Can excess liquidity signal an asset price boom ?

Working Paper Research

by Annick Bruggeman

August 2007 No 117

National Bank OF BELGIUM
Eurosystem

Editorial Director

Jan Smets, Member of the Board of Directors of the National Bank of Belgium

Statement of purpose:

The purpose of these working papers is to promote the circulation of research results (Research Series) and analytical studies (Documents Series) made within the National Bank of Belgium or presented by external economists in seminars, conferences and conventions organised by the Bank. The aim is therefore to provide a platform for discussion. The opinions expressed are strictly those of the authors and do not necessarily reflect the views of the National Bank of Belgium.

Orders

For orders and information on subscriptions and reductions: National Bank of Belgium,
Documentation - Publications service, boulevard de Berlaimont 14, 1000 Brussels

Tel +32 2 221 20 33 - Fax +32 2 21 30 42

The Working Papers are available on the website of the Bank: http://www.nbb.be

ISSN: 1375-680X (print)
ISSN: 1784-2476 (online)

Abstract

This paper analyses the relationship between the prevailing liquidity conditions (such as measures of money, credit and interest rates) and developments in asset prices from a monetary analysis perspective. After having identified periods of sustained excess liquidity, we analyse under which conditions they are more likely to be followed by an asset price boom. The results from a descriptive analysis of the developments in a number of macroeconomic and financial variables suggest that periods of sustained excess liquidity that are accompanied by strong economic activity, low interest rates, high real credit growth and low inflation have a higher likelihood of being followed by an asset price boom. This conclusion is also confirmed by a logit analysis.

JEL-code : E41, E51, E52.
Keywords: excess liquidity, asset prices, logit model.

Corresponding author:

NBB, Research Department, e-mail: annick.bruggeman@nbb.be

Paper prepared for the BIS Autumn 2006 Central Bank Economists' Meeting.

My special thanks go to David Cornille for constructing the database used in this paper and for his research assistance. I also thank, without implicating, Luc Aucremanne, Jef Boeckx, Emmanuel Dhyne and Vincent Périlleux for very helpful discussions and suggestions.

TABLE OF CONTENTS

1. INTRODUCTION

The empirical research on leading indicators for inflation is vast compared to that on leading indicators for asset price booms. This differential treatment can most likely be explained by the fact that monetary policy is geared towards containing consumer price inflation, while central banks generally do not have a target for asset price inflation. However, the large swings in asset prices (equity as well as real estate) over the past decade and their impact on the real economy have recently attracted the attention of researchers and policymakers alike.

One of the issues investigated in recent years is the role of monetary variables in predicting periods of financial instability or asset price booms that lead to costly recessions in the bust phase. Borio and Lowe (2002; 2004), for example, find that sustained strong credit growth combined with large rises in asset prices increases the probability of an episode of financial instability or a banking crisis. In the same vein, Detken and Smets (2004) suggest that money and credit growth could be useful indicators to distinguish between high-cost booms (in terms of the subsequent drop in real GDP) and low-cost booms relatively early on. They find that real money growth is significantly higher during the two-year pre-boom period for the high-cost booms, while during the asset price boom itself, credit growth is significantly higher too. Finally, in a follow-up paper, Adalid and Detken (2007) again find a strong association between money growth and those asset price booms that led to more costly recessions in the bust phase.

This paper differs from the work cited above in two ways. First, it analyses the issue from the opposite perspective, namely whether periods of excess liquidity are generally followed by asset price booms. The finding that most high-cost booms are preceded by high money growth does not necessarily imply that all periods of excess liquidity signal an imminent asset price boom. For policymakers, however, it is important to know to what extent they can rely on a specific (set of) variable(s) as a warning signal for asset price booms. It is particularly important to know whether a specific event is often followed by an asset price boom, or whether this is only the case under certain conditions, such as a combination of events, as suggested by Borio and Lowe (2002; 2004). Second, this paper does not aim at constructing the best leading indicator for asset price booms, but instead focuses on the potential role of one particular indicator, namely excess liquidity. This choice can be motivated by the prominent role that money plays within the monetary policy strategy of the Eurosystem. While monetary analysis initially concentrated on money's role as an indicator of inflationary pressures in the medium to longer term, more recently it has also been used in the context of asset price developments (Issing, 2003). For instance, in the Editorial of its October 2004 Monthly Bulletin, the ECB warns that "... high excess liquidity and strong credit growth could become a source of substantial asset price increases". Contrary to Gouteron and Szpiro (2005), who find that excess liquidity does not generally help to explain movements in stock prices or

residential property prices, this paper stresses the importance of allowing for non-linearities in the relationship between liquidity and asset prices and of analysing combinations of events. To take account of the likely non-linearities, we restrict our set of observations to periods of sustained excess liquidity. But even then, we find that only about one-third of these periods have been followed by an asset price boom, which seems to confirm the conclusion of Gouteron and Szpiro (2005) and clearly warns against a 'naive' type of monetary analysis. We therefore investigate whether information on the developments in other variables could help in distinguishing the periods that have been followed by an asset price boom from those that have not. We find that specific combinations of events do seem to increase the likelihood of periods of sustained excess liquidity being followed by asset price booms.

The structure of the paper is as follows. The next section is devoted to the selection of the periods of sustained excess liquidity and describes them in terms of their length, the typical size of the money gap and their distribution over time and across countries. Section 3 analyses a number of macroeconomic and financial developments associated with the identified periods of sustained excess liquidity. In section 4, we report how often the identified excess liquidity periods have been followed by an asset price boom. Section 5 analyses which macroeconomic and/or financial variables might help to signal an increased risk of an imminent asset price boom. Finally, section 6 deals with the real-time identification of the periods of sustained excess liquidity and section 7 concludes.

2. IDENTIFICATION OF PERIODS OF SUSTAINED EXCESS LIQUIDITY

The empirical analysis is based on a dataset of quarterly figures for 18 industrial countries, namely Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States. The sample starts in the first quarter of 1970 (whenever possible) and ends in the last quarter of 2005.

In line with Borio and Lowe (2002; 2004), we focus on cumulative imbalances, rather than on growth rates, when identifying periods of excess liquidity or asset price booms. This implies that excess liquidity can be the result not only of a relatively short period of very strong money growth, but also of a sustained period of above-average money growth. This focus on cumulative imbalances or gap measures also implies that we disregard the long-term developments to a certain extent, while it is exactly the long-term trend in monetary data that is generally found to contain most of the information regarding future inflation. As a consequence, the relative impact of the noisy part of monetary developments could become too large in our analysis compared to the signal, in

which case the link between money and asset prices could be underestimated. However, we try to limit the impact of the noisy part by setting a lower limit to the length of the periods of sustained excess liquidity. Moreover, taking out the long-term trend of monetary data also has the advantage that it results in data that are probably more comparable to the current situation in which the nominal trend can be considered to be relatively flat.

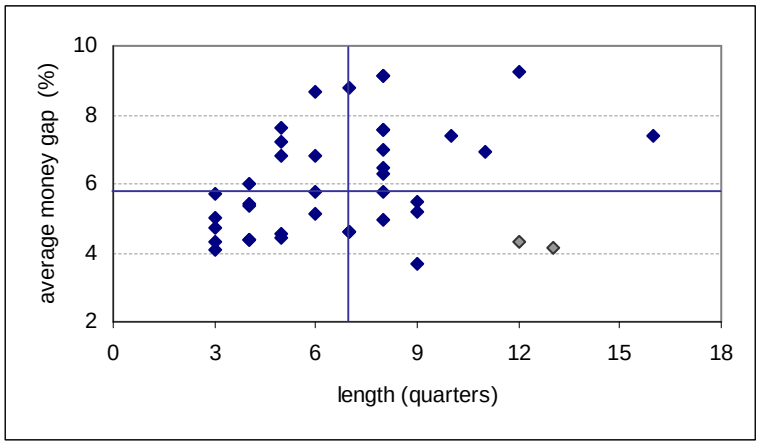
We define a period of sustained excess liquidity as at least three consecutive quarters during which the money gap exceeds a specified cut-off level. The money gap is defined as the deviation of the broad money-to-GDP ratio from its trend level, which in turn is calculated as the HP-filtered series of the ratio of broad money to GDP, using a smoothing parameter of 10000. The choice of the cut-off level is based on the statistical properties of the calculated money gaps. As the standard deviation of the money gap series for all countries combined is equal to 3.68%, the cut-off level is set at 3.75%.

Three 'corrections' have been applied. First, whenever three quarters of excess liquidity are separated by one quarter during which the money gap is still positive (but smaller than the cut-off level) the four quarters are considered as a period of sustained excess liquidity. Second, whenever two periods of sustained excess liquidity are separated by no more than four quarters, they are combined into one period. Third, the periods of excess liquidity that extend to the second half of 2003 or beyond are excluded from the analysis, as they do not enable us to determine whether or not the subsequent two-year period witnessed the start of an asset price boom[1].

