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ECONOMIC SURVEY OF THE EURO AREA 2007:

THE ROLE OF MONETARY AGGREGATES IN MONETARY POLICY

This is an excerpt of the OECD Economic Survey of the Euro Area, 2007, from the annex to chapter 2 on the role of monetary aggregates.

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The role of monetary aggregates in monetary policy

1. There is no question that central banks should monitor monetary developments and assess their implications for price stability. The monetary and economic analyses are intended to complement each other and aim to develop a deeper insight into the risks to price stability at various horizons in order to ensure that the most appropriate policy decisions are made. The ECB's two pillar strategy is one response to the difficulty of finding a single model or analytical framework which encompasses both the economic and monetary analyses in a meaningful way. Its approach is motivated by the historical evidence that money growth and inflation are closely related in the medium to long-run (ECB, 2004) and is intended to ensure policy retains a medium-term focus by reducing the chances of over-reacting to the transient impacts of shocks. One element of the ECB's monetary pillar is the reference value for M3 growth. A growth rate of M3 in excess of the reference value of 4.5% per annum is in principle regarded as signalling a risk to inflation over the medium-term, although it does not imply a mechanical policy reaction. The Bank looks at whether special factors such as portfolio shifts or financial innovation may be distorting the relationship. Moreover it takes into account a wide range of monetary indicators, including the counterparts and components of M3. It gives particular attention to M1 and private sector credit as indicators of aggregate spending (ECB, 2004).

2. The ECB is not alone in paying attention to monetary aggregates. The Bank of Canada uses a suite of models, including monetary ones; the Bank of England's *Inflation Report* starts by discussing money supply; the quarterly Monetary Policy Reports of the New Zealand, Australian and Swedish central banks regularly discuss money and credit aggregates; only the US Fed does not put any noticeable weight on the money supply, and indeed has stopped publishing M3 (but continues to publish M2). While the ECB goes further by singling out money from other indicators, giving it a special status in its "two pillar" strategy, it is difficult to say whether the differences between the ECB and other central banks are more cosmetic than real. The ECB describes monetary analysis as a "cross check" on the economic analysis to ensure that monetary policy does not overlook important information on future price trends. The Bank of Canada for example performs the same type of cross-checking with its suite of models, but does so less publicly. Ultimately, the question is what weight money should have relative to other indicators of future inflation and how its role in the decision process should be presented to the public.

3. The ECB gives several reasons for singling out money for special attention (ECB, 2004). They relate to money as a cause and as an indicator of future inflation. There is little disagreement that inflation is a monetary phenomenon in the sense that to be sustained it must be accommodated through monetary expansion. As ECB (2003) points out, money aggregates are a useful guide for day-to-day policy provided two conditions are met. First, the money supply has to be able to predict future movements in the price level. Second, the relationship between the money supply, output, and prices must be stable, or at least predictable. Of course, the same is true for any indicator that the central bank looks at. Thus, to give money a special status requires it to be better than the other variables. The ECB has given a prominent role to money partly because it believes that the money stock provides more information than other indicators about inflation at longer time horizons. In its June 2003 *Monthly Bulletin* (p. 87), it wrote:

> "An important argument in favour of adopting the two-pillar approach relates to the difference in time perspectives for analysing price developments. The inflation process can be broadly decomposed into two components, one associated with the interplay between demand and supply factors at a high frequency, and the other connected to more drawn-out and persistent trends. The latter component is empirically closely associated with the medium-term trend growth of money."

4. There have been various studies looking directly at how well monetary indicators predict inflation at different time horizons (see Masuch *et al.*, 2003 for a review). Before 2000, they tended to find that money growth and other indicators such as the monetary overhang or a *P** model helped predict future inflation and that broader aggregates such as M3 tended to work better at longer horizons. Measures of real activity such as the output gap and GDP growth tended to work better at shorter (1 to 2 year) horizons. This pattern is broadly confirmed for the 1995-2000 period in Annex 2.A2.

