0.90	**-0.27***	0.78	**-0.98***
Nominal short-term interest rates	**7.39****	**8.57****	**8.85****	**7.27****
Nominal long-term interest rates	**8.03****	**8.84****	**9.25****	**8.04****
Real short-term interest rates	**2.91****	**2.18****	**4.16****	**3.96****
Real long-term interest rates	**3.55****	**2.45****	**4.57****	**4.73****
Nominal effective exchange rate	-1.16	-0.46	-0.53	-0.48
Real effective exchange rate	-0.52	0.04	-0.60	-0.13

Note: the bold values denote statistical significance at 1% (labeled with "**"), 5% ("*") and 10% ("† ").

Table 3

Average levels of some macroeconomic variables during and after the episodes and significance of the differences across periods (during versus after)

	Inflationary episodes		Non-inflationary episodes	
	During	After	During	After
Inflation gap	**-0.86****	**0.68****	**0.17****	**-0.28****
Real stock price growth	**5.32****	**-2.00****	6.78	6.80
Real house price growth	**3.44***	**2.39***	**0.54****	**1.73****
Real GDP growth	**3.25****	**2.71****	**1.92****	**2.56****
Investment growth	8.08	7.97	**3.31****	**4.97****
Money gap	**2.50****	**-1.50****	**2.07****	**-1.10****
Credit gap	**0.90****	**-0.27****	**0.78****	**-0.98****
Nominal short-term interest rates	**7.39****	**8.57****	**8.85****	**7.27****
Nominal long-term interest rates	**8.03****	**8.84****	**9.25****	**8.04****
Real short-term interest rates	**2.91****	**2.18****	4.16	3.96
Real long-term interest rates	**3.55****	**2.45****	4.57	4.73
Nominal effective exchange rate	-1.16	-0.46	-0.53	-0.48
Real effective exchange rate	-0.52	0.04	-0.60	-0.13

Note: see Table 2.

In order to shed some light on the different economic conditions characterising inflationary with respect to non-inflationary episodes, we analyse them separately. In

particular, we check whether the differences in the means both across the two types of episodes and across the periods (i.e. during and after the episodes) are statistically significant using the mean test based on a single factor, analysis of variance (ANOVA).[11]

The values in bold in the Table 2 and Table 3 denote the means which are statistically different either across episodes or across periods. It should be noted that, however, this simple analysis is bivariate in nature and does not provide any insight into how developments in a single variable are interrelated with one another around the excess money growth episodes. These types of issues are, in fact, analysed in the next section. Bearing in mind these caveats, the following observations are worth noting.

The development of several variables during and after inflationary episodes seems to differ from the dynamics recorded on the occasion of non-inflationary episodes. With regard to the inflation gap, the deviation from the trend is significantly lower (almost by construction) during inflationary than non-inflationary episodes (see Table 2) and, as expected, it increases significantly after the inflationary episodes, while, on average it decreases after the non-inflationary ones (see Table 3). Concerning asset prices, even starting from comparable rates during the episodes, real stock prices growth significantly declines after inflationary episodes (becoming even negative), whereas it remains unchanged in the case of non-inflationary money growth. This evidence is suggestive of the fact that excessive money growth episodes precede falls in share prices (see Figure 1). When considering real house prices, again the difference in the dynamics is striking. During inflationary episodes real house prices growth is significantly higher than in the non-inflationary cases. In addition, it significantly declines after inflationary episodes while it significantly increases after non-inflationary episodes.

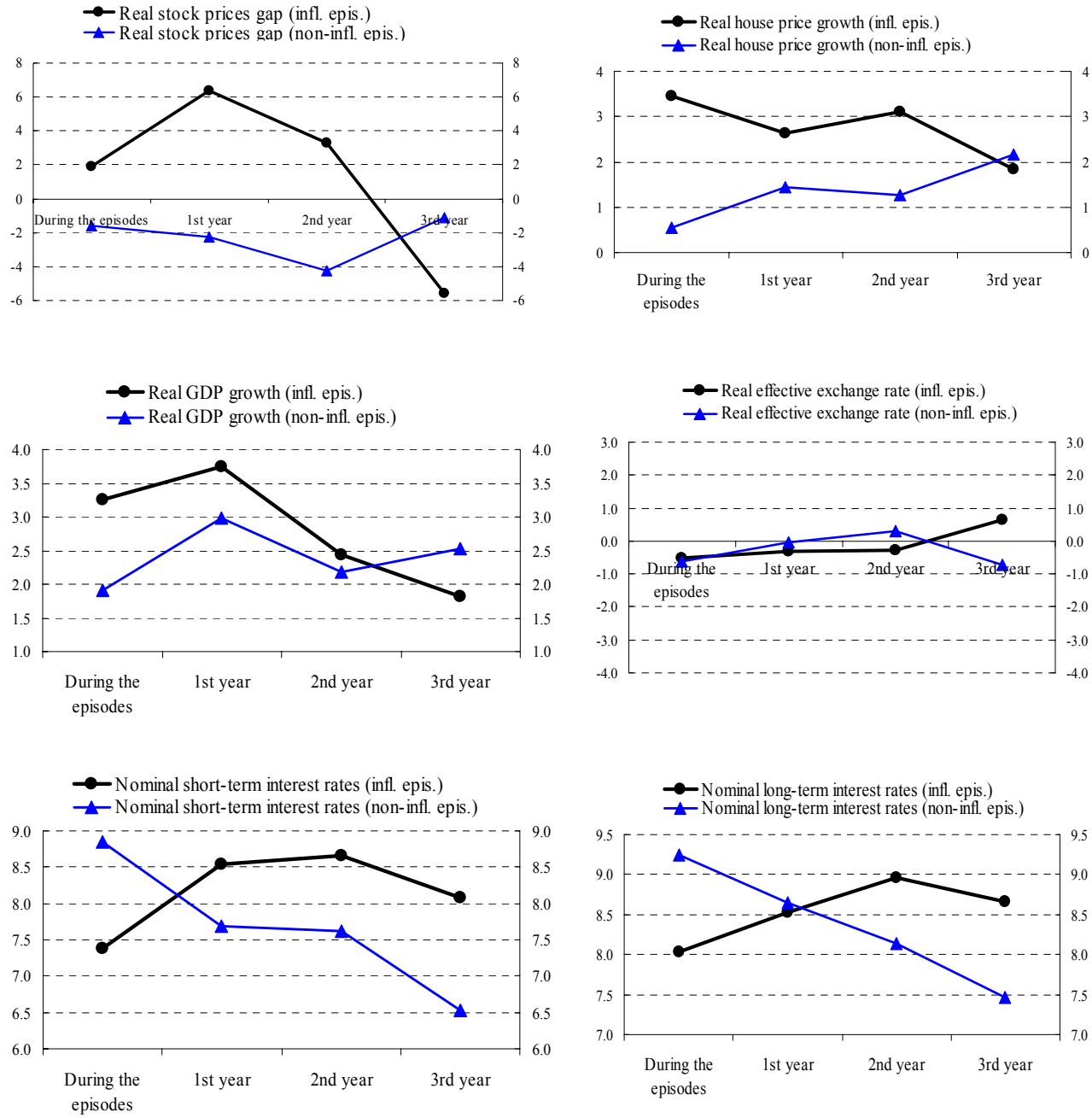
Also business cycle fluctuations surrounding inflationary and non-inflationary money growth episodes exhibit very different dynamics. First, real GDP growth rate during the episodes is significantly higher in the inflationary cases. Second, real growth significantly declines after inflationary episodes whereas it significantly increases after non-inflationary periods of strong money growth. This finding is partially confirmed by investment dynamics