This procedure results in the selection of 40 periods of sustained excess liquidity. Assuming that the best approximation of a typical period is the median of the distribution of all excess liquidity periods (to minimise the impact of outliers), we find that a period of sustained excess liquidity typically lasts for about seven quarters and is characterised by an average money gap of about 5¾%. As can be seen in Chart 1, these figures hide considerable heterogeneity. The length of the identified excess liquidity periods ranges from the imposed minimum of three quarters (e.g. in Germany, Ireland and Japan) to four years (in Switzerland during the second half of the 1990s). The smallest average money gap of 3.7% even stood slightly below the cut-off level (because two intermediate quarters were included), whereas the largest average money gap amounted to 9.3%. In general, there seems to be a positive relationship between the length of the excess liquidity period and the average money gap. There are two notable exceptions, namely Norway and Spain which both witnessed a rather long period of excess liquidity in the 1980s, during which the average money gap was relatively low.

1 An asset price boom is defined in section 4 of the paper as a period of at least three consecutive quarters during which asset prices exceed their trend level by more than a specified percentage.

Chart 1: Some characteristics of the identified periods of sustained excess liquidity



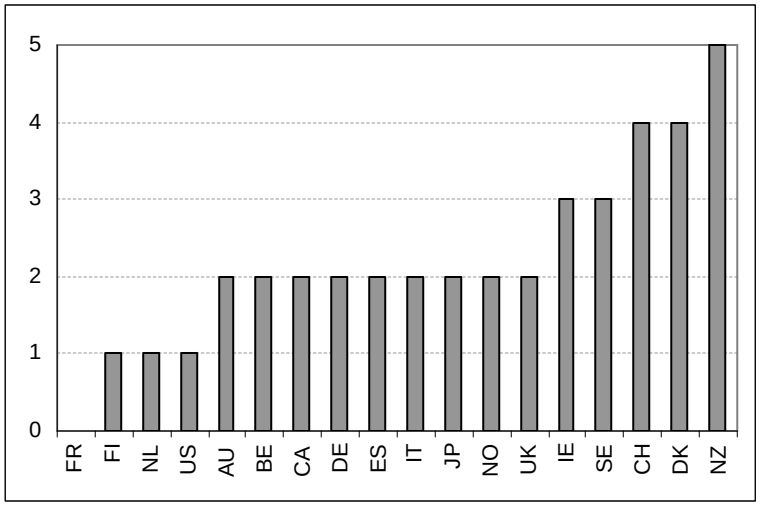
When classifying a period of sustained excess liquidity in the decade that contains its midpoint, several observations can be made. It is not possible to derive the typical features of periods of sustained excess liquidity in the 2000s, as we have retained only one such episode in our sample, so we disregard that period in this part of the analysis. Table 1 shows that the 1990s witnessed the largest number of sustained excess liquidity periods. At the same time, these were typically relatively short and most of them were characterised by a rather low average money gap. By contrast, the 1970s periods usually recorded the largest average money gap, while they were again relatively short. The longest periods of sustained excess liquidity were found in the 1980s, but the average money gap during these periods was generally rather low.

Table 1: Distribution of the periods of sustained excess liquidity over time

Midpoint	Number of periods	Length (quarters)			Average money gap (%)		
		1st quartile	Median	3rd quartile	1st quartile	Median	3rd quartile
1970-2003	40	4.8	7.0	8.0	4.6	5.7	7.3
1970-1979	12	4.0	6.5	8.0	5.7	6.6	7.1
1980-1989	9	6.0	7.0	9.0	4.3	5.1	6.8
1990-1999	18	4.3	6.5	8.0	4.6	5.2	7.4

The distribution of these periods of sustained excess liquidity across countries is not uniform either: the number of periods ranges from zero in France to five in New Zealand. Half of the countries witnessed two periods of sustained excess liquidity.

Chart 2: Geographical distribution of the periods of sustained excess liquidity



3. MACROECONOMIC AND FINANCIAL DEVELOPMENTS BEFORE, DURING AND AFTER PERIODS OF SUSTAINED EXCESS LIQUIDITY

In order to find some common patterns in macroeconomic and financial developments around periods of sustained excess liquidity, we analyse for each period a number of indicators over a variable time span, namely from two years before the start of the excess liquidity period up to two years after its end. Table 2 reports some summary statistics for these data. For this purpose, the quarterly data are first averaged over five specific time spans, namely each of the two years before the start of the excess liquidity period, the period itself and each of the two years after its end. The table then reports the median values across all identified periods of sustained excess liquidity of these average developments for each of the five time spans, as well as the median value of the variables across 'normal' periods, the latter being defined as those periods that witnessed neither sustained excess liquidity nor a sustained shortage of liquidity. We again use medians in this context instead of averages in order to avoid the typical developments being influenced by outliers. The selection of macroeconomic and financial indicators is motivated by our aim to explain both the causes and the consequences of the build-up of excess liquidity, but we are constrained by the availability of data. Most of the data in this section refer to annual growth rates of data expressed in real terms, such as real money growth, real GDP growth, real credit growth and real aggregate asset price inflation. As interest rates and inflation are characterised by a clear downward nominal trend over the time span considered, we use gap measures for these variables, i.e. deviations from their HP-filtered trend. Finally, we also show the results for the real aggregate asset price gap, because we will use this gap measure in the next section to define an aggregate asset price boom.

Table 2: Median values of some macroeconomic and financial variables before, during and after the identified periods of sustained excess liquidity

	Second year before the start	First year before the start	During	First year after the end	Second year after the end	'Normal'
Money gap	-1.1	0.4	5.7	0.4	-2.4	-0.3
Real money growth	4.7	5.4	6.6	-0.1	0.3	3.7
Real GDP growth	2.8	2.4	2.4	3.5	2.1	3.0
Short-term interest rate gap	0.3	0.6	-0.5	-0.1	0.2	-0.3
Long-term interest rate gap	0.1	-0.1	-0.3	0.2	0.4	0.0
Real credit growth	4.7	5.3	5.3	1.6	2.2	4.6
Inflation gap	-0.1	-0.4	-0.5	0.6	0.5	-0.1
Real aggregate asset price inflation	1.1	1.5	2.2	0.9	-1.0	1.6
Real aggregate asset price gap	-1.0	-1.0	0.8	0.2	-0.7	-1.4

Note: 'Normal' periods which witnessed neither excess liquidity nor liquidity shortage are characterised by a real money gap which lies between -3.75 and 3.75%.

Table 2 shows that the developments in the money gap before and after a period of sustained excess liquidity are quite different from the developments during such a period. The money gap usually remains negative up to three quarters before the start of the excess liquidity period - although real money growth is already quite strong in the two years leading up to the excess liquidity period - but subsequently picks up sharply. After the end of an excess liquidity period, real money growth is generally so low that it takes only three quarters for the large money gap to fall into negative territory again.

In order to analyse which variables may explain the occurrence of a period of sustained excess liquidity, we look at the developments in the traditional determinants of money demand, namely economic activity and opportunity costs, particularly during and in the run-up to the periods of sustained excess liquidity. We find no evidence that most excess liquidity periods would have been driven by a business cycle upturn: real GDP growth even seems to be somewhat lower both before and during a typical excess liquidity period than during a 'normal' period, although the difference is statistically insignificant. The interest rate gaps, however, seem to play a more important role. The periods of strong real money growth (before and during the excess liquidity periods) are generally characterised by a declining long-term interest rate gap and thus falling opportunity costs of holding money. Similarly, after the end of the excess liquidity period, the long-term interest rate gap typically rises while real money growth falls. The short-term interest rate gap tends to reach a peak only shortly before the start of an excess liquidity period, but then drops considerably up until the first few quarters of the excess liquidity period. This suggests that periods of sustained excess liquidity have often been accompanied by a loosening of monetary policy and the induced fall in the

opportunity costs of holding money. This hypothesis is supported by the fact that the developments in real credit growth were very similar to those in real money growth, although the changes in credit growth were generally smaller and more gradual.

As periods of sustained excess liquidity often seem to have been accompanied by a decline in the interest rate gaps, such periods might well be signalling a rise in consumer prices and/or asset prices. To which extent this has been the case can be checked in the lower part of Table 2. The reported median values suggest that most of the identified excess liquidity periods indeed have been followed by an increase in the inflation gap.

The interpretation of the developments in asset prices following a period of sustained excess liquidity is less clear-cut, however. The analysis is based on a real aggregate asset price index, calculated by the BIS, which combines information on a stock market index, a price index for residential property and one for commercial property when available and weights these components by estimates of the relative shares of these asset classes in the private sector's wealth[2]. The median values reported in the lower part of Table 2 indicate that the rate of growth of this real aggregate asset price index typically reaches a peak during the excess liquidity period and moderates considerably afterwards. Looking at the real aggregate asset price gap instead yields a similar result. This suggests that a large proportion of the excess liquidity periods have not been followed by higher asset price inflation, in which case this behaviour would not turn up in the median values.