5. The forecasting results for 2000 to 2005 are less favourable for money. The results reported in Annex 2.A2 demonstrate that, broadly speaking, monetary indicators became less reliable while the output gap and other activity indicators improved. For example, the real-time estimate of the output gap (*i.e.* the estimate of the output gap made at the same time as the forecast) was better than money growth. This is interesting as the ECB has down-played the usefulness of the output gap, emphasising how unreliable and prone to revision the estimates can be.[1] GDP growth, industrial production and the OECD's leading indicator all generated lower forecast errors than the monetary indicators from two to four years ahead. Overall therefore, the relative performance of the monetary aggregates appears to be less impressive in the 2000s than in the second half of the 1990s. Of course, while this analysis does provide some grounds for being more circumspect about monetary indicators, it is far from conclusive. It is one type of test over a relatively short sample, and like any econometric test it may suffer from mis-specification or power problems. There are other studies that give a slightly more favourable view of the indicator properties of money in recent years. For example, Hofmann (2006), while finding that monetary indicators have become less reliable in the 2000s, shows more favourable results for the portfolio-shift-adjusted monetary indicator constructed by the ECB. Hence, in coming to an overall assessment it is best to look at results from a wide variety of statistical approaches and try to make a judgement based on the relative strengths and weaknesses of each technique.

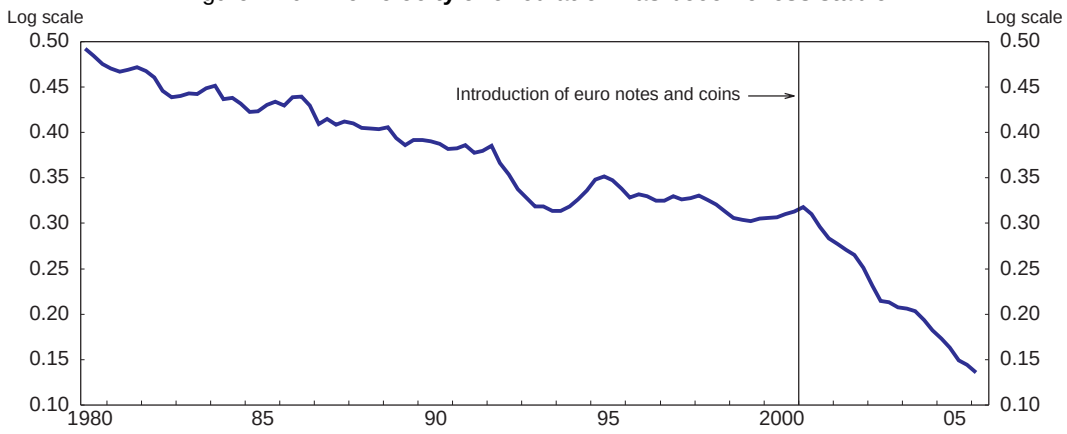
6. An alternative statistical approach, based on the view that money affects inflation over a longer time horizon, is to use frequency domain techniques.[2] Such studies typically show that the low frequency component of money has been correlated with and generally precedes the low frequency component of inflation. This provides supporting evidence that inflation is a monetary phenomenon in the long-term. However, there are drawbacks with this style of analysis as well (Rae and Bellone, 2006). First, tight correlations are usually observed only if the data is smoothed over very long periods, sometimes a decade or more.[3] Second, they are not especially robust. Different filters produce different outcomes; the results for the euro area excluding Germany are less strong than when Germany is included, suggesting that there may be something specific to one country; and the link is weaker if the 1970s are omitted. This latter

finding may be because frequency domain estimates have low power unless very long spans of data are used or it may be because the 1970s were a special case.

7. A second reason why the ECB has given more emphasis to money is that, unlike in many countries, euro area money demand functions have been relatively stable, at least until the advent of the euro (Bruggeman *et al.*, 2003). There are several reasons why (Calza and Sousa, 2003). *i*) There has been less financial innovation in the euro area and what has occurred has led to substitution towards instruments that could be considered part of the money stock and which can thus be taken care of by redefining the monetary aggregates. *ii*) Financial innovation has been especially weak in Germany, so its money demand function has been particularly stable. That has helped anchor the euro-area-wide equation. *iii*) The share of wealth held in financial assets is smaller than in other economies, so portfolio shifts between money and bond and stock mutual funds may have been less pronounced. *iv*) The different timing and speed of financial deregulation in euro area countries has spread their overall effect on the euro aggregate over time. *v*) Some of the deregulation has led to substitution within the euro area, which washes out in the aggregate. Most of these factors will play less of a role in future. Because financial innovation has been slow compared with the rest of the OECD, there may be some catching up to do. And this process will become more synchronised across countries as it is driven by the European Commission's welcome drive to create a pan-European financial market.