[11] The basic idea of the test is that if subgroups have the same mean, then the variability between the sample means (between groups) should be the same as the variability within any subgroup (within group).

which suggest that the average growth level of gross fixed capital formation is significantly higher during inflationary than non-inflationary episodes.

Figure 1

Developments of some macroeconomic variables during and after the monetary episodes



The money gap declines in both kinds of episode, but it is significantly larger during the inflationary cases. The credit to the private sector dynamics seem instead to be similar across episodes. A decline in the credit gap in the three years after the monetary episode is a common (and statistically significant) feature of all excess money growth periods selected. Concerning both 3-month and 10-year interest rate developments, after the inflationary episodes there is a significant increase in the nominal rates, whereas significant declines are reported after non-inflationary periods. Both rates are significantly higher during non-inflationary than inflationary episodes. Real interest rates developments are consistent with different inflation rate dynamics in the 3-year horizon after the two types of episodes. Finally, the real effective exchange rate tends to slightly depreciate after the inflationary episodes, the average size of the depreciation being however never significant. After non-inflationary episodes, both the nominal and the real exchange rates exhibit a tendency to appreciate after the first/second year, which is in line with an average deflationary effect (Figure 1).

To sum up, one can conclude that inflationary episodes seem to be associated with increased asset prices and credits gaps and occur at times of relatively high GDP growth. They are then followed by a strong decline in the real stock market index below the trend and an upward adjustment in the average level of nominal interest rates. On the contrary, non-inflationary episodes are characterized by relatively subdued growth, are not associated with particular asset prices boom and bust cycles and show higher interest rates both in nominal and real terms.

4. An econometric investigation

This section provides an econometric investigation of whether various financial and macroeconomic variables help to distinguish inflationary from non-inflationary periods of excessive money growth. The study rests on probit regressions for the 15 economies under analysis. In particular, from the selection criterion highlighted in Section 2, we can construct the dependent variable. By attaching a "1" to the inflationary episodes and a "0" to the non-inflationary ones, we ended up with an array of 38 zeros and 33 ones. For each period of excessive money growth we consider the average value of the relevant variables during the episode. More specifically, given the episodes of sustained monetary growth, we estimate

how the probability of incurring in a significant increase in inflation can be explained by a set of regressors, denoted as x:

$$(3) \qquad \Pr(InflOut \neq 0 \mid x) = \Phi(\beta' x),$$

where Φ is the standard cumulative normal distribution and β is the vector of coefficients.

The vector x of explanatory variables can be divided into three groups. The first set is made up by conventional determinants of current and future inflation rate, the second set relates to financial factors that may have an impact on the development of the consumer price index, while the third set concerns some specific characteristics of the selected episodes. More precisely, as for the variables that most likely influence inflationary dynamics and money demand, we referred to nominal short-term interest rates, indicators of the business cycle (GDP growth rate), exchange rate measures (nominal and real effective exchange rate), commodity price indexes and measures of fiscal sustainability (debt and general government deficit). As for financial factors, we employed, on the one hand, real and nominal stock market values and housing prices and, on the other hand, credit to the private sector (loans to the private sector when available). Finally, we checked whether the length, the intensity and the time period in which the episode of strong money growth occurred had also a role in the determination of inflationary outcomes.

Table 4 reports the estimates of the basic model for the 71 episodes previously selected (column 1). The signs of the coefficients of the real GDP growth and the interest rate are, as expected, positive and negative, respectively. However, the interest rate turned out to be non-significantly different from zero, while real growth is highly significant. Nominal and real measures of the exchange rate, current oil and commodity price levels and debt to GDP ratio were not significantly different from zero.

The contribution of other assets prices in influencing the probability that a period of strong money growth is followed by an outburst of inflation is instead broadly significant. Both the deviations of the stock market and housing price from the trend turned out to be significantly positive. In addition, also the credit gap contributes positively to the inflationary outcome. As for the specific characteristics of the episode, the average size of the money gap during the episode (a measure of the magnitude of the episode) is significant whereas the length of the excess money growth period is not.