While this evidence does not imply that periods of sustained excess liquidity cannot be used as a signalling device for imminent asset price booms, it does suggest that some additional conditions will need to be met before a period of sustained excess liquidity is likely to be followed by higher real aggregate asset price inflation. In what follows, we will analyse how often and under which circumstances a period of sustained excess liquidity is most likely to be followed by an asset price boom.

4. HOW OFTEN ARE THESE EXCESS LIQUIDITY PERIODS FOLLOWED BY AN ASSET PRICE BOOM?

An asset price boom is defined as a period of at least three consecutive quarters during which the real aggregate asset price index exceeds its trend level by more than 10% (i.e. approximately one standard deviation). This trend level is calculated by running a smooth HP-filter on the series of the

2 The methodology is described in detail in Borio, Kennedy and Prowse (1994). We thank Steve Arthur for kindly supplying us with the data on this real aggregate asset price index.

real aggregate asset price index. One 'correction' has been applied: as was the case when identifying the excess liquidity periods, whenever three quarters of an exceptionally large asset price gap are separated by one quarter during which the gap is still positive but smaller than the cut-off level, the four quarters are considered as an asset price boom.

According to this procedure, only about one-third of the periods of sustained excess liquidity, i.e. 14 out of 40, have been followed by an asset price boom, in that the identified boom starts either during the period of sustained excess liquidity or within two years after the end of such a period. This ratio of periods of sustained excess liquidity that have been followed by an aggregate asset price boom - henceforth XLB periods - was not uniformly distributed over time, as can be seen in Table 3 where the periods of sustained excess liquidity are categorised on the basis of their midpoint. While half of the excess liquidity periods of the 1970s have been followed by an asset price boom (6 out of 12), this ratio declined to one-third (3 out of 9) for the 1980s periods and further to about one-fourth (5 out of 18) for the 1990s periods. The most recent period of sustained excess liquidity was not followed by an asset price boom, but that sample is clearly too small to draw any conclusion. Nevertheless, it seems that the chances of an excess liquidity period being followed by an asset price boom - as we defined it - have declined over time.

Table 3: Distribution of the excess liquidity periods depending on whether or not they were followed by an asset price boom

	Number of periods	Followed by a boom		Not followed by a boom	
1970-2003	40	14	35%	26	65%
1970-1979	12	6	50%	6	50%
1980-1989	9	3	33%	6	67%
1990-1999	18	5	28%	13	72%
2000-2003	1	0	0%	1	100%

It should be mentioned that there are also quite a few asset price booms that have not been preceded by a period of sustained excess liquidity. In fact, out of the 42 aggregate asset price booms for which we have obtained money data in the two years before their start, only 14 were preceded by a period of sustained excess liquidity. The analysis presented in this paper should therefore in no way be seen as an attempt to construct the best leading indicator for asset price booms. At the same time, the link between excess liquidity and asset price booms is also more complex than we assume in this paper, as suggested by the fact that our sample of aggregate asset price booms also contains 13 boom periods that were followed by a period of sustained excess liquidity, suggesting that the temporal precedence is not unidirectional.

5. WHAT DETERMINES WHETHER OR NOT A PERIOD OF SUSTAINED EXCESS LIQUIDITY IS FOLLOWED BY AN ASSET PRICE BOOM?

The results presented in this section are based on an event study and thus only refer to the timing of phenomena such as periods of sustained excess liquidity and asset price booms. The results should therefore not be interpreted as implying causality between excess liquidity and asset price booms.

As a first step, we analyse, in a purely descriptive way, whether some macroeconomic and financial indicators could help differentiate between the XLB periods and those periods of sustained excess liquidity that have not been followed by an aggregate asset price boom. This approach has a number of disadvantages, however. First, the information is summarised by looking at the median values of the distribution only, which implies that quite a lot of information is ignored. Second, this descriptive analysis does not permit the impact of the relevant variables to be quantified and thus their relative importance to be assessed. Third, it is a simple bivariate approach which does not take account of possible interactions between the candidate explanatory variables. In order to overcome these disadvantages, we also estimate logit models that enable a formal quantification of the relative importance of those macroeconomic and financial variables that emerged from the descriptive analysis as most likely candidates to differentiate between the XLB periods and the other periods of sustained excess liquidity.

5.1 A descriptive analysis

The following macroeconomic and financial indicators are considered as potential explanatory variables: the length of the excess liquidity period, the money gap, the number of countries that simultaneously witness a period of excess liquidity (labelled synchronisation), real money growth, real GDP growth, the short-term interest rate gap, the long-term interest rate gap, real credit growth, the inflation gap and the real aggregate asset price inflation rate. For each of these variables, we calculate their average value during each period of sustained excess liquidity. We then categorise these average values into two subgroups according to whether or not the period has been followed by an asset price boom. We further assume that the distribution of these two subgroups can be summarised by their median value and then test whether the two medians are significantly different from one another by means of the rank-based Wilcoxon-Mann-Whitney WMW-test. In order to limit the impact of the (variable) length of these excess liquidity periods, we also calculate the average value of the indicators of interest over the first three quarters of each excess liquidity period. While this could be seen as a kind of robustness check, it could also help to detect changes in typical behaviour during longer periods of sustained excess liquidity.

Table 4: Macroeconomic and financial developments during excess liquidity periods, categorised according to whether or not they have been followed by an asset price boom

	Periods of sustained excess liquidity					
	Whole period			First three quarters		
	Boom	No boom	WMW-test	Boom	No boom	WMW-test
Real money growth	7.8	6.3		10.1	8.3	**
Real GDP growth	3.5	1.5	***	2.9	1.1	**
Short-term interest rate gap	-0.8	0.3	**	-1.8	1.1	***
Long-term interest rate gap	-0.7	0.0	**	-0.9	0.4	***
Real credit growth	8.1	4.4	*	9.2	4.2	
Length	8.0	6.5				
Money gap	6.6	5.4		5.6	5.3	
Synchronisation	3.4	3.6		3.5	3.8	
Inflation gap	-1.0	-0.2	**	-1.3	-0.4	**
Real aggregate asset price inflation	5.8	-1.1	***	6.1	-1.6	***

Note: The asterisks (***,** and *) denote that the null hypothesis of equal medians is rejected at the 1%, 5% and 10% level respectively on the basis of the rank-based Wilcoxon-Mann-Whitney test.

The results - summarised in Table 4 above - indicate that XLB periods typically recorded stronger real money growth, particularly during the first three quarters of the period, than those excess liquidity periods that were not followed by a boom. This stronger real money growth during XLB periods seems to have been fuelled by the traditional determinants of money demand, namely economic activity and opportunity costs. A typical XLB period is characterised by stronger real GDP growth and by lower interest rate gaps. The hypothesis that strong real money growth during XLB periods is driven by its traditional determinants is further supported by the evidence that real credit growth seems to be higher during XLB periods as well.

These XLB periods also seem to have been generally longer and characterised by a larger money gap, but these differences are statistically not significant at the 10% level. The degree of synchronisation across countries - measured as the number of countries that simultaneously witness a period of sustained excess liquidity - is found to always have been quite low, which probably explains why this variable does not seem to differ between a typical XLB period and a typical period that is not followed by an asset price boom.

The inflation gap is usually found to be lower during XLB periods, which is in line with the finding in Detken and Smets (2004) that inflation around boom periods is typically lower than in 'normal' periods. The combination of a lower inflation gap and higher real GDP growth could be seen as an indication that the majority of the asset price booms considered may have been triggered by favourable supply shocks. While such favourable supply shocks would justify a rise in asset prices (particularly stock prices), they often result in an overshooting of asset prices, as speculative rather

than fundamental investment motives gradually gain in importance. The fact that the interest rate gaps are also quite low during these XLB periods suggests that monetary policy may have attached too much weight to the initial downward impact on inflation of these favourable supply shocks, and may therefore have been too accommodating, allowing the financial imbalances to build up. This argument is very well documented in White (2006).

As almost half of our XLB periods took place in the 1970s, this favourable supply shock story comes to some extent as a surprise, since this decade is generally seen as being characterised by poor supply conditions (oil price shock, productivity slowdown, etc.) resulting in rather high and volatile inflation. It could be that our result is driven by the particular definition of the inflation gap measure (as the deviation from an HP-filtered trend) which could be especially problematic in the beginning of the sample and could lead to spurious large negative inflation gaps during some of the excess liquidity periods considered. Two types of robustness checks - the results of which are reported in section 5.3 - suggest, however, that only part of the impact can indeed be attributed to the biased estimate of the inflation gap at the beginning of the sample period.