8. More recent evidence suggests the money demand function has indeed become less stable.[4] Simply looking at a time series of the velocity of circulation shows this clearly and explains why most econometric relationships have broken down (Figure 2.10). Some studies (for example, Greiber and Lemke, 2005) have shown that a stable M3 demand function can be restored when a measure of uncertainty is added to the specification; this variable is intended to capture the portfolio shifts observed between 2001 and 2003. Boone and van den Noord (2006) show that a stable function can be recovered if proxies for wealth, namely house and stock prices, are included. They show that all the excess M3 growth over the reference value of 4.5% per annum from 1999 to 2004 can be accounted for by the housing market. To the extent that strong money growth reflects lending for house purchases rather than being a monetary overhang, it may have few direct implications for future prices of goods and services – it represents "too much money chasing too few houses", not too much money chasing too few goods. When thought of within an asset portfolio framework, the systematic overshooting of the M3 target may not be a puzzle in a low inflation environment with credible monetary policy where money is considered to be a relatively safe asset that agents are prepared to hold more of as their housing wealth rises.

Figure 2.10. **The velocity of circulation has become less stable**



Source: ECB.

9. Third, money can be a proxy for other variables that are measured inaccurately or published with a lag. For example, narrow money is a good indicator of current activity in some countries. That may be so, but other indicators such as surveys and high-frequency data also contain useful information. This means that central bankers should extract whatever information they can from money aggregates, just like any other variable.

10. A fourth argument for paying attention to the money stock is that it can be a proxy for financial conditions more broadly. The historical experience has shown that costly asset price crashes have often been preceded by asset price booms accompanied by brisk growth of credit and money (Borio and Lowe, 2004). In the build-up to an asset price bubble, risk premia and the implicit rate at which investors discount expected future earnings may vary in unpredictable and unobservable ways. Nominal interest rates may therefore give unreliable signals if looked at in isolation. In addition, money and credit can provide information over and above the role of interest rates if imperfections in financial markets lead to borrowing and liquidity constraints, although this effect is asymmetric, operating mainly in a downturn. In this respect, Issing (2002) argues that three great monetary policy mistakes associated with asset price booms – the "roaring 1920s" in the United States, and Japan and continental Europe in the 1980s – could have been avoided if more weight had been given to the signals given by the monetary aggregates.

11. There are several responses to this argument. First, there is the historical point that the big policy mistake in those episodes was not so much the failure to lean against the boom, but the slowness to ease monetary policy after the downturn (Mishkin, 2006). Second, while paying more attention to the money supply may have helped in those episodes, there are also examples where money supply gave the wrong signal – for example, the United States in the 1990s and Germany and Switzerland for most of the period they were notionally targeting the money supply.[5] While asset price crashes were often preceded by strong monetary growth, the converse is not always the case, implying that monetary indicators have a high false alarm rate: historically, only one in three periods of excess liquidity in OECD countries has been followed by a house price boom and only one in four led to an equities boom (Posen, 2003).[6] Evidence for the euro area shows that money and credit lead house prices in just a handful of countries (IMF, 2005c). But more fundamentally, if it is asset prices that the central bank is worried about, it should respond to those directly using money and credit dynamics to help make an assessment of whether a bubble exists. In any case, if the central bank is concerned about an irrational house price bubble, it may help if it explained to the public clearly and directly that interest rates are being raised for that reason, rather than talking just about excess monetary growth. That way, it may have some chance of calming private-sector expectations and taking some of the steam out the market. Finally, it is far from obvious whether the central bank *should* lean against asset price booms unless the subsequent wealth effects and financial imbalances pose a threat to consumer price inflation. This is a hotly debated issue among central bankers (Box 2.3).

Box 2.3. Should central banks respond to asset price booms?

he question of how central banks should respond to asset price booms remains vigorously debated. Leaving aside the most extreme views (that there is no such thing as a bubble, that asset prices should form part of the price index, or they should be targeted directly), the issue is whether central bankers should try to lean against asset price booms even if there does not seem to be any threat to price stability over the medium-term.