Table 4
Results from probit regressions

	(1)	(2)	(3)	(4)	(5)
Constant	**-1.8706**	**-2.4732***	**-2.5054**	**-2.3881***	**-2.594***
	(1.3681)	(1.4763)	(1.6219)	(1.4481)	(1.4540)
Real GDP growth	**0.6380*****	**0.6329****	**0.6669****	**0.6132****	**0.6387****
	(0.2347)	(0.2722)	(0.2802)	(0.2642)	(0.2638)
Interest rate	**-0.0068**	**0.1046**	**0.0912**	**0.0939**	**0.0879**
	(0.1143)	(0.1411)	(0.1484)	(0.1416)	(0.1479)
Credit gap	**0.2364***	**0.3283***	**0.3421***	**0.2967***	**0.2282***
	(0.13697)	(0.1723)	(0.1919)	(0.1573)	(0.1386)
Real stock price gap	**0.2633****	**0.6157****	**0.7034****	**0.6296****	
	(0.1376)	(0.2713)	(0.2983)	(0.2681)	
Real house price gap	**0.5275****	**0.6597****	**0.5607***	**0.6271****	
	(0.2552)	(0.2988)	(0.3140)	(0.2925)	
Money gap	**0.4379****	**0.4078***	**0.4321**	**0.3974***	**0.5255****
	(0.2223)	(0.2628)	(0.3036)	(0.2410)	(0.2507)
Dummy 1970s (D70)		**3.3498****	**5.0548****	**3.5846****	**4.1115*****
		(1.4746)	(2.3771)	(1.4112)	(1.4530)
Dummy 1980s (D80)		**-0.3925**			
		(0.6660)			
Credit gap*D70			**0.0915**		
			(0.6376)		
Real stock price gap*D70			**0.1790**		
			(0.2536)		
Real house price gap*D70			**0.6022**		
			(0.5553)		
Real asset gap					**0.5944****
					(0.3062)
McFadden R^2	0.5143	0.6076	0.6262	0.6040	0.6047
LR p-value	0.000	0.000	0.000	0.000	0.000
Marginal coeff.	0.3942	0.3782	0.3988	0.3756	0.383
Total obs.	71	71	71	71	71
Dep=0	38	38	38	38	38
Dep=1	33	33	33	33	33

Note: Standard errors in parentheses coefficients. *, **, *** denote statistical significance at 10, 5 and 1 per cent, respectively.

We then checked whether there are differences among time periods. In particular, we considered three sub-samples (the 1970s, the 1980s and the 1990s, including the few episodes occurred after 2000). A set of dummy variables suggests that there is indeed a higher probability of inflationary outburst in the 1970s (column 2). In order to check whether this higher probability has an impact also on other coefficients of the model we introduced in the

regressions also a multiplicative dummy for both the of asset prices variables and the credit dynamics one (column 3). It turns out that the coefficients are not significantly different from zero. This in turn implies that the model specification is the same across time periods and that the stock market, the housing price and the credit dynamics exerted the same effects on the probability of inflation along the whole time span.

Since probit regressions are non-linear in nature, the coefficients of the regressors do not have the standard derivatives concept they show in the linear OLS regression. To obtain the derivatives of the endogenous variable with respect to each of the exogenous variable we have to multiply the estimates of β by a marginal coefficient (shown in the last row of Table 4).[12] In addition, due to the fact that the endogenous variable is a probability, we can directly compute the variation in the probability of a monetary episode becoming inflationary due to a change in each exogenous variable. Thus, focusing on regression 4 in Table 4, it is easy to compute that a unit increase in the credit gap induces an 11% increase in the probability of an inflationary outcome occurring (when all other exogenous variables are at their mean level). At the same time, a unit increase in the stock index or in the housing price measure would determine an increase of around 23%.

The predictive ability of the model is investigated via the "Classification table" (Table 5), which shows the number of "hits" and "misses" of the prediction rule. In this regard, the performance of the model is assessed on the basis of a bivariate indicator which assigns "1" to the dependent variable ("Dep") if the estimated probability is larger than 0.5 and "0" otherwise. Overall, our model performs fairly well: in the event of an excess money growth episode, it correctly predicts around 85% of both inflationary and non-inflationary outcomes. Only 6 times out of 34 is an inflationary outcome incorrectly signalled (i.e., it actually did not occur); and only 5 times out of 37 is a non-inflationary outcome wrongly classified.[13] Given that in terms of policy Type I errors (i.e. missing an inflationary outburst) are more relevant than Type II errors (i.e. calling a crisis that does not materialise), we can read the data in a

[12] For the exact computation of the marginal coefficient see, for instance, Greene (2003).

[13] The right-hand side of Table 5 reports the relative performance of our model with respect to the naive rule which assigns "1" to the dependent variable if the proportion of 1 in the sample is larger than 0.5 and "0" otherwise. Overall, the total gain in using our model (measured by the difference between the percentage of corrected predictions from the model and those from the constant probability specification) is 31 percentage points (from 53.5% to 84.5%), which represents a relative improvement of 67%.

different way. Notwithstanding a value as low as 17.6 of the "noise to signal ratio", which is the share of wrong inflationary signals, the model is able to predict a large number of crisis (84.8%).

It should be noted, however, that the model is not meant as a predicting tool for inflation in a 3-year horizon as we relied on the *ex post* knowledge of the variables' dynamics over the whole time horizon. A "truly" leading indicator could be only devised if trend measures could be updated in real time every quarter, taking into account only the information available at that point in time. In this respect, our method departs from the one used by Borio and Lowe (2004), which a) compute recursive type trends and gap measures up to each episode using, however, *ex post* (revised) data; and b) look at a list of financial distress dates which could not be, obviously, available *a priori*.