Finally, the real aggregate asset price inflation rate is found to have been significantly higher for XLB periods than for the excess liquidity periods that were not followed by an asset price boom. Several factors could be behind this observation. A first explanation is a purely mechanical one: the higher the asset price inflation before and during the period of sustained excess liquidity, the higher the likelihood that the asset price gap will exceed the cut-off level of 10% during or after the period of sustained excess liquidity. This suggests that this differential development of the aggregate asset price inflation rate is simply induced by our definition of an asset price boom.

However, there is also a second (complementary) explanation which is more of an economic nature. The fact that the aggregate asset price inflation rate has typically been lower in periods of sustained excess liquidity that were not followed by an asset price boom could be seen as evidence of the 'benign' character of sustained excess liquidity periods that are the result of large portfolio shifts at times when, for instance, stock markets have been performing poorly. While the accumulated excess liquidity might drive up asset prices once these portfolio shifts are reversed, this would most likely not result in an asset price boom - as we defined it - given the poor performance of asset prices in the previous quarters. Unfortunately, it is not possible to quantify the relative importance of this complementary explanation for the differential developments in real aggregate asset price inflation. However, the real aggregate asset price inflation rate during those excess liquidity periods that were not followed by an asset price boom is not only low compared to the XLB periods, but also compared to the 'normal' periods described in Table 2, which seems to back up this additional interpretation.

If this second explanation holds, one would expect to find that the real aggregate asset price inflation rate also helps to differentiate between periods of sustained excess liquidity that have been followed by a period of excess inflation and those that have not. In order to test this hypothesis, we define a period of excess inflation as a period of at least three quarters during which the inflation rate exceeds its trend level by more than 2 percentage points (i.e. about one standard deviation of the estimated inflation gaps for all countries combined). We then find that those excess liquidity periods that turned out not to be inflationary were indeed characterised by lower real aggregate asset price inflation, although the difference is found to be significant at the 22% level only. The median value of the real aggregate asset price inflation rate during these non-inflationary periods of excess liquidity is only -0.3%, while it is 4.8% for the excess liquidity periods that have been followed by excess inflation. When we restrict our attention to the first three quarters of the excess liquidity periods, the difference becomes significant at the 3% level, as the median values then stand at -1.5% and 5.8% respectively. These results suggest that the real aggregate asset price inflation rate can indeed help to differentiate between those periods of excess liquidity that are not likely to be followed by either an asset price boom or excess inflation and those periods that represent a higher risk in this respect, based on an economic interpretation.

Finally, as some of the asset price booms had already started during the excess liquidity period, in particular the longer ones, the averaging scheme applied could also have introduced an upward bias into the median value of the real aggregate asset price inflation rate during the XLB periods. However, we find the same significantly different behaviour of the real aggregate asset price inflation rate when we look at the four quarters before the start of the periods of sustained excess liquidity. This timing argument should thus be dismissed as an explanation for the differential developments in the real aggregate asset price inflation rate, since periods of sustained excess liquidity that are preceded by an asset price boom are not considered XLB periods.

To sum up, the preliminary conclusion that can be drawn from this descriptive analysis seems to be that the driving factors of the excess liquidity build-up determine whether or not the period is likely to be followed by an asset price boom. A period of excess liquidity is more likely to be followed by an asset price boom when the strong real money growth is mainly related to low interest rates and high economic growth and when at the same time the inflation gap is low. Mechanically speaking, a higher real aggregate asset price inflation rate also increases the likelihood of the real aggregate asset price gap passing the specified cut-off level. By contrast, a period of sustained excess liquidity is less likely to be followed by an asset price boom when the strong real money growth mainly results from portfolio shifts in the context of low real aggregate asset price inflation and low economic growth. An additional feature of these excess liquidity periods is that the interest rate gaps and the inflation gap are generally larger.

5.2 Logit models

Having identified which variables seem to behave differently across the two types of excess liquidity periods, we now test this in a more formal way by means of a logit model. The goal is to quantify the relationship between these variables and the probability that the excess liquidity period will be followed by an aggregate asset price boom.

The sample of observations again consists of the 40 periods of sustained excess liquidity that we identified, but due to the unavailability of some relevant data in some versions of the model, we reduce the sample to 38 periods of sustained excess liquidity (13 of which have been followed by an asset price boom) for which all versions of the model could be estimated. The dependent variable is constructed by setting it equal to 1 if the excess liquidity period is followed by an asset price boom (the XLB periods) and equal to 0 in the other cases. We thus estimate how the probability of the excess liquidity period being followed by an asset price boom can be explained by developments in variables such as real GDP growth, interest rate gaps, real credit growth, the inflation gap and real aggregate asset price inflation.

In order to judge the quality of the various models, we use three criteria. First, the estimated coefficients need to have the expected sign and should be significantly different from zero. Second, we analyse the predictive ability of the models by means of the classification table, assigning a value of 1 to the fitted dependent variable when the predicted probability is larger than 50% and a value of 0 otherwise. Finally, we look at the total gain (in terms of the percentage of correct predictions) compared to a naive constant probability model that predicts that none of the excess liquidity periods will be followed by an asset price boom, as the proportion of these periods is larger in our sample than that of the XLB periods.

As a first step, we include each of the variables identified in section 5.1 separately. This exercise broadly confirms the results of the descriptive analysis. Starting with the variables whose median values did not differ significantly between XLB periods and the other excess liquidity periods (i.e. the length of the excess liquidity period, the average size of the money gap and the degree of synchronisation), their coefficient has the expected positive sign in the logit model, but only the money gap coefficient is found to be statistically different from zero at the 10% level. The coefficient of the length of the excess liquidity period, for example, is estimated to be positive in model (1.1) in Table 5, but it is found not to be statistically different from zero at the 10% level.

Table 5: A selection of logit models with only one explanatory variable (and a constant)

	Model (1.1)			Model (1.2)			Model (1.3)			Model (1.4)			Model (1.5)		
	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value
Length excess liquidity period	0.17	0.04	0.16												
Inflation gap				-0.44	-0.09	0.08									
Real GDP growth							0.46	0.10	0.02						
Long-term interest rate gap										-1.03	-0.22	0.02			
Real credit growth													0.12	0.03	0.03
Correct predictions if Dep=0	24 out of 25			23 out of 25			22 out of 25			21 out of 25			23 out of 25		
Correct predictions if Dep=1	3 out of 13			3 out of 13			4 out of 13			5 out 13			5 out of 13		
Total gain (in pp) compared to the constant probability model	5.3			2.6			2.6			2.6			7.9		

Note: The constant probability model always predicts Dep=0.

The simple logit models also confirm the other results of the descriptive analysis: higher real money growth, real GDP growth, real credit growth or real aggregate asset price inflation (in the four quarters before the start of the excess liquidity period) all increase the probability of an asset price boom, while a larger interest rate gap or a larger inflation gap reduce this probability. The inflation gap coefficient in model (1.2), for example, is significantly negative at the 8% level. However, the predictions of this model are correct in only 26 of the 38 cases, although this is an improvement on the predictive power of a naive constant probability model by 2.6 percentage points. A similarly bad prediction performance is found for models (1.3) and (1.4) which feature real GDP growth and the long-term interest rate gap, respectively, with the expected signs. Finally, model (1.5) - in which the significantly positive coefficient of real credit growth might reflect the developments in both economic activity and interest rates - outperforms all other models with only one explanatory variable (and a constant) in that it correctly predicts the outcome in 28 of the 38 cases. A general feature of these 'univariate' models, however, is that they all perform quite badly in identifying the XLB periods.

As a second step, we therefore combine several of these variables to build a logit model that is able to accurately predict whether or not an excess liquidity period will be followed by an asset price boom. Model 2.1 combines real credit growth and the long-term interest rate gap. The results in Table 6 show that the signs of the coefficients are as expected. The probability of an asset price boom increases with real credit growth and decreases with the size of the long-term interest rate gap. While the predictive performance improves, particularly for the XLB periods, there are still a lot of boom periods that are not correctly signalled by model 2.1. We therefore add the real aggregate asset price inflation rate in the four quarters before the start of the excess liquidity period to obtain model 2.2. This variable shows up with the expected positive sign, but the coefficient of real credit growth becomes statistically insignificant. So, we can reduce the model to version (2.3) according to which the probability of an asset price boom following an excess liquidity period increases with the

real aggregate asset price inflation rate in the four quarters before the start of the excess liquidity period and decreases with the long-term interest rate gap.