On one side are those who argue that central banks should not try to lean against or prick bubbles but should mop up afterwards (Posen, 2006). The US Federal Reserve is in this camp. First of all, bubbles are hard to recognise. It is difficult to know whether an asset price or credit boom is justified by economic fundamentals such as a pickup in productivity growth or whether it reflects irrational exuberance by investors. Second, policymakers couldn't prick a bubble even if they were sure there was one. If a bubble is being driven by irrational expectations of higher returns, an extra 50 basis points on interest rates is unlikely to make much difference and the sort of increase in interest rates that would be required would risk driving the economy into recession. The implicit view is that the reaction to interest rate increases is discontinuous: no reaction to moderate increases, but financial collapse and recession following large increases. Third, they argue that the optimal policy is to cut interest rates aggressively after the bubble bursts. Policy

should be asymmetric because the financial transmission mechanism through which asset prices affect economic activity is asymmetric: in a downswing, credit constraints and falling collateral values act as financial multipliers. Fourth, bubbles are harmful only when the financial system is fragile, but a problem of under-capitalised banks or poor supervision should be dealt with directly.

On the other side are those who believe that central banks should lean against asset price booms, even if it means that inflation under-shoots its target for a while (Roubini, 2006). By doing so, policymakers are taking out insurance against a costly boom-bust cycle, and tighter monetary policy is the insurance premium that must be paid. The main arguments are as follows. First, the problem of being unsure whether there is a bubble is no different in principle from the sort of uncertainty that policymakers face all time. An optimal policy rule would still put weight on asset prices, although the weight would be less the greater is the uncertainty. Second, they dispute there being a discontinuous reaction to interest rate increases. In their view there are several examples where central banks have contributed to deflating asset price booms. Third, the type of boom can make a difference. Real estate busts are more costly than equity busts because bank-based financial systems, which are more exposed to real estate, tend to incur larger losses than market-based systems. A fourth argument is sometimes put forward – that an asymmetric policy creates a moral hazard problem for investors (the "Greenspan put", in which the central bank implicitly underwrites the market), but few policymakers take this argument seriously.

The ECB leans cautiously towards the view that leaning against asset price booms may be warranted in some circumstances (Trichet, 2006). It states that "allowing some short-term deviation from price stability in order to better ensure price stability over more extended horizons might – under very restrictive assumptions – be the optimal policy to follow", and this is one of the justifications for its monetary pillar, which can be used to assess "the extent to which excess creation of liquidity and over-extension of credit can be a driving force behind excessively valued assets." However, it emphasises that its strategy does not imply a "systematic reaction to asset price booms, but rather is a selective response based on the careful analysis of all available information." Moreover, the ECB stresses that it does not target asset prices or try to prick bubbles. In its view "the monetary policy instrument is too blunt to allow the type of surgical intervention that the pricking of the bubble would require," and "it is likely that the circumstances in which a policymaker will embark with confidence upon leaning against the wind policy will occur rarely."

How does the transmission mechanism work?

12. The appropriate policy response to the money aggregates depends in part on how money affects inflation – that is, on the transmission channel. The effect of money growth on the economy depends on its underlying causes, in particular whether it is demand or supply driven. As a result, there is no mechanical short-run link between money growth and the economy and, by the same token, there is no mechanical monetary policy reaction to money growth. If observed money growth were driven by an expansion of the money supply, the conventional view is that money affects inflation by first affecting real activity. The difficult question then becomes whether policy should react to money growth when it sees it, or whether it should wait until the first confirmatory signs that output is picking up. The answer will depend on the reliability of monetary signals versus the length of the lags in policy, and in particular whether waiting for output to move would be leaving it too late. This question has not been fully answered in the policy literature. Money may also operate through the asset price channel, the implications of which were discussed above. Alternatively, the broad money aggregates may be largely endogenous, responding to rather than causing economic activity. In this case, the central bank might still put some weight on the money supply as an indicator of the state of the business cycle. The issue then, as discussed above, is how reliable money aggregates are compared with other indicators.