Table 5

Classification table (success cut-off C=0.5)

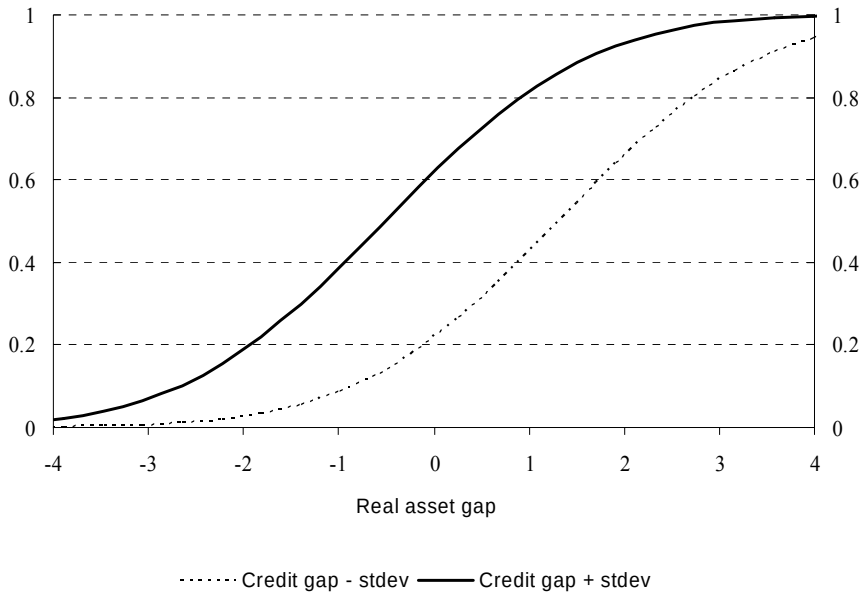
	Estimated Equation			Constant Probability		
	Dep=0	**Dep=1**	**Total**	**Dep=0**	**Dep=1**	**Total**
P(Dep=1)<=C	32	5	37	38	33	71
P(Dep=1)>C	6	28	34	0	0	0
Total	38	33	71	38	33	71
Correct	32	28	60	38	0	38
%Correct	84.21	84.85	84.51	100	0	53.52
%Incorrect	15.79	15.15	15.49	0	100	46.48
Total Gain*	-15.79	84.85	30.99			
Percent Gain**		84.85	66.67			

Notes:
* Change in "%Correct" from default (constant probability) specification.
**Percent of incorrect (default) predictions corrected by equation.

In order to investigate the joint effect of asset price and loans dynamics, we constructed an aggregate gap measure just averaging the real stock and house price gaps. We then estimated the probit regression with this new variable (see column 5 of Table 4). Figure 2 depicts the evolution of the probability of an inflationary outburst with respect to the

aggregated asset price gap when the other explanatory variables are at their average levels.[14] The dotted line is computed for a low level of the credit gap (the average value less the standard deviation), while the continuous line is associated to a higher level of the same variable (the average value plus the standard deviation). It is immediately clear that the effect of an increase in the asset gap is non-linear, but it is also evident that its relative contribution to the probability of an inflationary outburst depends on the level of the credit gap. In fact, when both variables are at low levels, an increase in the asset gap determines a relatively mild increase in the probability, while the same increase is significant when the credit gap is at a higher level. For instance, when the latter is 1 time the standard deviation below its long-term trend, a position of 1.5% of the asset gap determines a probability of inflation still around 0.5, while the same position leads to a much larger probability (0.88) when also the credit gap is above the trend.

Figure 2
Probability of inflationary outcome



This empirical evidence is in line with the reasoning put forward in Borio and Lowe (2002 and 2004), who suggest that the simultaneous violation of a given threshold in both

[14] The real asset price gap ranges from -13 to 15, however between the values from -4 to 4 displayed in Figure 2 there are almost 2/3 of the observations.

variables represents the best proxy of the notion of financial imbalance. A rapid and sizeable increase in credit may not necessarily be a problem if the asset prices backing that expansion grow at a sustainable rate. Similarly, booms and busts in asset prices do not necessarily cause great disruption if agents are not burdened by large debts and thus rigid liability commitments. Thus, in their opinion, the likelihood of a disruption increases greatly only when the two developments occur at the same time. Figure 2 seems to fully support this view.

However, we depart from Borio and Lowe (2004) in an important aspect. The two authors report three main findings: 1) an indicator made by a combination of credit and equity excessive growth is able to anticipate financial imbalances (i.e. banking distress) fairly well; 2) the same indicator shows some leading properties for a reduction in the inflation rate; 3) a positive money gap in excess of 2% does lead to some upward pressure on inflation over a 2-year horizon. Our results instead highlight that periods of significant imbalances in money growth shortly precede an inflationary increase when they are associated with a contemporaneous expansion of the credit to the private sector and with assets prices being above their trend developments. As a support to our interpretation, Detken and Smets (2004) and Helbling and Terrones (2003) in their analyses of asset price booms and busts find evidence that booms (in particular those followed by sharp reductions in the GDP growth rate) are accompanied by easy monetary and credit conditions and are also characterised by a subsequent large increase in the inflation gap. Similar results are obtained when starting from housing market cycles (Catte et al., 2004; Ahearne et al., 2005; Van den Noord, 2006).

A theoretical background for the relationship among monetary aggregates, asset prices and inflation can be dated as back as Brunner and Meltzer (1973). They build on the traditional Keynesian liquidity effect to introduce a broader range of assets in the monetary policy transmission mechanism. Central bank operations that increase liquidity will have the prices of assets to rise almost step by step. Substitutions from more to less liquid assets take place as returns on more liquid instruments decreases relative to the less liquid and usually riskier assets. Thus, short-term government bonds should be affected relatively early, followed by longer-term securities, by other assets such as stocks and real estate, and finally by the overall price index. In this framework price pressure on the stock markets is then seen as a possible warning of future price inflation.