Table 6: A selection of logit models with more than one explanatory variable

	Model (2.1)			Model (2.2)			Model (2.3)		
	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value
Real credit growth	0.12	0.02	0.05	-0.06	-0.01	0.49			
Long-term interest rate gap	-1.03	-0.22	0.04	-1.50	-0.27	0.02	-1.41	-0.26	0.02
Real aggregate asset price inflation (before)				0.28	0.05	0.02	0.24	0.04	0.01
Correct predictions if Dep=0	23 out of 25			23 out of 25			24 out of 25		
Correct predictions if Dep=1	7 out of 13			11 out of 13			11 out of 13		
Total gain (in pp) compared to the constant probability model	13.2			23.7			26.3		

Note: The constant probability model always predicts Dep=0.

When multiplying the estimated coefficients with the scale factor to obtain the marginal effect of the explanatory variables, our preferred model (2.3) suggests that, at the sample mean, one additional percentage point in the long-term interest rate gap would reduce the probability of an asset price boom by 26 percentage points. At the same time, one additional percentage point in the real aggregate asset price inflation rate (in the four quarters before the start of the excess liquidity period) would increase this probability by 4 percentage points. When comparing these marginal effects, however, one should take account of the fact that the range of values spanned by the real aggregate asset price inflation rate is much wider. It is therefore preferable to compare the marginal effects of changes in both variables of the size of one standard deviation compared to the sample mean. The marginal effects then amount to -26 and +37 percentage points respectively.

Table 6 also shows that, overall, the preferred model (2.3) correctly predicts 92% of the 38 observations. Only two of the 13 boom periods are not predicted by the model, while in one case, the model wrongly predicts an asset price boom. Compared to a naive constant probability model, our preferred model results in a total gain of 26.3 percentage points.

These results suggest that only some periods of sustained excess liquidity have signalled an aggregate asset price boom. They thus warn against a 'naive' type of monetary analysis that would simply look at measures of excess liquidity. Instead, a thorough analysis of the possible determinants of the accumulated excess liquidity is needed before any judgement can be made about its potential consequences in terms of the risk of higher asset price inflation.

5.3 Some robustness checks

A first type of robustness check aims at alleviating the problem of the beginning of the sample bias in the estimated inflation gap measure, by extending the dataset with data on consumer prices for the 1960s. This extension has no impact on the identification of the periods of sustained excess liquidity or of the aggregate asset price booms. It only affects the developments in the inflation gap measure during some of the excess liquidity periods considered. In fact, when restricting our attention to the more important changes in the average inflation gap (i.e. those of more than 15 basis points in absolute value), we find eight periods of sustained excess liquidity during which the average inflation gap becomes less negative or even positive (six of which were followed by an asset price boom) and one period (that was not followed by an asset price boom) during which the negative inflation gap becomes even more negative. This suggests that the impact of the inflation gap on the probability of ending up in an aggregate asset price boom will most likely be smaller than suggested in the previous two sections.

First, the median value of the inflation gap during the XLB periods increases to -0.7 percentage point (compared to -1.0 percentage point in Table 4), but it does remain lower than the median value of the inflation gap during the other excess liquidity periods of -0.1 percentage point, although the difference is only significant at the 17% level. When we only consider the first three quarters of the excess liquidity periods, the differential developments in the inflation gap are statistically significant at the 6% level. Second, in the estimated logit model with the inflation gap (and a constant), its coefficient has the expected negative sign, but its marginal effect declines from -0.09 to -0.08 and the significance level rises from 8% to 13%. Overall, this first type of robustness check suggests that only part of the impact found in the previous two sections can indeed be attributed to the biased estimate of the inflation gap at the beginning of the sample period.

A second type of robustness check aims at obtaining a sample of XLB periods that is more evenly distributed over time, to test for the impact of the dominance of the 1970s periods. This can be achieved by using an alternative cut-off level, for example, the third quartile. In that setting, a period of sustained excess liquidity is defined as at least three consecutive quarters during which the money-to-GDP ratio exceeds its trend level by more than 2% (instead of 3.75% in the first exercise). Similarly, an aggregate asset price boom is defined as a period of at least three consecutive quarters during which the real aggregate asset price gap is larger than 4.5% (instead of 10%). These alternative criteria enable 57 periods of sustained excess liquidity to be identified, 24 of which have been followed by an asset price boom. Unlike the XLB periods that were identified on the basis of the one standard deviation cut-off level, these XLB periods are distributed somewhat more evenly over time, as illustrated in Table 7. At the same time, a period now classifies more easily as an 'exceptional' period (in terms of developments in liquidity or asset prices), which could

be a serious disadvantage of this exercise given the importance of taking due account of the non-linearities involved in the whole analysis.

Table 7: Distribution over time of the excess liquidity periods that were followed by an asset price boom for different cut-off levels

	One standard deviation		Third quartile	
1970-1979	6	43%	9	38%
1980-1989	3	21%	8	33%
1990-1999	5	36%	6	25%
2000-2003	0	0%	1	4%

The lower cut-off level results in somewhat longer periods of excess liquidity: a typical excess liquidity period now lasts for about 8 quarters, compared to 7 quarters in the case of the higher cut-off level of about one standard deviation. It is therefore not surprising that some of the differential developments that are found during the first three quarters of the excess liquidity periods become statistically insignificant at the 10% level once the entire excess liquidity period is considered, particularly for the nominal variables. A period of excess liquidity is typically followed by a widening of the inflation gap. The probability of this inflation pickup already starting before the end of the excess liquidity period clearly increases with the length of that period. In addition, central banks will most likely react to the higher inflation by raising their key interest rates, which would then also give rise to higher market interest rates during the longer periods of sustained excess liquidity. In general, however, the results found in sections 5.1 and 5.2 are confirmed. As is shown in Table 8, the XLB periods typically recorded stronger real money growth which seems to have been supported by stronger real GDP growth and lower interest rate gaps. The hypothesis that these traditional determinants of money demand play a role is further supported by the fact that real credit growth has tended to be higher during the XLB periods too. The inflation gap is again found to have been typically lower during XLB periods, although this differential development now occurs almost exclusively during the first quarters of the excess liquidity periods.

Table 8: Macroeconomic and financial developments during excess liquidity periods, categorised according to whether or not they have been followed by an asset price boom

	Periods of sustained excess liquidity					
	Whole period			First three quarters		
	Boom	No boom	WMW-test	Boom	No boom	WMW-test
Real money growth	6.5	5.2		8.8	7.4	*
Real GDP growth	2.9	1.8	**	3.0	1.2	**
Short-term interest rate gap	-0.6	-0.2		-1.0	0.3	**
Long-term interest rate gap	-0.5	0.2	**	-0.6	0.2	***
Real credit growth	7.9	3.9	***	8.4	4.6	**
Length	9.0	8.0				
Money gap	4.4	3.8		4.1	3.8	
Synchronisation	5.2	5.6		5.0	5.7	
Inflation gap	-0.4	0.1		-0.9	-0.1	**
Real aggregate asset price inflation	6.1	-0.7	***	5.6	-0.7	***

Note: The asterisks (***,** and *) denote that the null hypothesis of equal medians is rejected at the 1%, 5% and 10% level respectively on the basis of the rank-based Wilcoxon-Mann-Whitney test.

For the estimation of the logit models, we again have to reduce our sample of periods of sustained excess liquidity due to the unavailability of some relevant data in some versions of the model. We proceed with a sample of 54 periods (22 of which have been followed by an aggregate asset price boom) for which all versions of the model could be estimated. Table 9 and Table 10 present a selection of the results.

The 'univariate' models indicate that the probability of an asset price boom increases with higher real money growth, real GDP growth, real credit growth or real aggregate asset price inflation (in the four quarters before the start of the excess liquidity period) and decreases with a larger interest rate gap or a larger inflation gap. In the 'multivariate' model (2.1b) in Table 10, the coefficients of real credit growth and the long-term interest rate gap both have the expected sign, but this model performs only slightly better than the univariate model (1.5b) which only includes real credit growth. We therefore add the real aggregate asset price inflation rate in the year before the start of the excess liquidity period to obtain model (2.2b). However, the coefficient of this additional variable is not significant at the 10% level, although the model clearly performs better in predicting aggregate asset price booms. Combining this variable with the long-term interest rate gap only (model 2.3b) turns out to be the preferred multivariate model. Both coefficients are significant at the 5% level and have the correct sign. In addition, this model outperforms model (2.1b) in that it correctly predicts two more observations. Although the structure of this preferred model (2.3b) is similar to that of the preferred model (2.3) in section 5.2, the marginal effect of the retained explanatory variables at their sample mean is somewhat smaller. In addition, this model (2.3b) also has lower predictive power. While it correctly predicts 78% of the observations, model (2.3) in section 5.2 correctly predicted

92% of the observations. Although this model (2.3b) does not perform as well as the preferred model (2.3), the overall conclusion remains the same, which suggests that it is fairly robust to the distribution over time of the periods considered.