Policy implications

13. To sum up, some recent evidence has weakened two of the rationales that were used to justify the prominence given to monetary indicators: money demand functions are less stable than they were and the leading indicator properties of money appear to have diminished. Different methods, however, can give different answers. Where does this leave us? If it is accepted that a central bank should look at everything, the issue comes down to the appropriate weight to put on money relative to other indicators and on how to communicate policy decisions when different indicators may be giving different signals. The ECB's two-pillar framework is one response to the difficulty of finding a single model or analytical framework which encompasses both the economic and monetary analyses. However, presenting monetary policy decisions to

the public within this framework, which reflects the complexity of the decision-making process, poses communication challenges. In responding to these challenges, the ECB has now achieved a high degree of predictability for its monetary policy decisions over shorter horizons. Yet other challenges remain. For example, it is sometimes argued that external observers do not know how much weight the ECB puts on money in its policy making process in practice. Many suspect it is too high. It would help if the ECB continued to enhance its communication strategy in order to be even clearer about the analysis underlying its policy assessments at any point in time. There is no perfect way of doing this, but some options for the presentation of the monetary analysis include:

- Publishing quantified, money-based medium-term inflation forecasts along with the quarterly inflation projections based on its economic analysis. The ECB went some way in this direction in recent *Monthly Bulletins* where it published forecasts for the average inflation rate over various horizons, including 2006-09. These were based on a range of money-based models and showed that the median model predicts inflation in the 2.5 to 3% range over that period.[7] However, the information could be enhanced in several ways, especially by showing how much of the inflation forecast is due to money growth compared with other factors in the model. One way to illustrate this would be to show what the models would predict if the components of money were growing at a lower rate, such as the reference rate of 4½ per cent per annum. It could also try to quantify the distribution of risks around these monetary forecasts.
- As the ECB "has developed a framework for extracting the signal in monetary developments that is relevant for policy assessments from the inevitable noise in the monthly data" (Issing, 2006), it could publish and describe this information in more meaningful ways. It periodically publishes M3 adjusted for the estimated impact of portfolio shifts, but this is not quite the same as publishing a thorough analysis of low-frequency information.

14. At the same time, the ECB could improve its communication regarding the economic analysis. For example:

- It could extend the horizon of its economic forecasts now that it uses forward market rates for its interest rate assumptions. Policy decisions at the time of writing (September 2006) must focus on the outlook for inflation in 2008 and beyond, yet forecasts for 2008 will not be published until December. Currently, the ECB publishes annual ranges for inflation and output with a short description. In the interest of further enhancing its communication, the ECB could consider publishing a more detailed analysis and reasoning behind its forecasts, although whether this would increase transparency in the context of its two-pillar strategy, where such forecasts play only a partial role in the process underlying monetary policy decisions, remains open to question.

- It could also try to quantify more precisely the risk distribution around its forecasts at various horizons, perhaps by using a "fan chart", although better alternatives could also be developed.

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ANNEX 2.A2. IS MONEY A USEFUL INDICATOR?

15. Inflation is a monetary phenomenon is the sense that, to be sustained, it must be accommodated through monetary expansion. But as the ECB points out (ECB, 2003), two conditions must be met for monetary aggregates to be a useful part of day-to-day monetary policy. First, money has to be able to predict future developments in the price level. Second, the relationship between money, output, and prices must be stable – or at least predictable. Of course, the same conditions are true for *any* indicator that the central bank may look at. Thus, to give the money supply a special status requires that it performs better than the other indicators that are available to policymakers. Indeed, the ECB has given a prominent role to money partly because of its belief that monetary growth provides information about inflation at longer time horizons than the other indicators.

16. This Annex reviews the information content of various monetary indicators, and in particular whether things have changed in the 2000s. In essence, it runs out-of-sample forecasting tests to see whether various indicators help predict future inflation. The focus is on the annual HICP inflation rate. The first step is to estimate a baseline model in which inflation is regressed on its own lags. Changes in oil prices are also included as they have had a strong influence on the headline rate of inflation over the past few years. If oil prices were omitted, it can be argued that the tests would be biased and unreliable because the "best indicator" would be the one that was correlated with oil prices, especially in the 2000s, even if this correlation was coincidental.[8] In other words, by including oil prices we implicitly assume they are exogenous with respect to the various euro area indicator variables. This is probably a reasonable assumption for most indicator variables shown below, including the monetary aggregates. While there may be a common global factor behind movements in oil prices and in the euro area monetary aggregates, the euro area should have been able to partially if not fully insulate itself from that since it has a floating exchange rate and in any case it seems implausible that a common factor would explain more than a small proportion of the co-movement between the two variables. Hence, the assumption of weak exogeneity seems to be a reasonable approximation. The exercise conducted here is similar to that of Nicoletti-Altimari (2001) in the sense that it conducts a crude "tournament" in which various indicators are assessed for their ability to predict inflation out of sample. But it differs in some of the technical details: his sample period was 1992 to 2000, he had fewer variables in the tournament, he did not condition on oil prices, he looked at average inflation rates over a particular period rather than annual rates and he estimated the optimal lag structure for each period and each indicator. Both approaches should be regarded as tests of the *minimum* requirement for the utility of an indicator variable, namely that they have predictive power in a bivariate model. A more comprehensive but much tougher test would be to add various indicators to a fully specified structural model of inflation and test their marginal predictive power.