Also the result that money and credit developments may contain useful information for forecasting price developments is well-established in the literature as well as in central banks' experience. On the one hand, it has been empirically shown that money and credit aggregates are characterised by additional information content for price developments beyond that contained in other macroeconomic indicators (Altissimo et al., 2001; Leeper and Roush, 2002; Nelson, 2003; Gerlach and Svensson, 2003). On the other hand, a large number of the theoretical and empirical works emphasised the role of monetary and credit developments in the transmission of monetary policy shocks and the determination of the price level (Bernanke and Gertler, 1995; Engert and Selody, 1998). For example, when bank credit is rationed via non-price mechanisms, monitoring credit aggregates helps to better understand the economic and financial outlook and the likely impact of monetary policy actions on price developments.[15]

Furthermore, a shock to the financial system which increases the efficiency in the banking sector may reduce the cost of intermediation, thus making credit more readily available. This in turn leads to increasing demand and building inflationary pressures.

Summing up, we showed that following episodes of significant monetary growth inflation occurred in a less than expected number of times. In particular, a set of probit regressions suggests that inflationary pressures materialize only when the economy is growing at a fast rate and possible financial imbalances are gathering. This, in turn, leads us to conclude that, together with strong monetary growth, there should also other "fundamental" factors at work for the occurrence of inflationary outburst in the short run. This result is fully consistent with the large body of the empirical literature providing evidence that in the short run output gap measures and business cycle indicators are better suited at forecasting inflation.[16] The analysis of the joint development of the variables which turned out to be significant for the inflationary outcome is beyond the scope of this work, but it indeed represents a possible avenue for future research.

[15] See the large body of the credit rationing literature which followed Stiglitz and Weiss (1981).

[16] See Orphanides and Van Norden (2005), Banerjee et al. (2005) and Stock and Watson (2006) for some recent contributions.

Our empirical results suggest also that large increases in monetary aggregates are less likely to be inflationary when output growth is subdued, other assets are not experiencing unjustified price rallies, and credit developments are along trend standards. In that case other reasons of the increased money growth have to be investigated, which are, however, less likely to lead to inflationary consequences. For instance portfolio-shift between assets may be the results of temporary change in investors' preference for safe and liquid assets included in broad monetary aggregates. This in turn may happen in periods of high financial market volatility, very low level of interest rates or heightened economic and geopolitical uncertainty.

5. Conclusions

We investigated the short-run consequences of periods of strong monetary growth for inflation dynamics in 15 industrial economies. As a first step, we detected 71 episodes of prolonged money growth above trend values. We then checked in how many cases the inflation gap had increased significantly over a 3-year horizon. We found that in roughly half of the cases strong monetary dynamics were followed by prices development that can be labelled as inflationary. This result is striking considering that we focused only on periods of abnormal money growth for which we expected a much higher correlation with prices. However, our finding is in line with the recent studies by Bachmeier and Swanson (2005), De Grauwe and Polan (2005) and Assenmacher-Wesche and Gerlach (2006a) that suggest that the predictive capacity of monetary aggregates for inflation dynamics may be weak at shorter horizons and when inflation is at very low levels.

As a further step we extended the analysis by considering whether the evolution of various macroeconomic and financial variables during the excess money growth episodes could help to predict inflation. The results from an econometric investigation based on probit regressions suggest that developments in asset prices (both stock and housing prices) and in credit to the private sector help identify the implications for price dynamics over three years after the strong monetary growth. In particular, it appears that the relationship is non-linear. A strong increase in the probability of recording inflation is associated with an increase in one of the two indicators only when the other is already at high levels. Even large increases in one

of the two variables do not lead to a worrying increase in the probability when the other is below the trend value.

Our analysis support the view that when money growth is accompanied by strong credit and asset prices growth, it seems to be "more fundamental" in nature and more likely to lead to inflationary pressures. Conversely, when strong monetary dynamics are not accompanied by high credit growth and strong dynamics in asset prices, other determinants seem to affect monetary growth, which are not necessarily linked to inflationary consequences. In the latter case, the probability that excessive money growth are be followed by inflationary outbursts is much lower.

A note of caution in interpreting our results has to be mentioned. In our analysis the role of monetary policy is not explicitly considered. A central bank may react to an excessive increase in monetary aggregates, thereby changing the contemporaneous and subsequent behaviour of other macroeconomic and financial variables. Such responses might have been different not only across time but also across countries. However, a possible qualitative assessment about the monetary policy stance during the analysed episodes may be extracted from the changes in the short-term nominal and real interest rates. The preliminary analysis has shown that the level of those rates are lower during than after the episodes which were followed by a significant increase in inflation, while the opposite is true for the non-inflationary episodes. Thus, even though we did not test the appropriateness of the stance in each country, for instance through a Taylor rule, the fact the we recorded an average large and significant increase in the short-term nominal rates after the inflationary episodes may suggest that the stance was relatively loose in those periods of excess money growth. On the opposite, the evidence of an average interest rates reduction after the episodes that were not followed by an increase in inflation hints to a tighter policy stance which may have contributed to the price stability.

Appendix

Description of the data and their sources

This appendix contains additional information about the series used in our analysis. In order to save space, we present them in a table format. The main sources for the series were: BIS, Datastream, Euro area wide model (AWM), Eurostat, Global Financial Data, IMF International Financial Statistics (abbreviated as IMF), the respective National Central Banks for each country, OECD Main Economic Indicators (abbreviated as OECD) and Reuters. All data are seasonally adjusted (with the exception for the interest rates, exchange rates and the stock market index) either from the original source (whenever available) or via the multiplicative (ratio to moving average) method. Sources are reported in italics below each series to which they refer to.