Table 9: A selection of logit models with only one explanatory variable (and a constant)

	Model (1.1b)			Model (1.2b)			Model (1.3b)			Model (1.4b)			Model (1.5b)		
	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value
Length excess liquidity period	0.09	0.02	0.18												
Inflation gap				-0.43	-0.10	0.07									
Real GDP growth							0.35	0.08	0.02						
Long-term interest rate gap										-0.88	-0.21	0.03			
Real credit growth													0.18	0.04	0.01
Correct predictions if Dep=0	26 out of 32			27 out of 32			24 out of 32			24 out of 32			28 out of 32		
Correct predictions if Dep=1	6 out of 22			6 out of 22			5 out of 22			11 out 22			11 out of 22		
Total gain (in pp) compared to the constant probability model	0.0			1.85			-5.6			5.6			13.0		

Note: The constant probability model always predicts Dep=0.

Table 10: A selection of logit models with more than one explanatory variable

	Model (2.1b)			Model (2.2b)			Model (2.3b)		
	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value	Coeff.	Marg. effect	P-value
Real credit growth	0.19	0.04	0.01	0.15	0.04	0.05			
Long-term interest rate gap	-0.98	-0.23	0.03	-1.00	-0.23	0.02	-0.98	-0.23	0.02
Real aggregate asset price inflation (before)				0.04	0.01	0.42	0.10	0.02	0.02
Correct predictions if Dep=0	27 out of 32			28 out of 32			28 out of 32		
Correct predictions if Dep=1	13 out of 22			15 out of 22			14 out of 22		
Total gain (in pp) compared to the constant probability model	14.8			20.4			18.5		

Note: The constant probability model always predicts Dep=0.

6. REAL-TIME IDENTIFICATION OF EXCESS LIQUIDITY PERIODS

The results of the *ex post* analysis reported in section 5 suggest that the combination of high money growth and strong credit expansion, low interest rates, strong real GDP growth and low inflation should be seen as signalling an increasing risk of an imminent asset price boom. While this finding is important in itself, the challenge is to make it operational for the policymaker who has to assess the economic situation in real time. More specifically, this implies that he has to estimate the various trend developments and gap measures in real time, i.e. using only information that is available to him at the time he is making an assessment of whether or not a period of sustained excess liquidity exists.

Borio and Lowe (2002; 2004) and Detken and Smets (2004) approximate such a real-time situation by calculating the gap measures recursively, i.e. by first applying the HP-filter for a starting sample and then gradually extending the window for the HP-filter quarter by quarter. In this way, the calculated money gap measure for, say, the first quarter of 1985 is obtained by using information up to the first quarter of 1985 only.

Applying these simple recursive HP-filters to our database (using the period 1970Q1-1975Q4 as the starting sample) and comparing the resulting recursive money gap estimates with the full sample cut-off level of 3.75% results in 38 periods of sustained excess liquidity. Ten of these 38 periods are new in the sense that they do not (partly) overlap with one of the 40 periods that were identified when using the full sample information. Half of the 12 full sample periods that were no longer identified as excess liquidity periods in real time are situated in the 1970s. The distribution over time of the recursively estimated periods of sustained excess liquidity in Table 11 shows that the relative weight of the 1970s periods is smaller than in the *ex post* analysis in Table 1. The dominance of the 1990s periods is confirmed, however. The table further shows that a typical recursively identified period of excess liquidity still lasts for about 6 quarters, although we now also find some very long periods of sustained excess liquidity, i.e. of more than four years.

Table 11: Distribution of the recursively estimated periods of excess liquidity over time

Midpoint	Number of periods	Length			Average money gap		
		1st quartile	Median	3rd quartile	1st quartile	Median	3rd quartile
1970-2003	38	4.0	6.0	15.0	5.0	5.7	6.2
1970-1979	7	4.0	5.0	7.0	5.1	6.0	8.2
1980-1989	12	5.8	7.5	15.0	4.6	5.4	6.1
1990-1999	17	4.0	6.0	15.0	5.0	5.8	6.1
2000-2003	2		11.0			5.3	

At first sight, this simple exercise suggests that it is not easy to correctly identify periods of sustained excess liquidity in real time. However, it should also be clear that this type of analysis most likely underestimates the policymaker's ability to extract the underlying trend in the broad money-to-GDP ratio. First, this approach assumes that the policymaker has no information about the future developments in the variables considered, which is most likely not the case even though forecasts will never be perfect. Second, this simulation exercise does not allow the policymaker to adjust his assessment of the previous quarter once new information becomes available. It therefore reduces the likelihood of correctly identifying a period of at least three consecutive quarters of excess liquidity. A full-scale real-time exercise - taking account of these issues and of further data

issues such as the publication delay and data revisions - is, however, far beyond the scope of this paper.

As argued above, the results in this section most likely paint too negative a picture about the policymaker's ability to identify the excess liquidity periods in real time. Nevertheless, this illustration suggests that it is very important to continue putting effort into forecasting monetary and economic developments in order to be able to extract the trend developments more accurately.

7. CONCLUSION

In this paper, we analysed whether a period of sustained excess liquidity can signal an aggregate asset price boom and, more specifically, under what conditions such an excess liquidity period is more likely to be followed by an asset price boom.

The fact that only about one-third of the identified periods of sustained excess liquidity has been followed by an asset price boom tends to warn against any 'naive' kind of monetary analysis. Moreover, factors such as the length of the excess liquidity period or the average money gap do not seem to matter in a systematic way.

At the same time, our analysis suggests that the periods of sustained excess liquidity that have been followed by an aggregate asset price boom can be distinguished from those periods of excess liquidity that have not. The results suggest that the combination of high money and credit growth, low interest rates, strong real GDP growth and low inflation should be seen as signalling an increasing risk of an imminent aggregate asset price boom. If the excess liquidity period is characterised by high interest rates, low real GDP growth, high inflation and exceptionally low asset price inflation, however, the risk of an imminent asset price boom seems rather low.

All in all, these results stress that there is no simple link between money and asset prices, as Gouteron and Szpiro (2005) also found. However, if one takes account of the likely non-linearities in the relationship and if one combines the information from broad monetary aggregates with that of other variables, some indication can be gained on the probability of the excess liquidity period being followed by an asset price boom. It should be stressed, however, that this analysis does not say anything about the marginal predictive power of excess liquidity, nor does it imply causality between excess liquidity and asset prices.

While our paper in no way tries to provide the best leading indicator for asset price booms, our findings do seem to support the ECB Governing Council's concern in recent years, as the strong money growth in the euro area coincided with very low interest rates and considerable asset price rises in some euro area countries.

REFERENCES

Adalid R. and C. Detken (2007), *Liquidity shock and asset price boom/bust cycles*, ECB, working paper 732.

Borio C.E.V., N. Kennedy and S.D. Prowse (1994), *Exploring aggregate asset price fluctuations across countries. Measurement, determinants and monetary policy implications*, BIS, economic papers 40.

Borio C. and P. Lowe (2002), *Asset prices, financial and monetary stability: exploring the nexus*, BIS, working paper 114.

Borio C. and P. Lowe (2004), *Securing sustainable price stability: should credit come back from the wilderness?*, BIS, working paper 157.

Detken C. and F. Smets (2004), *Asset price booms and monetary policy*, ECB, working paper 364.

Gouteron S. and D. Szpiro (2005), *Excès de liquidité monétaire et prix des actifs,* Banque de France, note d'études et de recherche 131.

Greene W.H. (1993), *Econometric analysis*, New York, United States, Macmillan Publishing Company.

Issing O. (ed.) (2003), *Background studies for the ECB's evaluation of its monetary policy strategy*, Frankfurt am Main, Germany, European Central Bank.

White W.R. (2006), *Is price stability enough?*, BIS, working paper 205.

ANNEX - DATA SOURCES

The paper is based on quarterly data. The period covered is 1970Q1 (whenever possible) until 2005Q4. We consider 18 industrial countries, namely Australia, Belgium, Canada, Denmark Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Data on the real aggregate asset price indices (deflated by consumer prices) have been kindly supplied by Steve Arthur from the BIS. These indices are the weighted average of three sub-indices (for equity, residential property, and commercial property prices) whenever available, the weight being the actual share of the asset components in the respective economy. The underlying methodology is described in detail in Borio, Kennedy and Prowse (1994).

For the other variables used in the analysis, various databases have been combined in order to obtain a consistent dataset for the period covered. These data sources are: the BIS, the IMF's International Financial Statistics (IFS), Eurostat, the OECD Economic Outlook, the ECB, as well as National Statistical Institutes when no other source was available.

Data for broad money and for credit to the private sector are taken from the IFS, codes 34+35 and 32d respectively. For the euro area countries, data from 1997Q4 onwards have been reconstructed on the basis of detailed flow data from the ECB in order to match the IFS definitions.

Data for interest rates are mainly from the BIS database, supplemented with data from the OECD, the IFS and national sources (when no other source was available).