17. The baseline model for an *n*-quarter-ahead forecast is:

$$\Delta_4 \log p_t = \alpha_0 + \alpha_1 \Delta_4 \log p_{t-n} + \alpha_2 \Delta_4 \log p_{t-(n+4)} + \alpha_3 \Delta_4 \log p_{t-(n+8)} + \beta_0 \Delta_4 \log poil_t + \beta_1 \Delta_4 \log poil_{t-4} + \beta_2 \Delta_4 \log poil_{t-8}$$

where p_t is the HICP price level and $poil_t$ is the domestic-currency oil price.

18. This equation is estimated on quarterly data from 1980 onwards. To simulate the sort of forecasting problem that policymakers face in real time, a set of rolling regressions is estimated and rolling

out-of-sample forecasts are made. Some indicator variables, such as money growth, are then added to the equation and the rolling forecasting exercise is repeated. (*i.e.* the model is estimated up to some point; post-sample forecasts are made; then the sample period is extended by another quarter and the exercise is repeated). It differs from a genuine real-time exercise in a number of ways, in particular by conditioning on oil prices. This is done to isolate the contribution that money makes to reducing forecast errors without mixing it up with the inevitable (and large) errors that were made predicting oil prices. The estimated equation for an *n*-quarter-ahead forecast then becomes:

$$\begin{aligned}\Delta_4 \log p_t = {} & \alpha_0 + \alpha_1 \Delta_4 \log p_{t-n} + \alpha_2 \Delta_4 \log p_{t-(n+4)} + \alpha_2 \Delta_4 \log p_{t-(n+8)} \\ & + \beta_0 \Delta_4 \log poil_t + \beta_1 \Delta_4 \log poil_{t-4} + \beta_2 \Delta_4 \log poil_{t-8} \\ & + \gamma_0 Z_{t-n} + \gamma_1 Z_{t-(n+4)} + \gamma_2 Z_{t-(n+8)}\end{aligned}$$

where Z_t is the indicator being tested.[9]

19. In order to see whether each indicator's predictive power has changed, the forecasting period is split into two halves: 1995 to 2000; and 2000 to 2005. The indicator variables that are tested are described below:

- Monetary indicators:
  - The growth rates of M1, M2, M3 and the ECB's estimate of M3 adjusted for portfolio shifts that are not expected to affect inflation.
  - The growth rate of lending to the private sector.
  - The monetary overhang: the difference between actual M3 money balances and their equilibrium level. This is proxied by the residuals from a simple long-run money demand equation in which real M3 depends on real output and short-term and long-term interest rates.
  - *P**: the *P** indicator is based on the quantity theory equation (MV=PY) and is defined as the long-run equilibrium price level that would result with the current money stock, provided that output was at potential and velocity was at its long-run equilibrium level (P*=MV*/Y*). It is calculated in a similar way to the monetary overhang, except that the equilibrium is calculated by substituting in the long-run or potential levels of output and velocity rather than their actual values.
- Gap or capacity indicators:
  - The output gap (from *OECD Economic Outlook* No. 79).
  - The real-time output gap, which was the estimate and forecasts of the output gap made at the relevant time period. For example, if the equation is estimated up to September 2001 the forecasts are based on the output gap that was estimated in the *OECD Economic Outlook* No. 70.
  - The unemployment gap: the unemployment rate minus the NAIRU. The latest estimate of the NAIRU is used because real-time estimates are unavailable (although they could in principle be extracted from the Kalman filter estimation process used to calculate the NAIRU).
  - Capacity utilisation in manufacturing.
- Other indicators:
  - Growth in GDP, both real-time and final estimates.
  - Growth in industrial production and equity prices.

- The OECD leading indicator.
- The slope of the yield curve.