		Australia	Canada	Denmark	Euro area
Inflation rate	*Definition*	year-on-year changes in the CPI - all items (base year = 1990)	year-on-year changes in the CPI - all items (base year = 1992)	year-on-year changes in the HICP, before 1992 based on the rates of change of CPI (excluding owner occupied housing)	year-on-year changes in the HICP, before 1992 based on the rates of change of national CPIs (excluding owner occupied housing, except for Spain)
	Source	*Reserve Bank of Australia*	*BIS*	*ECB, Eurostat*	*ECB, Eurostat*
Nominal GDP	*Definition*	gross domestic product at current prices	gross domestic product at market prices (current prices, including 2001 revisions)	gross domestic product at market prices (current prices)	gross domestic product at current prices, based on aggregating national GDP data using the irrevocable fixed exchange rates
	Source	*Reserve Bank of Australia*	*BIS*	*Eurostat. Global Financial Data*	*Area wide model, ECB, Eurostat*
Real GDP	*Definition*	gross domestic product at constant prices, chain volume measure	gross domestic product at market prices - chained 1997	gross domestic product at market prices (constant 1995 prices)	gross domestic product at market prices (constant 1995 prices), based on aggregating national GDP data using the irrevocable fixed exchange rates
	Source	*Reserve Bank of Australia*	*BIS*	*Eurostat, Global Financial data*	*Area wide model, ECB, Eurostat*
Investment	*Definition*	investment, gross fixed capital formation (SNA 93), current prices	investment, gross fixed capital formation, total (including 2001 revisions), current prices	investment, gross fixed capital formation, current prices	investment, gross fixed capital formation, current prices
	Source	*BIS*	*BIS, IMF*	*Eurostat*	*AWM, Eurostat*
Monetary aggregates	*Definition*	M3 stock (adjusted)	M3 (currency plus total privately-held chartered bank deposits)	M3 stock	M3 stock (adjusted after October 1997 for the effect of reclassifications, other revaluations, exchange rate variations and the enlargement in 2001)
	Source	*Reserve Bank of Australia*	*BIS*	*OECD*	*ECB calculations, ECB*
Credit aggregates	*Definition*	credit to the private sector	credit to the private sector	credit to the private sector	loans to the private sector stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations and the enlargement in 2001)
	Source	*IMF, Reserve Bank of New Zealand*	*OECD*	*BIS, OECD*	*ECB, ECB calculations*
Stock market prices	*Definition*	stock exchange prices, shares, overall index	S&P/TSX composite price index	KAX CSE all shares index	DJ Euto Stoxx 50 price index and, before 1987, share index covering a set of stocks representing 75%-80% of the total market capitalisation
	Source	*BIS, Global Financial Data*	*Datastream*	*Global Financial data, OECD*	*Datastream, Reuters*

		Australia	Canada	Denmark	Euro area
House prices	*Definition*	residential property prices	residential property prices	residential property prices	residential property prices
	Source	*BIS, Reserve Bank of Aistralia*	*BIS*	*BIS, Eurostat*	*ECB, ECB calculations, Eurostat*
Short-term interest rate	*Definition*	3-months bank accepted bills	money market interest rate, 3-months treasury bills	3-months money market interest rate (before 1982 call money rate)	EURIBOR, before 1999 weighted average of national 3-month money market interest rates, based on 2004 GDP weights at PPP exchange rates
	Source	*Reserve Bank of Australia*	*BIS*	*BIS, IMF*	*BIS, Reuters*
Long-term interest rate	*Definition*	10-year treasury bonds yield	10-year government bonds yield (before 1989 yiled on government bonds with maturity more than 10 years)	10-year government bond yield	weighted average of national 10-year government bond yields, based on 2004 GDP weights at PPP exchange rates
	Source	*BIS*	*BIS, IMF*	*BIS, IMF*	
Nominal effective exchange rate	*Definition*	nominal effective exchange rate, Australian dollar, based on currencies covering at least 90% of Australia's trade	nominal effective exchange rate	nominal effective exchange rate	nominal effective exchange rate, euro, broad index (euro area 12)
	Source	*BIS, Reserve Bank of Australia*	*BIS*	*IMF*	*BIS, ECB*
Real effective exchange rate	*Definition*	real effective exchange rate, Australian dollar, 1990=100	real effective exchange rate, Canadian dollar, 1990=100	real effective exchange rate, Danish Kroner, 1990=100	real effective exchange rate, euro, 1990=100
	Source	*BIS*	*BIS*	*BIS*	*BIS*
Debt	*Definition*	government debt (as a percentage of nominal GDP)	gross federal government debt (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)
	Source	*BIS, IMF*	*Bankf of Canada, IMF*	*European Commission*	*European Commission*

		France	Germany	Italy	Japan
Inflation rate	*Definition*	year-on-year changes in the HICP, before 1992 based on the rates of change of CPI (excluding owner occupied housing)	year-on-year changes in the HICP, before 1992 based on the rates of change of CPI (excluding owner occupied housing)	year-on-year changes in the HICP, before 1992 based on the rates of change of CPI (excluding owner occupied housing)	year-on-year changes in the CPI - all items (whole country)
	Source	*ECB, Eurostat*	*ECB, Eurostat*	*ECB, Eurostat*	*BIS*
Nominal GDP	*Definition*	gross domestic product at market prices (current prices, ESA 95)	gross domestic product at market prices (current prices, ESA 95)	gross domestic product at market prices (current prices, ESA 95)	gross domestic product at market prices (current prices, SNA 93)
	Source	*ECB, Eurostat, IMF*	*ECB, Eurostat, IMF*	*ECB, Eurostat, IMF*	*BIS, IMF*
Real GDP	*Definition*	gross domestic product at market prices (constant 1995 prices)	gross domestic product at market prices (constant 1995 prices)	gross domestic product at market prices (constant 1995 prices)	gross domestic product at market prices (constant 2000 prices, chained, SNA 93)
	Source	*ECB, Eurostat, IMF*	*ECB, Eurostat, IMF*	*ECB, Eurostat, IMF*	*BIS, IMF*
Investment	*Definition*	investment, gross fixed capital formation, current prices	investment, gross fixed capital formation, current prices	investment, gross fixed capital formation, current prices	investment, gross fixed capital formation (SNA 93), current prices
	Source	*Eurostat, IMF*	*Eurostat, IMF*	*Eurostat, IMF*	*BIS, IMF*
Monetary aggregates	*Definition*	M3 stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	M3 stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	M3 stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	M2 + certificates of deposits (CDs) stock
	Source	*ECB calculations, ECB*	*ECB calculations, ECB*	*ECB calculations, ECB*	*BIS*
Credit aggregates	*Definition*	loans to the private sector stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	loans to the private sector stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	loans to the private sector stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	credit to the private sector by domestically licensed banks
	Source	*ECB, ECB calculations*	*ECB, ECB calculations*	*ECB, ECB calculations*	*OECD*
Stock market prices	*Definition*	CAC 40 shares price index and, before 1988, CAC general index	CDAX total share price index	share overall price index (MIB) and, before 1974, BCI general index	Nikkei 225 stock exchange prices index
	Source	*BIS, Global Financial Data*	*BIS, Global Financial Data*	*BIS, Global Financial Data*	*BIS*