Data for consumer prices are from the BIS, except for EU countries since the 1990s, where we used Eurostat's HICP data instead. For Australia, national data are used.

Data for GDP are mainly from the OECD, in some cases supplemented by data from the BIS.

When series showed significant structural breaks as indicated by a TRAMO application, breaks have been corrected one by one, either by using alternative sources, estimates or interpolations, or on a judgmental basis.

NATIONAL BANK OF BELGIUM - WORKING PAPERS SERIES

1. "Model-based inflation forecasts and monetary policy rules" by M. Dombrecht and R. Wouters, *Research Series*, February 2000.
2. "The use of robust estimators as measures of core inflation" by L. Aucremanne, *Research Series*, February 2000.
3. "Performances économiques des Etats-Unis dans les années nonante" by A. Nyssens, P. Butzen, P. Bisciari, *Document Series*, March 2000.
4. "A model with explicit expectations for Belgium" by P. Jeanfils, *Research Series*, March 2000.
5. "Growth in an open economy: some recent developments" by S. Turnovsky, *Research Series*, May 2000.
6. "Knowledge, technology and economic growth: an OECD perspective" by I. Visco, A. Bassanini, S. Scarpetta, *Research Series*, May 2000.
7. "Fiscal policy and growth in the context of European integration" by P. Masson, *Research Series*, May 2000.
8. "Economic growth and the labour market: Europe's challenge" by C. Wyplosz, *Research Series*, May 2000.
9. "The role of the exchange rate in economic growth: a euro-zone perspective" by R. MacDonald, *Research Series*, May 2000.
10. "Monetary union and economic growth" by J. Vickers, *Research Series*, May 2000.
11. "Politique monétaire et prix des actifs: le cas des Etats-Unis" by Q. Wibaut, *Document Series*, August 2000.
12. "The Belgian industrial confidence indicator: leading indicator of economic activity in the euro area?" by J.-J. Vanhaelen, L. Dresse, J. De Mulder, *Document Series*, November 2000.
13. "Le financement des entreprises par capital-risque" by C. Rigo, *Document Series,* February 2001.
14. "La nouvelle économie" by P. Bisciari, *Document Series*, March 2001.
15. "De kostprijs van bankkredieten" by A. Bruggeman and R. Wouters, *Document Series*, April 2001.
16. "A guided tour of the world of rational expectations models and optimal policies" by Ph. Jeanfils, *Research Series*, May 2001.
17. "Attractive Prices and Euro - Rounding effects on inflation" by L. Aucremanne and D. Cornille, *Documents Series*, November 2001.
18. "The interest rate and credit channels in Belgium: an investigation with micro-level firm data" by P. Butzen, C. Fuss and Ph. Vermeulen, *Research series*, December 2001.
19. "Openness, imperfect exchange rate pass-through and monetary policy" by F. Smets and R. Wouters, *Research series*, March 2002.
20. "Inflation, relative prices and nominal rigidities" by L. Aucremanne, G. Brys, M. Hubert, P. J. Rousseeuw and A. Struyf, *Research series*, April 2002.
21. "Lifting the burden: fundamental tax reform and economic growth" by D. Jorgenson, *Research series*, May 2002.
22. "What do we know about investment under uncertainty?" by L. Trigeorgis, *Research series*, May 2002.
23. "Investment, uncertainty and irreversibility: evidence from Belgian accounting data" by D. Cassimon, P.-J. Engelen, H. Meersman, M. Van Wouwe, *Research series*, May 2002.
24. "The impact of uncertainty on investment plans" by P. Butzen, C. Fuss, Ph. Vermeulen, *Research series*, May 2002.
25. "Investment, protection, ownership, and the cost of capital" by Ch. P. Himmelberg, R. G. Hubbard, I. Love, *Research series*, May 2002.
26. "Finance, uncertainty and investment: assessing the gains and losses of a generalised non-linear structural approach using Belgian panel data", by M. Gérard, F. Verschueren, *Research series*, May 2002.
27. "Capital structure, firm liquidity and growth" by R. Anderson, *Research series*, May 2002.
28. "Structural modelling of investment and financial constraints: where do we stand?" by J.- B. Chatelain, *Research series*, May 2002.
29. "Financing and investment interdependencies in unquoted Belgian companies: the role of venture capital" by S. Manigart, K. Baeyens, I. Verschueren, *Research series*, May 2002.
30. "Development path and capital structure of Belgian biotechnology firms" by V. Bastin, A. Corhay, G. Hübner, P.-A. Michel, *Research series*, May 2002.
31. "Governance as a source of managerial discipline" by J. Franks, *Research series*, May 2002.

32. "Financing constraints, fixed capital and R&D investment decisions of Belgian firms" by M. Cincera, *Research series*, May 2002.
33. "Investment, R&D and liquidity constraints: a corporate governance approach to the Belgian evidence" by P. Van Cayseele, *Research series*, May 2002.
34. "On the Origins of the Franco-German EMU Controversies" by I. Maes, *Research series*, July 2002.
35. "An estimated dynamic stochastic general equilibrium model of the Euro Area", by F. Smets and R. Wouters, *Research series*, October 2002.
36. "The labour market and fiscal impact of labour tax reductions: The case of reduction of employers' social security contributions under a wage norm regime with automatic price indexing of wages", by K. Burggraeve and Ph. Du Caju, *Research series*, March 2003.
37. "Scope of asymmetries in the Euro Area", by S. Ide and Ph. Moës, *Document series*, March 2003.
38. "De autonijverheid in België: Het belang van het toeleveringsnetwerk rond de assemblage van personenauto's", by F. Coppens and G. van Gastel, *Document series*, June 2003.
39. "La consommation privée en Belgique", by B. Eugène, Ph. Jeanfils and B. Robert, *Document series*, June 2003.
40. "The process of European monetary integration: a comparison of the Belgian and Italian approaches", by I. Maes and L. Quaglia, *Research series*, August 2003.
41. "Stock market valuation in the United States", by P. Bisciari, A. Durré and A. Nyssens, *Document series*, November 2003.
42. "Modeling the Term Structure of Interest Rates: Where Do We Stand?, by K. Maes, *Research series*, February 2004.
43. Interbank Exposures: An Empirical Examination of System Risk in the Belgian Banking System, by H. Degryse and G. Nguyen, *Research series*, March 2004.
44. "How Frequently do Prices change? Evidence Based on the Micro Data Underlying the Belgian CPI", by L. Aucremanne and E. Dhyne, *Research series*, April 2004.
45. "Firms' investment decisions in response to demand and price uncertainty", by C. Fuss and Ph. Vermeulen, *Research series*, April 2004.
46. "SMEs and Bank Lending Relationships: the Impact of Mergers", by H. Degryse, N. Masschelein and J. Mitchell, *Research series*, May 2004.
47. "The Determinants of Pass-Through of Market Conditions to Bank Retail Interest Rates in Belgium", by F. De Graeve, O. De Jonghe and R. Vander Vennet, *Research series*, May 2004.
48. "Sectoral vs. country diversification benefits and downside risk", by M. Emiris, *Research series*, May 2004.
49. "How does liquidity react to stress periods in a limit order market?", by H. Beltran, A. Durré and P. Giot, *Research series*, May 2004.
50. "Financial consolidation and liquidity: prudential regulation and/or competition policy?", by P. Van Cayseele, *Research series*, May 2004.
51. "Basel II and Operational Risk: Implications for risk measurement and management in the financial sector", by A. Chapelle, Y. Crama, G. Hübner and J.-P. Peters, *Research series,* May 2004.
52. "The Efficiency and Stability of Banks and Markets", by F. Allen, *Research series*, May 2004.
53. "Does Financial Liberalization Spur Growth?" by G. Bekaert, C.R. Harvey and C. Lundblad, *Research series*, May 2004.
54. "Regulating Financial Conglomerates", by X. Freixas, G. Lóránth, A.D. Morrison and H.S. Shin, *Research series*, May 2004.
55. "Liquidity and Financial Market Stability", by M. O'Hara, *Research series*, May 2004.
56. "Economisch belang van de Vlaamse zeehavens: verslag 2002", by F. Lagneaux, *Document series*, June 2004.
57. "Determinants of Euro Term Structure of Credit Spreads", by A. Van Landschoot, *Research series*, July 2004.
58. "Macroeconomic and Monetary Policy-Making at the European Commission, from the Rome Treaties to the Hague Summit", by I. Maes, *Research series*, July 2004.
59. "Liberalisation of Network Industries: Is Electricity an Exception to the Rule?", by F. Coppens and D. Vivet, *Document series*, September 2004.
60. "Forecasting with a Bayesian DSGE model: an application to the euro area", by F. Smets and R. Wouters, *Research series*, September 2004.
61. "Comparing shocks and frictions in US and Euro Area Business Cycle: a Bayesian DSGE approach", by F. Smets and R. Wouters, *Research series*, October 2004.