20. The key results are summarised in Table 2.A2.1, which shows the mean absolute forecasting error of the various models. For example, the univariate baseline model had an average one-year-ahead forecast error of 0.87 percentage points over the period 1995 to 2000. Models that do better than the baseline are highlighted in bold.[10] Looking first at the period 1995 to 2000, several interesting results emerge. First, several monetary indicators do contain useful information in the sense that they reduce the inflation forecast error. The growth rate of M2 leads to a slight improvement in the forecasts at shorter horizons while M1 and especially M3 work better at longer horizons. The *P** indicator is also a good performer, but interestingly credit growth has little predictive power. Some other indicators perform about as well as the monetary aggregates. Measures of the current state of activity, such as GDP growth, industrial production and the OECD's leading indicator, tend to work better at shorter horizons. All in all, the results for the 1995 to 2000 period are broadly consistent with the view that monetary aggregates provide some useful information at longer time horizons.

Table 2.A2.1. **Inflation forecast errors**

Mean absolute out-of-sample forecast error, percentage points

	1995-2000				2000-05			
	1 year ahead	2 years ahead	3 years ahead	4 years ahead	1 year ahead	2 years ahead	3 years ahead	4 years ahead
Baseline	0.87	1.66	1.39	1.56	0.45	0.73	1.01	0.80
Monetary indicators								
M1	1.48	**1.32**	**0.86**	**1.44**	0.61	**0.71**	**0.69**	1.26
M2	**0.48**	**0.96**	1.41	3.82	0.52	0.76	**0.86**	0.87
M3	0.93	**1.23**	**0.79**	**0.61**	0.52	1.00	1.28	1.33
M3 adj. for portfolio shifts	. .	. .	. .	. .	0.54	0.95	1.27	1.41
Credit	0.94	1.82	2.31	2.07	**0.40**	0.90	1.65	2.07
Monetary overhang	0.96	**1.06**	**0.90**	**1.12**	1.05	0.81	**0.95**	0.80
p-star	**0.83**	**0.90**	**0.76**	**0.56**	1.12	1.00	**0.92**	**0.75**
Gap indicators								
Output gap	**0.62**	**1.33**	1.91	1.59	**0.40**	**0.29**	**0.48**	**0.39**
Real-time output gap	1.07	**1.41**	**1.28**	1.65	0.47	**0.66**	**0.93**	**0.75**
Unemployment gap	0.94	**1.32**	1.54	**1.42**	**0.36**	**0.28**	**0.46**	**0.55**
Capacity utilisation	1.40	2.94	1.98	3.18	0.50	1.06	1.51	2.00
Other indicators								
GDP growth	0.93	**0.89**	**0.68**	**0.64**	0.52	**0.47**	**0.64**	**0.55**
GDP growth: real time est.	**0.93**	**0.92**	**1.10**	**1.47**	0.52	**0.52**	**0.89**	0.80
Industrial production	**0.72**	**1.58**	1.61	2.08	0.49	**0.38**	**0.59**	**0.40**
OECD leading indicator	**0.76**	**1.53**	1.46	1.70	0.47	**0.37**	**0.60**	**0.40**
Business confidence	1.70	2.54	1.52	1.68	0.50	0.91	1.31	1.45
Equity prices	0.93	1.84	1.43	1.79	0.47	0.77	**0.95**	0.82
Yield curve slope	1.37	2.53	2.70	2.87	0.50	**0.70**	**0.86**	**0.32**

Note: **Boldface** is used to highlight models which are better than the baseline.

21. The situation changes to some extent in the 2000 to 2005 period. The predictive power of the broader monetary aggregates declines noticeably, except for *P** which remains useful at longer horizons. Moreover, other indicators tend to outperform the monetary indicators. The real-time estimate of the output gap and real-time GDP growth were at least as useful as money growth, while (final) GDP growth, industrial production and the OECD's leading indicator generated substantially lower forecast errors even three or four years ahead. Overall therefore, the relative performance of the monetary aggregates was much less impressive in the 2000s than in the second half of the 1990s.[11]

22. Repeating the exercise using core inflation (HICP excluding energy and unprocessed food) leads to qualitatively similar results – that monetary aggregates do reasonably well in the 1995 to 2000 period, although not noticeably better than the other indicators, but they perform very poorly in the second half of the sample. They have virtually no predictive power over any horizon in the 2000-05 period whereas various other indicators generate substantially lower forecast errors even at longer horizons.