		France	Germany	Italy	Japan
House prices	*Definition*	residential property prices	residential property prices	residential property prices	residential property prices
	Source	*ECB, Government Agency*	*ECB*	*ECB*	*BIS, Bank of Japan*
Short-term interest rate	*Definition*	3-month money market interest rates	3-month money market interest rates	3-month money market interest rates (before 1974 3-month treasury bills)	3-month repos on bonds - Gensaki - (before 1979 call money rate)
	Source	*Reuters*	*Reuters*	*Global Financial Data, Reuters*	*BIS, IMF*
Long-term interest rate	*Definition*	10-year government bonds yield	10-year public sector bonds yield	10-year government bonds yield	10-year government bond yield
	Source	*BIS*	*BIS*	*BIS*	*BIS, IMF*
Nominal effective exchange rate	*Definition*	nominal effective exchange rate	nominal effective exchange rate	nominal effective exchange rate	nominal effective exchange rate, yen
	Source	*IMF*	*IMF*	*IMF*	*BIS, Bank of Japan*
Real effective exchange rate	*Definition*	real effective exchange rate	real effective exchange rate	real effective exchange rate	real effective exchange rate, Japanese yen, 1990=100
	Source	*IMF*	*IMF*	*Banca d'Italia, IMF*	*BIS*
Debt	*Definition*	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)
	Source	*European Commission*	*European Commission*	*European Commission*	*European Commission*

		Netherlands	New Zealand	Norway	Spain
Inflation rate	*Definition*	year-on-year changes in the HICP, before 1992 based on the rates of change of CPI (excluding owner occupied housing)	year-on-year changes in the CPI - all items	year-on-year changes in the CPI - all items	year-on-year changes in the HICP, before 1992 based on the rates of change of CPI
	Source	*ECB, Eurostat*	*Reserve Bank of New Zealand*	*BIS*	*ECB, Eurostat*
Nominal GDP	*Definition*	gross domestic product at market prices (current prices, ESA 95)	gross domestic product at market prices (current prices)	gross domestic product at market prices (current prices)	gross domestic product at market prices (current prices, ESA 95)
	Source	*ECB, Eurostat, IMF*	*Global Financial Data, IMF*	*IMF*	*ECB, Eurostat, IMF*
Real GDP	*Definition*	gross domestic product at market prices (constant 1995 prices)	gross domestic product at market prices (constant 1995/96 prices, chained, SNA 93)	gross domestic product at market prices (constant 2001 prices)	gross domestic product at market prices (constant 1995 prices)
	Source	*ECB, Eurostat, IMF*	*BIS, Global Financial Data, IMF*	*IMF*	*ECB, Eurostat, IMF*
Investment	*Definition*	investment, gross fixed capital formation, current prices	investment, gross fixed capital formation (SNA 93), current prices	investment, gross fixed capital formation, total (ESA 95), current prices	investment, gross fixed capital formation, current prices
	Source	*Eurostat*	*BIS, IMF, Reserve Bank of New Zealand*	*Eurostat, IMF*	*Eurostat, IMF*
Monetary aggregates	*Definition*	M3 stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	M3 stock	M2 stock	M3 stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)
	Source	*ECB calculations, ECB*	*OECD*	*OECD*	*ECB calculations, ECB*
Credit aggregates	*Definition*	loans to the private sector stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)	credit to the private sector	credit by all financial institutions	loans to the private sector stock (adjusted after October 1997 for the effect of reclassifications, other revaluations and exchange rate variations)
	Source	*ECB, ECB calculations*	*OECD, Reserve Bank of New Zealand*	*OECD*	*ECB, ECB calculations*
Stock market prices	*Definition*	stock exchange all shares price index	NZSE All shares Capital index	OSE Total TOTX share prices index	shares overall price index and, before 1985, Madrid general index
	Source	*BIS, Global Financial Data*	*OECD*	*Global Financial data, OECD*	*BIS, Global Financial Data*