62. "Voting on Pensions: A Survey", by G. de Walque, *Research series*, October 2004.
63. "Asymmetric Growth and Inflation Developments in the Acceding Countries: A New Assessment", by S. Ide and P. Moës, *Research series*, October 2004.
64. "Importance économique du Port Autonome de Liège: rapport 2002", by F. Lagneaux, *Document series*, November 2004.
65. "Price-setting behaviour in Belgium: what can be learned from an ad hoc survey", by L. Aucremanne and M. Druant, *Research series,* March 2005.
66. "Time-dependent versus State-dependent Pricing: A Panel Data Approach to the Determinants of Belgian Consumer Price Changes", by L. Aucremanne and E. Dhyne, *Research series*, April 2005.
67. "Indirect effects – A formal definition and degrees of dependency as an alternative to technical coefficients", by F. Coppens, *Research series,* May 2005.
68. "Noname – A new quarterly model for Belgium", by Ph. Jeanfils and K. Burggraeve, *Research series*, May 2005.
69. "Economic importance of the Flemish maritime ports: report 2003", F. Lagneaux, *Document series*, May 2005.
70. "Measuring inflation persistence: a structural time series approach", M. Dossche and G. Everaert, *Research series*, June 2005.
71. "Financial intermediation theory and implications for the sources of value in structured finance markets", J. Mitchell, *Document series*, July 2005.
72. "Liquidity risk in securities settlement", J. Devriese and J. Mitchell, *Research series*, July 2005.
73. "An international analysis of earnings, stock prices and bond yields", A. Durré and P. Giot, *Research series*, September 2005.
74. "Price setting in the euro area: Some stylized facts from Individual Consumer Price Data", E. Dhyne, L. J. Álvarez, H. Le Bihan, G. Veronese, D. Dias, J. Hoffmann, N. Jonker, P. Lünnemann, F. Rumler and J. Vilmunen, *Research series*, September 2005.
75. "Importance économique du Port Autonome de Liège: rapport 2003", by F. Lagneaux, *Document series,* October 2005.
76. "The pricing behaviour of firms in the euro area: new survey evidence, by S. Fabiani, M. Druant, I. Hernando, C. Kwapil, B. Landau, C. Loupias, F. Martins, T. Mathä, R. Sabbatini, H. Stahl and A. Stokman, *Research series*, November 2005.
77. "Income uncertainty and aggregate consumption, by L. Pozzi, *Research series*, November 2005.
78. "Crédits aux particuliers - Analyse des données de la Centrale des Crédits aux Particuliers", by H. De Doncker, *Document series*, January 2006.
79. "Is there a difference between solicited and unsolicited bank ratings and, if so, why?" by P. Van Roy, *Research series*, February 2006.
80. "A generalised dynamic factor model for the Belgian economy - Useful business cycle indicators and GDP growth forecasts", by Ch. Van Nieuwenhuyze, *Research series*, February 2006.
81. "Réduction linéaire de cotisations patronales à la sécurité sociale et financement alternatif" by Ph. Jeanfils, L. Van Meensel, Ph. Du Caju, Y. Saks, K. Buysse and K. Van Cauter, *Document series*, March 2006.
82. "The patterns and determinants of price setting in the Belgian industry" by D. Cornille and M. Dossche, *Research series*, May 2006.
83. "A multi-factor model for the valuation and risk management of demand deposits" by H. Dewachter, M. Lyrio and K. Maes, *Research series*, May 2006.
84. "The single European electricity market: A long road to convergence", by F. Coppens and D. Vivet, *Document series*, May 2006.
85. "Firm-specific production factors in a DSGE model with Taylor price setting", by G. de Walque, F. Smets and R. Wouters, *Research series*, June 2006.
86. "Economic importance of the Belgian ports: Flemish maritime ports and Liège port complex - report 2004", by F. Lagneaux, *Document series*, June 2006.
87. "The response of firms' investment and financing to adverse cash flow shocks: the role of bank relationships", by C. Fuss and Ph. Vermeulen, *Research series*, July 2006.
88. "The term structure of interest rates in a DSGE model", by M. Emiris, *Research series,* July 2006.
89. "The production function approach to the Belgian output gap, Estimation of a Multivariate Structural Time Series Model", by Ph. Moës, *Research series*, September 2006.
90. "Industry Wage Differentials, Unobserved Ability, and Rent-Sharing: Evidence from Matched Worker-Firm Data, 1995-2002", by R. Plasman, F. Rycx and I. Tojerow, *Research series,* October 2006.

91. "The dynamics of trade and competition", by N. Chen, J. Imbs and A. Scott, *Research series,* October 2006.
92. "A New Keynesian Model with Unemployment", by O. Blanchard and J. Gali, *Research series,* October 2006.
93. "Price and Wage Setting in an Integrating Europe: Firm Level Evidence", by F. Abraham, J. Konings and S. Vanormelingen, *Research series,* October 2006.
94. "Simulation, estimation and welfare implications of monetary policies in a 3-country NOEM model", by J. Plasmans, T. Michalak and J. Fornero, *Research series,* October 2006.
95. "Inflation persistence and price-setting behaviour in the euro area: a summary of the Inflation Persistence Network evidence ", by F. Altissimo, M. Ehrmann and F. Smets, *Research series*, October 2006.
96. "How Wages Change: Micro Evidence from the International Wage Flexibility Project", by W.T. Dickens, L. Goette, E.L. Groshen, S. Holden, J. Messina, M.E. Schweitzer, J. Turunen and M. Ward, *Research series*, October 2006.
97. "Nominal wage rigidities in a new Keynesian model with frictional unemployment", by V. Bodart, G. de Walque, O. Pierrard, H.R. Sneessens and R. Wouters, *Research series*, October 2006.
98. "Dynamics on monetary policy in a fair wage model of the business cycle", by D. De la Croix, G. de Walque and R. Wouters, *Research series*, October 2006.
99. "The kinked demand curve and price rigidity: evidence from scanner data", by M. Dossche, F. Heylen and D. Van den Poel, *Research series*, October 2006.
100. "Lumpy price adjustments: a microeconometric analysis", by E. Dhyne, C. Fuss, H. Peseran and P. Sevestre, *Research series*, October 2006.
101. "Reasons for wage rigidity in Germany", by W. Franz and F. Pfeiffer, *Research series*, October 2006.
102. "Fiscal sustainability indicators and policy design in the face of ageing", by G. Langenus, *Research series*, October 2006.
103. "Macroeconomic fluctuations and firm entry: theory and evidence", by V. Lewis, *Research series*, October 2006.
104. "Exploring the CDS-Bond Basis" by J. De Wit, *Research series*, November 2006.
105. "Sector Concentration in Loan Portfolios and Economic Capital", by K. Düllmann and N. Masschelein, *Research series*, November 2006.
106. "R&D in the Belgian Pharmaceutical Sector", by H. De Doncker, *Document series*, December 2006.
107. "Importance et évolution des investissements directs en Belgique", by Ch. Piette, *Document series*, January 2007.
108. "Investment-Specific Technology Shocks and Labor Market Frictions", by R. De Bock, *Research series*, February 2007.
109. "Shocks and frictions in US Business cycles: a Bayesian DSGE Approach", by F. Smets and R. Wouters, *Research series*, February 2007.
110. "Economic impact of port activity: a disaggregate analysis. The case of Antwerp", by F. Coppens, F. Lagneaux, H. Meersman, N. Sellekaerts, E. Van de Voorde, G. van Gastel, Th. Vanelslander, A. Verhetsel, *Document series,* February 2007.
111. "Price setting in the euro area: some stylised facts from individual producer price data", by Ph Vermeulen, D. Dias, M. Dossche, E. Gautier, I. Hernando, R. Sabbatini, H. Stahl, *Research series,* March 2007.
112. "Assessing the Gap between Observed and Perceived Inflation in the Euro Area: Is the Credibility of the HICP at Stake?", by L. Aucremanne, M. Collin, Th. Stragier, *Research series,* April 2007.
113. "The spread of Keynesian economics: a comparison of the Belgian and Italian experiences", by I. Maes, *Research series,* April 2007.
114. "Imports and Exports at the Level of the Firm: Evidence from Belgium", by M. Muûls and M. Pisu, *Research series,* May 2007.
115. "Economic importance of the Belgian ports: Flemish maritime ports and Liège port complex - report 2005", by F. Lagneaux, *Document series*, May 2007.
116. "Temporal Distribution of Price Changes: Staggering in the Large and Synchronization in the Small", by E. Dhyne and J. Konieczny, *Research series,* June 2007.
117. "Can excess liquidity signal an asset price boom?", by A. Bruggeman, *Research series,* August 2007.