Concluding comments

23. This Annex has presented some evidence that, conditioning on oil prices, *i*) monetary indicators may have had reasonably good predictive power in the 1995-2000 period; but *ii*) they appear to have lost much of their predictive power in the 2000s, at least so far. However, it is worth bearing in mind that these conclusions are far from definitive as they relate to a single tournament over two specific time periods. Other statistical methods can of course give different results. Varying the lag structures or eliminating the constant term for example may affect the outcomes. Moreover, the results may reflect a *temporary* decline in the usefulness of monetary aggregates due to a structural break in economic relationships with the advent of the euro or due to some other event. "Normal service" may return eventually, but it will be some time before policymakers will be able to say with confidence whether the predictive relationships have indeed reasserted themselves.

NOTES

1. The ECB emphasises that the output gap is difficult to measure, but so too is money. There is a conceptual question of what should be included in a money aggregate, and how they should be aggregated. Also, the aggregates are adjusted for portfolio shifts, but recognising and adjusting for these in real time is just as much an art as is the case of estimating the output gap.

2. For example, see Neumann and Greiber (2004), Bruggeman *et al.* (2005) and Assenmacher-Wesche and Gerlach (2006).

3. More precisely, the money-inflation correlation is high only for cycle periods of ten years and upwards.

4. See Boone and van den Noord (2006); Dreger and Walters (2006); Gerlach and Svensson (2003); Carstensen (2004); Kugler and Kaufmann (2005) and Greiber and Lemke (2005).

5. Mishkin (2006) argues that because they were comfortable missing money targets so long as inflation appeared to be on track, German and Swiss monetary policy "was actually closer in practice to inflation targeting than it was to Friedman-like monetary targeting, and thus might best be thought of as hybrid inflation targeting" (p. 500).

6. Borio and Lowe (2002) show that bubbles are correlated with long credit booms. Specifically, an early warning when both the credit-to-income ratio and real asset prices simultaneously deviate from their trends by 4 percentage points and 40% respectively would have predicted half of financial crises three years in advance, with a very low false alarm rate. The credit-to-income ratio on its own has a higher false alarm rate, reinforcing the point made later that central banks should wait until asset prices start to move before they react. For the euro area at the end of 2005, the gap between the credit-to-income ratio and its trend was around half a percentage point, well under the 4% threshold. Adalid and Detken (2006) show that a slowdown or recession following an asset price boom is likely to be more severe if there was excess M3 growth (but not excess credit growth) during the boom phase. However, the interpretation of this result is complicated by the finding that excess credit growth does not affect the size of the slowdown after the boom. This begs questions about the transmission mechanism.

7. The M3 model has predicted HICP inflation reasonably well from 2002 to 2004, which in some ways is worrying. Oil prices and administered prices clearly played an important role over that period, and they are not driven by the euro area monetary aggregates, suggesting that at least part of the models' good performance is fortuitous.

8. In a recent paper, Hofmann (2006) performs a similar exercise to the one conducted here except he does not take account of energy prices. That may partly explain why his results are slightly more favourable to M3 adjusted for portfolio shifts, although his basic results are broadly consistent with the conclusions of this Annex in that they find some deterioration in predicting power in the 2000s. He concludes that a broad based monetary analysis is needed to extract the information content of monetary developments.

9. Implicitly this formulation assumes perfect foresight regarding oil prices, or equivalently it eliminates forecast errors stemming from energy prices in order to focus on the remaining predictive errors that are of primary interest here. Repeating the exercise without oil prices leads to a very poor performance of the equations that include monetary indicators. Note also that a constant term has been included and the coefficients on the lagged dependent variable are not restricted to sum to one because this is a simple bivariate forecasting equation rather than a structural model of inflation.

10. Differences in forecast accuracy were assessed using the Diebold-Mariano test. In general, however, the test had low power to discriminate between models at conventional significance levels because the number of independent observations was low.

11. Comparing mean errors rather than absolute errors can give a measure of average forecast bias. These results, which are not reported here, show that the money aggregates tended to reduce the forecast bias in the 1995 to 2000 period but in the 2000 to 2005 period they led to considerably more biased forecasts (over-predicting) relative to the other indicators for horizons of two years ahead and longer.

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