		Netherlands	New Zealand	Norway	Spain
House prices	*Definition*	residential property prices	residential property prices	residential property prices	residential property prices
	Source	*ECB*	*BIS, Reserve Bank of New Zealand*	*BIS, Statistics Norway*	*ECB*
Short-term interest rate	*Definition*	3-month money market interest rates (before 1972 3-month treasury bills)	3-month bank bills yield	3-month money market interst rates - Nibor - (before 1978 call money rate)	3-month money market interest rates
	Source	*Reuters*	*OECD*		*Reuters*
Long-term interest rate	*Definition*	10-year government bond yield	10-year government bond yield	10-year government bond yield	10-year government bonds yield (before 1977 10-year government bonds yield)
	Source	*BIS, IMF*	*BIS, IMF*	*BIS, IMF*	*BIS, Global Financial Data*
Nominal effective exchange rate	*Definition*	nominal effective exchange rate	nominal effective exchange rate calculated on the basis of representative market rates for the currencies in the basket	nominal effective exchange rate	nominal effective exchange rate
	Source	*IMF*	*BIS, Reserve Bank of New Zealand*	*IMF*	*IMF*
Real effective exchange rate	*Definition*	real effective exchange rate	real effective exchange rate, New Zealand dollar, 1990=100	real effective exchange rate, Norvegian Kroner, 1990=100	real effective exchange rate
	Source	*IMF*	*BIS*	*BIS*	*IMF*
Debt	*Definition*	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series)(as a percentage of nominal GDP)	public government debt (as a percentage of nominal GDP)	government debt (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)
	Source	*European Commission*	*Global Financial Data, IMF, Reserve Bank of New Zealand*	*European Commission, IMF, OECD*	*European Commission*

		Sweden	Switzerland	United Kingdom	United States
Inflation rate	*Definition*	year-on-year changes in the HICP, before 1992 based on the rates of change of CPI (excluding owner occupied housing)	year-on-year changes in the CPI - all items (base year = 2000)	year-on-year change in the retail prices index - all items	year-on-year changes in the CPI - all items (all urban consumers)
	Source	*ECB, Eurostat*	*OECD*	*UK Office for National Statistics*	*BIS*
Nominal GDP	*Definition*	gross domestic product at market prices (current prices)	gross domestic product at market prices (current prices, ESA 95)	Gross domestic product at market prices (current prices)	gross domestic product at market prices (current prices, including 1999 revisions)
	Source	*Eurostat, Global financial data*	*BIS, IMF*	*Eurostat*	*BIS*
Real GDP	*Definition*	gross domestic product at market prices (constant 1995 prices)	gross domestic product at market prices (ESA 95, constant 2000 prices, chained)	gross domestic product at market prices (constant 1995 prices)	gross domestic product at market prices (constant 2000 prices, chained)
	Source	*Eurostat, Global Financial Data*	*BIS, IMF*	*Eurostat*	*BIS*
Investment	*Definition*	investment, gross fixed capital formation, current prices	investment, gross fixed capital formation, total (ESA 95), current prices	investment, gross fixed capital formation, current prices	investment, gross fixed capital formation, total, current prices
	Source	*Eurostat*	*BIS, IMF*	*Eurostat*	*BIS*
Monetary aggregates	*Definition*	M3 stock	M3 stock	M4 stock	M2 (M1 plus small time and saving deposits and money market funds)
	Source	*OECD*	*OECD*	*OECD*	*BIS*
Credit aggregates	*Definition*	credit to the private sector	credit to the private sector	loans to the private sector	commercial bank credit
	Source	*BIS, IMF*	*IMF, OECD*	*Bank of England*	*OECD*
Stock market prices	*Definition*	shares overall index (SAX) and, before 1996, share prices AFGX index	UBS 100 share price index	FTSE 100 - price index	S&P 500 composite price index
	Source	*BIS, OECD*	*OECD*	*Global Financial Data, Reuters*	*Reuters*

		Sweden	Switzerland	United Kingdom	United States
House prices	*Definition*	residential property prices	residential property prices	residential property prices	residential property prices
	Source	*BIS, Statistics Sweden*	*BIS, OECD, Swiss National Bank*	*Communities and Local Government (DCLG), UK Office for National Statistics*	*BIS, Office of Federal Housing Enterprise Oversight (OFHEO)*
Short-term interest rate	*Definition*	3-month treasury bills yield	3-months money market interest rate (before 1974 discount rate)	3-month sterling interbank deposits interest rate (before 1977 treasury bill interest rate)	3-month money market treasury bills interest rates
	Source	*Global Financial data, OECD*	*IMF, OECD*	*BIS, IMF*	*BIS*
Long-term interest rate	*Definition*	10-year government bond yield	10-year government bond yield	10-year government bond yield	10-year government bond yield (before 1966 10-year tresury bonds yield)
	Source	*BIS, IMF*	*IMF*	*BIS, IMF*	*BIS, Reuters*
Nominal effective exchange rate	*Definition*	nominal effective exchange rate	nominal effective exchange rate	nominal effective exchange rate, broad index	nominal effective exchange rate, broad index, weighted average of the foreign exchange value of the US dollar against the currencies of a broad group of US trading partners
	Source	*IMF*	*BIS*	*BIS*	*BIS, FED*
Real effective exchange rate	*Definition*	real effective exchange rate, Swedish Kronor, 1990=100	real effective exchange rate, Swiss franc, 1990=100	real effective exchange rate, Sterling pound, 1990=100	real effective exchange rate, US dollar, 1990=100
	Source	*BIS*	*BIS*	*BIS*	*BIS*
Debt	*Definition*	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)	total government debt (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)	general government consolidated gross debt Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (as a percentage of nominal GDP)
	Source	*European Commission*	*BIS, IMF*	*European Commission*	*European Commission*

Notes: sources are reported in italics. To backdate a series, the growth rates of the longer available series further back in the past are used.

[1]For the BIS source of house price series see the paper "What drives housing price dynamics: cross-country evidence", by K. Tsatsaronis and H. Zhu.

[2]For more information on the construction of M3 and GDP series for the euro area, see the ECB Occasional Paper no. 3 "Estimating the trend of M3 income velocity underlying the reference value for monetary growth", by Claus Brand, Dieter Gerdesmeier and Barbara Roffia, May 2002.

[3]For more information on the AWM dataset, see the ECB Working Paper no. 42 "An area-wide model (AWM) for the euro area", by Gabriel Fagan, Jérôme Henry and Ricardo Mestre, January 2001.

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